Appendix 5A – Data Utilized in WatershedMVP

The fundamental goal of the 208 Plan Update, and the local planning consistent with this update, is the reduction of watershed nitrogen load to achieve the threshold identified by the total maximum daily load (TMDL). Present watershed nitrogen load and threshold nitrogen load are the critical information needed to develop nitrogen reduction scenarios. The present watershed load includes the total controllable nitrogen load which consists of septic, wastewater from treatment plants, fertilizer, and stormwater.

This information is available as unattenuated nitrogen loads in the Massachusetts Estuaries Project (MEP) reports and the Final TMDL reports (if published). Geographically linked data is not available in these reports. Each MEP report was completed in different years and, in some cases, the water use data utilized is now greater than 10 years old. In addition, the MEP methodology changed from one report to another over the course of the 13 year project. The data disks associated with the MEP reports are difficult to extract data from and similar data is not available through MEP for those watersheds where a report has not been completed.

Given these issues, it is difficult to link the underlying MEP data to a regionally consistent database, which is necessary in order to look at solutions to nitrogen impacts Cape-wide. We must be able to consider new data as it is available. In 2010, the Commission sought to collect regionally consistent data for the purposes of scenario development. The primary sources for this effort are parcel data and water use data, both of which have been collected for the entire region. Three years of water use data was averaged for each parcel and used to calculate the septic nitrogen load in WatershedMVP (wMVP).

WatershedMVP is an innovative, web-based, scenario planning tool developed by the Commission that allows the user to compare various wastewater treatment options at scales ranging from the neighborhood to the sub region in a geographic information systems (GIS) environment. It presents parcel-based data and calculations for land use, water use and build-out that allow the user to quickly select and evaluate wastewater treatment options by providing comparative nitrogen removal and cost analyses for different approaches.

The data provided in wMVP may differ from the data utilized by the MEP model to determine nitrogen loading to Cape Cod embayments. Achieving the nitrogen loading thresholds identified by MEP and in the TMDL reports is the paramount goal; however, given changes in land and water use, the identification of strategies necessary to meet that threshold may change.

The following is a list of potential reasons for the differences in nitrogen loading between MEP and wMVP:

1. WatershedMVP reflects updated water use since MEP technical reports were published.

2. WatershedMVP provides reasonable estimates of water use to parcels that do not have actual water use data.
3. WatershedMVP assigns some parcel loads to different watersheds (i.e. parcels split by sub-watershed boundaries)
4. WatershedMVP double counts some parcels connected to private sewer.
5. WatershedMVP reflects permitted effluent concentrations for municipal facilities that may be achieving lower actual effluent concentrations.
6. MEP loads are calibrated to embayment nitrogen concentrations; wMVP database is not calibrated.
7. Potential database errors (data source errors, data entry errors, other)

As with any model, wMVP operates within a range of precision. However, it is flexible enough to accommodate new data as it becomes available and it allows for user discretion in many instances during the scenario building process. The following provides more details on each of the potential reasons for differences between wMVP and MEP and outlines the importance of using a flexible, data-driven tool moving forward.

1. WatershedMVP reflects updated water use since MEP technical reports were published.

One of the biggest benefits of wMVP is that the entire region is query able and the water use data for every parcel has been updated to the most currently available water use. Every parcel's land use data in wMVP is from 2010-2012, depending on the town. Each of these parcels has water use data from 2008-2011 attached to it, depending on the water district. To illustrate this, examine the table below, which shows the ten embayments with the highest differentials between wMVP and MEP:

Embayment	Year of WU in MEP	Year of WU in wMVP
Green Pond	2002-2003	2008-2010
Little Pond	2001-2003	2008-2010
Oyster Pond	2001-2003	2008-2010
PhinneysBack River	2002-2004	2010
Popponesset Bay	1997-2000	2008-2011
Stage Harbor	2000-2001	2008-2010
Sulfur Springs Bucks Creek	2000-2001	2008-2010
Taylors Creek	2000-2001	2008-2010
Waquoit Bay	2007-2010	2008-2010
West Falmouth Harbor	2001-2003	2008-2010

The benefit of wMVP is that it allows for regional consistency and current data to be used for current model runs. This data is housed regionally in a transparent database that can be updated if newer data becomes available.

2. WatershedMVP provides reasonable estimates of water use for parcels that do not have actual water use data.

For every parcel that does not have an actual water use value, the model needs to assume a value. There are two instances that might cause this to happen:

1. The parcel has its own well and is not hooked up to a water district to obtain its water.
2. The water use table was not able to find a corresponding link in the parcel table. This may be caused by inconsistent parcel IDs or parcel addresses.

WatershedMVP assigns three possible values (based on land use) to a parcel that does not have a water use record. If the parcel is residential, it is assigned the average residential water use of the town it is in. If it is commercial or industrial it is assigned a regional coefficient for those two land uses.

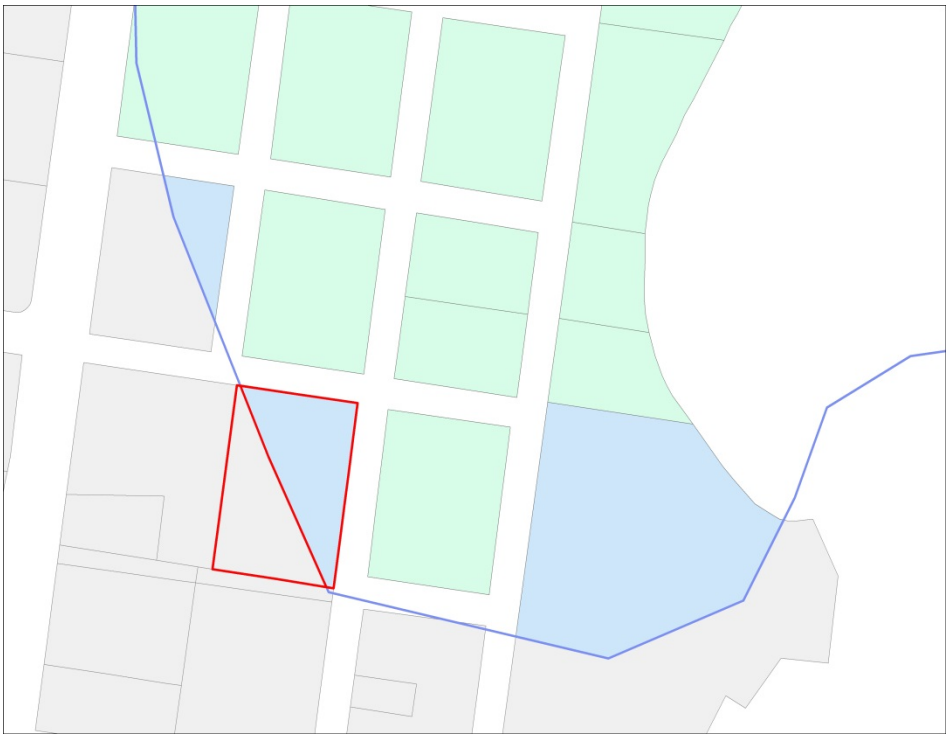
Embayment	WU coefficient Residential MEP	WU coefficient Residential wMVP	WU coefficient Commercial MEP	WU coefficient Commercial wMVP	WU coefficient Industrial MEP	WU coefficient Industrial wMVP	
Green Pond	151	155.12	$122/1000^2$	799	$112/1000^2$	1108	
Little Pond	102	155.12	$141/1000^2$	799	-	1108	
Oyster Pond	209	155.12	-	799	-	1108	
Phinneys/Back River	182	157.21	$21/1000^2$	799	$21/1000^2$	1108	
Popponesset Bay	154	147.45	$81.5/1000^2$	799	$81.5/1000^2$	1108	
Stage Harbor	154	138.08	580	799	522	1108	
Sulfur Springs/Bucks Creek	154	138.08	580	799	522	1108	
Taylors Creek	154	138.08	580	799	522	1108	
Waquoit Bay	135	155.12	$74/1000^2$	799	$21/1000^2$	1108	
West Falmouth Harbor	126	155.12	$18/1000^2$	799	-	1108	
							all values gpd

The benefits of wMVP include regional consistency and data that is housed in a transparent and flexible database. wMVP allows a user to exert his or her discretion in modifying water use information in areas where the database value may not be practical.

3. WatershedMVP assigns some parcel loads to different watersheds (i.e. parcels split by sub-watershed boundaries).

WatershedMVP will assigns parcels to different subwatersheds and/or embayments than MEP. MEP very carefully assigns and splits every parcel that intersects the subwatershed boundary to be either included or excluded from that subwatershed. wMVP does not perform this kind of analysis. As wMVP works on points, the parcel's data is coded on a point that is located in the parcel's center. Therefore, a parcel is considered included in a subwatershed if its point is within the subwatershed boundary.

Please examine the graphic below from Waquoit Bay to see the difference.



The figure above depicts parcels (grey) in Waquoit Bay. The subwatershed boundary is a blue line. MEP has the green parcels as fully in the subwatershed and thus their water use is counted towards that subwatershed's total. MEP has the blue parcels as split parcels. Only the red outline parcel's values are added to the subwatershed's total.

This figure depicts the same parcels. wMVP uses points to store a parcel's data. All the points in red are within the subwatershed and their parcel's data is added to the subwatersheds total.

Note: the two split parcels at the bottom of the subwatershed. The left parcel made it into the subwatershed in MEP and in wMVP. The right parcel did not make it into the subwatershed in MEP but it did in wMVP.

The benefit of the wMVP approach is that it allows the mapping application to select parcels and perform algorithms on those parcels very quickly. However, MEP includes a more thorough examination of parcels to determine which ones contribute to a subwatershed.

4. WatershedMVP double counts some parcels connected to private sewer.

WatershedMVP has coded every parcel in the region as a septic parcel, a sewered parcel or a Groundwater Discharge Permit (GWDP) parcel. Parcels in wMVP are coded with the data that is currently available to the Commission. However, there could be a situation where a private GWDP parcel is discharging effluent from a group of parcels coded as septic because we do not have data that identifies them as a sewered parcel; therefore, a subwatershed load could be double counting load from those associated parcels whose effluent is collected and treated in the GWDP parcel's effluent.

The potential for this scenario is less likely than some of the other reasons identified as possibly causing differences. Staff has identified and corrected the issue for several watersheds that have a number of private treatment facilities (ex. Popponesset). WatershedMVP is transparent and adaptable so that

treatment values on a particular parcel can be modified as we become aware of data that is not presently included.

5. WatershedMVP reflects permitted effluent concentrations for municipal facilities that may be achieving lower actual effluent concentrations.

This is a potential issue; however we have made every attempt to accurately reflect the municipally treated effluent.

The Commission has found that many embayment water use discrepancies can be attributed to values found in the Groundwater Discharge Permit parcels, as described above. This may be a result of different reported discharge rates and/or new permit requirements that are not reflected in the MEP report or the wMVP model. In some cases there have been upgrades to treatment facilities since the MEP reports were completed. The MEP used a nitrogen concentration of 10 ppm for the West Falmouth Harbor treatment facility, which has since been upgraded and permitted to treat to a concentration of 3 ppm.

With the transparency available with wMVP, we have the ability to minimize this difference by continuously updating the database to reflect new information. We will continue to seek new data and hope to receive input on the data used in the model and commit to updating it as necessary.

6. MEP loads are calibrated to embayment nitrogen concentrations; wMVP database is not calibrated.

The WatershedMVP nitrogen loads are not calibrated to the embayment nitrogen concentrations. This calibration is one of the proprietary components of the MEP process and wMVP has no ability to calibrate to these sources.

WatershedMVP does not replicate the MEP process. The benefits of wMVP are in its portability and its transparency. wMVP is a regionally consistent tool used to generate planning scenarios based on land use and updated water use . It is expected that the conceptual WMVP solutions will be further assessed through a subsequent design engineering stage and, if required, it is recommended that the results be confirmed through modeling.

7. Potential database errors (data source errors, data entry errors, other)

Systematic reasons that data may differ between models include errors in the parcel/assessor data, water use data, and the process of matching the two. The parcel/assessor data can change over time; therefore, the assessor data for a parcel may have changed since the time the MEP report was completed. A parcel can be coded as an undeveloped residential one year and a developed residential the next. A parcel can change from residential to commercial or vice versa. In addition, water use can change over time; as houses change hands water use values can increase or decrease.

The most significant factor can be the matching process. Record keepers from water districts handle their own billing and do not coordinate with a town's assessors' department, which handle their own billing. Many water districts bill by address and do not rely on about assessor's map and parcel ID. If

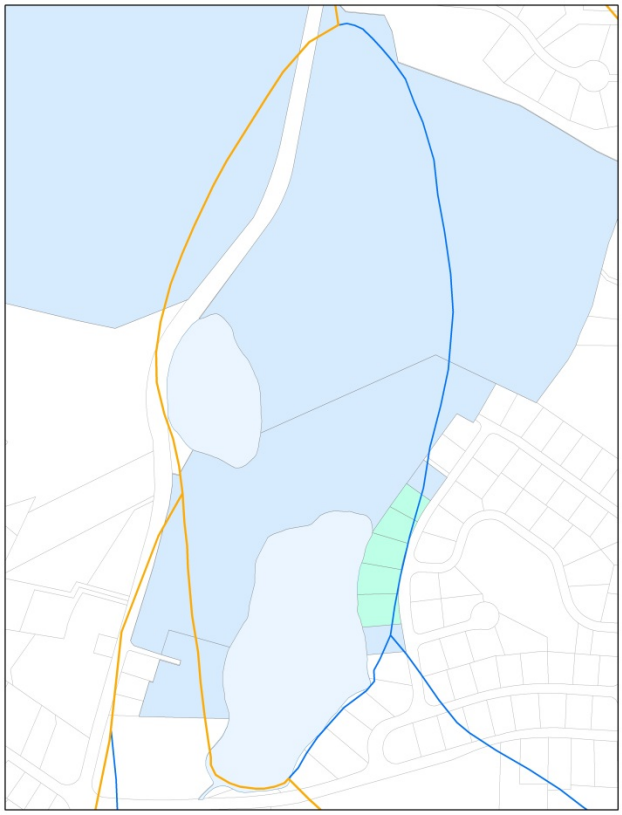
addresses from the water department and addresses from the assessor do not match then water use values cannot be accurately transferred from the water use data table to the assessor/land use table. This discrepancy may be a factor in both models. MEP might not have had a 100% match rate when the analyst did their match and wMVP didn't have a 100% match when its database was created.

Knowing that errors are in both models, the transparency of wMVP allows the database to be queried and corrected very quickly as these errors are identified.

The Jones Pond Example

Using one subwatershed as an example, we can show how a number of the reasons for differences in data can be compounded to create a large mismatch between MEP and wMVP. Please examine the Jones Pond subwatershed within the Little Pond embayment.

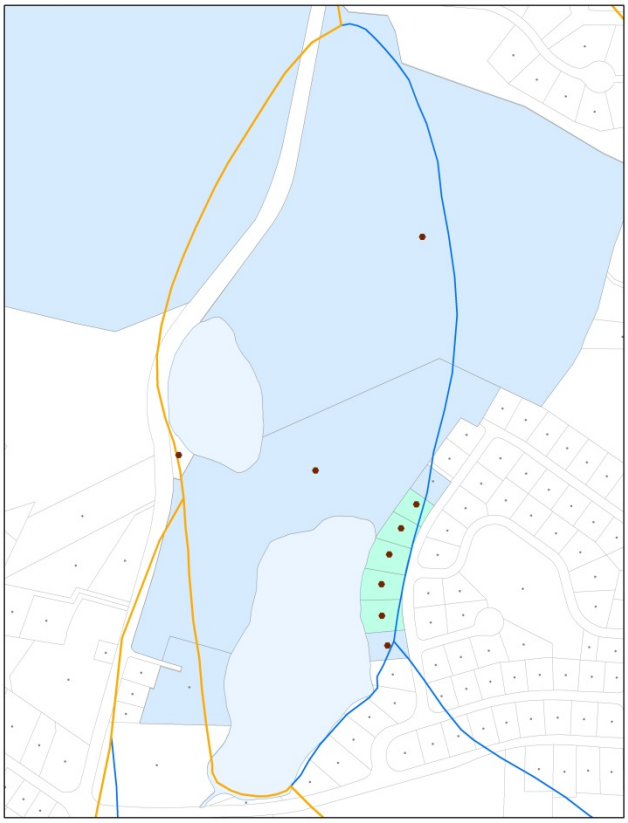
MEP Perspective:



The map above has a similar color scheme as the example from Waquoit Bay previously. In this subwatershed, MEP has taken the wateruse for eleven parcels. This eleven includes five whole parcels in green and six split parcels in blue. There are two ponds located in the subwatershed as well. Surrounding parcels are depicted in gray outlines. For simplicity, this table shows water use claimed:

Whole Parcels	MEP WaterUse
1	128.08
2	27.67
3	308.44
4	309.48
5	314.60
Split Parcels	
1	146.55
2	424.25
3	12652.30
4	0.00
5	148.58
6	43.04
Total	14502.99

WatershedMVP Perspective:



This map highlights the parcel centroids that watershedMVP has taken for water use in Jones Pond. wMVP takes water use from nine parcels. wMVP does not differentiate between whole and split; the parcel centroid is either in or out. For simplicity, this table shows wateruse values in wMVP:

Parcels	wMVP WaterUse
1	0.00
2	50.68
3	228.08
4	263.01
5	173.29
6	255.48
7	0.00
8	315.75
9	27.40
Total	1313.69

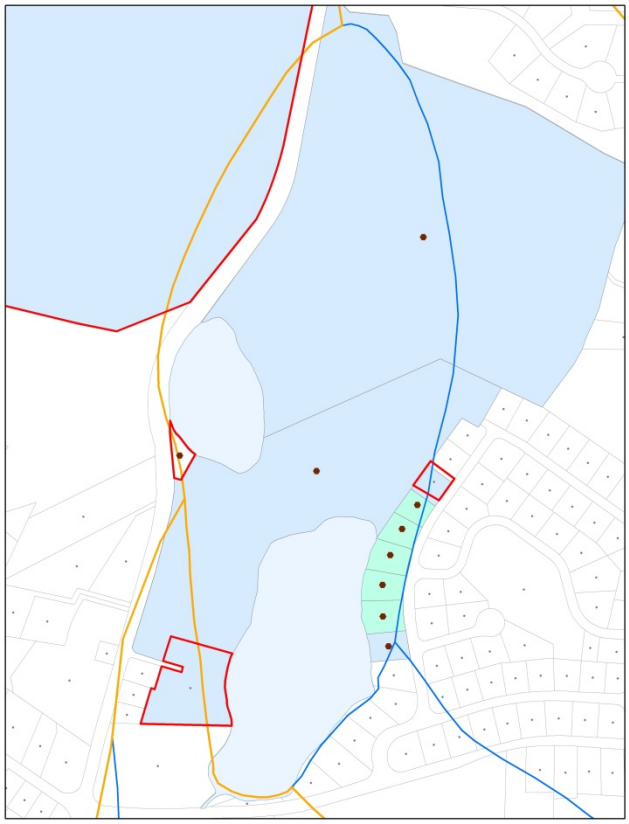
There is a large difference in water use between the two watersheds. Let's examine three factors that, in combination, lead to this discrepancy.

Water use numbers are updated from 2001-2003 to 2008-2010. If we solely look at the five parcels that are wholly claimed by MEP (in green) and compare their numbers to wMVP.

Whole Parcels	MEP WaterUse	wMVP WaterUse
1	128.08	173.29
2	27.67	50.68
3	308.44	315.75
4	309.48	255.48
5	314.60	228.08

Besides the third parcel, there have been changes to each parcel's water use.

Watershed parcel counts are different. Notice that MEP counted three parcels as split that wMVP is not considering "in" the subwatershed. These include a portion of a very large parcel in the northwest; a parcel to the southwest; and one of the residential lot parcels in the east. However, wMVP did capture a parcel that MEP did not; a small parcel below the pond in the center west. These are highlighted in red below.



This has a combined effect of a difference of 12947.43 gpd.

This last point brings up our third issue. The southwestern parcel that MEP counted as a split parcel and wMVP did not count at all is a Groundwater Discharge Permit. These GWDPs are parcels that are permitted to discharge larger amounts of wastewater directly to the groundwater by the State. In the below diagram, embayment boundaries are depicted in orange and subwatershed boundaries are in blue.

MEP has attributed this parcel as being part of the Jones Pond subwatershed within the Little Pond Embayment. wMVP has this parcel attributed to the Morse Pond subwatershed of the Falmouth Inner Harbor. So not only are the loads for Jones Pond not going to match up between MEP and wMVP for Jones Pond, they will not match for Morse Pond subwatershed and for the Little Pond and Falmouth Inner Harbor embayments.

Fortunately, there is not a discrepancy between water use at the GWDP. Sometimes, there may be a difference between what MEP used as a reported flow and the design flow that wMVP uses, if wMVP does not have a reported flow.

	MEP WaterUse	wMVP WaterUse
GWDP	12652.3	12485.62

This one subwatershed should begin to paint the picture of where discrepancies lie across all the subwatersheds in the region. For many watersheds, differences between MEP and wMVP data end up being caused by a combination of many of the points discussed in this document.