

APPENDIX A
NITRATE DILUTION ANALYSES

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I. Introduction

In January 2014, P.L. 2011, c. 203, was amended, supplemented and enacted as P.L. 2013, c. 188 (hereafter P.L. 2013, c.188), modifying the WQM Planning process. P.L. 2013, c.188 shall expire on January 17, 2016, or upon the reauthorization and adoption of WQM Planning rules N.J.A.C 7:15 et. seq.), whichever may come first. Particularly relevant to the review of Wastewater Management Plans (WMP) by the Department, Section 9 provides that upon adoption of the designation of a sewer service area pursuant to the WQM Planning rules, portions of the WMP may be submitted for review and subsequent adoption, in phases in a sequential or other manner deemed timely or expedient by the Department.

This WMP only includes for adoption those nitrate dilution analyses which comply with N.J.A.C. 7:15-5.25(e)iv –v. The analyses in this Appendix do not include an adjustment to the zoning in order to achieve consistency between zoning and the allowable number of additional equivalent dwelling units at build-out in the undeveloped and underdeveloped areas, therefore, they do not comply with N.J.A.C. 7:15-5.25(e)iv –v, and are not included in the WMP for adoption. However, as the analyses were required to be completed, they have been included in this Appendix to inform future planning efforts.

This document (Appendix “A”) describes the nitrate dilution analyses methods and results for Alloway Township, Carneys Point Township, Elmer Borough, Elsinboro Township, Lower Alloways Creek Township, Mannington Township, Oldmans Township, Pilesgrove Township, Pittsgrove Township, Quinton Township and Upper Pittsgrove Township.

II. Nitrate Dilution Analysis Methods and Summary of Results

In areas outside of sewer service areas, the wastewater management alternative is on-site discharge to groundwater of 2,000 gallons per day or less, commonly referred to as septic systems. The assessment of water quality impacts from development on septic systems relies on nitrate concentration. In this analysis, nitrate acts as a conservative surrogate for any of a number of constituents that could be discharged from a septic system (e.g. cleaners, solvents, pharmaceuticals, etc.). Nitrate was chosen because it is highly soluble in water, and because it is a stable compound that by itself could render water unsuitable for human consumption. The capacity to support septic systems without violating groundwater quality standards is determined by the amount of dilution available.

The Water Quality Management Planning Rules advocate a watershed approach to assessing the adequacy of available dilution to meet future development on septic systems. Using this approach, available dilution, (essentially groundwater recharge), is calculated within a HUC 11 watershed and translated into a finite amount of wastewater that can be discharged, which in turn can be translated into a finite number of housing units that can be supported while maintaining a target concentration of nitrate in groundwater. Zoning is then applied to the available land in that same watershed, outside of any sewer service area, to calculate the number of units that could be developed on septic systems.

The results of above two analyses are then compared and if the number of units based on zoning does not exceed the maximum units that can be supported, adequate capacity has been demonstrated. If the number of units allowed by zoning exceeds that which can be supported in a particular watershed, then some adjustment to zoning within that watershed may be warranted.

The nitrate dilution analysis for septic systems was performed Countywide in similar fashion to that conducted for sewer service areas except that environmentally sensitive areas are not removed prior to performing the build-out analysis. This is due to the fact that while certain areas may be unbuildable, such as riparian zones or steep slopes, they still contribute to the overall available dilution of nitrate in groundwater. These areas were also not removed when analyzing the available dilution on a HUC11 basis used to establish the maximum number of units that can be built in a watershed and continue to meet the 2 mg/L nitrate target. Thus while some areas may contribute less overall groundwater recharge, due to factors such as soils or topography, these limitations have already been taken into consideration when calculating the maximum average density allowable. The intent of this analysis is to assess the available dilution on a HUC 11 basis used to establish the maximum number of units that can be built in a watershed and continue to meet the regulatory nitrate target.

This analysis used NJDEP's nitrate-nitrogen target of 2 mg/L, with the assumption that all ammonium and other nitrogen compounds are converted to nitrate within the property, and that the nitrate concentrations dilute evenly across the HUC11. These assumptions are implicit in the nitrate dilution model developed by NJDEP.

The wastewater summary projections presented for areas outside the SSA were prepared on behalf of the County of Salem by Fralinger Engineering in accordance with the Wastewater Estimation tool provided by the Department.

The goal of this HUC11-scale planning exercise to estimate the number of residential and commercial units within each HUC 11 on a municipal basis. The number of units that could be built under the existing zoning is compared to the allowable number of residential and commercial units in an effort to ensure that the current nitrate dilution standards can be satisfied. This method is intended to be a guide for estimating the impact of nitrate from septic tanks on HUC11-scale ground-water quality. This analysis scale is at a regional watershed level. Other, more specific, methods may be required to further detail impacts to the zoning of each municipality.

The Wastewater Estimation model builder was provided to assist with the preparation of a countywide Wastewater Management Plan consistent with the Water Quality Management Planning rule (N.J.A.C. 7:15). The application of this tool is specific to the estimation of new Wastewater Flows within Sewer Service Areas and to compare existing zoning to HUC 11 Nitrate Dilution Septic Densities. In addition, it compares new development potential, based on local zoning, to regional septic density standards for those areas outside of sewer service area. The nitrate dilution standards of the Water Quality Management Planning rule result in a "septic density" for each watershed in the State. This septic density identifies the maximum comparable residential zoning density that meets the groundwater quality goal.

The Wastewater Estimation model builder uses results from a separate nitrate dilution model designed by New Jersey Geological Survey to estimate septic densities. This separate model is titled: *A Recharge-Based HUC 11-Scale Nitrate-Carrying-Capacity Planning Tool for New Jersey, v1.0 (MS Excel Workbook)*. The method presented here combines a model of nitrate dilution (based on Trela and Douglas, 1978) with one of ground-water recharge on a HUC11 basis (based on Charles and others, 2003). To further develop this tool, The County provided additional customization to the application. The information depicted within this application was provided by the Department as a resource in the development of a GIS Model Builder Application tool for Counties/Municipalities. The information depicts regional overlays, which are not site specific.

The condition of any area appearing suitable for an intended use must be assessed by a comprehensive, due diligence investigation of several factors, including but not limited to a Natural Resource Inventory, physical on-site conditions, local, State and Federal requirements, approvals, status of any outstanding violation, the past uses and possible residual contamination of a site. NJDEP Land Use/ Land Cover and aerial photographs were utilized as the base layers.

The method/data generated by the Wastewater Estimation model builder has specific limitations within the application, as identified by the Department. As a result of these limitations, the current output of this GIS tool can only be qualified as an initial screen of current field conditions per County/ Municipality. Any other representation of generated results from this tool is not an accurate depiction of development potential and will be deemed to be a misrepresentation. Further customization of the application was performed at the municipal level, by the County, as identified above. However, more specific, methods will be required to further detail impacts to the zoning of each municipality.

The Wastewater Estimation model builder was utilized to compare existing zoning to the available nitrate dilution within each HUC11. The HUC11 analysis was performed for each municipality independently. The available land use within each HUC was proportioned based upon the total number of acres located within the municipal boundary. Consequently, distributing the total number of allowable units among municipalities, within a given HUC11, was not necessary as the land area used for the analysis had already been proportioned. When determining the number of potential units, based on zoning, permanently preserved open space was removed from the potential buildout. Conversely, the number of allowable units, based on available dilution capacity within each HUC, utilized permanently preserved open space areas.

Table 1 summarizes the results of the nitrate dilution capacity analysis. The table reflects the (build-out) number of residential units and commercial square footage that could potentially generate wastewater per zone within each HUC 11, outside the sewer service area, within the municipality. In addition, the allowable (capacity) number of residential units and commercial square footage that could be developed by the municipality outside the wastewater service area, while maintaining a target concentration of nitrate in groundwater has been identified. For the purposes of this analysis it is inconsequential if one municipality's zoning exceeds its allocation provided that the HUC 11 does not exceed the total sustainable development.

Table 1. HUC-11 Dilution Analysis Summary- Potential Development and Available Capacity						
Municipality	HUC11	Total Area (Acres)	Residential Buildout (Units)	Residential Capacity (Units)	Commercial Buildout (SF)	Commercial Capacity (SF)
Alloway Township						
	02040206040	1,092.43	360.50	143.74	0.00	0.00
	02040206060	9,255.94	5,401.33	1,267.94	97,495.92	4,088.03
	02040206070	214.11	107.05	31.96	0.00	0.00
	02040206080	4,004.60	3,529.16	572.09	0.00	0.00
Carneys Point Township						
	02040206120	114.3	59.8	9.8	113,378.5	2,264.0
	02040206130	1,300.9	901.6	180.7	2,198,304.0	93,202.3
Elmer Borough						
	02040206150	131.65	287.78	19.06	50,868.55	5,118.03
Elsinboro Township						
	2040206040	1,148.22	556.17	151.08	4,671,444.88	141,107.39
	2040206060	623.13	360.62	85.36	15.9	0.5
Lower Alloways Creek Township						
	02040204910	1.21	0.12	0.00	0.00	0.00
	02040206040	23.78	15.86	3.13	0.00	0.00
	02040206060	3,470.69	2,148.30	475.44	828,118.27	34,723.25
	02040206070	2,918.53	1,813.34	435.60	0.00	0.00
Mannington Township						
	02040206030	2,861.32	944.09	397.41	0.00	0.00
	02040206040	12,053.26	4,796.68	1,585.96	2,392,898.01	72,280.76
Oldmans Township						
	02040202160	2,920.44	1,682.78	411.33	6,048,348.84	254,224.91
	02040206020	443.35	239.53	38.22	2,300,936.17	60,715.20
	02040206030	1,784.46	930.03	247.84	279,359.97	8,907.25
Penns Grove Borough	The Borough is designated as an urban municipality. Analysis was not prepared for inclusion within report.					
Pennsville Township	This Township already has an adopted WMP. Analysis was not prepared for inclusion within report.					
Pilesgrove Township						
	02040202160	3,563.9	2,655.6	502.0	0.0	0.0
	02040206030	11,499.4	5,796.1	1,597.1	1,177,674.2	100,132.1
	02040206040	30.5	23.8	4.0	0.0	0.0
	02040206060	876.6	466.2	120.1	0.0	0.0
Pittsgrove Township						
	2040206040	2,797.0	526.9	129.2	468,037.9	6,701.2
	2040206060	262.3	0.0	0.0	0.0	0.0
	2040206070	10,819.2	2,344.5	569.7	1,578,725.5	178,037.3
	02040206150	15,360.9	2,401.2	711.2	1,596,739.5	139,688.7

Table 1. HUC-11 Dilution Analysis Summary- Potential Development and Available Capacity (continued)						
Municipality	HUC11	Total Area (Acres)	Residential Buildout (Units)	Residential Capacity (Units)	Commercial Buildout (SF)	Commercial Capacity (SF)
Quinton Township						
	2040206040	764.93	147.20	54.37	3,370,339.54	185,101.31
	2040206060	4,771.13	1,589.33	641.30	931,492.98	49,119.51
	2040206070	3,565.76	1,175.27	526.24	313,308.43	23,855.96
Salem City	Refer to municipal chapter regarding HUC11 Analysis.					
Upper Pittsgrove Township						
	02040202160	1,571.20	605.00	221.30	0.00	0.00
	02040206030	3,690.68	1,194.70	512.59	1,774,481.27	120,878.53
	02040206060	2,508.69	850.96	343.66	0.00	0.00
	02040206080	266.92	88.08	38.13	0.00	0.00
	02040206120	1,887.69	996.67	286.01	283,592.09	19,728.42
	02040206150	7,574.17	2,898.86	1,097.71	4,900,520.24	333,105.59
Woodstown Borough	Refer to municipal chapter regarding HUC11 Analysis.					

The information used to generate the results of the HUC-11 analysis presented above for areas outside the SSA were prepared on behalf of the County of Salem by Fralinger Engineering in accordance with the Wastewater Estimation tool provided by the Department. The summary table has been prepared to reflect the resultant values for each municipality. HUC-11 areas within each municipality have been identified and each appropriate zoning criteria for each municipality has been applied. The number of units allowed by zoning exceeds that which can be supported in a particular watershed.

The Municipalities are currently reviewing the results of the dilution analysis in an effort to determine what zoning adjustments may be appropriate to meet both the regulatory requirements and the development objectives of the municipality. The method/data generated by the Wastewater Estimation model builder has specific limitations within this application, as identified above. Consequently, this initial step does not provide sufficient data or an accurate depiction of development potential for the municipality. The municipalities will need to apply more specific methods of analysis prior to making adjustments to the current zoning.

The comparison of analyses shows that a build-out based on zoning would result in much more development than can actually be sustained to achieve adequate nitrate dilution. Therefore, the build-out based on the nitrate dilution analysis should be used in future planning.

Areas designated “Septic Area (planning flows of 2,000 gpd or less)” have not demonstrated that the zoning meets the nitrate planning standard of 2 mg/l on a HUC 11 basis. In areas where zoning is not in compliance with the nitrate planning standard, residential development or subdivisions with a total of less than six (6) dwelling units are allowed, but residential developments of six (6) or more units must undergo a nitrate dilution analysis to ensure that the individual or other subsurface sewage disposal systems can meet the two (2mg/l) nitrate planning standard on-site. The 2mg/l standard is intended to be applicable on an HUC11 watershed basis

III. Results by Municipality

A. Alloway Township Nitrate Dilution Analysis

1. Future Wastewater Outside of Sewer Service Areas Buildout

Table 2 summarizes the number of residential units and commercial square footage that could potentially generate wastewater per zone within each HUC11, outside the sewer service area, within the municipality.

Table 2: ALLOWAY TOWNSHIP HUC-11 BUILDOUT (Based on Existing Zoning)				
HUC11	Zoning	Total Acres	Residential (Units)	Commercial (SF)
02040206040	RR	1,092.43	360.50	0.00
TOTALS		1,092.43	360.50	0.00
02040206060	AR	2,239.11	2,239.11	0.00
	C	7.46	0.00	97,495.92
	HR	148.64	148.64	0.00
	LR	4,356.65	2,178.32	0.00
	MR	4.26	10.32	0.00
	RR	2,499.82	824.94	0.00
TOTALS		9,255.94	5,401.33	97,495.92
02040206070	LR	214.11	107.05	0.00
TOTALS		214.11	107.05	0.00
02040206080	A	3,053.72	3,053.72	0.00
	LR	950.88	475.44	0.00
TOTALS		4,004.60	3,529.16	0.00

2. Adequacy of dilution to meet future non-sewer service area demand

Table 3 below summarizes the allowable number of residential units and commercial square footage that could be developed by the municipality outside the wastewater service area, while maintaining a target concentration of nitrate in groundwater.

Table 3: ALLOWAY TOWNSHIP HUC-11 BUILDOUT CAPACITY / DENSITY				
HUC11	Zoning	Total Acres	Residential (Units)	Commercial (SF)
02040206040	RR	1,092.43	143.74	0.00
TOTALS		1,092.43	143.74	0.00
02040206060	AR	2,239.11	306.73	0.00
	C	7.46	1.02	4,088.03
	HR	148.64	20.36	0.00
	LR	4,356.65	596.80	0.00
	MR	4.26	0.58	0.00
	RR	2,499.82	342.44	0.00
TOTALS		9,255.94	1,267.94	4,088.03
02040206070	LR	214.11	31.96	0.00
TOTALS		214.11	31.96	0.00
02040206080	A	3,053.72	436.25	0.00
	LR	950.88	135.84	0.00
TOTALS		4,004.60	572.09	0.00

The following Table 4 summarizes the results of the nitrate dilution capacity analysis. The table reflects the differences between the potential number of residential units and commercial square footage that could be projected by the municipality outside the wastewater service area and number of allowable units necessary to maintain a target concentration of nitrate in groundwater.

TABLE-4: Alloway Township HUC-11 Dilution Analysis Summary- Potential Development and Available Dilution

HUC11	Total Acres	Residential Buildout (Units)	Residential Capacity (Units)	Commercial Buildout (SF)	Commercial Capacity (SF)
02040206040					
TOTALS	1,092.43	360.50	143.74	0.00	0.00
02040206060					
TOTALS	9,255.94	5,401.33	1,267.94	97,495.92	4,088.03
02040206070					
TOTALS	214.11	107.05	31.96	0.00	0.00
02040206080					
TOTALS	4,004.60	3,529.16	572.09	0.00	0.00

The number of units allowed by zoning exceeds that which can be supported in a particular watershed, meaning that a build-out based on zoning would result in much more development than can actually be sustained to achieve adequate nitrate dilution. The Municipality is currently reviewing the results of the dilution analysis in an effort to determine what zoning adjustments may be appropriate to meet both the regulatory requirements and the development objectives of the municipality. The method/data generated by the Wastewater Estimation model builder has specific limitations within this application. Consequently, this initial step does not provide sufficient data or an accurate depiction of development potential for the municipality. The Municipality will need to apply more specific methods of analysis prior to making adjustments to the current zoning.

B. Carneys Point Township Nitrate Dilution Analysis

1. Future Wastewater Outside of Sewer Service Areas Buildout

Table 5 summarizes the number of residential units and commercial square footage that could potentially generate wastewater per zone within each HUC11, outside the sewer service area, within the municipality.

Table 5: CARNEYS POINT TOWNSHIP HUC-11 BUILDOUT (BASED ON EXISTING ZONING)				
HUC11	Zoning	Total Acres	Residential (Units)	Commercial (SF)
02040206120				
	AG	30.23	30.23	0.00
	GC	0.03	0.00	359.63
	GI-R	6.33	0.00	110315.70
	LC	0.19	0.00	2505.93
	LI	0.02	0.00	197.21
	LR	9.93	28.82	0.00
	MHR	0.13	0.80	0.00
	OS	67.41	0.00	0.00
TOTALS		114.3	59.8	113,378.5
02040206130				
	AG	741.65	741.65	0.00
	GC	164.06	0.00	2143886.32
	IC	1.37	0.00	23847.25
	LI	2.34	0.00	30570.45
	LR	0.42	1.22	0.00
	OS	73.97	0.00	0.00
	RR-1	0.13	0.26	0.00
	RR-2	316.98	158.49	0.00
TOTALS		1,300.9	901.6	2,198,304.0
02040206140				
	GC	0.00	0.00	0.00
TOTALS		0.0	0.0	0.0

2. Adequacy of dilution to meet future non-sewer service area demand

Table 6 below summarizes the allowable number of residential units and commercial square footage that could be developed by Carneys Point outside the wastewater service area, while maintaining a target concentration of nitrate in groundwater.

Table 6: CARNEYS POINT TOWNSHIP HUC-11 BUILDOUT/CAPACITY				
HUC11	Zoning	Total Acres	Residential (Units)	Commercial (SF)
02040206120				
	AG	30.23	2.61	0.00
	GC	0.03	0.00	9.49
	GI-R	6.33	0.55	2183.19
	LC	0.19	0.02	66.12
	LI	0.02	0.00	5.20
	LR	9.93	0.86	0.00
	MHR	0.13	0.01	0.00
	OS	67.41	5.81	0.00
TOTALS		114.3	9.8	2,264.0
02040206130				
	AG	741.65	103.01	0.00
	GC	164.06	22.79	91142.33
	IC	1.37	0.19	760.36
	LI	2.34	0.32	1299.63
	LR	0.42	0.06	0.00
	OS	73.97	10.27	0.00
	RR-1	0.13	0.02	0.00
	RR-2	316.98	44.03	0.00
TOTALS		1,300.9	180.7	93,202.3
02040206140				
	GC	0.00	0.00	0.00
TOTALS		0.0	0.0	0.0

The following **Table 7** summarizes the results of the nitrate dilution capacity analysis. The table reflects the differences between the potential number of residential units and commercial square footage that could be projected by the municipality outside the wastewater service area and number of allowable units necessary to maintain a target concentration of nitrate in groundwater.

Table 7: Carneys Point Township HUC-11 Dilution Analysis Summary- Potential Development and Available Dilution					
HUC11	Total Acres	Residential Buildout (Units)	Residential Capacity (Units)	Commercial Buildout (SF)	Commercial Capacity (SF)
02040206120					
TOTALS	114.3	59.8	9.8	113,378.5	2,264.0
02040206130					
TOTALS	1,300.9	901.6	180.7	2,198,304.0	93,202.3
02040206140					
TOTALS	0.0	0.0	0.0	0.0	0.0

The number of units allowed by zoning exceeds that which can be supported in a particular watershed, meaning that a build-out based on zoning would result in much more development than can actually be sustained to achieve adequate nitrate dilution. The Municipality is currently reviewing the results of the dilution analysis in an effort to determine what zoning adjustments may be appropriate to meet both the regulatory requirements and the development objectives of the municipality. The method/data generated by the Wastewater Estimation model builder has specific limitations within this application. Consequently, this initial step does not provide sufficient data or an accurate depiction of development potential for the municipality. The Municipality will need to apply more specific methods of analysis prior to making adjustments to the current zoning. In addition, the current septic densities for the HUC-11's in Carneys Point Township are also expected to be much lower than required to achieve adequate nitrate dilution, when compared to the results of the nitrate dilution analysis.

C. Elmer Borough Nitrate Dilution Analysis

1. Future Wastewater Outside of Sewer Service Areas Buildout

Table 8 summarizes the number of residential units and commercial square footage that could potentially generate wastewater per zone within each HUC11, outside the sewer service area, within the municipality.

HUC11	Zoning	Total Acres	Residential (Units)	Commercial (SF)
02040206150	CONS	13.91	13.91	0.00
	GB	0.52	0.00	4,568.83
	HB	1.79	0.00	7,807.57
	LI	4.20	0.00	18,311.77
	LM	47.07	102.52	0.00
	LR-1	4.69	6.81	0.00
	LR-2	19.69	28.60	0.00
	MR	37.45	135.94	0.00
	RP	2.32	0.00	20,180.38
TOTALS		131.65	287.78	50,868.55

2. Adequacy of Dilution to Meet Future Non-Sewer Service Area Demand

Table 9 below summarizes the allowable number of residential units and commercial square footage that could be developed by the municipality outside the wastewater service area, while maintaining a target concentration of nitrate in groundwater.

HUC11	Zoning	Total Acres	Residential (Units)	Commercial (SF)
02040206150	CONS	13.91	2.01	0.00
	GB	0.52	0.08	304.02
	HB	1.79	0.26	1,039.06
	LI	4.20	0.61	2,432.12
	LM	47.07	6.81	0.00
	LR-1	4.69	0.68	0.00
	LR-2	19.69	2.85	0.00
	MR	37.45	5.42	0.00
	RP	2.32	0.34	1,342.83
TOTALS		131.65	19.06	5,118.03

The following **Table 10** summarizes the results of the nitrate dilution capacity analysis. The table reflects the differences between the potential number of residential units and commercial square footage that could be projected by the municipality outside the wastewater service area and number of allowable units necessary to maintain a target concentration of nitrate in groundwater.

Table 10: Elmer Borough HUC-11 Dilution Analysis Summary- Potential Development and Available Dilution					
HUC11	Total Acres	Residential Build-Out (Units)	Residential Capacity (Units)	Commercial Build-Out (SF)	Commercial Capacity (SF)
02040206150					
TOTALS	131.65	287.78	19.06	50,868.55	5,118.03

The number of units allowed by zoning exceeds that which can be supported in a particular watershed, meaning that a build-out based on zoning would result in much more development than can actually be sustained to achieve adequate nitrate dilution. The Municipality is currently reviewing the results of the dilution analysis in an effort to determine what zoning adjustments may be appropriate to meet both the regulatory requirements and the development objectives of the municipality. The method/data generated by the Wastewater Estimation model builder has specific limitations within this application. Consequently, this initial step does not provide sufficient data or an accurate depiction of development potential for the municipality. The Municipality will need to apply more specific methods of analysis prior to making adjustments to the current zoning. In addition, the current septic densities for the HUC-11's in Elmer Borough are also expected to be much lower than required to achieve adequate nitrate dilution, when compared to the results of the nitrate dilution analysis.

D. Elsinboro Township Nitrate Dilution Analysis

1. Future Wastewater Outside of Sewer Service Area Buildout

Table 11 summarizes the number of residential units and commercial square footage that could potentially generate wastewater per zone within each HUC11, outside the sewer service area, within the municipality.

Table 11: ELSINBORO TOWNSHIP HUC-11 BUILDOUT (Based on Existing Zoning)				
HUC11	Zoning	Total Acres	Residential (Units)	Commercial (SF)
02040206040	C	268.10	0.00	4,671,444.88
	CONS	27.12	5.42	0.00
	LR	6.86	11.95	0.00
	MR	25.75	62.32	0.00
	RR-A	820.38	476.48	0.00
TOTALS		1,148.22	556.17	4,671,444.88
02040206060	C	0.00	0.00	15.90
	CONS	14.30	2.86	0.00
	LR	3.57	6.23	0.00
	RR-A	605.26	351.54	0.00
	TOTALS		623.13	360.62

2. Adequacy of Dilution To Meet Future Non-Sewer Service Area Demand

Table 12 below summarizes the allowable number of residential units and commercial square footage that could be developed by the municipality outside the wastewater service area, while maintaining a target concentration of nitrate in groundwater.

Table 12: ELSINBORO TOWNSHIP HUC-11 BUILDOUT CAPACITY / DENSITY				
HUC11	Zoning	Total Acres	Residential (Units)	Commercial (SF)
02040206040	C	268.10	35.28	141,107.39
	CONS	27.12	3.57	0.00
	LR	6.86	0.90	0.00
	MR	25.75	3.39	0.00
	RR-A	820.38	107.95	0.00
	TOTALS		1,148.22	151.08
02040206060	C	0.00	0.00	0.50
	CONS	14.30	1.96	0.00
	LR	3.57	0.49	0.00
	RR-A	605.26	82.91	0.00
	TOTALS		623.13	85.36

The following Table 13 summarizes the results of the nitrate dilution capacity analysis. The table reflects the differences between the potential number of residential units and commercial square footage that could be projected by the municipality outside the wastewater service area and number of allowable units necessary to maintain a target concentration of nitrate in groundwater.

Table-13: Elsinboro HUC-11 Dilution Analysis Summary- Potential Development and Available Dilution					
HUC11	Total Acres	Residential Build-Out (Units)	Residential Capacity (Units)	Commercial Build-Out (SF)	Commercial Capacity (SF)
2040206040					
TOTALS	1,148.22	556.17	151.08	4,671,444.88	141,107.39
2040206060					
TOTALS	623.13	360.62	85.36	15.9	0.5

The number of units allowed by zoning exceeds that which can be supported in a particular watershed. The Municipality is currently reviewing the results of the dilution analysis in an effort to determine what zoning adjustments may be appropriate to meet both the regulatory requirements and the development objectives of the municipality. The method/data generated by the Wastewater Estimation model builder has specific limitations within this application, as identified above. Consequently, this initial step does not provide sufficient data or an accurate depiction of development potential for the municipality. The Municipality will need to apply more specific methods of analysis prior to making adjustments to the current zoning. In addition, the current septic densities for the HUC-11's in Elsinboro Township are also expected to be much lower than required to achieve adequate nitrate dilution, when compared to the results of the nitrate dilution analysis.

E. Lower Alloways Creek Township Nitrate Dilution Analysis

1. Future Wastewater Outside of Sewer Service Area Buildout

Table 14 summarizes the number of residential units and commercial square footage that could potentially generate wastewater per zone within each HUC11, outside the sewer service area, within the municipality.

Table 14: LOWER ALLOWAYS CREEK TOWNSHIP HUC-11 BUILDOUT (Based on Existing Zoning)				
HUC11	Zoning	Total Acres	Residential (Units)	Commercial (SF)
02040204910	W	1.21	0.12	0.00
TOTALS		1.21	0.12	0.00
02040206040	AR	23.78	15.86	0.00
TOTALS		23.78	15.86	0.00
02040206060	AR	2,870.80	1,914.82	0.00
	I	63.37	0.00	828,118.27
	V	35.79	183.40	0.00
	W	500.74	50.07	0.00
TOTALS		3,470.69	2,148.30	828,118.27
02040206070	AR	2,573.41	1,716.47	0.00
	C-P	199.50	7.98	0.00
	V	14.79	75.81	0.00
	W	130.83	13.08	0.00
TOTALS		2,918.53	1,813.34	0.00

2. Adequacy of dilution to meet future non-sewer service area demand

Table 15 below summarizes the allowable number of residential units and commercial square footage that could be developed by the municipality outside the wastewater service area, while maintaining a target concentration of nitrate in groundwater.

Table 15: LOWER ALLOWAYS CREEK TOWNSHIP HUC-11 BUILDOUT CAPACITY / DENSITY				
HUC11	Zoning	Total Acres	Residential (Units)	Commercial (SF)
02040204910	W	1.21	0.00	0.00
TOTALS		1.21	0.00	0.00
02040206040	AR	23.78	3.13	0.00
TOTALS		23.78	3.13	0.00
02040206060	AR	2,870.80	393.26	0.00
	I	63.37	8.68	34,723.25
	V	35.79	4.90	0.00
	W	500.74	68.59	0.00
TOTALS		3,470.69	475.44	34,723.25
02040206070	AR	2,573.41	384.09	0.00
	C-P	199.50	29.78	0.00
	V	14.79	2.21	0.00
	W	130.83	19.53	0.00
TOTALS		2,918.53	435.60	0.00

The following **Table 16** summarizes the results of the nitrate dilution capacity analysis. The table reflects the differences between the potential number of residential units and commercial square footage that could be projected by the municipality outside the wastewater service area and number of allowable units necessary to maintain a target concentration of nitrate in groundwater.

TABLE-16: Lower Alloways Creek HUC-11 Dilution Analysis Summary- Potential Development and Available Dilution					
HUC11	Total Acres	Residential Buildout (Units)	Residential Capacity (Units)	Commercial Buildout (SF)	Commercial Capacity (SF)
02040204910					
TOTALS	1.21	0.12	0.00	0.00	0.00
02040206040					
TOTALS	23.78	15.86	3.13	0.00	0.00
02040206060					
TOTALS	3,470.69	2,148.30	475.44	828,118.27	34,723.25
02040206070					
TOTALS	2,918.53	1,813.34	435.60	0.00	0.00

The number of units allowed by zoning exceeds that which can be supported in a particular watershed. The Municipality is currently reviewing the results of the dilution analysis in an effort to determine what zoning adjustments may be appropriate to meet both the regulatory requirements and the development objectives of the municipality. The method/data generated by the Wastewater Estimation model builder has specific limitations within this application, as identified above. Consequently, this initial step does not provide sufficient data or an accurate depiction of development potential for the municipality. The Municipality will need to apply more specific methods of analysis prior to making adjustments to the current zoning. In addition, the current septic densities for the HUC-11's in Lower Alloways Creek Township are also expected to be much lower than required to achieve adequate nitrate dilution, when compared to the results of the nitrate dilution analysis.

F. Mannington Township Nitrate Dilution Analysis

1. Future Wastewater Outside of Sewer Service Area Buildout

Table 17 summarizes the number of residential units and commercial square footage that could potentially generate wastewater per zone within each HUC11, outside the sewer service area, within the municipality.

Table 17: MANNINGTON TOWNSHIP HUC-11 BUILDOUT				
(Based on Existing Zoning)				
HUC11	Zoning	Total Acres	Residential (Units)	Commercial (SF)
02040206030	A	2,666.41	879.92	0.00
	CONS	1.12	0.22	0.00
	CR	0.02	0.01	0.00
	RR	193.77	63.94	0.00
	TOTAL	2,861.32	944.09	0.00
02040206040	A	9,485.75	3,130.30	0.00
	CONS	78.12	15.62	0.00
	CR	1,042.46	344.01	0.00
	GC	26.23	0.00	456,984.11
	HR	67.84	147.76	0.00
	I	69.19	0.00	1,205,624.96
	LC	41.91	0.00	730,288.94
	MR	530.45	924.26	0.00
	RR	711.31	234.73	0.00
	TOTAL	12,053.26	4,796.68	2,392,898.01

2. Adequacy of dilution to meet future non-sewer service area demand

Table 18 below summarizes the allowable number of residential units and commercial square footage that could be developed by the municipality outside the wastewater service area, while maintaining a target concentration of nitrate in groundwater.

Table 18: MANNINGTON TOWNSHIP HUC-11 BUILDOUT CAPACITY / DENSITY				
HUC11	Zoning	Total Acres	Residential (Units)	Commercial (SF)
02040206030	A	2,666.41	370.33	0.00
	CONS	1.12	0.16	0.00
	CR	0.02	0.00	0.00
	RR	193.77	26.91	0.00
	TOTAL	2,861.32	397.41	0.00
02040206040	A	9,485.75	1,248.12	0.00
	CONS	78.12	10.28	0.00
	CR	1,042.46	137.17	0.00
	GC	26.23	3.45	13,803.83
	HR	67.84	8.93	0.00
	I	69.19	9.10	36,417.55
	LC	41.91	5.51	22,059.38
	MR	530.45	69.80	0.00
	RR	711.31	93.59	0.00
TOTAL	12,053.26	1,585.96	72,280.76	

The following **Table 19** summarizes the results of the nitrate dilution capacity analysis. The table reflects the differences between the potential number of residential units and commercial square footage that could be projected by the municipality outside the wastewater service area and number of allowable units necessary to maintain a target concentration of nitrate in groundwater.

TABLE-19: Mannington Township HUC-11 Dilution Analysis Summary- Potential Development and Available Dilution					
HUC11	Total Acres	Residential Buildout (Units)	Residential Capacity (Units)	Commercial Buildout (SF)	Commercial Capacity (SF)
02040206030					
TOTALS	2,861.32	944.09	397.41	0.00	0.00
02040206040					
TOTALS	12,053.26	4,796.68	1,585.96	2,392,898.01	72,280.76

The number of units allowed by zoning exceeds that which can be supported in a particular watershed. The Municipality is currently reviewing the results of the dilution analysis in an effort to determine what zoning adjustments may be appropriate to meet both the regulatory requirements and the development objectives of the municipality. The method/data generated by the Wastewater Estimation model builder has specific limitations within this application, as identified above. Consequently, this initial step does not provide sufficient data or an accurate depiction of development potential for the municipality. The Municipality will need to apply more specific methods of analysis prior to making adjustments to the current zoning. In addition, the current septic densities for the HUC-11's in Mannington Township are also expected to be much lower than required to achieve adequate nitrate dilution, when compared to the results of the nitrate dilution analysis.

G. Oldmans Township Nitrate Dilution Analysis

1. Future Wastewater Outside of Sewer Service Area Buildout

Table 20 summarizes the number of residential units and commercial square footage that could potentially generate wastewater per zone within each HUC11, outside the sewer service area, within the municipality.

Table 20: OLDMANS TOWNSHIP HUC-11 BUILDOUT (Based on Existing Zoning)				
HUC11	Zoning	Total Acres	Residential (Units)	Commercial (SF)
02040202160	AR	1,649.48	824.74	0.00
	C	18.08	0.00	196,850.33
	CI	397.25	0.00	5,191,286.01
	I	13.52	0.00	176,630.23
	IPRA	21.40	0.00	465,991.03
	R	806.31	806.31	0.00
	VC	1.01	0.00	17,591.24
	VR	11.88	51.73	0.00
TOTALS		2,918.92	1,682.78	6,048,348.84
02040206020	AR	55.48	27.74	0.00
	CI	122.28	0.00	1,597,920.59
	I	53.80	0.00	703,015.58
	R	211.79	211.79	0.00
TOTALS		443.35	239.53	2,300,936.17
02040206030	AR	1,756.51	878.25	0.00
	R	0.03	0.03	0.00
	VC	16.03	0.00	279,359.97
	VR	11.88	51.75	0.00
TOTALS		1,784.46	930.03	279,359.97

The wastewater summary projections presented above for areas outside the SSA were prepared on behalf of the County of Salem by Fralinger Engineering in accordance with the Wastewater Estimation tool provided by the Department.

The Wastewater Estimation model builder was provided to assist with the preparation of a countywide Wastewater Management Plan consistent with the Water Quality Management Planning rule (N.J.A.C. 7:15). The application of this tool is specific to the estimation of new Wastewater Flows within Sewer Service Areas and to compare existing zoning to HUC 11 Nitrate Dilution Septic Densities. In addition, it compares new development potential, based on local zoning, to regional septic density standards for those areas outside of sewer service area. The nitrate dilution standards of the Water Quality Management Planning rule result in a "septic density" for each watershed in the State. This septic density identifies the maximum comparable residential zoning density that meets the groundwater quality goal.

2. Adequacy of dilution to meet future non-sewer service area demand

Table 21 below summarizes the allowable number of residential units and commercial square footage that could be developed by Carneys Point outside the wastewater service area, while maintaining a target concentration of nitrate in groundwater.

Table 21: OLMANS TOWNSHIP HUC-11 BUILDOUT CAPACITY / DENSITY				
HUC11	Zoning	Total Acres	Residential (Units)	Commercial (SF)
02040202160	AR	1,651.01	232.54	0.00
	C	18.08	2.55	10,183.80
	CI	397.25	55.95	223,803.81
	I	13.52	1.90	7,614.78
	IPRA	21.40	3.01	12,053.73
	R	806.31	113.56	0.00
	VC	1.01	0.14	568.79
	VR	11.88	1.67	0.00
TOTALS		2,920.44	411.33	254,224.91
02040206020	AR	55.48	4.78	0.00
	CI	122.28	10.54	42,164.61
	I	53.80	4.64	18,550.59
	R	211.79	18.26	0.00
TOTALS		443.35	38.22	60,715.20
02040206030	AR	1,756.51	243.96	0.00
	R	0.03	0.00	0.00
	VC	16.03	2.23	8,907.25
	VR	11.88	1.65	0.00
TOTALS		1,784.46	247.84	8,907.25

The following **Table 22** summarizes the results of the nitrate dilution capacity analysis. The table reflects the differences between the potential number of residential units and commercial square footage that could be projected by the municipality outside the wastewater service area and number of allowable units necessary to maintain a target concentration of nitrate in groundwater.

Table-22: Oldmans Township HUC-11 Dilution Analysis Summary- Potential Development and Available Dilution					
HUC11	Total Acres	Residential Buildout (Units)	Residential Capacity (Units)	Commercial Buildout (SF)	Commercial Capacity (SF)
02040202160					
TOTALS	2,920.44	1,682.78	411.33	6,048,348.84	254,224.91
02040206020					
TOTALS	443.35	239.53	38.22	2,300,936.17	60,715.20
02040206030					
TOTALS	1,784.46	930.03	247.84	279,359.97	8,907.25

The number of units allowed by zoning exceeds that which can be supported in a particular watershed. The Municipality is currently reviewing the results of the dilution analysis in an effort to determine what zoning adjustments may be appropriate to meet both the regulatory requirements and the development objectives of the municipality. The method/data generated by the Wastewater Estimation model builder has specific limitations within this application, as identified above. Consequently, this initial step does not provide sufficient data or an accurate depiction of development potential for the municipality. The Municipality will need to apply more specific methods of analysis prior to making adjustments to the current zoning. In addition, the current septic densities for the HUC-11's in Oldmans Township are also expected to be much lower than required to achieve adequate nitrate dilution, when compared to the results of the nitrate dilution analysis.

H. Pilesgrove Township Nitrate Dilution Analysis

A build out analysis for the non sewer service area was prepared for Pilesgrove Township by Richard A. Alaimo Association of Engineers in November 2010. The build out in the non-sewer service area was calculated by applying the zoning, as defined within the November 2010 report, over all undeveloped land. The analysis also determined the build-out based on nitrate dilution modeling for the Township's target limit of 5.2 mg/l and for the NJDEP's limit of 2.0 mg/l. The methodology based on the NJDEP nitrate dilution limit allows for substantially less future dwelling units than is permitted by current zoning. The results of the analysis are presented in Appendix B. The methodology of preparing the build-out analysis is further defined within the Richard A. Alaimo Association of Engineers report.

I. Pittsgrove Township Nitrate Dilution Analysis

A build out analysis for the non sewer service area was prepared for Pittsgrove Township by Clarke Caton Hinz in August 2009. The build out in the non-sewer service area was calculated by applying the zoning, as defined within the August 2009 report, over all undeveloped land. The number of residential units and non-residential floor area were then multiplied by the wastewater planning flow estimates in either N.J.A.C. 7:14A or 7:9A as appropriate. The results of the analysis are presented in Appendix C. The methodology of preparing the build-out analysis is further defined within the Clarke Caton Hinz report.

During the WMP review process, Salem County and the Department was approached by Atlantic City Electric to include approximately 200 acres of land in the FWSA for the “Pepco Development”. The addition of this area to the FWSA would essentially change the nitrate dilution analysis. At this time, the nitrate dilution analyses that are not in compliance are not being included in the WMP, but are included for reference in this Appendix. It is not necessary at this time to update the nitrate dilution analyses, therefore it is not included.

J. Quinton Township Nitrate Dilution Analysis

1. Future Wastewater Outside of Sewer Service Area Buildout

Table 23 summarizes the number of residential units and commercial square footage that could potentially generate wastewater per zone within each HUC11, outside the sewer service area, within the municipality.

Table 23: QUINTON TOWNSHIP HUC-11 BUILDOUT (Based on Existing Zoning)				
HUC11	Zoning	Total Acres	Residential (Units)	Commercial (SF)
2040206040	LI/O	351.69	0.00	3,370,339.54
	PBR	411.39	137.13	0.00
	R-2	1.85	10.07	0.00
	TOTALS	764.93	147.20	3,370,339.54
2040206060	LI/O	68.86	0.00	659,898.74
	M	20.78	0.00	271,594.24
	PBR	4,675.77	1,558.59	0.00
	R-1	2.00	5.81	0.00
	VR	3.72	24.93	0.00
	TOTALS	4,771.13	1,589.33	931,492.98
2040206070	HC	39.96	0.00	313,308.43
	PBR	3,525.80	1,175.27	0.00
	TOTALS	3,565.76	1,175.27	313,308.43

2. Adequacy of Dilution To Meet Future Non-Sewer Service Area Demand

Table 24 below summarizes the allowable number of residential units and commercial square footage that could be developed by the municipality outside the wastewater service area, while maintaining a target concentration of nitrate in groundwater.

Table 24: QUINTON TOWNSHIP HUC-11 BUILDOUT CAPACITY / DENSITY				
HUC11	Zoning	Total Acres	Residential (Units)	Commercial (SF)
2040206040	LI/O	351.69	0.00	185,101.31
	PBR	411.39	54.13	0.00
	R-2	1.85	0.24	0.00
	TOTALS	764.93	54.37	185,101.31
2040206060	LI/O	68.86	0.00	37,731.48
	M	20.78	0.00	11,388.03
	PBR	4,675.77	640.52	0.00
	R-1	2.00	0.27	0.00
	VR	3.72	0.51	0.00
	TOTALS	4,771.13	641.30	49,119.51
2040206070	HC	39.96	0.00	23,855.96
	PBR	3,525.80	526.24	0.00
	TOTALS	3,565.76	526.24	23,855.96

The following **Table 25** summarizes the results of the nitrate dilution capacity analysis. The table reflects the differences between the potential number of residential units and commercial square footage that could be projected by the municipality outside the wastewater service area and number of allowable units necessary to maintain a target concentration of nitrate in groundwater.

Table 25: Quinton Township HUC-11 Dilution Analysis Summary- Potential Development and Available Dilution					
HUC11	Total Acres	Residential Build-out (Units)	Residential Capacity (Units)	Commercial Build-out (SF)	Commercial Capacity (SF)
2040206040					
TOTALS	764.93	147.20	54.37	3,370,339.54	185,101.31
2040206060					
TOTALS	4,771.13	1,589.33	641.30	931,492.98	49,119.51
2040206070					
TOTALS	3,565.76	1,175.27	526.24	313,308.43	23,855.96

The number of units allowed by zoning exceeds that which can be supported in a particular watershed. The Municipality is currently reviewing the results of the dilution analysis in an effort to determine what zoning adjustments may be appropriate to meet both the regulatory requirements and the development objectives of the municipality. The method/data generated by the Wastewater Estimation model builder has specific limitations within this application, as identified above. Consequently, this initial step does not provide sufficient data or an accurate depiction of development potential for the municipality. The Municipality will need to apply more specific methods of analysis prior to making adjustments to the current zoning. In addition, the current septic densities for the HUC-11's in Quinton Township are also expected to be much lower than required to achieve adequate nitrate dilution, when compared to the results of the nitrate dilution analysis.

K. Upper Pittsgrove Township Nitrate Dilution Analysis

1. Future Wastewater Outside of Sewer Service Area Buildout

Table 26 summarizes the number of residential units and commercial square footage that could potentially generate wastewater per zone within each HUC11, outside the sewer service area, within the municipality.

Table 26: UPPER PITTSGROVE TOWNSHIP HUC-11 BUILDOUT (Based on Existing Zoning)				
HUC11	Zoning	Total Acres	Residential nits)	Commercial (SF)
02040202160	A	1,062.37	350.58	0.00
	LR/A	508.82	254.41	0.00
TOTALS		1,571.20	605.00	0.00
02040206030	A	3,429.80	1,131.83	0.00
	B	55.60	0.00	363,262.34
	HB	143.88	0.00	1,253,495.36
	P	18.10	0.00	157,723.57
	VR	43.30	62.87	0.00
TOTALS		3,690.68	1,194.70	1,774,481.27
02040206060	A	2,488.11	821.08	0.00
	VR	20.58	29.88	0.00
TOTALS		2,508.69	850.96	0.00
02040206080	A	266.92	88.08	0.00
	TOTALS	266.92	88.08	0.00
02040206120	HB	32.55	0.00	283,592.09
	LR	1,432.27	716.14	0.00
	LR/A	350.29	175.15	0.00
	VR	72.58	105.38	0.00
TOTALS		1,887.69	996.67	283,592.09
02040206150	A	4,682.80	1,545.32	0.00
	B	48.42	0.00	316,371.59
	HB	358.23	0.00	3,120,933.71
	LR	903.95	451.98	0.00
	LR/A	1,207.81	603.91	0.00
	P	121.86	0.00	1,061,673.29
	VB	46.09	0.00	401,541.63
	VR	205.00	297.65	0.00
TOTALS		7,574.17	2,898.86	4,900,520.24

2. Adequacy of dilution to meet future non-sewer service area demand

Table 27 below summarizes the allowable number of residential units and commercial square footage that could be developed by the municipality outside the wastewater service area, while maintaining a target concentration of nitrate in groundwater.

Table 27: UPPER PITTSBORO TOWNSHIP HUC-11 BUILDOUT CAPACITY / DENSITY				
HUC11	Zoning	Total Acres	Residential (Units)	Commercial (SF)
02040202160	A	1,062.37	149.63	0.00
	LR/A	508.82	71.67	0.00
	TOTALS	1,571.20	221.30	0.00
02040206030	A	3,429.80	476.36	0.00
	B	55.60	7.72	30,886.50
	HB	143.88	19.98	79,934.15
	P	18.10	2.51	10,057.87
	VR	43.30	6.01	0.00
	TOTALS	3,690.68	512.59	120,878.53
02040206060	A	2,488.11	340.84	0.00
	VR	20.58	2.82	0.00
	TOTALS	2,508.69	343.66	0.00
02040206080	A	266.92	38.13	0.00
	TOTALS	266.92	38.13	0.00
02040206120	HB	32.55	4.93	19,728.42
	LR	1,432.27	217.01	0.00
	LR/A	350.29	53.07	0.00
	VR	72.58	11.00	0.00
	TOTALS	1,887.69	286.01	19,728.42
02040206150	A	4,682.80	678.67	0.00
	B	48.42	7.02	28,069.15
	HB	358.23	51.92	207,671.82
	LR	903.95	131.01	0.00
	LR/A	1,207.81	175.05	0.00
	P	121.86	17.66	70,645.41
	VB	46.09	6.68	26,719.21
	VR	205.00	29.71	0.00
	TOTALS	7,574.17	1,097.71	333,105.59

The following **Table 28** summarizes the results of the nitrate dilution capacity analysis. The table reflects the differences between the potential number of residential units and commercial square footage that could be projected by the municipality outside the wastewater service area and number of allowable units necessary to maintain a target concentration of nitrate in groundwater.

TABLE-28: Upper Pittsgrove Township HUC-11 Dilution Analysis Summary- Potential Development and Available Dilution					
HUC11	Total Acres	Residential Buildout (Units)	Residential Capacity (Units)	Commercial Buildout (SF)	Commercial Capacity (SF)
02040202160					
TOTALS	1,571.20	605.00	221.30	0.00	0.00
02040206030					
TOTALS	3,690.68	1,194.70	512.59	1,774,481.27	120,878.53
02040206060					
TOTALS	2,508.69	850.96	343.66	0.00	0.00
02040206080					
TOTALS	266.92	88.08	38.13	0.00	0.00
02040206120					
TOTALS	1,887.69	996.67	286.01	283,592.09	19,728.42
02040206150					
TOTALS	7,574.17	2,898.86	1,097.71	4,900,520.24	333,105.59

The number of units allowed by zoning exceeds that which can be supported in a particular watershed. The Municipality is currently reviewing the results of the dilution analysis in an effort to determine what zoning adjustments may be appropriate to meet both the regulatory requirements and the development objectives of the municipality. The method/data generated by the Wastewater Estimation model builder has specific limitations within this application, as identified above. Consequently, this initial step does not provide sufficient data or an accurate depiction of development potential for the municipality. The Municipality will need to apply more specific methods of analysis prior to making adjustments to the current zoning. In addition, the current septic densities for the HUC-11's in Upper Pittsgrove Township are also expected to be much lower than required to achieve adequate nitrate dilution, when compared to the results of the nitrate dilution analysis.