APPENDIX 1.6
FUTURE WATER DEMANDS AND CONSERVATION ISSUES

CDM

Memorandum

DEIS Support Technical Memorandum *October 1, 2010 revised*
UWNY Future Water Demands and Conservation Issues

Introduction

As part of the DEIS for the Haverstraw Water Treatment plant (HWTP), UWNY is developing future water demands to properly size and phase the construction of the HWSP. CDM has reviewed existing water use records and population projections to provide future water demand projections. The study has been organized into the following sections to develop the projection.

1. Existing Water Use
2. Water Demand Forecasts
3. Water Conservation Savings
4. Conclusions

1.0 Existing Water Use

Existing water use has been categorized into three specific areas as follows:

- Existing Water Use Patterns
- Seasonality of Water Use
- Water Use Metrics

1.1 Existing Water Use Patterns

Monthly billing data from 2000 through 2009 was evaluated to examine water use patterns among UWNY customers. The monthly billings are a combination of monthly and quarterly meter readings. Thus, the reported volume of water does not necessarily correspond with consumption by month. Monthly reported billed water volumes and the number of accounts were provided for twelve customer account categories (i.e., billing sectors). **Table 1** presents the number of accounts by sector from 2000 to 2009. Note that the number of accounts reported by sector for each year was the number of accounts in December of each year.

Single-family residential accounts represent 89 percent of UWNY accounts during this time period. Apartments and multifamily accounts make up 3 percent of accounts, commercial customers represent 6 percent of accounts and hospitals, industries, schools, warehouses and municipal accounts combined make up 2 percent of accounts.

Table 1. Number of UWNY Customers by Sector 2000-2009

Sector	2000	2001	2002	2003	2004	2005	2006*	2007	2008	2009	average%
Apartment	956	965	969	972	979	996	1,027	1,066	1,122	1,143	1.5%
Commercial	4,122	4,184	4,244	4,330	4,388	4,442	4,490	4,527	4,569	4,626	6.3%
Hi-Rise	3	3	3	3	3	3	3	3	3	3	0.0%
Hospital	84	85	84	82	78	80	79	79	83	83	0.1%
Industrial	168	167	169	167	171	172	173	176	175	179	0.2%
Municipal	252	249	250	251	249	253	263	269	279	281	0.4%
Res Single Family	59,579	60,301	60,925	61,456	61,964	62,416	62,911	63,317	64,026	64,789	89.4%
Res Multi-Family	797	804	819	834	830	827	833	867	935	980	1.2%
School	481	487	491	495	509	513	518	534	538	539	0.7%
Warehouse	76	76	76	76	75	76	79	79	79	79	0.1%
Building Rates	-	-	-	-	-	-	-	-	-	0	0.0%
Resale	1	1	1	1	1	1	3	3	3	3	0.0%
Total	66,519	67,322	68,031	68,667	69,247	69,779	70,379	70,920	71,812	72,705	100.0%

Monthly billed water consumption by customer sector is summarized by year in **Table 2**. The residential single-family customers represent more than half (approximately 57 percent) of all billed water use. Apartments and commercial accounts each represent approximately 12 percent of billed consumption. Industrial accounts represent approximately 9 percent of billed water use, while hospitals and schools each represent approximately 2 percent of billed consumption.

Table 3 presents the annual average day and maximum day production in million gallons per day (MGD) for UWNY from 2000 to 2009. The annual average day production averages approximately 30 MGD while the maximum day production averages approximately 42 MGD with a max-day ratio of about 1.4. (This average is calculated without data from the year 2002 because water use restrictions imposed due to drought conditions in that year artificially reduced the maximum day ratio.) The maximum day to average day ratio of recent record is 1.56 (in 2001).

On average, the difference between annual water production (29.4 MGD) and annual billed consumption (24.1 MGD) is approximately 5.3 MGD, or about 18 percent of total production. This difference represents Non-Revenue Water (NRW) which consists of unbilled authorized use and water loss. Water use for firefighting, line flushing and other authorized, but unbilled, use is classified as unbilled consumption. Water loss is comprised of apparent loss and real loss. *Apparent Loss* consists of unauthorized consumption (theft), meter inaccuracies, and data errors. As with the unbilled authorized uses, these categories represent a loss of revenue to the utility but not actual loss of water. *Real Loss* consists of leakage on mains, leakage and overflows at storage and leakage at service connections.

An analysis of UWNY 2007 data by UWY staff using the AWWA Water Loss Control Software indicated that apparent water loss, such as unmetered use, meter error and data error account for an estimated 7.5 percent of total production, while real water loss accounts for about 13 percent of total production for a total NRW of 20.4 percent of production in 2007. A similar analysis for 2009 indicates apparent water loss of an estimated 6.5 percent of total production, while real water loss accounts for about 17.3 percent of total production for a total NRW of 23.8 percent of total production.

Table 2. UWNY Billed Water Use by Sector 2000-2009 in Gallons per Day

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Average	%
Apartment	3,218,027	3,279,529	3,068,036	3,151,232	3,137,053	3,144,131	3,061,582	3,047,180	2,915,028	2,824,190	3,084,599	12.8%
Commercial	3,071,302	3,104,919	2,845,433	2,811,449	2,977,048	3,085,000	2,859,266	3,004,847	2,695,679	2,613,701	2,906,864	12.1%
Hi-Rise	4,752	1,451	1,197	842	602	205	162	162	250	373	1,000	0.0%
Hospital	699,134	662,728	626,156	602,433	607,128	577,278	574,560	561,783	570,224	530,553	601,198	2.5%
Industrial	2,108,870	2,012,741	1,882,339	2,106,429	2,433,664	2,378,753	2,506,013	2,256,253	2,298,073	1,386,399	2,136,953	8.9%
Municipal	282,605	299,243	318,334	334,721	358,933	404,369	419,985	399,545	397,249	301,967	351,695	1.5%
Res SF	13,362,770	14,242,326	12,797,735	13,241,772	13,393,434	14,433,199	14,135,532	14,337,365	13,885,796	13,156,529	13,698,646	57.0%
Res MF	377,539	389,308	354,960	394,686	380,621	394,960	397,430	379,871	378,082	369,045	381,650	1.6%
School	632,117	709,018	598,312	642,366	633,079	671,956	691,660	712,780	662,388	609,995	656,367	2.7%
Warehouse	33,678	63,766	72,734	75,470	66,636	70,634	75,507	85,305	95,060	85,106	72,390	0.3%
Bldg Rates	10,144	2,336	6,455	16,108	9,591	13,095	8,546	10,083	7,378	0	8,374	0.0%
Resale	123,664	139,921	103,339	84,247	88,086	101,744	224,418	219,131	219,652	86,288	139,049	0.6%
Total	23,924,604	24,907,287	22,675,030	23,461,756	24,085,875	25,275,324	24,954,661	25,014,305	24,124,859	21,964,145	24,038,784	100.0%

Table 3. UWNY Annual Production and NRW 2000 - 2009 in MGD

	2000	2001	2002**	2003	2004	2005	2006	2007	2008	2009	Average	w/o 2002
AAD Production	28.550	29.700	26.670	28.540	29.160	31.060	30.910	31.430	29.920	28.408	29.435	29.891
Max Day Production	39.070	46.480	31.940	37.350	40.000	43.640	44.780	44.180	40.850	35.330	40.362	41.576
Max Day Ratio	1.37	1.56	1.20	1.31	1.37	1.41	1.45	1.41	1.37	1.24	1.368	1.389
Quarterly billed	14.843	15.762	14.198	14.695	14.822	15.877	15.554	15.691	15.174			
Monthly billed	9.072	9.143	8.471	8.751	9.254	9.385	9.392	9.305	8.944			
Total billed	23.925	24.907	22.675	23.462	24.086	25.275	24.955	25.014	24.125	22.294	24.072	24.265
NRW*	4.625	4.793	3.995	5.078	5.074	5.785	5.955	6.416	5.795	6.114	5.363	5.626
NRW%	16.2%	16.1%	15.0%	17.8%	17.4%	18.6%	19.3%	20.4%	19.4%	21.5%	18.2%	18.8%

* NRW = production minus billed consumption ** 2002 was a year in which water use restrictions were imposed.

1.2 Seasonality of Water Use

The seasonality of water use among billing sectors is shown in **Figure 1**. Seasonality is skewed by the quarterly billing cycles, particularly in the customer sectors with small number of accounts or smaller volume of water, thus the data may not align exactly with the month of actual consumption. However, the analysis does provide information on which sectors demonstrate variation in use throughout the year (i.e., seasonality of use), and thus which sectors contribute to the peak water demand.

Figure 1 is a stacked line graph in which the water use of each sector is added on top of the preceding sector, thus creating a cumulative effect. The twelve billing categories are combined into six major sectors to simplify the graph. The residential single-family sector uses the most water and has a clear seasonal pattern. Billing volumes in July through October are significantly more than in the winter months, suggesting that the seasonality is due to outdoor irrigation and other summer water use patterns (e.g., swimming pool make-up water, car washing, etc).

The combined apartments, multifamily residences and hi-rise accounts are the second largest volume sector but show relatively little seasonal variation. (Water use among multifamily accounts shows a distinct 3-month variation indicating that the variation is due to the billing cycle.) Water use among commercial accounts shows distinct seasonal variation while water use among industrial accounts is non-seasonal.

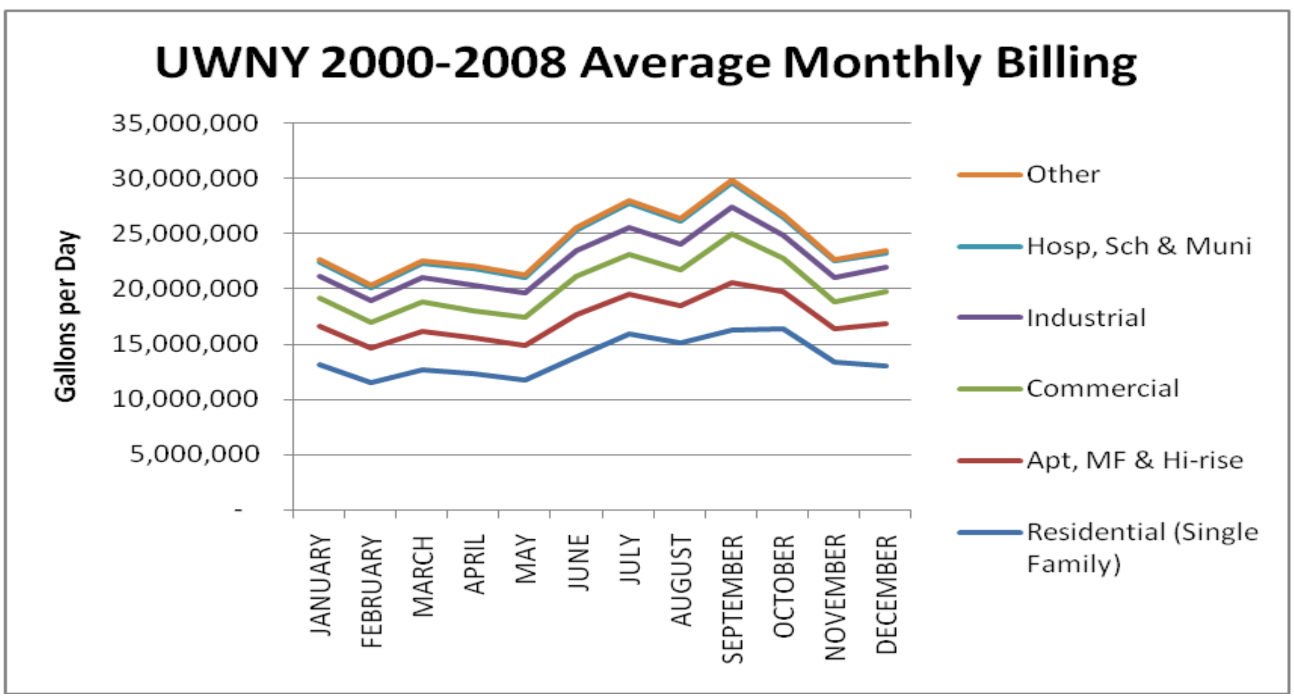

Figure 1 Seasonality of UWNY Customers

Water use among the hospital, school and municipal accounts is relatively small but does show seasonal variation. The average monthly water use among these three customer classes are further illustrated in **Figure 2**. Water use among schools may show some seasonal variation in addition to the variation from the billing cycle. Water use among hospital and municipal accounts shows very clear increases in summer water use. The seasonality of hospital water use is due to increased water needs for cooling towers in addition to outdoor irrigation, while the seasonality of municipal water use is assumed to be predominately outdoor irrigation.

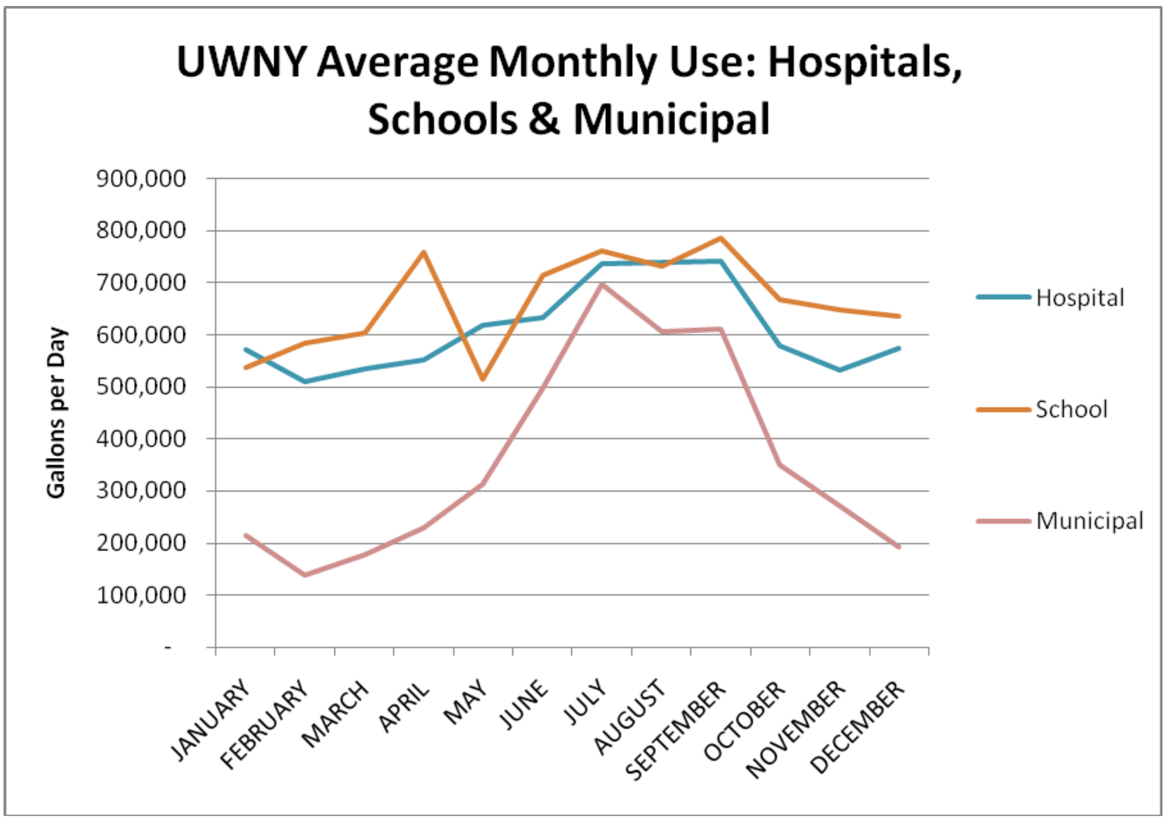

Figure 2 Seasonality of hospitals, schools and municipal accounts

Thus, the summer peak water demand appears to be driven by the increase in water use among single-family, commercial, and municipal accounts. Water conservation programs intended to reduce the summer peak water use should be targeted to these sectors.

1.3 Water Use Metrics

Table 4 presents average monthly water use per account by sector among all the years 2000 – 2009 plus the overall monthly average for all accounts. The average gallons per month for each sector is shown for the period 2000 – 2009. The daily water use per account as calculated from the data in Tables 1 and 2 is shown in **Table 5** for the years 2000 – 2009. The average *minus 2002* is also shown because of the *water use restrictions in that year*.

Table 4. UWNY Average Monthly Gallons per Day per Account 2000 - 2009

	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	AVERAGE
Apartment	3,195	2,946	2,900	2,948	2,992	3,259	3,264	3,126	3,677	2,970	2,834	3,204	3,110
Commercial	558	525	587	547	566	806	823	755	1,006	688	569	668	675
Hi-Rise	667	819	74	107	201	60	27	1,363	252	283	241	186	357
Hospital	7,010	6,235	6,549	6,750	7,553	7,756	9,034	9,056	9,088	7,071	6,507	7,006	7,468
Industrial	11,465	11,253	12,839	13,538	12,735	13,718	14,346	13,387	14,514	12,690	12,859	12,549	12,991
Municipal	841	533	690	889	1,209	1,920	2,698	2,345	2,362	1,353	1,054	749	1,387
Res SF	212	187	206	199	190	224	256	244	262	264	215	211	222
Res MF	421	205	670	412	204	671	470	243	804	515	227	656	458
School	1,059	1,153	1,191	1,485	1,027	1,411	1,498	1,442	1,548	1,313	1,280	1,256	1,305
Warehouse	839	754	906	824	715	969	967	831	1,418	1,013	733	1,089	922
Resale	120,409	82,047	97,398	83,875	92,015	99,955	113,017	104,836	101,385	87,371	77,953	89,796	95,838
Overall Monthly Average (all accounts)	327	294	325	319	307	370	405	381	432	386	327	340	351

Table 5. UWNY Average Gallons per Day per Account 2000 – 2009												w/o 2002
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Average	
Apartment	3366	3398	3166	3242	3204	3157	2981	2859	2598	2471	3,044	2,989
Commercial	745	742	670	649	678	695	637	664	590	565	664	652
Hi-Rise	1584	484	399	281	201	68	54	54	83	124	333	169
Hospital	8323	7797	7454	7347	7784	7216	7273	7111	6870	6392	7,357	7,224
Industrial	12553	12052	11138	12613	14232	13830	14486	12820	13132	7745	12,460	12,614
Municipal	1121	1202	1273	1334	1441	1598	1597	1485	1424	1075	1,355	1,394
Res SF	224	236	210	215	216	231	225	226	217	203	220	221
Res MF	474	484	433	473	459	478	477	438	404	377	450	449
School	1314	1456	1219	1298	1244	1310	1335	1335	1231	1132	1,287	1,293
Warehouse	443	839	957	993	888	929	956	1080	1203	1077	937	996
Resale	123664	139921	103339	84247	88086	101744	74806	73044	73217	28763	89,083	87,499
Overall Daily Average (all accounts)	360	370	333	342	348	362	355	353	336	302	346	347

As discussed in the preceding section, some of the monthly seasonality is skewed by billing cycles. This billing cycle bias is evident in the monthly pattern for hi-rise and multifamily accounts.

The average water use per account can be a useful metric for benchmarking water use within a given sector. Water use per account may be useful in estimating future water use within a sector if there are projections of the future number of accounts within the sector. However, projections of other demographic indicators, such as population, number of households and employment are more common than projections of number of accounts.

AKRF compiled projections of population, households, and employment for Rockland County from a variety of sources including Cornell, New York Metropolitan Transportation Council (NYMTC), ESRI Business Analyst, American Community Survey, and Woods & Poole Economics. These data sets included estimates of Rockland County residential population, households and employment for the years 2000 – 2009. These demographic estimates for the county were then adjusted to the UWNY service area, based on the estimated percentage of Rockland County residents and employees currently located within the UWNY service area. The average historical population, households and employment estimates from the various sources as applied to the UWNY service area are presented in **Table 6**. Also presented in Table 6 are the average persons per household and the average employment to population ratio as derived by CDM from the calculated averages, which indicate consistent patterns within the calculated average values. CDM used these average population, household and employment values for 2000 – 2009 in conjunction with the UWNY 2000 – 2009 production and billing data to derive additional water use metrics presented in **Table 7**.

UWNY billing categories of single-family, multifamily, apartment and hi-rise accounts were combined to compute the residential water use metrics. The residential metrics are gallons per day per account, per household and per capita. Such metrics are best used to observe trends in water use within one's own system. Use of metrics in comparisons with other systems should be made with caution, in particular differences in billing customer classifications of different systems inhibit good comparisons.

The UWNY residential water use metrics from 2000 – 2009 show consistent water use per household, or per capita, with minor variations due to weather conditions year to year. In comparison to residential water use in other systems, the UWNY residential water use is relatively conservative. Residential water use per household may range from 150 to 800 gallons per day per household depending upon the region of the country and socio-economic status of a community. The American Water Works Association Research Foundation (AWWARF) conducted a detailed study of residential end uses of water across the US and Canada. (See *Residential End Uses of Water*, Mayer et al., AWWARF 1999.) This study measured water use in households in twelve systems and found that while average water use per household varied from 192 to 825 gallons per day per household (mean was 400 gpd) due to the influence of outdoor water use, the indoor water use was much more consistent. Average indoor water use ranged from 79 to 267 gallons per day with an average (mean) of 173 gallons per day per household. On a per capita basis, this indoor water use ranges from 57 to 84 gallons per capita per day (gpcd), with an average of 69 gpcd.

Comparing UWNY residential water use to the AWWARF average residential water use, the residential water use of UWNY indicates that the UWNY average total residential water use (209 gpd) is slightly higher than the AWWARF average indoor water use (173 gpd) when looking at water use per household. However, on a per capita basis, the UWNY average total residential water use (67 gpcd) is slightly lower than the AWWARF average indoor water use (69 gpcd). This suggests that even with outdoor water use, the UWNY residential customers are water efficient relative to other systems.

Table 6. UWNY Historical Demographics for Service Area

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Population*	248,841	250,019	251,320	252,463	253,844	255,047	257,447	258,531	259,997	261,837
Households*	80,604	81,116	81,290	81,672	81,971	81,900	82,352	82,754	83,167	85,015
Employment*	118,557	120,005	121,577	122,996	124,316	125,551	126,821	128,410	129,258	129,797
persons per household	3.09	3.08	3.09	3.09	3.10	3.11	3.13	3.12	3.13	3.08
empl/pop ratio	0.48	0.48	0.48	0.49	0.49	0.49	0.49	0.50	0.50	0.50

*Average values derived from multiple sources.

Commercial, hospital, industrial, municipal, school, and warehouse accounts were combined to compute the nonresidential water use metrics. The nonresidential metrics are gallons per day per account, per employee and per capita.

Water use among building rates and resale accounts were combined to compute “other” water use metric in gallons per capita. In addition, the gallons per day per capita values for total water production, total billed consumption, and nonrevenue water were calculated.

Table 7. UWNY Water Use Metrics

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Average	w/o 2002
Residential (Apartment, Hi-rise, Single-family, Multifamily)												
GPD	16,963,089	17,912,614	16,221,927	16,788,532	16,911,710	17,972,495	17,594,706	17,764,578	17,179,156	16,350,136	17,165,894	17,309,241
Accounts	61,335	62,073	62,716	63,265	63,776	64,242	64,774	65,253	66,086	66,914	64,043	64,548
Households/Acct	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3
GPD/Acct	277	289	259	265	265	280	272	272	260	244	268	268
GPD/Household	210	221	200	206	206	219	214	215	207	192	208.9	209.9
GPD/pop	68	72	65	66	67	70	68	69	66	62	67.4	67.6
NonResidential (Commercial, Hospital, Industrial, Municipal, School, Warehouse)												
GPD	6,827,707	6,852,416	6,343,308	6,572,869	7,076,488	7,187,989	7,126,991	7,020,513	6,718,673	5,527,720	6,725,467	6,760,457
Accounts	24,500	24,088	22,712	24,234	26,268	25,578	26,283	24,494	24,450	17,986	24,059	24,173
Empl/Acct	4.8	5.0	5.4	5.1	4.7	4.9	4.8	5.2	5.3	7.2	5.2	5.2
GPD/Acct	279	284	279	271	269	281	271	287	275	307	280	281
GPD/empl	58	57	52	53	57	57	56	55	52	43	54	54
GPD/pop	27	27	25	26	28	28	28	27	26	21	26	26.4
Other (Building Rates, Resale)												
GPD	133,808	142,257	109,794	100,355	97,677	114,840	232,964	229,214	227,029	86,288	147,423	153,828
GPD/pop	0.5	0.6	0.4	0.4	0.4	0.5	0.9	0.9	0.9	0.3	0.6	0.6
Per Capita Metrics												
Billed GPD/pop	96	100	90	93	95	99	97	97	93	84	94.3	94.6
Prod GPD/pop	115	119	106	113	115	122	120	122	115	108	115.5	116.7
NRW GPD/pop	19	19	16	20	20	23	23	25	22	25	21.1	22.1

2.0 Water Demand Forecasts

In 2006, a water demand forecast for the UWNY service area was prepared by UWNY in cooperation with the Rockland County Department of Health. The development of this forecast is described in the testimony of Dr. Daniel M. Miller (pgs 7-9 and exhibits). This forecast included a projection of the average annual demand (AAD) using a regression analysis of the historical trend, and upper and lower bounds expressed in confidence intervals surrounding the expected AAD. UWNY chose to use the 95 percent confidence interval upper bound (95%CI) for planning purposes. As illustrated in **Figure 3** the AAD reflects average annual water use and actual usage varies from year to year above and below this average as observed in the historical data. The 95%CI projection is used for planning purposes because it is likely to incorporate the upper limit of the variation in demand.

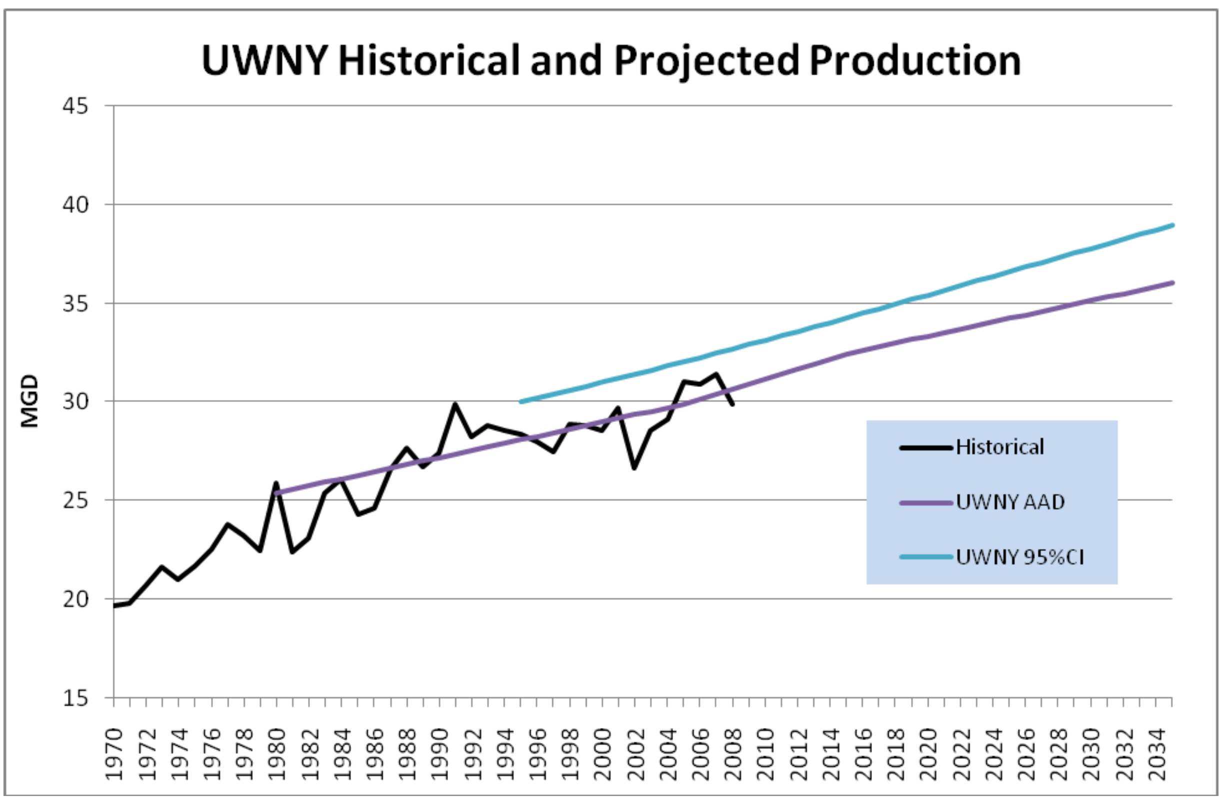

Figure 3 Historical and Projected Annual Average Demand with 95% Confidence Interval

The 2006 water demand forecast estimates that UWNY AAD will reach 33.3 MGD by 2020 and 36.0 MGD by 2035. The 95%CI forecast is estimated to reach 35.4 MGD by 2020 and 39.0 MGD by 2035.

The intent of this report is to develop alternative water demand projections for the UWNY service area using demographic projections for the county for comparison with the 2006 projected water demand. There are a number of standard methodologies used to forecast future water demand. These include:

- Trend extrapolation – this method assumes historical water use trends will continue into the future
- Per capita method – this method assumes that water use per person will continue into the future and is dependent upon population projections
- Unit use method – this method assumes that the rate of water use per unit will continue into the future and is dependent upon the projected number of units
- Multivariate models – this method assumes that the water use per unit is a function of explanatory factors, thus the unit use changes over time; and is dependent upon projected values of the explanatory factors and the number of units. The *function* is determined from a regression analysis of historical water use and explanatory factors.
- Econometric models - this a multivariate model that includes variables representing the price of water, income, or other economic factors

These methodologies are described in greater detail in:

- *Urban Water Demand Management and Planning,* Edited by D. Baumann, J. Boland and W. M. Hanemann. McGraw-Hill, 1998. (Baumann et al.)
- *Water Resources Planning,* Manual of Water Supply Practices M50. American Water Works Association, 2001, 2007. (AWWA M50)

The selection of an appropriate water demand forecasting approach requires an assessment of the project objectives, the availability and quality of supporting data, and the resources (time and budget) available to develop the forecast. The trade-offs among the different approaches are illustrated in **Figure 4**.

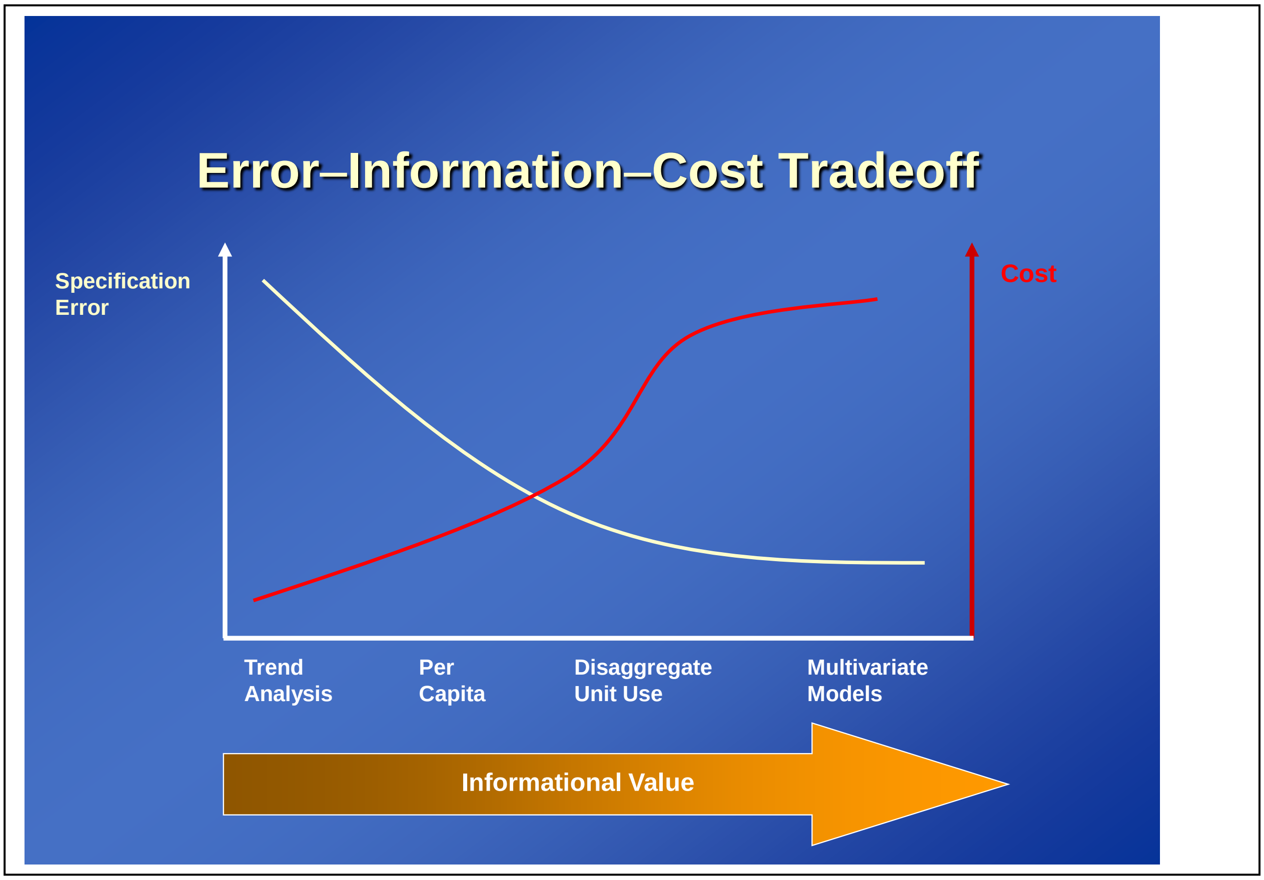

Figure 4 Trade-off among water demand forecasting approaches

In addition, the standard approach to addressing uncertainty in water demand forecasts includes (Baumann et al.):

- Incorporate "safety factors" – adding a fixed (percent) adjustment to the forecast to address all likely uncertainty
- Develop alternative scenarios – prepare a range of forecasts to convey the range of possible outcomes, and sensitivity analysis
- Conduct sensitivity analysis – examine changes in individual underlying assumptions to determine the most critical assumptions and the range of likely outcomes
- Set forecast bounds – identify the maximum range of plausible outcomes through either arbitrary assignment of upper and lower bounds, or developing confidence intervals from the probability of error

This last approach of addressing the forecast uncertainty through estimating the probability of error includes the Monte Carlo simulation approach in which the statistical model error of a multivariate (regression) model, in combination with the range and probability of each model input, can be used to generate multiple simulations of model estimates that provide a probabilistic forecast. This approach represents the state-of-the-art of water demand forecasting and requires extensive data, time and resources, but provides water resource managers with a maximum level of decision-making information regarding future water demands.

For the purposes of this analysis, a per capita methodology is used to develop a plausible range of likely water demand forecasts. A Monte Carlo application using the regression statistics of the 2006 trend analysis, in combination with statistics associated with the population projection models, would generate a probabilistic range of outcomes of future water demand (assuming that the population projection model statistics were available). However, a per capita methodology in combination with alternative scenarios can provide similar bounds of likely outcomes adequate for planning purposes even though the probability of outcomes is not determined.

The per capita metrics shown in Table 7 for each sector were multiplied by the projected population to estimate the water demand of each sector. In addition, a percent of total production for non-revenue water was added to the sum of the sector demands to calculate the total water production for the service area. Initially, a 23 percent NRW factor was used to estimate the NRW water to reflect current system conditions.

UWNY obtained population projections for Rockland County issued in 2010 from the Rockland County Department of Planning. In addition, AKRF identified alternative projections of population, households, and employment for Rockland County from a variety of sources (Cornell, NYMTC09, and Woods & Poole Economics).

A per capita water demand forecast was estimated using the Rockland County Department of Planning (RCDP) as the "most likely" scenario, and using the NYMTC and Woods & Poole (W&P) population projections as alternatives for comparative purposes.

The demographic projections for the county were adjusted to the UWNY service area. UWNY estimated that it currently serves about 86.9 percent of the county population. It is estimated that by 2040 UWNY would serve 91.9 percent (91.5 percent by 2035) of the county population and housing as self-supplied households (on private wells) shift to UWNY water service. It is estimated that UWNY serves about 87 percent of county employment through its commercial, industrial, and institutional customers. This percentage is expected to remain about the same into the future.

These initial water demand projection with the alternative population projections are shown in **Table 8**. The forecast based upon the Woods & Poole Economic projections are higher than those based upon the RCDP projections, while those based upon the NYMTC projections are lower. Therefore, the RCDP based forecast is deemed reasonable for further analysis. These three alternative forecasts are shown in **Figure 5** in comparison with the 2006 UWNY projections. *The* *conclusion from this comparison is that the per capita forecast using the Rockland County Department of Planning population projections is very similar to the 2006 forecast with the 95 percent confidence interval that was selected for planning purposes.*

Note that for the remainder of this analysis, only the Rockland County Department of Planning (RCDP) per capita forecast will be used.

Table 8. Initial Per Capita Forecasts for UWNY Service Area in MGD

		2010	2015	2020	2025	2030	2035
Per Capita - W&P							
Residential	GPD/household	17.811	18.790	19.779	20.749	21.714	22.652
Nonresidential	GPD/employment	6.959	7.341	7.728	8.107	8.484	8.850
Other	GPCD x pop	0.158	0.167	0.175	0.184	0.193	0.201
Total Billed	summed	24.927	26.298	27.683	29.039	30.390	31.703
NRW	23% of Prod	7.446	7.855	8.269	8.674	9.077	9.470
Production	summed	32.373	34.153	35.951	37.713	39.467	41.173
Per Capita - RCDP							
Residential	GPCD x pop	17.776	18.498	19.220	19.926	20.611	21.244
Nonresidential	GPCD x pop	6.945	7.227	7.509	7.785	8.053	8.300
Other	GPCD x pop	0.158	0.164	0.170	0.177	0.183	0.188
Total Billed	summed	24.879	25.889	26.900	27.887	28.846	29.732
NRW	23% of Prod	7.431	7.733	8.035	8.330	8.616	8.881
Production	summed	32.311	33.621	34.935	36.217	37.463	38.614
Per Capita - NYMTC							
Residential	GPCD x pop	17.571	18.375	19.148	19.906	20.493	21.021
Nonresidential	GPCD x pop	6.865	7.179	7.481	7.777	8.007	8.213
Other	GPCD x pop	0.156	0.163	0.170	0.177	0.182	0.186
Total Billed	summed	24.591	25.717	26.799	27.860	28.682	29.421
NRW	23% of Prod	7.345	7.682	8.005	8.322	8.567	8.788
Production	summed	31.937	33.399	34.804	36.182	37.249	38.209

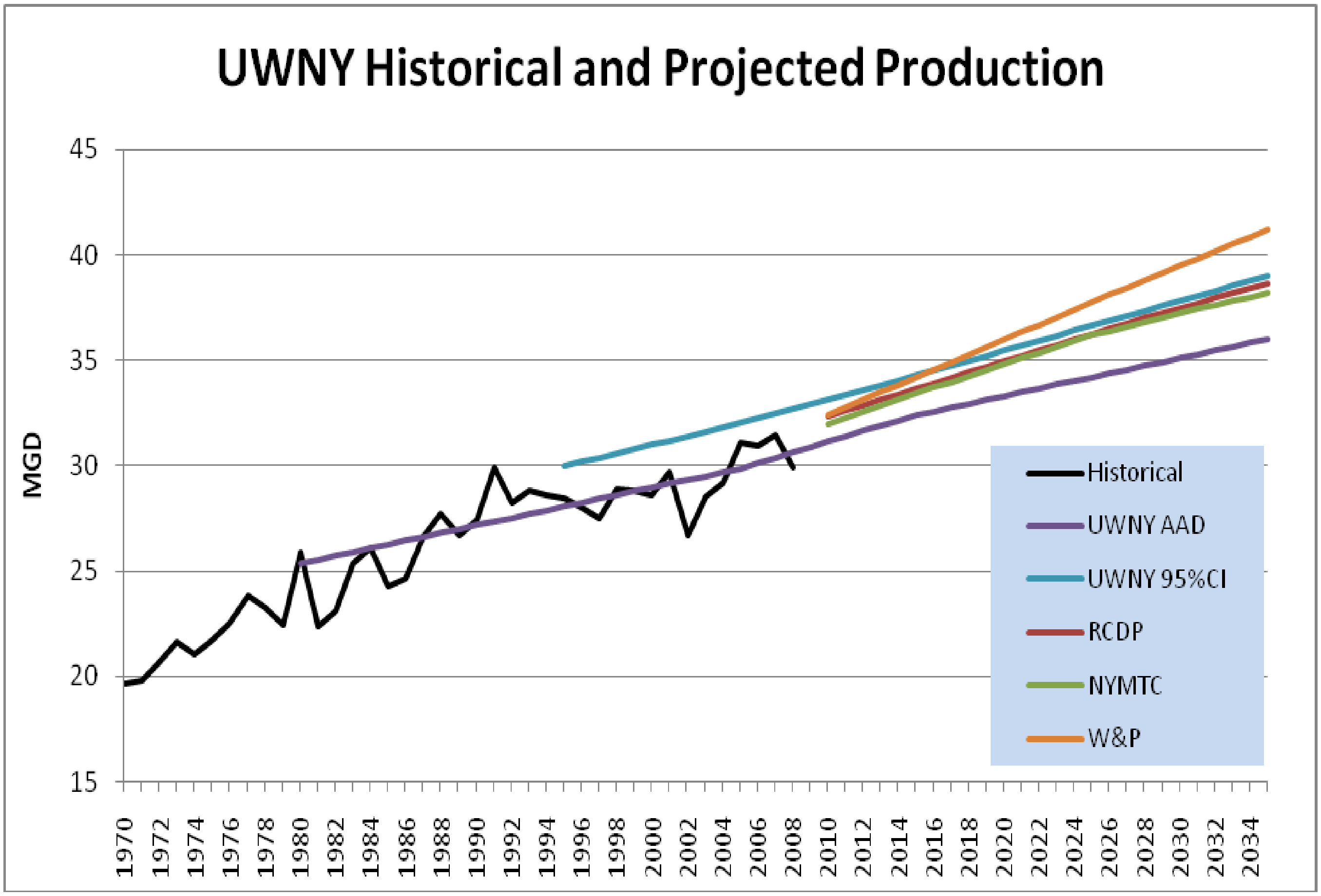

Figure 5 Alternative Per Capita Projections in comparison with 2006 Projections

3.0 Water Conservation Potential Impacts

UWNY has provided a number of water conservation programs and incentives to its customers. Past and current water conservation programs are described below.

- Public education and customer outreach programs (since 1970s)
- Declining-block rate structure with seasonal component (1981)
- Distribution of residential retrofit kits (1983, 1993, 1994, 2007)
- Guides of use of evapotranspiration (ET) in computing proper landscape irrigation requirements (1992)
- Automatic meter reading monitoring (1992)
- Multifamily residential billing and audits (1994)
- Guides on water efficient landscape materials (2007)

In addition, droughts occurred in 1980-81, 1985-86, 1995, 1998, and 2001-02, with mandatory water use restrictions imposed in 1980-81, 1985-86, and 2001-02. Drought effects raise awareness of water conservation and have some lingering effects among the community.

Figure 6 shows changing trends in total UWNY water production that could be interpreted as responses to improved water use efficiency due to plumbing fixture standards and UWNY conservation programs, as well as changes in underlying demographic growth patterns within the service area. While conservation cannot claim all responsibility for the decreasing trends in total production, the UWNY conservation programs have likely had significant influences in reducing the overall water use patterns in the service area.

Continuation of current water conservation programs is important in maintaining the level of awareness and current water use efficiency practices within the UWNY service area into the future. As illustrated in **Figure 7**, the adoption of water efficiency practices are supported by (1) having water efficient technology available, (2) providing information about water efficiency and why it is important, and (3) incentives for customers to implement water efficient technologies and behaviors. UWNY conservation programs to date have focused on providing information to customers, implementation of water conserving rate structure, distribution of water saving kits, and promoting voluntarily adoption of available technology and more water efficient practices.

Table 9 provides a comparison of the water conservation programs of UWNY and other similar water utilities in the northeastern and mid-Atlantic US.

WATER CONSERVATION PROGRAM COMPARISON

Operation	State	Ownershi p	Population Served[1]	Median Income[2]	Single Family[2]	Conservatio n Info	WaterSens e Partner[3]	Discounted Products	Line Protection[4]	Rebates	Ordinances or Regulations	ICI Programs[5]	Xeriscape Gardening	ET Lawn Watering	Other	Conserving Rate Structure
UW New York	NY	Private	286,753	$84,105	68%	YES	YES	Showerheads, toilet devices, aerators, rain gauges, watering timers	YES	NO	NO	NO	YES	YES	CAG, School Program	YES:Seasonal/Inclinin g Block
Aquarian	CT	Private	573,126	$83,492	76%	YES	NO	Rain barrel	YES	NO	NO	NO	NO	NO	NO	YES: Inclining Block
MDC	CT	Public	388,700	$63,310	61%	YES	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO: Uniform block
UW Delaware	DE	Private	105,270	$62,628	75%	YES	YES	Showerheads, toilet devices, aerators, rain gauges, watering timers	YES	NO	NO	NO	YES	YES	NO	YES(Part):Res: Inclining Block Comm: Uniform Ind:
MWRA	MA	Authority	2,360,000	$77,373	55%	YES	YES	Showerheads, aerators	NO	Toilet (Municipal only)	Leak study regulation for member systems	Surveys/Cas e study info	NO	NO	School program, Free spray valves for	Varies by system
WSSC	MD	Authority	1,800,000	$93,999	69%	YES	NO	NO	NO	NO	NO	NO	NO	NO	NO	YES: Inclining Block
Harford County DPW	MD	Public	104,567	$75,872	80%	NO	NO	NO	NO	NO	NO	NO	NO	NO	School lectures	NO: Uniform block
Cary	NC	Public	149,000	$89,053	74%	YES	YES	Rain barrel	NO	Toilet	Alternate Day Watering Water Waste Ordinance Rain Sensor Ordinance	Toilet Rebate	YES	NO	Turf Buy-back, school program	YES: Inclining Block
Middlesex Water	NJ	Private	233,376	$77,315	65%	YES	YES	NO	YES	NO	NO	NO	NO	NO	NO	NO: Uniform block
Passaic Valley	NJ	Authority	314,900	$55,647	46%	YES	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO (Most): Uniform block (most), Inclining block (some)
New York City	NY	Public	6,552,718	$50,403	16%	YES	YES	NO	NO	NO	NO	Reuse discount	NO	NO	Leaks Audits	NO: Uniform block
Nyack Village	NY	Public	14,700	$87,696	42%	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO: Declining block
UW New Rochelle	NY	Private	141,000	$81,732	43%	YES	YES	Showerheads, toilet devices, aerators, rain gauges, watering timers	YES	NO	NO	NO	YES	NO	NO	NO: Declining block
Westchester Joint	NY	Public	55,210	$112,842	64%	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	Varies by system
Suffolk County Water	NY	Authority	1,100,000	$84,767	85%	YES	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO: Uniform block
Suffern Village	NY	Public	12,000	$74,000	45%	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	YES: Inclining Block
York Water Company	PA	Private	159,623	$56,723	79%	YES	YES	NO	NO	NO	NO	NO	NO	NO	NO	NO:Res: Uniform Block Comm & Ind: Deceasing Block
Aqua	PA	Private	1,400,000	$76,834	76%	YES	NO	LeakAlertor	NO	NO	NO	NO	NO	NO	NO	YES: Inclining Block
Westmoreland	PA	Authority	140,000	$46,966	79%	NO	NO	NO	YES	NO	NO	NO	NO	NO	NO	NO: Declining block
Statistics for All Systems			836,365	$75,514	63%											
UWNY Stats & Status			286,753	$84,105	68%	YES	YES	YES	YES	NO	NO	NO	YES	YES	YES	YES
Percent of Other Systems with Program						72%	39%	33%	28%	11%	11%	17%	17%	6%	22%	33%

NOTES:
1 Source: EPA SWDIS Database
2 Source: U.S. Fact Finder Narrative Report U.S. Census
3 EPA Water Sense is a rubust water conservation info site that water suppliers can join if they commit to specific water conservation goals and policies
4 Programs by water systems offered to replace leaking customer owned water supply pipes
5 ICI = Industrial, Commercial & Institutional

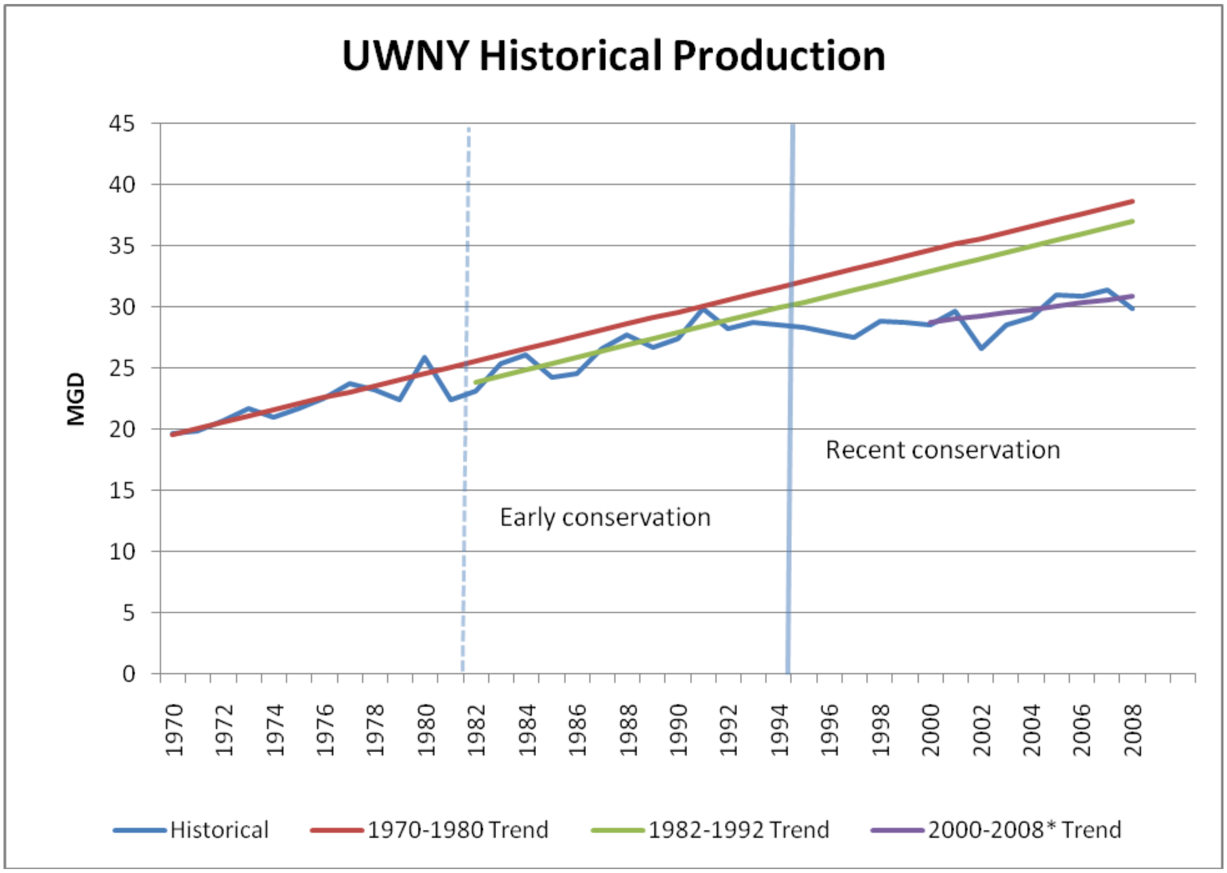

Figure 6 Changing trends in UWNY total production over time

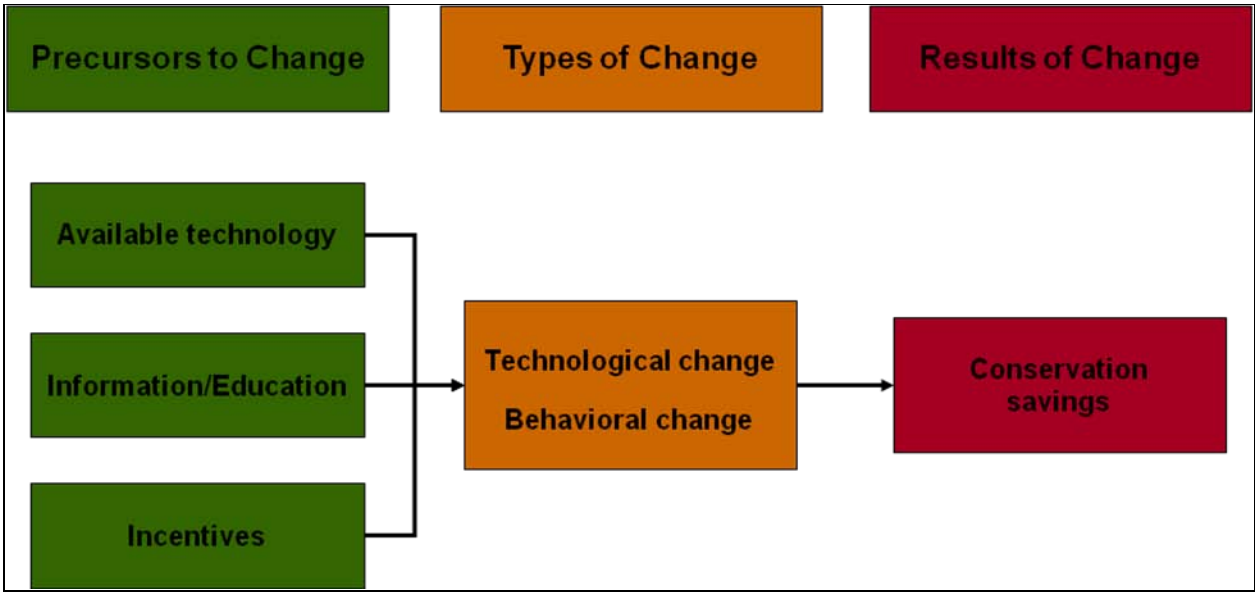

Figure 7 How change occurs

Two certain impacts on the future water demands of the UWNY service area are reviewed in this analysis. These likely scenarios include the following:

- Existing national and state plumbing codes and water fixture standards will increase water use efficiency over time

- Currently planned UWNY programs will reduce non-revenue water (NRW) in the future

3.1 Impact of Fixture Standards

State and national legislation set water use performance standards for toilets, showerheads, faucets, and urinals. The State of New York first set regulations on low volume plumbing fixtures in 1981. The National Energy Policy Act set fixture standards that became effective in 1994. Standards have recently been established for more efficient clothes washers and dishwashers. These standards apply to fixtures in new construction and remodeled bathrooms and kitchens. Over time, as the percentage of new and remodeled homes and businesses increase, indoor water use efficiency is expected to increase.

In assessing future water demands for UWNY, it is estimated that about 1.1 gpd per household, or 0.5 percent of residential water use per year could be saved through the natural replacement of fixtures over time, if all other household water end uses remain the same. However, the water efficiency gains from fixture replacement are offset by other changing characteristics of residential water use. For example, new housing construction trends include multiple showerheads for shower stalls and automatic irrigation systems, which may lead to an increase in water use per household. The precise impact of these countervailing trends are unknown, however it is assumed for this analysis that residential water use will gradually be more efficient over time at a rate of 0.1 percent per year. **Table 10** shows the impact on the water demand forecasts of a 0.1 percent reduction in residential water use per year.

Table 10. Impact of Residential Fixture Replacement on UWNY Service Area in MGD

		2010	2015	2020	2025	2030	2035
Per Capita – RCDP with fixture replacement							
Residential	GPD/household	17.687	18.035	18.740	19.428	20.096	20.713
Nonresidential	GPD/employment	6.945	7.227	7.509	7.785	8.053	8.300
Other	GPCD x pop	0.158	0.164	0.170	0.177	0.183	0.188
Total Billed	summed	24.790	25.426	26.419	27.389	28.331	29.201
NRW	23% of Prod	7.405	7.595	7.891	8.181	8.462	8.722
Production	summed	32.195	33.021	34.311	35.570	36.793	37.924
Savings		0.115	0.601	0.624	0.647	0.669	0.690

3.2 Current UWNY NRW Programs

In addition to water conservation programs targeting the reduction of customer water use, UWNY has a plan to reduce the non-revenue water component of their system. As shown in Table 3 above, the difference between annual water production and annual billed consumption has averaged about 18 percent of total production from 2000 to 2009, although it has increased in recent years. This difference represents non-revenue water (NRW) and is comprised of both *apparent* and *real* water losses. It should be noted that the volume of NRW has been rather consistent from 2005 to 2009 with a range of 5.785 to 6.416 mgd or an average 6.013 mgd. During the same time period the AAD production ranging from 28.41 to 31.43 mgd, a 3 mgd difference. Therefore, although the volume of NRW has been consistent for the last five years, the lower production rates in 2008 and 2009 cause the overall percentage of NRW to total production to increase.

An analysis of the UWNY system was conducted by UWNY using the American Water Works Association Water Loss Control Committee software with data from 2007. Results of the analysis indicate that about 7.5 percent of total production is lost to apparent losses and about 13.1 percent are real losses (Table 3 shows NRW of 20.4 percent of production in 2007). A similar analysis by UWNY with data from 2009 shows apparent losses of 6.5 percent and real losses of 17.2 percent of total production, for a total NRW of 23.7 percent of production. The UWNY system has recently experienced unprecedented levels of real losses due to cold winters and a large number of main breaks. For purposes of this analysis, CDM assumed that the average 23 percent NRW is comprised of 7 percent apparent losses and 16 percent real losses.

UWNY has developed a plan of action through which UWNY can reduce both apparent and real losses. Significant reduction of apparent loss will not only reduce the system-wide losses, but also improve the revenue stream of the utility. An aggressive program to eliminate apparent loss could theoretically eliminate apparent losses, however, for this analysis *CDM assumes that reducing* *apparent losses to 5 percent is a realistic goal.* Since this reduction in apparent water loss is an accounting adjustment, CDM shifted this decreased volume of NRW water to billed consumption (i.e., the residential and nonresidential sectors, proportionally) in future years as the NRW apparent loss percentage decreases.

The analysis of 2007 data for the UWNY system estimates that the unavoidable real loss (UARL) is about 2.13 mgd, or 6.7 percent of total production. Even a new or perfectly maintained pressurized distribution system will experience some leakage. The UARL is an estimate of the unavoidable losses in a distribution system and is calculated based upon the number of miles of pipe, number of connections and average pressure of the system.

The ratio of real loss to UARL, or the Infrastructure Leakage Index (ILI), for the UWNY system was estimated to be 1.95 in 2007 and 2.29 in 2009. This ILI metric indicates that about half of the real loss could be avoidable or resolvable. The appropriate target ILI range for a given utility depends upon financial, operational and water resources considerations. The AWWA Water Loss Guidelines suggest that systems experiencing an ILI greater than 3.0 begin to invest in increased leak detection and line replacement programs. UWNY is investing in such programs despite having an ILI below this benchmark.

The reduction of real loss to the estimated unavoidable real loss level could potentially reduce the NRW real loss to about 7 percent of total production. United Water has the underground infrastructure renewal program (UIRP) in place to reduce real system loss. Such a target may not be realistic given other financial, operational and water resources considerations of the system. Therefore, for this analysis, CDM assumes that UWNY apparent losses can be reduced to 5 percent (with a transfer of this reduced NRW volume to billed consumption), and that real losses can be reduced to 13 percent of total production. Thus, it is assumed that the total NRW can be reduced from the current average of 23 percent to a target of 18 percent of total production by 2015.

These assumed reductions are illustrated in **Table 11**. The estimated impact of these reductions in apparent and real NRW loss is shown in **Table 12**.

The UWNY underground infrastructure renewal program (UIRP) and plans to reduce NRW are budgeted actions. Other more drastic measures to reduce NRW that could be considered would be complete replacement of all water mains within a ten year period. However, as stated above, all water systems leak and as it age's leakage will increase. The cost and impacts to the local community would be significant and would not eliminate NRW. Therefore, it is recommended that UWNY implement it present program to reduce NRW to within an acceptable percentage.

Table 11. Planned Reduction in NRW Losses

	2010	2015	2020	2025	2030	2035
NRW Apparent	7.0%	5.0%	5.0%	5.0%	5.0%	5.0%
NRW Real	16.0%	13.0%	13.0%	13.0%	13.0%	13.0%
NRW Total	23.0%	18.0%	18.0%	18.0%	18.0%	18.0%

Table 12. Impact of Reduced NRW Losses on UWNY Service Area in MGD

		2010	2015	2020	2025	2030	2035
Per Capita – RCDP with NRW reduction							
Residential	GPD/household	17.776	19.055	19.799	20.526	21.232	21.884
Nonresidential	GPD/employment	6.945	7.445	7.736	8.020	8.295	8.550
Other	GPCD x pop	0.158	0.164	0.170	0.177	0.183	0.188
Total Billed	summed	24.879	26.663	27.705	28.722	29.710	30.622
NRW apparent	% of Prod	2.262	1.626	1.689	1.751	1.812	1.867
NRW real	% of Prod	5.170	4.227	4.392	4.554	4.710	4.855
NRW total	summed	7.431	5.853	6.082	6.305	6.522	6.722
Production	summed	32.311	32.516	33.787	35.027	36.231	37.344
Savings		0.000	1.105	1.148	1.190	1.231	1.269

3.3 Impact of Both Fixture Replacement and Reduced NRW

Applying potential reductions to the residential sector from fixture replacement in conjunction with the planned reduction in NRW (i.e., Table 11), results in a forecast adjusted for likely conservation as shown in **Table 13**. As indicated previously, the per capita forecast based upon RCDP population projections are similar to the 95 percent confidence interval forecast developed by UWNY in 2006. With adjustments to the per capita forecast for the impact of potential water conservation savings, the forecast is similar to the annual average demand (AAD) forecast developed by UWNY in 2006 (refer back to Figure 3).

Table 13. UWNY Demands with Planned and Likely Conservation in MGD

	2010	2015	2020	2025	2030	2035
Per Capita - RCDP						
Residential	17.687	18.578	19.304	20.013	20.701	21.337
Nonresidential	6.945	7.445	7.736	8.020	8.295	8.550
Other	0.158	0.164	0.170	0.177	0.183	0.188
Total Billed	24.790	26.187	27.210	28.209	29.179	30.075
NRW	7.405	5.748	5.973	6.192	6.405	6.602
Production	32.195	31.935	33.183	34.401	35.584	36.677
Savings	0.115	0.581	0.604	0.626	0.647	0.667

4.0 Conclusions

Figure 8 shows the 2006 UWNY forecast with anticipated supply expansions necessary to meet the projected annual (95 percent confidence) demand as well as the maximum day demand.

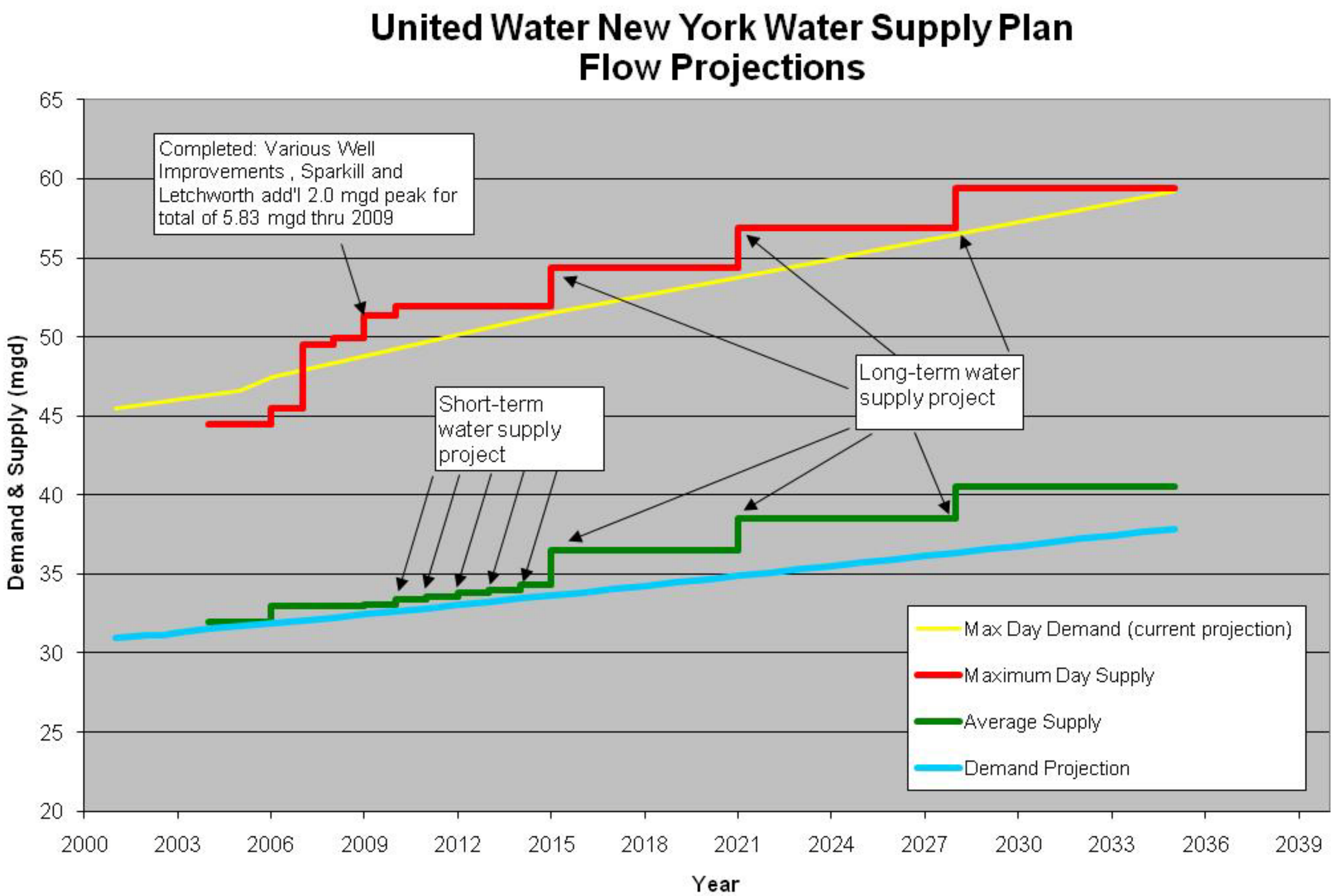

Figure 8 UWNY Demand and Supply Projections