ASSET MANAGMENT PLAN
for the
ORLEANS WATER DEPARTMENT

MAY 2014

WRIGHT-PIERCE
Engineering a Better Environment

ASSET MANAGMENT PLAN

FOR THE

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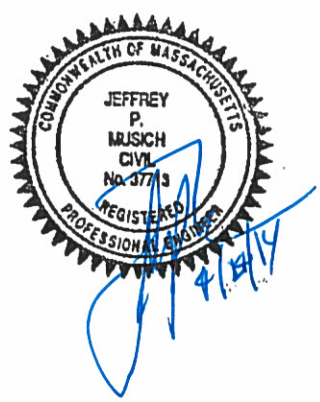

Prepared By:

Wright-Pierce
169 Main Street
ANDOVER, MA 06457

ORLEANS WATER SYSTEM ASSET MANAGEMENT PLAN

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Abbreviations, Acronyms, Definitions

AM	Asset Management
AMR	Automatic Meter Read
ASME	American Society of Mechanical Engineers
ASR	Annual Statistical Report
AWWA	American Water Works Association
BMP	Best Management Practice
BRE	Business Risk Exposure
CCL3	Contaminate Candidate List 3
CI	Cast Iron
CIP	Clean in Place, Capital Improvements Plan
CoF	Consequence of Failure
CP	Control Panel
CTS	Copper Tube Size
DBP	Disinfection By-Product
DCR	Department of Conservation and Recreation
DEP	Department of Environmental Protection
DI	Ductile Iron
EFM	Enhanced Flux Maintenance
FY	Fiscal Year
GIS	Geographic Information System
GPD	Gallons Per Day
GPM	Gallons Per Minute
HAA5	Haloeacetic acid
HMI	Human Machine Interface
Hp	Horse power
IBTA	Inter Basin Transfer Act
ISO	Insurances Services Organization
KoH	Potassium Hydroxide
LoF	Likelihood of Failure
LOS	Level of Service
MGD	Million Gallons Per Day
MGY	Million Gallons per Year
MISER	Massachusetts Institute for Social and Economic Research
MTU	Main Terminal Unit
NAOC1	Sodium Hydroxide
O&M	Operations and Maintenance
OIT	Operator Interface Terminal, Operator in Training
OWD	Orleans Water Department
OWR	Massachusetts Office of Water Resources
PLC	Programmable Logic Controller
RAD	Right Angle Drive

RF	Radio Frequency, Reverse Flow
RPCPD	Residential Water use per Capita per Day
RPM	Revolutions Per Minute
RTU	Remote Terminal Unit
SDWA	Safe Drinking Water Act
SWMI	Sustainable Water Management Initiative (Massachusetts)
TDH	Total Dynamic Head
TEFC	Totally Enclosed Fan Cooled
TTHM	Total Trihalomethane
UAW	Unaccounted for Water
UCMR3	Unregulated Contaminants Monitoring Rule 3
USEPA	United States Environmental Protection Agency
VFD	Variable Frequency Drive
WMA	Water Management Act
WTF	Water Treatment Facility
WTP	Water Treatment Plant

Executive Summary

Wright-Pierce
Engineering a Better Environment

EXECUTIVE SUMMARY

ES.1 INTRODUCTION AND BACKGROUND

The Town of Orleans has an excellent water system that is modern and well maintained. The Town began construction of the public water system in the early 1960's. The initial water distribution system consisted of 41 miles of cement-lined cast iron piping. Since construction of the original system, the distribution system has grown to over 100 miles in length serving most of the community but limited areas remain supplied by private wells. Because the public water system is relatively modern, extensive need to replace aging infrastructure is not a challenge for the water system at this time. However, prudent continual investment is needed to maintain the water system, to prepare for the future and to provide reliable service to the Town's water customers.

The Town of Orleans is experiencing many demographic challenges. The year-round population and household size have declined in the last decade. These trends are typical of other Cape communities which are transitioning to retirement communities. The challenges of a smaller service population will change how the water system is managed and maintained in the future.

In 2013, the Orleans Water Department commissioned this study to develop a 20-year asset management plan based on sound financial principles geared towards providing an adequate level of service to the Town's water customers. The plan is more advanced than prior capital improvement plans, looking at criticality of assets and establishing level of service goals and objectives for the water system to optimize performance of the water system.

ES.2 STUDY OBJECTIVES

The purpose of this asset management plan is outlined in the following objectives:

- Develop accurate water-use projections for the system over the next 20-year period
- Perform a condition assessment of all water system assets
- Develop level of service goals and objectives for the water system

- Determine the feasibility of an interconnection to Eastham
- Develop an integrated asset management plan
- Develop a financial plan that meets the department's goals and objectives
- Present the plan to community leaders for adoption

The intent of the study is to develop a strategic plan to meet the Town's water needs for the next 20 years. The study also incorporated build-out population projections in Orleans to determine the required capacity of the water system to meet future needs. The final financial plan includes recommended improvements to the system and defines the revenue requirements to fund the improvements.

ES.3 LEVEL OF SERVICE GOALS

A Level of Service Agreement (LOS) defines the way in which the utility owners, managers, and operators want the system to perform over the long term. Establishing the level of service in a utility is a critical first step in creating an asset management plan. The LOS becomes a fundamental part of how the system is operated, how assets are replaced and renewed, and how performance is benchmarked and reported to the public.

A LOS was developed for Orleans after a series of workshops to define critical performance benchmarks in the following areas:

- Customer service
- Workplace environment
- Definition of critical assets
- Tools for assessing overall system performance
- Establishing links between costs and service
- Management and operational goals
- Regulatory goals
- Annual reporting

The goals and objectives set forth in the level of service plan included herein are summarized in Table ES-1. The major driver for these LOS goals is meeting regulatory requirements.

TABLE ES-1
LEVEL OF SERVICE GOALS AND OBJECTIVES

	Operations	Target	Driver	Tracking Method	Frequency
1	Compliance with Safe Drinking Water Rules and Regulations*	100%	Safe drinking water act	Compliance reports	Annually
2	Compliance with USEPA Secondary Drinking Water Standards*	100%	Safe drinking water act	Sampling	Annually
3	Repair leaks within 24 hours*	>95%	MADEP	Work order records	Annually
4	Maintain a level of service where there are less than 1 break per 25 miles of distribution water main*	<5 /yr	Self imposed	Work order records	Annually
5	Maintain a full inventory of distribution system parts and for spare parts identified in operations manuals for supply/treatment	100%	MADEP	Work order records	Annually
6	Maintain water system facilities power and communications capacity	>95%	DEP/ Emergency Response Plan	SCADA	Annually
7	The Department shall maintain infrastructure that allows for fire flows that exceed ISO needed fire flows in the community.	100%	ISO insurance ratings	Flow testing	Bi-annually
8	Compliance with all the ISO water rating requirements	3/9 or better	ISO insurance ratings	ISO rating reviews	5-10 years
9	Deliver consistent, high quality water to all customers that meets both Primary and Secondary MCLs*	Zero Complaints	Mission Statement	Complaint Log	Annually
10	Maintain a highly functional fleet of vehicles and equipment*	< 10 years old	MADEP/ ERP	Equipment inventory	Annually
11	Ensure GIS and Utility Cloud data sets are aligned	100%	Records maintenance	Data set review	Annually
12	Inspect and maintain all hydrants in the distribution system	300/year	AWWA G200/M-17	Work order records	Annually
13	Inspect and maintain all valves in the distribution system*	100%	AWWA G200/M-17	Work order records	Annually

	Compliance with Water Management Act Regulations	Target	Driver	Tracking Method	Frequency
1	Replace all customer water meters in the system over a 15 year period	15 yrs	Water Management Act Permit	Work order records	Annually
2	Perform leak detection across the distribution system every 2 years*	2 yrs	Water Management Act Permit	Work order records	Bi-Annually
3	Ensure well pumping rates are less than the allowable rates at all times*	100%	Water Management Act Permit	Annual report	Annually
4	Minimize unaccounted for water in the water distribution system*	<10%	Water Management Act Permit	Annual report	Annually
5	Maintain residential water use to less than 65 gpd/person*	<65 GPD/person	Water Management Act Permit	Annual report	Annually
6	Water treatment plant production efficiency	>95%	Water Management Act Permit	Annual report	Annually
7	Periodically perform hydrant flushing in the water distribution system *	100%	MADEP	flushing records	Annually
8	Eliminate all cross connections in the system	0 cross connections	MADEP	Work order records	Annually
9	Meet Projected Maximum-day Demand with the Largest Source Off-line	Flow rate	MADEP	Annual Report	Annually

	Business	Target	Driver	Tracking Method	Frequency
1	Water rate increases below 5% per year	<5%	Self imposed	Budget review	Annually
2	Maintain an appropriate fund balance to maintain operations	25%	AWWA/MADEP guidance	Funding balance	Annually
3	Comply with all State regulations*	100%	State regulations	Compliance reports	Annually
4	Move to a quarterly billing frequency	Quarterly Billing	Department audit	Billing cycle	Annually

	Workplace Environment	Target	Driver	Tracking Method	Frequency
1	Maintain a safety committee and deliver service in the safest possible manner*	Zero accidents	DOL and OSHA regulations	Accident reports	Annually
2	Treatment Operator training level*	Grade 2	State regulations	Certification records	Annually
3	Distribution Operator training level*	Grade 3	State regulations	Certification records	Annually
4	Training level per operator*	100%	State regulations	Certification records	Annually
5	Cross training between treatment and distribution staff*	50%	DEP Regulations	Training Records	Annually

	Customer Service	Target	Driver	Tracking Method	Frequency
1	Respond to a customer by next business day of receiving inquiry*	>95%	MADEP	Work order records	Annually
2	Respond to water quality or pressure service complaints within 4 hours*	>95%	MADEP	Work order records	Annually
3	Contact affected customers prior to a water main shutdown in both planned and emergency situations*	>95%	Water Dept. regulations	Work order records	Annually

*Indicates this LOS goal is currently being met

ES.4 RISK ASSESSMENT

The asset management plan incorporated a risk-based approach to determine need and priority in the water system for all improvements recommended to meet the level of service goals. For all assets in the water system, the likelihood of failure and the consequence of failure of that system asset was determined and aggregated into a business risk exposure (BRE) score. This methodology provides an understanding of why and how each improvement will impact performance of the water system and what risks are assumed if the improvement is delayed or omitted from the capital improvement plan.

It should be noted that the distribution system in Orleans is relatively new and in good condition. There is low likelihood of failure for any of the key distribution and transmission mains in the current system. Although many key pipelines have a high consequence of failure (Loss of service to peninsular areas, etc.), improvements to these mains will reduce risk but there is still significant service life left in the assets so monitoring these assets at this time is recommended.

The challenge for the Orleans system in the next 20 year planning period (beyond years 2034) will be to focus on main replacement in the distribution system as 40% of the water mains approach 75-100 years of age.

The likelihood and consequence of failure are discussed for each of the following findings or recommendation. A more rigorous discussion and supporting documentation for the recommendation is included in Sections 5-10 of this report.

ES.5 SUMMARY OF FINDINGS

ES.5.1 Well Supply and Water Treatment Facility (WTF)

- **Well Supply and Capacity –** The Town of Orleans has adequate supply to meet projected build-out conditions in the Town. There are several mechanical improvements recommended to improve well performance up to their permitted limits. No additional supply development is needed in Orleans to meet the projected build-out demands in the community.

- **Well Cleaning and Maintenance –** The Orleans Water Department budgets for annual cleaning and inspection of each well, well pump and motor. This important routine maintenance should continue to be budgeted to assure that all wells remain serviceable at all times to meet projected peak demands during the summer months.

- **Well Supply Reliability –** Several deficiencies were identified in the emergency power systems, well pumps and electric systems in the wells that compromise reliability of the well supply. The improvements will improve redundancy, increase pumping capacity in and provide for emergency power generation at all well supplies. The consequence of failure of these systems will be inadequate ability to meet peak summer demands because of a major regional power failure or inadequate emergency power at all the needed facilities. This investment is recommended for Fiscal Years (FY) 2014-2017 at a total estimated cost of $935,000 (Well No. 7 improvements are not included in this cost).

- **Well No. 7 Improvements –** This project will incorporate Well No. 7 into the water treatment facility by extending a new raw water main from the well to the water treatment facility. The project will help the department meet several LOS objectives including improved reliability during peak summer demand periods and delivering consistent, high quality water to all of the Town's customers as water in South Orleans when this well is operational has consistently higher iron that the other portions of the system. Presently, this source of supply has high iron concentrations which are an aesthetic concern during the well's occasional summer use. Treatment will also improve the water supply reliability and redundancy allowing this well to be used on a more regular basis.

  The estimated capital cost for this project is $1.95M including engineering and contingencies. It is recommended that this project be funded and designed in FY 2020.

- **WTF Improvements –** Reliability and criticality of the treatment was evaluated to determine if investment is needed to meet the LOS goal of reliable supply delivery. In addition, gaps in emergency power and equipment reliability were identified in the conditional assessment. The following improvements are recommended at the water treatment facility:
    - ***Replace Raw and Finished Water Variable Frequency Drives* –** The existing Variable Frequency Drives (VFDs) are old technology, have part availability issues and at risk of physical failure. The immediate likelihood of failure of these systems is very high and the consequence of failure will be inability for Orleans to meet MassDEP regulations and peak summer demands in the system. The water treatment facility must have two raw water pumps and finished water pumps available to meet the system demands during the summer months and to maintain consistent reliable operations at the treatment facility. Replacement of these VFDs is needed immediately. The estimated cost for these improvements is estimated to be $300,000. This investment is recommended for FY 2014.
    - ***Containment in Chemical Storage Area* –** The chemical storage area in the treatment facility is open to the main operating area and does not meet current building codes. The recommended improvements to this area of the facility include constructing a properly isolated and vented work space for this equipment. The estimated cost for these improvements is $250,000. The consequence of not addressing these deficiencies will be continued corrosion of key system components and a reduction of reliability and the useful life of key control systems. This investment is recommended for FY 2018.
    - ***Roof Replacement* –** The current membrane roof system is 7 years old. A maximum useful life of about 20 years can be expected from a ballasted membrane roof system on this type of building. The likelihood of failure of the existing roof is low but will continue to increase as the roof system ages and approaches the end of its useful life. The estimated cost to replace the roof is $150,000. The condition of the roof should be inspected in year 2016, and every 5 years, and budgeted for replacement in FY 2026.

- **Establish Capital Reserve Fund Accounts for Membrane Replacement –** The existing water treatment facility has three membrane rack assemblies that will require sequential replacement in years 2019, 2020 and 2021 at an estimated cost in those years of approximately $362,000 for each assembly (Total - $1.086M). It is recommended that the Department establish a capital reserve fund in the amount of $179,000 per year to fund the next replacement cycle. This amount should be changed to $120,000 per year after FY 2021 for the next membrane replacement in 2029-2031. The initial annual allocations ($179,000/year) are higher than the future allocations ($120,000/year) as the time to replacement is much shorter in this period (Four years versus a normal 10 year cycle). The capital reserve fund for membranes replacement should be established beginning in FY 2015.

- **Regulatory Compliance –** The Orleans Water Department currently complies with all EPA primary drinking water standards and MassDEP drinking water standards. A regulatory review did not identify any areas for changes in policy, procedures or infrastructure needs to maintain 100% compliance with all regulations.

- **Residuals Handling Optimization Study –** The MassDEP is requiring the Town to perform a study to reduce water loss and improve residuals disposal in the treatment facility. As such, the Orleans water department has established a goal of optimizing plant efficiency as a LOS goal for the system. The residuals handling system at the water treatment facility will be subject to future regulatory scrutiny.

  The DEP is requiring an improvement to the efficiency of this system, which will require additional study beyond the scope of this asset management plan. We recommend that a budget of $75,000 be allocated to conduct an optimization study of the residuals handling system at the water treatment facility. In anticipation of new regulation from the MassDEP and an existing deficiency in this area, we recommend that the study be conducted in FY 2015 in accordance with existing DEP correspondence. Costs associated with capital recommendations from this study will need to be integrated into the financial implementation plan moving forward.

ES.5.2 Distribution and Storage System

- **Managing Unaccounted-For and Lost Water** – The Orleans water system has maintained unaccounted-for water well below 10% in accordance with the standards established in the water management act permit. The system has benefitted from excellent management over the years and routine leak detection surveys of the system. The department should continue biannual leak detection surveys and continue to minimize unaccounted for water in the system.

- **Establish Capital Reserve Fund Accounts for Storage Tank Maintenance –** The two water storage tanks in the Orleans water system will require new coating systems in years 2027 and 2028. It is recommended that the Department establish a capital reserve fund in the amount of $62,000 per year to fund the next replacement cycle for Standpipe No. 1 and $67,000 per year for Standpipe No. 2. The capital reserve funds should be established beginning in FY 2015.

- **Demand Management –**The residential per capita consumption in Orleans meets Massachusetts DEP standards. This data suggests excellent awareness in the community for water conservation. The department should continue efforts to manage summer lawn watering and other conservation measures included in the permit.

- **Water Main Renewals** – The work plan includes annual allocations for main replacements to meet fire flow requirements and to improve looping and service reliability in the distribution system, both LOS goals for the water system. All the mains recommended for replacement have a current low likelihood of failure because the entire distribution system is less than 60 years old and the condition is relatively good. However, this condition will begin to change in this next planning period as the distribution system continues to age. The Tonset Road project was given high priority because it improves a hydraulic deficiency on a roadway scheduled for repaving and reconstruction. The following list of water mains are recommended for replacement in the next 20-year Replace 6-inch on Tonset Road with 12-inch Main period:

- Replace 8-inch on Beach Road with 16-inch Main
- Replace 6-inch on Countryside Road with 8-inch Main
- Replace 6-inch on Rock Harbor Road with 8-inch Main
- Replace 12-inch on Beach Road with 16-inch Main
- Replace 12-inch on Route 28 with 16-inch Main
- Replace 12-inch Well Discharge line 16-inch Main
- Replace 6-inch on Canal Road with 8-inch Main
- Replace 6-inch on Lake Drive with 8-inch Main
- Connect Lake Drive and Quanset Road with 8-inch Main

- **Cross Connection Control –** The department has established a goal of eliminating all cross connections in the water system as they are identified. This effort is required by MADEP. The department should continue with the cross connection training and certifications for two operators and maintain this program into the future. The department should continue providing this service internally by cross training of key staff. This value added service is estimated to save the water department approximately $15-$20,000 annually if the service were to be contracted to third parties.

- **Hydrant and Valve Maintenance –** The department has an excellent valve and hydrant maintenance program that should continue during the planning period. Valve exercising and hydrant inspections are routinely conducted and should continue as a matter of practice to maintain these key assets in excellent condition to maximize ISO point allocations.

ES.5.3 General Operations and Customer Service

- **Vehicles –** The water department maintains a fleet of vehicles described in Section 2 of this report. The cost to replace these vehicles is expensed in the given year of the expenditure. The department also installs water main and does service repairs at considerable savings to the customers. The current vehicles are required to meet several LOS objectives such as customer response.

The department should continue to strive to maintain the fleet in good condition. It is understood that the Town is considering new storage and housing options for the vehicle fleet, of which a portion is presently housed at the garage located near Well No. 1. This space is insufficient to house all of the vehicles in the water division inside.

- **Customer Meters –** Maintaining accurate, modern customer meters is essential for maintaining accurate measurements of water use in any water system and to build credibility with your customer base. The water department has an ongoing program of acquiring 300 meters per year with the intent of full replacement of all meters in the system every 15 years. The new metering program uses automatic read technology which will allow remote collection and reporting of water use data without the need to enter private property. The cost for the meters is expensed annually without borrowing. The continued annual funding and implementation of the metering program is recommended and required under provisions of the water departments DEP Water Management Act.

- **Training, Safety and Operations Certifications –** The water department operates safely and maintains Grade 3 operator certifications to meet MassDEP requirements. The department monitors and requires routine training for each operator to meet minimal standards required by the Commonwealth of Massachusetts for licensed treatment and distribution operators of the water system and to meet OSHA requirements for safety. These procedures and investments should continue.

- **Customer Service –** The Orleans Water Department began implementing the Utility Cloud system to manage and track work orders in 2013. This investment will create a more streamlined work order process which will allow the department to enhance three important LOS goals; (1) Response to Customer inquiries within 24 hours, (2) Response to pressure or water quality complaints within a four hour period and (3) Efficient communication regarding interruption of service from main breaks or emergencies. The investment for annual maintenance fees for this valuable asset management tool should continue.

ES.5.4 Considerations for Supplying Eastham

An analysis was conducted to determine the impact of a permanent inter-municipal interconnection to supply an average day 0.50 MGD, (Maximum day demand of 1.25 MGD) to Eastham on the Orleans water system. The following impacts and needs were identified:

- **Permitted Yield of Orleans Well Supply** – The current Orleans water management permit contains a reopener clause to expand the withdrawal limits on an annual basis in Orleans if a 0.5 MGD of average day demand is added to the system from Eastham. Because of this provision, the well supply in Orleans could meet the additional Eastham demand on an annual yield basis.

- **Supply Pumping Capacity –** The projected demands in Orleans at build-out, if a maximum day 1.25 MGD supply to Eastham was added to the system, would be approximately 4.4 MGD. The maximum-day pumping capacity of the Orleans well supply is about 3.36 MGD suggesting a pumping deficit unless further investment is made to improve redundancy at the water treatment facility.

- **Storage** - A storage deficit of about 275,000 gallons would be created in the Orleans system if a 1.25 MGD interconnection to Eastham is made. The deficit would require additional storage capacity to be installed at either of the two storage tank locations in Orleans to prevent a reduction in available fire storage volume in the Orleans system with the addition of the proposed Eastham demands. A study should be conducted to determine the exact configuration of the new storage volume and if the existing sites can accommodate additional tanks. Any storage improvements required as a function of the additional demand from Eastham should be funded by the Town of Eastham.

- **Distribution System –** The distribution system in Orleans can deliver a sustained flow rate of 1.25 MGD to the Town of Eastham without compromising fire flow capacity in

Orleans if an interconnection was constructed between the two communities in the vicinity of the Route 6 roundabout.

ES.6 RECOMMENDATIONS

A capital improvement program has been developed for the capital needs described above. All improvements and recommendations have been prioritized based on projected growth of the water system, criticality analyses, and other criteria. Immediate and Short-term priority improvements are listed in FY 2014 through 2017, presented on Table ES-2, each have high likelihood or consequence of failure and should be implemented as recommended.

ES.7 FINANCIAL IMPLEMENTATION PROGRAM (FIP)

The required revenue requirements to fund the asset management plan for the next 20-year period have been incorporated into the water department's financial planning spreadsheet as discussed in Section 11. To implement the capital improvements as proposed, the revenue requirements to fund the work plan are shown in Table ES-3. As discussed in the report, the estimated project costs for each project have been escalated by 3% annually to the proposed project initiation date to account for construction cost inflation.

TABLE ES-2
ASSET MANAGEMENT PLAN RECOMMENDATIONS AND PRIORITY NEEDS

Project Description	Estimated Costs	Implementation Year (FY)	Risk Ranking	Goal and Objective
Treatment / Well Facility Improvements				
Replace Raw and Finished VFDs	$300,000	2014	High	Consequence of failure will be loss of treatment facility. Reduce immediate high risk of failure
Well No. 4 Pump, Motor and VFD	$55,000	2014	High	Improve available pumping capacity. Reduce risk of not meeting peak summer demands
Residuals Handling Study	$75,000	2015	High	Required by MassDEP. Reduce risk from regulatory action for management of backwash residuals
Well No. 1, 2, 3, 5 & 6 Improvements - Design	$100,000	2015	High	Improve available pumping capacity. Reduce risk of not meeting peak summer demands
Well No. 1, 2, & 3 Improvements - Construction	$535,000	2016	High	Improve available pumping capacity. Reduce risk of not meeting peak summer demands
Well No. 5 & 6 Improvements - Construction	$165,000	2017	High	Improve available pumping capacity. Reduce risk of not meeting peak summer demands
Chemical Containment/HVAC	$250,000	2018	Moderate	Reduce likelihood of failure of electrical systems from corrosion in WTF
Well No. 7 to WTP Raw Water Main Project	$1,953,000	2020	Moderate	Improve redundancy and reliability of water supply, Improves finished water quality
Membrane Rack Assembly Replacement	$1,086,000	2019-2021	High	Firm maintenance date for normal membrane replacement cycle
WTF Roof Replacement	$150,000	2026	Moderate	Firm maintenance date for normal roof replacement cycle
Membrane Rack Assembly Replacement	$1,380,000	2029-2031	High	Firm maintenance date for normal membrane replacement cycle
Storage Improvements				
Tank 1 Coatings Replacement	$1,057,000	2027	Low	Critical Facility. Project replaces tank coatings on a routine maintenance cycle
Tank 2 Coatings Replacement	$1,149,000	2028	Low	Critical Facility. Project replaces tank coatings on a routine maintenance cycle
Distribution System Improvements				
Replace 6-inch on Tonset Road with 12-inch Main	$683,000	2016	Low	Hydraulic Improvement. Increases system redundancy and reliability, Concurrent road reconstruction on Tonset Road
Replace 8-inch on Beach Road with 16-inch Main	$2,048,000	2019	Moderate	Hydraulic Improvement. Project will meet LOS goals of improved fire flow at ISO Location
Replace 6-inch on Countryside Road with 8-inch Main	$78,000	2021	Moderate	Hydraulic Improvement. Project will meet LOS goals of improved fire flow at ISO Location
Replace 12-inch on Beach Road with 16-inch Main	$228,000	2021	Moderate	Hydraulic Improvement. Project will meet LOS goals of improved fire flow at ISO Location
Replace 6-inch on Rock Harbor Road with 8-inch Main	$546,000	2023	Moderate	Hydraulic Improvement. Project will meet LOS goals of improved fire flow at ISO Location
Replace 12-inch on Route 28 with 16-inch Main	$59,000	2024	Moderate	Hydraulic Improvement. Project will meet LOS goals of improved fire flow
Replace 12-inch Well Discharge line 16-inch Main	$286,000	2024	Moderate	Hydraulic Improvement. Project will meet LOS goals of improved fire flow
Replace 6-inch on Canal Road with 8-inch Main	$293,000	2026	Low	Hydraulic Improvement. Project will meet LOS goals of improved looping and fire flow
Replace 6-inch on Lake Drive with 8-inch Main	$78,000	2032	Low	Hydraulic Improvement. Project will meet LOS goals of improved looping and fire flow
Connect Lake Drive and Quanset Road with 8-inch Main	$303,000	2032	Low	Hydraulic Improvement. Project will meet LOS goals of improved looping and fire flow

TABLE ES-3
PROPOSED FINANCIAL IMPLEMENTATION PLAN
ORLEANS WATER DEPARTMENT - 20-YEAR PLANNING PERIOD (2014-2034)

Income								Expenses																	Balance		
		Billable	Income	Added Income			Total	annual [5]	Operating Expense						Net	Capital Expense			Debt Service				Proposed	Total	Income vs.	Fund	%
FY	rates	Gallons	Rates	Services	Other	WSC Xfer	Income	rate of	Budget	Salaries	Benefits [6]	Services [7]	Encumbr.	Total	Operating	Vehicles	Capital Inv	Meters	WTP	Well 8	Membranes	Tanks 1&2	CIP	Expenses	Expenses	Balance	Expense
04																				200K	3 X	1.5M				1,385,734	
05	1.5% [3]		1,223,512				1,223,512									48,000			429,955							1,307,246	
06			1,371,539			35,000	1,406,539	-	863,228		121,789	133,138	(89,682)	1,028,473	378,066	15,603	326,400 [a]		424,855					1,795,331	(388,792)	918,454	-
07			1,442,201			40,000	1,482,201	-5.9%	812,471		128,696	159,312	13,500	1,113,979	368,222	49,745			419,755					1,583,478	(101,278)	817,176	-
08	5.0% [3]		1,672,174		100,000	50,000	1,822,174	14.3%	928,350		143,056	159,323	(15,367)	1,215,362	606,812	18,121			413,380					1,646,863	175,311	992,487	-
09		301,545,792	1,847,130			50,000	1,897,130	16.3%	1,079,674		150,582	176,840	851	1,407,947	489,183	22000	12000	54,000	405,730	1,811 [d]				1,815,488	81,642	1,074,129	-
10		259,339,770	1,716,108			50,000	1,766,108	-15.3%	914,210		163,267	161,323	821	1,239,621	526,487	28,970	27,427 [b]	30,896	398,080	5,135	—			1,730,129	35,979	1,110,108	64%
11	5.0% [3]	313,357,349	2,035,011	14,200		25,000	2,074,000	-6.3%	856,863		161,253	179,345	30,869	1,228,000	846,000	-	36,852 [c]	51,145	389,793	20,741	—			1,726,861	347,000	1,457,000	84%
12		275,614,199	1,896,134	15,840	4,807	25,000	1,942,000	-64.9%	300,349	515,037	167,415	169,201	(8,878)	1,143,000	799,000	41,504	61,870	71,451	338,300	20,295	38,625 [e]			1,715,169	227,000	1,684,000	98%
13	1.8%		1,929,000	-		25,000	1,954,000	31.6%	395,182	507,166	186,000	171,000		1,259,000	695,000		24,000	54,000	335,838	19,580	111,825 [e]			1,804,591	149,000	1,833,000	102%
14	0.0%		1,929,000	-			1,929,000	3.5%	371,000	539,846	176,000	160,000		1,247,000	682,000	100,000	12,000	73,000	337,300	19,355	83,186	77,185 [f]	$ 340,000	2,288,872	(360,000)	1,473,000	64%
15	7.0%		2,064,000	-			2,064,000	3.5%	384,000	558,741	125,000	166,000		1,234,000	830,000	46,000	12,000	77,000	322,000	19,093	108,615	186,250	$ 548,250	2,552,949	(489,000)	984,000	39%
16	7.0%		2,208,000	-			2,208,000	3.5%	397,000	578,297	129,000	172,000		1,276,000	932,000		12,000	81,000	310,575	18,793	106,005 #	181,900 [g]	$ 394,216	2,380,786	(173,000)	811,000	34%
17	7.0%		2,363,000	-			2,363,000	3.5%	411,000	598,537	134,000	178,000		1,322,000	1,041,000	50,000	12,000	85,000	307,850	18,478	103,545	177,550	$ 680,435	2,756,395	(393,000)	418,000	15%
18	5.0%		2,481,000	-			2,481,000	3.5%	425,000	619,486	139,000	184,000		1,367,000	1,114,000	25,000	12,000	89,000	290,200	18,103	100,935	173,200	$ 407,253	2,483,177	(2,000)	416,000	17%
19	5.0%		2,605,000	-			2,605,000	3.5%	440,000	641,168	143,000	190,000		1,414,000	1,191,000	120,000		93,450	282,700	17,690	92,050	168,850	$ 407,253	2,596,161	9,000	425,000	16%
20	5.0%		2,735,000	-			2,735,000	3.5%	455,000	663,609	148,000	197,000		1,464,000	1,271,000	35,000		98,123	270,275	17,240	90,665	164,500	$ 696,370	2,835,782	(101,000)	324,000	11%
21	3.5%		2,831,000	-			2,831,000	3.5%	471,000	686,835	154,000	203,000		1,515,000	1,316,000	25,000		103,029	262,925	11,775	87,995	150,150	$ 703,666	2,859,375	(28,000)	296,000	10%
22	3.5%		2,930,000	-			2,930,000	3.5%	487,000	710,874	159,000	210,000		1,567,000	1,363,000	65,000		108,180	250,650	11,450	60,420	155,800	$ 694,666	2,913,040	17,000	313,000	11%
23	3.5%		3,033,000	-			3,033,000	3.5%	504,000	735,755	164,000	218,000		1,622,000	1,411,000	-		113,589	238,525	11,100	58,710	151,250	$ 742,551	2,937,480	96,000	409,000	14%
24	0.0%		3,033,000	-			3,033,000	3.5%	522,000	761,506	170,000	226,000		1,680,000	1,353,000	135,000		119,269		10,750		72,100	$ 747,881	2,764,506	268,000	677,000	24%
25	0.0%		3,033,000	-			3,033,000	3.5%	540,000	788,159	176,000	233,000		1,737,000	1,296,000	62,000		125,232		10,375			$ 747,881	2,682,646	350,000	1,027,000	38%
26	0.0%		3,033,000	-			3,033,000	3.5%	559,000	815,744	182,000	241,000		1,798,000	1,235,000	-		131,494					$ 803,368	2,732,607	300,000	1,327,000	49%
27	0.0%		3,033,000	-			3,033,000	3.5%	579,000	844,295	189,000	250,000		1,862,000	1,171,000	68,000		138,068					$ 803,368	2,871,732	161,000	1,488,000	52%
28	0.0%		3,033,000	-			3,033,000	3.5%	599,000	873,846	195,000	259,000		1,927,000	1,106,000	34,000		144,972					$ 803,368	2,909,186	124,000	1,612,000	55%
29	0.0%		3,033,000	-			3,033,000	3.5%	620,000	904,430	202,000	268,000		1,994,000	1,039,000			152,220					$ 808,368	2,955,019	78,000	1,690,000	57%
30	0.0%		3,033,000	-			3,033,000	3.5%	642,000	936,085	209,000	277,000		2,064,000	969,000	47,000		159,831					$ 813,368	3,084,285	(51,000)	1,639,000	53%
31	0.0%		3,033,000	-			3,033,000	3.5%	664,000	968,848	216,000	287,000		2,136,000	897,000	34,000		167,823					$ 860,696	3,198,368	(165,000)	1,474,000	46%
32	0.0%		3,033,000	-			3,033,000	3.5%	687,000	1,002,758	224,000	297,000		2,211,000	822,000	88,000		176,214					$ 860,696	3,335,668	(303,000)	1,171,000	35%
33	0.0%		3,033,000	-			3,033,000	3.5%	711,000	1,037,855	232,000	307,000		2,288,000	745,000	-		185,025					$ 860,696	3,333,576	(301,000)	870,000	26%
34	0.0%		3,033,000	-			3,033,000	3.5%	736,000	1,074,180	240,000	318,000		2,368,000	665,000	182,000		194,276					$ 860,696	3,605,152	(572,000)	298,000	8%
Total, millions:							74.1							45.7	27.2			4.7				9.4		73.9		0.2	

Income data X 1000

FY	Aug	Feb	Total
06	564	833	$ 1,397
07	602	802	1,404
08	733	925	1,658
09	840	1,013	1,853
10	749	906	1,655
11	927	1,094	2,021
12	818	1,047	1,865

Variables - Income & Operating Expenses

5.0% [3]	Scheduled rate increases -FY05, FY08, FY11.	5,201	accounts
3.5% [4]	Rate increase -COLA.	2	billing periods
3.5% [5]	Rate of increase -expenses.	$ -	surcharge
36.6% [6]	Fringe Benefits as %expense salries.		
43.2% [7]	Admin. Services as %expense budget.		

Capital Expense

[a] WTP Improvements
[b] Capital Investment -small
[c] Small Main replacement
[d] New Well no. 8
[e] WTP Membrane replacement
[f] Tank Painting, Tank no. 2
[g] Tank Painting, Tank no. 1

Notes

FY08; +$100,000 added income from the wind turbine appropriation.

Budgetary Estimates

replace;	amount	year
tank no. 1	$ 2,800,000	2063
tank no. 2	$ 3,800,000	2074
system mains	$ 66,000,000	2063
wtp	$ 6,000,000	2063

Section 1

WRIGHT-PIERCE
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SECTION 1

INTRODUCTION

1.1 BACKGROUND

The Town of Orleans is a seaside community of 5,890 year-round residents, located on Cape Cod, Massachusetts. Similar to other communities on Cape Cod, the town experiences large influxes in seasonal residents and tourists during summer months.

The public water system serves most areas of the community but limited areas served by private wells remain. The Town of Orleans began construction of the water system in the early 1960's after a planning study was completed in 1961 by the engineering firm, Whitman and Howard Inc. The initial water distribution system consisted of 41 miles of cement-lined cast iron piping. Since construction of the original system, the distribution system has grown to over 100 miles in length. Because the public water system is relatively modern, extensive need to replace aging infrastructure is not a challenge for the water system at this time. Since approximately one-third of the distribution system was installed at the same time, replacement of this initial water system infrastructure 40 -60 years from now will be the water systems primary concern.

The Town of Orleans is experiencing many demographic challenges. The year-round population and household size have declined in the last decade. These trends are typical of other Cape communities which have become important retirement communities.

Since the water department completed its last comprehensive water system master plan in 1999, much has changed in the water system. The water management act (WMA) permit issued by the Massachusetts Department of Environmental protection (MassDEP) has further restricted withdrawal volumes from the Town's eight municipal well supplies, creating new challenges meeting peak summer water-use demands. In 2006, the Water Department commissioned a new water treatment facility to treat four of the Town's wells.

In 2013, the Orleans Water Department commissioned this study to develop a 20-year asset management plan based on sound asset management principles geared towards delivering an adequate level of service to the Town's water customers. The plan will be more advanced than prior plans, looking at criticality of assets and establishment of service goals and objectives for the water system.

1.2 GOALS AND OBJECTIVES OF STUDY

The purpose of the asset management plan is to meet the following objectives:

- Develop accurate water-use projections for the system over the next 20-year period
- Perform a condition assessment of all water system assets
- Develop level of service goals and objectives for the water system
- Develop an integrated asset management plan
- Develop a financial plan that meets the goals and objectives based on need

The intent of the study is to develop a strategic plan to meet the Town's water needs for the next 20 years. The study will also consider a possible wholesale interconnection to the Town of Eastham to the north. Eastham is considering construction of a new public water system which could be supplied, in part, by water produced from the Orleans well supply.

1.3 SCOPE OF SERVICES

The following specific scope of services was completed as part of this study to meet the Town's goals and objectives:

Demand Projection Development

A. Develop water demand projections for the next 20-year period to assess the adequacy of treatment and pumping facilities and to test distribution system needs with the hydraulic model. Specific tasks included:
   a. Collection of published population data and projections for Orleans from various planning agencies, the Cape Cod Planning Commission, US Census, the

Massachusetts DCR and other resources. Development of residential population projections for the service area.

b. Collection of 10 years of water-use records, ASR reports, WMA permits, water department records, and other information to evaluate trends in revenue and non-revenue water-use.
c. A meeting with the Orleans Town Planner to review impacts of future water use if a sewer plan is adopted by the Town. Development goals and objectives in the community were reviewed. Economic enterprise and development land-use zones and specific projects that may impact water-use in the future were also identified.
d. Non-revenue and unaccounted-for water demand trends were evaluated. Scenarios if SWMI requirements are implemented were also considered.
e. Large water users in the system and any planned changes to their water demands through the planning period were identified.
f. SCADA records and peak-hour water-use records were reviewed.
g. Average-day, maximum-day and peak-hour demand projections through year 2034 (20-years) were developed.

B. A meeting/workshop with the stakeholders to review timing and projected water use requirements for possible interconnection with Eastham was conducted. Two overlays were created for impacts to the Orleans distribution, treatment, storage and pumping systems as a result of the study as follows:
   - **Alternative 1 –** Demand Projections serving only Orleans in the next 20-year period
   - **Alternative 2 –** Demand Projections plus Reserve Allocation in Orleans WMA permit to supply south end of Eastham

Distribution System Hydraulic Model Improvements

A. The existing WaterGems-based hydraulic model was recalibrated and updated. Specific efforts in this task included:
   a. Model performance using new demand scenarios were performed.

b. New field flow test data was collected from an abbreviated set of flow tests to check model calibration. Operating parameters during the hydrant flow testing such as tank and pumping information were used to check calibration.
c. Demands were allocated within the hydraulic model using the customer billing database with the exception of the largest users whose demand will be assigned to specific nodes.
d. New diurnal demand curves for the system to facilitate the preparation of an Extended Period Simulation were developed.

B. Using the hydraulic computer model developed in Task A, the hydraulic characteristics of existing distribution piping, pump stations and storage facilities under existing and projected demands were evaluated. This effort included the following:
a. Testing the distribution system using projected maximum-day demands under several stress conditions: (1) with fire flows at each Insurances Services Organization (ISO) location, (2) projected peak-hour demands and (3) during daytime and nighttime refill conditions. Identify hydraulic deficiencies in the system and simulate improvements which would correct deficiencies.
b. Identified areas of poor pipe looping, excessive pipe velocities, low and high systems pressures, redundancy and other water system characteristics in accordance with AWWA criteria as well as general water works engineering practice. Specific flow restricted areas such as the "Community of Jesus" and the Heights area will be evaluated along with other known low pressure or low fire flow areas.
c. A storage analysis was conducted to determine the adequacy of existing storage to meet current and projected needs. The analysis will determine the required storage volumes for emergency, peak-hourly and fire protection. Storage will be determined on a system-wide and service zone basis under various ISO flow scenarios.
d. Peak-hour storage requirements were determined from existing demand trends during peak demand periods, storage records and diurnal water use demand patterns. Fire protection needs were calculated based on recommended ratings by the ISO.
e. The analysis determined if a storage deficit or surplus existed and recommended enhancements to meet the projected storage needs through the planning period were developed.

f. Risks and vulnerabilities of major infrastructure based on a variety of criteria such as age, condition, maintenance history, impact to service, etc., were identified

C. Operation and preventative maintenance programs in the distribution system with regard to compliance with Level of Service goals and objectives were identified. A senior grade IV treatment plant operator conducted an audit of operations procedures, reviewed maintenance of flushing procedures, and conducted staff interviews. Our team used AWWA QualServe Guidelines for the water system benchmarking audit.

Condition Assessment of Existing Treatment Facility

A. A review of the capacity of the current treatment facility was conducted under the following scenarios:
   a. To meet projected future demands
   b. To serve a potential future interconnection to Eastham
   c. To integrate Well No. 7 into the facility to provide treatment
   d. Evaluate performance of the chemical feed systems, ventilation of this area of the plant and offer ideas to reduce corrosivity of these systems

B. For each major system in the facility, we:
   - Performed a condition assessment
   - Determined performance limitations under scenarios described above
   - Assessed redundancy and N-1 (loss of largest source) requirements from MassDEP and 10 State Standards
   - Reviewed appropriate timing for replacement of systems
   - Suggested capital reserve values for large systems such as roofing or membrane replacement
   - Reviewed maintenance and upgrade history
   - Determined hydraulic capacity and constraints
   - Determined adequacy under current and projected plant flows
   - Considered future regulations

C. Specific issues identified in our preliminary site reconnaissance were reviewed including:
   a. SCADA, PLC and HMI software that appears to be outdated and limited

b. SWMI impacts
c. Membrane feed pump VFDs

D. Developed a report narrative of the control, PLC and SCADA requirements at the treatment facility to document the need for this project and to allow this time sensitive project to proceed in 2014. The work was procured under a separate solicitation.
E. Evaluated each individual process to determine the extent of improvements required, what modifications can be made to the existing process. Alternative products or process technologies were also considered.
F. Reviewed performance of primary unit processes including performance limiting factors, conditional assessment, process control and redundancy. Assessed the capacity of each system to meet projected future water demands.

Condition Assessment of Existing Pumping Stations and Wells

A. For each well pumping station, visits to the sites were made to assess the following:
- Performed a condition assessment
- Determined performance limitations
- Reviewed well cleaning records
- Reviewed raw water quality
- Reviewed maintenance and upgrade history
- Determined hydraulic capacity and constraints
- Determined adequacy under current and projected plant flows
- Considered impact of future regulations

B. Specific issues identified in our preliminary site reconnaissance included:
a. Evaluated check valves in the system, possible sources of leakage and unaccounted-for water, and devised a plan to measure well flow and measure performance of the wells
b. VFD, pump and motor capacity at Wells No 4, 5 and 6
c. Auxiliary power
d. Any constraints preventing full use of the WMA registrations for the wells
e. Piping, metering, safety, security issues

C. Assess operation and preventative maintenance programs at the well stations with regard to compliance with Level of Service goals and objectives. A senior grade IV treatment plant operator will audit procedures at the stations and wells, review security and controls, and interview staff. Our team used AWWA QualServe Guidelines for the pumping station audit.

Regulatory Review

A. Reviewed current and proposed EPA and MassDEP regulations to determine gaps and vulnerabilities in the Orleans system regarding compliance with future regulations. Specifically, we reviewed:
    a. Revised TCR Rule
    b. EPAs CCL3
    c. UCMR3
    d. DEP regulated manganese concentrations
    e. Draft Radon Rule and other radionuclides
    f. Other published regulations
B. Assessed regulatory impacts such as triggering of the Interbasin Transfer Act (IBTA) with sale of water to Eastham or other regulations by MassDEP.
C. Reviewed recent updates to the Orleans Water Management Act permit and how new constraints will impact Level of Service goals and objectives.

Review of Security, Water Metering and Accounting, and Management Functions

A. Reviewed system security and metering needs in the system and required investment to meet Level of Service objectives.
B. Reviewed existing storage and maintenance building and determine needs to meet Level of Service objectives.
C. Defined deficiencies and needs in the system for the operational aspects of the system.

Likelihood and Consequence of Failure of Critical Assets

A. Develop a risk-based model to assign likelihood and consequence of failure to key assets in the Orleans water system.

B. Collected or imported from the GIS systems and other databases key information including:

   a. Critical facilities such as schools, businesses, and tourist destinations
   b. Soil information
   c. Main break history
   d. Customer complaint logs
   e. Redundancy and reliability data
   f. Other crucial information for critical assets
   g. Potential environmental impacts

C. Developed an asset rating model using the Asset Management (AM) database developed for the project. Developed a composite criticality ranking for all key assets to meet required Level of Service for the Orleans systems.

Establish Life Cycle Cost and Develop Integrated Capital Improvement Plan

A. Integrated findings into an integrated 20-year capital improvement plan which meets the Town's water rate goals and objectives. The plan will consider timing and projected costs based on the AM evaluation. Two cost overlays were developed, one with the Eastham demands and one without the Eastham demands. The plan includes all capital and operation/preventive maintenance costs and needs:

   a. Capital investments
      i. Pumping stations and wells
      ii. Treatment facility
      iii. Storage tanks
      iv. Distribution system
      v. Auxiliary power systems
   b. Made a cursory review of the water department's vehicle fleet and allocate appropriate cost in the financial plan for vehicle replacement.

c. The existing garage and vehicle storage area was evaluated in a cursory manner to understand general functions and space needs and how this space may fit into the proposed DPW garage.

d. Annual operation and preventative maintenance costs or allocations were made for the following:

   i. Well cleanings

   ii. Pump, motor, VFD replacements

   iii. Tank maintenance and painting

   iv. Membrane replacement

   v. Annual software maintenance costs

   vi. Metering and billing

   vii. Security needs such as fencing and surveillance

B. The capital improvement plan will use the Town's financial model spreadsheet to project revenue requirements in each given year. The revenue requirements will consider:

   a. Suggested capital reserves for large irregular maintenance costs such as membrane replacement and tank repainting.

   b. Annual payments and timing for large capital projects (Projects to be bonded).

   c. Existing debt retirement.

   d. Annual allocations for routine maintenance.

   e. Projected revenue over next 20-year plan from projected demands and restrictions required under the water management act.

C. If requested, offer alternative funding mechanisms other than the current, traditional increasing block rate structure.

Section 2

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SECTION 2

EXISTING WATER SYSTEM CONDITION ASSESSMENT

2.1 GENERAL

The Town of Orleans is supplied water from eight wells, seven gravel-packed and one naturally developed. Four of the well supplies are treated to remove iron and manganese using a membrane filtration water treatment facility. The remaining wells pump directly to the distribution system. The supply is classified as a non-disinfected supply, although free chlorine is added to the system, to provide a low chlorine residual in the distribution system. Water storage is provided by two welded steel standpipes.

The Orleans Water Department commissioned this study to develop a 20-year asset management plan based on sound asset management principles geared towards delivering an adequate level of service to the Town's water customers. A brief description of the existing facilities, well field sites, treatment facility, storage standpipes and interconnections with neighboring public water systems is discussed herein to form a basis for this evaluation.

2.2 WATER SYSTEM HISTORICAL PERSPECTIVE

The Town of Orleans began construction of the water system in the early 1960's after planning studies were completed in 1952 and 1961 by the engineering firm, Whitman and Howard Inc. The initial water distribution system consisted of 41 miles of cement-lined cast iron piping, constructed in two separate contracts.

The original distribution system consisted of water mains ranging in size from 6-inch diameter to 16-inch diameter piping. Approximately 300 fire hydrants and 1,000, 1-inch diameter cement lined iron pipe service connections were installed in the original system. The original distribution system was well conceived and continues to function well as the system has expanded. The primary spine of the system in the north-south direction was a 10-inch main extending along State Route 28 (South Orleans Road) from the Brewster town line to Orleans town center.

Similarly, a 12-inch water main extending in the east-west direction was installed along Main Street to supply East Orleans.

Storage in the original water system consisted of a single 1.38 million gallon (MG) welded steel facility located on Mill Hill (Now referred to as Standpipe No. 1). The overflow elevation of El. 218 feet was selected to maintain static pressures in the system below 100 psi at low lying areas near sea level and pressures of about 68 psi in the village area. This current water system continues to operate on a hydraulic gradeline of El. 218 feet.

The original water was supplied by three wells in the Gould Pond area, now referred to as Well No.1, Well No. 2 and Well No. 3, all commissioned in 1963. The wells are located along South Orleans Road near Gould Pond and continue to be important supplies for the water system. The original well facilities were each equipped with right-angle drive engines to provide emergency power and supply. Each of the well supplies was constructed within a small pumping station structure. The pumping station for Well No. 1 was constructed adjacent to a garage and storage facility, which was also constructed as part of the original water system.

The Orleans water system has continued to grow and expand since the original water system was conceived and constructed in the early 1960s.

2.3 EXISTING WELL SUPPLIES

The Town of Orleans has eight groundwater supplies that are registered or permitted under the Massachusetts Water Management Act (WMA) to withdrawal water for public purposes. Registered supplies pre-date the water management act and are grandfathered and are therefore not subject to the same flow restrictions that recently permitted wells have. The well supplies and the regulatory status of each well are shown in Table 2-1 below.

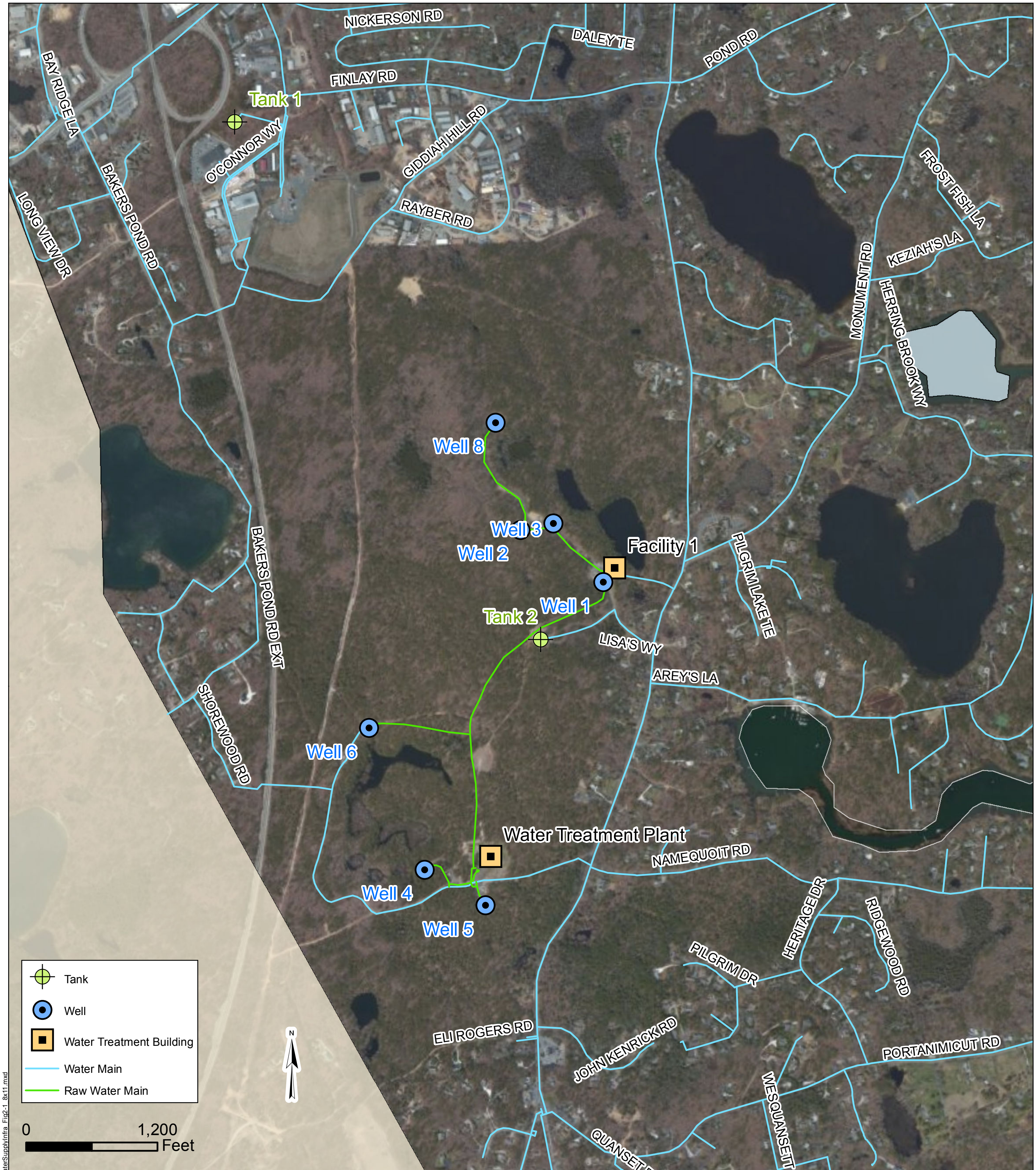
The water department tests and monitors performance of each well pump and well casing every year. The most recent assessment of the Town’s wells and well pump performance was made by Maher Services in June 2013. As part of this testing the well drawdown (the difference in water level within a well when no water is being pumped from the well) and specific capacity (the pumping rate of a well divided by the related drawdown) was measured and recorded. It is a very valuable number that can be used to provide the design pumping rate or maximum yield for the well. It can be used to identify potential well, pump, or aquifer problems, and accordingly to develop a proper well maintenance schedule.

Site visits were conducted by Wright-Pierce staff in April and June 2013 to observe the current condition of the facilities. A brief description and history of each source, current performance constraints and a condition assessment of each facility follows.

TABLE 2-1
ORLEANS GROUNDWATER SUPPLIES

Source Name	Source ID	Permitting Status	Location/Sub Basin
Well No. 1	4224000-01G	Registered	Gould Pond
Well No. 2	4224000-02G	Registered	Gould Pond
Well No. 3	4224000-03G	Registered	Gould Pond
Well No. 4	4224000-04G	Registered	Cliff Pond
Well No. 5	4224000-05G	Registered	Cliff Pond
Well No. 6	4224000-06G	Permitted	Cliff Pond
Well No. 7	4224000-07G	Permitted	Quanset Road
Well No. 8	4224000-08G	Permitted	Gould Pond

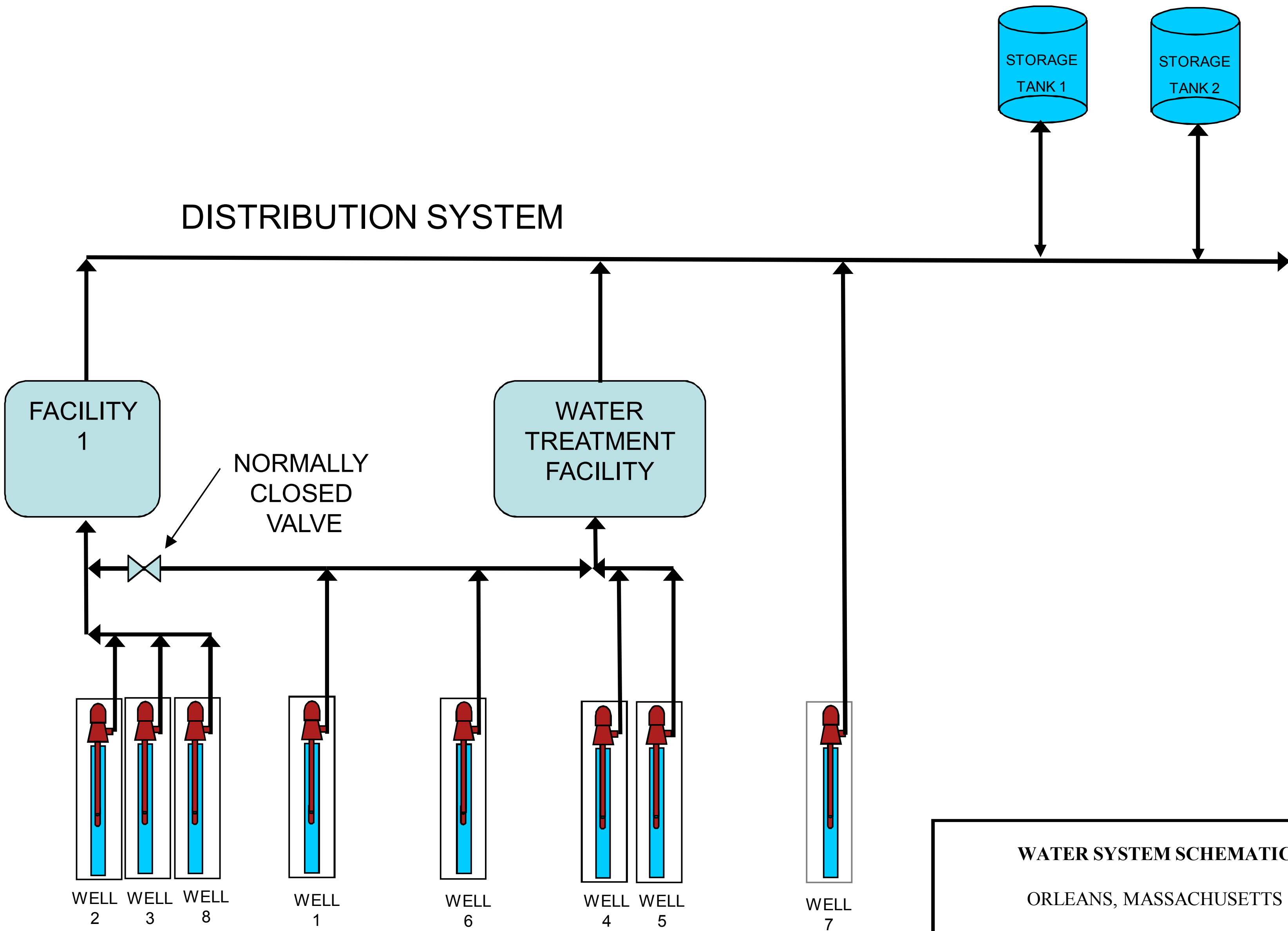
A site location map showing the well supplies is presented in Figure 2-1 and a schematic representation of water system is included in Figure 2-2. More detailed schematic diagrams of the well supplies are presented in Figures 2-4 and 2-5 later in this section.



Town of Orleans, MA

Water Supply Infrastructure

PROJ NO: 12779	DATE: Feb 2014
WRIGHT-PIERCE Engineering a Better Environment	FIGURE: 2-1



Currently pumps and motors for Wells No. 4, 5 and 6 are sized to pump through the Water Treatment Facility and cannot pump directly to distribution. The Well No. 1 pump and motor is sized to pump either to the WTF (normal operating condition) or to distribution through Facility No. 1.

WATER SYSTEM SCHEMATIC

ORLEANS, MASSACHUSETTS

PROJ NO: 12779	DATE: FEB 2014	FIGURE: 2-2

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2.3.1 Watershed Protection Areas and Land Protection

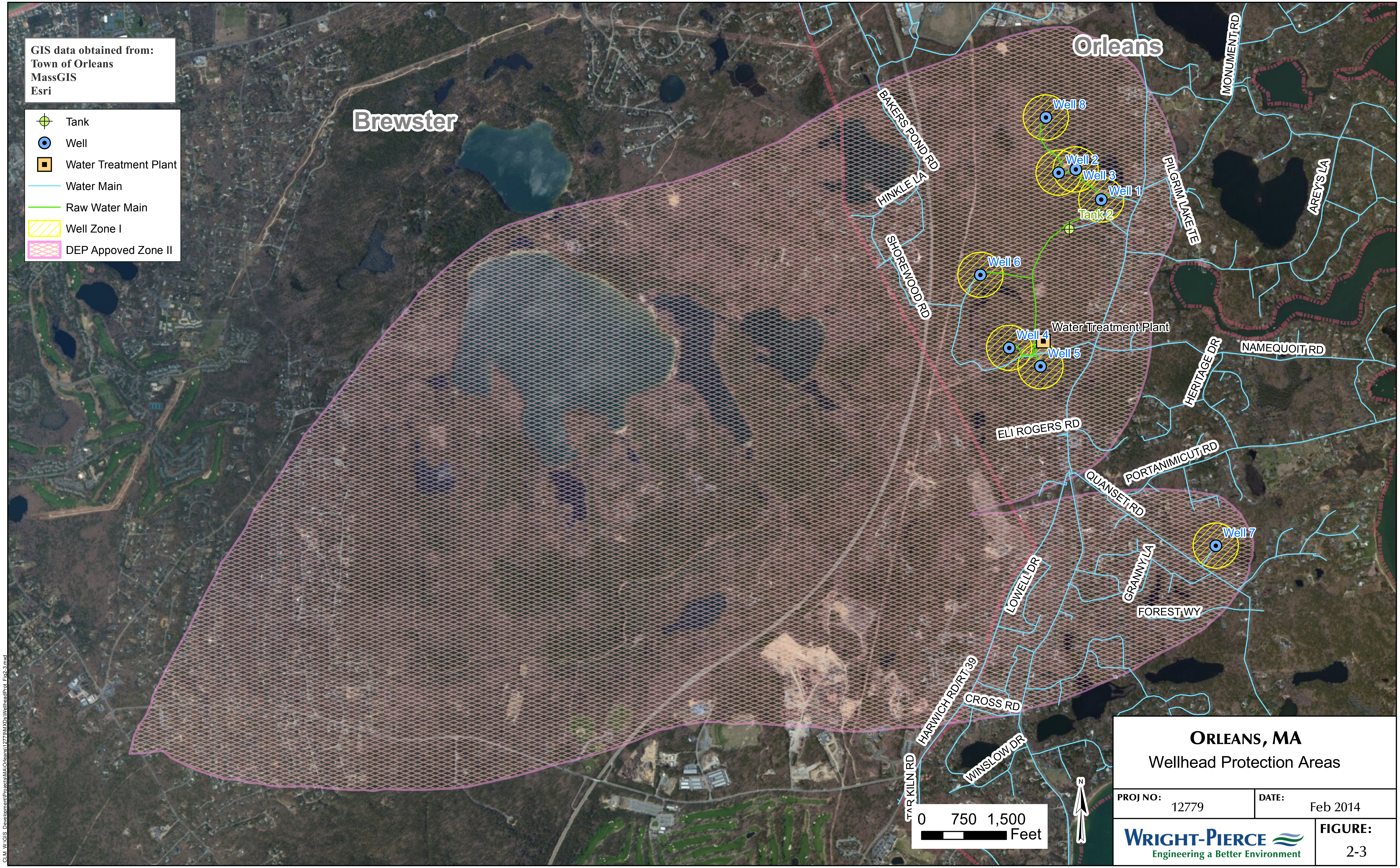
MassDEP requires all public water systems to develop and define watershed protection areas dependent on the withdrawal capacity of the system. The water department has DEP approved Zone II wellhead delineations for each source of supply. In addition, the Town controls the fixed Zone I, 400-foot radius wellhead protection are around each well supply. Figure 2-3 shows the wellhead delineations in the vicinity of the well supplies.

A Zone I Wellhead Protection Area is defined in general by DEP as: "The area closest to a well; a 100 to 400 foot radius proportional to the well's pumping rate. This area should be owned or controlled by the water supplier and limited to water supply activities." For the Orleans wells, a 400-foot radius is required.

A Zone II Wellhead Protection Area is defined by DEP as: "That area of an aquifer which contributes water to a well under the most severe pumping and recharge conditions that can be realistically anticipated (180 days of pumping at safe yield, with no recharge from precipitation). It is bounded by the groundwater divides which result from pumping the well and by the contact of the aquifer with less permeable materials such as till or bedrock. In some cases, streams or lakes may act as recharge boundaries. In all cases, Zone II delineations shall extend up gradient to its point of intersection with prevailing hydrogeologic boundaries (a groundwater flow divide, a contact with till or bedrock, or a recharge boundary)."

The Zone II delineations are determined using a groundwater model.

In general, all the wells are protected from sources of contamination and meet the requirements of their Water Management Act permits with regard to land use control and protection.



ORLEANS, MA

Wellhead Protection Areas

PROJ NO:	DATE:	FIGURE:
12779	Feb 2014	2-3

WRIGHT-PIERCE
Engineering a Better Environment

2.3.2 Well No. 1 (Source ID 4224000-01G)

2.3.2.1 Existing Equipment and Performance

General - Well No. 1 was installed in 1963 as part of the original Orleans water system. The pumping station is a masonry building, approximately 14-feet x 18-feet in plan attached to the water department maintenance garage. The original building structure has essentially remained unchanged over the years except as noted below.

Well, Pump and Motor Information - The original 24-inch well casing, located within the Well No. 1 pumping station, is sealed and no longer used. The original well was 64-feet deep and equipped with a 10-foot split screen consisting of two 5 foot long sections. The top screen section was reported to be in poor condition.

In 2005, a new well was drilled adjacent to the pumping station in an effort to improve yield and water quality and to modernize one of the oldest supplies in the Orleans water system. The present well is a 12-inch gravel-packed well equipped with a 15-foot, stainless-steel screen and pitless unit. The total well depth is 98-feet. The well was last tested in June 2013 and found to have a specific capacity of about 24-gpm per foot of drawdown when pumped at the operating point of 434 gallons per minutes (gpm) by the Maher Services. The Town operates this well at maximum of 400 gpm to ensure compliance with their permitted withdrawal rates. A summary table of the well and pump data is included in section 2.3.10 of this report.

The present well pump was installed in 2007 as part of an upgrade to the water treatment facility. The pump is a Gould's 8RJLC closed impeller, submersible pump selected to produce 450 gpm at 280-feet of total dynamic head (TDH). The most recent pump evaluation completed by Maher Services in May 2012 demonstrated that the pump is presently producing 434 gpm at a TDH of 276 feet, suggesting excellent performance and little wear from its original design intent.
The pump is powered by a 50 hp, 480V, 3,600 RPM motor. The pumping system is equipped with a VFD, located in the upper floor of old Well No. 1 station building to adjust output.

Process and Control - The magnetic flow meter and discharge piping flow through the lower level of the original Well No. 1 building, which is an extension of the garage building, before connecting to the distribution system building. The flow meter and piping were replaced as part of an upgrade in 2005.

Well No. 1 can be operated in two modes. Normal operation is to reduce pump speed and direct water to a dedicated raw water main to the water treatment facility for removal of iron and manganese. Alternately, the well can pump directly to the distribution system at high pressure. The water department has reported that iron and manganese concentrations are substantially lower in the new well and delivery directly to the distribution system is now possible without compromising water quality. This configuration provides additional supply redundancy in the event that the WTP is offline for repairs (Discussed further in section 5).

Currently water from Well No.1 is pumped to the WTF for treatment prior to being sent to the distribution system. Well No. 1 is also configured to pump directly to the distribution system as needed. No provisions for contact time after disinfection are available other than the small amount of contact time in the distribution pipeline before the first customer. There is no indication that contact time is needed to comply with the groundwater rule since the well is deep, well protected, has adequate setback from surface waters, and does not have any history of microbial activity.

The upper floor of the original pumping station now houses RTU 1, the primary SCADA node for Well No. 1, Facility No. 1, and Wells No. 2, 3 and 8. A schematic of the controls, piping and auxiliary power for the Gould Pond wells is shown on Figure 2-4.

Connection of Well No. 1 with fiber optic control wiring to the water treatment facility may be desirable in the future to reduce disruption of communications with the WTF.

Electrical - The primary three-phase power drop for this facility is on service pole just to the South of the Well. The motor control center at Well No. 1 is in good condition.

The facility was originally equipped with a right-angle drive unit, which has since been removed. There is currently no auxiliary power available at this facility. During a power failure event, the remote control and surveillance of Well No. 1, 2, 3, and 8 and Facility No. 1 is lost because this facility lacks an auxiliary power supply. The motor control center is located on the upper floor of this facility. Options to rectify this situation are included in Section 5.

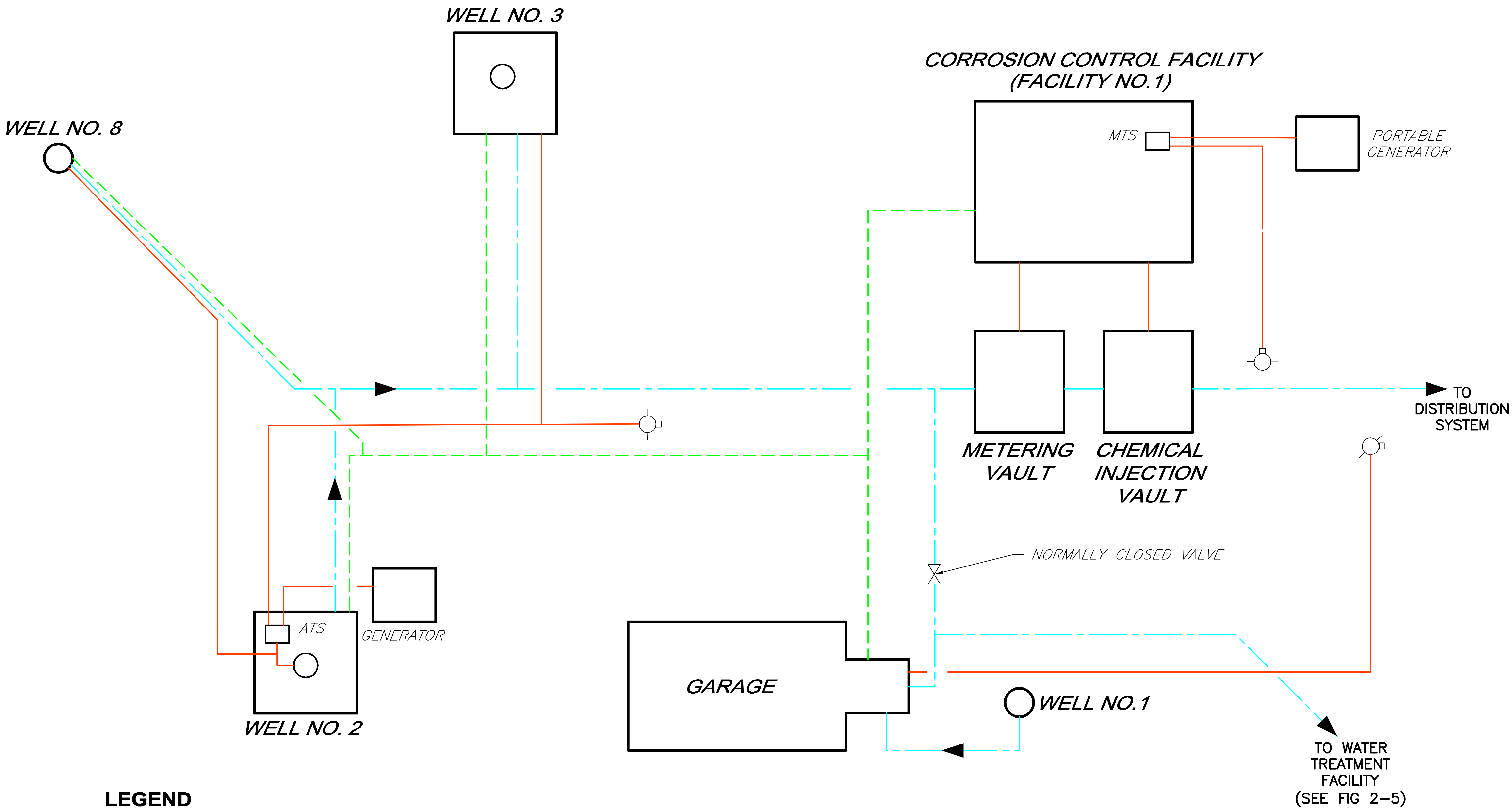
Communications - Control locally at Well No. 1 is through RTU 1. RTU 1 is built into the main control panel at this facility. Communication with the WTF is completed through the use of radio telemetry. As there is no auxiliary power available at this facility, when power is lost operations at this and the other the Gould Pond wells cannot be observed or controlled from the WTF.

2.3.2.2 Water Management Act Constraints

Well No. 1 is a registered supply. The Zone II delineation for Well No. 1 is based on a flow rate of 576,000 gpd or an instantaneous flow rate of 400 gpm when pumped continuously. It is understood that the maximum-daily withdrawal from the supply is based on the 2006 WMA permit for Orleans. Although not explicitly stated in the 2012 permit renewal, it is our understanding that this requirement remains in the current permit. Well No. 1 is a registered supply.

2.3.2.3 Water Quality and Wellhead Protection

The Zone I delineation for Well No. 1 includes the water department's service garage, which is part of the Well No. 1 pumping station. The water department has firm policies that restrict and control activities in the garage such as oil changes, vehicle cleaning or use of potential lubricants and other materials that could be a risk to the well supply. These activities are conducted off site in other facilities. MassDEP has noted this deficiency but has not formally objected to the presence of the garage within the Zone I delineation of Well No. 1.



LEGEND

- BUILDING AND EQUIPMENT
- PRIMARY AND AUXILLIARY POWER
- FIBER OPTIC CONTROLS
- WATER TRANSMISSION MAINS
- POWER POLE WITH UTILITY METER

FLOW, POWER, AND CONTROL SCHEMATIC
WELL NO. 1, 2, 3 AND 8
ORLEANS, MA

PROJ NO:	DATE:	FIGURE:
12779	AUG 2013	2-4

WRIGHT-PIERCE
Engineering a Better Environment

2.3.3 Well No. 2 (Source ID 4224000-02G)

2.3.3.1 Existing Equipment and Capacities

General - The Well No. 2 supply was constructed as part of the original Orleans water system in 1963. The well is housed within the pumping station structure. The pumping station is a masonry building, approximately 14-feet x 18-feet in plan. The pumping station has two floors, one at grade and one below grade. The discharge piping exits the building through the foundation wall below grade. To access the below grade section of the facility climbing down a ladder is required and as such this area is now classified as a confined space. The original structure has essentially remained unchanged over the years except as noted below.

Well, Pump and Motor Information - The present well is a 24-inch gravel-packed well equipped with a 10-foot, stainless-steel screen (slot size - 0.190 inches). The total well depth is 78-feet. The present well pump was installed in 2001 and serviced and tested annually over the past 4 years. Well reports describe the pumping system and well to be in good condition. The current pump is a Gould's 9RCLC open impeller, vertical turbine lineshaft pump, selected to produce 315 gpm at 265-feet of total dynamic head (TDH). The most recent pump evaluation completed by Maher Services in June 2013 demonstrated that the pump is presently producing 396 gpm with 13.6 feet of drawdown, for a specific capacity of 29.1 gpm per foot of drawdown. The original design documents from 1963 suggest that the original well pump was designed to meet an operating point of 325 gpm at a TDH of 279 feet. A summary table of the well data is included in section 2.3.10 of this report.

The pump is powered by a 40 hp, 460V, 1,780 RPM motor, installed in 2007. The pumping system is equipped with a VFD located on the upper floor of this building.

The June 2013 well and pump assessment report completed by Maher Services did not identify any major challenges at Well No. 2. A slight pump vibration was eliminated by rebalancing the motor when the right angle drive was removed in November 2013.

Process and Control – Generally the equipment within Well No. 2 is modern and was mostly upgraded in 2007. The well pump is operated by a VFD manufactured by Allen Bradley, which has been standardized by the Orleans Water Department. A circular, flow chart recorder monitors production and flow at the site. Similar to Well No. 8 and 3, chemical dosing is based on the local flow meter at Facility No. 1 where chemicals are added.

An older-style, cast-iron venturi flow tube and surge control valve are present in the lower floor of the facility. A new magnetic flow meter and updated discharge piping is needed at this facility for accurate water accounting purposes and to document source water withdrawals.

Electrical - The motor control center at Well No. 2 is in good condition. The primary power feed to the Gould Pond wells is complicated (see Figure 2-4). Options for rectifying this complication are discussed in Section 5. Wells Nos. 2, 3 and 8 are powered from a common three-phase power drop at a service pole near Well No. 3. Power consumption for these three facilities is metered at this pole.

The facility was originally equipped with a right-angle drive unit, which was removed in November 2013. The exhaust piping for the removed RAD and ancillary piping and equipment should also be removed.

Auxiliary power is provided to the facility from a pad-mounted liquid propane generator manufactured by Onan Generators located behind the building. This generator was installed as part of the Well No. 8 construction as electricity and communications was subfed to Well No. 8 through Well No. 2. This generator is sized to supply power to both wells in the event of power failure.

Communications - Control locally at Well No. 2 is through RTU 2. RTU 2 is connected to the other wells with a buried fiber optic cable. However, when power is lost at Well No. 1, the primary SCADA control node back to the treatment facility, operations at the Gould Pond wells cannot be observed or controlled from the treatment facility. Options to rectify this situation are discussed in Section 5.

2.3.3.2 Water Management Act Constraints

Well No. 2 is a registered supply. The Zone II delineation for Well No. 2 is based on a flow rate of 468,000 gpd or an instantaneous flow rate of 325 gpm when pumped continuously. The present available pumping capacity of 396 gpm is higher than this approved withdrawal rate. This is understood that the maximum-daily withdrawal from the supply is based on the 2006 WMA permit for Orleans. Although not explicitly stated in the 2012 permit renewal, it is our understanding that this requirement remains in the current permit.

2.3.3.3 Water Quality and Wellhead Protection

A 400-foot protective radius for a Zone I wellhead protection delineation is required around each well in Massachusetts. The perimeter of the Zone I delineation is located in close proximity to the pipe storage yard. Although a permitted use in Zone I by the MassDEP, any expansion of existing facilities within this zone should be scrutinized, reviewed with MassDEP, and be protective of the source water quality. The existing pumping station is a permitted use as prescribed by the MassDEP.

2.3.4 Well No. 3 (Source ID 4224000-03G)

2.3.4.1 Existing Equipment and Capacities

General - The Well No. 3 supply was constructed as part of the original Orleans water system in 1963. The well is housed within the pumping station structure. The pumping station is a masonry building, approximately 14-feet x 18-feet in plan. The pumping station has two floors, one at grade and one below grade. The discharge piping exits the building through the foundation wall below grade. To access the below grade section of the facility climbing down a ladder is required and as such this area is now classified as a confined space. The original structure has essentially remained unchanged over the years except as noted below.

Well, Pump and Motor Information - The present well is a 24-inch gravel-packed well equipped with a 10-foot, stainless-steel screen. The total well depth is 97.5-feet. The well pump was installed in 1992 and has been serviced and tested annually over the past 3 years. Well reports describe the pumping system and well to be in good condition. The current pump is a Gould's 10RJLO7 open impeller, vertical turbine lineshaft pump, selected to produce 500 gpm at 265-feet of total dynamic head (TDH). The most recent pump evaluation completed by Maher Services in June 2013 did not identify any major challenges at this Well and demonstrated that the pump is presently producing 514 gpm with 11.3 feet of drawdown, for a specific capacity of 45.4 gpm per foot of drawdown. The original design documents from 1963 suggest that the original well pump was designed to meet an operating point of 625 gpm at a TDH of 286 feet.

The pump is powered by an open drip proof, inverted duty 50 hp, 460V, 1,780 RPM motor installed in 2006 with a right angle drive assembly. The pumping system is equipped with a VFD. A summary table of the well and pump data is included in section 2.3.10 of this report.

The well pump is operated by a VFD manufactured by Allen Bradley, which has been standardized by the Orleans Water Department. The current flow meter and circular flow chart recorder monitor production and flow at the site. Similar to Well No. 2 and 8, chemical dosing is conducted on the local flow meter at Facility No. 1, where chemicals are added.

Process and Control - An older-style, cast-iron venturi flow tube and surge control valve are present in the lower floor of the facility. This equipment should be replaced with a new flow tube and a magnetic flow meter. Because of the piping alignment, an eccentric reducer or pipe offset will be needed to match the existing piping. This work may also require replacement of some buried piping to correct the alignment. The difficulty of correcting this alignment is discussed in Section 5.

Electrical - The motor control center at Well No. 3 appears to date back to the original facility installation. This equipment is old and in need of replacement. A liquid propane, right-angle drive engine is installed and coupled to the pump to drive the pump during power failures. The RAD is engaged with a manual clutch.

A plan for auxiliary power is also needed at Well No. 3. As discussed, the primary power feed to the Gould Pond wells is complicated. Wells Nos. 2, 3 and 8 are powered from a single primary three-phase power drop at a service pole near Well No. 3. Power consumption for these three facilities is metered at this pole. A new generator would require either a new power service to isolate the auxiliary power feed from Well No. 2 and 8, or alternatively, power could be extended from the power service at Well No. 1 and Facility No. 1 which is separate, to form a common circuit that could be fed with another generator system. A third alternative could be retention of the RAD engine. Alternatives are further reviewed in section 5.

Auxiliary power was not extended to include Well No. 3 during the 2007 upgrade to Well No. 2 because of funding limits that did not permit extension of back-up power to this site as part of that project.

Communications - Control locally at Well No. 3 is through RTU 3. RTU 3 is connected to the other Gould Pond wells with a buried fiber optic cable. However, when power is lost at Well No. 1, the primary SCADA control node back to the treatment facility, operations at the Gould Pond wells cannot be observed or controlled from the treatment facility. Options to rectify this situation are discussed in Section 5. A control and piping schematic of control wiring and piping in the vicinity of Well No.1, 2, 3 and 8 is shown in Figure 2-4.

2.3.4.2 Water Management Act Constraints

Well No. 3 is a registered supply. The Zone II delineation for Well No. 3 is based on a flow rate of 720,000 gpd or an instantaneous flow rate of 500 gpm when pumped continuously. The present pumping capacity of 514 gpm is very close to this approved withdrawal rate (500 gpm).

2.3.4.3 Water Quality and Wellhead Protection

A 400-foot protective radius for a Zone I wellhead protection delineation is required around each well in Massachusetts. The perimeter of the Zone I delineation is located in close proximity to the pipe storage yard. Although a permitted use in Zone I by the MassDEP, any expansion of existing facilities within this zone should be scrutinized, reviewed with MassDEP and be protective of the source water quality. The existing pumping station is a permitted use as prescribed by the MassDEP.

The Zone II well delineation for Well No. 3 was approved by the MassDEP in 1993 and based on a maximum-daily flow rate of 720,000 gallons per day.

2.3.5 Well No. 4 (Source ID 4224000-04G)

2.3.5.1 Existing Equipment and Capacities

General - Well No. 4 was constructed in 1975 to supplement the well supply in Orleans. The facility originally pumped directly to the water distribution system with no treatment. The well is located within the building footprint.

The original well pump was equipped with a propane-driven, right-angle drive engine to power the pump in emergencies. The drive unit is still present in the facility but is decoupled from the pump and no longer in use and can be removed from the facility. The water department is planning to upgrade the propane gas system storage tank located on the property to allow better competition to purchase liquid propane. The replacement system will be downsized to meet the needs of the heating system only now that the right-angle drive engine is no longer operational.

The pumping station structure remains virtually unchanged since its original construction. The pumping station is approximately 18' x 20' in plan and constructed of a single course of masonry block. The building has a wood-framed roof with asphalt shingles. The building roof was replaced in 2012. The pumping station is well maintained and in good condition.

In the early 1990's, a corrosion control facility referred to as Facility No. 2, was constructed downstream of Well No. 4 to inject potassium hydroxide for pH control. The pH control for Well No. 4 now occurs at the WTF. Facility No. 2 no longer provides a process function and currently provides space for storage of brass.

Well, Pump and Motor Information - The well is a 24-inch gravel-packed well equipped with a 10-foot, 0.17 slot stainless-steel well screen. The total well depth is 66.5 feet. The present low head, well pump and motor were installed in 2005 as part of an upgrade to the water treatment facility. The pump is a Gould's 10RJMO, 2-stage open impeller, vertical turbine, lineshaft pump selected during design to produce 520 gpm at 60-feet of TDH. The pump is powered by a 10 hp, 460V, 1,760 RPM TEFC motor. The most recent pump evaluation completed by Maher Services in June 2013 recommends pump removal and inspection in 2014 and demonstrated that the pump is presently producing 320 gpm with 9.9 feet of drawdown, for a specific capacity of 32.3 gpm per foot of drawdown. The pumping system is equipped with a VFD to adjust operational speed and output. A summary table of the well and pump data is included in section 2.3.10 of this report.

Well No. 4 produces much lower flow than allowed in the permitted limit of 520 gpm. The June 2013 report recommended that Well No. 4 be removed and inspected to determine if the pump capacity can be increased to the permitted limits.

Process and Control - The VFD, magnetic flow meter, electric motor and motor control center have all been modernized and are in good condition. The local 6-inch flow meter is used only for accounting purposes and to monitor performance of the well pump. Chemical dosing and flow control for Well No. 4 is controlled by the raw water flow meter at WTF.

Electrical – The motor control center is good condition and was updated as part of the WTF construction project. Power is supplied to Well No. 4 through the water treatment facility. Similarly, emergency power is provided by the auxiliary generator at the water treatment facility.

Communications - Well No. 4 is controlled and powered from the water treatment facility. Control is provided locally by an RTU connecting this facility to the water treatment facility. Similarly, emergency power is provided by the auxiliary generator at the water treatment facility. A schematic of the primary piping and wiring between Well No. 4, 5 and 6 is shown in Figure 2-5.

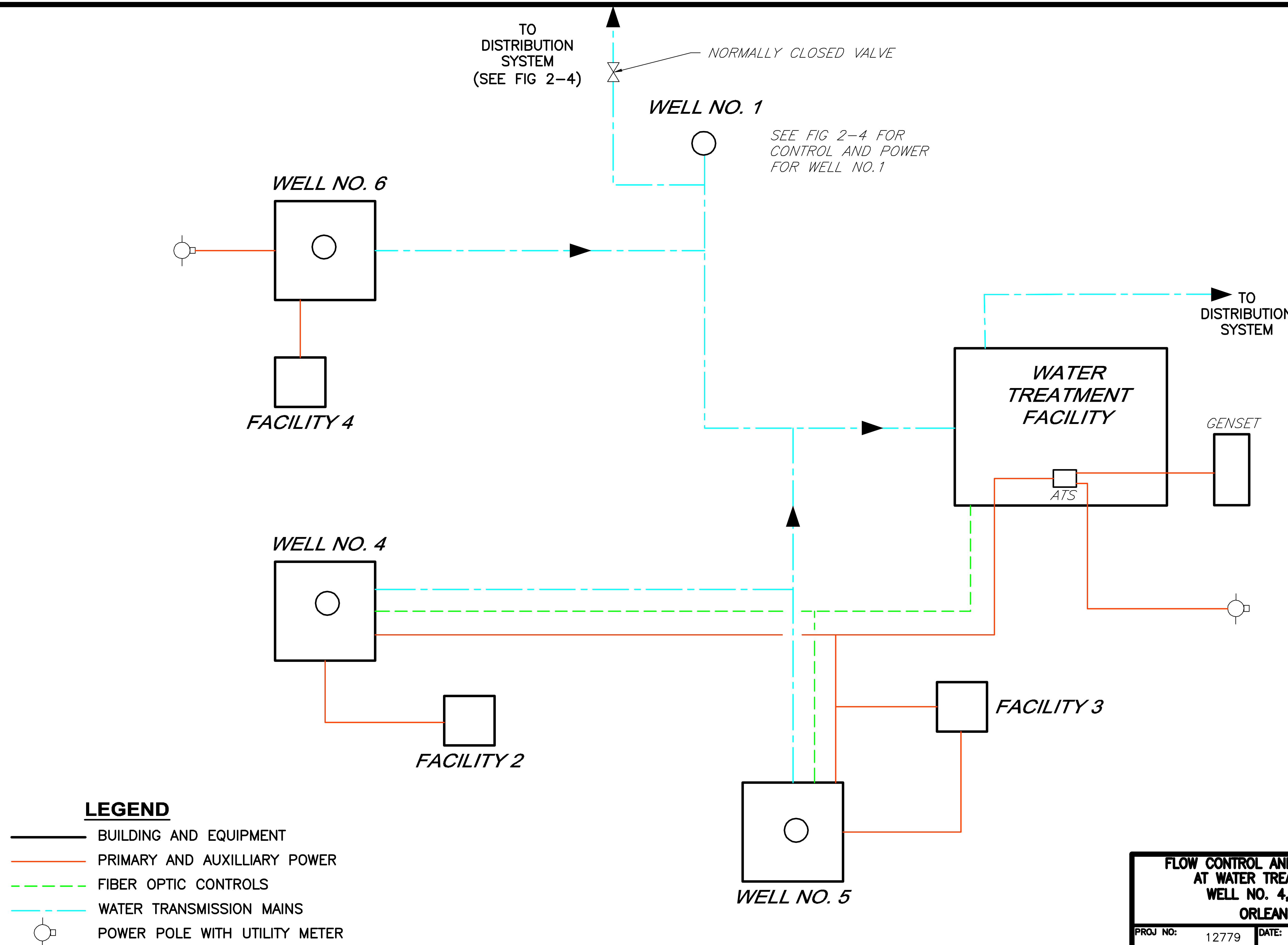
2.3.5.2 Water Management Act Constraints

Well No. 4 is a registered supply. The Zone II delineation for Well No. 4 is based on a flow rate of 749,000 gpd or an instantaneous flow rate of 520 gpm when pumped continuously. The present pumping rate is much lower than this approved withdrawal rate suggesting that a larger pump might be needed at this location. In 2012, the Town's maximum-day flow rate from this source was only 309,800 gpd, suggesting that significant additional capacity would be available from this source if the pump size was increased to the permitted capacity. It should be noted that the present VFD and well pump are 10 hp in size. These will need to be increased to 15-20 hp to accommodate the additional flow from this site.

2.3.5.3 Water Quality and Wellhead Protection

A 400-foot protective Zone I radius is required around each well. The Zone I delineation for Well No. 4 is wooded, well protected and located entirely within Town forest lands. The Zone I delineation for Well No. 4 is located close to the water treatment facility. Any expansion of existing facilities within this zone should scrutinized, reviewed with MassDEP and be protective of the source water quality. The existing pumping station is a permitted use as prescribed by the MassDEP.

The Zone II well delineation for Well No. 4 was approved by the MassDEP in 1993 for a maximum daily withdrawal rate of 750,000 gallons per day.



FLOW CONTROL AND POWER SCHEMATIC AT WATER TREATMENT FACILITY, WELL NO. 4, 5, AND 6
ORLEANS, MA

PROJ NO:	DATE:	FIGURE:
12779	FEB 2014	2-5

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2.3.6 Well No. 5 (Source ID 4224000-05G)

2.3.6.1 Existing Equipment and Capacities

General - Well No. 5 was constructed along with Well No. 4 in 1976 to supplement supply. Both facilities are essentially identical except for well capacity and pump size. The facility originally pumped directly to the water distribution system with no treatment. The well is located within the building footprint.

The original well pump was equipped with a propane-driven, right-angle drive engine to power the pump in emergencies. The drive unit is still present in the facility but is decoupled from the pump and no longer in use and can be removed from the facility. The water department is planning to upgrade the propane gas system storage tank located on the property to allow better competition to purchase liquid propane. The replacement system will be downsized to meet the needs of the heating system only now that the right-angle drive engine is no longer operational.

The pumping station structure remains virtually unchanged since its original construction. The pumping station is approximately 18’ x 20’ in plan and constructed of a single course of masonry block. The building has a wood-framed roof with asphalt shingles. The building roof was replaced in 2012. New ceiling tiles are needed as they have been damaged by a leak in the roof which has since been repaired. The pumping station is well maintained and in good condition.

In the early 1990’s a corrosion control facility, referred to as Facility No. 3, was constructed downstream of Well No. 5 to inject potassium hydroxide for pH control. The pH control now occurs with the treatment facility for this source. Facility No. 3 is now used for storage of dry records.

Well, Pump and Motor Information - The well is a 24-inch gravel-packed well equipped with a 10-foot, stainless-steel screen. The total well depth is 67.4-feet. The present well pump and motor were installed in 2005 as part of an upgrade to the water treatment facility. The pump is a Gould’s 10RJLO, 2-stage open impeller, vertical turbine, lineshaft pump selected to produce 325 gpm at 52-feet of TDH. The pump is powered by a 7.5 hp, 460V, 1,760 RPM TEFC motor. The most recent pump evaluation completed by Maher Services in June 2013 demonstrated that the pump is presently producing 275 gpm with 14.9 feet of drawdown, for a specific capacity of 18.4 gpm per foot of drawdown. The pumping system is equipped with a VFD to adjust operational speed and output. A summary table of the well and pump data is included in section 2.3.10 of this report.

Because of the high iron concentrations, Well No. 5 loses capacity quickly and requires more routine cleaning. The May 2013 report recommended that Well No. 5 be cleaned and redeveloped. The well produced a flow of about 310 gpm in 2012 during the prior annual pumping test. The static pressure at the well is only about 5 psi when the pump is not operational. During pumping, the discharge pressure increases to about 15 psi.

Process and Control - The VFD, magnetic flow meter, electric motor and motor control center have all been modernized and are in good condition. The local 6-inch flow meter is used only for accounting purposes and to monitor performance of the well pump. Chemical dosing and flow control for Well No. 5 is controlled by the raw water flow meter at WTF.

Electrical –Power is supplied to Well No. 5 through the water treatment facility. Similarly, emergency power is provided by the auxiliary generator at the water treatment facility.

Communications - Well No. 5 is controlled and powered from the water treatment facility. Control is provided locally by RTU No. 5 connecting this facility to the water treatment facility. Similarly, emergency power is provided by the auxiliary generator at the water treatment facility. A schematic of the primary piping and wiring between Well No. 4, 5 and 6 is shown in Figure 2-5.

2.3.6.2 Water Management Act Constraints

Well No. 5 is a registered supply. The Zone II delineation for Well No. 5 is based on a flow rate of 468,000 gpd or an instantaneous flow rate of 325 gpm when pumped continuously. The present pumping rate is much lower than this approved withdrawal rate based on the need to clean the well screen. This is understood that the maximum-daily withdrawal from the supply is based on the 2006 WMA permit for Orleans. In 2012, the Town's maximum-day flow rate from was 279,600 gal/day.

2.3.6.3 Water Quality and Wellhead Protection

A 400-foot protective radius for the Zone I wellhead protection area is required around each well. The Zone I delineation for Well No. 5 is located in close proximity to the water treatment facility. Although a permitted use in Zone I by the MassDEP, any expansion of existing facilities within this zone should scrutinized, reviewed with MassDEP and be protective of the source water quality. The existing pumping station is a permitted use as prescribed by the MassDEP.

The Zone II well delineation for Well No. 5 was approved by the MassDEP in 1993 and based on an maximum-daily flow rate of 470,000 gallons per day.

2.3.7 Well No. 6 (Source ID 4224000-06G)

2.3.7.1 Existing Equipment and Capacities

General - Well No. 6 was commissioned in 1986 to supplement the well supply in Orleans. The well is located within the building footprint. Well No. 6 was originally constructed to pump directly into the distribution system at high pressure at Shorewood Drive via 12-inch and 16-inch mains. The mains are still interconnected to provide forest fire protection and for flushing. The facility is normally accessed by a long road which ends at the facility. There is an access road that extends along the raw water main path from Well No. 6 connecting to the Tank No. 2 / Well No. 1 area.

In 2005, when the treatment facility was constructed, a new low pressure, 12-inch discharge pipe loop was constructed, overland and cross-country back to the water treatment. The 12-inch main is connected to the 12-inch low pressure main that delivers water from Well No. 1 to the water treatment facility. This main is accessible via a dirt road if a repair is needed. The 12-inch low pressure main, that transports combined flows from Wells No. 1 and 6, connects to a common pipe with Well No. 4 and Well No. 5 in the treatment facility yard.

The pumping station structure is constructed of composite brick masonry and is in good condition. The building has a wood-framed roof with asphalt shingles. The building roof was replaced in 2012. Some interior ceiling tile damage occurred prior to the roof replacement. The ceiling and insulation should be removed and replaced.

Similar to the other wells in this well field, a corrosion control facility referred to as Facility No. 4 was constructed downstream of Well No. 6 to inject potassium hydroxide for pH control. The pH control now occurs with the treatment facility for this source. Facility No. 4 is now used for storage of lawn maintenance equipment.

Well, Pump and Motor Information - The well is a 24-inch gravel-packed well equipped with a 10-foot, stainless-steel screen. The total well depth is 73.2-feet. The present well pump and motor were installed in 2005 as part of an upgrade to the water treatment facility. The pump is a Gould's 11CLC, 2-stage closed impeller, vertical turbine, lineshaft pump selected to produce 680 gpm at 65-feet of total dynamic head (TDH). The pump is powered by a 30 hp, 460V, 1,760 RPM motor. The most recent pump evaluation completed by Maher Services in June 2013 demonstrated that the pump is presently producing 578 gpm with 15.7 feet of drawdown, for a specific capacity of 36.8 gpm per foot of drawdown. The pumping system is equipped with a VFD to adjust operational speed and output. RTU No. 6 provides local control at the facility. A summary table of the well and pump data is included in section 2.3.10 of this report.

Because of the high iron concentrations, Well No. 6 loses capacity quickly and requires more routine cleaning. The local 6-inch flow meter is used only for accounting purposes and to monitor performance of the well pump. Chemical dosing and flow control within the treatment facility is controlled by the raw water flow meter at the treatment facility. This flow meter measures the aggregated flow from Wells No. 1, 4, 5, and 6 and is properly submerged in a small pipe loop to prevent cavitation. The raw water pipe discharges above the water surface in the raw water well at the plant, so the pipe loop is critical to assure accurate chemical dosing within a full pipe. Air release valves have been installed on high elevation areas of the discharge pipeline to prevent cavitation in the low pressure discharge line.

Process and Control - The VFD, 6-inch magnetic flow meter, electric motor and motor control center have all been modernized and are in good condition. The VFD at this location is manufactured by Danfoss. Other VFDs have been standardized around Allen-Bradley.

Electrical - The primary three-phase power drop for this facility is on service pole near the well. The motor control center at Well No. 6 is in good condition. It is also important to note that the primary power feed to this facility is from a major electric transmission system that serves the central cape area. This provides some level of redundancy within the electric grid in Orleans if a major failure of the electric transmission system were to occur from a hurricane, ice storm or similar widespread event. A schematic of the primary piping and wiring between well No. 4, 5, and 6 is shown in Figure 2-5.

There is currently no auxiliary power available at this facility and as such this well is in operable during a power failure. Options to install auxiliary power at this station are included in Section 5.

Communications - Control locally at Well No. 6 is through RTU 6. RTU 6 is built into the main control panel at this facility. Communication with the WTF is completed through the use of radio telemetry.

2.3.7.2 Water Management Act Constraints

Well No. 6 is a permitted supply. The Zone II delineation for Well No. 6 is based on a flow rate of 980,000 gpd or an instantaneous flow rate of 680 gpm when pumped continuously. The present pumping rate is much lower than this approved withdrawal rate based on the need to clean the well casing and possible increase the impeller diameter on the pump. Options to improve the pumping rate at this facility up closer to the permitted Zone II yield will provide an additional 100 gpm from this source. In 2012, the maximum pumpage was 583,000 gallons per day.

2.3.7.3 Water Quality and Wellhead Protection

A 400-foot protective radius for the Zone I wellhead delineation is required around each well. The Zone I delineation for Well No. 6 is located in closest to Route 6 of all the wells. Any expansion of the existing roadway or changes in drainage patterns on Route 6 should be reviewed with MassDEP and be protective of the source water quality. The existing pumping station is a permitted use as prescribed by the MassDEP.

Although a permitted use in Zone I by the MassDEP, any expansion of existing facilities within this zone should scrutinized, reviewed with MassDEP and be protective of the source water quality. The existing pumping station is a permitted use as prescribed by the MassDEP.

The Zone II well delineation for Well No. 6 was approved by the MassDEP in 1993 and based on a maximum-daily flow rate of 980,000 gallons per day.

2.3.8 Well No. 7 (Source ID 4224000-07G)

2.3.8.1 Existing Equipment and Capacities

General - Well No. 7 was commissioned in 1994 to supplement the well supply in Orleans. Well No. 7 is located adjacent to Quanset Road, easterly of South Orleans Road. The well is configured to provide chemical addition at the pumping station and pump directly into the distribution system. This well pumps directly into the distribution system through a 12-inch main on Quanset Road (Figure 2-2).

The pumping station structure is constructed of composite brick masonry and is in good condition. The building has a wood-framed roof with asphalt shingles. The well is equipped with vertical turbine, lineshaft pump and is located within the building footprint. In general, the facility is new and was constructed with current building codes and should remain functional into the future.

Well, Pump and Motor Information - Well No. 7 is the deepest well in the Orleans system at a depth of 171.75 feet. The well is a 24-inch gravel-packed well equipped with a 40-foot, stainless-steel screen. The present well pump and motor date back to the original installation in 1994. The pump is a Gould's 12RJLO, 4-stage open impeller, vertical turbine, lineshaft pump selected to produce 700 gpm at 237-feet of TDH. The pump is powered by a 75 hp, 460V, 1,775 RPM motor. The most recent pump evaluation completed by Maher Services in June 2013 demonstrated that the pump is presently producing 589 gpm with 9 feet of drawdown, for a specific capacity of 65.4 gpm per foot of drawdown. This data suggests that Well No. 7 is a strong producing well with minimal drawdown. Under normal operation speed and pumping rate of the pump is controlled with a VFD. A summary table of the well and pump data is included in section 2.3.10 of this report.

Process and Control - The VFD and 6-inch magnetic flow meter and have been modernized and are in good condition. The VFD at this location is manufactured by Allen Bradley. Chlorine residual is paced using a feedback loop from a Hach CL-17 Chlorine Analyzer.

Because of its higher iron concentrations (above secondary MCL of 0.3 mg/L), Well No. 7 is only operated on peak demand days during the summer months. The pumping station contains provisions to feed potassium hydroxide (KOH) and sodium hypochlorite (NaOCl) for disinfection. The KOH system includes a bulk storage tank situated within a containment area and a day tank. The equipment is housed in a separate room, which has prevented corrosion on much of the electrical equipment. The NaOCl system consists of a day tank and chlorine analyzer. The chemical feed systems meet the MassDEP's chemical safety design requirements.

Electrical - The motor control center is in very good condition with no signs of corrosion or rust. The pumping system is equipped with a RAD unit and gas-fired, liquid propane gas engine. The RAD is engaged with a manual clutch when operated.

Communications - Control locally at Well No. 7 is through RTU 7. RTU 7 is built into the main control panel at this facility. Communication with the WTF is completed through the use of radio telemetry.

2.3.8.2 Water Management Act Constraints

Well No. 7 is a permitted supply. The Zone II delineation for Well No. 7 is based on a flow rate of 1,008,000 gpd or an instantaneous flow rate of 700 gpm when pumped continuously. The present pumping rate is about 589 gpm, suggesting that an additional capacity of 110 gpm could be achieved with a slightly larger well pump.

2.3.8.3 Water Quality and Wellhead Protection

The water department has identified treatment of Well No. 7 as a priority. This study will investigate alternatives to either treat this source on site or pump this supply to the water treatment facility for removal of metals. The site is gated and fenced and well protected from unauthorized access.

The Zone I delineation for Well No. 7 is located on Town owned lands and is well protected. The Zone II well delineation for Well No. 7 was approved by the MassDEP in 1993 and based on an maximum-daily flow rate of 1,010,000 gallons per day.

2.3.9 Well No. 8 (Source ID 4224000-08G)

2.3.9.1 Existing Equipment and Capacities

General - Well No. 8 is the water department's newest well supply. The well casing was original constructed as a 12-inch test well in 1998 to conduct a prolonged pump test and expand the supply at the Gould Pond well field. The well was constructed by D.L. Maher without a permanent well seal since its original intent was to serve as a temporary pumping well.

In 2002, the water department began the conversion of this well to a permanent supply. The work, completed by Orleans water department staff, included extension of a quality service road to the site, construction of a monitoring vault and installation of a permanent well seal and pitless unit for the well casing. The wellhead area, exposed equipment and fenced in protection area is well maintained and in excellent condition.

The well pumps into the distribution system through a buried, 8’ x 11’ masonry block vault with a concrete roof. The structure houses flow metering equipment and is accessible through a roof hatch. The facility is a confined space and not routinely entered. The well pump is equipped with a VFD which is housed in an electrical cabinet above grade. The area around the well head is paved with asphalt and graded to shunt surface water away from the well head.

Well, Pump and Motor Information - The well is a 12-inch naturally developed well equipped with a 16.1-foot, stainless-steel screen; the total well depth is 86.5-feet. The present well pump and motor were installed in 2005. The pump is a Christensen 7 CHC, 3-stage closed impeller submersible pump. The pump is powered by a 50 hp, 460V, 1,775 RPM motor. The most recent pump evaluation completed by Maher Services in June 2013 demonstrated that the pump is presently producing 388 gpm with 21.8 feet of drawdown, for a specific capacity of 17.7 gpm per foot of drawdown. The well was redeveloped in October 2013. Under normal operation speed and pumping rate of the pump is controlled with a VFD. A summary table of the well and pump data is included in section 2.3.10 of this report.

The pump is capable of producing about 388 gpm although the water management act permit restricts its production to 347 gpm, which is pumped continually. This is not an issue with the DEP as long as the SCADA system does not call the pump to operate for a period of 24 hours straight, in which case, the permitted withdrawal volume would be exceeded. The Water Department currently operates this pump at a maximum flow rate of 347 gpm.

Process and Control - The well is controlled via fiber optic cable back to the RTU at Well No. 1. Local flow monitoring is for accounting purposes only. The well discharges into a 12-inch water main which is a common line for Well. No 1, 2, 3 and 8 before chemical addition is provided at Facility No. 1 (Figure 2-4).

Electrical - The primary power feed to the Gould Pond wells is complicated (see Figure 2-4). Options for rectifying this complication are discussed in Section 5. Wells Nos. 2, 3 and 8 are powered from a common three-phase power drop at a service pole near Well No. 3. Power consumption for these three facilities is metered at this pole. The motor control center at Well No. 2 is in good condition.

Auxiliary power is provided to the facility from a pad-mounted liquid propane generator manufactured by Onan Generators located behind Well No. 2. This generator was installed at well No.2 as part of the Well No. 8 construction as electricity and communications was subfed to Well No. 8 through Well No. 2. This generator is sized to supply power to both wells in the event of power failure.

Communications - Control locally at Well No. 8 is through RTU 8. RTU 8 is connected to the other wells with a buried fiber optic cable. However, when power is lost at Well No. 1, the primary SCADA control node back to the treatment facility, operations at the Gould Pond wells cannot be observed or controlled from the treatment facility. Options to rectify this situation are discussed in Section 5.

2.3.9.2 Water Management Act Constraints

Well No. 8 is a permitted supply. The Zone II delineation for Well No. 8 is based on a flow rate of 500,000 gpd or an instantaneous flow rate of 347 gpm when pumped continuously.

2.3.9.3 Water Quality and Wellhead Protection

The 400-foot protective radius around Well No. 8 which constitutes the Zone I delineation is all located on Town owned lands and is well protected. The Zone II well delineation for Well No. 8 was approved by the MassDEP in 2006 after the water management act permit renewal was issued and based on a maximum-daily flow rate of 500,000 gallons per day. The maximum-day pumping rate in 2012 was 434,000 gal/day.

The site is well protected and surface water run-off near the wellhead is controlled and directed away from the wellhead. The site is gated and well protected from vandalism and unauthorized intrusion despite its relatively remote location.

2.3.10 Summary of Well and Pumping Station Data

Performance operation data for each well is summarized in Table 2-2 below.

TABLE 2-2
PUMP AND WELL DATA FOR ORLEANS WELL SUPPLIES

Well and Pumping Station	Well No. 1	Well No. 2	Well No. 3	Well No. 4	Well No. 5	Well No. 6	Well No. 7	Well No. 8
Construction Date	1963	1963	1963	1976	1975	1986	1994	2002
Well Type	Gravel-Packed	Gravel-Packed	Gravel-Packed	Gravel-Packed	Gravel-Packed	Gravel-Packed	Gravel-Packed	Naturally-Developed
Well Depth (Feet)	98	78	97.5	66.5	67.4	73.2	171.75	86.5
Filtration	Yes/No	No	NO	Yes	Yes	Yes	No	No
Well Diameter (inches)	12	24	24	24	24	24	24	12
Screen Length (feet)	15	15	15	10	10	10	40	16
Screen Material	S.S.	S.S	S.S	S.S	S.S	S.S	S.S	S.S
Reported slot size	NA	0.190	0.190	0.170	0.170	NA	NA	NA
Current Pump Capacity (gpm)	434	396	514	320	275	578	589	388
Current TDH (feet)	280	315	265	60	52	56	237	265
WMA Maximum Daily Capacity (gpm)	400	325	500	520	325	680	700	347
Flow Metering Type	Magmeter	Cast Iron Venturi	Cast Iron Venturi	Magmeter	Magmeter	Magmeter	Magmeter	Magmeter
Specific capacity (gpm/foot)	24	29	45.4	32.3	18.4	36.8	65.4	17.7
Pitless Unit?	Yes	No	No	No	No	No	No	Yes
Motor hp	50	40	50	10	7.5	30	75	50
Emergency Generator?	No	Yes	No	Yes at WTP	Yes at WTP	No	Yes	Yes at Well No.2

2.4 CORROSION CONTROL FACILITY (FACILITY NO. 1)

Facility No. 1 is the last of four corrosion control facilities constructed in the early 1990's that continues to function as originally intended. Facility No. 1 (FAC1) provides disinfection and pH adjustment for corrosion control for the Gould Pond wells (Wells 1, 2, 3 and 8). Facility Nos. 2, 3 and 4 were discontinued as corrosion control facilities when the treatment facility was constructed in 2006. These buildings continue to provide value for storage of records, lawn equipment and water supply equipment as previously described.

Facility No. 1 houses a potassium hydroxide (KOH) feed system consisting of a 1,400 gallon bulk storage tank, day tank, pH analyzer and chemical feed control panel. In addition to KOH, the facility feeds sodium hypochlorite using a basic positive displacement metering pump and 30 gallon chemical carboys. The target dosage at the facility is 1.0 mg/L. Orleans is a non-disinfected water system and feeds chlorine voluntarily to provide a minimal residual in the distribution system to control heterotrophic plate count activity. Chlorine residual is monitored with a Hach CL-17 chlorine residual monitor. Alarms and control set points are monitored locally and transmitted to CP-1 in Well No. 1 for radio communication back to the central operations center at the water treatment facility. The local control panel in Facility No. 1 and CP-1 communicate with a fiber optic connection.

Facility No. 1 has no automatic auxiliary power system. A receptacle is provided for manual power transfer with a portable generator available to power the facility locally, but this condition cannot be monitored from the operations center. Reconfiguring the primary electric power service to the site could be complicated if a single common generator to power Well No.1 and Facility No. 1 was desired because of the manner in which the facility is sub-metered and would require relocation of the primary power feed down to the site. Options for rectifying this situation are discussed in Section 5.

Flows are metered at Facility No. 1 with a magnetic flow meter located in a buried vault upstream of a second chemical injection vault. Both vaults are located on the consolidated 12-inch transmission main that collects flow from Wells No 2, 3 and 8 from the Gould Pond area. Flows from Well No. 1 can also be directed to this pipeline if this mode of operation is selected as previously described. The transmission pipeline changes to 16-inch just downstream of the facility, prior to distribution of finished water to the 16-inch main on South Orleans Road.

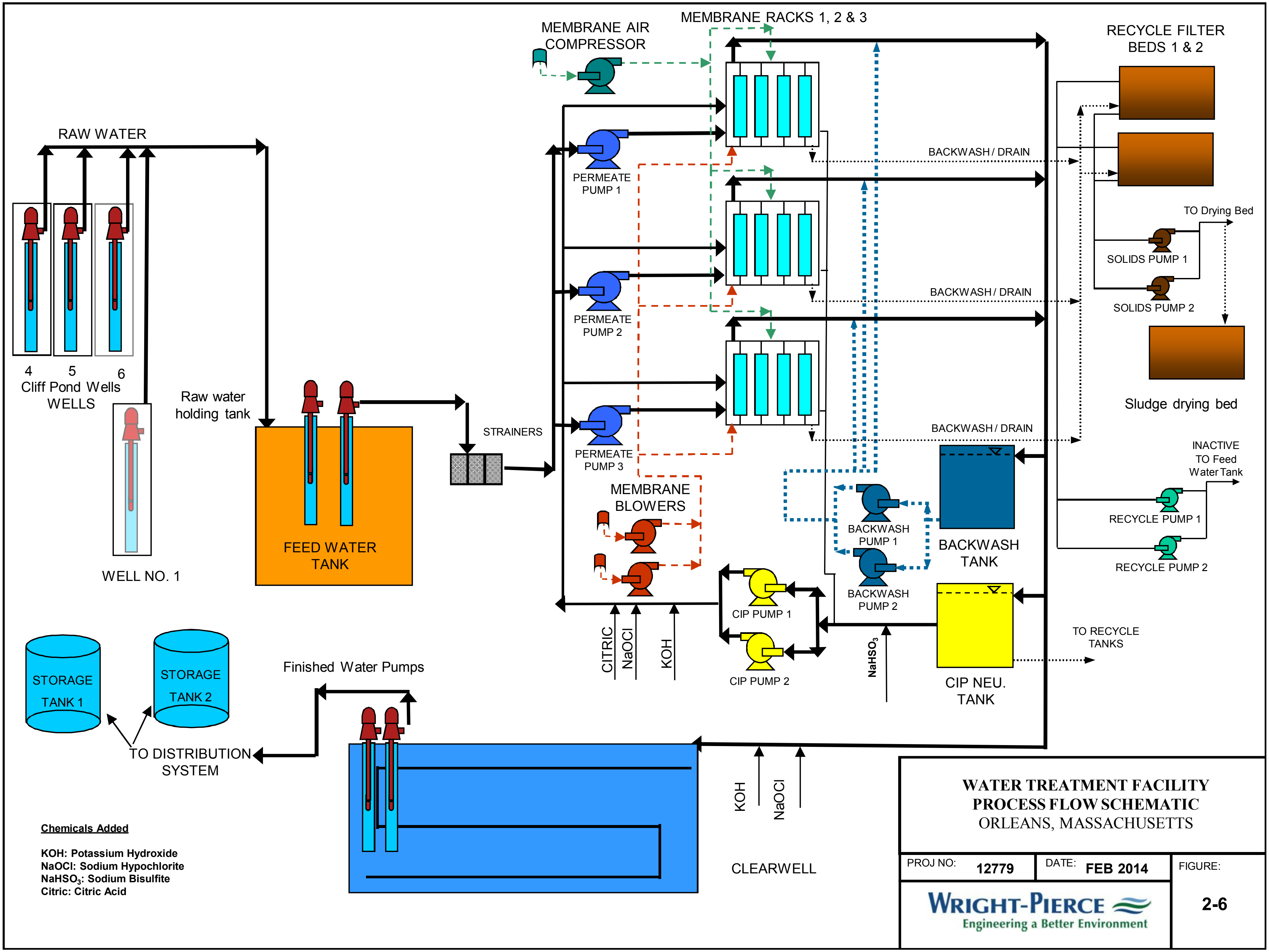
A site tour of this facility was conducted on June 26, 2012. The facility is in good condition and has been well-maintained. The primary need at this facility is developing an auxiliary power plan that is easy to operate and conveys operational data to the operations center at the treatment facility.

2.5 WATER TREATMENT FACILITY

Raw water from Well No. 1, 4, 5, and 6 is filtered to remove iron and manganese at the water treatment facility (WTF). The facility was constructed in 2003 and 2004, and commissioned in 2005. A process flow schematic of the facility is included in Figure 2- The water treatment facility can treat a maximum flow of about 2,000 gpm (2.9 MGD) from the four wells based on the following individual rated capacities:

- Well No. 1 - 400 gpm
- Well No. 4 - 520 gpm
- Well No. 5 - 325 gpm
- Well No. 6 - 680 gpm

A brief description of major components of the facility follows.



MEMBRANE AIR COMPRESSOR
MEMBRANE RACKS 1, 2 & 3
RECYCLE FILTER BEDS 1 & 2
RAW WATER
PERMEATE PUMP 1
PERMEATE PUMP 2
PERMEATE PUMP 3
BACKWASH / DRAIN
BACKWASH / DRAIN
BACKWASH / DRAIN
TO Drying Bed
SOLIDS PUMP 1
SOLIDS PUMP 2
Sludge drying bed
4
5
6
Cliff Pond Wells
WELLS
Raw water holding tank
STRAINERS
WELL NO. 1
FEED WATER TANK
MEMBRANE BLOWERS
INACTIVE TO Feed Water Tank
RECYCLE PUMP 1
RECYCLE PUMP 2
BACKWASH PUMP 1
BACKWASH PUMP 2
BACKWASH TANK
CIP PUMP 1
CIP PUMP 2
CITRIC
NaOCl
KOH
$NaHSO_3$
CIP NEU. TANK
TO RECYCLE TANKS
STORAGE TANK 1
STORAGE TANK 2
Finished Water Pumps
TO DISTRIBUTION SYSTEM
KOH
NaOCl
CLEARWELL
Chemicals Added
KOH: Potassium Hydroxide
NaOCl: Sodium Hypochlorite
$NaHSO_3$: Sodium Bisulfite
Citric: Citric Acid
WATER TREATMENT FACILITY
PROCESS FLOW SCHEMATIC
ORLEANS, MASSACHUSETTS
PROJ NO: 12779
DATE: FEB 2014
FIGURE: 2-6
WRIGHT-PIERCE
Engineering a Better Environment

Raw Water Supply. The four wells are pumped to the treatment facility with low pressure well pumps. The piping from the wells joins a common 12-inch yard pipe which discharges into a raw water holding tank below the floor of the treatment facility.

Water is pumped from the raw water holding tank with two, 100 hp raw water vertical turbine pumps that pump feed water through a microstrainer system to the membrane filtration units. The raw water feed pumps are equipped with 18-pulse variable frequency drive (VFD) units manufactured by Robicon. A VFD is used to vary pump speed and flow by changing the frequency. Operations staff reports that this equipment is not able to steadily adjust flow from the wells within the speed range for the pumps. In addition, spare parts, service for diagnostic analysis, and computer components are no longer manufactured and second hand parts are increasingly difficult to find. This equipment is in need of immediate replacement. A more thorough analysis is provided in section 5.

Microfiltration Membranes. The original facility used ultrafiltration membranes manufactured by Pall Corporation of Cortland, New York to remove iron and manganese. These membranes were replaced with more efficient, higher performance microfiltration membranes in 2009-2011.

The replacement membranes modules were Model UNA-620A microfiltration membranes also manufactured by Pall Corporation. The membrane system is configured using an "outside-in" flow configuration which is more easily maintained and more ideal for filtering oxidized metals from well supplies, while maintaining consistent low flux rates across the membranes.

The WTF is configured with three membrane rack assemblies, each containing 50 active modules with space to add additional module capacity. Each rack assembly is capable of producing 1.5 MGD for a total plant capacity of 4.5 MGD. The individual membrane modules can be individually isolated for fiber pinning and repair. With one rack assembly off-line, the facility can produce about 2,100 gpm or 3.0 MGD.

As described, the membrane rack assemblies were replaced sequentially over a three year period in 2009, 2010 and 2011. The membranes were furnished with a 10-year warranty, so replacement of the modules should be anticipated in years 2019, 2020 and 2021, respectively. The current replacement module warranty is calculated pro-rata linearly by dividing the cost of the membrane module by the number of months in service divided by 120 months, so at the end of 10 years, there will be no residual value.

The membranes are routinely flushed with a reverse flow (RF) stream, approximately every 45 minutes, to partially restore flux rate using water pumped from the clearwell. The RF process is enhanced with an air scrub, to loosen adhered particles not removed by the RF process. Reverse flow water was originally supplied directly from the water distribution system through a hydraulic open-close control valve. Because of erratic pressure conditions in the distribution system near the plant, the control valve did not produce the type of uniform, reliable flows required to flush the membranes. The control valve was replaced with a dedicated vertical turbine pump which pumps directly from the clearwell. This new system was installed by the Orleans Water Department at a cost of $80,000. This new RF system works better than the original system and produces reliable RF flows for routine flushing.

The rack assembly is equipped with one 40 hp centrifugal recirculation pump, to circulate water during the cleaning process. This horizontal pump is located at the end of the rack assembly.

Chemical Feed Systems and Membrane Restoration. A chemical clean-in-place (CIP) process occurs less frequently to restore flux to the membranes once every 8 weeks. The original CIP process presently used three chemicals for cleaning; (1) citric acid, (2) sodium hypochlorite and (3) potassium hydroxide administered in a sequence prescribed in the operations manual. The “recipe” for chemical cleaning has changed and evolved during the life of the facility. Currently, the CIP process uses either just citric acid or a citric acid, potassium hydroxide and sodium hypochlorite combination.

The citric acid feed system consists of a small feed tank, located adjacent to a large polyethylene warm water recirculation tank used to hold and feed cleaning water to the membranes. The citric acid system is only used as part of the membrane cleaning process for infrequent CIP cleanings.

Sodium hypochlorite (NaOCl) is injected at two locations in the plant (1) raw water, (2) membrane cleaning process. The NaOCl system consists of a bulk storage tank, day tank and two positive displacement chemical feed pumps to feed chemical to the two locations described above. The bulk storage tank is situated in a containment chamber for spill containment. The chemical room does not have a limited area sprinkler and is not separately ventilated from the main treatment room. This space does not meet current building and fire codes and will require future building modifications to house these chemicals properly. The chemical is also very corrosive and operators report that fumes from this system are corroding electrical and process equipment in the main treatment area. The bulk tank appears properly sized to allow for frequent deliveries of chemical to maintain consistent concentrations of NaOCl on site, at all times.

Potassium hydroxide (KOH) is injected at the same location as the NaOCl as described above. The bulk tank is larger for more economic deliveries. NaOC1 does not have a shelf life like KOH. The KOH system is situated similarly to the NaOCl system. Both systems are accessible to operators via a grating platform located at the same elevation as the operating level of the treatment facility.

Finished Water Delivery. From the membrane filters, permeate (filtrate) flows to a single, chambered clearwell, located along the south wall of the treatment facility. Controls are available to adjust the pH of the membrane permeate with potassium hydroxide (KOH) and disinfected with sodium hypochlorite before discharging into the clearwell, but this WTF has been operated in such a fashion where this adjustment has not been required.

Finished water flow to the distribution is provided by two 125 hp vertical turbine pumps, which draw from the clearwell. Pumps are vertical turbine pumps mounted on the floor of the treatment facility. The pumps draw suction from the clearwell. The finished water feed pumps are also equipped with 18-pulse variable frequency drive (VFD) units manufactured by Robicon. Operations staff reports that this equipment is not able to steadily adjust flow from the wells within the speed range for the pumps. In addition, spare parts, service for diagnostic analysis, and computer components are no longer manufactured and second hand parts are increasingly difficult to find. This equipment is in need of immediate replacement. A more thorough analysis is provided in section 5. The 16-inch finished water main interconnects with 12-inch distribution main on Cliff Pond Road.

The facility typically operates at flow rates between 950 gpm (1.4 MGD) minimum and 1,550 gpm (2.2 MGD) maximum to meet demands in the system. The higher flows occur during the summer tourist season when demands increase.

Residuals Collection and Handling. Three primary types of non-sanitary backwash wastes are generated by the membrane processes in the facility; (1) Chemical Cleaning (CIP) wastes, (2) Air scrub/reverse flush wastes and (3) Enhanced flux maintenance (EFM) wastes. Currently, the OWD does not conduct EFM as part of the WTF membrane maintenance program. Wastes are collected as described below and discharged to a infiltration system on the site.

CIP wastes are collected in a neutralization tank located below the operations floor where the product is neutralized before flowing to the dewatering/infiltration system. The air scrub/reverse flow wastes are discharged into a decanting system located below the operating floor of the WTF. The decant system consists of one tank with a separating weir. The first section is called the backwash holding tank, where all the wastes initially flow. From this tank, the backwash waste overflows another weir and flow to one of two 1,200 square foot sand backwash filtering beds. The filtering beds are rectangular concrete boxes are constructed with a sand underdrain system that filters out solids before discharging the filtrate to a leaching system.

A third sludge drying bed of similar size and dimension is located adjacent to the two backwash filtering beds. As sludge accumulates in the decant and backwash holding tanks, sludge is pumped to the sludge drying bed for dewatering. Similar to the filter backwash beds, the filtrate from this tank also flows to the leaching system from a sand underdrain system. The backwash filter beds appear to be undersized and should be further studied to determine if additional capacity is needed.

In earlier years of operation, the decant system recirculated clarified backwash water to the raw water feed system to conserve water and improve plant efficiency. This recirculation system was discontinued after the presence of iron bacteria was discovered in the backwash holding tanks.

Like most residuals handling systems in water filtration plants, the system requires attention and maintenance. The SWMI standards include stringent requirements for accounting and reuse of recoverable backwash water at water treatment facilities. A further discussion of this issue is included in section 5.

SCADA System and Remote Plant Surveillance. The primary operations center for the water system is the control room at the water treatment facility. The control functions as the nerve center for plant operations as well as the central hub for the system wide SCADA system. The Main Terminal Unit (MTU) receives signals from all remote facilities (Pumping stations, chemical feed facilities, storage tanks, etc.) from either fiber optic cables or from radio telemetry. Three laptops are also currently equipped for remote access.

Both the programmable logic controls (PLC) and human machine interface (HMI) software at the treatment facility is based on RSView32 architecture from General Electric. This system is becoming outdated and the water department is in the process of updating and replacing portions of this system. It is anticipated that the control system upgrade will occur in year 2014.

Operators have access to the SCADA system using laptops for remote surveillance of system operations and for response to alarms. The water department has also purchased a cloud-based surveillance system to improve access to controls and alarming using a web-based approach. This UtilityCloud™ system includes a work order module and functions as a computerized maintenance management module for tracking and monitoring capital and maintenance projects, service repairs, meter installations and other tasks.

Auxiliary Power Generator. The treatment facility has a standby-generator that provides power to the entire 1,200 amp main bus in the treatment facility in addition to all electrical loads in Well No. 4 and Well No. 5 pumping stations. The system is equipped with an automatic transfer switch. The capacity of this system to accommodate new loads, such as possible Well No. 6, and its ability to meet current needs in the facility is discussed in Section 5 of the report.

2.6 STORAGE SYSTEM

The entire Orleans water system operates on one hydraulic gradeline driven by the operating water level in the two storage standpipes. The overflow elevation of the storage system is El. 218 feet, but the system normally operates between a El. 204 feet and El. 214 feet. The standpipes are referred as (1) Standpipe No. 1 and (2) Standpipe No. 2. A brief description of the facilities, historical improvements and maintenance to the facilities, and a condition assessment of each facility follow.

2.6.1 Standpipe No. 1

Standpipe No. 1 was added to the Orleans system in 1963 a s the primary water storage tank for the original system. The standpipe was constructed by Pittsburgh-Des Moines Company. The standpipe is a welded steel standpipe with a total storage capacity of 1.382 million gallons (MG). The standpipe is 87-feet high and founded on a ring wall foundation set at El. 131feet. The foundation and standpipe have functioned well during its service life.

The Orleans Water Department follows a routine tank inspection program to track performance of the coating system on their storage tanks. The inspections include routine annual or bi-annual exterior inspections and a more in-depth interior inspection approximately every 5-years. The standpipe experienced its first coating replacement cycle in 1981. In 1995, a more extensive rehabilitation of the standpipe was completed including substantial pit filler and sealer to repair erosion between welded steel plates. The 1995 work included complete interior and exterior surface preparation with sandblasting and new interior and exterior coating systems. A warranty issue led to additional coating replacement work in 1998 to replace areas of the interior coating system that were delaminating. Similarly, in 2008, areas of delamination were identified during inspections and replaced with a limited rehabilitation contract.

In 2013, the standpipe was again painted and rehabilitated. The total construction cost for the rehabilitation project was $564,000 including installation of a mixing system. This cost did not include professional services or contingencies. The standpipe was equipped with an internal PAX mixing system which will reduce water age, even CL2 residual, reduce DBP's, reduce ice abrasion, and should extend the life of the interior coating system during the next painting cycle. Exterior coating systems on most welded steel standpipes can last 20 years or more except in harsher coastal climates. The replacement cycle between the last two coating systems for this standpipe suggests that 15 years is an appropriate life cycle cost for a coating system for Orleans. Orleans routinely drains and inspects the interior of the standpipes every 5-years. The exterior of the standpipe is inspected on an annual basis by a local engineering firm.

2.6.2 Standpipe No. 2

Standpipe No. 2 was added to the Orleans system in 1974 to supplement and to add redundancy to the storage system. The standpipe was constructed by Chicago Bridge and Iron Company. The standpipe is a welded steel standpipe with a total storage capacity of 2.0 million gallons (MG). The standpipe is 114.5-feet high and founded on a ring wall foundation set at El. 103.5 feet. The foundation and standpipe have functioned well during its service life.

Standpipe No. 2 is equipped with a 10-inch single acting altitude valve located in a buried concrete vault. The valve bypass is equipped with a 12-inch check valve to allow flow in one direction in and out of the standpipe. Although equipped with two access hatches, the vault is a confined space and is not ventilated to meet current regulations.

In 1988, the coating system on both tanks was sampled and found not to contain lead. The coating system was replaced on Standpipe No. 2 in 1991. The sheriff's department, Cape Cod Regional Transit Authority and Orleans Fire Department all have installed communication antennae on the tank. In 2011, the Orleans Fire Department replaced their communication antennae on the tank after a brief evaluation was completed to engineer the attachment details to the standpipe.

In 2012, the standpipe was again painted and rehabilitated. The total construction cost for the rehabilitation project was $564,000 including installation of a mixing system. This cost did not include professional services or contingencies. The standpipe was equipped with an internal PAX mixing system which will reduce water age, even CL2 residual, reduce DBP's, reduce ice abrasion, and should extend the life of the interior coating system during the next painting cycle. Exterior coating systems on most welded steel standpipes can last 20 years or more except in harsher coastal climates. The replacement cycle between the last two coating systems for this standpipe suggests that 15 years is an appropriate life cycle cost for a coating system for Orleans. Orleans routinely drains and inspects the interior of the standpipes every 5-years. The exterior of the standpipe is inspected on an annual basis by a local engineering firm.

2.6.3 Summary Data

Data for the two standpipes in Orleans is summarized in Table 2-3 below:

TABLE 2-3
STORAGE SYSTEM DATA
ORLEANS, MASSACHUSETTS

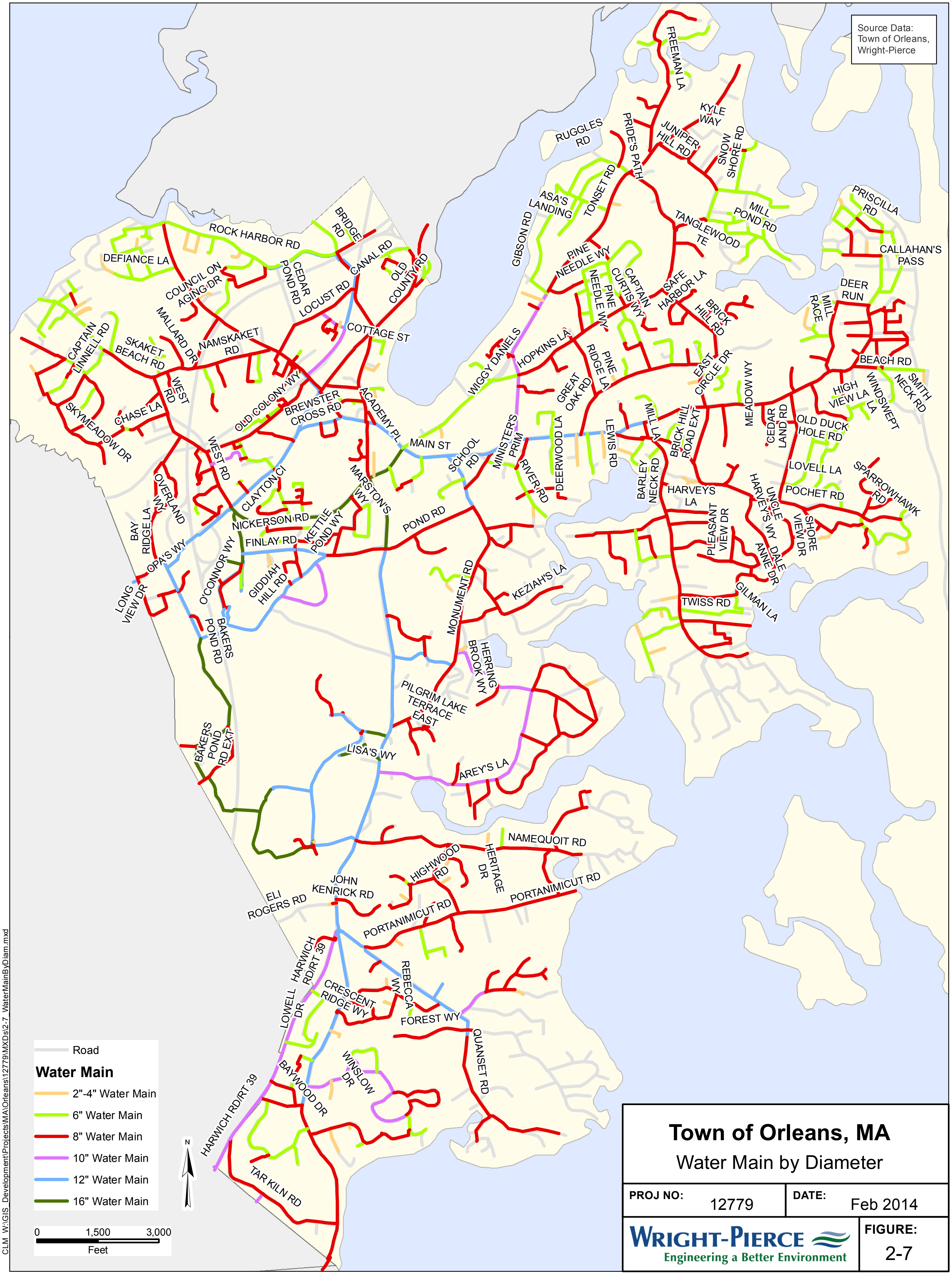
Feature	Standpipe No. 1	Standpipe No. 2
Construction Type	Welded Steel	Welded Steel
Year Constructed	1963	1974
Diameter	52-feet	54.5-feet
Standpipe Height (From Base to Overflow)	87-feet	114.5-feet
Base Elevation (feet-USGS)	El. 131	El. 103.5
Total Storage Volume (gallons)	1,382,000	2,000,000
Unit Volume (Gallons/Foot)	15,885	17,450
Operating Range	El. 204-214-feet	

2.7 DISTRIBUTION SYSTEM

2.7.1 Distribution System Water Mains

The Orleans distribution system consists of approximately 110 miles of distribution mains ranging in size from 2-inch up to 16-inch diameter. The original water system constructed in the early 1960's under two construction contracts consisted of about 41 miles of pipe of cement lined cast iron piping. The water system services most of the community except for very small peninsular areas or where extensive conservation land is present. The extent and general service area of the distribution system is shown on Figures 2-7, 2-8 and 2-9 showing diameter, material type and installation date, respectively.

The original system was installed using Class 52 cement lined cast iron pipe. This material was the standard material for pipe installation until 1979 when standard installation material was switched to Class 52 cement lined ductile iron pipe. All the primary mains in the current system are cement-lined cast iron or ductile iron. The distribution of mains by size and material type are present in Table 2-4 and Figure 2-10. As shown in the table the majority of the water main in the system is 8-inch and approximately 65% of the water mains are cast iron (assuming all of the unknown material type is cast iron).



Town of Orleans, MA

Water Main by Diameter

PROJ NO:	12779	DATE:	Feb 2014

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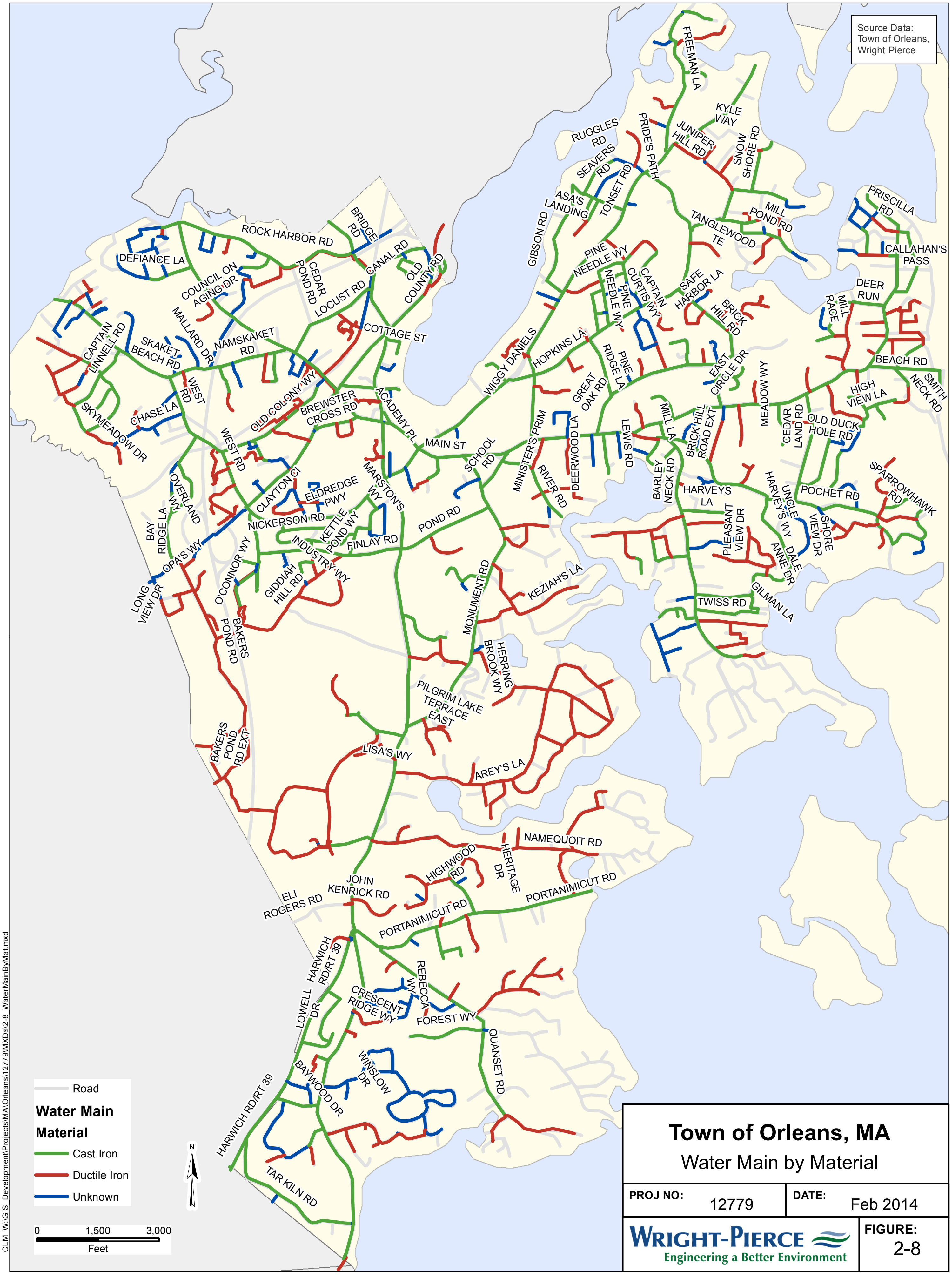
Engineering a Better Environment

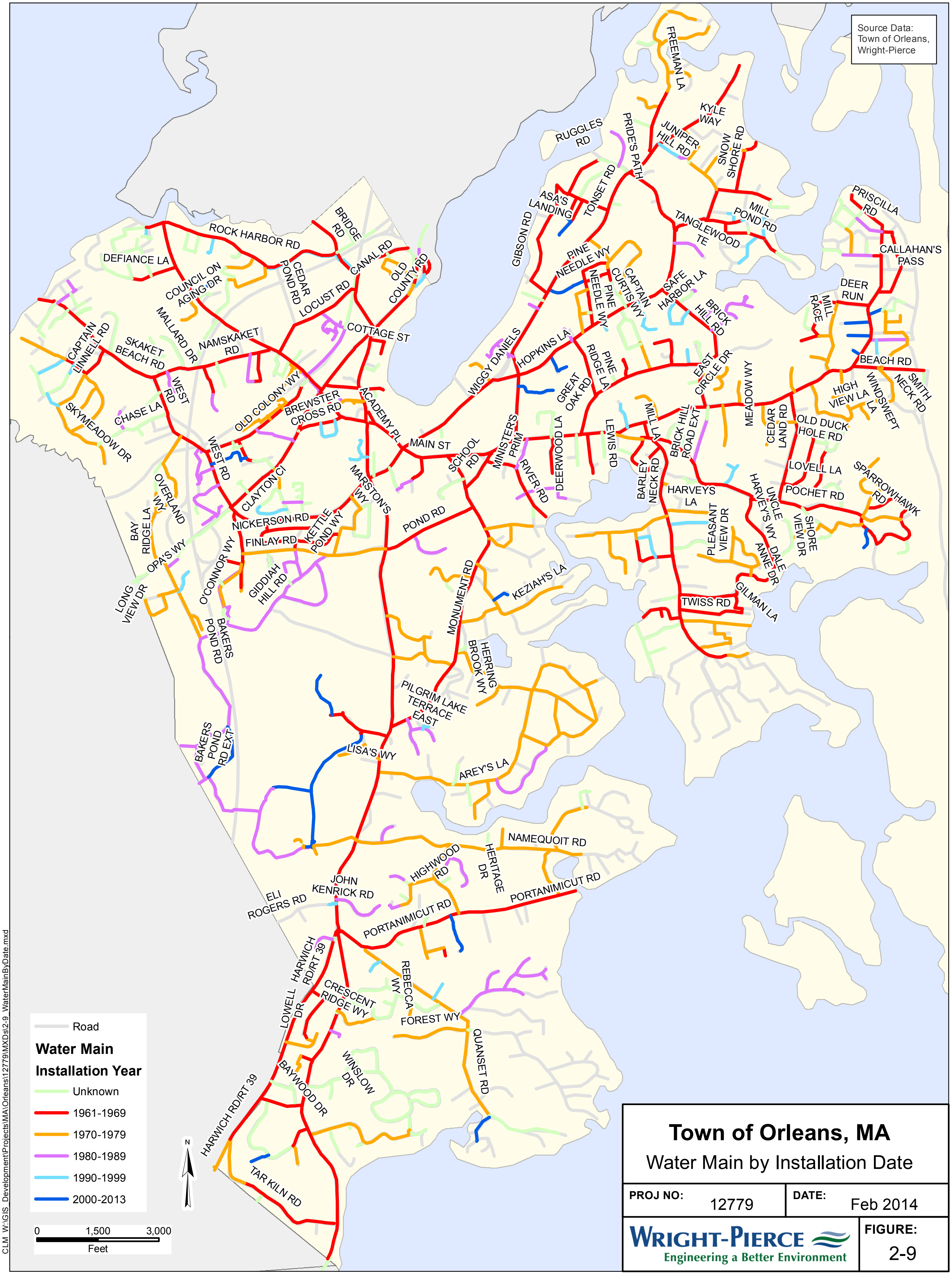
FIGURE: 2-7



Town of Orleans, MA

Water Main by Material

PROJ NO: 12779	DATE: Feb 2014
WRIGHT-PIERCE Engineering a Better Environment	FIGURE: 2-8



Town of Orleans, MA

Water Main by Installation Date

PROJ NO: 12779	DATE: Feb 2014
WRIGHT-PIERCE Engineering a Better Environment	FIGURE: 2-9

TABLE 2-4
WATER MAIN SIZE AND MATERIAL TYPE DISTRIBUTION

Pipe Diameter	Cement-Lined Ductile Iron	Cement-Lined Cast Iron	Unknown	Length of Mains in the System (feet)
<4-inch	3,703	647	15,223	19,573
6-inch	13,995	81,592	38,730	134,317
8-inch	142,918	144,916	28,773	316,607
10-inch	14,072	10,665	4,924	29,661
12-inch	18,927	37,878	3,475	60,280
16-inch	10,638	9,200	0	19,838
Total	204,253	284,898	91,125	580,276

*Small amounts of wrought iron, PVC and other materials are present in very limited quantities

FIGURE 2-10
GRAPHICAL DISTRIBUTION OF WATER MAIN SIZES

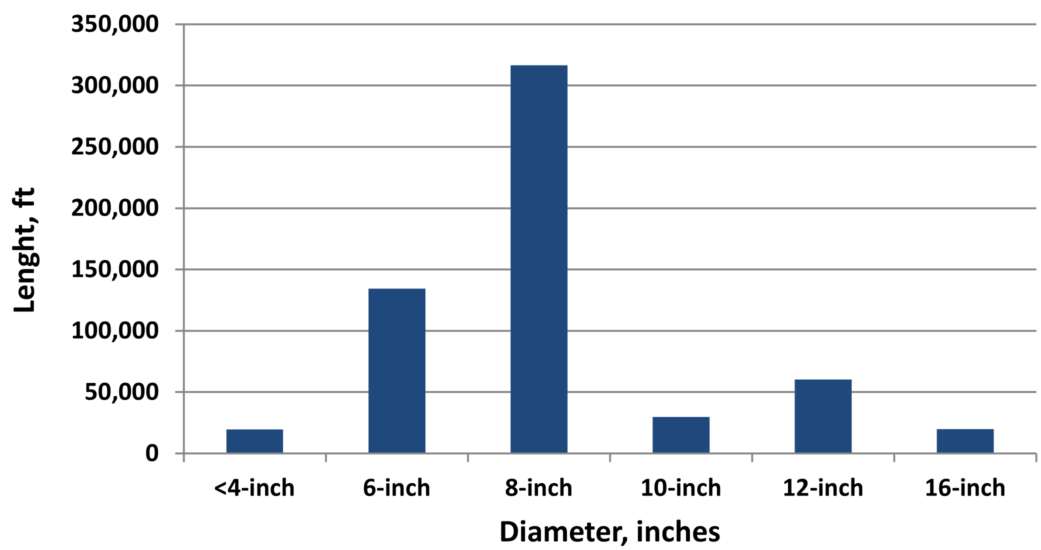
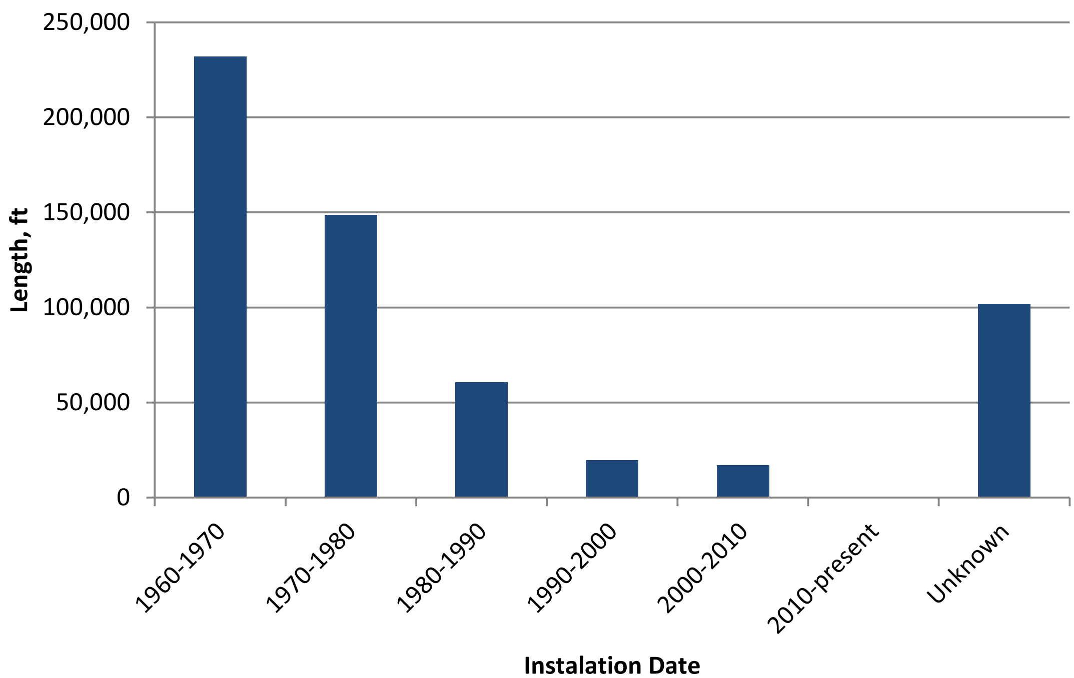


Table 2-5 delineates the available installation date information of the water main in the system. As shown in Figure 2-11 ~40% of the distribution system was installed in the 1960s. In the next planning cycle the water department will need to start consistent water main renewal to ensure water main are replaced in a cost effective maximizing service life while minimizing water rate impacts. This data was obtained from the previous reports and interviews with OWD staff and has been integrated into the OWD GIS database along with available installation date information.

TABLE 2-5
WATER MAIN INSTALLATION DATE DISTRIBUTION

Installation Year	Length of Mains in the System (feet)	Percentage of total water main in the system
1960-1969	231,967	40.0%
1970-1979	148,635	25.7%
1980-1989	60,571	10.4%
1990-1999	19,685	3.5%
2000-2090	17,012	2.9%
2010-present	404	<0.1%
Unknown	102,002	17.5%
Total	580,276	100

FIGURE 2-11
GRAPHICAL DISTRIBUTION OF WATER MAIN INSTALLATION DATES



Annual Water Main Flushing. The water department has an excellent, routine water flushing program that is conducted annually in the spring. Water quality in the distribution system is quickly restored after flushing and operators report that the system is generally clean. Because the distribution system consists entirely of cement-lined piping, accumulation of rust and oxidized metals is not as big of a problem in Orleans as it is in many older water systems.

The flushing program can be used to enhance the Towns ISO rating by cataloging hydrant condition, operability and other factors during the flushing program. The ISO allocates about 4% of the rating in a system to hydrant monitoring and maintenance. The use of UtilityCloud software to enhance, collect and record the needed data is discussed in Section 6.

Biannual Leak Detection. The Orleans Water Department has been very proactive in conducting leak detections in the water system. The Town jointly purchased leak detection equipment with the Town of Harwich using a grant program to reduce the cost to both communities. This equipment is currently stored with the Town of Harwich and is not always available to the OWD. The Town has very low unaccounted-for water and has been diligent in tracking leaks and making needed repairs. Remaining older wrought iron service connections on private property between the water mains and the meter are suspected sources of leakage in the system.

As part of the leak detection program any wrought iron service on which leaks are found, is required to be replaced with CTS plastic. The OWD has consistently replaced the public portion of each wrought iron water service they encounter as part of this process from the curb stop to the water main with CTS plastic. Orleans has also required that wrought iron services be replaced in their entirety during a homeowner's septic system replacement if the water service is located near the septic system. Approximately 300 wrought iron services have been replaced in this manner since 1979.

2.7.2 Fire Protection

924 public fire hydrants are connected to the distribution system. The water department also maintains a small number of dry hydrants, which are painted with black caps to distinguish them from other hydrants.

These hydrants are widely and uniformly distributed throughout the town and provide coverage to most of the area served by the water system except for areas serviced with pipe diameter that is too small to provide fire protection (generally below 4-inch).

The Insurance Services Office (ISO) conducts an assessment of fire protection in a given community roughly every 10 years. The effort culminates in the development of a Public Protection Classification for each Town. This classification assigns a value ranging from 0 to 10 to classify the level of fire protection in a given community. Class 1 represents exemplary fire protection and a Class 10 represents a system that does not meet minimum fire protection criteria. Development of the classification is quite complex considering a variety of factors. The three primary factors effecting the classifications are:

- Fire Alarm and Communication Systems - This factor includes an assessment of community's ability to handle and dispatch fire alarms. This task accounts for 10 percent of a community's rating.
- Fire Department - This factor accounts for 50% of the total classification and focuses on such factors as distribution of engine companies and fire stations, pumping capacity, reserve apparatus, training and staffing issues.
- Water Supply System - The water supply accounts for 40% of a community's classification. Factors affecting the rating include hydrant flow capacity, hydrant inspection protocols, condition of hydrants and other factors. It is this portion of the totals score that can be influenced by the Orleans water department activities

Fire Protection Assessment - Orleans received a classification of Class 4, in the last classification of the system, an outstanding score and well above average for most communities. Orleans improved its classification from Class 5 during the prior 10 year period. This improved score will result in lower insurance premiums for structures in the Town of Orleans.

Orleans received a rating of 34.7% out of a total score of 40% for the portion of the rating controlled by the water department. A portion of this score can be improved further by documenting hydrant flushing records which will be facilitated as the department phases in its recently adopted cloud-based data management system.

Fire flow tests completed by ISO in the Town of Orleans are presented in Table 2-6. It is important to note that the Town meets ISO recommendations at all the test locations except for three sites, which are only marginally flow deficient. These two commercial sites are located in peninsula areas where additional pipe looping is very difficult. Available fire flow rates throughout Town currently meet typical residential fire flow requirements of greater than 750 gpm. A discussion of alternatives to improve flow in these areas to remedy the low available fire flows is discussed in Section 6 of this report.

TABLE 2-6

ISO FLOW TEST RESULTS CONDUCTED IN THE TOWN OF ORLEANS

Test No.	Land-Use Description	Test Location	Residential Flow Test (GPM)	Pressure (psi)		Flow @ 20 psi		Adequate?
				Static	Resid.	Needed	Avail.	
1	Commercial	Main St. @ Old Colony Way	2300	61	52	3000	5200	Yes
2	Commercial	Canal Rd. e/o Bridge Rd.	2210	79	42	2500	2800	Yes
3	Commercial	S. Orleans Rd. nr Harwich Rd.	2210	55	41	2500	3600	Yes
4	Commercial	Cranberry Hwy. Rte. 6A @ West Rd.	2390	50	42	2000	4900	Yes
5	Commercial	Beach Rd. @ Nauset Rd.	1120	75	25	2000	1200	No
6	Commercial	Main St. @ Barley Neck Rd.	1919	67	36	2500	2400	Yes
7	Commercial	Rte. 28 between Main St. @ Elbridge Pkwy	2780	62	55	3000	7300	Yes
8	Commercial	O'Connor Rd. nr Hollow Rd.	2070	43	35	2000	3700	Yes
9	Commercial	Monument Rd. @Rte. 28	2710	71	59	1750	5900	Yes
10	Commercial	Cove Rd. @ Rte. 28	1430	64	55	1750	3400	Yes
11	Commercial	Rock Harbor Rd. n/o Defiance Ln.	1500	80	38	2500	1800	No
12	Commercial	School Rd. @ River Rd.	2390	73	56	1250	4400	Yes
13	Commercial	Bay Ridge Rd. @ Oak Ridge Ln.	1910	70	46	1500	2800	Yes
14	Residential	Barley Neck Rd. @ Ori Ln.	1430	75	20	1500	1400	No
15	Residential	Lake Dr. @ Boulder Ln.	1800	65	25	1500	1900	Yes
16	Residential	Hopkins Ln. @ Pine Needle Way	1910	50	35	1250	2800	Yes
17	Residential	Pochet Rd. nr Gosmold Rd.	1060	65	49	1000	1900	Yes
18	Residential	Nauset Rd. nr Standish Rd.	1430	66	16	750	1400	Yes
19	Commercial	Finlay Rd. @ Nickerson Rd.	2470	68	57	1500	5500	Yes

2.7.3 Emergency Interconnections with Other Communities

Orleans is interconnected with the Brewster water system at three locations.

1. At the town line on Route 39.
2. At the distribution system limits on Tar Kiln Road.
3. At the town line on Route 6A.

All three of these interconnection locations are unmetered and the two distribution systems are isolated by closed gate valve. These interconnections are for emergency use only and the OWD has yet to activate these interconnections. Brewster's distribution system has a HGL of 218 ft. which is very similar to Orleans.

2.7.4 Service Connections

The original distribution system was installed with cement lined wrought iron service connections and this was the standard practice for new connections until 1979 when the OWD switched the standard service installation material to Copper Tube Size (CTS) plastic. The wrought iron service pipe has a tendency to fail at the pipe joints when approaching its service life. In corrosive soils or in areas where stray voltage from improper electrical system grounding to a water service has induced galvanic corrosion, the expected life of a wrought iron service pipe can be severely reduced. It is estimated that there are ~2500 wrought iron services remaining in the distribution system. As part of the leak detection program any wrought iron service on which leaks are found, is required to be replaced with CTS plastic. The OWD has consistently replaced the public portion of each wrought iron water service they encounter as part of this process from the curb stop to the water main with CTS plastic. Orleans has also required that wrought iron services be replaced in their entirety during a homeowner's septic system replacement if the water service is located near the septic system. Approximately 300 wrought iron services have been replaced in this manner since 1979.

2.7.5 Water Conservation

The town has an ongoing water conservation program that restricts certain water uses seasonally and during any given day. During the period between June 15 and September 15, the following water uses are restricted during the time periods of 9:00 AM – 5:00 PM:

- Lawn watering
- Car washing
- Filling swimming pools
- Operating washing machines
- Other non-essential water-use

Many automatic lawn sprinkling systems operate in early morning hours using timer systems. These small changes have helped control peak-hour water use during the critical July-August period when water-use is at its highest.

In addition to these practices, the WMA permit has several other mandates or goals for water conservation. These are discussed in sections 5 and 7 of this report but include:

- Leak detection and water audit requirements
- Meter calibrations
- Establishing full-cost water pricing
- Provisions for low flow toilets and showerheads
- Industrial and commercial water conservation
- Public outreach and education

2.7.6 Cross Connection Control Program

The Town of Orleans has a well-developed cross connection control program. The water department superintendent and two operators are certified backflow testers/surveyors. The Town performs this function without the use of subcontractors.

The Town has identified approximately 500 commercial and municipal service connections that are in the process of being surveyed for cross connection control protection. The water system currently has about 100 reduced pressure backflow prevention devices and double check valve assembly devices in place in Orleans. The water department intends to continue providing this service internally with operations staff.

2.7.7 AMR Metering Conversion

The OWD is progressing towards conversion of all customer meters to an Automatic Meter Read (AMR) system. The water department estimates that approximately 71% of customer meters in 2013 are currently using the AMR technology. The replacement program is continuing and the entire water system will eventually be converted to this technology. The OWD projects that all services will be converted to the AMR system by 2016.

The AMR technology provides many benefits to the Orleans system including:

- Reducing internal labor to manually read water meters
- Reduces liability of entering private homes and property
- More accurate, consistent reading of water use data reducing both unaccounted for water and lost revenue from meter inaccuracies.
- Opportunity to improve cash flow with more frequent reads and billings without adding substantial cost for meter reads

The AMR system continues to improve accounting of water in the Orleans system and is expected to be fully installed in the upcoming years. The financial evaluation in this planning document will include a cost allocation for ongoing meter replacements to meet this objective.

2.8 EQUIPMENT AND MATERIAL STORAGE

The water department has several locations where materials and equipment are stored. The water department has three previously mentioned buildings, now used referred to as Facility No. 2, Facility No. 3 and Facility No. 4, which were all formerly used for feeding and storing corrosion control chemicals. These facilities are now for storage. These facilities and their current purpose are:

- **Pipe, Valves and Hydrants –** The water department uses land between Well No. 3 and the garage to store these materials. Valve boxes and other large piping components are stored in this yard.
- **Facility No. 2 –** This brick masonry building is located near Pumping Station No. 4 and is used to store high value service parts, brass and meter components and miscellaneous accessories.
- **Facility No. 3 –** This brick masonry building is located near Pumping Station No. 5 and is used to store paper records and other documents requiring a controlled environment. The building space is heated during the winter months.
- **Facility No. 4 –** This brick masonry building is located on the along the discharge line of Pumping Station No. 6 and is used to store lawn maintenance equipment.

2.9 GARAGE AND VEHICLE STORAGE

The Orleans water department maintains a 3-bay garage facility connected to Well No. 1 off the South Orleans Road. The garage was constructed in 1963 along with Well No. 1, 2 and 3. The facility is a masonry structure with a bathroom facility and office. The garage space is important because it serves as a central location for the distribution crew in addition to equipment and vehicle storage. The facility does not have adequate lockers, showers and male and female bathroom facilities to meet current use codes. Despite these deficiencies, the facility has generally met the minimum needs of the water department.

As discussed, the facility is located within the Zone I delineation for Well No. 1, so the water department has rigorous procedures to protect water quality. Changing of fluids and lubricants and vehicle washing are prohibited at the facility. The water department's current vehicle inventory is presented in Table 2-7 below. It is important to note that the Town has created great value for the community and water customers by using equipment, vehicles and staff to complete construction projects that would cost much more if completed by a general contractor.

TABLE 2-7
WATER DEPARTMENT VEHICLES AND MAJOR EQUIPMENT

Year Purchased	Manufacturer & Model	Original Cost	Mileage	Condition	Primary Use
1999	Case Loader 590SL	$65,426	4,315	Fair	• Distribution System Repairs • Water Main Installations • Unloading Supplies
2012	Ford F350 4 x 4 1-ton Dump Truck	$43,992	12,866	Excellent	• Transport Chemicals • Emergency System Repairs. • Snowplowing
2013	Ford F250 4x4 pickup w/ utility body	$41,435	4,047	Excellent	• Distribution system Maintenance • Meter reading • Flushing
2005	Ford F250 3/4 ton pickup truck	$24,756	78,320	Poor	• Distribution System and Well Repairs • Towing compressor, • Snowplowing
2005	Sullivan Air Compressor	$15,007	217	Good	• Various uses
2007	Ford heavy-duty dump truck	$49,680	23,888	Good	• Distribution System and Well Repairs • Towing compressor • Snowplowing
2007	Ford F250 diesel pickup w/utility body	$28,696	42,750	Good	• Service Truck
2008	Ford Ranger R15 pickup	$17,940	50,262	Excellent	• Water Supt. transport/emergency response
2008	Interstate MFG I612S Trailer	$3,995	-	Excellent	• Transport shoring equipment

2.10 WATER DEPARTMENT STAFF AND MANAGEMENT

The Orleans Water Department staff performs all of the functions described herein with a management and operations staff consisting of nine full time workers and one seasonal worker, excluding the Director of the Department of Public Works and Natural Resources, Thomas Daley P.E. The water department is under the direction of Todd Bunzick, Superintendent. Susan Brown is the Assistant Superintendent. Both have been with the Orleans Water Department for over 20 years. The administrative staff office is located along with other town administrative staff in the Town office building on School Rd.

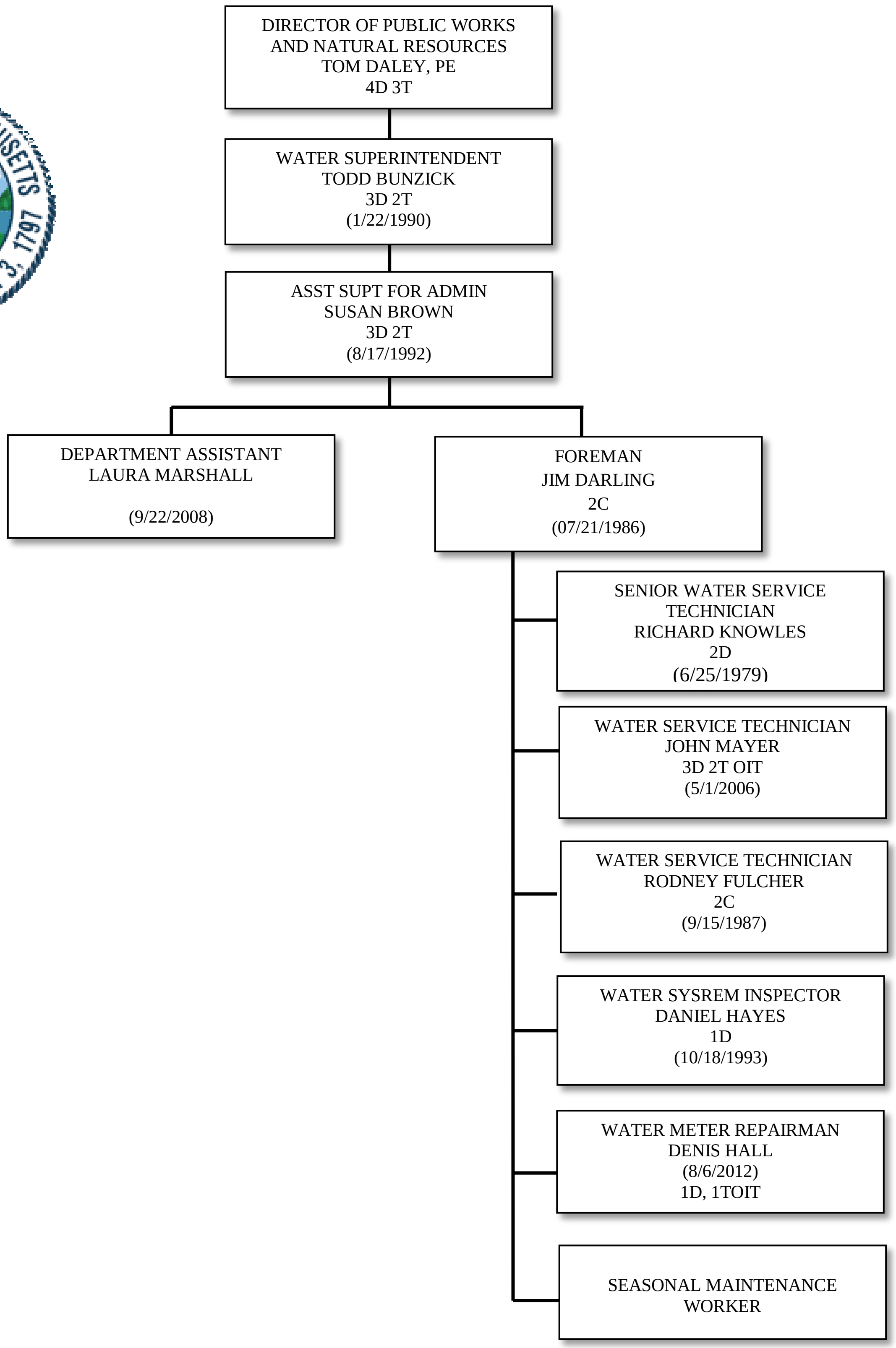
Management staff is supported by administrative staff and an additional staff of eight maintenance and operations workers (seven full time and one seasonal worker). The support staff is located at the garage facility in South Orleans. An organizational chart of the water department is included as Figure 2-12.

The Orleans water system is classified as a Grade III system for Distribution and a Grade II system for treatment. The department has three staff that met both of these minimum operation license requirements, including the DPW Director, as well as one OIT. Other staff have lower grade license for both treatment and distribution.

In addition to water system operations licenses, the water department has three backflow testing/surveying licenses as previously described for testing and surveying cross connection control devices. These certifications are important and allow the system to do the required work without the need for subconsultants.

The water department has three staff with hoisting licenses for safe tree removal, pipe installation and for backhoe operations.

Figure 2-12
Water Department Branch of the Department of Public Works And Natural Resources



Section 3

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SECTION 3

POPULATION DEMOGRAPHICS AND PROJECTED WATER USE IN ORLEANS

3.1 GENERAL

The Town of Orleans supplies public water to approximately 5,187 customers. The customer base is primarily residential with small percentages of light commercial, small industrial and municipal service connections. The general extent of the service area is discussed in Section 2 of this report.

Understanding the future water needs in Orleans is important for sizing any new facilities and for assessing the system's ability to provide reliable service over the next 20-year planning period. This report section reviews historical water use in Orleans and develops projections for future water-use based on local, state and regional planning population projections and local build-out projections on residential growth.

3.2 POPULATION DEMOGRAPHICS AND HISTORIC TRENDS IN ORLEANS

The population data discussed herein will serve as the basis for projecting water-use needs within the Town of Orleans and to understand the ability of the water system to meet these needs in the future.

To better understand the population demographics in the Town of Orleans, three primary sources of information were collected and analyzed:

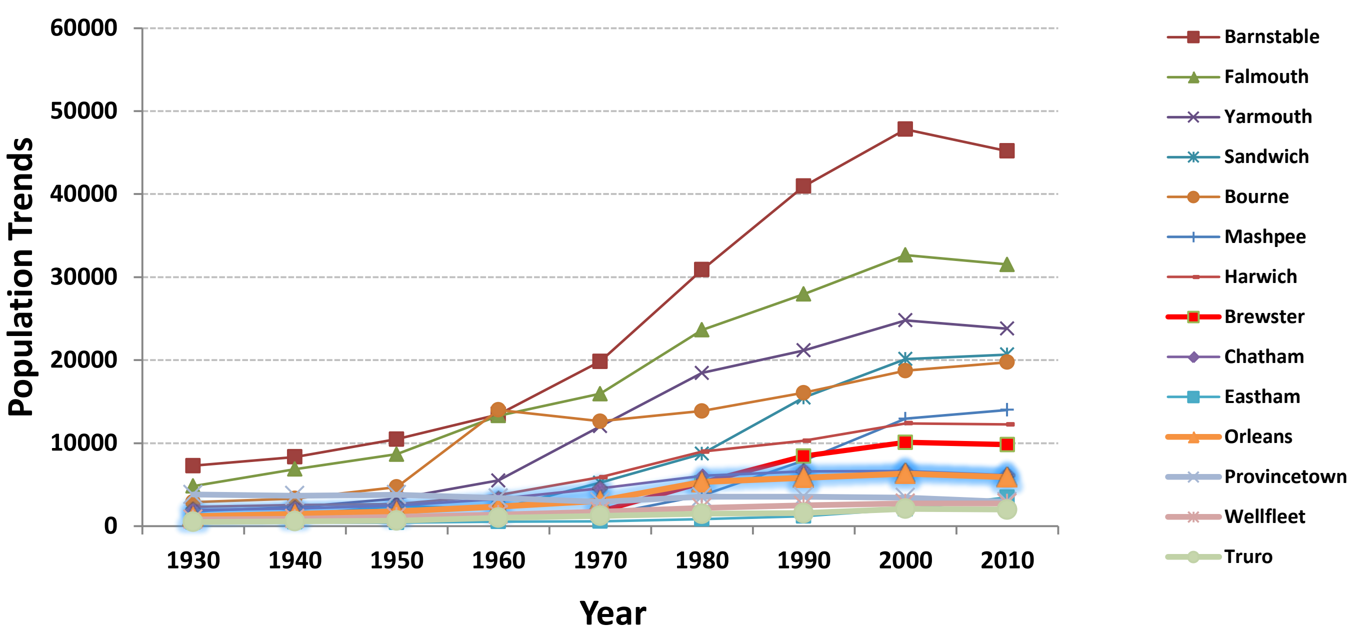
- Orleans Comprehensive Plan, amended in 2006
- Massachusetts Institute for Social and Economic Research (MISER)
- Massachusetts DCR Office of Water Resources (OWR)

The MISER data includes population trends in each community in Massachusetts extending back to 1930. The population trends in Orleans and in surrounding Cape Cod communities of are presented in Table 3-1 and graphically in Figure 3-1 below.

TABLE 3-1
POPULATION TRENDS FOR ORLEANS AND OTHER BARNSTABLE COUNTY COMMUNITIES

Town	1930	1940	1950	1960	1970	1980	1990	2000	2010
Barnstable	7,271	8,333	10,480	13,465	19,842	30,898	40,949	47,821	45,193
Falmouth	4,821	6,878	8,662	13,307	15,942	23,640	27,960	32,660	31,531
Yarmouth	1,794	2,286	3,297	5,504	12,033	18,449	21,174	24,807	23,793
Sandwich	1,437	1,360	2,418	2,082	5,239	8,727	15,489	20,136	20,675
Bourne	2,895	3,315	4,720	14,011	12,636	13,874	16,064	18,721	19,754
Mashpee	361	434	438	867	1,288	3,700	7,884	12,946	14,006
Harwich	2,329	2,535	2,649	3,747	5,892	8,971	10,275	12,386	12,243
Brewster	769	827	987	1,236	1,790	5,226	8,440	10,094	9,820
Chatham	1,931	2,136	2,457	3,273	4,554	6,071	6,579	6,625	6,125
Eastham	518	430	543	582	860	1,200	2,043	3,472	4,462
Orleans	**1,181**	**1,451**	**1,759**	**2,342**	**3,055**	**5,306**	**5,838**	**6,341**	**5,890**
Provincetown	3,808	3,668	3,795	3,389	2,911	3,536	3,561	3,431	2,942
Wellfleet	823	890	1,123	1,404	1,743	2,209	2,493	2,749	2,750
Truro	513	585	661	1,002	1,234	1,486	1,573	2,087	2,003

FIGURE 3-1
POPULATION TRENDS FOR ORLEANS AND OTHER BARNSTABLE COUNTY COMMUNITIES



In general, Cape Cod experienced rapid growth from 1960's through the 1990's related to vacation and second homes and as a regional tourist destination. Growth in population began to level off, and in some cases decline, in most Cape communities. In response to this growth, improved land-use planning, growth management and stricter development standards led to more sustained, managed growth over the last 20-30 years. In addition, escalating property values and high housing costs have also contributed to slower growth and development. Smaller communities further out on the Cape such as Orleans experienced less pronounced, rapid growth perhaps in part because of its distance from the Boston metropolitan area. Several communities, including the Town of Orleans, have actually experienced a declining population between 2000 and 2010, based on the US Census data. The population in Orleans was reported by MISER to have declined from 6,341 residents in 2000 to 5,890 residents in 2010.

3.3 MANAGEMENT ACT (WMA) PERMIT

The Orleans Water Department received a draft Water Management Act Permit for its well supply in January 2012. The permit renewal retained some of the original permit conditions from the prior 2006 WMA permit but dramatically curtailed the well withdrawals. In addition to the WMA permit renewal, a registration statement (#42222301) controls withdrawals for portions of the well supply. The Orleans well supply is located in the Cape Cod Watershed as designed by the MassDEP. The WMA permit is a critical document and policy statement which will control the quantity of withdrawal from the well supply over the next 20 year period.

The draft Water Management Act Permit contains the following provisions:

- Average-daily withdrawals limits based on annual averages
- Maximum-daily withdrawals from three designated wells
- Consumption goals to manage residential per capita water usage
- Limitations on unaccounted-for water
- Seasonal water-use restrictions
- Offset water-use goals if standards in the permit are exceeded
- Options to reallocate additional yield if Eastham interconnection is implemented

The annual withdrawal volumes for the Orleans system are specified in the permit and described as follows in Table 3-2.

TABLE 3-2
MAXIMUM AUTHORIZED ANNUAL WITHDRAWAL VOLUME ON AN AVERAGE-DAY BASIS

5-Year Withdrawal Period	Total Raw Water Withdrawal Volumes		
	Permit	Registered**	Total Permitted Rate (MGD)
	Daily Average (MGD)	Daily Average (MGD)	
Average-daily Withdrawal Volumes (Years 1-5)	0.16	0.86	1.02
Average-daily Withdrawal Volumes (Years 6-10)	0.21	0.86	1.07
Average-daily Withdrawal Volumes (Years 11-15)	0.25	0.86	1.11
Average-daily Withdrawal Volumes (Years 16-20)	0.29	0.86	1.15*

*Provisions to add an additional 0.06 MGD buffer are provided in the permit.

The total withdrawal volume when all the wells are aggregated will be limited to a withdrawal rate of 1.02 MGD or 372.2 million gallons per year (MGY). These withdrawal restrictions were based on annual withdrawals and do not impact the water department's ability to meet peak-day conditions encountered during summer months which drive supply planning in Orleans. For these peak days, each individual well has a maximum flow rate.

In addition to these withdrawal limits, the WMA permit includes other special conditions and performance standards:

- **Maximum Daily Withdrawal for Wells** –Maximum daily withdrawals from each well will be limited to the flow rates used for the Zone II wellhead delineations. These maximum daily withdrawal rates are:
    - Well No. 1 – 0.58 MGD
    - Well No. 2 – 0.47 MGD
    - Well No. 3 – 0.72 MGD
    - Well No. 4 – 0.75 MGD
    - Well No. 5 – 0.47 MGD
    - Well No. 6 – 0.98 MGD
    - Well No. 7 – 1.01 MGD
    - Well No. 8 – 0.50 MGD

- **Reserve Capacity for Eastham Interconnection –** The permit contains a reopener clause to provide additional allocation if a request to purchase water is made by the Town of Eastham in the future. It is understood that the Town of Eastham may request flows up as follows:
    - 1.25 MGD Maximum Daily Demand
    - 0.85 MGD Seasonal Daily Demand
    - 0.50 MGD Average Daily Day
- **Seasonal Water-Use Restrictions –** The permit includes a provision to include summer water use restrictions when a final policy statement is completed for the Cape Cod area. Presently, no water-use restrictions are included in the draft permit.
- **Unaccounted-For-Water (UAW) -** UAW cannot exceed 10% of total volume on an annual basis as reported in the DEP annual statistical report (ASR). The Orleans system has attained this goal easily over the past 8 years.
- **Residential Water-use per Capita per Day (rpcpd) –** RPCPD is not directly referenced in the new permit but assumed to be remain at 80 gallons per capita per day from the earlier 2006 WMA permit. The rpcpd water usage in the Orleans system has averaged 63 rpcpd over the last 7 year if this limit is lowered to 65 gallons rpcpd, the most restrictive standard the Commonwealth of Massachusetts for stressed basins.
- **Proposed Sustainable Water Management Initiative (SWMI) –** The permit will require a Offset Feasibility Study to establish triggers for reducing water use in the basin if historic baselines of water use increase. The scope of the study has not been determined but will likely consider best management practices (BMPs) for:
    - Development projects
    - Water banking
    - Storm water management and recharge
    - Infiltration of wastewater

The MassDEP is in the process of implementing the Sustainable Water Management Initiative (SWMI), which will be used to amend the WMA Regulations. SWMI evaluates a river basins safe yield, biological categorization and stream flow criteria and would be used as the criteria for future WMA permitting. The draft SWMI framework outlines a series of permitting steps and mitigation requirements for new permits. While SWMI is not finalized, it will have an impact on Orleans's water supply, as indicated in the draft permit language. Additional items not specifically mentioned in the draft permit but which may impact Orleans in the future will be:

- Optimization of existing sources
- Outdoor water use restrictions
- Implementing advanced water conservation measures

3.4 WATER PRODUCTION AND DEMAND TRENDS IN ORLEANS

The Orleans Water Department has excellent data records on water-use. Withdrawal volumes from the well supply or system demands, reported in the Annual Statistical Reports (ASR) prepared for DEP, account for all components of water use delivered to the distribution system including non-revenue water, unaccounted-for (UAW) water, and metered-use (revenue water).

Understanding the following trends in water production will be important in determining the adequacy of the well supply, pumping stations and treatment facility to meet future water supply needs in the Town of Orleans:

- Maximum annual withdrawal volumes expressed as million gallons per year (MGY)
- Average-Daily withdrawal volumes expressed as million gallons per day (MGD)
- Maximum-Daily withdrawal volumes from each well supply expressed in MGD
- Peak-Day summer water-use in MGD
- Residential per capita consumption in gallons per capita per day (rgpcpd)
- Unaccounted-for Water

3.4.1 Annual Water Withdrawal Trends in Orleans

The annual withdrawal amount from the Town’s wells from 2005 through 2012 is presented in Figure 3-2 below. This period was selected because it best reflects the current well configuration within the confines of the current regulatory environment. The data in Figure 3-2 shows that the annual withdrawals have continued to decline as conservation measures, summer withdrawals limits and other provisions in the current water management permit have influenced water-use in the system. The current Orleans WMA permit limits withdrawals from the water department’s 8 wells to no more than 372.3 million gallons per year. The actual annual withdrawals have ranged from about 324 MGY to 370 MGY over the past 8 years. Similarly, Figure 3-3 shows the same data on an average-day basis in the Orleans system.

FIGURE 3-2
ANNUAL WATER USE TRENDS IN ORLEANS BASED ON TOTAL ANNUAL DEMANDS

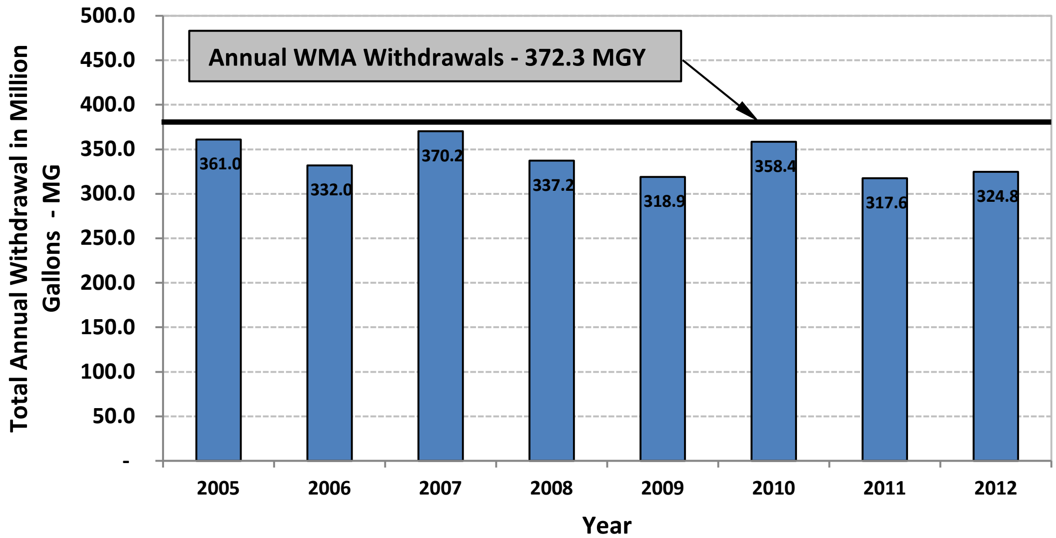
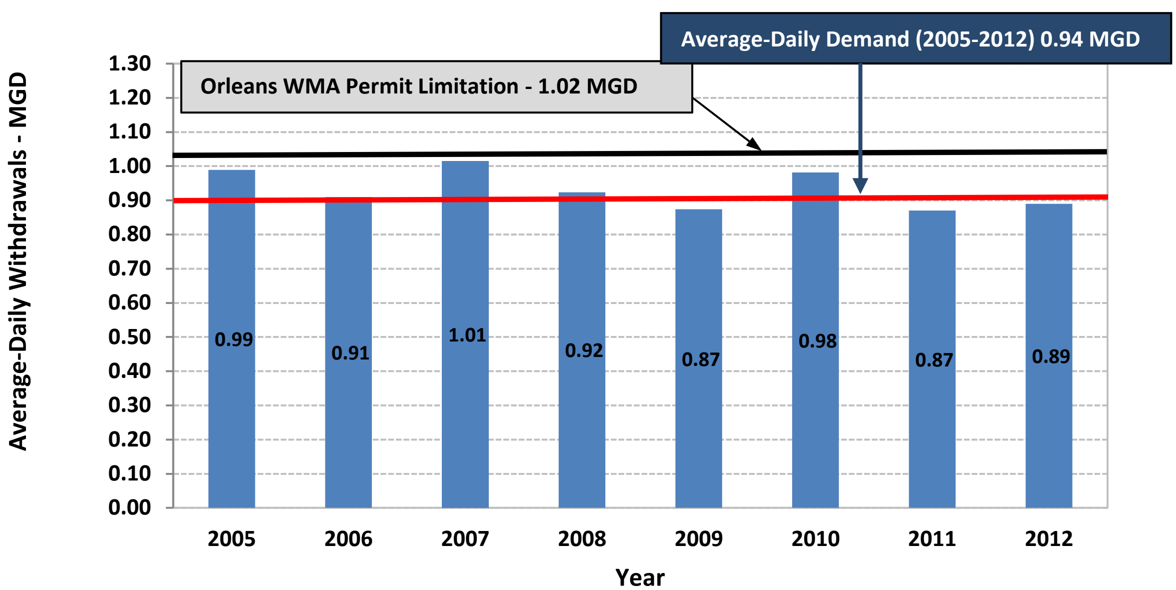


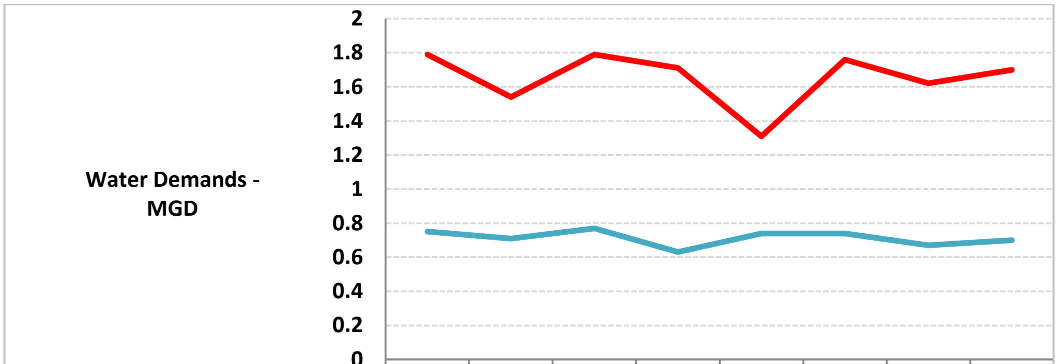
FIGURE 3-3
ANNUAL WATER USE TRENDS IN ORLEANS ON AN AVERGE DAILY BASIS



3.4.2 Summer Water Withdrawal Trends

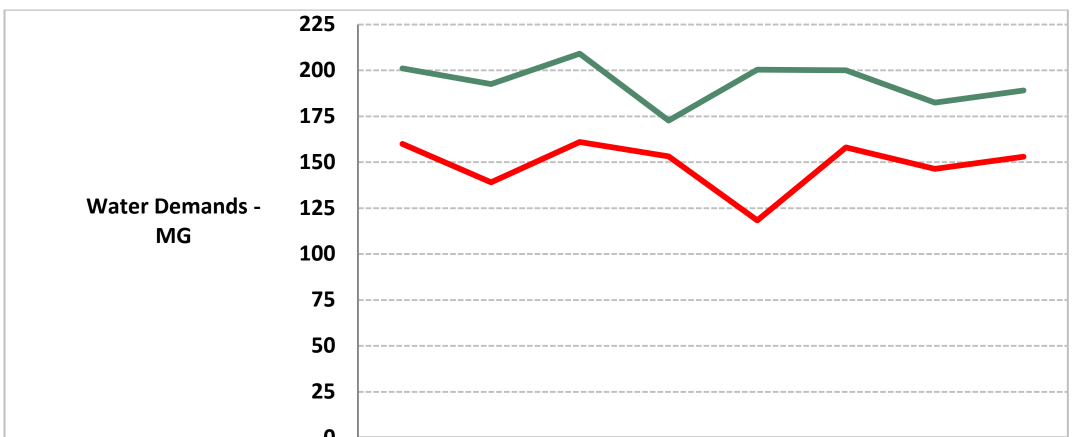
Trends for summer water-use are presented in Figures 3-4 and 3-5 below. The summer demands in Orleans drive water supply planning and operations in the water system.

FIGURE 3-4
AVERAGE DAILY WITHDRAWAL TRENDS



	2005	2006	2007	2008	2009	2010	2011	2012
Summer Demands (June-September) in MGD	1.79	1.54	1.79	1.71	1.31	1.76	1.62	1.7
Spring-Winter Demands (October-May) in MGD	0.75	0.71	0.77	0.63	0.74	0.74	0.67	0.7

FIGURE 3-5
SEASONAL WITHDRAWAL TRENDS
(*Same data as Figure 3-5, expressed on a Total Million Gallons Basis)



	2005	2006	2007	2008	2009	2010	2011	2012
Summer Demands (June-September) in MG	160	139	161.1	153.1	118.4	158	146.4	153
Spring-Winter Demands (October-May) in MG	201.1	192.6	209.1	172.7	200.4	200	182.5	189

The data in Figure 3-4 show that average daily demands during the summer months (June-September) have averaged about 1.65 MGD over the past 8 years. During the same period, average-day demands during the remaining 9 months averaged about 0.71 MGD. This data is shown in Figure 3-5 on a totalized volume basis for the two time periods. The total amount of water used in the 8 month period October to May period is consistently higher than the 4 month period of June to September.

3.4.3 Maximum-Daily Water Withdrawal Trends in Orleans

The MassDEP requires that key facilities such as water treatment facilities and well supplies be designed to meet the projected maximum-day condition during the selected design period with the largest mechancial unit off-line for mainteance or repair. Sources of supply are limited by two factors: (1) the WMA permit and (2) the capacity or yield of the groundwater aquifer to provide the quanity of water needed for a sustained period. Limitations on Orleans supply capacity are discussed in Section 5.

The maximum-day design condition occurs during the summer tourist season in Orleans. The maximum-day for each of the past 7 years and the date of occurrence is shown in Table 3-3 below.

TABLE 3-3
MAXIMUM-DAY DEMANDS IN ORLEANS (2005-2012)

Year	Maximum-Day Demand (MGD)	Date of Event
2005	2.517	August 20, 2005
2006	2.352	August 3, 2006
2007	2.665	August 25, 2007
2008	2.31	July 18, 2008
2009	2.002	August 16, 2009
2010	2.768	July 5, 2010
2011	2.592	July 31,2011
2012	2.657	July 21, 2012

As discussed earlier, the Orleans system withdrawals are not specifically limited during the summer months by permit but will need to be carefully considered because of individual withdrawal limitations on key, specific well sources.

The data in Figure 3-6 shows that the maximum-day of production for each of the last 8 years. The specific maximum-day demand in any given year in Orleans is likely driven by a variety of factors including weather and precipitation patterns, local and regional tourist events and other factors during the summer months. The maximum day has occurred during either July or August over the past 8 years of records. The ratio of maximum-day to average-day usage for each of the past 8 years is shown in Table 3-4. The ratio has averaged 2.67 for this time period. This data is useful in projected maximum-day usage patterns in the future.

FIGURE 3-6
MAXIMUM-DAY SUMMER DEMAND IN ORLEANS (2005-2012)

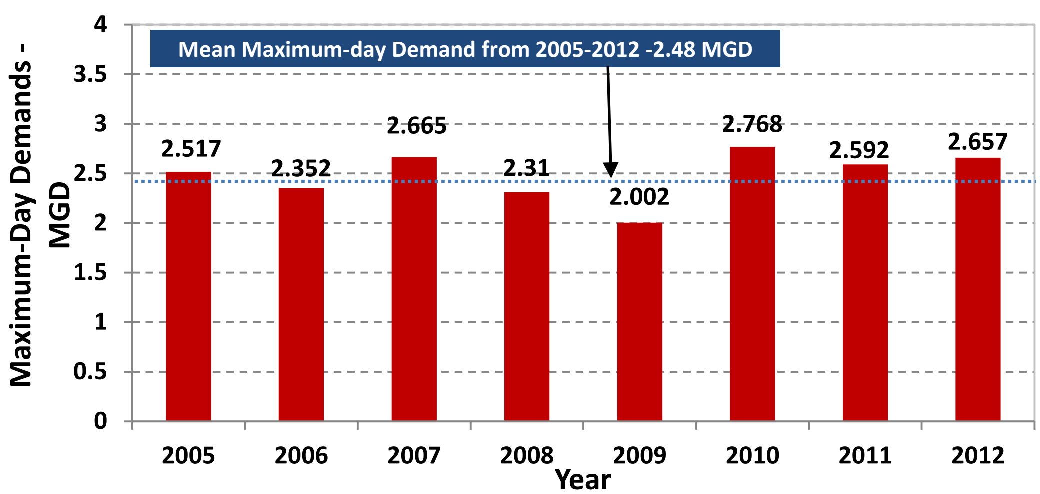


TABLE 3-4
RATIO OF MAXIMUM-DAY TO AVERAGE-DAY DEMAND TRENDS

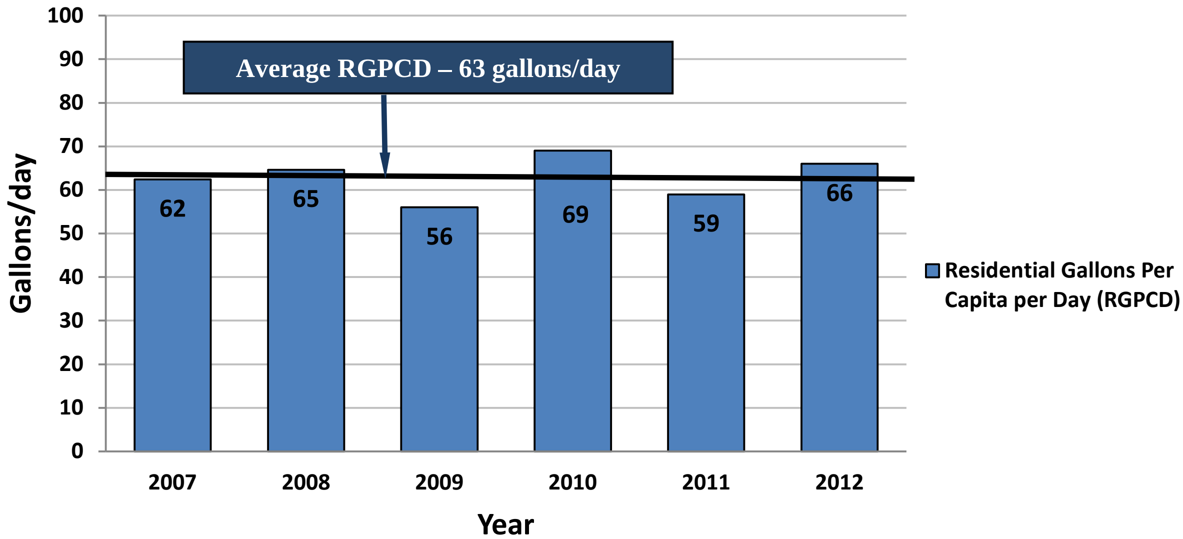
Year	Maximum-Day Demand (MDD) (MGD)	Average-Day Demand (ADD) (MGD)	Ratio of MDD/ADD
2005	2.52	0.99	2.54
2006	2.35	0.91	2.58
2007	2.67	1.01	2.64
2008	2.31	0.92	2.51
2009	2.00	0.87	2.30
2010	2.77	0.98	2.82
2011	2.59	0.87	2.98
2012	2.66	0.89	2.99
Average	**2.48**	**0.93**	**2.67**

3.4.4 Residential Gallons Per Capita Per Day Water Consumption (RGPCPD)

Residential water-use in Orleans has averaged between 56-69 rgpcpd over the past six years. The WMA permit will limit residential consumption to 80 rgpcpd on an annual basis. It is expected that the standard of 65 rgpcpd, the current standard for stressed basins in Massachusetts will be applied to all basins including the Cape Cod basin.

These values are excellent by any standard and represent a well-managed system. Conservation restrictions and other provisions in the permit are leading to lower water use. Future water-use projections will be based on 65 rgpcpd for new water customers. The water department has averaged 63 rgpcpd over the past 6 years. Trends for residential per capita water-use are presented in Figure 3-7.

FIGURE 3-7
MAXIMUM-DAY SUMMER DEMAND IN ORLEANS (2007-2012)



3.4.5 Non-Revenue and Unaccounted-For Water (UAW)

Unaccounted-for water is lost that is not metered. Non-revenue water is for specific uses but is measured and often not-metered. Sources of non-revenue water include hydrant usage and flushing, leaks in the distribution system, inaccuracy in meters, and lost or unaccounted-for water. Other sources of UAW may include main breaks, unauthorized use, and drainage of storage facilities for maintenance or repair, or non-functioning meters.

Unaccounted-for water in the Orleans system has continued to decline over the past several years due to diligent and routine leak detection, a meter replacement program and a low rate of water loss in the distribution system. UAW in the Orleans system is below 10% of the system's annual production. The WMA permit will restrict the amount of UAW to 10% in the next permit cycle on an annual basis, to be reported in the Town's Annual Statistical Report (ASR). Future water-use projections will assume that current levels of UAW will be maintained in the future. Figures 3-8 and 3-9 illustrate trends in UAW in the Orleans system.

FIGURE 3-8
ANNUAL WATER ACCOUNTING BREAKDOWN IN ORLEANS (2005-2012)

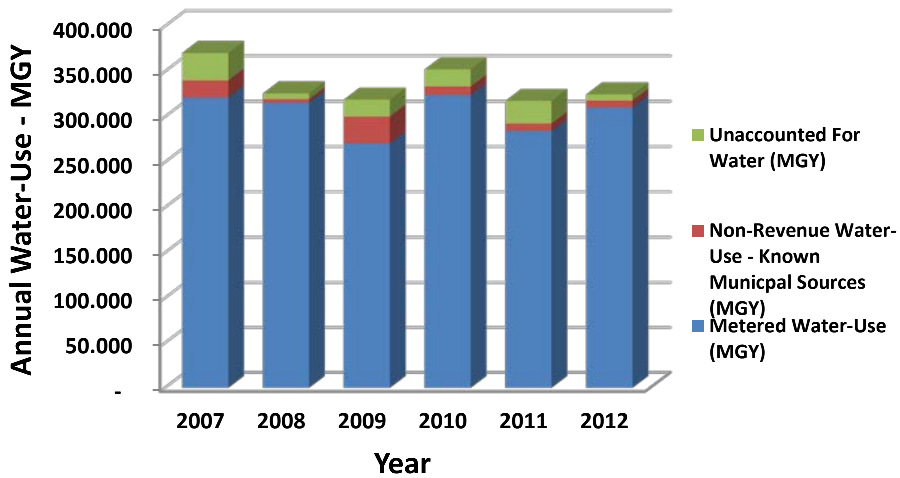
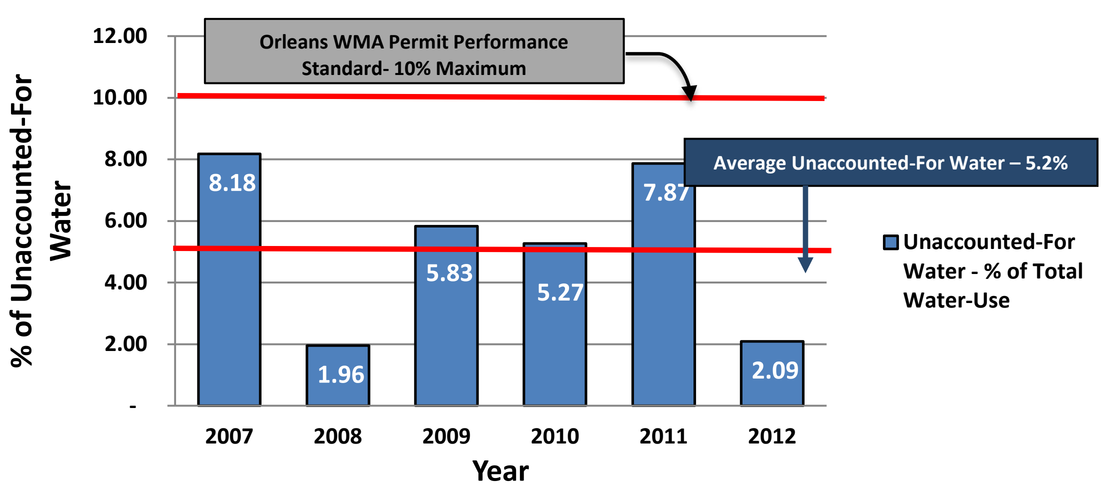


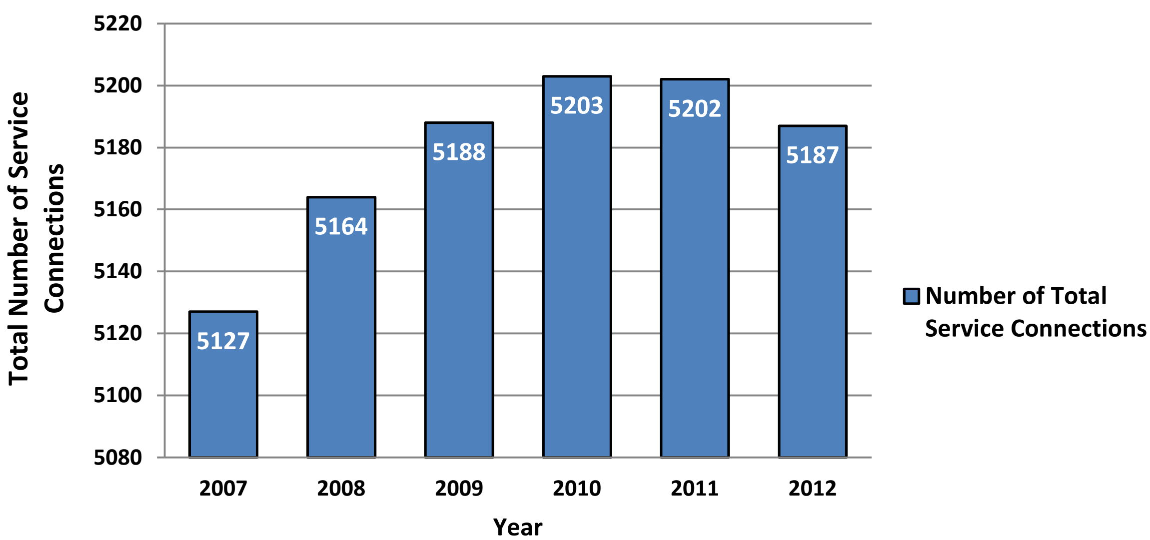
FIGURE 3-9
UNACCOUNTED FOR WATER IN ORLEANS (2005-2012)



3.4.6 Service Connections

The number of service connections in Orleans has trended downward in recent years, consistent with the small decrease in population. Much of the population decrease and service connection decrease in Orleans can be attributed to change of use of the residential housing stock.

FIGURE 3-10
NUMBER OF TOTAL SERVICE CONNECTIONS IN ORLEANS (2007-2012)



3.5 WATER DEMAND PROJECTIONS

3.5.1 Build-Out Projections in Orleans

The Orleans planning department provided excellent insights into the projected growth and conversion of the housing stock in the Town of Orleans. Orleans is a community in transition. The community has experienced a slight decrease in population in the past decade due in large part to displacement of families by retirees with smaller households. The planning department reports that Orleans has an average of approximately 2.05 persons per residential dwelling. Because of the unique demographics of Orleans, population projections are not a representative model to project water-use growth in Orleans.

A build-out analysis was conducted by the Town in 2006 to better understand growth in the community, remaining buildable lots and possible impacts of conversion of housing stock to condominiums and other multi-family housing. Although the problem is complex, an estimate of current and projected housing was developed and is presented in Table 3-5 and Table 3-6 below. By using this estimate of projected build-out of the housing stock, residential per capita water-use and average-household size, an estimate of projected water-use at build-out can be made for the community of Orleans.

TABLE 3-5
EXISTING RESIDENTIAL DWELLINGS IN ORLEANS*

Housing Type	Existing Housing Units
Single Family Homes	3,617
Condominiums	642
2-Family Homes	88
3-Family Homes	18
Other Multi-unit Dwellings	104
Housing Authority	115
Other	25
Estimated Total	**4,609**

*Based on a 2006 evaluation by the Orleans planning department

TABLE 3-6
PROJECTED NEW RESIDENTIAL DWELLINGS IN ORLEANS AT BUILD-OUT*

Potential Future Development	Projected New Housing Units
Single Residential Vacant Building Lots	528
Potential New Lots through Subdivisions	274
Conversion of Housing in Residential Land-use District	412
Conversion of Housing in Industrial Land-use District	98
Conversion of Housing in Village Land-use District	290
Estimated Total	**1,768**

*Based on a 2006 evaluation by the Orleans planning department

3.5.2 Projected Average-Day and Maximum-Day Demands

Build-Out Demand Projections. Using a residential per capita consumption rate of 63 gpcpd and an average household size of 2.05 persons, an additional annual demand of 0.235 MGD is estimated in Orleans when build-out occurs. Using an average-day demand of 0.94 MGD, the average-day demand over the past 8-years in Orleans, a projection of average-day water usage of 1.175 MGD is projected at build-out if all the residential housing were to be constructed or converted. This assumption is based on no new changes to unaccounted-for, commercial or industrial demand components, which are all very small in Orleans.

Using the average-day to maximum-day ratio of 2.67, the average ratio for the past 8 years, a maximum-day demand at build-out of 3.15 MGD is projected for Orleans using this methodology.

Projected Demands within 20-Year Planning Horizon (2013-2033). The Orleans planning department reports that 42 dwellings per year on average have been added to the Orleans housing stock over the past 30 years.

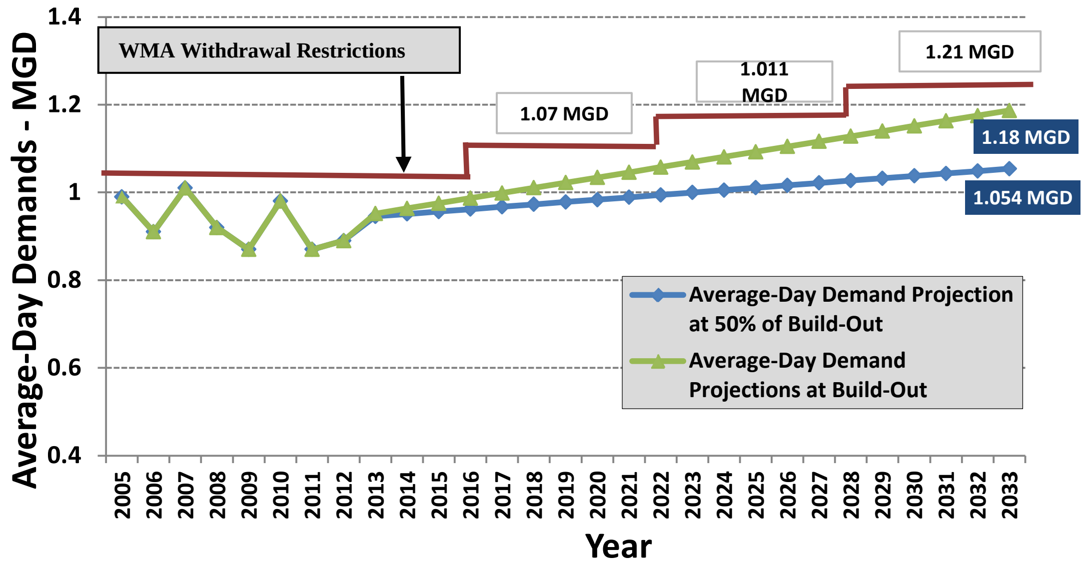
If the housing stock continued to develop at the historic annual rate, then approximately 840 new residential units would be constructed in Orleans over the next 20-year period. This value would represent about 50% of the build-out projections. Using this value, a projected average-day demand in year 2033 would be approximately 1.054 MGD.

Using the average-day to maximum-day ratio of 2.67, the average ratio for the past 8 years, a maximum-day demand at build-out of 2.82 MGD is projected for Orleans using this methodology.

This data is shown graphically on Figure 3-11. In both scenarios, the projections for both build-out conditions suggest that the Town of Orleans will be allocated sufficient withdrawal in the current water management act permit to meet projected average-day needs in the water system.

In Section 4 of this report, each component for the Orleans system will be assessed for its ability to meet these projected demand conditions.

FIGURE 3-11
PROJECTED ANNUAL DEMANDS THROUGH YEAR 2033 IN ORLEANS



Section 4

WRIGHT-PIERCE
Engineering a Better Environment

SECTION 4

LEVEL OF SERVICE

4.1 INTRODUCTION

A Level of Service Agreement (LOS) defines the way in which the utility owners, managers, and operators want the system to perform over the long term. Establishing the level of service in a utility is a critical first step in creating an asset management plan. The LOS can include any technical, managerial, or financial components the Water Department wishes, as long as all regulatory requirements are met. The LOS will become a fundamental part of how the system is operated and how assets are replaced and renewed.

For the Orleans system, several workshops were conducted to develop the level of service plan described herein. Once the LOS goals and objectives were defined, an asset management plan described later in this document was developed to meet this vision for the water system.

4.2 LEVEL OF SERVICE DEVELOPMENT

4.2.1 Overview

There are two key facets to asset management – defining the level of service the system will strive to provide its customers over the long term and determining the most efficient and economical way to deliver that service. Therefore, determining and detailing the level of service that the system is going to provide is a key step in the overall process.

The Level of Service Agreement – the document that will spell out the service the system wishes to provide – is a multi-faceted tool that can fulfill a wide array of purposes as described below. Further explanation regarding each of these items follows:

- Customer Communication
- Determine critical assets
- Provide a means of assessing overall system performance

- Provide a direct link between costs and service
- Serve as an internal guide for system management and operations staff
- Provide information for system annual report or annual meeting presentation

4.2.1.1 Customer Communication

It is important for a water utility to communicate with its customers to avoid confusion, bad feelings, accusations of improper operation, and to make clear what the customer's expectations should be. Effective communication aligns the utilities and customers' expectations on issues such as water quality, water rates, service responses and other issues related to how a water utility operates and is managed.

4.2.1.2 Determine Critical Assets

The LOS can be one factor in determining critical assets. An example of how the LOS can impact criticality is where a system's LOS includes the factor "water will be delivered to customers 99% of the time." If the system has only one water source, the source will be a critical asset for the system. It must keep the source operational at all times in order to meet this criteria.

4.2.1.3 Provide a Means for Assessing Overall System Performance

If at least some of the LOS factors include measurable items, the system can keep information regarding how well they are meeting these criteria and use the criteria as a benchmark in assessing the overall operation. *For example*, consider a system that includes the following measures in its LOS:

- Breaks will be repaired within 6 hours of initiation of repair 95% of the time.
- Customer complaints will be responded to within 24 hours, Monday through Friday.
- Losses will be kept to less than 15% as measured by gallons pumped each month – gallons sold each month.
- System will meet all state and federal regulations.

All of these items in this *example* are measurable if the system collects the appropriate data. Assume the system has the following data from its first year of operation.

- 250 breaks occurred, 230 were fixed in less than 6 hours
- 30 complaints were received, all 30 responded to within 24 hours
- Losses over the year as follows: January 12%, February 10%, March
- 19%, April 14%, May 9%, June 13%, July 9%, August 10%, September
- 12%, October 9%, November 10%, December 12%
- System met all regulations; no violations

Based on this data, the system met some, but not all of its LOS factors. The following items were met: The customer complaints were responded to on time and the system met all the state and federal regulations. The following items were not met: breaks were not repaired within 6 hours and the losses were not kept to less than 15% in all months. The system can look at these results and determine the items that it needs to work harder on in order to meet the level of service requirements.

It is important to note that data collected on LOS items must be consistently collected and recorded at given intervals (daily, weekly, monthly or quarterly) to be able to assess and make changes in the system as necessary. Orleans use of the UtilityCloud software should provide for an efficient method of collection and analysis of water system data.

4.2.1.4 Provide a Direct Link between Costs and Service

There is a direct link between the Level of Service provided and the cost to the customer. When a higher LOS is provided, the costs to the customers will likely increase. This relationship provides an opportunity for the water system to have an open dialogue with its customers regarding the LOS desired and the amount the customers are willing to pay for this level of service or increased services.

For example, customers may complain about aesthetic contaminants in the water – those contaminants that cause taste, odor, or color issues in the water, but not health concerns – and wish to have these contaminants removed. The water system can install treatment to remove these contaminants but it will cost each customer more for their water each month. The water system can have a dialogue with the customers to explain what the treatment would entail, what the finished water quality would be, and how much it would cost the customers. Following the discussions, the customers could decide whether or not they were willing to pay for the additional treatment. In this way, the LOS sets desired services and provides information to the customers regarding what the costs of their LOS will be.

4.2.1.5 Serve as an Internal Guide to System Operation and Management

It is much easier to operate or manage a system when the operations and maintenance staff as well as the management staff understand the goals of the operation. Defining the LOS sets these goals for the system. These goals allow the operations staff to have a better understanding of what is desired from them and the management has a better understanding of how to use staff and other resources more efficiently and effectively. Checking how well the system is meeting LOS also allows the management to shift resources, if need be, from one task to another to meet all the goals more effectively.

4.2.1.6 Provide Information for Annual Report or Meeting

If the system tracks information regarding how well it is meeting the LOS criteria on a weekly or monthly basis, it can use this information to prepare an annual report regarding how well the system met these criteria over the course of a year. This information can be presented to the Board of Water and Sewer Commissioners, Board of Selectmen or customers at an annual meeting so that customers are aware of how well the system met the overall goals for the operations of the system.

This meeting would also be an opportunity to discuss any changes needed in the LOS, based on the operations data. Perhaps some of the LOS conditions are not possible to be met given the current staff or resources. If that is the case, the system will either have to reduce the LOS provided or increase staff or other resources in order to meet the current LOS. The decision to increase staff or other resources or decrease LOS will directly impact customers, so it is important to use the opportunity of the annual meeting to discuss the potential options with them. Alternatively, the system may decide that some criteria are very easily met and may not be stringent enough. The system may find that it can increase the LOS for particular criteria without impacting costs and may wish to discuss the changes with the customers at the annual meeting.

In Orleans, this process helps define capital needs for presentation at the town meeting and to engage customers and community leaders on the need for improvements and investment in the water system.

4.2.2 Level of Service Goals for Orleans

The proposed OWD level of service goals can be organized into the following categories:

A. Operations
B. Compliance with Water Management Act, EPA and MassDEP Regulations
C. Business
D. Workplace Environment

4.2.2.1 Water System Operations Goals

A. *Compliance with Safe Drinking Water Act (SDWA) rules and regulations*- Set to a target goal of 100% compliance. This goal is driven by the USEPA Safe Drinking Water Act and will be measured using annual compliance reports. This goal is important because its compliance is federally mandated to ensure safe public drinking water supplies nationwide.
B. *Compliance with USEPA secondary drinking water standards*- Set to a target goal of 100% compliance. The goal is driven by the USEPA Safe Drinking Water Act and will be measured using samples taken annually. This goal is important because, although compliance is not mandatory due to secondary drinking water standards being comprised of non-life threatening water qualities, it does measure aesthetic qualities such as taste and odor. Customers value such aesthetic qualities and compliance will also avoid DEP intervention.

C. *Repair leaks within 24 hours*- Set to a target goal of greater than 95% compliance. This goal is driven by the Department of Environmental Protection and will be measured annually using work order records. This goal is important because compliance will avoid intervention by the DEP and for compliance with lost water requirements in Orleans Water Management Act permit.

D. *Maintain a level of service where there is less than 1 break per 25 miles of distribution water main*- This goal is self-imposed and set to less than 5 incidences of more than one break per 25 miles of water distribution main. This goal will be measured annually using work order records. This goal is important because excessive breaks may indicate an area of distribution main where an underlying problem is present. Breaks in distribution mains are also costly to repair in terms of time, labor, parts, and an inconvenience to customers.

E. *Maintain a full inventory of distribution system parts*- Set to a target of 100% compliance. Inventory shall be monitored and recorded annually. This goal is driven by the Department of Environmental Protection. Work order records and purchase order invoices will be used to track changes in inventory. This goal is important because compliance will avoid intervention by the MassDEP, minimize service disruptions to customers and businesses, and reduce response time for repairs.

F. *Maintain water system facilities power and communications capacity*- Set to a target of greater than 95% compliance and is driven by the MassDEP as well as the town's emergency response plan. This will be measured annually using the water department's SCADA system. Compliance with this goal is required by the MassDEP and helps ensure that the water infrastructure will be operational during an emergency.

G. *Maintain infrastructure that allows for fire flows that exceed ISO needed fire flows in the community*- Set to a target of 100% compliance. This goal is driven by ISO insurance ratings measured bi-annually by performing flow tests. Compliance with this goal is important for ensuring that adequate flows are available in case of a fire, and is required to maintain a good insurance rating.

H. *Comply with all ISO water ratings requirements*- this goal is set to a target compliance of 3, or more, out of 9 ISO requirements being met and is driven by ISO insurance ratings.

This goal will be measured by ISO rating reviews, which are performed every 5 to 10 years. Compliance is important to maintain a good ISO insurance rating.

I. *Deliver consistent, high quality water to all customers that meets both primary and secondary MCLs* - this goal is self-imposed and has a target goal of zero water quality complaints. This goal is included in the water department's mission statement and should be supported by every other goal set forth by the water department.

J. *Maintain a highly functional fleet of vehicles and equipment*- this goal is driven by the MassDEP as well as the Emergency Response Plan. A target goal of all vehicles being less than 10 years old has been set and will be measured annually by equipment review. Compliance with this goal is important to ensure that a well maintained fleet of service vehicles are available in emergency situations. This goal is also important from a business perspective in regulating depreciation of assets.

K. *Ensure GIS and UtilityCloud data sets are aligned*- this goal is driven by a need for records maintenance and is set at a target goal of 100% compliance. It will be measured annually by reviewing data sets from both GIS and Utility Cloud for agreement. This goal is important because it ensures continuity among different data management platforms and helps to avoid major system maintenance at a later date.

L. *Inspect and maintain all hydrants in the distribution system*- this goal is driven by AWWA G200/M-17 and is set to a target goal of 300 hydrants per year. This goal will be measured annually using work order records. Compliance with this goal helps to improve hydrant life and distribution system function as well as contribute to a high ISO rating in Town.

M. *Inspect and maintain all valves in the distribution system*- this goal is driven by AWWA G200/M-17 and is set to a target goal of 100% compliance. This goal will be measured annually using work order records. Compliance with this goal helps to improve valve life and distribution system function.

4.2.2.2 Compliance with Water Management Act Regulations

A. *Replace all customer water meters in the system over a 15 year period*- this goal is driven by the need to comply with the Water Management Act. A target goal of 15 years for full replacement of all water meters has been set and will be measured annually using work order records. Compliance with this goal is required for the Water Management Act Permit.

B. *Perform leak detection across the distribution system every 2 years*- this goal is driven by the need to comply with the Water Management Act. A target goal of every two years for a full system leak detection has been set. This goal will be measured bi-annually using work order records. Compliance with this goal is required for the Water Management Act Permit.

C. *Ensure well pumping rates are less than the allowable rates at all times*- this goal is driven by the need to comply with the Water Management Act. A target goal of 100% compliance has been set. This goal will be measured using the annual report. Compliance with this goal is required for the Water Management Act Permit.

D. *Minimize unaccounted for water in the water distribution system*- this goal is driven by the need to comply with the Water Management Act. A target goal of < 10% of the total annual water in the system being unaccounted for has been set. This will be measured using the annual report. Compliance with this goal is required for the Water Management Act Permit.

E. *Reduce residential water use to less than 65 gpd/person* - this goal is driven by the need to comply with the Water Management Act. A target goal of less than 65 gpd/person for residential water use has been set. This goal will be measured using the annual report. Compliance with this goal is required for the Water Management Act Permit.

F. *Water treatment plant production efficiency*- this goal is driven by the need to comply with the Water Management Act. A target goal of greater than 95% efficiency has been set. This will be measured using the annual report. Compliance with this goal is required for the Water Management Act Permit.

G. *Periodically perform hydrant flushing in the water distribution system*- this goal is driven by the MassDEP and has been set for a target goal of 100% compliance. This goal will be measured annually using flushing records. Compliance with this goal will avoid intervention by the MassDEP as well as improve the lifespan and operation of the distribution system.

H. *Eliminate all cross connections in the system*- this goal is driven by the MassDEP and has been set for a target goal of 0 cross connections. This goal will be measured annually using work order records. Compliance with this goal will avoid intervention by the MassDEP as well as ensure the quality of the potable water supply.

4.2.2.3 Business Goals

A. *Water rate increases below 5% per year*- This is a self-imposed goal which has been set at less than 5% yearly increase in the water rates. This goal will be measured annually by way of a budget review. Meeting this goal avoids complaints from customers due to sharp, unexpected rate increases some years and relatively low rate increases other years.
B. *Maintain an operation's fund balance level* - Appropriate fund balances are discussed in Section 11 of this report.
C. *Comply with all state regulations*- This goal is driven by Massachusetts state regulations and is set at 100% compliance. This goal will be measured annually using compliance reports. Compliance with this goal is required by the state.
D. *Move to a quarterly billing frequency*- This goal is driven by the water department audit and is set to change the current billing cycle to quarterly. Compliance with this goal will be measured annually by way of examining the billing cycle in place. Moving to a quarterly billing cycle is important because it provides a more efficient revenue stream and may help avoid billing disputes with customers. Revenue frequency is increased and smaller bills are more likely to be paid by customers.

4.2.2.4 Workplace Environment

A. *Maintain a safety committee and deliver service in the safest possible manner*- this goal is driven by Department of Labor and OSHA regulations. The target for this goal has been set at 0 accidents per year as measured by accident reports. Compliance with this goal not only helps meet DOL and OSHA standards, but should also always be the number one priority of any workplace.
B. *Treatment system operator training level*- This goal is driven by State Regulations and has been set at all treatment system operators being Grade 2 or better. This goal will be measured annually using certification records. Compliance with this goal is required by the state and helps increase the depth of knowledge among treatment operators.

C. *Distribution system operator training level*- This goal is driven by State Regulations and has been set at all distribution system operators being Grade 3 or better. This goal will be measured annually using certification records. Compliance with this goal is required by the state and helps increase the depth of knowledge among distribution operators.

D. *Training level per operator*- This goal is driven by state regulations and is set at 100% per operator as measured by annual certification records. Compliance with this goal is required by the state and helps ensure that operators are trained to 100% of their grade level.

E. *Cross training between treatment and distribution staff*- this goal is driven by DEP regulations and is set at 50% as measured annually by training records. Compliance with this goal is required by DEP and helps to expand the knowledge base of the staff.

4.2.2.5 Customer Service Goals

A. *Respond to a customer by next business day of receiving inquiry*- This goal is driven by MassDEP policy and set to a target of greater than 95% compliance. This goal is measured annually through work records. Compliance with this goal satisfies DEP policy and will increase customer satisfaction.

B. *Respond to water quality or pressure service complaints within 4 hours*- This goal is driven by MassDEP policy and set to a target of greater than 95% compliance. This goal is measured annually through work records. Compliance with this goal satisfies DEP policy and will increase customer satisfaction.

C. *Contact affected customers prior to a water main shutdown in both planned and emergency situations*- This goal is driven by water department regulations and set to a target of greater than 95% compliance. This goal is measured annually through work records. Compliance with this goal satisfies MassDEP policy, reduces customer complaints, and increases customer satisfaction.

4.2.3 Level of Service Agreement

The level of service goals described above provides the basis for the proposed OWD level of service agreement. This agreement defines the way in which the water commissioners, managers, operators, and customers want the system to perform over the long term and by what means this performance is measured. The level of service agreement is consolidated Table 4-1. The Orleans Water Department currently complies with items shown with an asterisk in Table 4-1.

4.2.4 Recommendations

The OWD should review and report on the level of service agreement annually to evaluate its effectiveness for delineating the necessary effort required by the OWD to provide clean safe drinking water to the public in the most efficient, economical and sustainable way. The Level of Service Agreement in its entirety, or in excerpts, is an excellent tool to communicate the how the department is operating and how well the community is being served.

If the OWD finds that an alternative method for measurement better fits a level of service goal or a level of service goal target should be modified. Changes to the document should be recommended to the Board and discussed annually.

TABLE 4-1
LEVEL OF SERVICE GOALS AND OBJECTIVES

	Operations	Target	Driver	Tracking Method	Frequency
1	Compliance with Safe Drinking Water Rules and Regulations*	100%	Safe drinking water act	Compliance reports	Annually
2	Compliance with USEPA Secondary Drinking Water Standards*	100%	Safe drinking water act	Sampling	Annually
3	Repair leaks within 24 hours*	>95%	MADEP	Work order records	Annually
4	Maintain a level of service where there are less than 1 break per 25 miles of distribution water main*	<5 /yr	Self imposed	Work order records	Annually
5	Maintain a full inventory of distribution system parts and for spare parts identified in operations manuals for supply/treatment	100%	MADEP	Work order records	Annually
6	Maintain water system facilities power and communications capacity	>95%	DEP/ Emergency Response Plan	SCADA	Annually
7	The Department shall maintain infrastructure that allows for fire flows that exceed ISO needed fire flows in the community.	100%	ISO insurance ratings	Flow testing	Bi-annually
8	Compliance with all the ISO water rating requirements	3/9 or better	ISO insurance ratings	ISO rating reviews	5-10 years
9	Deliver consistent, high quality water to all customers that meets both Primary and Secondary MCLs*	Zero Complaints	Mission Statement	Complaint Log	Annually
10	Maintain a highly functional fleet of vehicles and equipment*	< 10 years old	MADEP/ ERP	Equipment inventory	Annually
11	Ensure GIS and Utility Cloud data sets are aligned	100%	Records maintenance	Data set review	Annually
12	Inspect and maintain all hydrants in the distribution system	300/year	AWWA G200/M-17	Work order records	Annually
13	Inspect and maintain all valves in the distribution system*	100%	AWWA G200/M-17	Work order records	Annually

	Compliance with Water Management Act Regulations	Target	Driver	Tracking Method	Frequency
1	Replace all customer water meters in the system over a 15 year period	15 yrs	Water Management Act Permit	Work order records	Annually
2	Perform leak detection across the distribution system every 2 years*	2 yrs	Water Management Act Permit	Work order records	Bi-Annually
3	Ensure well pumping rates are less than the allowable rates at all times*	100%	Water Management Act Permit	Annual report	Annually
4	Minimize unaccounted for water in the water distribution system*	<10%	Water Management Act Permit	Annual report	Annually
5	Maintain residential water use to less than 65 gpd/person*	<65 GPD/person	Water Management Act Permit	Annual report	Annually
6	Water treatment plant production efficiency	>95%	Water Management Act Permit	Annual report	Annually
7	Periodically perform hydrant flushing in the water distribution system *	100%	MADEP	flushing records	Annually
8	Eliminate all cross connections in the system	0 cross connections	MADEP	Work order records	Annually
9	Meet Projected Maximum-day Demand with the Largest Source Off-line	Flow rate	MADEP	Annual report	Annually

	Business	Target	Driver	Tracking Method	Frequency
1	Water rate increases below 5% per year	<5%	Self imposed	Budget review	Annually
2	Maintain an appropriate fund balance to maintain operations	25%	AWWA/MADEP guidance	Funding balance	Annually
3	Comply with all State regulations*	100%	State regulations	Compliance reports	Annually
4	Move to a quarterly billing frequency	Quarterly Billing	Department audit	Billing cycle	Annually

	Workplace Environment	Target	Driver	Tracking Method	Frequency
1	Maintain a safety committee and deliver service in the safest possible manner*	Zero accidents	DOL and OSHA regulations	Accident reports	Annually
2	Treatment Operator training level*	Grade 2	State regulations	Certification records	Annually
3	Distribution Operator training level*	Grade 3	State regulations	Certification records	Annually
4	Training level per operator*	100%	State regulations	Certification records	Annually
5	Cross training between treatment and distribution staff*	50%	DEP Regulations	Training Records	Annually

	Customer Service	Target	Driver	Tracking Method	Frequency
1	Respond to a customer by next business day of receiving inquiry*	>95%	MADEP	Work order records	Annually
2	Respond to water quality or pressure service complaints within 4 hours*	>95%	MADEP	Work order records	Annually
3	Contact affected customers prior to a water main shutdown in both planned and emergency situations*	>95%	Water Dept. regulations	Work order records	Annually

*Indicates this LOS goal is currently being met

Section 5

WRIGHT-PIERCE
Engineering a Better Environment

SECTION 5

EVALUATION AND CONDITION ASSESSMENT OF WATER SUPPLY AND TREATMENT SYSTEMS

5.1 GENERAL

This report section includes a complete review of the Water Department's present well supply capacity and its ability to meet projected demands in the next 20-year planning period. The asset management plan developed in Sections 9, 10 and 11 of this report establishes timing and priority for each recommended improvement.

The project values for recommendations are based on recent similar publicly bid construction project pricing referenced to the February 2014 Engineering News Record (ENR) construction cost index.

5.2 WELL SUPPLIES

5.2.1 Water Supply Quantity

A water system in Massachusetts is considered to have adequate long-term supply if it can meet the following system standards:

- **Condition #1** - The safe yield of the source of supply should exceed the projected average day demand in the planning period and comply with projected annual water allocation in the Water Management Act Permit (WMA).
- **Condition #2** - The pumping capacity of the supply, with the largest pumping unit out of service, should be greater than or equal to the projected maximum-day demand in the planning period while pumping the wells an average of 16-18 hours a day to allow for recovery of the well between pumping intervals.

5.2.2 Adequacy of Permitted Yield and Withdrawal Rates of the Well System

The Orleans Water Department maintains eight well supplies, each are permitted or registered through the Massachusetts Water Management Act. In aggregate, the eight wells are permitted to withdrawal and pump up to a maximum flow rate of 5.48 MGD in any given day but are limited on an annual basis to a stepped increase from the current approved annual daily rate of 1.02 MGD (372.2 MG/year) in year 2013 to a rate of 1.21 MGD (441.7 MG/year) in year 20 of the current WMA permit. These annual limits allow the water department to pump up to the maximum daily amount in any given day as long as the average withdrawal rate per day on an annual basis is not exceeded.

The projected average-day demands in the Orleans system are projected to increase to about 1.18 MGD at residential build-out as discussed in Section 3 of this report. On this basis, the water department has sufficient yield or permitted capacity in the well system to meet long-term needs in the community. Again, this is a conservative assessment since build-out will likely not occur within the next 20-year planning cycle.

5.2.3 Pumping Capacity of the Orleans Well System to Meet Summer Demands

Each well supply is also restricted to a maximum daily flow. The maximum-day condition, which occurs during summer tourist season, is the critical supply challenge for Orleans. To determine the available pumping capacity in the Orleans system, three pumping scenarios were evaluated as follows:

- **Scenario #1 –** Existing Conditions
- **Scenario #2** - Pumping Capacity of Wells with Largest Source (WTF - Well No. 4, No. 5, and No. 6) offline, Well No. 1 pumped to distribution.
- **Scenario #3** - Pumping Capacity of Wells with Largest Well (WTF - Well No. 4 and No. 5) offline, Well Nos. 1 and 6 pumped to distribution, pumps replaced in Well No. 6 and No. 7.

Scenario 1: This scenario shows the existing pumping capacity of the wells based on the 2013 well cleaning report results assuming all wells are available. Operational data, permit restrictions and historical average and maximum pumping records for the eight wells is presented in Table 5-1 below.

TABLE 5-1
SCENARIO #1 –EXISTING PUMPING CAPACITY OF WELLS

Well	Zone II Daily Maximum Pumping Rate		Current Well Pump Capacity*	Original Design Pumping Capacity of Current Well Pump	Current Yield based on 16-hour Pumping Interval**	Current Yield based on 18-hour Pumping Interval**	2013 Average Daily Pumping Volume	2013 Maximum Daily Pumping Volume
	gal/day	gpm	gpm	gpm	gal/day	gal/day	gal/day	gal/day
Well No. 1	580,000	402	434	450	417,000	469,000	216,000	437,000
Well No. 2	470,000	326	396	325	380,000	427,000	74,500	328,500
Well No. 3	720,000	500	514	500	493,000	555,000	113,500	490,700
Well No. 4	750,000	521	320	520	307,200	345,600	70,100	309,800
Well No. 5	470,000	326	310	325	298,000	335,000	132,600	279,600
Well No. 6	980,000	680	578	680	554,900	624,000	281,000	583,100
Well No. 7	1,010,000	701	589	700	566,000	636,000	13,300	593,600
Well No. 8	500,000	347	388	350	373,000	419,500	37,293	433,900
Total	5,480,000				3,389,100	3,811,100		

[1] Based on 2013 Well Cleaning Report
[2] Based on current well pump capacity

Table 5-1 also includes available capacities for each well based on the current pump capacities for each well.

For the purposes of this study, the capacity of the well supply will be based on the current pump capacity of each well pump, pumped no more than 16-18 hours per day to allow for well recovery and to prevent water quality degradation from over pumping. On this basis, the Orleans water system has a pumping capacity of between 3.39 MGD and 3.81 MGD when all 8 wells are operational.

Scenario 2: This scenario considers the existing pumping capacity of the Orleans water supply in an event where the largest source is unavailable. The Commonwealth of Massachusetts defines the maximum rating of a system to be based on the largest source (Well No. 4, No. 5, and No. 6 – 2.20 MGD through the water treatment plant) off-line for mechanical repairs. Well No. 1 can also be pumped directly to distribution so it would remain available in this scenario. On this basis, the maximum pumping capacity of the Orleans system decreases to a range of 2.22 MGD to 2.52 MGD as shown in Table 5-2. The projected maximum-day pumping requirement in the Orleans system is 3.15 MGD at residential build-out. On this basis, Orleans would be in a supply deficit under maximum day demands in the build out scenario if no further improvements were made to the water supply infrastructure.

It should be noted that loss of the entire treatment facility is unlikely unless the clearwell or major piping or conveyance system were to fail or become contaminated. A more likely scenario is that a major pump, VFD, air processing system or control system would fail reducing the plant capacity but not rendering the plant completely unavailable.

Scenario 3: The pumping capacity of the system can be increased to a range of 2.98 MGD to 3.36 MGD to meet the projected build-out scenario assuming total loss of the treatment facility with two mechanical changes to the existing well pumps as shown in Table 5-3:

TABLE 5-2
SCENARIO #2 - PUMPING CAPACITY OF WTF WELLS WITH LARGEST SOURCE (WTF WELL NO. 4, NO. 5, AND NO. 6) OFFLINE

Well	Zone II Daily Maximum Pumping Rate		Current Well Pump Capacity*	Original Design Pumping Capacity of Current Well Pump	Current Yield based on 16-hour Pumping Interval**	Current Yield based on 18-hour Pumping Interval**	2013 Average Daily Pumping Volume	2013 Maximum Daily Pumping Volume	Auxiliary Power System
	gal/day	gpm	gpm	Gpm	gal/day	gal/day	gal/day	gal/day	Type
Well No. 1	580,000	402	434***	450	417,000	469,000	216,000	437,000	None
Well No. 2	470,000	326	396	325	380,000	427,000	74,500	328,500	Generator
Well No. 3	720,000	500	514	500	493,000	555,000	113,500	490,700	Right-Angle Drive
Well No. 4	0	521	320	520	0	0	70,100	309,800	Generator
Well No. 5	0	326	310	325	0	0	132,600	279,600	Generator
Well No. 6	0	680	578	680	0	0	281,000	583,100	None
Well No. 7	1,010,000	701	589	700	566,000	636,000	13,300	593,600	Right-Angle Drive
Well No. 8	500,000	347	388	350	373,000	419,500	37,293	433,900	Generator
Total	3,280,000				2,229,000	2,506,500			

[1] Based on 2013 Well Cleaning Report
[2] Based on current well pump capacity
[3] Well No. 1 can be pumped directly to distribution

TABLE 5-3
SCENARIO #3 - PUMPING CAPACITY OF WELLS WITH LARGEST WELL (WTF WELL NO. 4 AND NO. 5) OFFLINE, WELL NO. 6 PUMPED DIRECT TO DISTRIBUTION AND PUMPS REPLACED IN WELL NO. 6 AND NO. 7

Well	Zone II Daily Maximum Pumping Rate		Current Well Pump Capacity[1]	Original Design Pumping Capacity of Current Well Pump	Current Yield based on 16-hour Pumping Interval[2]	Current Yield based on 18-hour Pumping Interval[2]	2013 Average Daily Pumping Volume	2013 Maximum Daily Pumping Volume	Auxiliary Power
	gal/day	gpm	gpm	Gpm	gal/day	gal/day	gal/day	gal/day	Type
Well No. 1	580,000	402	434[3]	450	417,000	469,000	216,000	437,000	None
Well No. 2	470,000	326	396	325	380,000	427,000	74,500	328,500	Generator
Well No. 3	720,000	500	514	500	493,000	555,000	113,500	490,700	Right-Angle Drive
Well No. 4	0	521	320	520	0	0	70,100	309,800	Generator
Well No. 5	0	326	310	325	0	0	132,600	279,600	Generator
Well No. 6	980,000	680	680[4]	680	652,000	734,000	281,000	583,100	None
Well No. 7	1,010,000	701	700[5]	700	672,000	756,000	13,300	593,600	Right-Angle Drive
Well No. 8	500,000	347	388	350	373,000	419,500	37,293	433,900	Generator
Total	4,260,000				2,987,000	3,360,500			

[1] Based on 2013 well cleaning report
[2] Based on current well pump capacity
[3] Well No. 1 can be pumped directly to distribution
[4] Assumes Well No. 6 improvements to maximize capacity and allow this well to be pumped directly to distribution
[5] Assumes Well No. 7 improvements to maximize capacity

- Replace Well Pump No. 6 and provide capacity to pump to distribution to restore pump capacity of pump to the 680 gpm flow rate allowed in the water management act permit. The current pump is worn and limited to about 578 gpm. Allowing water from Well No. 6 to be sent directly to distribution similar to Well No. 1 reduces the amount of source capacity that is impacted by a shutdown at the WTF. This would require changing the electrical service to the building and increasing the horsepower of the pump and VFD to accommodate the higher TDH on the pump. The water quality is not good in Well No. 6 but this additional design capacity could allow the system to meet the summer demands if the treatment facility is lost.

- Replace Well Pump No. 7 to restore pump capacity of pump to the 700 gpm flow rate allowed in the water management act permit. The current pump is worn and limited to about 589 gpm.

The normal capacity of the system can be further increased by completing the following improvements as well:

- Replace Well Pump No. 4 with a new pump rated at 520 gpm to match the flow limits in the water management act permit. The current pump and motor limit capacity to about 320 gpm.

These changes will replace outdated equipment and add over 400 gpm of pump capacity to the system at a minimum cost. In addition, this evaluation also reinforces the need to have Well No. 7 available routinely during summer months to meet projected maximum-day demands. Although the system, can meet the demands with this well off-line, the loss of Well No. 7 from the system or concerns about using this well because of poor water quality reduces redundancy in the system and requires more aggressive pumping of existing wells to meet the projected peak summer demands. Options to improve treatment of Well No. 7 to improve reliability and availability are discussed later in the report.

It should be noted that the water department has done an excellent job in managing maximum pumping intervals to 16-18 hours a day for all the wells. The maximum-day pumping days for each well from year 2012 pumping data is shown in Tables 5-1, 5-2 and 5-3. The water department should continue to strive to limit daily pumping to 16-18 hours a day and operate all the wells as needed to assure balanced use and wear of mechanical systems.

In summary, the Orleans water system has adequate well and pumping capacity to meet projected build-out conditions in the system if the improvements recommended above to Well No. 4, Well No. 6 and Well No. 7 are implemented and if the WMA permit remains unchanged. The data is summarized below in Table 5-4. Table 5-4 only discusses the well capacity and source of supply. Other deficiencies, such as inadequate auxiliary power which may further constrain the supply, are discussed further in this report section after Table 5-4.

TABLE 5-4
ADEQUACY OF ORLEANS WELL SUPPLY TO MEET FUTURE BUILD-OUT CONDITIONS AND SUMMER PUMPING DEMANDS

Well	Projected Maximum-Day Pumping Needs at Build-Out in Orleans (MGD)	Current Maximum-Yield based on 16-hour Pumping Interval** (MGD)	Current Maximum Yield based on 18-hour Pumping Interval** (MGD)	Adequate?
Scenario #1 – All Wells Available for Pumping	3,150,000	3,389,100	3,811,100	Yes
Scenario #2 – WTF Wells No. 4, 5, and 6 Off-line		2,229,000	2,506,500	No
Scenario #3 – WTF Wells No. 4 and No. 5 off-line and Pumps Replaced in Well No. 6 and No. 7		2,987,000	3,360,500	Yes

5.2.4 Auxiliary Power Systems And Supply Availability During Power Failures

The Orleans well stations are designed to meet projected peak summer pumping days with adequate back-up power systems. There are however, reliability issues with several of the back-up power systems. In addition, to meet the projected demands and to have reliable sources of supply, all well sources must have reliable back-up power systems as described in Scenario#1 above to meet demands over a 16-hour pumping period.

All the pumping stations are equipped with propane-fired generators except the following locations:

- Well No. 3, and 7 – The well pumps at these facilities are equipped with a right-angle drive units and propane-fired engines.

- Well No. 1 and 6 – These sources have no generator. During power failures, remote surveillance and control of Wells No. 1, 2, 3, 8, 6 and FAC-1 by the SCADA system are lost as well (Wells 2, 3, 8 and FAC-1 have back-up power systems but no remote SCADA surveillance during a power failure). Options for a new generator to power Well No. 1, possibly incorporating Facility No. 1, are discussed below. Manual operation of well supplies may not be reliable if a major hurricane or power failure were to occur in town.

Right-angle drive units are robust, reliable auxiliary power systems that allow for a well pump to be engaged and powered by engaging a coupled engine drive unit manually with a clutch. They provide one advantage over a pad-mounted generator in that they can drive a well pump and produce water even if the electric motor is no longer functional. In the case of a power failure, an operator needs to be available to physically go to a site to engage a manual clutch before service can be restored, unlike a generator which is equipped with an automatic transfer switch. Generator starts and stops can be observed remotely through a SCADA system without direct operator attention, although often in emergency mode operators visit the site to observe operations. During the critical summer pumping period, automatic transfer of power can improve reliability and reduce risk of human error. Although the possibility of a massive power failure or destruction of the electrical distribution system in the outer Cape is remote, it would not be unprecedented. Changing weather patterns, ice storms and hurricanes have caused widespread power outages in New England in the past. Planning for such an event is prudent and should be considered. Options for improved reliability in emergency mode are discussed below.

5.2.4.1 Auxiliary Power Alternatives for Well No. 1

As discussed, loss of power at Well No. 1 creates a logistic problem for the water department and loss of remote surveillance of the SCADA system for Wells No. 1, 2, 3 and 8. Two alternatives have been investigated to improve this situation:

- **Option 1 –** Reconfigure the Primary Electrical Power Feeds to Facility No. 1 and Well No. 1 and provide a single common generator to power both facilities in emergency mode.
- **Option 2 –** Provide a smaller generator just for Well No. 1 and Retain Existing Portable Generator System for Facility No. 1

Cost estimates for each of these two options are presented in Table 5-5 below.

TABLE 5-5
OPTIONS TO PROVIDE EMERGENCY POWER AT WELL NO. 1 AND FACILITY NO. 1

Option	Advantages	Estimated Cost*
Option 1 – Provide Single Common generator to power both Facility No. 1 and Well No. 1 in Emergency Mode.	• Elimination of Manual Generator at Facility No. 1 • Provides Automatic Power Transfer to Entire Well Field for SCADA system • Reduces Complexity • Eliminates need for manual attention during emergency	$375,000
Option 2 – Provide a smaller generator just for Well No. 1 and Retain Existing Portable Generator System for Facility No. 1	• Corrects Primary Problem of Loss of SCADA System • Less Costly	$175,000

*Costs include a 20% contingency and allocation for design engineering support

5.2.4.2 Auxiliary Power Alternatives for Well No. 3

The power distribution system at Wells No. 2, 3 and 8, makes a single common generator a cost effective alternative for adding auxiliary power to Well No. 3. The present propane fired generator at Well No. 2 powers both Well No. 2 and Well No. 8. This equipment is not large enough to add Well No. 3 electrical loads to the system. A separate smaller generator at Well No.

3 would require configuring the primary electrical feed, metering and the transformer to create a common location for transfer of power from the electrical system to a generator.

The estimated cost to increase the size of the generator to accommodate the additional electrical loads from Well No. 3 is $250,000 assuming a new automatic transfer switch, larger generator set and a new power feed between the generator and Well No. 3. The existing concrete pad should be sized adequately to accommodate a new gen-set at the site.

5.2.4.3 Auxiliary Power Alternatives for No. 6

Well No. 6 is too remote from the water treatment facility to provide auxiliary power from the treatment facility generator, similar to how Well No. 4 and 5 are powered in stand-by mode. Harmonics and the control of voltage losses will make this approach too costly.

A pad-mounted generator could improve reliability at this site. Several options exist to provide auxiliary power at Well No. 6:

- **Option 1 –** Retain present 30 hp low pressure well supply, replace well pump and relocate pad-mounted generator from Well No. 2
- **Option 2 –** Reconfigure the well to pump either to treatment or distribution system. Replace pump, motor and VFD to accommodate higher pressure (60 Hp estimated load). Provide new pad-mounted propane-fired generator in sound-proof enclosure.

Options for auxiliary power at Well No. 6 are shown in Table 5-6. Although Option No. 2 is more costly, redundancy in the system is improved by providing the capability to pump directly to the distribution system in emergencies. The costs do not include any provisions for changes to the power lines into the site, just a larger electrical service for the higher horsepower into the pumping station building.

TABLE 5-6
OPTIONS TO PROVIDE EMERGENCY POWER AT WELL NO. 6

Option	Advantages	Estimated Cost*
Option 1 – Retain present 30 hp low pressure well supply, replace well pump and relocate pad-mounted generator from Well No. 2 to the site. Construct new concrete pad.	• Minimal disruption to operations • Reuses existing equipment • Lowest cost	$70,000
Option 2 – Reconfigure the well to pump either to treatment or distribution system. Replace pump, motor, and VFD to accommodate 60 hp load. Provide new pad-mounted propane-fired generator in sound proof enclosure	• Improves emergency redundancy • Reduces manual operations at remote site	$225,000

*Costs include a 20% contingency and allocation for design engineering support

5.2.4.4 Auxiliary Power Alternatives for Well No.7

Well No. 7 currently has a 75 hp well pump motor and a right-angle drive unit. If water from this well was pumped exclusively to the WTF, this motor would decrease in size to 20 hp because of the much lower operating pressure.

However, the water department has requested the flexibility at this site to pump either to treatment in the future or directly to the distribution system similar to current operations, a generator system should be sized for this higher pressure. We recommend the installation of a new, appropriately sized propane fired generator onsite as part of the pumping improvements discussed below.

5.2.5 Summary of Mechanical and Electrical Improvements to Well Supplies and Pumping Stations

A basic condition assessment of each well was made in addition to the aforementioned to replace outdated equipment and improve reliability. In addition to the auxiliary power improvements discussed above, the following observations and incidental improvements are recommended in Table 5-7.

It is likely that the recommended work in each well field (Well No. 1, 2 and 3 and Well No. 4, 5 and 6) will be grouped into projects to minimize mobilization costs for construction economy. The well pumps at these sources may have been improperly sized when the operation conditions were changed when the treatment facility was constructed. New well pumps will correct this design condition as well as modernizing the new pumps.

The consequence of failure of any of these systems reduces the reliability of the water system and may prevent delivery of water during the critical summer demand period if a hurricane or other major emergency were to occur

TABLE 5-7
RECOMMENDED IMPROVEMENTS TO WELLS AND PUMPING STATIONS

Well and Pumping Station	Assessment and Needs	Estimated Cost for Improvements
Well No. 1	• Add emergency power system – option 1 above	$375,000
Well No. 2	• Remove remaining RAD appurtenances • Add new mag-meter and reconfigure lower level piping • Reconfigure Generator at Well No. 2 to add Well No 3	$20,000
Well No. 3	• Replace and straighten lower level piping and add new mag-meter • Remove drive unit and associated equipment • Replace MCC • Add common generator with Well No. 2	$250,000
Well No. 4	• Replace well pump • Remove decoupled engine drive units and associated Equipment	$55,000
Well No. 5	• Remove decoupled engine drive units and associated Equipment	$10,000
Well No. 6	• Replace well pump with larger pump capable of pumping to distribution • Add generator • Replace ceiling and roof insulation	$225,000
Well No. 7	• Add generator • See discussion below about treatment options*	(Shown elsewhere)
Well No. 8	• No improvements needed	
Improvements at Well No. 1 through No. 6 Total		**$935,000**

5.3 WATER TREATMENT FACILITY

5.3.1 Treatment Plant Capacity to Meet Future Needs

The Orleans water treatment facility presently treats water from Well No.1, No. 4, No. 5 and No. 6. (Well No. 1 can be pumped directly to distribution but is normally fed to the distribution system through the WTF). The combined capacity of these wells when pumped at the maximum-daily rate prescribed in the Orleans water management act permit is about 2,000 gallons per minutes (gpm) or about 2.83 MGD. The plant is designed and rated for a maximum instantaneous treatment rate of 4.5 MGD when all three membrane rack assemblies are operational. The plant would retain an operating capacity of 3.0 MGD if one membrane rack was off-line for membrane replacement.

Massachusetts DEP regulations require that the rating of a treatment facility be based on loss of the largest mechanical unit for any operational system such as a source of supply, membrane rack assembly, finished water pump, etc. For the Orleans WTF, loss of the largest well (Well No. 6 – 680 gpm), would result in an output of about 1.9 MGD. This treatment output could allow incorporation of an additional flow rate of 1.01 MGD from Well No. 7 for iron and manganese removal (See discussion in Section 5.4 of this section) without overloading the facility as designed. This data is summarized below in Tables 5-8.

TABLE 5-8
CAPACITY EVALUATION OF THE
ORLEANS WATER TREATMENT FACILITY

Project Component	Non-Operational Redundancy	Largest Membrane Rack off-line
Design Hydraulic Capacity of WTF	**4.5 MGD**	**3.0 MGD**
Raw Water Supply Capacity (Well No. 1,4,5 and 6)	2.9 MGD	2.9 MGD
Treatment Surplus (Deficit)	1.6 MGD	0.1 MGD
Adequate	Yes	Marginal

TABLE 5-8 (continued)

Project Component	Non-Operational Redundancy	Largest Membrane Rack off-line
Design Hydraulic Capacity of WTF	**4.5 MGD**	**3.0 MGD**
Raw Water Supply Capacity (Well No. 6 off-line)	1.86 MGD	1.86 MGD
Treatment Surplus (Deficit)	2.64 MGD	2.14 MGD
Adequate	Yes	Yes
Raw Water Supply Capacity (Add Well No. 7 to other 4 wells))	3.9 MGD	3.9 MGD
Treatment Surplus (Deficit)	0.6 MGD	(0.9 MGD)
Adequate	Yes	No
Raw Water Supply Capacity (Add Well No. 7 to other 4 wells, the largest well is off line for repairs)	2.89 MGD	2.89 MGD
Treatment Surplus (Deficit)	1.61 MGD	0.11 MGD
Adequate	Yes	Marginal

It is also conceivable that the entire treatment facility could be lost from a major conflagration in the control room. Membrane plants are difficult to operate without integrated automated controls. Given that loss of the entire facility is very remote, it is likely that a temporary system would be installed and unfiltered water directly from the raw water intake to the clearwell for disinfection prior to distribution. This emergency scenario may require issuance of a boil water order but would allow for supply delivery in this instance. Fires are very unusual in water treatment facilities which are equipped with fire alarm systems and are generally constructed of non-flammable materials.

5.3.2 Mechanical and Electrical Improvements to Improve Reliability and Performance

Several specific process/electrical and building code compliance issues were identified in the treatment facility that should be address over the next 20 year planning period:

- **Replace Raw and Finished Water VFDs** – The 18-pulse Robicon VFDs are old technology and a risk for maintaining consistent, reliable operations at the treatment facility. The work plan would include a harmonic study during the design phase to see if harmonic filters or line reactors are needed. VFD technology continues to improve. It is recommended that the two 100 hp raw water pump VFDs and the two 125 hp finished water VFDs be replaced. The estimated cost for these improvements is estimated to be $300,000. This budget assumes that a harmonic filter and line reactor will be needed for each new VFD.

- **Containment in Chemical Storage Area –** As discussed, the chemical storage area in the treatment facility is open to the main plant operating area and does not meet current building codes. The corrosive environment is leading to crazing and corrosion in electrical equipment housed in the main treatment room. The recommended improvements to this area of the facility include:
    - Installation of a containment wall and doors to isolate the chemical storage area from the main treatment area
    - Installation of a limited area sprinkler system
    - Updating the HVAC system to provide code compliant air exchange in the area

  The estimated cost for these improvements is $250,000.

- **Roof Replacement –** The current membrane roof system is 7 years old. A maximum useful life of about 20 years can be expected from a ballasted membrane roof system on this type of building. The estimated cost to replace the roof is $150,000. The condition of the roof should be inspected in year 2016 and budgeted for replacement in year 2026.
- **Residuals Handling System Study–** A budget allocation of $75,000 is recommended to conduct a study of alternatives for disposal and dewatering of waste residuals from the water treatment facility. The existing system is not performing well and improvements to the current system may be impacted by the proposed SWMI regulations. It is recommended that a basic alternatives study be conducted to developed cost and alternatives to enhance this existing system. Costs associated with capital recommendations from this study will need to be integrated into the financial implementation plan moving forward.

5.3.3 Membrane Replacement

The membranes racks were replaced in three sequential years beginning in year 2010. The original cost for the membrane replacement projects were:

- Membrane Rack Assembly #1 (Year 2009) $285,000
- Membrane Rack Assembly #2 (Year 2010) $242,000
- Membrane Rack Assembly #3 (Year 2011) $256,000

The variable costs reflect one-time charges for initial vendor design drawing approvals and changes from the initial 68-module ultrafiltration membranes to the 50-module microfiltration membranes. For the purposes of projecting appropriate reserve account for replacing these systems an average replacement cost of $270,000 will be assumed for each of the three rack assemblies.

At the time, the membrane vendor provided one hundred and twenty month (10 years) warranty commencing from the date of start-up. The warranty included a straight line depreciation provision at a rate of 1/120 per month, effectively creating no salvage value for the equipment after 10 years. For the purposes of projecting the next replacement cycle costs, a 10-year useful life from the date of installation of the current rack assemblies assuming an annual inflation rate of 3%. On this basis, we project a replacement cost for the membranes as follows:

	Projected Replacement Year	Projected Future Cost
• Membrane Rack Assembly #1	2019	$362,000
• Membrane Rack Assembly #2	2020	$362,000
• Membrane Rack Assembly #3	2021	$362,000

Since the funding of the first rack of membranes is scheduled for 2019 the normal 10 year period is compressed and the annual allocations to fund the replacements start in FY 2016 and increase as follows:

	Projected Replacement Year	Projected Capital Reserve Payment Allocation
• Membrane Rack Assembly #1	2019	$70,000
• Membrane Rack Assembly #2	2020	$58,000
• Membrane Rack Assembly #3	2021	$49,000

The second set of membranes scheduled for replacement in the planning cycle starts in 2029. Estimated costs for each membrane rack assembly is $434,000. In a capital reserve fund the annual allocations to fund the replacements start in FY 2020 as follows:

	Projected Replacement Year	Projected Capital Reserve Payment Allocation
• Membrane Rack Assembly #1	2029	$40,000
• Membrane Rack Assembly #2	2030	$40,000
• Membrane Rack Assembly #3	2031	$40,000

5.3.4 Ongoing Projects at Treatment Facility

The water department is proceeding with updating the HMI and PLC software and controls in the water treatment facility in 2014. In addition, the water department has purchased a cloud-based software program to manage work orders and to integrate billing, SCADA and database functions. This work is ongoing and is expected to be complete by the end of 2014.

5.3.5 Options to Improve Water Quality at Well No. 7

Well No. 7 is the largest supply in the Orleans system, permitted for a maximum-day withdrawal of 1.01 MGD (~700 gpm). Because the well is high in iron and manganese, the water department uses the well sparingly and only during summer months. Improving the reliability quality of water and availability of Well No. 7 will improve reliability of the water supply in Orleans immensely.

To improve reliability and availability of Well No. 7, two options were explored to improve water quality:

- <u>Option 1</u> – Pump the Well to the Water Treatment Facility for Treatment to Remove Iron and Manganese
- <u>Option 2</u> – Construct a Pressure Filtration Facility at Well No. 7 and Treat the Supply

A third option of constructing membrane filtration plant was also considered but eliminated from detailed evaluation because of the high capital cost.

5.3.5.1 Construct Raw Water Transmission Main to WTF

A new 12-inch raw water transmission main extended down Quanset Road from Well No. 7, than northerly via South Orleans Road (State Route 28) would be needed to convey flows to the water treatment facility. The treatment facility has a hydraulic capacity of 4.5 MGD when all membranes racks are operational. The plant has a capacity of 3.0 MGD when a rack assembly is off-line. The plant would have hydraulic capacity to incorporate the flow into the treatment process to meet peak summer-day demands.

A conceptual routing for the pipeline is shown in Figure 5-1. Options for routing this pipe along Route 28 are as follows:

- <u>Option A</u> – Pipeline follows State Route 28 corridor
- <u>Option B</u> – Pipeline follows a combination State Route 28 corridor and cross-country across Town-owned land
- <u>Option C</u> – Cross-country route across Water Department land

The conceptual pipe route would initially follow Quanset Road to the intersection of State Route 28, a busy intersection and primary road corridor in the Orleans area. The pipeline could be directionally bored below the roadway and follow State Route 28 a short distance northerly until it approaches two large land parcels owned by the Town which abut State Route 28 (Tax map parcels 54-1 and 68-7). The pipeline could travel cross-country from this location and connect to yard piping near the treatment facility and Well No. 5. The exact pipeline route would require further study to determine conservation land-use restrictions. If land-use restrictions or deed convents prevent this type of use, the most costly alternative of extending the pipeline further north to the WTF access road is possible.

A cost estimate for the transmission main is shown in Table 5-9 below. The cost estimate in Table 5-9 is based on routing Option C as described in Figure 5-1. At this juncture, further research is needed to select the best route but this cost allocation will bracket any of the three alternative routes under consideration. The pipeline would have no service connections or hydrants, so use of high density polyethylene pipe (HDPE) may be attractive for this application.

TABLE 5-9
ESTIMATED PROJECT COST FOR A RAW WATER TRANSMISSION MAIN FROM WELL NO. 7 TO THE ORLEANS WATER TREATMENT FACILITY

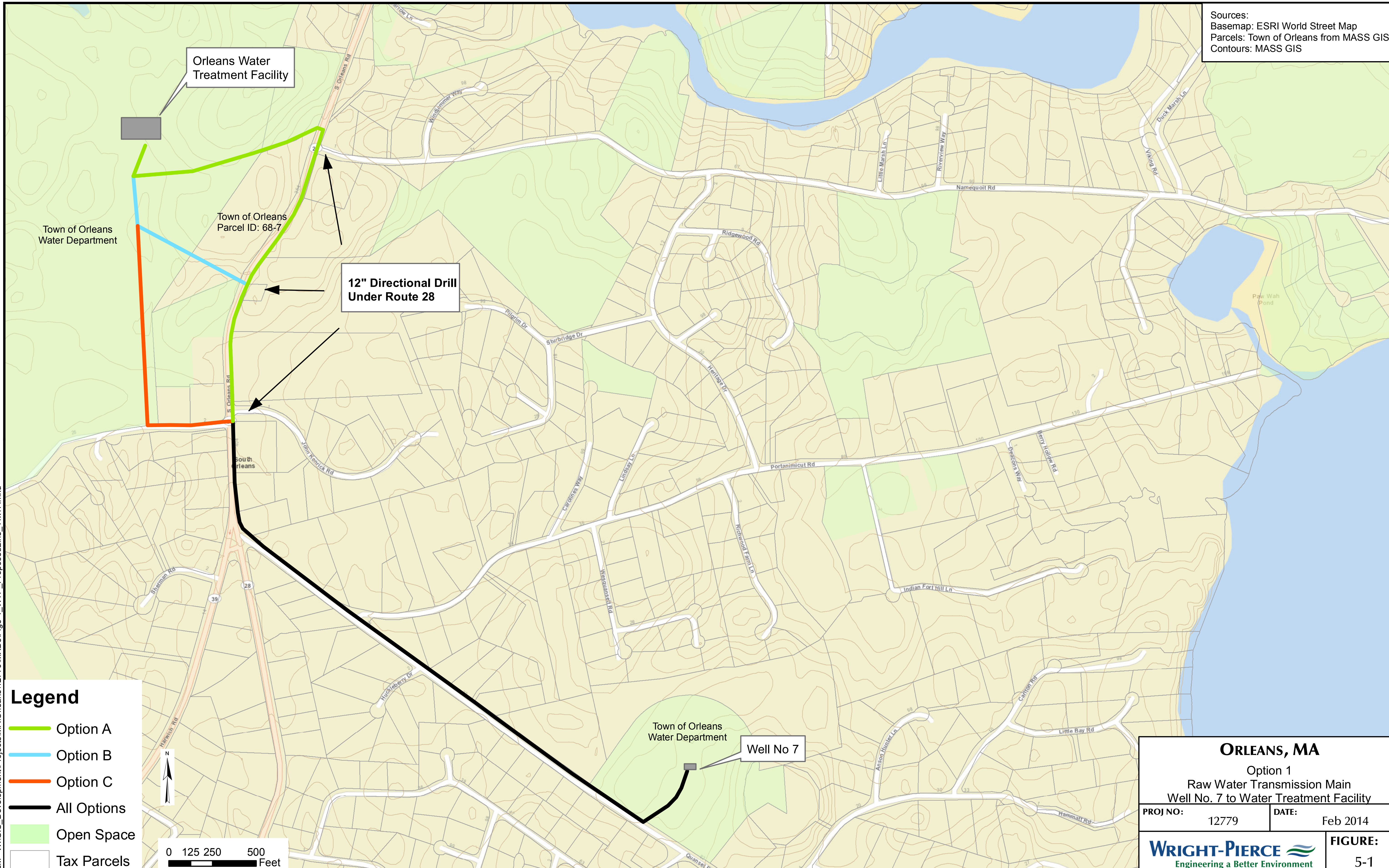
Project Component	Estimated Pipeline Length (feet)	Unit Cost ($/foot)	Estimated Cost
12-inch Transmission Main on Quonset Road	3,500	$150	$525,000
New Propane-Fired Generator and ATS	LS	LS	$150,000
Directionally Drilled 12-inch Main below Route 28	500	$100	$50,000
12-inch Transmission Main on Route 28	2,000	$175	$350,000
12-inch Cross Country Main to WTF*	1,500	$125	$188,000
Miscellaneous Improvements to SCADA and Process Equipment at Well No. 7	LS	LS	$200,000
		Estimated Construction Cost	**$1,463,000**
		15% Construction Contingency	$210,000
		20% Allocation for Design, Bidding and Construction Services	$280,000
		Total Estimated Project Cost	**$1,953,000**

*Assumes layout per option C in Figure 5-1

It may be desirable to equip Well No. 7's well pump with a larger capacity pump to allow the source to be pumped into the distribution system or to the treatment facility by adjusting the speed of a VFD (Similar to how Well No. 1 is configured) as previously described. The proposed cost estimate also includes a new propane-fired generator for permanent auxiliary power at the well site. Natural gas is also available in the street.

5.3.5.2 Provide Treatment at Well No. 7

Removal of metals from Well No. 7 would require use of a pressure filtration system using an oxide coated media. These basic treatment facilities are widely used in New England. Oxide-coated media are silica based sands which are coated with manganese dioxide. Manufacturers sell the media separately or provide oxide –coated media within pressure vessels as packaged systems. Greensand Plus™ and Pureflow™ are two commercially available media products which are packaged into complete filter systems.



ORLEANS, MA

Option 1
Raw Water Transmission Main
Well No. 7 to Water Treatment Facility

PROJ NO: 12779	DATE: Feb 2014
WRIGHT-PIERCE Engineering a Better Environment	FIGURE: 5-1

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Oxide-coated media is ideal for water supplies where the water has relatively moderate or low concentrations of iron, arsenic and/or manganese, which is not organically bound. These systems operate at high pressures and higher loading rates than manganese greensand, which is no longer commercially available but was the most common treatment technique used in New England to remove these metals.

The high-rate, oxide-coated media acts as a catalyst in the oxidation - reduction reaction of iron and manganese. A pre-oxidation step utilizes chlorination system to oxidize iron into a precipitate form (referred to as catalytic oxidation). The manganese oxidizes and is removed by direct contact with the treated media. Normally, pH adjustment is required to accelerate the reaction rate of iron before filtration. The media is housed in ASME rated pressure filters with support gravel and distribution systems which are designed to evenly distribute flow through the filter.

Filters are backwashed with either treated water from the distribution system or by pumping from a clearwell or treated water tank. Normally, three filter vessels are provided. During a backwashing event one filter is taken off-line while the remaining two filters continue to produce treated water. The other two filters will are sized to meet the design flow (N-1 condition). Typical loading rates are approximately 5.0 gpm/ft^2 of filter area when all three filters are operating. During backwashing, a loading rate of 7.5 gpm/ft^2 is typical. Pilot testing in other similar applications in New England have been successful at loading rates up to 8.0 gpm/ft^2.

The entire system is controlled by a programmable logic controller (PLC) located in a central control panel. The entire filter system is furnished as a package, complete with controls, flow meters and pressure sensors. A backwash can be initiated by a measured pressure drop across the filters, gallons of water filtered, or by pushbutton override. Control, valves can be equipped with electric motor, hydraulic or pneumatic operators.

Additional components of a pressure filter plant would include the following:

- **Finish Water Pumps** - Two finish water pumps installed in a small clearwell size to meet 4-log viral inactivation. One shall be for normal on-line operations and one for back-up or off-line maintenance, each sized for the recommended flow at the site. These will be controlled with variable frequency drive's (VFD's).

- **Sodium Hypochlorite Feed System (Pretreatment and Disinfection)** - A sodium hypochlorite feed system will be used as the pre-treatment oxidant and to provide the required chlorine residual in the finish water. The final design will be based on utilizing a 12.5% solution of sodium hypochlorite. Because the well is primarily high in manganese, a stronger oxidant or regenerant such as potassium permanganate is not likely needed.
- **Potassium Hydroxide (KOH) Feed System -** A chemical room will be included for a KOH feed system to adjust finish water pH and to adjust the pre-feed pH if required. The final design will be based on using a 45% potassium hydroxide system.
- **Backwash Pumps** - Two filter backwash pumps will draw water from the clear well to backwash the filters. Greensand Plus also uses a compressed air backwash in addition to a water backwash. A backwash can be triggered by either a pressure drop across the filters, gallons of water filtered, a pre-set filter run time, or by push button. The backwash pumps will be located above the clearwell in the south east section of the building.
- **Recycle Pumps –** Two decant pumps will draw water from either tank's floating suction strainer. These pumps will recycle the supernatant from the decant tanks to the head of the filtration system, upstream of the chlorine injection point. A modulated valve and flow meter will be provided to control recycle water flow so it does not exceed 10% of the raw water flow.
- **Sludge Pumps -** Each decant tank will have a sludge handling pump. The pumps will be horizontal, centrifugal solids handling pumps capable of passing a 1¼-inch solid. The pump will discharge the sludge to an exterior holding tank.

Although not specifically required, the clearwell would also be used as an atmospheric tank to provide backwash water. Initially, the facility would be designed for two chemicals; (1) potassium hydroxide for pH adjustment and (2) sodium hypochlorite for disinfection.

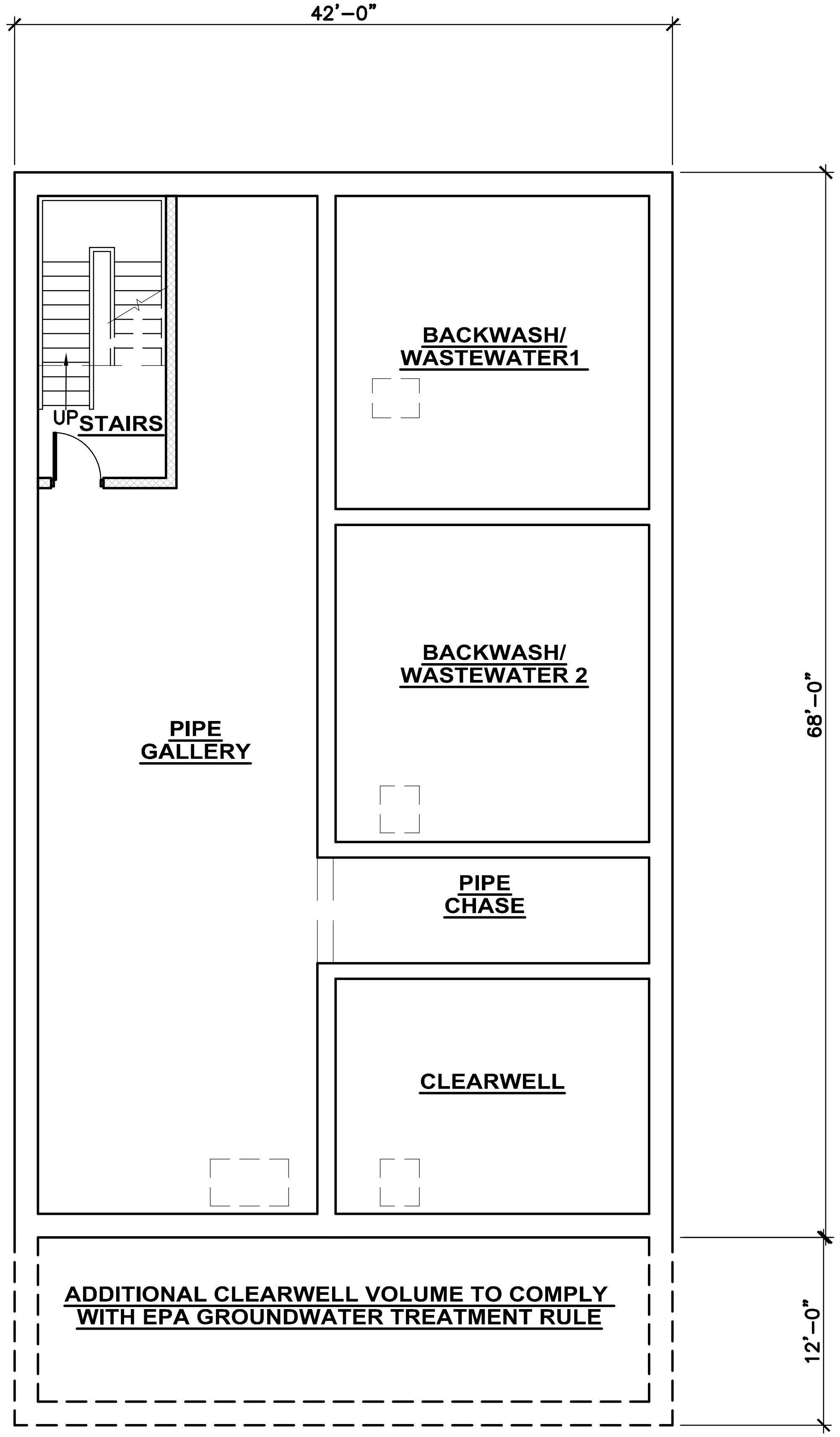
A conceptual floor plan, building sections and process flow schematic for a 1.0 MGD pressure filtration facility are presented in Figures 5-2, 5-3 and 5-4. An estimated project development cost for a facility within the 40 acres land parcel owned by the Town at Well No. 7 is presented in Table 5-10 below.

TABLE 5-10
PROBABLE PROJECT CAPITAL COSTS FOR TREATMENT OF WELL NO. 7

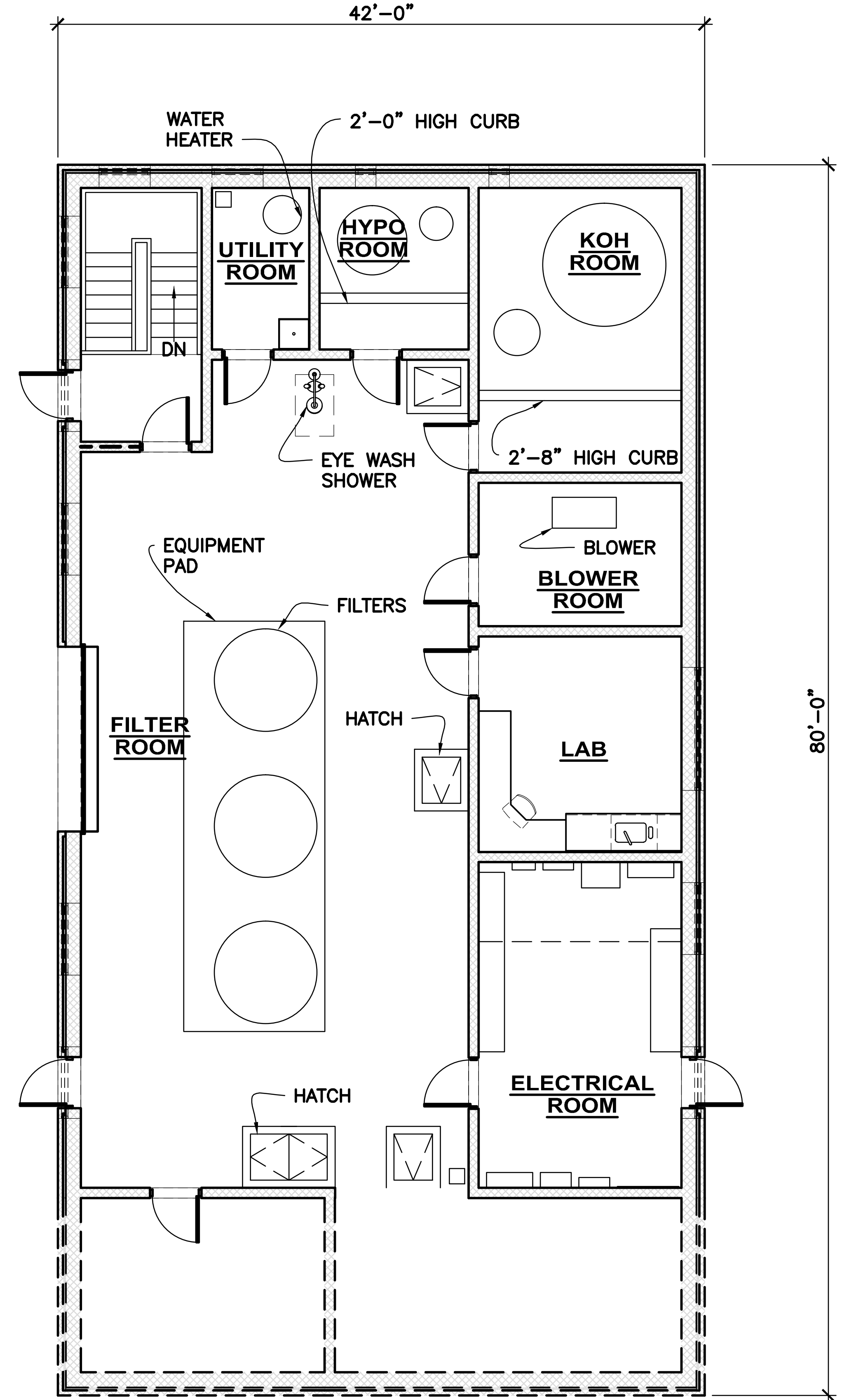
Project Component	Probable Project Development Costs
Construction Costs	
▪ General Conditions (10% of Construction)	$300,000
▪ Site Work, Exterior Piping, Restoration	$120,000
▪ New Masonry Filtration Building including HVAC, lavatory, interior rooms, electrical, plumbing and other building systems	$2,680,000
▪ Pressure Filters with oxide-coated media	$580,000
▪ New LP Gas Auxiliary Generator	$150,000
▪ Interior Piping, FW Pumps, and Control valves	$96,000
▪ Backwash and sludge handling pumps, exterior holding tank and equipment	$120,000
▪ SCADA and Telemetry	$40,000
▪ Chemical Feed Systems and Controls	$60,000
Subtotal Construction	**$3,246,000**
Construction Contingency (15%)	$487,000
Subtotal Construction	**$3,733,000**
Professional Services for Permitting and Design, Bidding, Construction Administration (20% of Construction Cost)	$746,000
Estimated Total Project Capital Cost	**$4,480,000**

5.3.5.3 Recommendations for Well No. 7

Based on the cost and complexity of adding treatment at Well No. 7, it is recommended that the OWD pursue interconnecting the supply to the Orleans WTF as described under Option 1 in Section 5.3.3 while retaining the flexibility to pump water directly to the distribution system. The recommended budget allocation for this improvement is $1,953,000.



LOWER LEVEL PLAN
SCALE: NTS

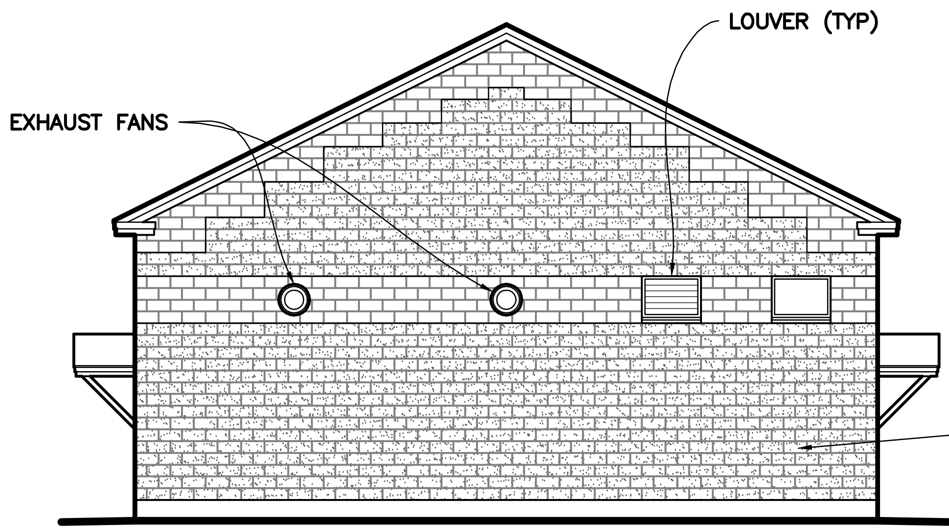


UPPER LEVEL PLAN
SCALE: NTS

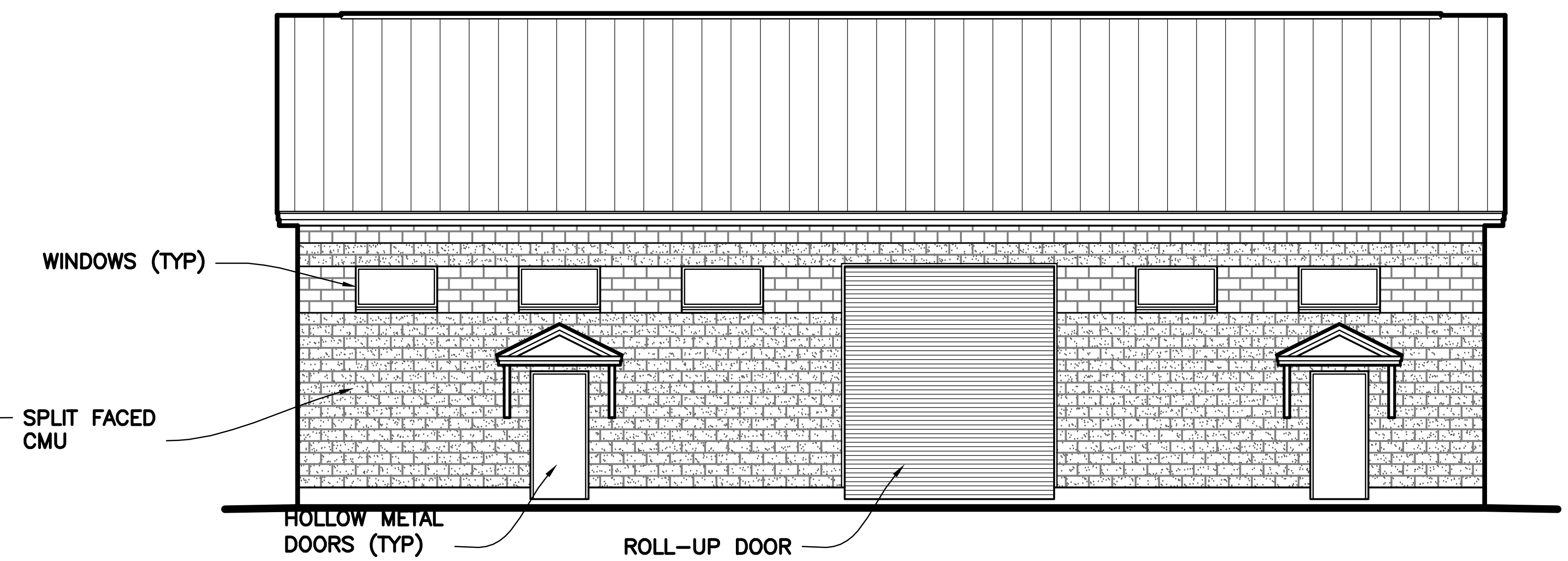
ORLEANS, MA

CONCEPTUAL FLOOR PLAN

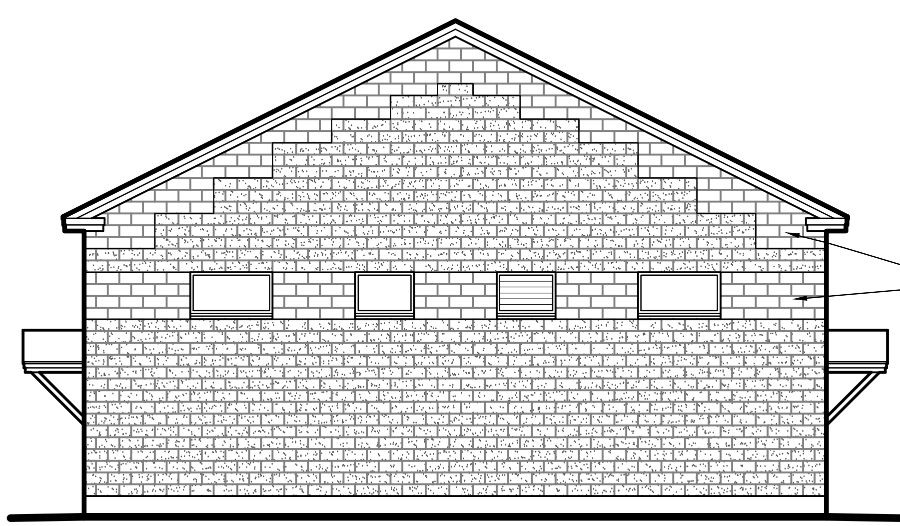
PROJ NO: 12779	DATE: AUGUST 2013	FIGURE:
WRIGHT-PIERCE Engineering a Better Environment		5-2



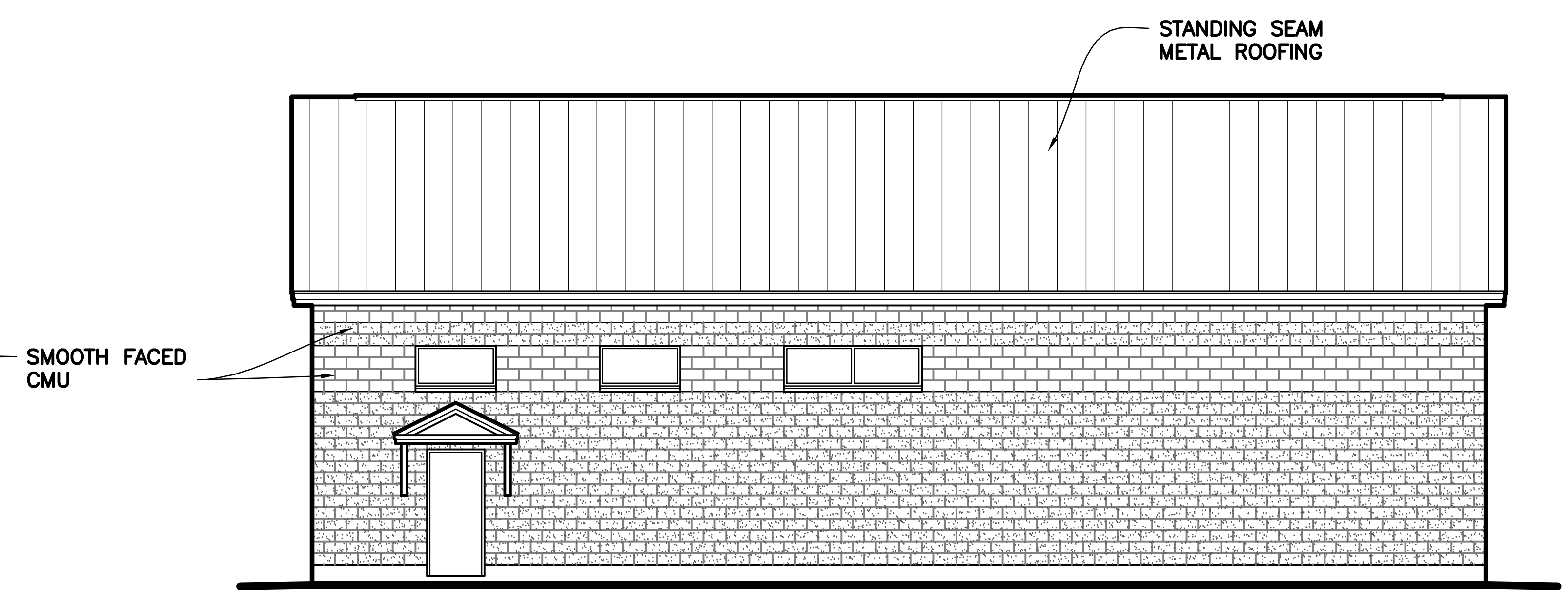
NORTH ELEVATION
SCALE: NTS



WEST ELEVATION
SCALE: 3/16"=NTS

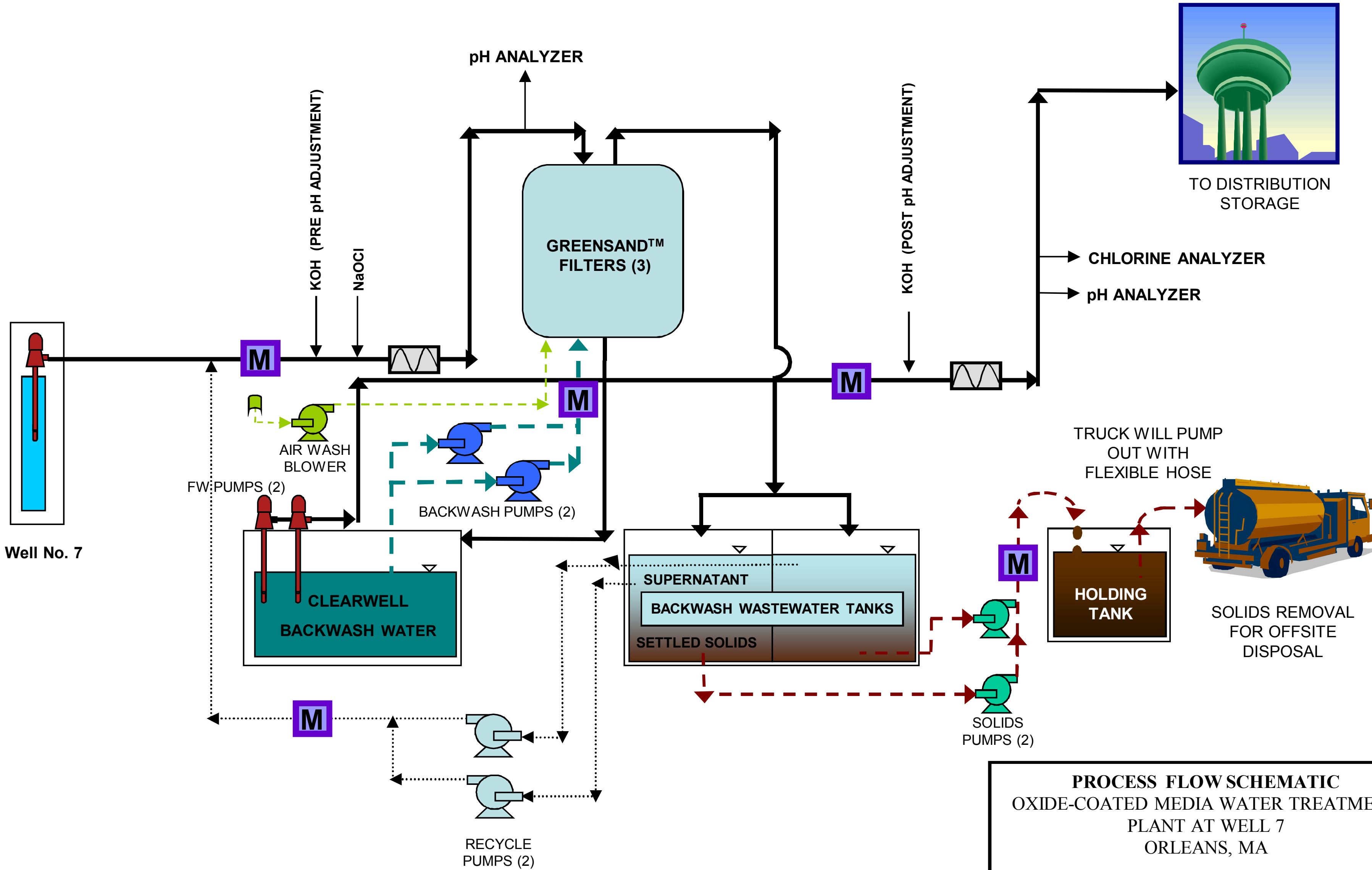


SOUTH ELEVATION
SCALE: NTS



EAST ELEVATION
SCALE: NTS

ORLEANS, MA CONCEPT ARCHITECTURAL BUILDING PLAN		
PROJ NO: 12779	DATE: AUG 2013	FIGURE:
WRIGHT-PIERCE Engineering a Better Environment		5-3



Chemicals Added
KOH: Potassium Hydroxide
NaOCl: Sodium Hypochlorite

Static Mixer
M Flow Meter

PROCESS FLOW SCHEMATIC
OXIDE-COATED MEDIA WATER TREATMENT
PLANT AT WELL 7
ORLEANS, MA

PROJ NO: 12779	DATE: Feb 2014	FIGURE:
WRIGHT-PIERCE Engineering a Better Environment		5-4

5.4 IMPACTS FROM INTERCONNECTION TO EASTHAM

A conceptual interconnection to the Town of Eastham to the north would create an additional average daily demand of 0.5 MGD, seasonal demand of 0.85 and maximum daily demand of 1.25 MGD. It is understood that the Town of Eastham would enter into an intermunicipal agreement to purchase the water at a metering facility to be constructed near the US Route 6 circle where the two communities intersect. Impacts to the well supply are discussed in this. Storage and distribution impacts from this additional demand are discussed in Section 6 of this report.

5.4.1 Orleans Permitted Yield

The Town of Orleans current permitted yield from the eight well supplies in Orleans is 1.21 MGD in year 20 of the current water management act permit. The projected average-day demand at build is projected to increase to 1.18 MGD, just sufficient to meet the needs of the customers in Orleans.

The permit does contain a reopener clause which would increase the water allocation by 0.5 MGD to meet the projected needs within the south side of Eastham. From a permitted yield or supply capacity perspective, the Town will have granted sufficient withdrawal capacity to serve Eastham up to an average-daily flow of 0.5 MGD (350 gallons per minutes).

5.4.2 Well Supply and Pumping Analysis

The critical challenge in the Orleans water system is meeting the peak summer demands. The current capacity evaluation with an additional demand of 1.25 MGD is presented in Table 5-11

TABLE 5-11
ADEQUACY OF ORLEANS WELL SUPPLY TO MEET FUTURE BUILD-OUT CONDITIONS AND SUMMER PUMPING DEMANDS WITH EASTHAM CONNECTIONS

Well	Projected Maximum-Day Pumping Needs at Build-Out in Orleans (gal/day)	Contract Maximum-Day Pumping Allocation to Eastham (gal/day)	Current Maximum-Yield based on 16-hour Pumping Interval (gal/day)	Current Maximum Yield based on 18-hour Pumping Interval (gal/day)	Surplus?
Scenario #1 – All Wells Available for Pumping	3,150,000	1,250,000	3,389,100	3,811,100	No
Scenario #2 – WTF Wells No. 4, 5, and 6 Off-line			2,229,000	2,506,500	No
Scenario #3 – WTF Wells No. 4 and No. 5 off-line and Pumps Replaced in Well No. 6 and No. 7			2,987,000	3,360,500	No

The demand scenarios shown in Table 5-11 suggest that the Town of Orleans would be placed in a pumping and supply deficit situation during the critical summer tourist season if an interconnection was made to Eastham.

Section 6

SECTION 6

DISTRIBUTION SYSTEM EVALUATION

6.1 PURPOSE/SCOPE OF SYSTEM ANALYSIS

The purpose of the system analysis is to assess the adequacy of the Orleans Water Department's storage facilities, transmission mains, and distribution piping to meet various demand conditions and to establish priority needs in the system using a comprehensive asset management approach. The scope of the evaluation focused on the following general areas:

- *Distribution System Hydraulic*
    1. Maximum and minimum system pressures.
    2. Adequate fire flows.
    3. Reliable pipe looping, pipe velocities and pipe sizing.
    4. Interconnections to adjacent utilities.

- *Storage Analysis*
    1. Proper design and location of storage facilities.
    2. Adequate storage volume in each service area.
    3. Storage redundancy.
    4. Adequate emergency, fire storage and peak-hour storage volumes.

- *Distribution System Water Quality*
    1. Adequate turnover of storage volume in reservoirs and standpipes.
    2. Distribution water quality.

- *Distribution System Maintenance*

Development of a computer model of the water system will be the central element to the analysis of the above parameters currently and into the future.

6.2 DISTRIBUTION SYSTEM COMPUTER MODEL

6.2.1 Overview

A computer hydraulic simulation model of the Orleans Water Department (OWD) water distribution system was developed for this project to evaluate the adequacy of the distribution system under existing and future water demand conditions. The OWDs existing WaterGEMS hydraulic model was selected for use as the software modeling tool.

The characteristics of the water system such as pipe sizes (diameter, length, C-value, and ground elevation at pipe intersections), hydraulic grade line elevations, pump operation characteristics, and total system demand are the primary inputs to the model. The model generates pressures, hydraulic grade line elevations and available flows at pipe junctions and flows, pipe velocities and head losses within each pipe.

The storage facilities and distribution mains were analyzed for their capacity to meet stressed demand conditions through the year 2033 (The planning period for this report). The build-out demands were used for all analyses, which is slightly more conservative than the projected demands in year 2033. This was done by simulating the following three demand conditions, using the computer model of the network for the piping and by performing extended time simulations for the supply and storage facilities:

- Peak hour on maximum day in the year 2033.
- Maximum day in the year 2033 plus various fire flow requirements.
- Night-time refill of the storage facilities on maximum day in the year 2033.

Under peak hour conditions, a water system is considered adequate if a minimum pressure of 30-35 psi is provided to the entire service area. Under the maximum-day plus fire flow requirement conditions, the system must be capable of providing the needed fire flow to the locations being evaluated (ISO locations, system high points and system extremities) with a residual pressure of 20 psi coincidental with maximum day system demand throughout the distribution system. Flow circulation, pipe sizes, pipe velocities, supply pumping capacity and storage volume were also reviewed. When simulating the night-time refill of the storage facilities, an 8-hour time period and night-time demand condition was simulated using Orleans diurnal (24-hour daily cycle) water-use pattern.

The computer model was calibrated to approximate the results measured in the field. Once calibrated, the model was used to simulate system operation under varying demand conditions. Where the system did not meet the criteria set forth, alternative distribution system improvements, such as increasing pipe sizes in bottleneck areas, were modeled and recommendations were made based on the hydraulic and cost effectiveness of the improvements.

6.2.2 Refinement of the Hydraulic Model Schematic

The OWD distribution system hydraulic model was refined to reflect the current distribution storage and supply systems. The hydraulic model was created within the WaterGEMS Software Program using the water department's electronic base mapping. As part of our refinement process, the latest electronic GIS base mapping was checked against model data and recent additions to the system were added. As part of this effort, Well No. 8 and some minor water main extensions were added to the model. The hydraulic model is a representation of the piping system in which pipes are represented as lines or "links" and pipe intersections and changes in pipe size are represented as "nodes". Points of supply and storage facilities are represented as special system nodes which contain information relating to the specific type of facility (pump, tank, well, valve, etc.) All water mains with fire flow capabilities, generally 6-inch diameter and larger, were included in the OWD system hydraulic model. For a specified demand condition (maximum day, peak hour, maximum day plus fire, etc.), the computer model will solve a series of mathematical algorithms for the flow in each pipe and the pressure at each node.

Information on pipe size, length between nodes, and C-values were assigned to each link. Pipe sizes and lengths are correlated to the OWD's GIS data, which was also updated as part of this study. All water mains in Orleans are cement lined. C-values for cement-lined pipes were based on typical values for new pipes, with a slight adjustment for pipe diameter. Piping materials, age of pipe, and type of pipe lining were obtained from the Department records including older distribution maps and institutional knowledge.

6.2.3 Water Demand Apportionment

Once the distribution system piping network was refined, the next step in ensuring hydraulic model calibration was to refine the existing and projected future water demands to the entire service area. For the purpose of the study, existing water demands at each node were scaled to match the current and future demands at each node throughout the system, except the pump and tank nodes which represent points of water supply and storage. Given the general residential nature of the customer base for the present and expected future condition utilizing the existing demand allocation was justified.

6.2.4 Model Calibration

Upon refinement of the hydraulic model, actual system operating data obtained from the fire flow testing program was used for calibration. Calibration generally involves simulating each fire flow test on the model and making adjustments or corrections to the input data, as required so the computer system response closely approximates the measured system response. Since most physical parameters such as pipe size, pipe age, material type etc. are fixed, the roughness coefficient is the primary variable requiring adjustment during calibration. Again, because all the piping is lined in Orleans, this process was used to see if restrictions, closed valves or possibly inaccurate pipe diameters were present in the system.

The 2013 summer average-day demand was used for calibration of the model. The accuracy of the estimates of total system demand and the apportionment to the nodes is not critical during calibration, because demands are distributed so widely throughout the system. These demands result in minimal pipe flow velocities and virtually static conditions. For this reason, the simulated fire flow, which stresses the system at a single location, tends to govern hydraulic effects.

During the field testing, hydraulic grade line data at the storage facilities, pumping stations, and other boundary conditions were obtained from trending data from the OWD SCADA system.

Initially, summer average-day demand was run on the model to check static pressures against those measured during the fire flow test program. This is done to calibrate the ground surface elevations at the test locations. Next, each fire flow was run on the simulation model until the model results replicated the field results.

6.3 FIELD TESTING PROGRAM

Fire flow tests were performed by Wright-Pierce and the Orleans Water Department personnel in June 2013. The individual field test calculation sheets are included in Appendix A. The results of these tests are also summarized in Table 6-1 and the locations of these tests are shown in Figure 6-1. Table 6-1 includes the boundary conditions from the OWD SCADA system obtained during fire flow testing used to calibrate the computer model. This data includes tank level data for the OWD storage tank levels and pumping station flows.

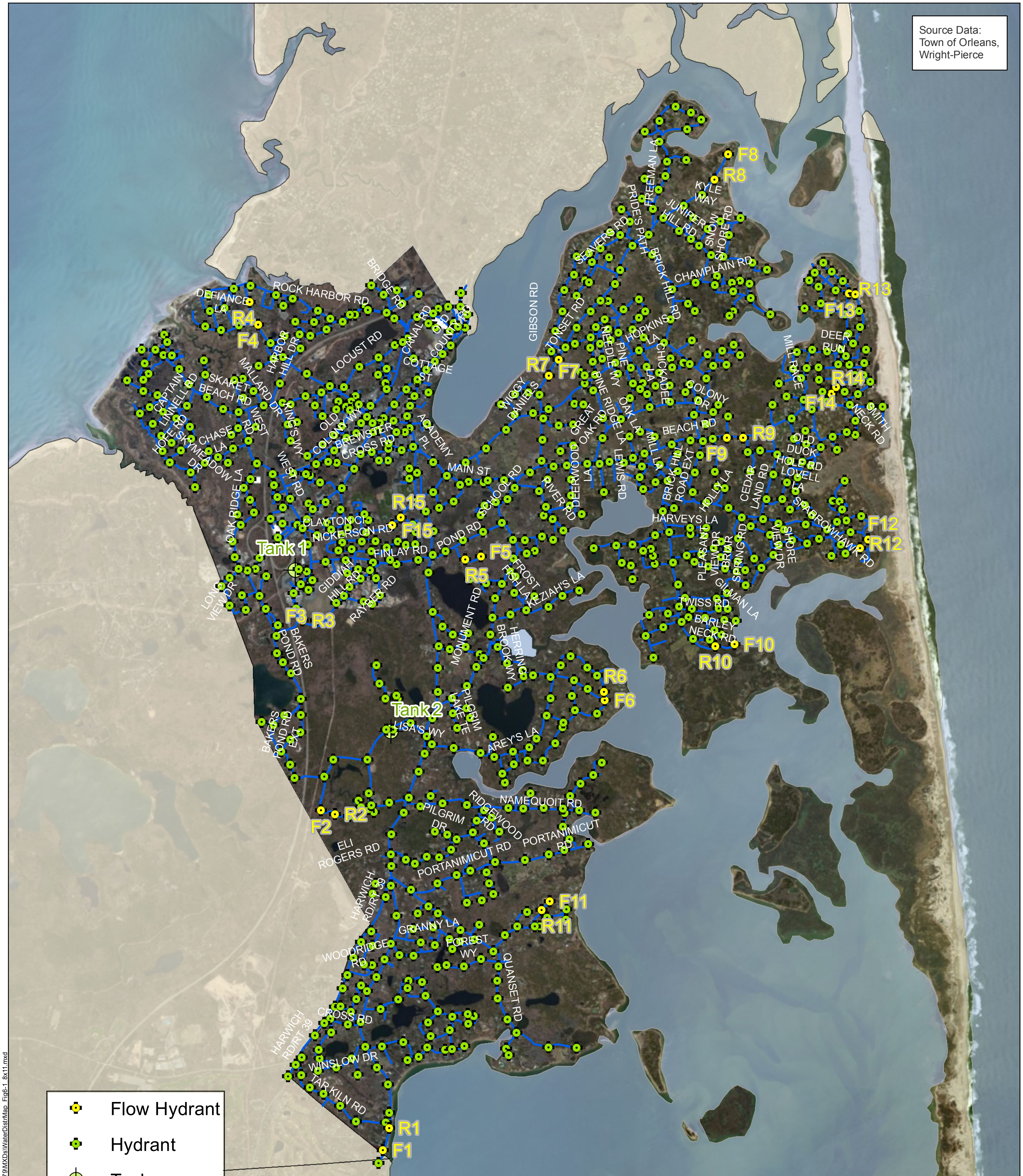
TABLE 6-1

HYDRAULIC MODEL CALIBRATION RESULTS

										Field Results				Model Simulated Fire Flows							
		Water Storage Tank Levels (feet)		Water Elevation (feet)		Pumping Rates				FLOW HYDRANT		GAUGE HYDRANT PRESSURE (PSI)		FLOW HYDRANT		GAUGE HYDRANT PRESSURE (PSI)			RESULTS		
TEST NO.	LOCATION	Tank#1	Tank#2	Tank#1	Tank#2	Well#2	Well#3	Well#8	WTP	Static	Flow (gpm)	STATIC	RESID.	Node ID	Static	Node ID	Static	Residual	Field Pressure Drop	Model Pressure Drop	Headloss Difference (PSI)
1	Route 28 (South of Tar Kiln Road)	58.04	92.22	189.04	195.72	324	503	350	1,102	76	1,086	77	60	3770	76	1658	77.0	62.0	17	15	2.0
2	Namequoit Road (West of Rt. 28)	60.12	93.94	191.12	197.44	323	499	349	1,087	60	1,149	68	66	4165	60	4169	67.2	65.2	2	2	0.0
3	Lots Hollow Road	64.18	97.6	195.18	201.1	324	500	349	1,095	48	1,033	38	37	3190	46	4172	38.0	37.8	1	0	0.8
5	Lake Farm Lane	66.14	98.8	197.14	202.3	0	0	0	0	68	1,137	66	58	1449	68	4178	66.0	57.3	8	9	-0.7
6	Pershing Lane	60.64	94.3	191.64	197.8	324	502	350	1,083	75	1,243	70	65	4184	76	4181	71.7	64.3	5	7	-2.4
7	Tonset Road	62.92	96.33	193.92	199.83	323	498	349	1,096	70	1,161	72	65	4187	70	1036	69.9	61.8	7	8	-1.1
8	Weeset Proprietor's Way	63.43	96.86	194.43	200.36	324	502	348	1,095	77	1,033	63	43	4220	77	4190	63.0	42.0	20	21	-1.0
9	Beach Road	63.88	97.3	194.88	200.8	324	503	348	1,100	58	918	50	41	406	58	4193	48.7	40.3	9	8	0.6
10	Barley Neck Road[2]	65.6	98.4	196.6	201.9	0	0	0	0	84	1,060	73	50	1667	84	4196	73.1	45.0	23	28	-5.1
11	Carlton Road	59.08	93.05	190.08	196.55	322	494	350	1,094	59	1,006	59	44	1506	60	4199	58.4	41.1	15	17	-2.3
12	Gosnold Road	65.6	98.82	196.6	202.32	324	502	348	1,081	72	1,047	68	57	390	72	4202	70.5	54.6	11	16	-4.9
13	Nauset Road [1]	65	98.3	196	201.8	324	501	346	1,095	66	933	62	38	3836	66	4205	63.8	28.0	24	36	-11.8
14	Oliver's Way	64.44	97.8	195.44	201.3	324	502	347	1,090	52	918	44	30	4208	52	1925	44.0	29.2	14	15	-0.8
15	Eldredge PKW	61.27	94.86	192.27	198.36	325	506	349	1,110	60	1,124	61	61	4211	58	3194	60.4	59.9	0	1	-0.5

1 - The pitot pressure varied from 32-30 psi during the fire flow test. The calibration result is based on the pitot pressure of 30 psi and corresponding flow rate of 918 gpm.

2 - The pitot pressure varied from 46-40 psi during the fire flow test. The calibration result is based on the pitot pressure of 40 psi and corresponding flow rate of 1,060 gpm.



Town of Orleans, MA

Flow Test Locations

PROJ NO:	DATE:
12779	Feb 2014

WRIGHT-PIERCE
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FIGURE: 6-1

6.3.1 Fire Flow Testing

The fire flow testing program was performed for the following reasons:

- To provide actual system data to calibrate the computer model and identify areas where closed valves may be present.
- To estimate the flow rate available for fire protection at specific locations within the system.
- To immediately indicate the relative strengths and weaknesses of the system.

Test locations were selected throughout the system based on system hydraulics, area zoning, known problem areas and the locations tested by the Insurance Service Office (ISO). Several of the locations tested by the ISO were repeated for this study. The remaining fire flow test locations were selected to provide data in order to calibrate the hydraulic simulation model, or to test known weak points in the distribution system.

Fire flow test locations are desired at points in the system that are remote from sources of supply and storage, primarily to provide data to calibrate the network model extending out to the hydraulic extremities. Tests are also performed at known or suspected areas where there are chronic low pressures or fire flows are a problem. This is to quantify the problem in areas where significant building development is planned or exists (i.e. downtown business, schools, hospitals, or housing complexes) for planning the system improvements.

Once the fire flow test location is selected, a field test is performed. The fire flow test procedure is conducted as follows. At each test location, two or more hydrants are used; one to monitor system pressure and the other to measured flow. The intent of the test is to stress the system to measure the drop in system pressure at a specific hydrant flow rate. As shown in Table 6-1, the static pressure represents the system pressure at the test location prior to imposing the hydrant flow. The residual pressure is recorded while the hydrant is flowing; and represents the resulting system pressure at that measured hydrant discharge rate. If necessary, more than one hydrant is used for flow measurement to achieve a target of a 10 psi drop or more in system pressure during the test (the greater the pressure drop, the higher the level of the accuracy). This objective was not always achieved during field testing due to concern over water loss from the system and damage to surrounding property. The results of the test were then used to calculate the flow rate that would be available from the system at the test location while maintaining a residual system pressure of 20 psi. This is the minimum system pressure used by the ISO to calculate available fire flow at specific locations within a distribution system. The intent of sustaining this residual pressure in the system during a fire is to maintain supply to area water users, to provide adequate suction pressure for firefighting pumping apparatus, and to insure against drawing a vacuum which could contaminate the system.

The fire flow testing program results are difficult to compare to the ISO test results since boundary conditions, such as tank elevations, were not recorded during the ISO testing program. In addition, modeling allows a specific available flow at a given location to be limited by low pressures elsewhere in the distribution system. Several areas still need to be addressed in the distribution piping improvement program to improve localized fire flow capacity.

6.4 FIRE FLOW REQUIREMENTS

The ability to provide fire protection is a valuable asset for a community. Guidelines for fire flow requirements are provided by the Insurance Services Office and discussed in detail in Section 2 of this report. As discussed previously, the ISO is an insurance service organization responsible for evaluating and classifying communities for insurance rating purposes.

Specific fire protection requirements at a given locale vary with the physical characteristics of a building. The required fire flows are based on the worst case premise in a general location using the following factors: (1) materials of construction, (2) its occupancy use, (3) proximity to other structures, (4) height and size of building, (5) the existence of fire walls, (6) presence or absence of sprinklers, and other factors. Specific buildings may have required fire flows as high as 12,000 gpm. Table 6-4 shows typical fire flow requirements for various building types and uses. This data will be used to assess the adequacy of the available fire flows at select locations throughout the distribution system. Actual fire flow requirements will be used at specific locations tested by ISO in 2003 and 2004.

Municipal fire insurance ratings are partially based on a water utility's ability to provide needed fire flows up to a maximum flow of 3,500 gpm. The ISO requirement of 3,500 gpm was the criteria used for all non-residential land uses. This is the largest fire flow that the ISO recognizes as necessary for any system to be required to provide. If a specific building has a required fire flow greater than 3,500 gpm, than the community's fire rating will only be based on the water system's ability to provide 3,500 gpm.

TABLE 6-2
TYPICAL FIRE FLOW REQUIREMENTS

Land-Use or Building Type	Range of Required Fire Flows
Single and Two Family Dwellings	
Over 100 feet Building Separation	500 gpm
31 to 100 feet Building Separation	750 gpm
11 to 30 feet Building Separation	1,000 gpm
10 feet or less Building Separation	1,500 gpm
Multiple Family Residential Complexes	2,000 to 3,000 gpm
Average Density Commercial	1,500 to 2,500 gpm
High Value Commercial	2,500 to 3,500 gpm
Light Industrial	2,000 to 3,500 gpm
Heavy Industrial	2,500 to 3,500 gpm

Presently, 16 of the 19 ISO test locations in Orleans meet minimum ISO standards, based on the last ISO rating. This is excellent by industry standards. As demands increase, additional stress on the system will reduce available pressures and lower available fire flows. The distribution model was used to forecast available flows at various locations in the distribution system under projected future demands.

Tables 6-3 list the results of the model simulations of the available fire flows coincident with the projected Year 2033 maximum-day demand for 19 representative locations throughout the

Orleans Water Department service area. These locations were either previously tested by the ISO or represented a hydraulic extremity in the system. The available flows were then compared to the required flows reported by the ISO. For locations not tested by ISO, required fire flows were estimated based on land-use zoning and dwelling type and spacing in the vicinity of the test. The available fire flows shown in Table 6-4 differ from the ISO test results and from field testing results completed for this study because of varying pumping rates, system demands and tank elevations during the testing periods. In addition, the available fire flows in Table 6-3 are based on maintaining a minimum 20 psi residual in all areas of the distribution system. Normal field and ISO testing procedures do not take into account pressures in the distribution system other than at a test hydrant. Based on the results of the hydraulic modeling, 16 out of 19 ISO test locations meet minimum ISO standards under the projected build-out maximum day demands in Orleans

Similarly, a second analysis was completed assuming that a future interconnection to Eastham is made near the town line at the US Route 6 roundabout. Tables 6-4 list the results of the model simulation of the available fire flows for the same 19 test locations described above coincident with a simulated demand of 1.25 MGD by the Town of Eastham.

In this instance, 15 out of 19 ISO test locations in Orleans meet minimum ISO standards under the project build-out maximum day demand with a sustained 1.25 MGD (875 gallons per minute) flow to Eastham. In summary, the data suggests that available fire flow will not be dramatically compromised if an interconnection to Eastham is made. Improvements to the distribution system in Orleans to retain current fire protection standards are discussed later in the report.

TABLE 6-3

AVAILABLE FIRE FLOWS AT ISO TEST LOCATIONS IN ORLEANS UNDER PROJECTED BUILD-OUT DEMANDS

Flow Location	Available Current Fire Flows (2013)	Estimated Fire Flow at Build-out (gpm) [1,2]	Required Fire Flow (gpm)	Adequate?
Main St. @ Old Colony Way	5200	5200	3000	Yes
Canal Rd. e/o Bridge Rd.	2800	2800	2500	Yes
S. Orleans Rd. nr Harwich Rd.	3600	3300	2500	Yes
Cranberry Hwy. Rte. 6A @ West Rd.	4900	4900	2000	Yes
Beach Rd. @ Nauset Rd.	1200	1000	2000	**No**
Main St. @ Barley Neck Rd.	2400	1900	2500	**No**
Rte. 28 between Main St. @ Elbridge Pkwy	7300	7300	3000	Yes
O'Connor Rd. nr Hollow Rd.	3700	3500	2000	Yes
Monument Rd. @Rte. 28	5900	4950	1750	Yes
Cove Rd. @ Rte. 28	3400	5800	1750	Yes
Rock Harbor Rd. n/o Defiance Ln.	1800	2200	2500	**No**
School Rd. @ River Rd.	4400	3400	1250	Yes
Bay Ridge Rd. @ Oak Ridge Ln.	2800	3900	1500	Yes
Barley Neck Rd. @ Ori Ln.	1400	1500	1500	Yes
Lake Dr. @ Boulder Ln.	1900	2400	1500	Yes
Hopkins Ln. @ Pine Needle Way	2800	2100	1250	Yes
Pochet Rd. nr Gosmold Rd.	1900	1700	1000	Yes
Nauset Rd. nr Standish Rd.	1400	950	750	Yes
Finlay Rd. @ Nickerson Rd.	5500	5500	1500	Yes

Notes:

[1] Flow capacity based on minimum system pressure of 20 psi. Model results rounded to the nearest 50 gpm.

[2] Simulated available fire flows are based on a projected maximum-day build-out demand water levels in the all storage tanks at 5' below overflow elevation, Wells No.2, 3, 8 and water treatment facility operational at projected average-day demand

[3] Flows greater than 3,500 gpm are not considered in evaluating system compliance with ISO fire suppressant rate schedule.

TABLE 6-4

AVAILABLE FIRE FLOWS AT ISO TEST LOCATIONS IN ORLEANS UNDER PROJECTED BUILD-OUT DEMANDS WITH 1.25 MGD EASTHAM INTERCONNECTION

Flow Location	Available Current Fire Flows (2013)	Estimated Fire Flow at Build-out (gpm) [1,2]	Required Fire Flow (gpm)	Adequate?
Main St. @ Old Colony Way	5200	5200	3000	Yes
Canal Rd. e/o Bridge Rd.	2800	2700	2500	Yes
S. Orleans Rd. nr Harwich Rd.	3600	3300	2500	Yes
Cranberry Hwy. Rte. 6A @ West Rd.	4900	4900	2000	Yes
Beach Rd. @ Nauset Rd.	1200	1050	2000	**No**
Main St. @ Barley Neck Rd.	2400	1800	2500	**No**
Rte. 28 between Main St. @ Elbridge Pkwy	7300	7200	3000	Yes
O'Connor Rd. nr Hollow Rd.	3700	3300	2000	Yes
Monument Rd. @Rte. 28	5900	4900	1750	Yes
Cove Rd. @ Rte. 28	3400	5500	1750	Yes
Rock Harbor Rd. n/o Defiance Ln.	1800	2200	2500	**No**
School Rd. @ River Rd.	4400	3100	1250	Yes
Bay Ridge Rd. @ Oak Ridge Ln.	2800	3600	1500	Yes
Barley Neck Rd. @ Ori Ln.	1400	1450	1500	**No**
Lake Dr. @ Boulder Ln.	1900	2400	1500	Yes
Hopkins Ln. @ Pine Needle Way	2800	2000	1250	Yes
Pochet Rd. nr Gosmold Rd.	1900	1300	1000	Yes
Nauset Rd. nr Standish Rd.	1400	900	750	Yes
Finlay Rd. @ Nickerson Rd.	5500	5500	1500	Yes

<u>Notes</u>:

[1] Flow capacity based on minimum system pressure of 20 psi. Model results rounded to the nearest 50 gpm.

[2] Simulated available fire flows are based on a projected maximum-day build-out demand water levels in the all storage tanks at 5' below overflow elevation, Wells No.2, 3, 8 and water treatment facility operational at projected average-day demand

[3] Flows greater than 3,500 gpm are not considered in evaluating system compliance with ISO fire suppressant rate schedule.

6.5 AVAILABLE FIRE FLOW WITH STANDPIPE NO. 1 OUT OF SERVICE

Orleans' water distribution hydraulic model was utilized to simulate a 3,600 gpm fire flow event for 3 hours during 2033 projected maximum day demand with the Standpipe No.1 out of service, all existing sources and the three existing Brewster interconnections on-line. The selected fire flow location is on South Orleans Road near Harwich Road. The static pressure prior to the fire flow was 58 psi and the residual pressure at the end of the fire flow event was 47 psi. System wide pressures at the end of fire flow event varied from 81 psi to 34 psi. The water tank level in Standpipe No.2 fluctuated between elevation 100 and 90 feet. The existing interconnections appear to provide adequate supply and pressure in an event of a fire flow with one tank out of service.

6.6 AVAILABLE WATER SYSTEM PRESSURES

A water system should be designed to accommodate a range of pressures within minimum and maximum guidelines. Low pressures lead to customer complaints and restrict available flows for firefighting. Higher pressures can also lead to increased water loss from leakage.

Water pressure will vary around the service area from variations in customer demand, changes in elevation and from proximity to pumping facilities and source of supply. In general, when customer demands increase, pressure will decrease. Areas with higher elevations typically have lower pressures.

Standard water works practice is to maintain minimum pressures in the distribution system above 35 psi under normal operating conditions. Pressures during fire flow conditions should be maintained above 20 psi at all locations in the system. Normal high pressures should not exceed 80 psi without pressure reduction at service connections, as requested by the State of Massachusetts Plumbing Code. The computer model was used to determine the adequacy of system pressures during stressed conditions. Four stressed conditions were simulated: (1) Peak-hour and (2) Nighttime Refill of Storage in Year 2033 and (3) Peak-hour and (4) Nighttime Refill of Storage in Year 2033 with Eastham interconnection on-line and flow of 1.25 MGD.

In general, the Orleans distribution system has developed to accommodate the needed pressures. The first stressed condition tested with the model was peak hour demand in the Year 2033. This condition resulted in all areas of the distribution system having minimum pressures of 30 psi, ranging from 31 psi on Locus Hollow Road in the vicinity of the Standpipe No.1 to 79 psi on Namequoit Road near Viking Road. The relatively low pressures (<35 psi) on Locus Hollow Road are primary contributed to high ground elevation relative to the water level in the Standpipe No.1 during the simulated 2033 maximum day demand of 2.82 MGD.

In general, pressures should meet the Mass DEP's minimum standard of 35 psi at the point of the service connection. Homes with pressures below 35 psi should have limited service agreements.

The second stress condition was a test of the system's ability to refill the storage facilities during the nighttime hours of 10 PM to 6 AM on the maximum-day Year 2033. This condition was tested using extended time simulations with a standard diurnal water use curve developed Wright-Pierce based on June 25, 2013 flow data provided by OWD. The diurnal curve distributes water use using average patterns over a 24-hour period. This distribution system did meet this condition under projected demand conditions.

The third stressed condition tested with the model was peak hour demand in the Year 2033 and Eastham interconnection on-line and flow of 1.25 MGD. This condition resulted in all areas of the distribution system having minimum pressures of 30 psi, ranging from 31 psi on Locus Hollow Road in the vicinity of the Standpipe No.1 to 81 psi on Namequoit Road near Viking Road. The relatively low pressures (<35 psi) on Locus Hollow Road are primary contributed to high ground elevation relative to the water level in the Standpipe No.1 during the simulated 2033 maximum day demand of 2.82 MGD and flow to Eastham of 1.25 MGD.

The fourth stress condition was a test of the system's ability to refill the storage facilities during the nighttime hours of 10 PM to 6 AM on the maximum-day Year 2033 and Eastham interconnection on-line and flow of 1.25 MGD. This condition was tested using extended time simulations with a standard diurnal water use curve developed by Wright-Pierce based on June 25, 2013 flow data provided by OWD. The diurnal curve distributes water use using average patterns over a 24-hour period. This distribution system did meet this condition under projected demand conditions but the Standpipe No.1 did not fully refill.

6.7 MAJOR DEAD-END MAINS

The OWD distribution system is well looped and connected. Dead-end mains and poorly looped systems are often hydraulically deficient and prone to water quality issues. As in many similar systems, there are dead-end mains located mostly in in dead-end streets residential areas. Major North-South and East-West water distribution transmission mains are connected and well looped. The following locations present looping opportunity and should be considered to improve system water quality, fire flow availability and improve reliability by providing redundant service to those areas of the system:

- Lake Drive and Quanset Road (loop along Quanset Pond)
- Freeman Lane and Bufflehead Lane

Refer to Figure 6-2 for the location of the suggested improvements.

6.8 WATER AGE ANALYSIS

Water distribution hydraulic model was utilized to determine average water age in Orleans water distribution system during off peak months (October through May) and average daily demand of 0.71 MGD. Both standpipes (Standpipe No.1 and No.2) were modeled as completely mixed reservoirs because of the existing mixing system installed in both tanks. In mixed system, the model assumes that all water that enters a tank is instantaneously and completely mixes with the water already in the tank. It applies well to a large number of facilities that operate in fill and-draw fashion with existing mixing systems.

Based on the hydraulic modeling results, the average water age in Orleans' water distribution system is just over 5 days ranging from 0 days at the sources to over 10 days at system extremities and at the end of dead-end mains. This water age is reasonable for a system such as Orleans and no improvements to reduce or manage water age are recommended.

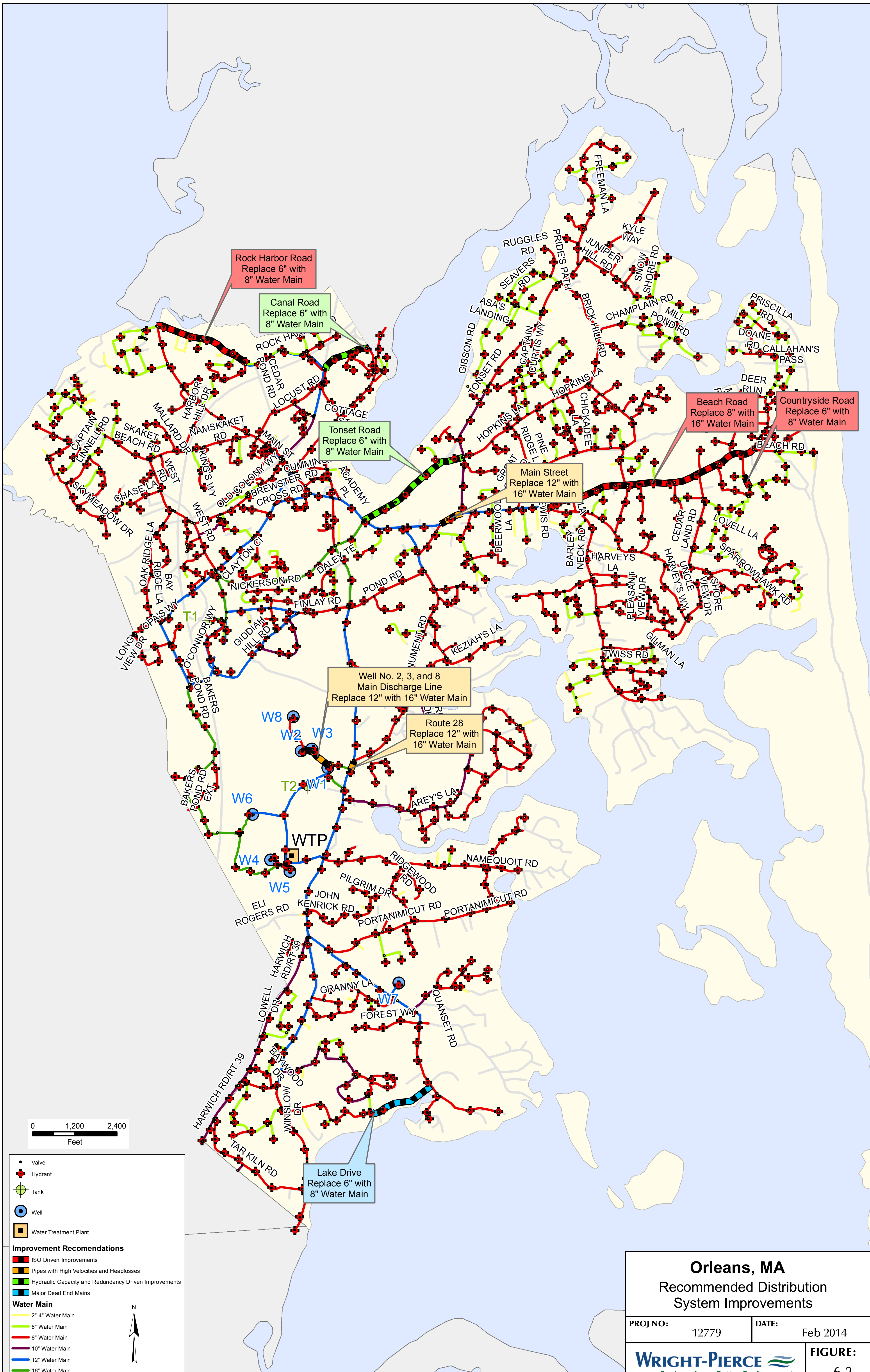
Rock Harbor Road
Replace 6" with
8" Water Main
Canal Road
Replace 6" with
8" Water Main
Tonset Road
Replace 6" with
8" Water Main
Main Street
Replace 12" with
16" Water Main
Beach Road
Replace 8" with
16" Water Main
Countryside Road
Replace 6" with
8" Water Main
Well No. 2, 3, and 8
Main Discharge Line
Replace 12" with 16" Water Main
Route 28
Replace 12" with
16" Water Main
Lake Drive
Replace 6" with
8" Water Main
W1
W2
W3
W4
W5
W6
W7
W8
T1
T2
WTP
0
1,200
2,400
Feet
Valve
Hydrant
Tank
Well
Water Treatment Plant
Improvement Recomendations
ISO Driven Improvements
Pipes with High Velocities and Headlosses
Hydraulic Capacity and Redundancy Driven Improvements
Major Dead End Mains
Water Main
2"-4" Water Main
6" Water Main
8" Water Main
10" Water Main
12" Water Main
16" Water Main
N
Orleans, MA
Recommended Distribution
System Improvements
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FIGURE:
6-2

6.9 PIPE VELOCITIES AND HEADLOSS

The computer model is useful in analyzing pipe velocity areas of the distribution system. High pipe velocities lead to higher head losses and often contribute to poor water quality in the distribution system. The model results can be configured to identify high pipe headloss or high velocity piping in the distribution system under various simulated conditions.

In general, pipe velocities greater than 2 feet per second (fps) present a risk of sediment mixing and scouring in piping. This condition can lead to isolated color or water quality complaints in areas where this condition occurs. Head losses increase rapidly when pipe velocities exceed 5 fps. According to the American Water Works Association (AWWA) Manual of Water Supply Practices, a pipe is considered to have deficient pipe looping or sizing if headlosses exceed 6 ft/1,000 ft or velocities exceed 5 fps.

Hydraulic simulations indicate that velocities in the following transmission mains exceed 2 fps and headlosses exceed 10 ft/1,000 ft :

- 100 feet of 8-inch main on Flax Pond Road (connecting 16” mains on Shorewood Drive) – recommend replacing with a new 16-inch main.
- 770 feet of 12-inch main from Wells No.2, No.3 and No.8 – recommend replacing with a new 16-inch main.
- 270 feet of 12-inch main on Route 28 (from Carmen Lane to Monument Drive)
- 670 feet of 12-inch on Main Street (from School Road to Meetinghouse Road)

Refer to Figure 6-2 for the location of the suggested improvements.

6.10 PIPING IMPROVEMENTS TO IMPROVE SYSTEM RELIABILITY

The OWD distribution system contains over 110 miles of water mains. Since the distribution system was initially constructed in the 1960’s, the oldest piping in the system is all cement lined cast iron and the rest of the water main is all cement lined ductile iron water main. The majority of this piping continues to function well and has not been diminished in hydraulic capacity.

In general, a water main has a useful life of approximately 100 years. A replacement program of about 1% of the distribution system each year, or about 4,000 feet of main, would approach sustainability for the OWD distribution system. The OWD has assisted in identifying and prioritizing piping in the system which has been maintenance intensive. A detailed list of piping improvements to improve system reliability is discussed in Section 10 of the report. This priority list includes critical spines of the distribution system or pipe segments within new or proposed roadway improvement projects. Older, small diameter cast iron piping (6-inch diameter or less) within residential areas should be replaced with 8-inch piping as opportunities arise (i.e. local road and sewer projects, new developments, etc.). The hydraulic model should be used to verify pipe sizes in each specific instance before a pipe replacement project is constructed.

In addition, a number of potential improvement scenarios were modeled to resolve the deficiencies identified from the distribution system analysis to provide adequate fire flows. In many cases, an improvement was found to resolve more than one deficiency. For this reason, the improvements were considered from a holistic perspective to maximize the benefit while minimizing the amount if infrastructure investment needed. Hydraulic simulations were run to address pressure, fire flow, velocity, headloss, and looping deficiencies as discussed below. Recommended improvements are discussed below.

6.10.1 Recommended Improvements to Improve Hydraulic Capacity

The following improvements are recommended to provide additional hydraulic capacity to meet ISO recommended fire flows and improve overall hydraulics in the system:

6.10.1.1 Beach Road and Country Side Road

The existing 8-inch main on Beach Road from Mill Lane to Nauset Heights Road is undersized to provide adequate fire flow from the west side of the system. The main on Beach Road is a critical main in the system as it is the primary transmission main from the tanks and sources to the east side of the system. The 8-inch main does not have the hydraulic capacity to provide the ISO recommended fire flow on Beach Road at Nauset Road. Therefore, in order to provide the inherent capacity to meet recommended ISO flows to this area and improve the overall system fire flow capacity, a new 16-inch water main is recommended to replace the existing 8-inch main from Mill Lane to Nauset Heights Road and a new 8-inch main is recommended to replace the existing 6-inch main on Country Side Road from High View Lane to 8-inch main running cross country and connecting to Beach Road. These recommended improvements will also help to meet the ISO on Main Street near Barley Neck Road and on Barley Neck Road near Ori Lane.

6.10.1.2 Rock Harbor Road

The existing 6-inch main on Rock Harbor Road from Captain Doanes Way to Bay View Drive is recommended to be replaced with a new 8-inch water main to address ISO fire flow deficiency on Rock Harbor Road north-of Defiance Lane. This improvement will also increase available fire flows on Rock Harbor Road (from Captain Doanes Way to Bay View Drive).

Refer to Figure 6-2 for the location of the suggested improvements.

6.10.1.3 Additional Recommended Hydraulic Capacity Improvements

The following improvements are recommended to provide additional hydraulic capacity and improve system connectivity and redundancy:

- Replace 6-inch with a new 12-inch main on Tonset Road from Main Street to Meetinghouse Road.
- Install new 8-inch main from Towhee Lane to Lake Drive and connect to 8-inch on Oyster Trail.
- Replace 6-inch with a new 8-inch on Canal Road from Jones Road to Route 6A.

Refer to Figure 6-2 for the location of the suggested improvements.

An important part of planning is development of an on-going replacement program to replace pipe as it approaches its useful life. OWD is in a unique position compared to many New England communities in that the oldest pipes in the system are ~65 years old so age is much less of a factor at this moment in time. Given that ~ 40 miles of distribution piping will be at or near its useful life as this water main approaches its useful life near 2060 funding this water main replacement without overwhelming the rate payer will be an increasing challenge for the Department over the next 50 year period.

The Department should consider partnering opportunities in most areas of the distribution system where roads or sewer improvements are planned for upgrading and cost sharing is possible.

6.11 WATER QUALITY MANAGEMENT IN THE DISTRIBUTION SYSTEM

6.11.1 Total Coliform Sampling

The total coliform rule (TCR) requires systems to routinely sample seven locations in the distribution for presence of coliform bacteria. During the summer when population increases in Town, 20 locations are sampled throughout Town. To meet the requirements of the TCR, the OWD has demonstrated on a routine basis that most test locations are negative for coliform bacteria.

6.11.2 Distribution System Flushing

The Department should continue its annual flushing program to exchange water from low flow areas and to reduce the general age of water in the distribution system. A flushing program will also improve taste and remove sediment from low flow piping.

6.12 STORAGE EVALUATION

6.12.1 Storage Adequacy to Meet Build-Out Demands

The OWD owns and operates two distribution storage facilities as previously described. System storage is necessary for the following reasons:

- Storage should be designed to provide all demands which exceed the maximum day average flow rate. The volume of storage which is depleted during the daytime, peak flow periods is refilled during the lower demand, early morning hours.

- Storage is provided for fire protection. If a fire occurred during the maximum day demand, all the water used to fight the fire would be drawn from storage volume.
- Storage provides water during emergency situations such as power failures, transmission main breaks, etc.
- To provide additional volume for pumping during off-peak electrical periods.
- Operating storage is used for cycling pumps during normal daily operation.

All storage components described above should be available while still providing at least 20 psi of pressure in the each pressure zone. This pressure is equivalent to the volume of water stored 46 feet above the highest service. This storage volume is referred to as the available or active storage.

To determine the adequacy of the existing storage volume, an analysis of each of the storage components described was made using build-out demand projections. A worst case scenario in Orleans would dictate that for a fire on the maximum-day in July when the fire flow and hourly fluctuation volume of the available storage are needed simultaneously.

The existing available active storage must be sized and located at the proper elevation to provide the required pressures in the service area during a fire condition. These requirements are presented in Table 6-5.

TABLE 6-5

EXISTING AVAILABLE ACTIVE STORAGE TANK VOLUMES

Storage Component	Standpipe No. 1	Standpipe No 2
Total Capacity (gallons)	1,382,000	2,000,000
Overflow Elevation (feet-USGS)	El. 218	El. 218
Maximum Operating Level (Feet-USGS)	El. 214	El. 214
Base Elevation (feet – USGS)	El. 131	El. 103.5
Unit Volume (gallons/foot)	15,890	17,467
Highest Elevation Served (feet- USGS)	El. 131[2]	El. 131[2]
Minimum Storage Elevation for Minimum 20 psi Residual System Pressure (feet – USGS)	El. 177	El. 177
Active Storage Volume (gallons)[1]	588,000	646,000
Total Service Active Storage (gallons)	**1,235,000 gallons**	

[1] Volume stored above El. 177 in each storage tank.
[2]Assumes homes could be constructed up to the base of Standpipe No. 1

The required storage in the service area can be calculated as follows:

1. *Fire Protection Storage Volume* - The volume which should be stored for fire protection should be capable of providing 3,500 gpm for 3 hours or 630,000 gallons. This is the Insurance Services Office (ISO) recommended maximum amount of fire protection necessary for a public water purveyor to supply for a test location within this zone. This flow is appropriate in the Orleans low service area where some commercial and industrial land-use zoning exists.

2. *Equalization Storage for Peak-Hour Storage Fluctuation* - The storage volume necessary to meet hourly demand fluctuations in Orleans was estimated to be 20 percent of the maximum day total demand in total for the entire water system. This equates to flow to about twenty percent of the projected maximum-day build-out demand (3.15 MGD) approximately 630,000 gallons for the entire water system.

3. *Emergency Storage* - Storage should be available to meet emergencies. Because the Orleans system is interconnected with adjacent water systems, no provisions for emergency storage are recommended or included in the storage analysis

The total required active storage volume for the Orleans systems is 1,260,000 gallons. The existing active storage volume in the Orleans is 1,235,000 gallons. Based on this analysis, the Orleans system has a very slight storage deficit. Because it is likely that no development will occur in the protected high topography areas around the storage tanks, it is assumed that this analysis is very conservative, therefore, no additional storage volume is recommended in Orleans. A similar analysis will follow assuming that the additional maximum day demand of 1.25 MGD is placed on the system to meet needs in Eastham if an interconnection was constructed on Route 6.

6.12.2 Storage Adequacy if Eastham Demands are Incorporated

Similarly, the current storage system would need to be properly sized to meet the current peak-hourly demands in Orleans concurrently while providing an additional 1.25 MGD maximum day demand to the Town of Eastham. If an interconnection were made to Eastham as conceived at U.S. Route 6, then the required active storage in Orleans would be as follows:

4. *Fire Protection Storage Volume* - The volume which should be stored for fire protection should be capable of providing 3,500 gpm for 3 hours or 630,000 gallons. This is the Insurance Services Office (ISO) recommended maximum amount of fire protection necessary for a public water purveyor to supply for a test location within this zone. This flow is appropriate in the Orleans low service area where some commercial and industrial land-use zoning exists.

5. *Equalization Storage for Peak-Hour Storage Fluctuation* - The storage volume necessary to provide meet hourly demand fluctuations in Orleans along with a demand of 1.25 MGD to Eastham equates to a flow of twenty percent of the projected maximum-day demand at build-out (3.15 MGD) plus 1.25 MGD for a total maximum day demand of

4.40 MGD. The storage requirement for this scenario is approximately 880,000 gallons for the entire water system.

6. *Emergency Storage* - Storage should be available to meet emergencies. Because the Orleans system is interconnected with adjacent water systems no provisions for emergency storage are recommended or included in the storage analysis

The total required active storage volume for the Orleans and Eastham systems is 1,510,000 gallons. The existing active storage volume in the Orleans is 1,235,000 gallons.

Based on this analysis, an interconnection to Eastham would create additional storage deficit in the Orleans system of about 275,000 gallons. Furthermore, provisions for emergency supply would certainly get more complicated likely requiring a rationing or allocation priority in the event of large scale emergency situation where supplying emergency flows are required from the communities adjoining Orleans.

A storage tank could be constructed in Eastham to provide supplemental storage back to the Orleans system in a fire emergency and perhaps provide an opportunity for increased storage redundancy in Orleans. Alternatively, a larger tank could be constructed to replace Standpipe No. 1 or an additional, third storage tank could be constructed at the Standpipe No. 1 site to supplement storage in the Orleans system.

It is recommended that a future study be conducted to determine if a suitable storage tank site exists and the economics of increasing storage in the Orleans system to meet demands in Eastham.

6.12.3 Storage Tank Condition Assessment

Both storage tanks have been rehabilitated with new mixing systems and internal and external coating systems in the past two years. No substantive additional work will likely be needed until the next painting cycle. However, routine inspections and surveillance of the storage tanks is recommended to track performance and to identify if any unanticipated or any unusual circumstances that might occur.

The performance of these systems should be evaluated through an informal inspection of each facility once a year by water department staff. A budget allocation for a dive inspection of each tank should be included in the capital improvement program every 5 years.

The two standpipes were painted through a competitive bidding process in years 2012 and 3013 at the costs as shown below:

- Standpipe No. 1 (Year 2013) $565,000
- Standpipe No. 2 (Year 2012) $614,000

For the purposes of projecting the next replacement cycle cost, a 15-year useful life of the current coating system has been assumed based on the performance of the current coating systems. A future cost was projected using an annual inflation rate of 3% over a 15 year period with an additional 20% added for bid documents, construction oversight and contingencies. Because of advancing safety requirements for industrial painting, costs have escalated at a higher rate in recent years but appeared to have stabilized. The Town should track these assumptions over the next 15-year period. On this basis, we project a replacement cost for the standpipe coating and mixing systems as follows:

	Projected Replacement Year	Projected Future Cost
• Standpipe No. 1	2028	$1,057,000
• Standpipe No. 2	2027	$1,149,000

Using a 15-year useful life at an interest rate of 2%, an annual capital reserve fund payment as shown below will be required to create a fund sufficient to fund the replacement costs for the coating systems without capital borrowing:

	Projected Replacement Year	Projected Annual Capital Reserve Payment
• Standpipe No. 1	2028	$61,300
• Standpipe No. 2	2027	$66,700

6.13 DISTRIBUTION SYSTEM MAINTENANCE

6.13.1 Unaccounted-for Water Reduction

As discussed in Section 3, unaccounted-for water in the OWD system was approximately 2% of the total water production in 2012. This is a very low value for unaccounted for water much lower than the industry standard. The water department should strive to continue to keep this value as low as possible. Approximately, 60% of all unaccounted-for water is attributed to leakage in water systems in the US.

Water that is lost via leakage is the only part of unaccounted -for water that is truly unaccounted-for. All other unaccounted-for water is actually used, but is either not measured (e.g., for flushing, fire use, unauthorized use) or is inaccurately measured (e.g. metering errors, meter slippage etc.).

Water leakage can be divided into two broad categories: (1) Unavoidable Leakage and (2) Underground Leakage, described below.

- Unavoidable Leakage - Unavoidable leakage includes the numerous minor water leaks that normally exist in any water system. However, because of their number and size, they are more costly to repair than to simply allow them to exist.
- Underground Leakage - Underground leakage occurs from factors such as earth settlement and corrosive water or corrosive soil, which cause deterioration of pipes and joints. It also includes serious water main breaks and service-line breaks. The cost of wasted water from underground leakage often makes leak repair economical.

Unfortunately, most underground leakage is never seen reaching the surface since the individual leaks, although numerous, are spread throughout the system and have relatively low flows. In the Orleans Water Department distribution system, low volume underground leakage is most likely the major contributor of leakage. The Department should continue its present leak detection program and consider a formal leak detection survey should an increasing pattern be noted.

6.13.2 Distribution System Asset Management

The Orleans Water Department is expanding its GIS mapping and current asset management program through the institution of a CMMS system in the form of UtilityCloud. Information from the report and the datasets developed can be imported in to this software to improve data collection and infrastructure assessment.

The dataset templates include information such as manufacturer, spare parts numbers, maintenance history, location ties and other customized features required by the Orleans Water Department. The use of a CMMS system reduces the reliance on written maintenance records to systematically plan and program maintenance in both the distribution and treatment systems. The program will improve inventory control and planning and allow for older equipment in the distribution system to be upgraded according to need and priority. Additionally, hard copy information can be digitally scanned and linked to assets within the asset management software.

After the templates and database are constructed, the Orleans Water Department would provide staffing to undertake the labor intensive task of creating and importing the data into the database. Summer students are an excellent resource for the development of this task as needed.

6.13.3 Valve Maintenance

Since operation of valves within a distribution system is usually required only in emergencies (water main breaks), valves are often installed and then forgotten until such an emergency arises. Like other mechanical devices, valve operability is adversely affected by neglect. As a result of this neglect, valves can be found to be inoperable at the worst possible time.

Most of the valves within the distribution system are of the sliding disk type (gate valves). This type of valve, which permits an unobstructed flow when fully opened, is hydraulically very efficient. However, when gate valves are left in the open position, deposits may settle and accumulate on the valve seats and prevent tight closure.

To prevent these problems, we recommend the water department continue to conduct their annual valve exercising and maintenance program. The Insurance Services Office (ISO) recommends that valves be inspected and operated annually. We recommend that the transmission main valves, those valves located on the larger diameter pipes between the supplies and storage, be inspected semi-annually, once in the spring and again in the fall. The fall operation will discover any problems before the onset of winter. In the spring, inspect these valves by making sure a valve wrench can be put on the operating nut. This inspection will uncover any problems that have been caused by the previous winter and spring rains. All data should be logged and recorded in the Orleans Water Department's data management system. The asset management system should have custom designed queries that will allow selection of valves by age, condition and type. The capital budget should include repair or replacement of a fixed number of valves each year based on condition or operational problems.

The following steps should be included in the asset management system for a formal valve inspection program:

1. The data file for each valve should contain at least the following information:
   - Valve size.
   - Opening direction.
   - Manufacturer of valve.
   - Number of turns to open.
   - Date of installation.
   - Both general and specific descriptions of valve location including valve ties.
   - Date of last maintenance - parts replaced and condition of valve.
2. Prepare a master sheet which would be used to summarize the work performed and man hours involved. The actual valve maintenance program should use a checklist to determine:
   - Condition of gate box
   - Obstructions in gate box that might prevent gate wrench from seating on valve operating nut
   - Operability of valve

- Number of turns to close and open the valve
- Any leaks detected

The most important part of the maintenance program is to evaluate the inspection reports and to implement the necessary repairs. The Fire Department should be notified whenever it is necessary to shut down a portion of the distribution system for such repairs.

Power valve operators are the preferred method for exercising valves for the following reasons. First, Department personnel are able to operate more valves per day, thus reducing the total time allotted for valve operation, and second, reduce the potential of physical injuries caused by valve operation. This program should continue.

6.13.4 Hydrant Maintenance

The necessity of hydrant maintenance with active involvement from the Fire Department is essential. The ISO recommends that fire hydrants be inspected twice a year. The best time for these inspections is in the spring and in the fall. The fall inspection enables detection of problems before the freezing temperatures arrive. The spring inspection uncovers any problems which may have been caused by the previous winter (e.g., frost heaves). In addition to semi-annual inspections, hydrants should be pumped dry immediately after use and checked for:

- Loose or missing caps
- Missing gaskets
- Damaged operating nuts or nozzle threads
- Corroded breakaway bolts at ground level

Similar to the valve management program, hydrant maintenance should be integrated with the asset management database. Currently OWD has an ongoing hydrant maintenance program which evaluates 300 hydrants per year (~1/3rd of the hydrants in the system). We recommend OWD continue to budget for maintenance on a fixed number of hydrants each year and begin to log this maintenance work into the asset management database.

6.13.5 Water Main Maintenance

The condition of the water mains must be monitored periodically to identify when rehabilitation is required and to plan for the rehabilitation. Fire flow tests provide a general picture of localized flow capabilities but do not indicate the condition of specific water mains. In general, the velocity of water steadily decreases as it leaves the source of supply and approaches the consumer. This decreasing velocity permits the formation of precipitates and allows them to settle out inside the pipe. To remove most of these deposits, a high velocity flushing (Unidirectional Flushing) program is recommended. The objective of a unidirectional flushing program is simply to create a high velocity in the pipeline to re-suspend the deposits and to scour the interior surface of the pipe. The water is then flushed out of a hydrant. The optimum times of year for flushing are in the spring and in the fall. To ensure compliance with MassDEP regulations requiring dechlorination of any water released to the ground and increase the efficiency of the department's flushing program, a second dechlorinator will be needed.

We recommend that the Department maintain an annual high velocity flushing program to improve distribution water quality and reduce water age in the distribution system. Flushing must be done from the supply and storage facilities out towards the extremities. In some locations, it may be necessary to isolate some of the system which is well looped in the distribution network. Alternately, computerized unidirectional flushing programs can assist in sequencing the flushing program for maximum water-use and cleaning efficiency. These programs easily interface with the modeling software used for this study and the Utility Cloud software OWD has purchased has a flushing module that can integrate the information into flushing sequences that can be utilized by staff in the field.

The accumulation of precipitates not only results in reduced flow capacity but also increases normal pumping costs and/or reduces normal system pressure. A flushing program will also reduce color and taste complaints from the customers, improve water quality overall and decrease the age of the water in the distribution system.

Section 7

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SECTION 7

REGULATORY REVIEW

7.1 GENERAL

The Town of Orleans Water Department (OWD) supplies drinking water to residents from eight well sources with varied levels of water quality concerns and treatment requirements. Over the past decade, EPA has undertaken significant rule making activity which affects the operations of water systems, including the Groundwater Rule, updates to the Lead and Copper Rule, the Stage 2 Disinfectants and Disinfection By-Product Rule, and the Long-Term 2 Enhanced Surface Water Treatment Rule, and updates to the Total Coliform Rule. New contaminants are under study or in the planning stages for future regulation by EPA.

This regulatory review assesses any impacts to operations to meet projected level of service goals or treatment requirements to comply with existing or projected regulations.

7.2 CLASSIFICATION OF THE ORLEANS WATER SYSTEM

Water system classification is typically based upon the population served and the character of the water source (e.g., surface water vs. groundwater). A water system's classification is used to establish which state and federal rules apply to a water system and the requirements for compliance. The OWD is classified as a non-transient community water system because it is a public water system that supplies water to the same population year round. OWD serves approximately 5,000 customers within Orleans. For regulatory purposes, the town serves a population of 10,326 which categorizes it as a large sized community water system (>10,000 people). During the summer season, the population is estimated to be as high as 17,670 persons, dropping to a winter population of 5,890. The OWD system is entirely served with groundwater obtained from eight sand and gravel wells.

7.3 OVERVIEW OF MAJOR DRINKING WATER REGULATIONS

A review of regulatory issues pertaining to large sized community groundwater systems such as OWD has been completed as part of this study. The purpose of this regulatory review is to assist

OWD in identifying major regulatory topics that might influence long-term decision making regarding supply or treatment strategies. This review highlights important new rules, but does not explore their implications for OWD in great detail as they are still in their early stages.
The Safe Drinking Water Act (SDWA) of 1974 (amended in 1984 and 1996) is the legal foundation of most EPA water regulations. The purpose of the SDWA to ensure that public water systems meet national standards that protect consumers from the harm of contaminants in drinking water, by requiring USEPA to regulate contaminants that present health risks and which are known to, or are likely to, occur in public drinking water supplies. For each regulated contaminant, EPA sets a legal limit on the amount allowed in drinking water. Limits set by States must be at least as strict as those established by EPA.

The Massachusetts Department of Environmental Protection (MassDEP) Drinking Water Program is the primacy agency which regulates Massachusetts water systems under 310 Code of Massachusetts Regulations, Chapters 22 and 36. Chapter 36 is the State's Well Head Protection Regulation and Water Management Act Program.

Existing and future regulations identified as impacting OWD's water quality include:

- National and State Primary and Secondary Standards, and MassDEP Guidelines
    - Perchlorate
    - Manganese
- Ground Water Rule (GWR)
- Total Coliform Rule (TCR) and Revised Total Coliform Rule (RTCR)
- Lead and Copper Rule (LCR)
- Stage 2 Disinfectants/Disinfection Byproduct Rule (Stage 2 D/DBPR)
- Radon Rules
- Groundwater Under the Influence
- Contaminant Candidate List (CCL3)
- Unregulated Contaminant Monitoring Rule 3 (UCMR3)

7.4 NATIONAL PRIMARY DRINKING WATER REGULATIONS

National Primary Drinking Water Regulations (NPDWR) (or primary standards) are legally enforceable standards that apply to public water systems for primary contaminants. Primary standards limit the levels of contaminants in drinking water that adversely affect the public's health. Currently, the primary contaminant standards are divided into the following six categories:

- Microorganisms;
- Disinfectants;
- Disinfection Byproducts;
- Inorganic Chemicals;
- Organic Chemicals;
- Radionuclides.

The concentrations limits for the primary contaminants are quantified with a maximum contaminant level (MCL) because either chronic or acute exposure can compromise public health. A complete listing of the national primary drinking water standards published by the EPA is included within Appendix B. The current listing of primary standards has incorporated several fairly recent regulations including the Total Coliform Rule, Arsenic Rule, Radionuclides Rule and Stages 1 and 2 Disinfectants/Disinfection Byproduct Rules (D/DBPR).

The 1996 Safe Drinking Water Act Amendments (SDWA) require EPA to review, and if appropriate, revise existing National Primary Drinking Water Regulations every six years. The first six year review, completed in 2003, resulted in a decision to revise the Total Coliform Rule. In 2010, the second six year review resulted in a decision to set revised standards for tetrachloroethylene (PCE), trichloroethylene (TCE), acrylamide, and epichlorohydrin. The third six year review is expected to be completed by 2016.

7.4.1 Upcoming NPDWR for Carcinogenic Volatile Organic Compounds (cVOC)

In lieu of setting individual standards for PCE and TCE, EPA has proposed group regulation of carcinogenic volatile organic compounds. EPA announced in February 2011 that it plans to develop one NPDWR covering up to 16 carcinogenic volatile organic compounds (cVOCs) which include eight currently regulated VOCs and eight unregulated VOCs from the EPA's Third Contaminant Candidate List (CCL3). EPA will propose a regulation to address carcinogenic VOC contaminants as a group rather than individually in order to provide public health protections more quickly and also allow utilities to more effectively and efficiently plan for improvements. PCE and TCE, which the Agency determined were candidates for regulatory revision under the second six year review of the existing NPDWRs, will be included in the VOC drinking water standard. These potential changes are not expected to impact OWD.

7.5 NATIONAL SECONDARY DRINKING WATER REGULATIONS

National Secondary Drinking Water Regulations (or secondary standards) are non-enforceable guidelines regulating contaminants that may cause cosmetic effects (such as skin or tooth discoloration) or aesthetic effects (such as color, taste, or odor) in drinking water. The EPA recommends secondary contaminant standards to water systems but does not require systems to comply. However, individual states may choose to adopt them as enforceable standards.

A complete listing of the national secondary drinking water standards as published by the EPA is also included within Appendix B.

7.6 MASSACHUSETTS DRINKING WATER STANDARDS

Under the SDWA, a state may be granted primacy for implementing the provisions of the SDWA. The Massachusetts Department of Environmental Protection (MassDEP) has primacy for administering the SDWA in the Commonwealth of Massachusetts. Within the MassDEP, the Office of Research and Standards is charged with establishing public health standards and guidelines for contaminants in drinking water. This involves adoption of standards established by the EPA, or the adoption of a more stringent standard or guideline.

In general, the Massachusetts drinking water standards follow the national primary and secondary standards. A complete listing of the Massachusetts drinking water standards and guidelines is included within Appendix B. The Commonwealth usually adopts each federal MCL as a Massachusetts Maximum Contaminant Level (MMCL); but MassDEP may adopt, and in some cases has adopted, stricter standards for protecting public health.

EPA-derived MCLs may not exist for some contaminants for a variety of reasons:

- The chemical doesn't typically occur widely enough to be of national significance;
- EPA has assigned a chemical to be of lower priority for regulation; or
- EPA has determined that the chemical doesn't pose a human health risk at concentrations typically found in drinking water.

However, some chemicals without MCLs may pose an aesthetic problem (e.g., color, odor). In this case, EPA provides a guidance value which is termed a "secondary" standard (SMCL).

When a contaminant is detected, or when testing is required for a contaminant that has no established MCL, MassDEP uses EPA-issued Health Advisories (HA) for guidance, or the MassDEP's Office of Research and Standards (ORS) may issue its own Guidelines (ORSG). HAs are EPA estimates of acceptable drinking water levels for chemical substances. They are not legally enforceable as federal standards, but "serve as technical guidance to assist federal, state, and local officials" when they are managing cases of drinking water contamination in order to protect public health.

In the absence of HA guidance, the Massachusetts ORS may issue new ORSGs to protect the public health (MGL Chapter 111, Section 160, and 310 CMR 22.00). MassDEP will enforce MCL, HA, and ORSG. When drinking water supply testing reveals contaminant levels in excess of an MCL, HA, or ORSG, retesting is required to validate the result. If additional testing confirms that a standard or guidance value has been violated or exceeded (see Massachusetts Drinking Water Regulations for specific language MCLs), the public is notified and the source of contamination is immediately investigated and, once found, removed or remediated. In a few cases follow-up action may occur prior to retesting to protect public health. Decisions as to whether a supply that exceeds an MCL, ORSG, or HA may remain in service depend on the type of contaminant(s) found, their levels, persistence of the compound(s), other contaminants present in the water, the duration and severity of the exceedence, whether treatment is feasible, and the availability of alternate sources of drinking water. In addition to the drinking water standards and guidelines, MassDEP has also derived Immediate Action Levels (IAL) for routinely used water treatment chemicals, to enable water treatment plant operators to identify and address serious incidents of chemical overfeed or misuse.

MassDEP has established additional MMCLs that are not currently listed in the U.S. EPA's National Primary Drinking Water Regulations, and also some MMCLs that are more stringent than the corresponding EPA MCL. These MassDEP MCLs include Total Nitrate/Nitrite (10 mg/L), Perchlorate (2 ppb), and Radon (ORS Guideline of 10,000 pCi/L). The Table below lists both MMCLs for which no corresponding EPA MCL exists, and those MMCLs which are more stringent than the EPA MCL (corresponding EPA MCL is listed in right-hand column). MassDEP has also established one additional SMCL for Methyl *tertiary* butyl ether (MTBE) which is not covered in the National standards.

TABLE 7-1
MASSACHUSETTS MAX CONTAMINANT LEVELS: SELECTED CONTAMINANTS
(Not Included by EPA Primary Standards or More Stringent Mass Standards)

Substance	MMCL (mg/L)	EPA MCL (mg/L)
1,4-Dichlorobenzene (pDCB)	0.005	0.075
Ethylene dibromide (EDB)	0.00002	0.00005
Nitrate/Nitrite (Total)	10	---
Perchlorate	0.002	--- [1.]
Radon 222	10,000 pCi/L	--- [2.]
Substance	**SMCL (mg/L)**	**EPA SMCL (mg/L)**
Methyl *tertiary* butyl ether (MTBE)	0.020-0.040 [3.]	---

1. Perchlorate has received an EPA positive regulatory determination published 2/2011
2. EPA has published a final radon regulation (64 FR211, Tues. 11/2/1999) but the rule has not been promulgated. Exceedance of the MassDEP guideline indicates that indoor air sampling for Radon-222 should be done.
3. Advisory

MassDEP has also established enforceable Office of Research and Standards Guidelines (ORSG) for 32 additional contaminants which are not covered in the National standards. These are listed in the Table 7-2 below.

TABLE 7-2
MASSACHUSETTS ORSG HEALTH GUIDELINES

Substance	ORSG (mg/L)
Acetone	6.3
Aldicarb [1.]	0.003
Aldicarb sulfone [1.]	0.002
Aldicarb sulfoxide [1.]	0.004
Bromomethane	0.01
Chloroform [2.]	0.07
Dichlorodifluoromethane	1.4
1,1-Dichloroethane	0.07
1,3 Dichloropropene	0.0004
1,4-Dixoane	0.0003
Ethylene glycol	14
Manganese [3.]	See endnote
Methyl ethyl ketone	4.0
Methyl isobutyl ketone	0.35
Methyl tertiary butyl ether (MTBE) [4.]	0.07
Metolachlor	0.1
Napthalene	0.140
Nickel [5.]	0.1

Substance	ORSG (mg/L)
n-Nitrosodimethylamine (NDMA)	0.00001
Petroleum hydrocarbons [6.]	
TPH	0.2
Aliphatics	
C_5-C_8	0.3
C_9-C_{12} [7.]	0.7
C_9-C_{18} [7.]	0.7
C_{19}-C_{36}	14.0
Aromatics	
C_6-C_8	Use guidance for individual chemicals
C9-C10	0.2
C11-C22	0.2
Sodium [8.]	20
Tertiary-Amyl Methyl Ether (TAME)	0.09
Tertiary Butyl Alcohol (TBA)	0.12
Tetrahydrofuran [9.]	1.3
1,1,2-Trichloro-1,2,2-trifluoroethane (FREON 113)	210

1. The MMCLs for aldicarb, aldicarb sulfone, and aldicarb sulfoxide have been stayed.
2. The guideline above for chloroform applies to non-chlorinated water supplies. For chlorinated drinking water supplies, please contact the Drinking Water Program.
3. As of this writing (07/15/2013) manganese is both an EPA and MassDEP SMCL. The State of MA is moving to regulate manganese (see below).
4. The health-based guideline for MTBE was reviewed by ORS in 2000.
5. The MCL for nickel has been remanded and is no longer in effect, however the current EPA IRIS chronic oral reference dose for soluble salts of nickel supports this value and it is also the currently listed EPA Life-time Health Advisory Value.
6. Monitoring for these compounds is not required but is done on a case by case basis. These limits may be used when evaluating healthier risks posed by clearly identified mixtures of petroleum hydrocarbon compounds. The analytical methods to use to generate data to compare to the Drinking Water Guidelines are the Volatile Petroleum Hydrocarbon (VPH) and the Extractable Petroleum Hydrocarbon (EPH) methods developed by the MassDEP.
7. The overlap in the C9-C12 range is the result of the VPH and EPH analytical methods used to quantitate these ranges of petroleum hydrocarbons in drinking water. The choice of the most appropriate range to use is based on the identity of the petroleum product of concern and is therefore determined on a case-specific basis.
8. All detections of sodium must be reported. Please refer to 310 CMR 22.06A for the specific requirements. The sodium guideline of 20 mg/L is based on an eight (8) ounce serving.
9. The IRIS has updated the toxicity values for tetrahydrofuran. They are currently under review by ORS.

The OWD is currently monitoring 1,4-Dioxane as part of the CCL3 list as part of the UCMR3 assessment monitoring at Well No. 7, Facility No.1, and the Orleans WTF. For the May 14, 2013 sampling 1,4-Dioxane was not detected at any of these locations.

7.6.1 MASSACHUSETTS PERCHLORATE MMCL

Perchlorate is currently regulated in the State of Massachusetts as a MMCL. MassDEP has set an MMCL for perchlorate in water systems at 2.0 ppb. The US EPA has recently made the decision to regulate perchlorate, but a federal regulation has not yet been proposed. Perchlorate has been detected in Well No. 7 at a concentration of 0.07 ppb, which is a very low level just above the method detection limit (MDL = 0.05 ppb) and well below the Mass MMCL of 2.0 ppb.

Perchlorate may occur in groundwater as a result of contamination during the manufacture, testing, or disposal of solid rocket propellant; manufacturing of perchlorate compounds; and industrial manufacturing operations where perchlorate compounds were used as reagents. Where perchlorate originates from pollution, the levels detected are usually much higher than the 0.06 ppb found in Well No. 7.

Low levels of perchlorate may also form naturally, and several mechanisms for this have been identified and theorized. The widespread presence of microorganisms capable of reducing perchlorate further supports the concept of naturally occurring perchlorate.

Several possible mechanisms involve the creation of perchlorate in the atmosphere which then is washed by rain onto the ground surface (reactions between suspended chloride, atmospheric ozone, light, and lightning) where it sometimes accumulates in arid environments. Evaporite deposits (precipitated salts in soil from evaporated wetting fronts) may form perchlorate, and perchlorate has been incorporated into certain geologic formations. Perchlorate has been detected in seaweed at a high concentration of 885 ppm in a sample of kelp collected and analyzed by the USGS. (Trumpolt, C.W., et al, ‘Perchlorate: Sources, Uses, and Occurrences in the Environment”, Remediation, Winter 2005 pp 65-89).

It is worth noting here that significant concentrations of perchlorate may also be generated spontaneously in stored sodium hypochlorite solutions. Wright-Pierce has seen levels as high as 10,000 ppb in stored hypochlorite. The factors governing this formation include:

- Increased perchlorate formation with increased solution age,
- Rate of perchlorate formation almost doubles for every 10 deg F increase in temperature,
- Light increases formation of perchlorate in hypochlorite solutions,
- Less perchlorate forms in more dilute solutions.

  (from Geiner, 2008, JAWWA 100(11) pp 68-74; B. Stanford et al, 2011, JAWWA 103(6) pp 71-83).

When a hypochlorite solution containing perchlorate is metered into process water, the concentration in the hypochlorite was diluted down to a level below the 2.0 ppb MMCL. However, should perchlorate be detected in finished water, the stored hypochlorite solution should be checked to see whether it is a contributing source of perchlorate.

7.6.2 MASSACHUSETTS MANGANESE GUIDANCE

In 2004, the EPA issued a report titled Drinking Water Health Advisory for Manganese with information suggesting that children and infants should not consume water with manganese concentrations above 0.3 mg/L for sustained periods of time. High concentrations of manganese have been found to effect nervous systems. Younger children and babies are more susceptible than adults because manganese-supplemented baby formula and foods when mixed with water high in manganese may result in an excessive dose. This EPA report prompted the MassDEP to examine raw water and distribution system manganese concentrations in Massachusetts more closely.

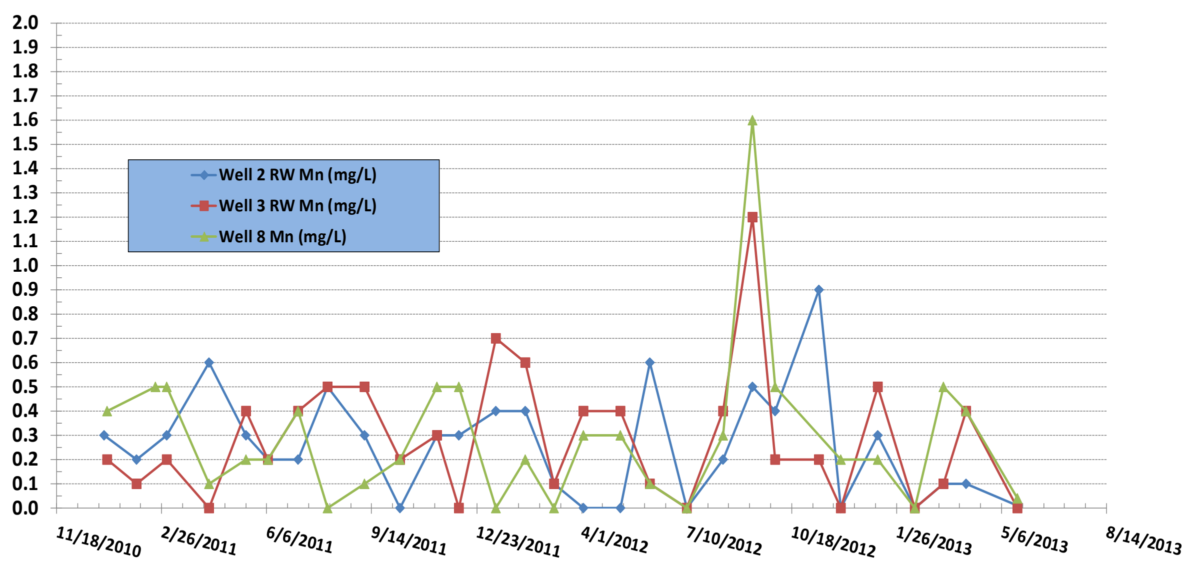
MassDEP is preparing new guidance for manganese, which is now waiting for final approval in 2014. If the manganese concentration in source water exceeds 1.0 mg/L, removal will be required. If the manganese concentration in source water is greater or equal than 0.3 mg/L but is less than or equal to 1.0 mg/L, an assessment by MassDEP's Office of Research and Standards will be required to determine whether manganese removal will be required. The regulation will require monitoring of manganese at water distribution entry points. A detected concentration greater than 0.05 mg/L must be reported in the unregulated table of the PWS's Consumer

Confidence Report in a newly required table entry and educational statement. The regulation will require public notice for a detected concentration greater than 0.3 mg/L, with certain actions to be required of the PWS. The North East Regional Office of MassDEP (Hilary Jean) was contacted for additional information on this regulation. A notification letter will be going out to all PWSs once the regulation is finalized. At this time there is no additional information available.

The Orleans Water Department provides membrane filtration to remove manganese from the water provided by Wells No. 1, 4, 5, and 6. Wells No. 2, 3, and 8 are chemically treated for disinfection and pH adjustment at Facility 1. Well No. 7 is treated at its pump station for disinfection and pH adjustment; it is used only during periods of high demand.

Figure 7-1 below shows the levels of manganese measured using field methods during 2013 for Wells No. 2, 3, and 8. The figure shows levels that are quite high, however, this is most likely

FIGURE 7-1
HISTORICAL TRENDS FOR MANGANESE CONCENTRATIONS IN WELLS NO. 2, 3 AND 8



caused by the field testing method used. Over the last three years, OWD has monitored Mn using a high range Periodate method, but has recently changed (May 2013) to using the low range PAN method which is in better agreement with the concentrations in Wells 2, 3, and 8 ranging from 0.01 to 0.05 mg/L in samples collected and sent to a certified lab. Of course, the best indication of manganese levels, are customer comments as to dirty or colored water.

The figure also shows an apparent periodic variation in manganese concentration. Variations in source water concentration may often occur as a result of water surface levels in the wells moving up and down, alternately exposing manganese mineral to oxidizing and reducing atmospheres. Alternatively, changes in manganese concentrations can also be attributed to changing influences of flows from various stratigraphies within the gravel layers. Samples may be higher if they are sampled upon start up compared to sampling after they have been running for a day or two.

Most representative samples would be obtained after the wells have been in use for a period of time and running near their normal pumping levels. To determine the usefulness of field test kits, one may take a split sample (testing half the sample using the minilab and send the other half to the certified lab), then the results can be used as monitored points and also serve as a basis for determining how well the field test is working. The fact that the low range field test is in agreement with the laboratory results (and customer complaints are not abundant) suggests that concentrations are truly lower in these sources than shown in data collected between 2011 and 2012. Additionally, it would be worth checking the HACH methods manual online to see whether there are interfering substances present in the well water that could throw off the field test accuracy.

If the manganese levels are such that they are sometimes truly high and sometimes truly low, it would be nice to know the cause so you could determine whether it is possible to change the way pumps are operated to avoid the high manganese occurrences. You would want to know whether the water levels in these wells continually drop while pumping, or whether water levels tend to remain stable while pumping (and the time period required for well levels to reach a stable pumping level).

Taking frequent monitoring samples would help detect whether trends exist; answering questions of whether Mn concentrations may change over time or whether Mn concentrations change with the well pumping levels (this is do-able if water level in the wells are monitored frequently while pumping). To capture the effect of pumping levels (and if you can monitor them, and if levels change) you would want to sample very frequently ideally until water level stabilizes. If the pumping levels are stable, you could test daily with the kit to see whether there is any change that could be tied to other factors you observe (weather, tide, operation of something else).

The manganese regulation is of particular concern to Orleans because it will require additional monitoring, and potentially changes in treatment and operation mandated by MassDEP.

7.7 Arsenic Rule

The Arsenic Rule, finalized on January 22, 2001, established a Maximum Contaminant Level (a National Primary Drinking Water Regulation) for Arsenic of 0.01 mg/L (10 µg/L) with a compliance date of February, 2006. The regulation also applies to non-transient, non-community water systems. Orleans routinely complies with this standard.

Arsenic in ground water may be difficult to remove when it is present in its lower oxidation state as arsenite (As III). As III has neutral charge within the pH range from 4 to 10 making it difficult to remove from water. For treatment to be effective, arsenite must be first be oxidized to the higher oxidation state form arsenate (AS V) prior to removal. Pre-oxidants include chlorine, permanganate, and ozone. UV light and solid oxidizing medias may also be appropriate. Table 6-3 describes EPA designated Best Available Technologies (BATs) for arsenic removal.

TABLE 7-3
ARSENIC REMOVAL – BEST AVAILABLE TECHNOLOGIES (BAT)

Best Available Technology	Maximum Percent Removal
Ion Exchange (sulfate < 50 mg/L0	95
Activated Alumina	95
Reverse Osmosis	>95
Modified Coagulation/Filtration	95
Modified Lime Softening (pH >10.5)	90
Electrodialysis Reversal	85
Oxidation/Filtration (20:1 iron:arsenic) this includes greensand filtration	80

Other removal technologies are in review or under development (e.g., granular ferric hydroxide and coagulation-assisted microfiltration). The disposal of arsenic waste brines will require careful investigation before committing to any removal technology.

7.8 PHASE I, II and V RULES

The Phase I, II, and V Rules require monitoring of and set limits in drinking water for a number of pesticides, herbicides, and chemicals used by industry and agriculture. The majority of the chemicals are organic but some are inorganic. Inorganic chemicals require annual analysis, while the organic chemicals require quarterly analysis for the first few years of treatment plant operation. If the chemicals are not present at levels above the limits, the system may request to analyze less frequently. Orleans routinely complies with this standard.

7.9 GROUND WATER RULE

The Ground Water Rule, which pertains to groundwater sources NOT under the influence of surface water, was finalized on November 8, 2006. Compliance requirements of the GWR began in 2010. Because most treatment systems serving groundwater sources do not include the protections against microbial contamination, filtration and primary disinfection, the Ground Water Rule served the purpose of better identifying systems at risk for fecal contamination, and to provide the primacy agency a flexible range of tools to better protect the public health.

The Ground Water Rule has the following four major components:

1. <u>Periodic sanitary surveys</u> of ground water systems that require the evaluation of eight critical elements and the identification of significant deficiencies (e.g., a well located near a leaking septic system). States must complete the initial survey by December 31, 2012 for most community water systems (CWSs) and by December 31, 2014 for CWSs with outstanding performance and for all non-community water systems.
2. <u>Source water monitoring</u> to test for the presence of *E. coli*, enterococci, or coliphage in the sample. There are two monitoring provisions:
    a. Triggered monitoring for systems that do not already provide treatment that achieves at least 99.99 percent (4-log) inactivation or removal of viruses and that

have a total coliform-positive routine sample under TCR sampling in the distribution system.

   b. Assessment monitoring - As a complement to triggered monitoring, a State has the option to require systems with sources that seem susceptible to fecal contamination, to conduct source water assessment monitoring to help identify high risk systems.

3. Corrective actions are required for any system with a significant deficiency or source water fecal contamination. Systems identified as having significant deficiencies or fecal contamination must implement one or more of the following correction action options:
   a. correct all significant deficiencies,
   b. eliminate the source of contamination,
   c. provide an alternate source of water, or
   d. provide treatment which reliably achieves 99.99 percent (4-log) inactivation or removal of viruses.
4. Compliance monitoring to ensure that treatment technology installed to treat drinking water reliably achieves at least 99.99 percent (4-log) inactivation or removal of viruses.

A sanitary survey by the State primacy agency is required every three years, and evaluates water systems against the following eight critical components (to the extent that they apply to the individual water system being surveyed):

1. Source
2. Treatment
3. Distribution System
4. Finished Water Storage
5. Pumps, Pump Facilities and Controls
6. Monitoring, Reporting, and Data Verification
7. System Management and Operation
8. Operator Compliance with State Requirements

Survey frequency may be reduced to five years if the system either treats to achieve a 4-log inactivation of viruses, or has an outstanding performance record in the eight performance elements documented in previous inspections, and has no history of TCR MCL or monitoring violations since the last sanitary survey.

Significant deficiencies in groundwater systems include, but are not limited to:

- Unsafe source (e.g., septic systems, sewer lines, feed lots nearby)
- Improper well construction
- Fecal indicators present
- Lack of proper cross-connection control for treatment chemicals
- Lack of redundant mechanical components where chlorination is required for disinfection
- Improper venting of chemical storage tanks
- Overflow and drain pipes not properly screened
- Holes in storage tank roof, improper hatch construction, improper clearwell hatch construction
- Inadequate internal cleaning and maintenance of storage tank
- Unprotected cross connection (e.g., hose bib without vacuum breaker)
- System leakage that could result in the introduction of contaminants
- Inadequate monitoring of disinfectant residuals and TCR MCL or monitoring violations

The Ground Water Rule uses the existing TCR monitoring as one trigger for determining whether a system should be defined as high risk. A groundwater system that does not disinfect to 4-log virus inactivation which has a distribution system TCR sample that tests positive for total coliform is required to conduct "triggered source water monitoring" to evaluate whether the total coliform presence in the distribution system is due to fecal contamination in the groundwater source. Within 24-hours of receiving the total coliform positive notice, the system must collect at least one groundwater sample from each groundwater source and test it for fecal indicators. If any monitoring sample is fecal indicator-positive, the system must notify the State immediately, and then take corrective action.

Ground water systems with significant deficiencies or source water fecal contamination must implement one of the following corrective action alternatives:

1. Correct all significant deficiencies;
2. Provide an alternate source of water;
3. Eliminate the source of contamination; or
4. Provide treatment that reliably achieves at least 4-log treatment of viruses (using inactivation, removal, or a Department-approved combination of 4-log virus inactivation and removal before or at the first customer for the ground water source.

The OWD uses membrane filtration (Pall microfiltration) as treatment for removal of iron and manganese for Wells No. 1, 4, 5, and 6. Microfiltration meets the requirements for treatment for 4-log virus removal when it is operated in accordance with MassDEP requirements and the integrity of the membrane is intact. For the other wells, where CT is not provided, it is likely that the discharge main could be used as a pipe contactor to meet CT if the rule is triggered in the future. However, Wells No. 1, 2, 3 and 8 are deep and have no history of bacterial contamination or the presence of surface water indicating organisms.

For systems serving 3,300 or more people per day, an alternative approved treatment technique is chemical disinfection, when it is continually monitored into the distribution system at a location approved by MassDEP, and is maintained every day the water is served to the public. Although OWD is not technically designated as a disinfected system, it maintains a free chlorine residual in the distribution system (through the addition of sodium hypochlorite) which is applied at all well stations.

7.10 TOTAL COLIFORM RULE

7.10.1 Current Requirements

The Total Coliform Rule (TCR) (promulgated in 1990) applies to all public water systems regardless of their size, water source, or whether transient or non-transient. The TCR requires monitoring the distribution system for total coliforms, and public notice is required for violations of the Maximum Contaminant Level (MCL) and monitoring/reporting requirements. All routine and repeat samples count toward calculating MCL compliance. Under the TCR, no reduced monitoring is allowed for systems serving more than 1,000 persons. In Massachusetts, TCR is implemented under 310 CMR 22.05.

Systems are required to take samples for total coliforms based on the population served, source type and vulnerability to contamination. The Maximum Contaminant Levels (MCLs) for microbiological contaminants is based on the presence or absence of total coliform in routine samples, rather than coliform density. No more than 5.0 percent of samples for total coliforms can be positive in one month. (For systems that collect fewer than 40 routine samples per month, like Orleans, no more than one sample can be total coliform-positive per month). If a sample tests positive for total coliforms, the system must collect a set of repeat samples within 24 hours at the sample tap that failed and at two additional taps, one within 5 services downstream, and one within 5 services upstream, and also analyze for fecal coliform or E. coli.

Any *E. coli*-positive routine sample, *E. coli*-positive repeat sample, fecal coliform positive repeat sample, or total coliform-positive repeat sample following a fecal coliform-positive sample constitutes a violation of the MCL for total coliform. For purposes of the public notification requirements in 310 CMR 22.16, this is a violation that may pose an acute risk to health.

A system the size of the OWD which serves population, for regulatory purposes of 10,326, is required to take 20 samples per month. However, the population in Orleans is seasonal with a much larger summer population compared to its winter population. MassDEP allows OWD to collect 20 TCR samples for six months of the year, and reduces to 7 samples per month for the other six months of the year due to the seasonal nature of the Town's population.

Although there have been coliform detections, and a violation received over 20 years ago (1992-1993), the OWD has been in good standing with the TCR Rule since that time.

The following have been determined to provide best available technology (BAT), is defined as treatment technique, or other means available for achieving compliance with the maximum contaminant level for total coliform:

1. Wells are protected from coliform contamination by appropriate placement and construction;
2. Disinfectant residual is maintained throughout the distribution system;

3. Proper maintenance of the distribution system including appropriate pipe replacement and repair procedures, main flushing programs, proper operation and maintenance of storage tanks and reservoirs, and continual maintenance of positive water pressure in all parts of the distribution system;
4. Filtration and/or disinfection of surface water, as described in 310 CMR 22.20A or disinfection of groundwater using strong oxidants such as chlorine, chlorine dioxide, or ozone; or
5. The development and implementation of a Department approved wellhead protection program under 310 CMR 22.21.

OWD has implemented all of these BAT's to some degree and the number of false positive samples have been reduced especially after the installation of the WTF. OWD is technically not a disinfected system, it does add disinfectant to the distribution system to all eight OWD well supplies. Wells No. 1, 4, 5, & 6 are treated at the WTF using microfiltration. Well No. 2, 3, and 8 enter a common facility (FAC-1) where the water is disinfected using sodium hypochlorite. Well No. 7 has its own facility where it is treated with potassium hydroxide and disinfected using sodium hypochlorite, after which it enters directly into the distribution system.

7.10.2 The Revised Total Coliform Rule (RTCR)

The Revised TCR was intended to reduce the implementation burden of the existing TCR (subject to anti-backsliding provisions to prevent a reduction in public health protection) while, at the same time , better ensuring the integrity of the distribution system.

The Revised Total Coliform Rule (RTCR) was promulgated in 2013 (final rule published Feb. 13, 2013 in the Federal Register, pp 10269-10365). Public water systems (PWS) must comply with the requirements of the Revised Total Coliform Rule (RTCR) by April 1, 2016. Until then, PWSs must continue complying with the 1989 TCR.

The RTCR represents a change from a public notification approach under TCR to a "find-and-fix" approach under RTCR. The RTCR maintains and strengthens the objectives of the TCR: (1) to evaluate the effectiveness of treatment, (2) to determine the integrity of the distribution system, and (3) to signal the possible presence of fecal contamination. The RTCR better addresses these objectives by requiring systems that may be vulnerable to fecal contamination (as indicated by their monitoring results) to do an assessment, to identify whether any sanitary defect(s) is/are present, and to correct the defects. It does not change the monitoring required, but it does change the actions PWSs must take for compliance.

Under the treatment technique for coliforms, Total Coliform sampling serves as an indicator of a potential pathway of contamination in the distribution system. A PWS that exceeds a specified frequency of total coliform occurrence must conduct an assessment to determine if any sanitary defects exist (a sanitary defect is defined by the RTCR as a “defect that could provide a pathway of entry for microbial contamination into the distribution system or that is indicative of a failure or imminent failure of a barrier that is already in place”. If any sanitary defects are found, the system must correct them. In addition, under the treatment technique requirements, a PWS that incurs an E. Coli MCL violation must conduct an assessment and correct any sanitary defects found.

Key differences between the TCR and the RTCR include:

- RTCR eliminates the MCL for total coliform, but includes an MCL for *E. coli*. Total coliform presence may indicate a potential pathway for contamination, but does not by itself indicate a health threat. The MCL for Total Coliform was replaced with a treatment technique that requires assessment and corrective action (see below). The purpose of this change was to minimize the number of MCL violations and reduce public notice requirements.
- Under RTCR, monitoring will continue for Total Coliforms and *E. coli* according to a sample siting plan and schedule specific to the PWS.
- When coliform are present or if monitoring is not done properly, under RTCR a PWS must conduct a full system assessment for sanitary defects, defects in the distribution system, and review monitoring practices to determine the reason samples were Total Coliform positive.
- Changes to the sampling site plan and monitoring requirements. These include changes to the number of repeat and additional routine samples required. Under RTCR, systems

have the flexibility to propose repeat sample locations that best verify and determine the extent of potential contamination rather than having to sample within five connections upstream and downstream of the total coliform-positive sample location. However, systems may continue to use this guideline if they so choose.

- New focus on seasonal non-community water systems. The RTCR specifies monthly monitoring, and requires a state-approved startup procedure (with the system certifying that the procedure was followed each season).
- Establishes criteria for systems to qualify for, and stay on reduced monitoring.

To maintain primacy, states will be required to adopt their own RTCR that is at least as strict as the federal regulation. In preparing for this rule, the American Water Works Association (AWWA) and the Water Research Foundation have developed best management practices.

7.11 LEAD AND COPPER RULE

The Lead and Copper Rule (LCR) was promulgated in 1991 is currently in effect for all community water systems and non-transient, non-community water systems. The purpose of the LCR is to protect public health by minimizing lead and copper levels in drinking water, primarily by reducing water corrosivity.

The LCR establishes action levels (AL) of 0.015 mg/L for lead and 1.3 mg/L for copper based on 90th percentile results of tap water samples. An AL exceedance is not a violation, but can trigger other requirements that can include the following:

- Water quality parameter monitoring;
- Corrosion control treatment;
- Source water monitoring/treatment;
- Public education; and
- Lead service line replacement.

Most water systems have incorporated the Rule's requirements. However, often it is difficult for utilities to remain in compliance or to remain on reduced monitoring as source water conditions change over time, or when a new treatment is implemented for the sake of other important water quality goals. Because lead and copper solubility are so sensitive to water quality, anytime a water system makes a change in water chemistry, the change should be brought about very gradually, if possible, and monitoring sampling should be conducted in distribution taps to detect changes in lead and copper levels.

Changes to the Lead and Copper Rule were made on October 10, 2007 that addressed the requirements for monitoring, treatment processes, reporting, public notification and education requirements, and lead service line replacement.

In January 4, 2011, the Reduction of Lead in Drinking Water Act was enacted, amending Section 1417 of the Safe Drinking Water Act reducing the use of lead in pipes, plumbing fixtures and fittings, solder and flux. The Act redefined “lead free” to lower the maximum lead content of plumbing products from 8.0% to 0.25%, and established January 4, 2014 as the initiation date of a three year period for water systems to transition to lead free.
A concern with the law was the possibility that water meters removed for servicing and calibration would not be allowed to be reinstalled, which would have a significant financial impact on water systems. However, the EPA is currently (Summer 2013) interpreting the law to mean that removing existing water meters for service will not result in that meter having to meet the new definition of lead free.

Currently, OWD is on a reduced monitoring schedule and complies with all the provisions of the lead and copper rule.

7.12 STAGE 2 DISINFECTANTS AND DISINFECTION BYPRODUCTS RULE (STAGE 2 D/DBPR)

The Stage 2 Disinfectants and Disinfection By-Products Rule (Stage 2 D/DBPR) was finalized as of January 4, 2006. The purpose of the rule is to increase public health protection by reducing the presence of disinfection by-products in drinking water. The Stage 2 Rule applies to all community water systems that add a primary or a residual disinfectant. The OWD system serves greater than 10,000 people and is therefore a "Schedule 3" system under the Stage 2 D/DBPR.

While the Stage 2 D/DBPR rule does not change the MCL values for TTHMs and HAA5s that were established under the Stage 1 D/DBPR, it does change the way sampling results are averaged to determine compliance. Compliance determination for Stage 2 is based upon a Locational Running Annual Average (LRAA) as opposed to the system-side running annual average (RAA) used in Stage 1. LRAAs must be met at every monitoring location while the RAA allows the system to average results over all monitoring locations.

The Stage 2 D/DBP requires systems to complete an Initial Distribution System Evaluation (IDSE) to identify new Stage 2 monitoring locations that best represent high-DBP locations. For Schedule 3 systems, this was to have been completed by January 2010. OWD identified its Stage 2 monitoring locations for the IDSE using a 40/30 Certification. Five monitoring locations were identified for the once per quarter DBP monitoring.

Starting in October 2013, systems must have completed their Stage 2 D/DBP Compliance Monitoring Plan and begin complying with the monitoring requirements of the Stage 2 D/DBP rule. By July 2014, the rule requires systems to be using rule requirements to determine compliance with operational evaluation levels for TTHM and HAA5.

OWD is in compliance with this regulation.

7.13 RADON RULES

Radon-222 is a naturally occurring volatile gas which forms from the radioactive decay of uranium-238 in the ground. Radon is colorless, odorless, tasteless, chemically inert, and radioactive. Radon can move through air or dissolve into water occurring in soil pores. Radon commonly enters homes through soil gas entering basement and crawl spaces, or when water containing radon is used for cooking or washing it is released into the air of the house where it can be inhaled.

7.13.1 US EPA Radon Rule

The US EPA proposed a Radon Rule on November 2, 1999, but this has not yet been finalized. It was re-scheduled to be promulgated in late 2004, but it still remains delayed. The rule is unique in that for the first time, the EPA seeks to address a health risk caused by an air and water-borne contaminant with one rulemaking.

USEPA originally proposed an MCL of 300 pCi/L and an alternative MCL (AMCL) of 4,000 pCi/L for governments or utilities that have implemented a "multi-media mitigation (MMM) program" to lower indoor air radon from all sources. This means that treatment would not be required for supplies with radon levels between 300 and 4,000 pCi/L if either the State , the Town of Orleans, or the OWD were to develop and implement a MMM program. With or without a MMM program, sources with radon levels above 4,000 pCi/L would be required to provide treatment. The volatile nature of radon makes it easy to remove with exposure to the atmosphere, usually during aeration, which EPA has designated as the Best Available Technology (BAT) for radon removal.

7.13.2 Massachusetts Radon Rule

MassDEP has an established an ORSGL for Radon of 10,000 pCi/L. This ORSGL is essentially an Action Limit which requires, when concentrations of Rn-222 in water equal or exceed the Action Limit of 10,000 pCi/L, the MassDEP addresses public water system exceedances in a case by case way. Steven Hallem, the MassDEP Radionuclides Coordinator, said that when a public water system finds radon in finished water above the 10,000 pCi/L limit, information about pumping rate, levels, water usage, and the population served is first collected from the water system and sent to the Office of Research and Standards (ORS) where an analysis is made as to whether a threat to public health exists. For a public water system exceeding the 10,000 pCi/L guideline, it is most likely that treatment by aeration of the source water would be preferred in lieu of developing an MMM style of program within the community.

Radon in the OWD sources have been measured at levels less than 100 pCi/L. In addition, the treated water at all sources was found to be below the anticipated MCL requirement of 300 pCi/L.

7.14 GROUND WATER UNDER THE INFLUENCE OF SURFACE WATER (AND SURFACE WATER TREATMENT RULE)

The OWD system is supplied entirely by groundwater, and no wells are currently classified as groundwater under the direct influence (GWUI) of surface water. There are a number of regulations normally pertaining to surface water that would apply to groundwater sources determined to be GWUI that treat (this is reviewed should this become an issue in the future).

These surface water treatment regulations include the following regulations that amend the Surface Water Treatment Rule (SWTR, 1989):

- Interim Enhanced Surface Water Treatment Rule (finalized in 1998)
- Filter Backwash Recycling Rule (finalized in 2001)
- Long Term 1 Enhanced Surface Water Treatment Rule (finalized in 2002)
- Long Term 2 Enhanced Surface Water Treatment Rule (promulgated in 2006)

The major requirements for these regulations can be summarized as follows:

- Pathogens:
  - 99.9% (3-log) inactivation and/or removal of *Giardia Lamblia.*
  - 99.99% (4-log) inactivation and/or removal of viruses.
  - 99% (2-log) removal of *Cryptosporidium* (additional removal could be required based on *Cryptosporidium* monitoring results obtained from source monitoring required as part of the Long Term 2 Enhanced Surface Water Treatment Rule).
- Residual Disinfectants:
  - Disinfectant residual $\geq$ 0.20 mg/L at entrance to distribution system.
  - Detectable disinfectant residual in the distribution system.
- Filtered Water Turbidity Performance:
  - Combined filter effluent turbidity $\leq$ 0.30 NTU 95% of time.
  - Maximum level of 1 NTU.
- Filter Backwash Water:
  - Required to be returned to the head of the plant for full treatment if recycling is practiced.

Whether or not a groundwater source is considered GWUI is determined by Microbiological Particulate Analysis (MPA) testing. Groundwater sources that meet MassDEP Drinking Water Program exemption criteria do not have to undertake microscopic particulate analysis (MPA) testing in order to evaluate the need for enhanced wellhead protection or filtration. These sources are recorded in the MassDEP database, as "exempt" from further testing. The treatment requirements of the SWTR do not apply to these sources; they are not considered to be GWUDI.

Note: changes in source water quality, quantity or physical surroundings, intrusions on the well or other criteria as noted by the MassDEP regional office may result in the need for MPA testing and further evaluation of the groundwater as a GWUDI source. Exemption from MPA testing is based on three criteria which must all be met. For sand and gravel (overburden) wells the exemption criteria are:

1. Criterion 1:
    a. Source is located more than 150 feet from a surface water feature;
2. Criterion 2:
    a. The well is constructed with a properly installed sanitary seal;
    b. The well screen is located below a geologic confining layer;
3. Criterion 3:
    a. The top of the well screen is 50 feet or more below the ground surface;
    b. The well is approved to pump on average 720,000 gallons per day or less;
    c. The well is constructed with a properly installed sanitary seal;
    d. The groundwater source has not had a total or fecal coliform or *E.coli* violation during the last three years.

OWD wells are all overburden wells. There are no bedrock wells so that bedrock well exemption criteria do not apply.

The OWD's WTF which treats Wells No. 1, 4, 5, and 6 would already meet SWTR regulations because water is treated using microfiltration membrane filtration (Pall), and therefore meets the filtration requirements. Wells No. 2, 3, 7, and 8 have not been evaluated by Microbiological

Particulate Analysis (MPA testing) and may be exempt. This would need to be confirmed with the local MassDEP (Southeast Regional Office).

7.15 UNREGULATED CONTAMINANT MONITORING, CONTAMINANT CANDIDATE CONTAMINANT LISTS, AND REGULATORY DETERMINATIONS

The 1996 Safe Drinking Water Act Amendments created a new method of prioritizing new contaminants to be regulated. As a result, EPA promulgated the Unregulated Contaminant Monitoring Rule (UCMR) and Contaminant Candidate List (CCL), which were developed as coordinating processes. The regulatory determinations are made based on the results of CCL/UCMR and the EPA's 6-year reviews. Although this section does not discuss regulations affecting OWD per se, it describes the regulatory process followed by EPA and provides a view to the regulatory horizon.

7.15.1 Contaminant Candidate Lists (CCL)

The CCL is used to define unregulated contaminants for which EPA needs to obtain occurrence data, develop analytical methods, ascertain potential health effects, and evaluate treatment techniques. Every five years the EPA is required to publish a CCL of currently unregulated contaminants in drinking water that may pose risks, and to make determinations on whether or not to regulate at least five contaminants on a five year cycle, or 3½ years after each CCL is published, if EPA finds that such regulation would present a meaningful opportunity for health risk reduction. The CCL comprises contaminants that are (1) not currently regulated by the National Primary Drinking Water Regulations, (2) are known or anticipated to occur at public water systems, and (3) that may warrant regulation under the Safe Drinking Water Act. The number of contaminants on the CCL lists are therefore much greater than those monitored under each UCMR.

The CCL process builds on evaluations used for previous CCLs and is based on substantial expert input and recommendations from the National Academy of Science's National Research Council (NRC) and the National Drinking Water Advisory Council (NDWAC). EPA re-issues the CCL list based on reviewed contaminants that had been targeted through existing prioritization processes, including previous UCMR contaminants and previous Contaminant Candidate Lists. Many contaminants may be carried over into succeeding CCLs. Additional contaminants are identified based on current research on occurrence and health effect risk factors. Contaminants are prioritized on the CCL according to whether they have analytical methods that are ready for use, have an analytical reference standard, or whether they are registered for use and are likely to be found in the United States (in the case of certain pesticides). EPA has further prioritizes contaminants based on more extensive health effects evaluations by the Office of Water's Office of Science and Technology. EPA evaluated approximately 7,500 chemicals and microbes that have the potential to present health risks through drinking water exposure.

On February 11, 2011 a Final Regulatory Determination was published in the Federal Register for the CCL2 contaminant perchlorate. This means that the EPA intends to propose a national primary drinking water regulation for perchlorate. Such a regulation has not yet been proposed. The current CCL3 was finalized in May 2012, and contains 104 chemicals or chemical groups and 12 microbiological contaminants which are known or anticipated to occur in public water systems. The list includes chemicals used in commerce, pesticides, biological toxins, disinfection byproducts, and waterborne pathogens. Contaminants from CCL3 have been included in UCMR3.

The CCL4 is currently under development. In early 2012, EPA published a Federal Register notice seeking nominations for inclusion with the draft CCL4 expected to be published in 2013 (final list expected in 2014).

7.15.2 Unregulated Contaminant Monitoring Rule (UCMR)

The UCMR process is used to generate occurrence data required by selected contaminants on the CCL. Once every five years the EPA issues a list of no more than 30 unregulated contaminants selected from the CCL for monitoring by public water systems under the UCMR. The first Unregulated Contaminant Monitoring Rule (UCMR 1) was published on September 17, 1999, the second (UCMR 2) was published on January 4, 2007 and the third (UCMR 3) was published on May 2, 2012 (monitoring by PWS is now in progress).

Data collected through UCMR are stored in the National Contaminant Occurrence Database (NCOD), and may be viewed by the public. The data are used to support analysis and review of contaminant occurrence, to guide the CCL selection process, and to support the Administrator's determination of whether to regulate a contaminant in the interest of protecting public health.

Sampling for the UCMR3 List 3 will occur between 2013 and 2015. The UCMR3 consists of three separate lists of contaminant groupings to be monitored: Assessment Monitoring (List 1), Screening Survey (List 2), and Pre-Screen Testing (List 3).

- Assessment Monitoring (List 1) consists of 21 contaminants which are analyzed using common analytical technologies. All systems serving more than 10,000 persons are required to monitor the Assessment Monitoring (List 1). In addition, a group of 800 systems, each serving fewer than 10,000 persons, was selected to sample List 1.
- Screening Survey (List 2) consists of seven (7) contaminants that will be analyzed using specialized analytical technologies that are not currently used by drinking water laboratories. All systems serving more than 100,000 are required to participate in the Screening Survey (List 2). In addition, a group of 320 representative systems serving from 10,001 to 100,000, and a group of 480 representative systems serving ≤ 10,000 were selected to participate in the Screening Survey (List 2).
- Pre-Screen Testing (List 3) includes two (2) viruses, and uses newer analytical techniques that are not commonly used by drinking water laboratories. A group of 800 systems that use wells in locations of fractured bedrock or karst, which do not disinfect, serving ≤ 1,000 persons was selected to participate in the Pre-Screen Survey (List 3).

OWD, with a population less than 10,000 persons, is required to collect sample for the UCMR3 List 1. The complete UCMR3 list of contaminants is presented in Tables 7-4, 7-5, and 7-6.

TABLE 7-4
ASSESSMENT MONITORING (LIST 1) CONTAMINANTS FOR UCMR 3

Assessment Monitoring (List 1 Contaminants)	
Contaminant	**Analytical Methods**
Volatile Organic Compounds	EPA 524.3
1,2,3-trichloropropane	
1,3-butadiene	
chloromethane (methyl chloride)	
1,1-dichloroethane [1.]	
bromomethane (methyl bromide)	
chlorodifluoromethane (HCFC-22)	
bromochloromethane (halon 1011)	
Synthetic Organic Compounds	EPA 522
1,4-dioxane	
Metals	EPA 200.8 Rev 5.4, ASTM D5673-10, Standard Methods 3125 (1997) (excluding chromium-6)
Vanadium	
Molybdenum	
Cobalt	
Strontium	
chromium*	
chromium-6	EPA 218.7
Oxyhalide Anion	EPA 300.1, ASTM D6581-08, Standard Methods 4110D (1997)
Chlorate	
Perfluorinated Compounds	EPA 537 Rev 1.1
perfluorooctanesulfonate acid (PFOS)	
perfluorooctanoic acid (PFOA)	
perfluorononanoic acid (PFNA)	
perfluorohexanesulfonic acid (PFHxS)	
perfluoroheptanoic acid (PFHpA)	
perfluorobutanesulfonic acid (PFBS)	

*Monitoring for total chromium- in conjunction with UCMR 3 Assessment Monitoring- is required under the authority provided in Section 1445(a)(1)(A) of SDWA

[1.] 1,2-Dichloroethane is already regulated as an MMCL = 0.005 mg/L

TABLE 7-5
LIST 2 CONTAINANTS FOR UCMR 3

Screening Survey (List 2 Contaminants)	
Contaminant	**Analytical Methods**
Hormones	EPA 539
17-β-estradiol	
17-α-ethynylestradiol (ethinyl estradiol)	
16-α-hydroxyestradiol (estriol)	
equilin	
estrone	
testosterone	
4-androstene-3,17-dione	

TABLE 7-6
LIST 3 CONTAMINANTS FOR UCMR 3

Pre-Screen Testing (List 3 Contaminants)	
Contaminant	**Analytical Methods**
Viruses	EPA 1615
enteroviruses	(qPCR & cell culture)
noroviruses	(qPCR)

7.15.2.1 *UCMR3 Results in Orleans*

The Table 7-4 UCMR3 contaminants; **total chromium, strontium, vanadium, chromium 6**, and **chlorate** were detected in Well No. 7 and Facility No. 1 water sources. At this time there are neither federal nor state no regulations or standards for these contaminants (although List 1 does include 1,2-Dichloroethane which is regulated as a Massachusetts MMCL, however it was a non-detect for OWD during the first phase UCMR). However, EPA does require notification in the Orleans Water Department Consumer Confidence Report (CCR) in the unregulated section that these substances have been detected under this program. At present, there is no prescribed language for this notification.

An important perspective to keep in mind is that the two previous UCMRs (UCMR1 and UCMR2) which did not result in a positive regulatory determination. Recently, under the CCL3, EPA made what was described as an “off cycle” positive regulatory determination for perchlorate (February 2011). This is the only positive regulatory determination made to date under these processes.

7.15.3 Regulatory Determination (RD)

EPA evaluates the CCL3 contaminants as information becomes available to include some in a “short list” of those contaminants with sufficient data to make a determination. A preliminary determination with the rationale for the determination is published in the Federal Register or public comment. In making a regulatory determination to regulate a substance, EPA considers the following criteria:

1. The contaminant may have an adverse effect on the health of persons;
2. The contaminant is known to occur or there is a substantial likelihood that the contaminant will occur in public water systems with a frequency and at levels of public health concern; and
3. In the sole judgment of the Administrator, regulation of such contaminant presents a meaningful opportunity for health risk reduction for persons served by public water systems.

Methyl-tertiary dibromoethylene (MTBE) and perchlorate were on the second Contaminant Candidate List. EPA did not make a regulatory determination on either perchlorate or MTBE in its CCL2 Preliminary Determinations; Proposed Rule (May 1, 2007). MTBE was not regulated at that time because EPA's health risk assessment had not been finalized. MassDEP has also included MTBE in its listing of health guidelines and SMCLs. However, in February 2011, EPA made an off-cycle determination to regulate Perchlorate which was on the CCL3. MassDEP has already established its own MMCL for Perchlorate of 2.0 ɥg/L (or 2.0 ppb).

7.16 CHEMICAL SAFETY CONTROL

MassDEP revised the Chemical Safety Control Strategy in January 2008, incorporating requirements into Chapter 6 of the Guidelines and Policies for Public Water Systems. Chapter 6 requires that critical chemical feed systems (those that may result in a threat to public health and safety in the event of an overfeed or underfeed of the chemical) be fitted with monitoring instrumentation, controls, and alarms. For the OWD, this requirement pertains to both the potassium hydroxide and the sodium hypochlorite storage and feed systems (pH adjustment chemical and disinfectant) in the WTF, Facility No. 1 and the Well No. 7 pump station.

The regulations therefore require OWD to provide instrumentation to monitor pH and free chlorine concentration in each of the three facilities (Well No. 7, Facility No. 1, and WTF). The well pump motor controller, pH and chlorine analyzer, and hypochlorite and caustic feed pumps must be interlocked to prevent chemical metering. Water flow in piping must be metered (or provided with a flow switch) and also interlocked to prevent chemical metering when low or no flow is detected. The system is intended to prevent metering under three conditions:

1) when the well pump is not running or producing water; and/or
2) when pH or chlorine concentrations are out of range;
3) when the analyzer is malfunctioning.

Additionally, the electrical power supply to chemical metering pumps must be configured to prevent overriding the safety shut down systems. When metering is in the manual mode, the operator is to be notified locally by a visual and/or audible alarm and /or remotely by an autodialer. Chapter six requires quarterly testing of critical chemical controls, alarms, and interlocks, with required maintenance of testing logs. Written protocols for testing alarms is required. If a remote notification device is required, that too needs to be tested quarterly according to a written protocol, with inclusion in the testing log.

7.17 SPENT ANALYZER SAMPLE DISCHARGE TO GROUND

The discharge of spent sample from in-line monitoring analyzers has received a Standard Operating Procedure issued by MassDEP which was effective 02/12/08. The Underground Injection Control program and Industrial Waste Water program jointly reviewed information on analyzer waste and determined that the nature of the chemicals in the concentrations of spent analyzer reagents being discharged were not a threat to public health and the environment. For this reason a Groundwater Discharge Permit is not required for such discharges if the PWS implements the best management practices and they register the discharge as a UIC Class V well. Discharge to dry wells is an "authorized by rule" activity where no permit is required. While they do allow discharge to the ground via a drywell, drainfield, borehole or sump, discharge to the surface of the ground (sheet flow) is not allowed.

A PWS is required to register with the UIC program in Mass DEP's Drinking Water Program using registration form BRP WP-06a, b, & c. Select "c" for 5G30 well type. A separate registration form is required for each site where effluent is discharged to a drywell. A MSDS for all reagents used in the on-line analyzer with dosage rate and concentration must be attached to the UIC application form. For most PWS this will be a one-time registration, modified only if the required information changed (e.g., location, No. of wells, or type of discharge(s)).

7.18 PUBLIC HEALTH SECURITY AND BIOTERRORISM PREPAREDNESS AND RESPONSE ACT OF 2002

In 2002, Congress amended the SDWA by enacting the Public Health Security and Bioterrorism Preparedness and Response Act, which added several important sections to the SDWA to address water system security.

Congress amended the Safe Drinking Water Act (SDWA) by enacting the Public Health Security and Bioterrorism Preparedness and Response Act of 2002 which became law on June 12, 2002, and added several important sections to address water system security. Water Systems serving more than 3,300 people must conduct Vulnerability Assessments and create or revise Emergency Response Plans according to the results. The Vulnerability Assessment is intended to evaluate a Water System's susceptibility to potential threats, and to identify corrective measures to mitigate or reduce risk from potential threats. The Emergency Response Plan serves as a source of information which would be needed in the event of an emergency, and contain the procedures for addressing emergencies when they occur.

For systems serving more than 3,300 people, a Vulnerability Assessment (VA) was required to have been submitted to the EPA by June 30, 2004. After completion of the VA, an Emergency Response Plan (ERP) which incorporated the findings of the VA is required within 6 months

(December 31, 2004). Very small systems between 500 and 3,300 persons are not required to submit a VA or ERP. OWD has complied with this regulation.

7.19 MASSACHUSETTS SOURCE APPROVAL AND WELLHEAD PROTECTION

The State of Massachusetts implements Ground Water Source Approval and Protection under 310 CMR 22.02, 22.03, and 22.21. Moreover, after Ground Source Approval is obtained, PWSs must also obtain a permit for withdrawal in accordance with the Water Management Act, MGL. c. 21 G, and 310 CMR 36.00. The State requires systems that are entirely reliant upon ground water to provide redundant wells and equipment capable of producing the same volumes and quantity of water as the system's primary well or wellfield at all times, or alternatively, that PWSs provide a storage capacity equivalent to two average days of demand, unless an interconnection with another PWS is available which can adequately provide the quantity and quality of water needed.

7.19.1 Wellhead Protection

The State requires that public water systems protect, by ownership or control, the closest radius around wells, which is termed Zone I. The next category out, Zone II, is delineated and approved by DEP, and is protected by municipal adoption of bylaws, zoning ordinances or health regulation which prohibit certain listed land uses.

Zone I radii Required	
Approved yields > 100,000 gpd	400 foot radius
Tubular well fields	250 foot radius
All other public water system wells	radius = [150 x log of pumping rate in gpd] - 350

Zone II is the area that contributes water under the most severe pumping and recharge conditions that can be anticipated (e.g., 180 days pumping at max approved yield with no recharge during a drought). Zone II must extend up-gradient to a hydrogeologic boundary (contact with less permeable bedrock or till or a recharge boundary). The down-gradient boundaries can be defined as the groundwater divide that results from pumping. Zone III consists of the remainder of the groundwater and surface drainage areas which contribute water to Zone II. New well supplies must implement a ground water monitoring well program. For new systems that haven't had an opportunity to establish the Zones, the State applies an interim protection area of ½ mile radius.

PWS must submit annual reports on approved forms of the results of a yearly land use survey by January 31 of each year to the Department Office of Water Supply at the Regional Office that serves the area where the well or wellfield is located.

The OWD has Zone IIs approved for all the well sources.

7.19.2 Source Water Assessment and Protection Program

The Massachusetts DEP has had a source protection program since 1980. The Federal Safe Drinking Water Act required all states to develop a Source Water Assessment and Protection Program (SWAP). SWAP reports are available in an electronic format at http://www.mass/gov/dep/brp/dws/files/swap/swapreps.htm.

A wellhead protection plan contains four (4) elements:

1. A delineation of a protection area for water sources,
2. An inventory of land uses for potential sources of contamination, and determines the susceptibility of the supply to these threats,
3. A management plan to mitigate current and prevent future threats to each well,
4. A contingency plan for dealing with any disruption of service

The finalized management plan for long-term protection of the well will include recommended measures which systems will initiate to eliminate or reduce existing threats. Such measures will likely include a combination of land ownership, easements, local ordinances and zoning, as well as enforcement of existing environmental regulations. Best management plans (BMP's) for nearby agricultural enterprises may also be included in a management plan, especially where agricultural activities threaten wells. Larger systems will work with the MassDEP to develop a tailored contingency plan.

7.19.3 Massachusetts Water Management Act Permitting

The Water Management Act (310 CMR 36.00) of 1986 requires that withdrawals of water above a threshold quantity are registered and regulated. The Water Management Act is administered by the DEP's Division of Water Supply and consists of a registration program and a permit program. The withdrawal registration program, completed in the late 1980's provided a procedure and deadline for filing a registration statement with DEP to enable documentation of baseline water use. New water withdrawals over 100,000 gpd average yearly usage or 36.5 M unregistered gallons per year must be permitted under the WMA. WMA permits run 20 years and are authorized in 5 year increments, however increased volumes require a new permit application. Permits require annual reports with monthly withdrawal information.

New water sources must also be reviewed under the Massachusetts Environmental Policy Act (MEPA). Increased withdrawals require MEPA review (301 CMR 11.00). If interbasin transfers are involved, for withdrawals crossing a river basin or municipal boundary, such transfer must be approved by the Water Resources Commission.

The OWD has a current WMA permit which is referenced herein that guides extraction of water from the Town's eight well sources.

Section 8

SECTION 8
UTILITY BENCHMARKING

8.1 INTRODUCTION

The first step in creating an effective asset management plan is establishing a level of service. The level of service defines the way in which the utility owners, managers, and operators want the system to perform over the long term. Benchmarking is a tool used to obtain data establishing how well a utility is performing in comparison to similar utilities. This information is then used in determining the correct level of service needed and supplied.

The objective of utility benchmarking is to create performance metrics with minimal bias and then poll and evaluate participants based on their specific data. The American Water Works Association's 2011 Utility Benchmarking Survey sorted the respondent's information into four (4) categories under which each performance indicator was placed and ranked.

- Organizational Development
- Customer Relations
- Business Operations
- Water Operations

For this study information was collected on the Orleans Water Department for the fiscal years 2011 and 2012 and was compared to two statistical data sets:

- National norms for water systems with populations 0-10,000. Orleans has a population of ~5000 making these values most relevant.
- Regional norms using the Northeast data set. Cost of service can often vary regionally due to specific regulatory limitations or cost of living situations.

Each indicator that received more than five (5) responses was statistically given quartiles (top and bottom) and for more than three (3) responses a median. Favorability of placement in a quartile depends on how the specific index is defined. For example, posting a lower number for Customer Service Costs per Account (e.g. $13.00 per account) would earn the utility a ranking in the top quartile (25%) and vice versa (e.g. $44.00 per account) for the bottom quartile (75%).

The 2011 AWWA 2011Survey lists the median for Customer Service Cost per Employee as $27.67 here in the Northeast. Orleans reported an average of $21.69 for the 2011 and 2012 fiscal years, placing them in the top quartile of this category by comparison. Data collected for Orleans, the Northeast, and National data are included in Appendix D.

In summary, the value of this analysis is to demonstrate if the Town needs to improve funding in certain areas to meet benchmarking standards for performance discussed herein. If this is the case, the funding changes would be recommended for the next 20-year planning period.

8.2 ORGANIZATIONAL DEVELOPMENT

Organizational Best Practices Indices (Refer to Table 8-1 – Organizational Best Practices Results, located on page 8-6)

The scoring system assigned to the management programs listed below is based on the following points:

5 – This activity is fully implemented.
4 – This activity is largely implemented but there is room for improvement.
3 – This activity is implemented but there is room for substantial improvement.
2 – This activity is implemented, but only occasionally or without uniformity.
1 – This activity is not currently practiced.

8.3 Organizational Best Practices (*Excerpt from the 2011 Benchmarking Performance Indicators for Water and Wastewater Utilities*)

8.3.1 Strategic Planning – Superior attributes include:

- *"Analyses and selection of strategies in the areas of water and/or wastewater system management, customer service, finance, human resources management, customer service, finance, human resources management, and business process improvement.*
- *Short-term and long-term action plans including allocation of resources directed at achieving the goals and strategies the utility has adopted.*

- *A process for strategic plan development and annual review of updates that facilitate input from customers, employees, and other stakeholders.*
- *An assessment of the utility's strengths and opportunities for improvement for the next 3 to 10 years.*
- *Vision, mission, and organizational value statements."*

8.3.2 Long-term Financial Planning

Long-term financial plans include development of adequate rates, fees, and charges for costs associated with operation, maintenance (including asset management), capital improvements, and reserves. Planning horizons typically range from 5 to 25 years. Financial planning matches resources to achievement of strategic goals such as:

- Funding of operations and maintenance costs.
- Funding of the capital improvement plan, taking into account effects of capital improvements on operations and maintenance costs.
- Funding of the asset management plan for all asset classes.
- Development of rate alternatives and recommend projected rates of the life of the plan."

(*Excerpt from the 2007 QualServe Benchmarking Report*)

8.3.3 Risk Management Planning

The program should define possible risks to the utility's strategic plan and ways to minimize the effects of physical and financial loss. "Examples of planning elements are:

- Health and safety programs for employees and the general public;
- Security and resiliency of resources, facilities, and service delivery systems;
- Disaster readiness and emergency operations;
- Assessment and mitigation of potential public and environmental liability;
- Hazardous material contingency planning; and

- Insurance procurement (or alternative self-insurance policies), including property and casualty insurance, health and workers compensation insurance, and liability insurance."

8.3.4 Performance Measurement System

An effective performance system measurement will:

- Provide measures focused on quality, efficiency, and effectiveness.
- Establish targets, usually in conjunction with the budgeting process, that reflect broad internal, external, and financial improvement goals.
- Include regular monitoring and reporting.
- Support both routine work and special projects as done by staff or outside parties.
- Tools such as the utility business process framework, the Kaplan and Norton balanced scorecard, and the Governmental Accounting Standards Board (GASB) performance measurement framework offer useful outlines for organizing performance measurement."

8.3.5 Optimized Asset Management Program

An optimized asset management program strikes a balance between performance, risk, and cost to support infrastructure repair and replacement decisions. Effective asset management programs include:

- A full inventory of infrastructure assets and their locations in the system.
- Condition assessment for all asset classes.
- Replacement cycle estimates for each asset class.
- Estimates of asset maintenance and replacement costs.
- Risk rankings based on the impacts of specific asset failure.

8.3.6 Customer Involvement Program

Utilities should encourage their ratepayers to become engaged through transparency of management practices and decisions. An effective customer involvement program can facilitate solid public relations. "Examples of good practice include:

- Offering educational programs and materials and assessing their effectiveness
- Conducting customer satisfaction surveys and responding to the results
- Soliciting input on projects and programs under consideration, in planning, or under construction
- Efficiently resolving customer issues and complaints."

8.3.7 Continuous Improvement

Utilities should promote organizational participation in regional and national competitions, participation in performance based programs sponsored by government agencies and accredited founders, and foster employee career growth and networking with peers in the profession. Examples of good practice include examining and participating in the following:

a) EPA Partnership for Safe Water.
b) ISO 9000 Series.
c) ISO 14001
d) Work Process Documentation Programs.
e) Self-Assessments.
f) Lunch-time training seminars.
g) NEWWA Educational Programs.
h) Employee Mentoring.
i) Stipends for Additional Licensing.

Table 8-1

Operational Best Practices Results

Index No.	Orleans			Region 1: Northeast 2011			National 2011		
	FY2011	FY2012	Average	Top Quartile	Median	Bottom Quartile	Top Quartile	Median	Bottom Quartile
1	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	3.0
2	5.0	5.0	5.0	5.0	4.0	3.3	5.0	4.0	3.5
3	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	3.0
4	4.0	4.0	4.0	3.8	3.0	2.3	4.0	3.0	3.0
5	4.0	4.0	4.0	4.0	4.0	3.0	4.0	3.0	2.0
6	3.0	3.0	3.0	4.0	3.0	3.0	3.5	3.0	2.5
7	4.0	4.0	4.0	4.0	3.0	3.0	3.0	3.0	2.5
Index Score			**27.5**		**25**			**24**	

8.4 Organizational Development

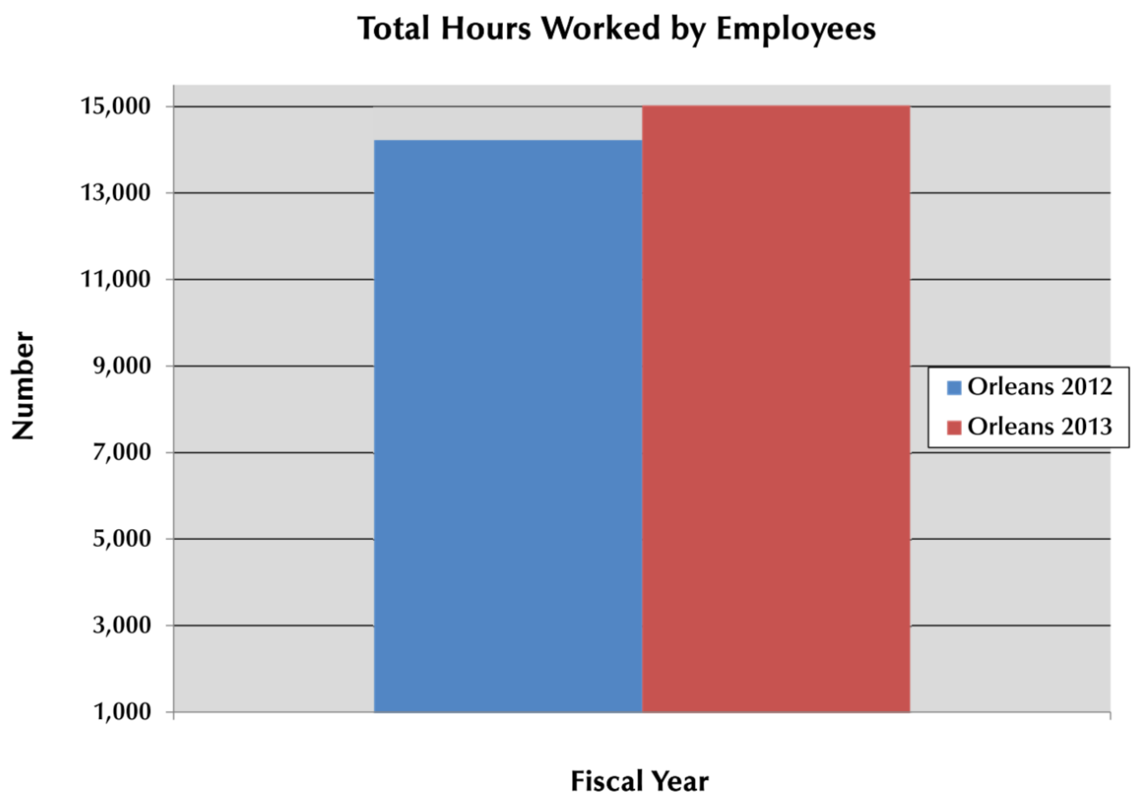
Various Organizational Performance Indices (Refer to Table 8-2 – Various Organizational Performance Results, located on page 8-10).

8.4.1 Health and Safety Severity Rate

Objective: To assess the impact of lost productivity due to illness or injury.

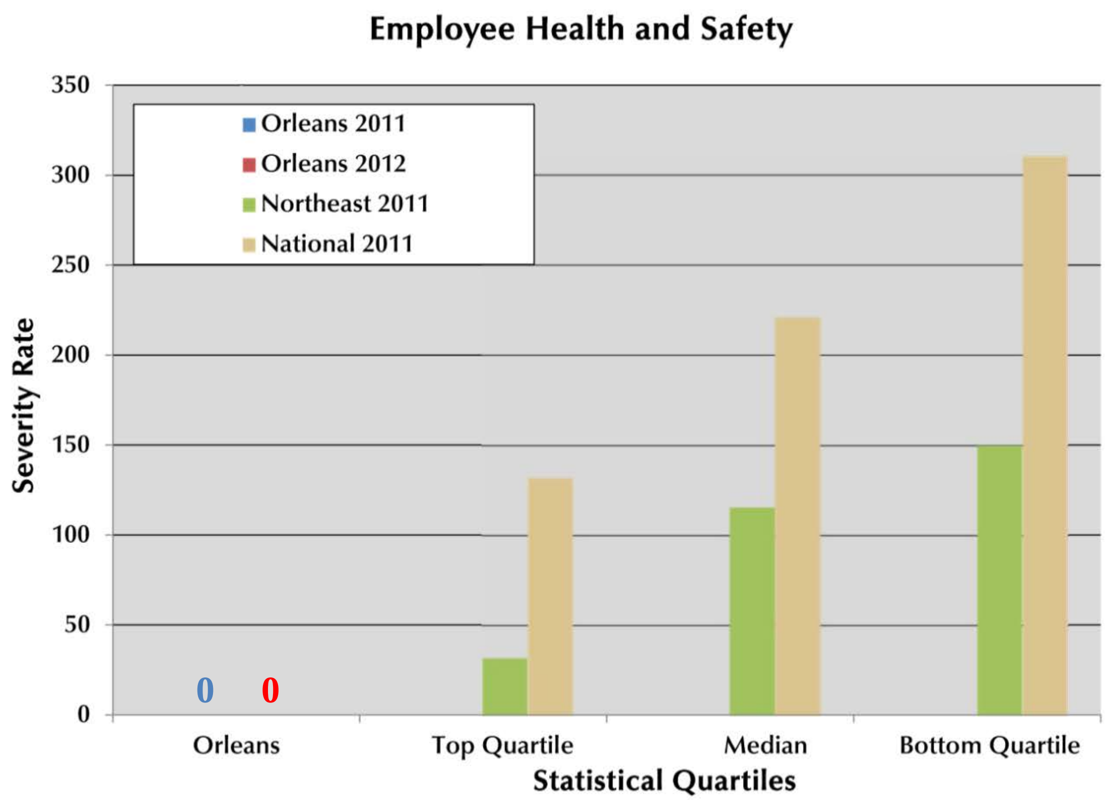
Index Formula: Employee Health and Safety Severity Rate = 200,000 (Total Days Away from Work) / Total Hours Worked by Employees. OSHA Form 300A is referenced for the Total Days Away from Work over a reporting year for the utility.

FIGURE 8-1



Orleans has seen a nearly 5% increase in total hours worked by employees from 2011 to 2012. Probable reasons include the slight increase in accounts per employee, and infrastructure repair and renewal to decrease distribution system losses.

FIGURE 8-2



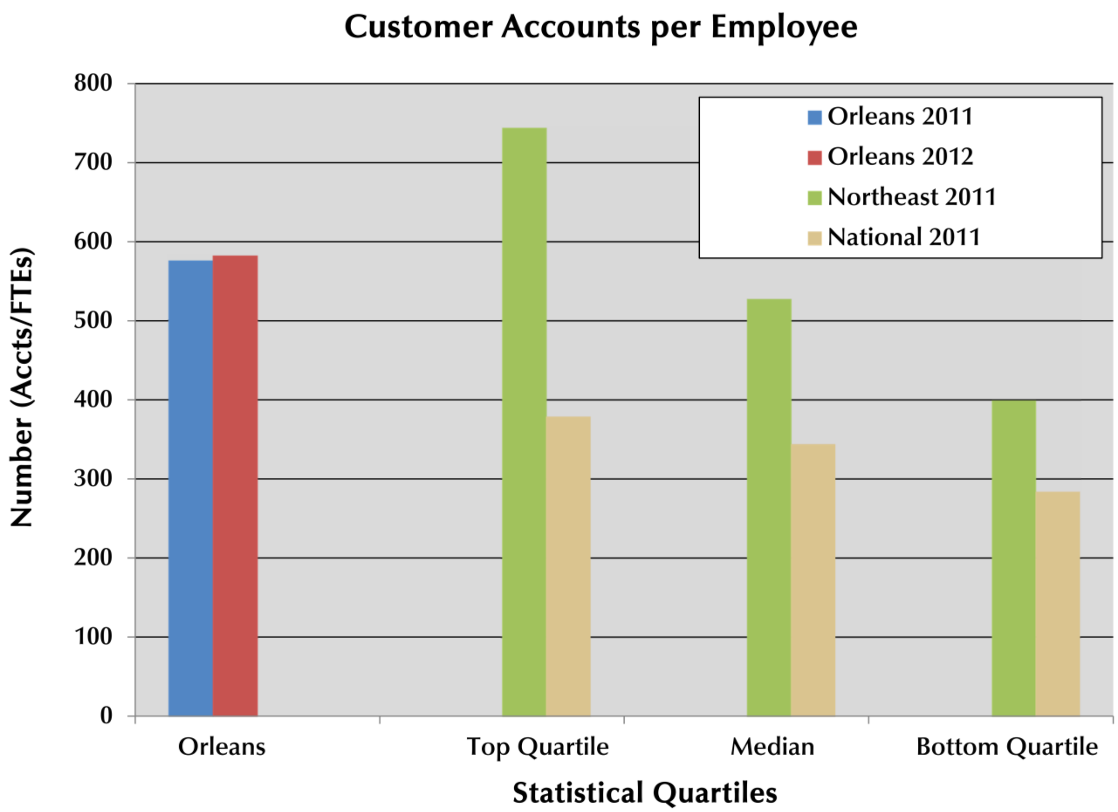
Orleans has managed to save time and money by sustaining a record of zero time away from work due to occupational injuries.

8.4.2 Customer Accounts per Employee

Objective: A measure of the employee efficiency in their prescribed duties.

Index Formula: Customer Accounts per Employee = No. of Accounts / No. of Full-Time Equivalents. FTE is a normalized unit of employees defined as the allotment of 2,080 hours per position. Part-time, temporary and seasonal employees are summed to an FTE from the total number of compensatory hours. An active customer account is water service billed for a partial or entire reporting period.

FIGURE 8-3



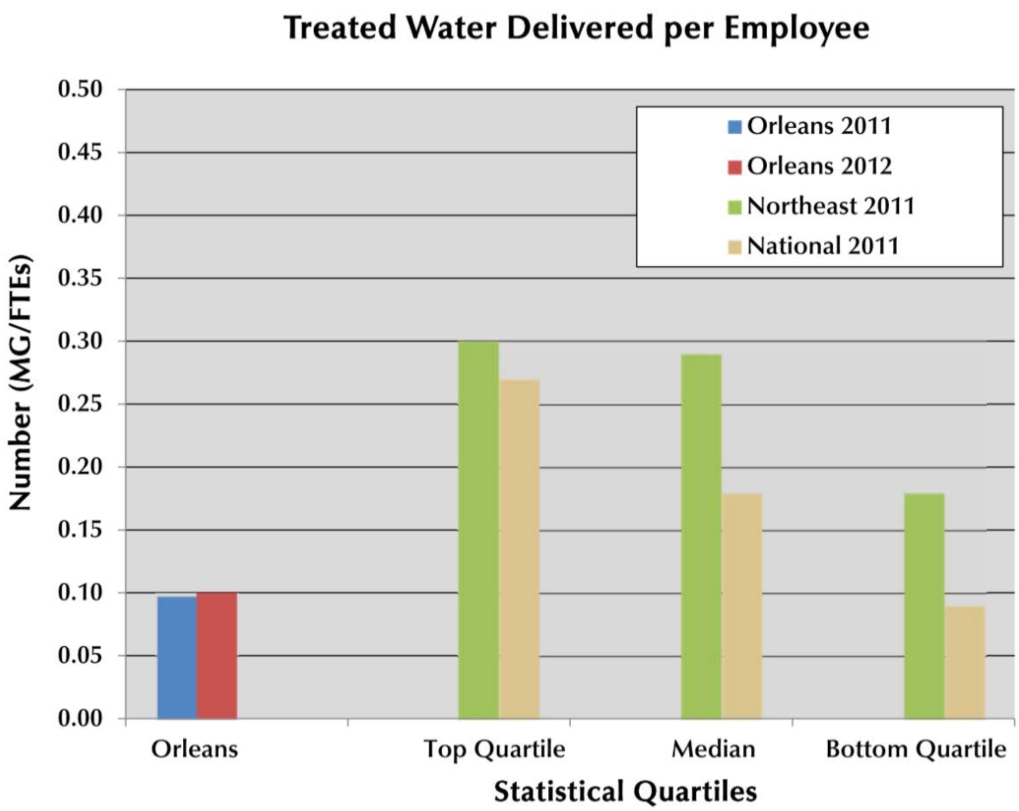
As can be seen above, Orleans ranks well above the top quartile in customer accounts per employee when compared to similar sized utilities nationally, and within the top quartile when compared to the Northeast.

8.4.3 Volume of Water Delivered per Employee

Objective: A measure of the employee efficiency in their prescribed duties.

Index Formula: Treated Water Processed per Employee = Average Water Production Flow (MGD) / No. of Full-Time Equivalents. FTE is a normalized unit of employees defined as the allotment of 2,080 hours per position. Part-time, temporary and seasonal employees are summed to an FTE from the total number of compensatory hours. Average water production (million gallons per day) includes surface water plants, well supplies and bulk water interconnects.

FIGURE 8-4



As in figure 8-4, Orleans ranks in the median quartile for treated water delivered per employee when compared to similar sized utilities nationally and bottom quartile in the Northeast. Due to the high seasonal population and almost complete water system coverage in Orleans, the water system is significantly larger than most communities of the same population. Figure 8-3 shows that Orleans is in the top quartile when compared to national and Northeast norms. To meet this demand on the water system and deliver satisfactory customer service, a correspondingly higher number of staff is required to operations and maintenance of the water system.

Table 8-2

Various Organizational Performance Results

Index No.	Orleans			Northeast 2011			National 2011		
	FY 2011	FY 2012	Average	Top Quartile	Median	Bottom Quartile	Top Quartile	Median	Bottom Quartile
8	0	0	0	32.0	116.0	150.0	132.3	221.5	310.8
9	576.3	582.4	579.4	744.0	528.0	400.0	379	344.5	284.5
10	0.10	0.10	0.10	0.30	0.29	0.18	0.27	0.18	.09

***Note*:** *Health and Safety data not available for 2011/2012 due to ambiguities in survey questions and reported data.*

8.5 Customer Relations

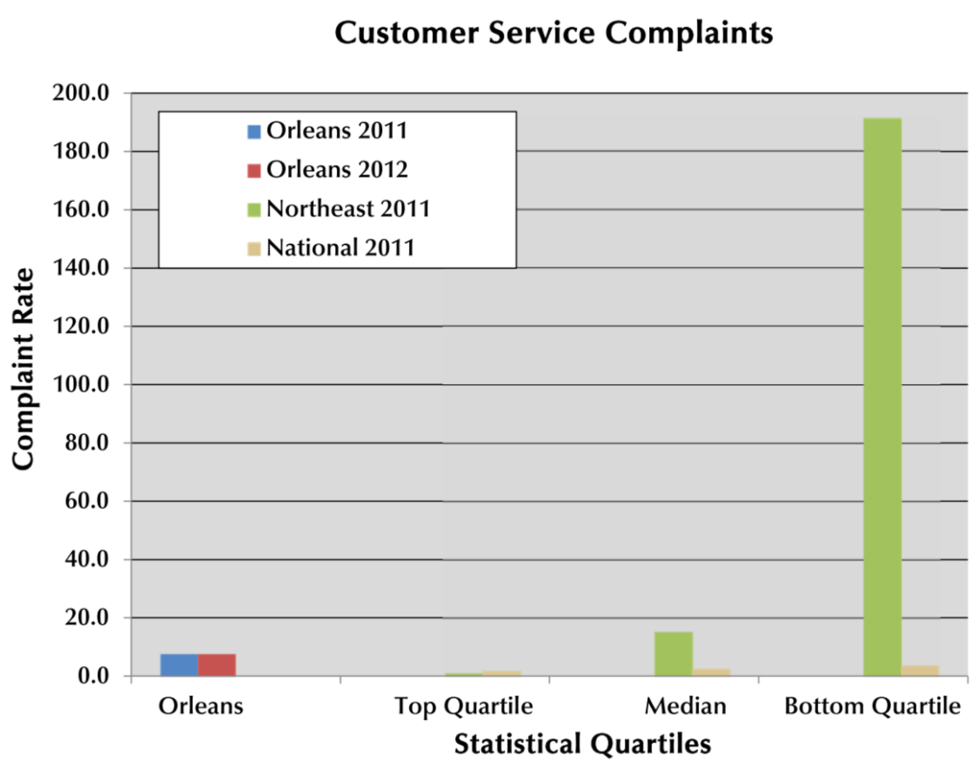
A) Customer Relations Performance Indices (Refer to Table 8-3 – Customer Relations Performance Results, located at the end of the section)

8.5.1 Customer Service Complaints

Objective: Metric for the customer service complaints logged by the water utility. The complaint rate is per 1,000 customers.

Index Formula: Customer Service Complaint Rate = 1,000 (No. of Complaints against Customer Service / No. of Accounts). A complaint is defined as written or oral customer dissatisfaction towards the utility personnel appearance, courteousness, helpfulness, professionalism, responsiveness, traffic laws abidance and timeliness. Shut-offs / activations, billing, user rates and communications also factor into the performance. An active customer account is water service billed for a partial or entire reporting period.

FIGURE 8-5



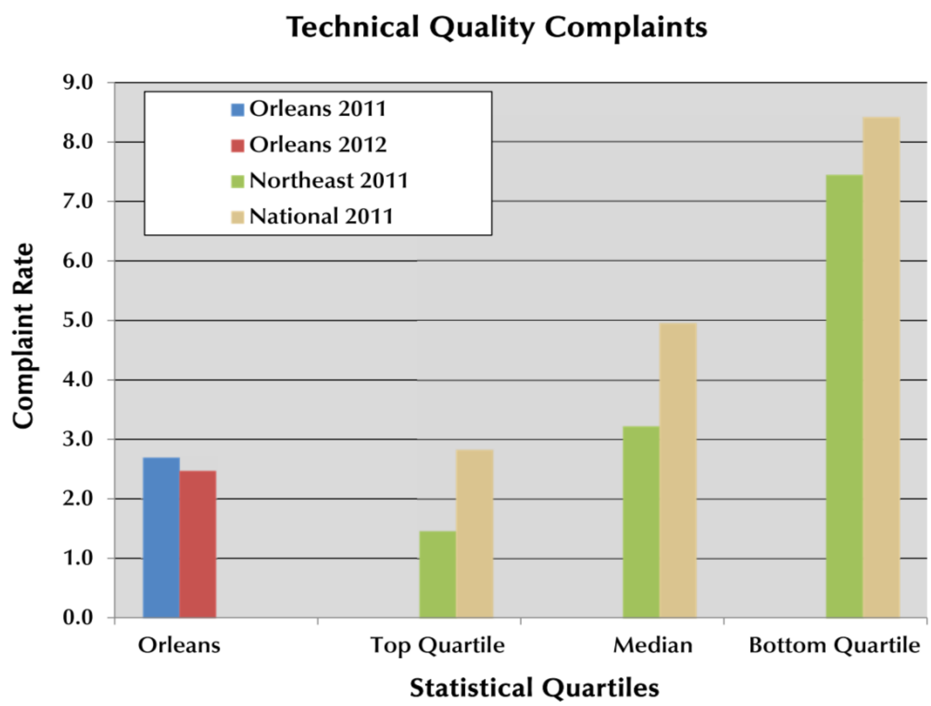
As can be seen in figure 8-5, Orleans ranks in the bottom quartile in customer service complaints when compared to similar sized utilities nationally, but within the top quartile when compared to the Northeast.

8.5.2 Technical Quality Complaints

Objective: A measure of the technical quality complaints logged by the water utility. The complaint rate is per 1,000 customers.

Index Formula: Technical Quality Complaint Rate = 1,000 (No. of Complaints against Technical Quality / No. of Accounts). A complaint is defined as written or oral customer dissatisfaction towards the water quality, taste, odor, appearance / aesthetics, pressure, disruptions of traffic and facilities upkeep. An active customer account is water service billed for a partial or entire reporting period.

FIGURE 8-6



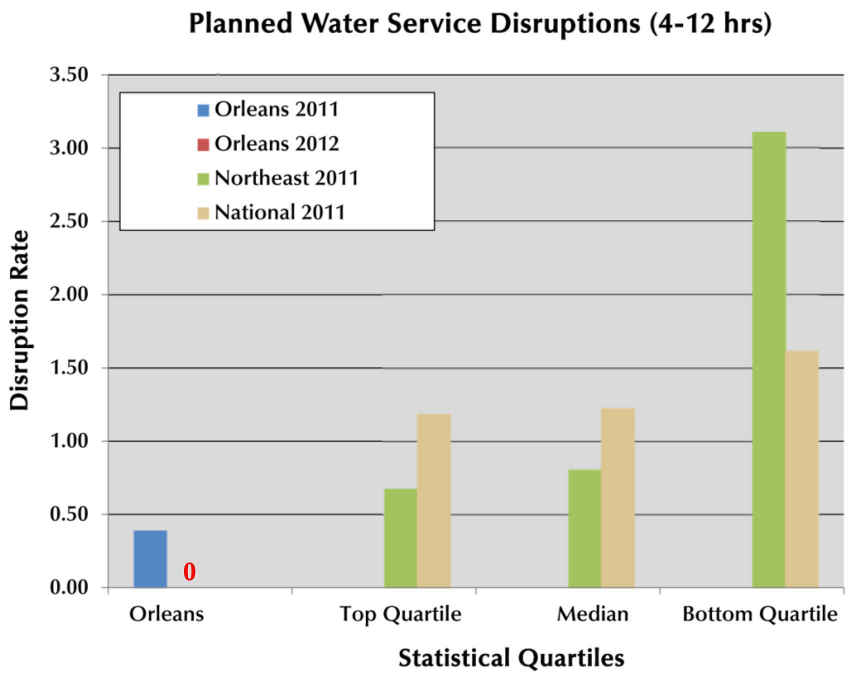
As can be seen above, Orleans ranks in the top quartile for technical quality complaints when compared to similar sized utilities nationally but in the median when compared to the Northeast.

8.5.3 Planned Disruption of Service

Objective: Quantifier for the number of planned water outages affecting the customers. The complaint rate is per 1,000 customers.

Index Formula: Disruption Rate = 1,000 (No. of Customers without Water Service / No. of Accounts). A planned disruption occurs when customers are delivered notices and experience a loss of water service due to construction tie-ins, replacement of valves, hydrants and meters or other non-emergency appurtenance work. An active customer account is water service billed for a partial or entire reporting period.

FIGURE 8-7



Note: No planned disruptions recorded for 2012

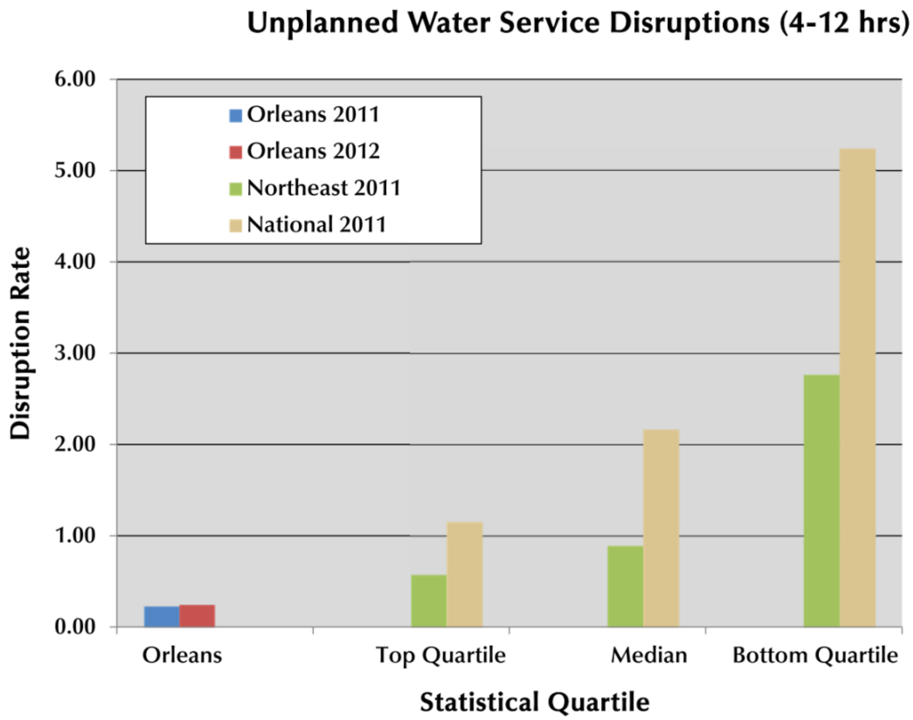
As can be seen above, Orleans ranks well below the top quartile in planned service disruptions when compared to both similar sized utilities nationally and in the Northeast.

8.5.4 Unplanned Disruption of Service

Objective: Quantifier for the number of unplanned water outages affecting the customers. The complaint rate is per 1,000 customers.

Index Formula: Disruption Rate = 1,000 (No. of Customers without Water Service / No. of Accounts). An unplanned disruption occurs when a customer(s) reports loss of pressure below 20 psi in the midst of an emergency repair, pipeline break and newly found leaks that could impose property damage and/or unsafe conditions. It does not include shut-downs for non-payment. An active customer account is water service billed for a partial or entire reporting period.

FIGURE 8-8



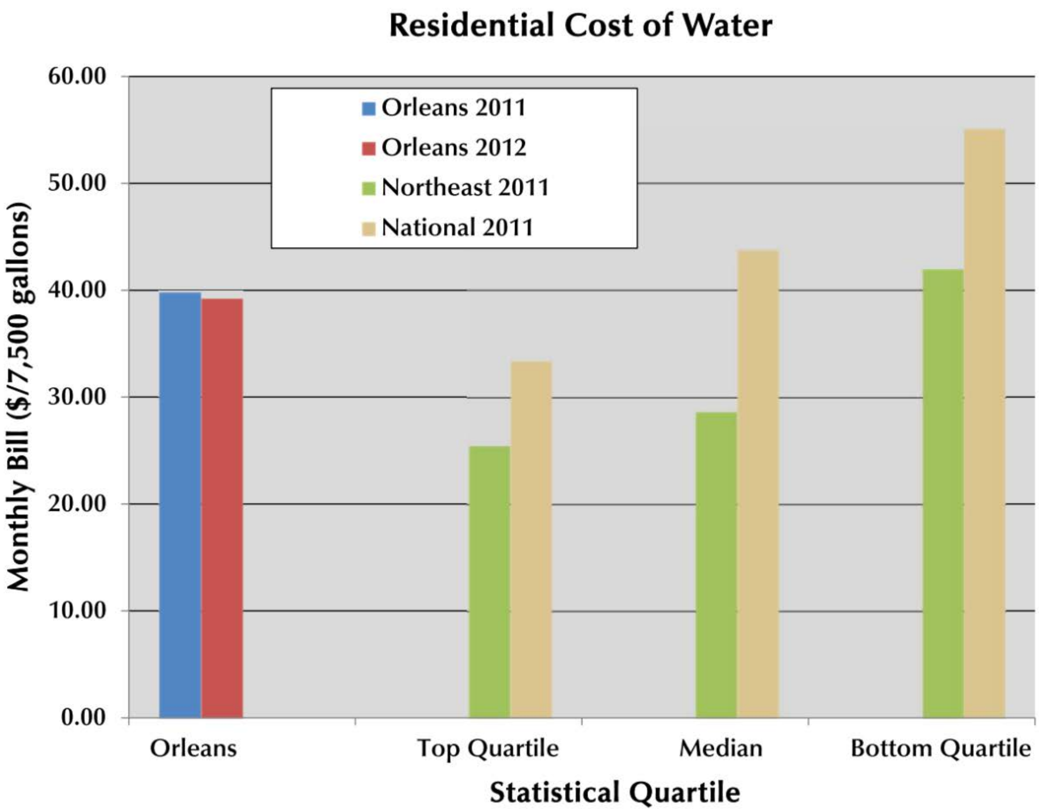
As can be seen above, Orleans ranks well below the top quartile in unplanned service disruptions when compared to similar sized utilities both nationally and in the Northeast.

8.5.5 Residential Cost of Water

Objective: Rank the utility's water bill based on a fixed consumption volume per month.

Index Formula: Cost of Water = User Rate per CCF (7,500 gallons / 7.48 gallons per ft^3 / 100). The 2011 AWWA Utility Benchmark Survey assumed the average residential customer consumes 7,500 gallons per month.

FIGURE 8-9



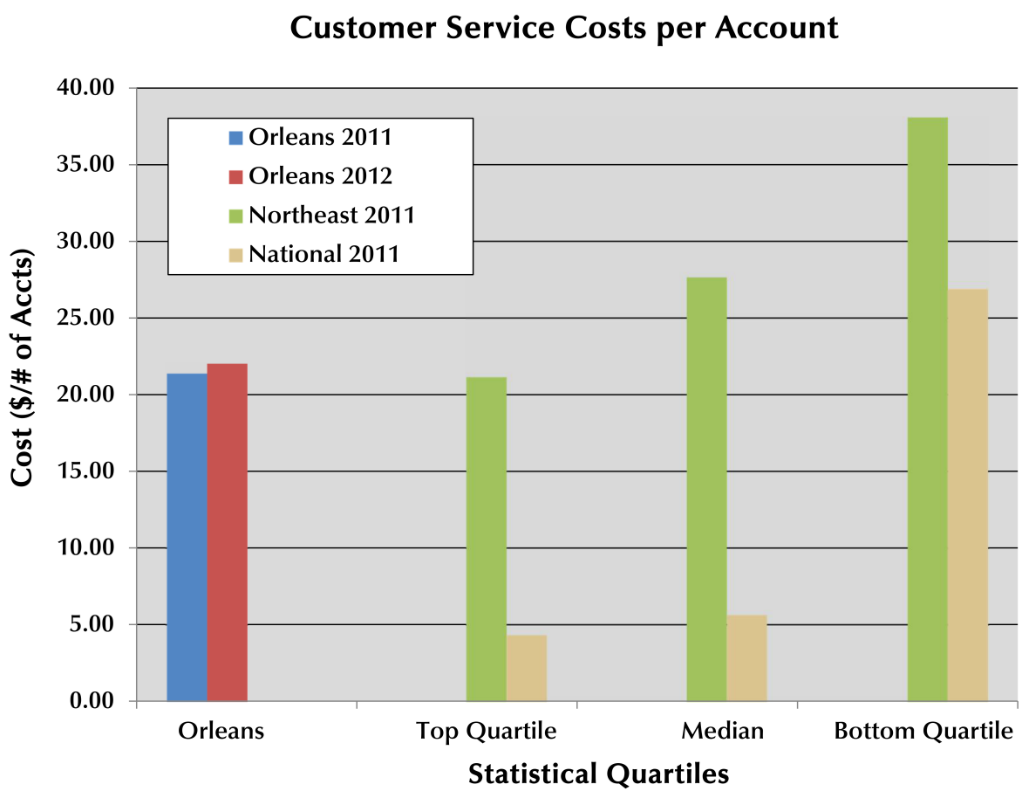
As can be seen above, Orleans ranks in the median for residential cost of water when compared to similar sized utilities nationally and within the bottom quartile when compared to the Northeast.

8.5.6 Customer Service Cost per Account

Objective: A metric for the budget emphasis a utility exerts into its customer service program.

Index Formula: Customer Service Cost per Account = Total Customer Service Costs / No. of Accounts. Customer Service Costs are those encumbered for: new account activations, meter reads / maintenance / testing / replacement, billing, payment processing, records maintenance, delinquent accounts, liens / bankruptcies, shut-offs / turn-ons, complaint resolution, Consumer Confidence Reports and outreach. An active customer account is water service billed for a partial or entire reporting period.

FIGURE 8-10



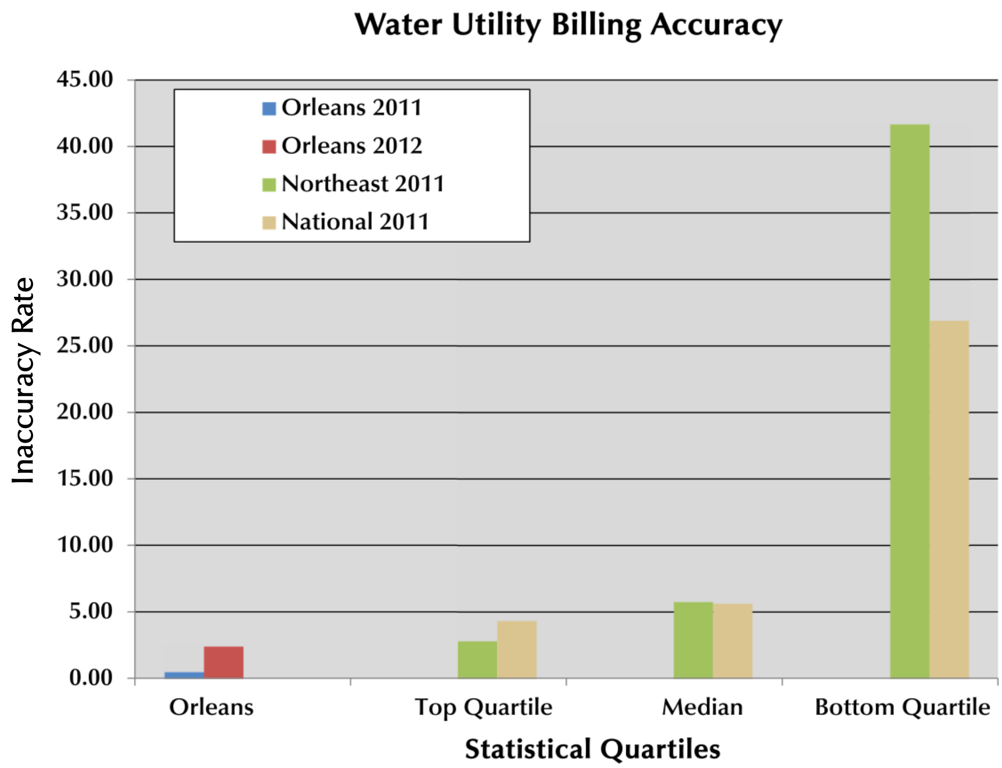
As can be seen above, Orleans ranks in the median quartile for customer service costs per account when compared to similar sized utilities nationally and within the median when compared to the Northeast.

8.5.7 Billing Accuracy

Objective: An efficiency metric for the utility billing practices. A calculation determines the number of bill errors that were adjusted per 10,000 bills produced for a one year report period.

Index Formula: Billing Accuracy = 10,000 (No. of Error Related Bill Adjustments / No. of Bills Generated for One Year. A bill is quarterly, monthly or other periodic statement where charges are assessed to the customer. Erroneous adjustments are those in which the utility is responsible (e.g. meter reads, data entry, calculation or computerized programs).

FIGURE 8-11



As can be seen above, Orleans ranks well below the top quartile in water billing accuracy when compared to similar sized utilities both nationally and in the Northeast. Notice that Orleans billing accuracy rate has jumped significantly between 2011 and 2012.

Table 8-3

Customer Relations Performance Results

Index No.	Orleans			Region 1: Northeast 2011			National 2011		
	FY 2011	FY 2012	Average	Top Quartile	Median	Bottom Quartile	Top Quartile	Median	Bottom Quartile
11	7.70	7.63	7.67	1.13	15.29	191.44	1.93	2.64	3.71
12	2.70	2.48	2.59	1.47	3.23	7.45	2.84	4.96	8.42
13	0.39	0.00	0.20	0.68	0.81	3.11	1.19	1.23	1.62
14	0.23	0.25	0.24	0.58	0.90	2.77	1.16	2.17	5.24
15	39.80	39.20	39.50	25.51	28.72	42.00	33.43	43.79	55.13
16	21.38	22.00	21.69	21.17	27.67	38.07	66.31	82.26	101.19
17	0.48	2.38	1.43	2.85	5.80	41.65	4.35	5.65	26.90

8.6 WATER OPERATIONS

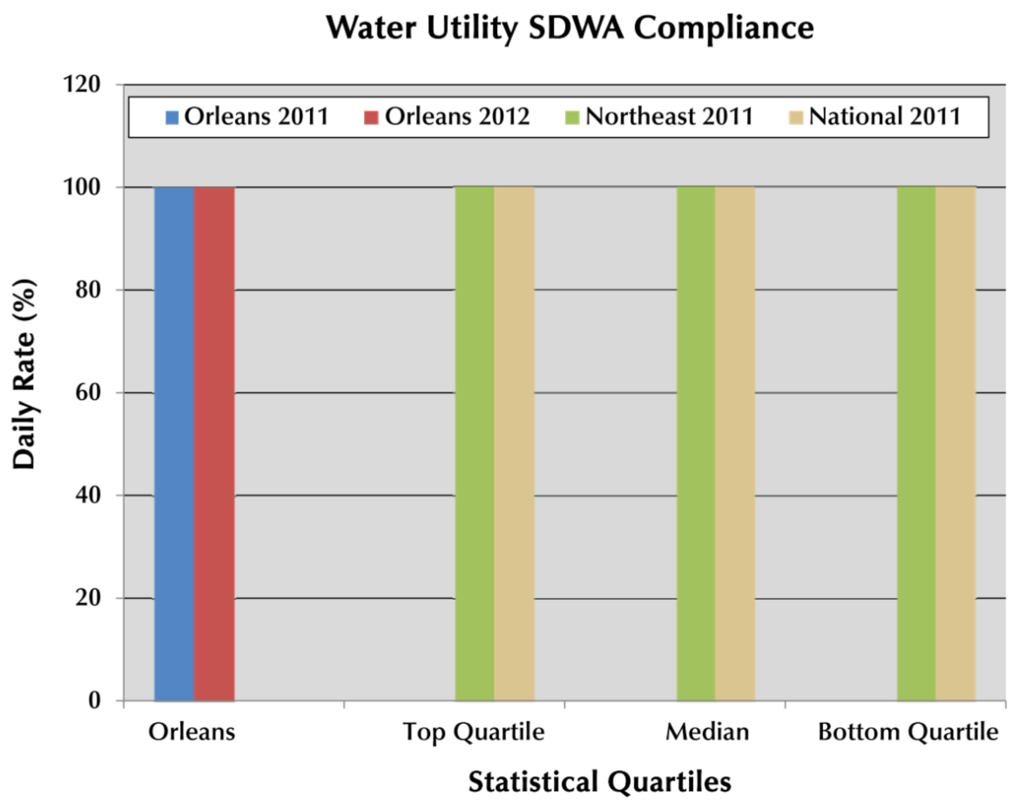
Water Operations Performance Indices (Refer to Table 8-4 – Water Operations Results located on page 8-24)

8.6.1 Drinking Water Compliance Rate

<u>Objective</u>: Indicator of the percentage of time during a year of record that the utility complied with all of the EPA National Primary Drinking Water Standards.

<u>Index Formula</u>: Drinking Water Compliance Rate = 100 (No. of Days in Full Compliance / 365 Days). Non-compliance is acknowledged when a public water system exceeds the Maximum Contaminant Level / Action Level for a 40 CFR Part 141 parameter or has incurred a treatment technique violation.

FIGURE 8-12



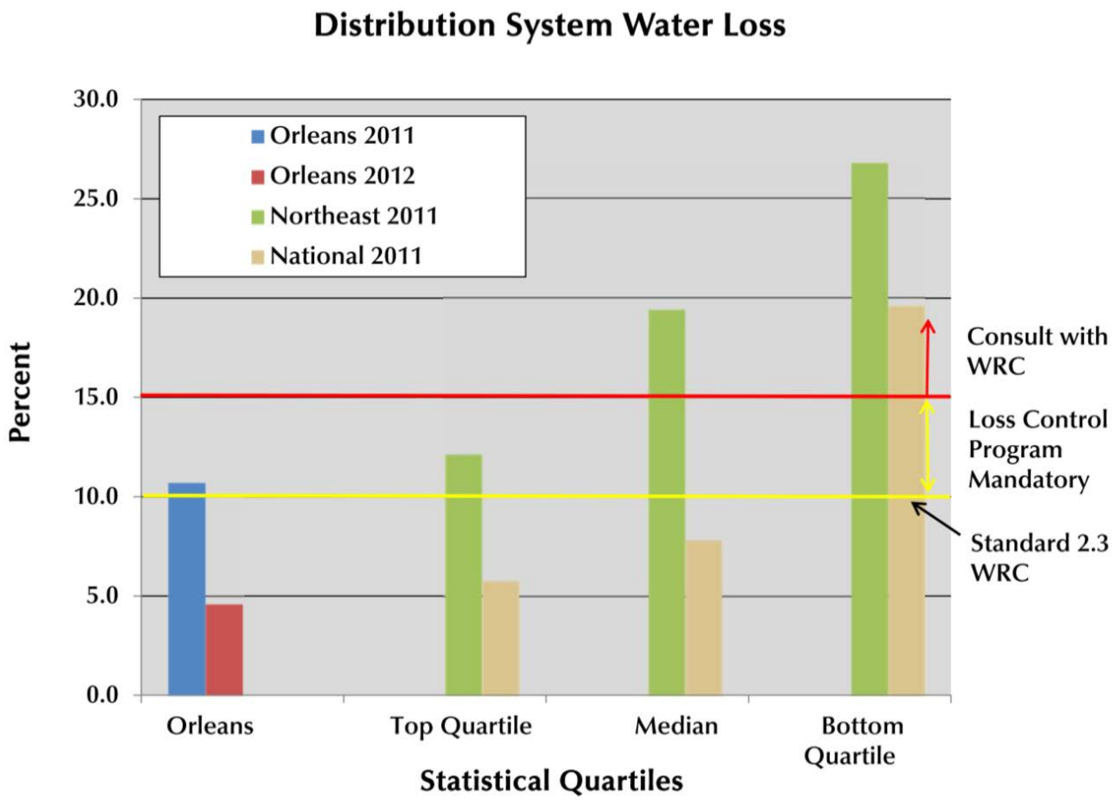
As can be seen above, Orleans ranks at exactly the same level in water utility SDWA compliance when compared to similar sized utilities nationally and in the Northeast.

8.6.2 Distribution System Water Loss

Objective: Estimate the percentage of water that does not reach the customers and not accounted for by authorized use. Standard 2.3 of the Massachusetts Water Resources Commission (WRC) set a water utility goal of 10.0% Unaccounted-for-Water (UAW). Systems that report 10 to 15% UAW are required to draft and enact a Water Loss Control Program.

Index Formula: Water Loss (% of Distribution) = 100 [(Treated Water Production – (Customer Volume Billed + Authorized Unbilled Volume)] / (Treated Water Production) Water losses are comprised of real losses or leaks, meter inaccuracy and unauthorized theft. Examples of unbilled authorized water use are hydrant flushing, public facilities (ice rink / pools), water quality bleeders, street cleaning and storage tank draining for maintenance.

FIGURE 8-13



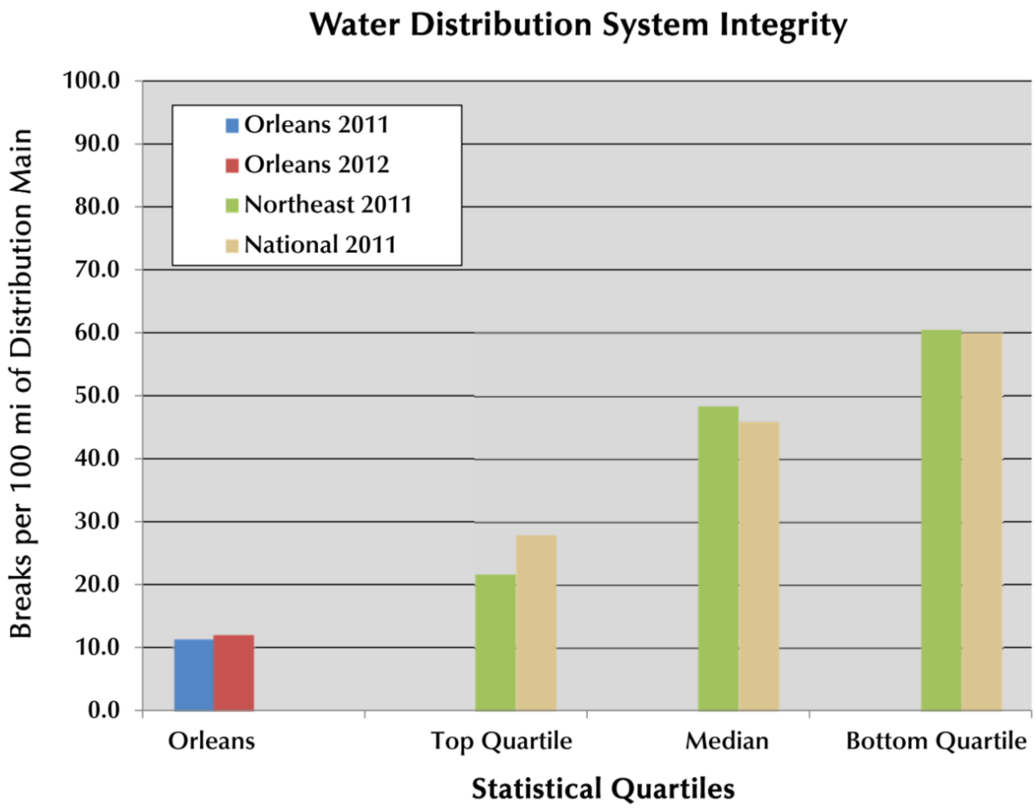
As can be seen above, Orleans' rank has changed from 2011 to 2012 in distribution system water loss. Orleans 2011 ranks in the bottom quartile when compared to similar sized utilities nationally and within the top quartile when compared to the Northeast. For 2012, Orleans changed their rank to among the top quartile when compared nationally.

8.6.3 Water Distribution System Integrity

Objective: Apply a performance measure to assess the distribution system aging infrastructure and its recent condition. The indicator is expressed as the number of water main breaks and service leak repairs per 100 miles of distribution pipe.

Index Formula: Frequency Rate = 100 [(Total Number of Leak + Total Number of Breaks) / (Total Miles of Distribution Pipe). The distribution pipe encompasses all valves, hydrants, pipes and appurtenances to carry water from the treatment facilities or well supplies to the customer curb stop. Private lines downstream of the curb stop and leaks inside of customer plumbing are not factored into the calculation. A water main or appurtenance break is differentiated from a leak in that the loss of water is rapid and the rate represents a risk of damage and/or contamination.

FIGURE 8-14



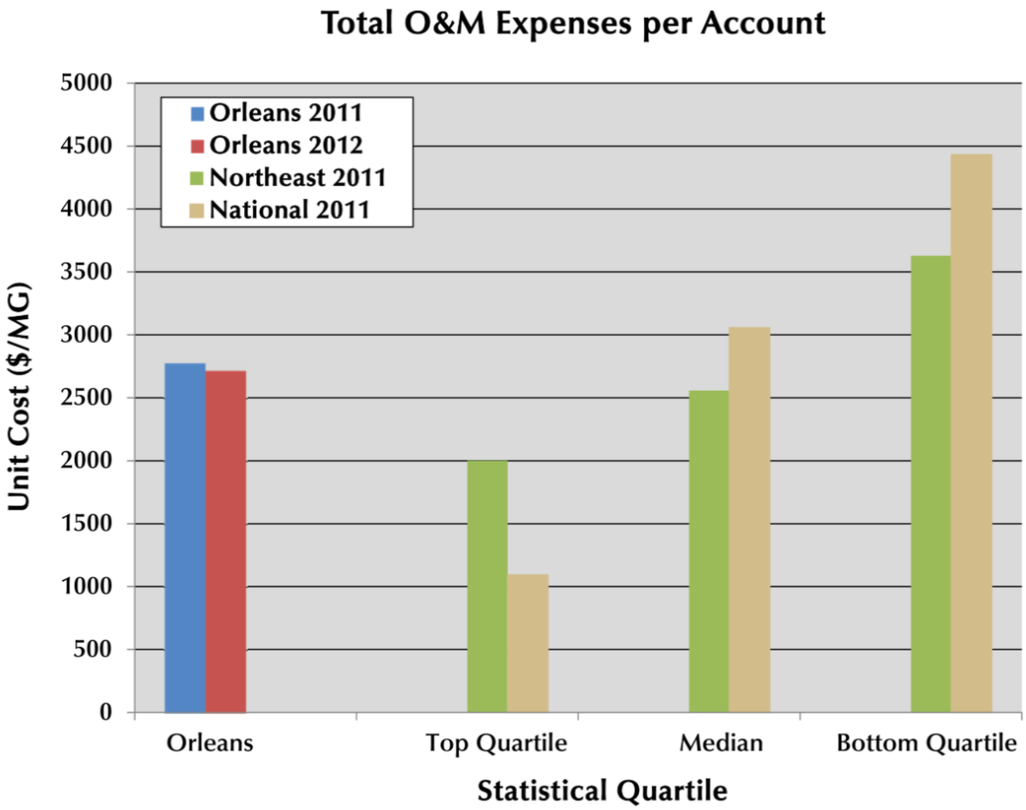
As can be seen above, Orleans ranks in the top quartile for water distribution system integrity when compared to similar sized utilities both nationally and in the Northeast.

8.6.4 Operations and Maintenance Cost per Account

Objective: A metric for water utilities to quantify operations and maintenance expenses to treat and distribute water as a function of the customer accounts for a report year period.

Index Formula: O&M Cost per Customer Account = Total Operations and Maintenance Cost (less depreciation) / Total Number of Accounts. An active customer account is water service billed for a partial or entire reporting period.

FIGURE 8-15



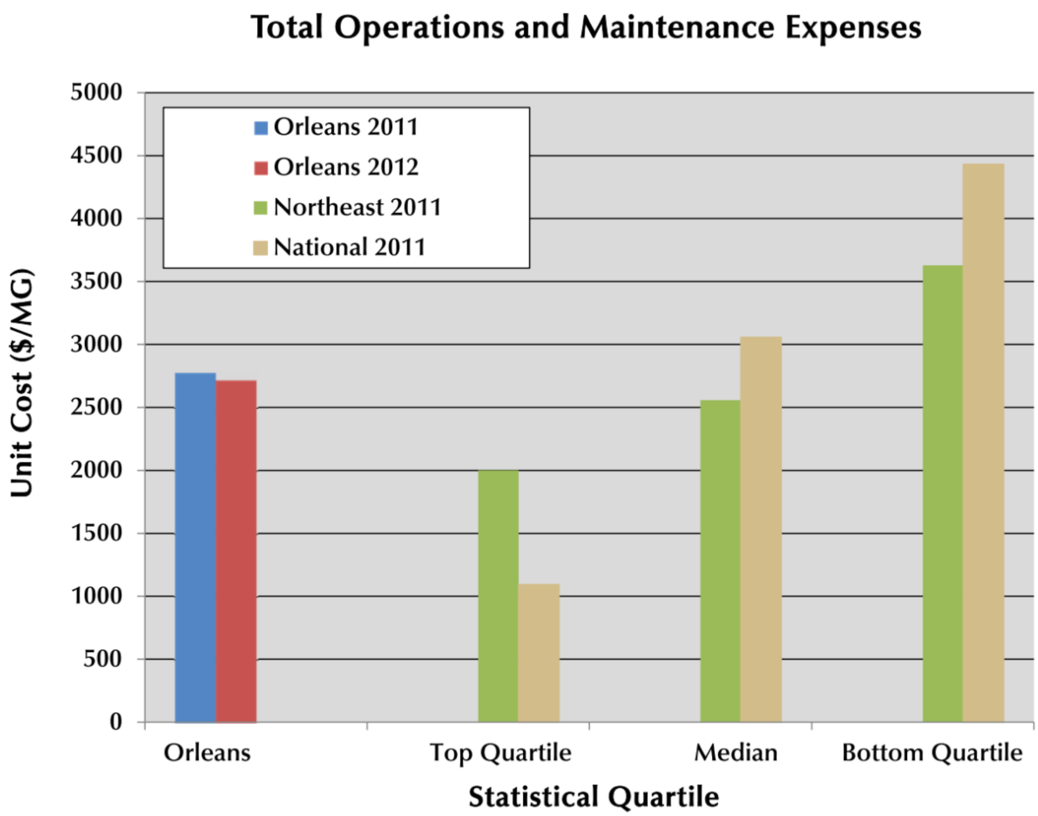
As can be seen above, Orleans ranks in the median for total O&M expenses per account when compared to similar sized utilities nationally and within the median quartile when compared to the Northeast.

8.6.5 Operations and Maintenance Cost per MG Delivered

Objective: A metric for water utilities to quantify operations and maintenance expenses to treat and distribute water as a function of the production volume for a report year period.

Index Formula: O&M Cost per MG Delivered = Total Operations and Maintenance Cost (less depreciation) / Treated Water Production Volume divided by 1×10^6. An active customer account is water service billed for a partial or entire reporting period.

FIGURE 8-16



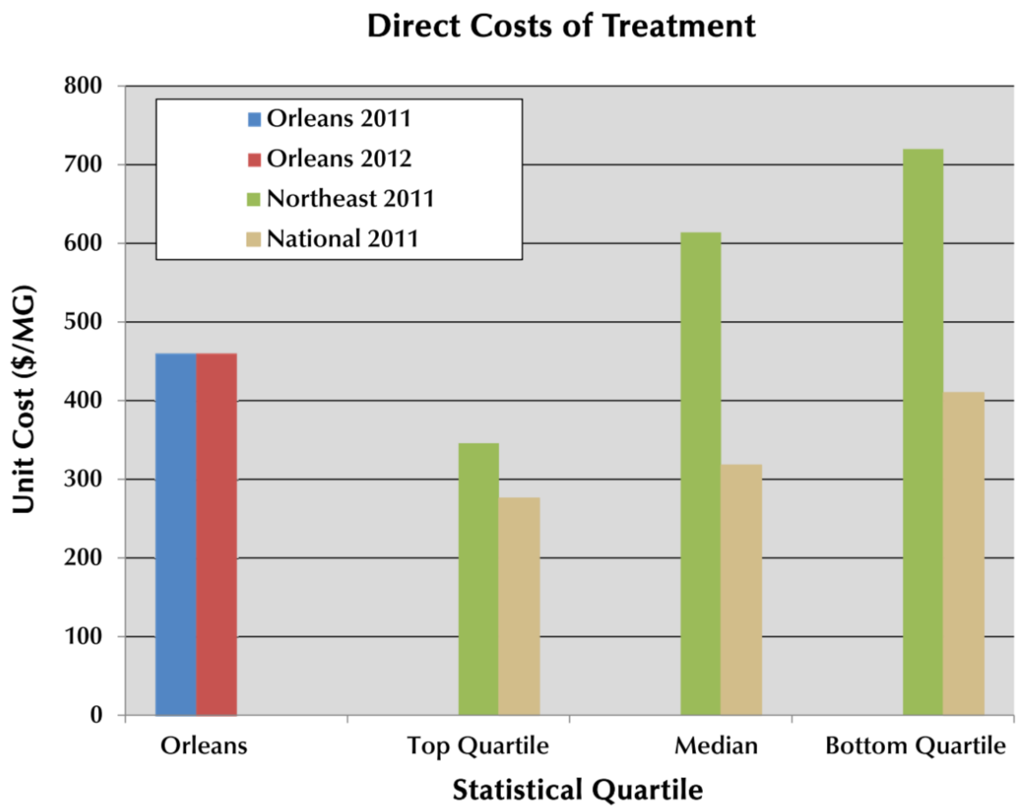
As can be seen above, Orleans ranks in the median for total O&M expenses when compared to similar sized utilities nationally and within the median quartile when compared to the Northeast.

8.6.6 Direct Cost of Treatment

Objective: A metric for water utilities to quantify direct costs to treat water as a function of the production volume for a report year period.

Index Formula: Direct Cost per MG Delivered = Total Operations and Maintenance Cost for Water Treatment / Annual Treated Water Production Volume divided by 1 x 10^6. Direct costs are the salaries and benefits of employees plus the operations and maintenance costs associated with treatment.

FIGURE 8-17



As can be seen above, Orleans ranks well above the bottom quartile for direct costs of treatment when compared to similar sized utilities nationally and within the median when compared to the Northeast.

Table 8-4

Water Operations Results

Index No.	Orleans			Region 1: Northeast 2011			National 2011		
	FY2011	FY2012	Average	Top Quartile	Median	Bottom Quartile	Top Quartile	Median	Bottom Quartile
18	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
19	10.7	4.6	7.7	12.2	19.4	26.8	5.8	7.8	19.6
20	11.3	12.0	11.7	21.8	48.5	60.5	28.0	46.0	60.0
21	170.1	168.4	169.3	256.0	335.0	431.0	251.0	324.0	456.0
22	2776	2716	2746.0	2002.0	2558.0	3628.0	1093.0	3057.0	4431.0
23	460	460	460.0	346.0	614.0	720.0	276.0	318.0	410.0

Note: Residential Water Usage is a regulatory standard in the State of Massachusetts.

8.7 BUSINESS OPERATIONS INDICES

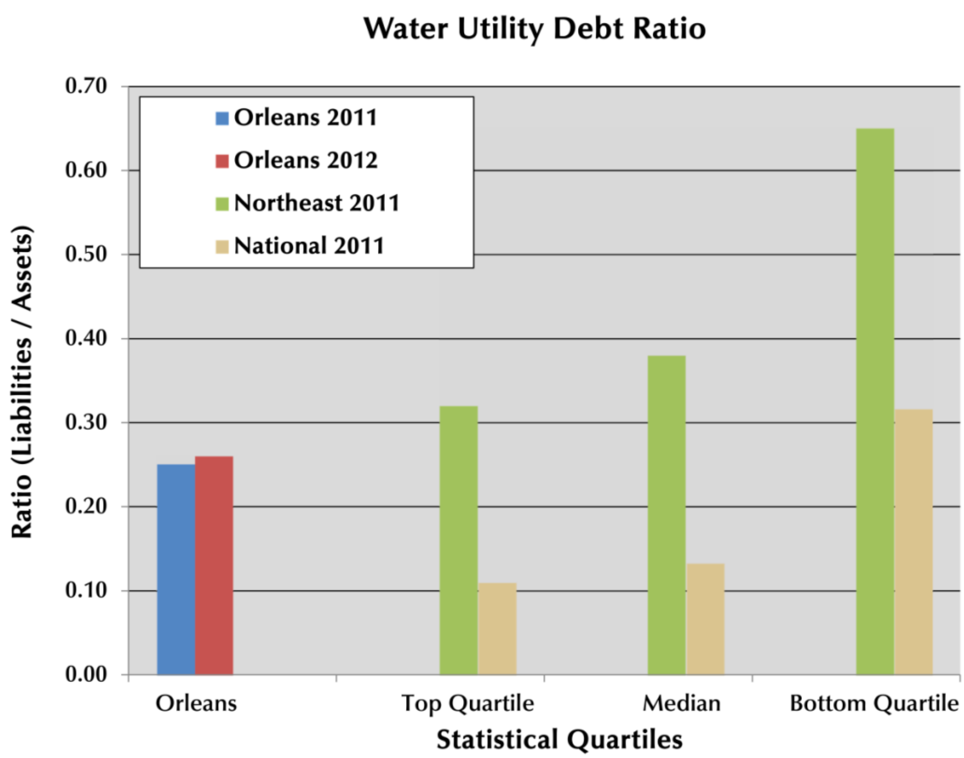
Business Operations Performance Indices (Refer to Table 8-5 – Business Operations Results, located on page 8-29)

8.7.1 Debt Ratio

Objective: To quantify the level of utility indebtedness and prospects to secure a superior bond rating on future obligations.

Index Formula: Debt Ratio (%) = 100 (Total Liabilities / Total Assets). Liabilities are debts the utility owes under law or equity. Government Accounting Standards Board (GASB) defines obligations as outstanding bond payments, long-term loans, short-term anticipation notes, payments to others, accounts payable and deposits collected from customers. Assets are both tangible and intangible properties under direct ownership of the utility. Typical assets under GASB include accounts receivable, cash, paid inventory, service delivery facilities minus depreciation, easement and water rights costs plus other items that can be assigned a value.

FIGURE 8-18



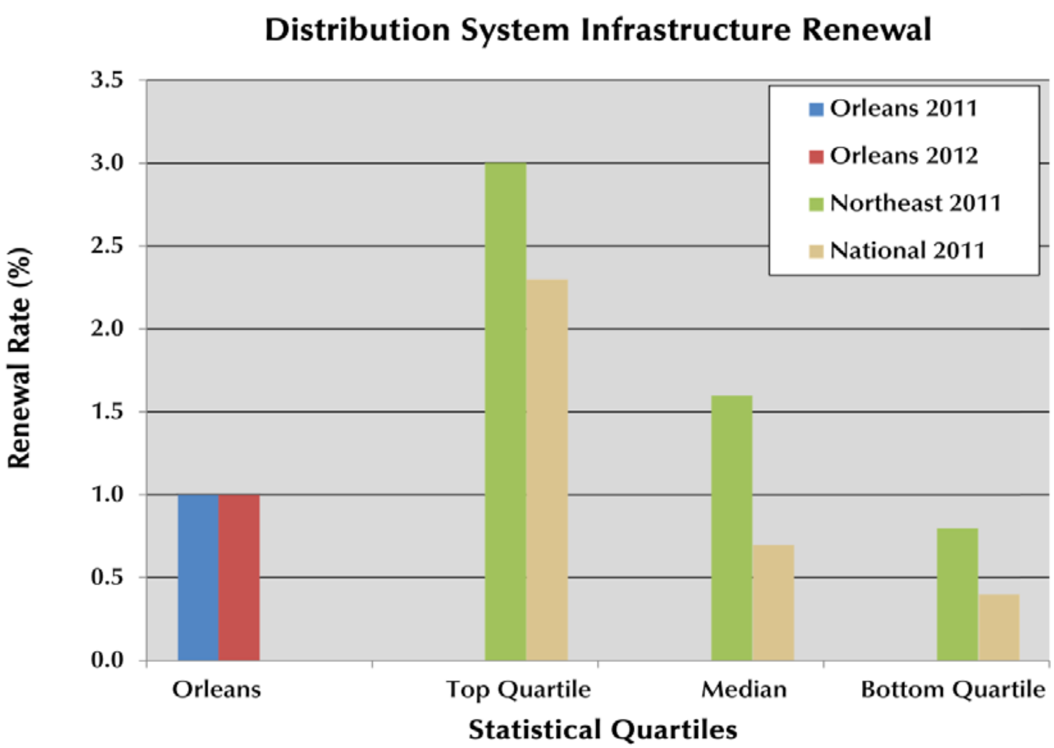
As can be seen above, Orleans ranks in the bottom quartile for water utility debt ratio when compared to similar sized utilities nationally and within the top quartile when compared to the Northeast.

8.7.2 Distribution System Renewal / Replacement Rate

Objective: Determine the rate at which a water utility is replacing or renewing its existing infrastructure. The Orleans Water District Utility Benchmarking Survey subdivides infrastructure renewal into two asset classes, Distribution System and Water Treatment / Pumping.

Index Formula: Renewal / Replacement Rate (%) = 100 (Infrastructure Capital Expenditures and Reserves / Total Present Worth of Renewal and Replacement Needs for an Asset Class). Distribution system assets cover water mains, storage tanks, booster pump stations, re-conditioning of water with chemicals, valves, hydrants, service taps, meters, maintenance buildings and other appurtenances for drinking water supply and fire protection.

FIGURE 8-19



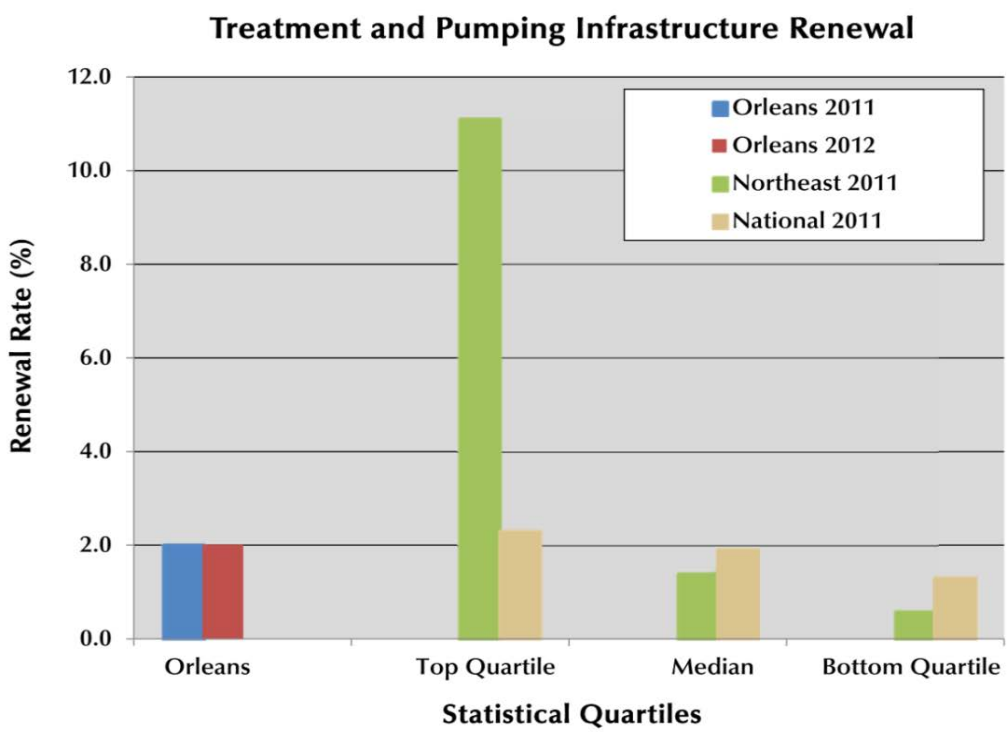
As can be seen above, Orleans ranks in the top quartile for distribution infrastructure renewal when compared to similar sized utilities nationally and within the median when compared to the Northeast.

8.7.3 Water Treatment / Pumping Renewal / Replacement Rate

Objective: Determine the rate at which a water utility is replacing or renewing its existing infrastructure. The Orleans Water District Utility Benchmarking Survey subdivides infrastructure renewal into Distribution System and Water Treatment / Pumping.

Index Formula: Renewal / Replacement Rate (%) = 100 (Infrastructure Capital Expenditures and Reserves / Total Present Worth of Renewal and Replacement Needs for an Asset Class). Water Treatment includes low-lift pumping, chemical facilities, groundwater and surface water processes to remove impurities and disinfect, waste solids handling, filter wash water management, resource protection land, buildings, laboratory and finished water pumping.

FIGURE 8-20



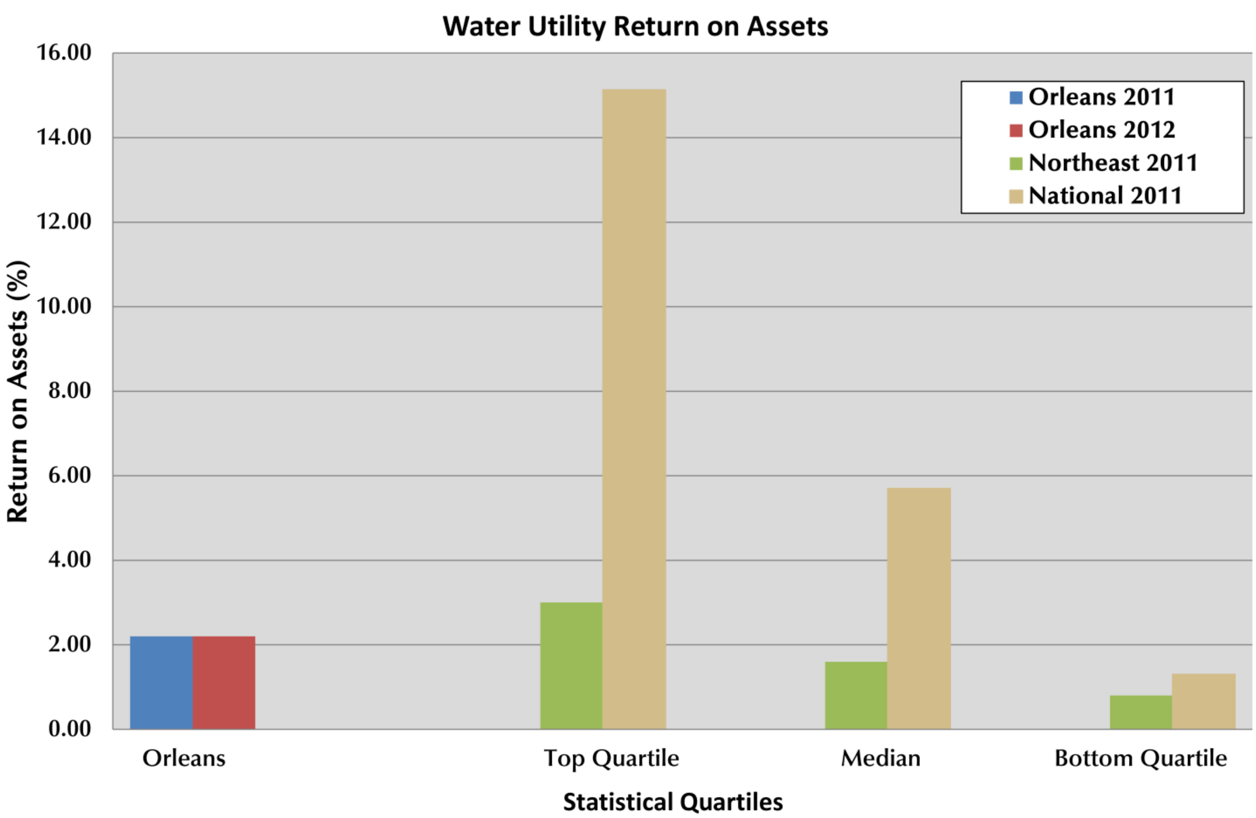
As can be seen above, Orleans ranks in the top quartile for treatment and infrastructure renewal when compared to similar sized utilities nationally and in the Northeast.

8.7.4 Return on Assets

Objective: A performance indicator of the water utility's financial management. Utility ROAs are lower than most businesses because they are either non-profit organizations or for-profit companies with tight regulatory controls on revenue.

Index Formula: Return on Assets (%) = 100 (Net Income / Total Assets). Net income according to GASB is defined as utility income minus expenses. Typical assets under GASB include accounts receivable, cash, paid inventory, service delivery facilities minus depreciation, easement and water rights costs plus other items that can be assigned a value.

FIGURE 8-21



As can be seen above, Orleans ranks in the median quartile for water utility return on assets when compared to similar sized utilities nationally and within the top quartile when compared to the Northeast. Overall this statistic means that the revenue generated vs. the total value of Orleans' assets is higher than most water utilities in the Northeast, but not the nation. Well maintained infrastructure along with low winter water demands may contribute to a relatively high ratio when compared to the Northeast. Revenue fluctuations due to population decreases and under-utilization of infrastructure seasonally may contribute to a relatively low ratio when compared nationally.

Table 8-5

Business Operations Results

Index No.	Orleans			Region 1: Northeast 2011			National 2011		
	FY2011	FY2012	Average	Top Quartile	Median	Bottom Quartile	Top Quartile	Median	Bottom Quartile
24	0.25	0.26	0.26	0.32	0.38	0.65	0.11	0.13	0.32
25	1.00	1.00	1.00	3.00	1.60	0.80	2.30	0.70	0.40
26	2.00	2.00	2.00	11.10	1.40	0.60	2.30	1.90	1.30
27	2.20	2.20	2.20	3.70	2.30	0.40	15.13	5.70	1.30

8.8 CONCLUSIONS AND RECOMMENDATIONS

This report subsection addresses the Orleans Water Department Utility Benchmarking Survey results; the data interpretations within each category discuss the comparison of the OWD survey results to the statistical survey results for the Northeast Region and National (0-10,000 customers) quartiles and overall performance. According to the EPA definition, Orleans is a medium-sized water system (3,301-10,000 populations served). The overall performance of the Orleans Water Department is summarized by individual performance categories below.

8.8.1 Best Practices

Best practices are methods and areas of focus within an organization that have consistently been shown to produce positive results. Following best practices allows an organization to achieve superior results in comparison to using other methods. While many best practices may seem to be typical business practice, such as strategic planning and long term financial planning, they must still be mentioned due to their importance in a well-operated organization.

Orleans has implemented each of the best practices mentioned in some way already. When compared to utilities of similar size, both nationally and in the Northeast, Orleans has irrefutably been more progressive with financial planning, staffing, technical operations and management. Orleans could strengthen customer relations, public outreach, health and safety in the workplace, risk / loss control and water distribution asset renewal in the future. Prioritize which areas are more important near-term to the organization and what can be reasonably accomplished within the present staffing structure or outside support. Adhere to a capital improvement plan for funding both new and retired infrastructure with user rates that are supportable. Presently, Orleans annual cost of water is about 1.1% the household median income.

8.8.2 Organizational Development

Organizational Development can be seen as the implementation of best practices to increase efficiency. From an Organizational Development perspective Orleans overall performance, when compared to the Northeast and National water providers of similar size is good. Orleans employees have done an exceptional job of sustaining zero recordable safety incidents. The Town ranks far below the top quartile rank of both the Northeast and National statistics. Orleans employee efficiency per account slid into the top quartile surpassing the National level, but a bit below the Northeast level. Orleans employee efficiency per MG of treated water delivered per employee fell into the bottom quartile just above the National level yet weaker than the Northeast peer utilities. Reasons for the dip in water delivery statistics could be attributed to seasonal volatility of water demand in Orleans, fact that the Massachusetts Department of Environmental Protection typically requires full-time shift operators of water treatment plants, other utilities do not have such low unaccounted-for-water thereby cutting treated water production volume or other staffing requirement factors specific to the Orleans water system. Overall, the organizational performance of Orleans is efficient and fully functional under the current staffed positions.

8.8.3 Customer Relations

Customer relations are an important aspect of any business and can be used to gauge how your product and performance are perceived by the consumer. Orleans has a good track record of informing customers when service is disrupted for both planned and unplanned events when compared to the Northeast and National water utilities in the same population bracket. The few number of water quality of complaints logged by Orleans each year is a testament to the staff's experience with treatment, supply management and swift resolution of an operational problem swiftly. Orleans ranks in the median in terms of customer service complaints, residential water cost, and customer service costs per account. Billing accuracy is paramount for all utilities. Orleans reads meters and bills the customer base biannually. While less frequent meter reads reduces the overhead costs, utility cash flow can be disrupted and offset with having to pay interest on short-term borrowing. Transitioning to automated meter reads (AMR) and quarterly billing would improve the utility efficiency. Inform the customer of utility intentions to change billing cycles before proceeding with a more frequent collection initiative. They have likely adapted their personal budgets to whenever the water bill is anticipated. Delinquencies and liens on property deeds for unpaid collections are not problematic for Orleans according to the interview responses. Having strict metered usage and collection policies enacted by the Town's Board of Commissioners deter controversial disputes with customers whose spike in consumption was due to leaky fixtures. Utilities who have installed AMRs will flag a customer if a usage surge is logged by the meter. Utility administration then contacts the customer to communicate the significant change in water usage. This approach most often addresses problems before the charges become overbearing for the customer.

8.8.4 Water Operations

Water operations take into account the efficiency of treating and distributing water to customers. Overall, Orleans has an above median rank when compared to the Northeast and National water providers. Safe Drinking Water Act compliance has been solid in the past. Water Operators have to fulfill their TCH / CEU requirements every two years. Regulatory competency and planning ahead for proposed EPA and Mass DEP Rules / Regulations is an attribute of premium efficient organizations. Orleans greatly lowered water losses in the distribution between 2011 and 2012. American Water Works Association has developed leakage indices in their M36 Water Audit Manual for reference. Distribution system integrity is sufficient with no evidence pointing to excessive frequency of water main breaks or leaks. Instituting Asset Management procedures and software would aid Orleans in distribution maintenance and infrastructure renewal. Supervisory Control and Data Acquisition Systems can be integrated with either Asset Management or Rapid Data Management Mobile applications to collect logged data, generate Work / Purchase Orders, track activity, schedule preventative maintenance, streamline communications internally, etc.

Orleans ranks in the median for operation and maintenance costs per account, operations and maintenance costs per MG of treated water, and the direct cost of treatment per MG. From the data it can be interpreted that while Orleans' distribution system ranks among the best in the country, their treatment and operations and maintenance systems can be improved from good to great.

8.8.5 Business Operations

OWDs financial position bodes well in comparison with the similarly sized Northeast and National water utilities. For debt ratio Orleans ranks favorably in the top quartile when compared to the Northeast, but in the bottom quartile when compared to National water providers. In terms of distribution infrastructure renewal Orleans ranks in the median when compared to the Northeast, but in the top quartile among National survey respondents. For treatment and pumping infrastructure renewal, Orleans ranks in the top quartile for both indices. The Town's return on water system assets ranked around the median within the Northeast group. National statistics are clearly skewed which could be due to regional and/or financial bias within the pool of respondents. For example, more for-profit utilities filed information with QualServ in the national responses. Orleans has a low debt ratio versus the majority of Northeast water utilities. Average return on assets along with a low debt ratio is indicative of sound infrastructure management.

There are unique challenges that face each water utility around the country. Some utilities are plagued by drought or poor water quality, while others are troubled with aging infrastructure and corrosive soils. The costs associated with these challenges and their effect on the strategic planning, infrastructure renewal, and other key benchmarking areas may vary greatly. The data used in our comparisons may have many unseen underlying factors. That being said, when comparing Orleans in the categories defined in this section to both similar sized utilities in the nation and in the Northeast, they rank very well. There is always room for improvement, but according to the data, Orleans' planning and performance is exceptional.

Section 9

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SECTION 9

RISK ANALYSIS

9.1 GENERAL

Not all assets are equally important to a water system's operation; some assets are highly critical to operations and others are much less so. Furthermore, the definition of a critical asset is completely system specific. A water system must examine its own assets very carefully to determine which current assets are critical and why.

Analyzing the existing water system assets to determine the likelihood of failure (LoF), and the consequence of failure (CoF), provides valuable information about assets in the water system that have the greatest business risk exposure (BRE). The scope of this risk analysis includes the water supply, treatment facilities, storage and water mains in the distribution system. This risk analysis evaluation provides the foundation for the development of the most cost effective CIP planning allowing the OWD to add business risk exposure to the process and ensure money is allocated where risk can best be mitigated.

9.1.1 Asset Hierarchy and Registry

An inventory of the water treatment and distribution system assets was developed as part of this analysis to ensure that evaluation of the system assets on a component basis could be completed. Table 9-1 lays out the asset hierarchy and registry for all Orleans Water Department assets. As part of this analysis, a review of the wells and WTF was completed to the component level. The focus of this plan includes the analysis of the water supply, treatment facility, storage and distribution system. Ancillary equipment and facilities listed in Table 9-1 (which generally are low risk assets) were not included in this analysis. Moving forward OWD can use this registry to further categorize and catalog the department's assets.

TABLE 9-1
ASSET HIERARCHY AND REGISTRY

Department	Asset Class	Facility/Site
Orleans Water Department	**Treatment Facilities**	WTP
	Well Facilities	Well 1
		Well 2
		Well 3
		Well 4
		Well 5
		Well 6
		Well 7
		Well 8
		Fac 1
	Distribution Facilities	Standpipe 1
		Standpipe 2
	Additional Facilities	Fac 2
		Fac 3
		Fac 4
		Town Hall
		Garage
		Land Holdings
	Distribution System	Water Main
		Hydrant
		Valves
		Service
		Curbstop
	Equipment	Admin
		Distribution
		Treatment
	Fleet	Admin
		Distribution
		Treatment
	Customer Facilities	Service
		Meter
		Irrigation Meter
		Backflow Preventer

Process/System	Sub Process									
Civil	*Driveway*	*Landscaping*	*Culverts*	*Gates*	*Fence*	*Utility Poles*				
Yard Piping	*Mains*	*Valves*	*Hydrants*							
Monitoring Wells	*Casing*	*Screen*	*Cover*							
Production Wells	*Casing*	*Screen*	*Gravel pack*	*Pump*	*Motor*	*Drop Pipe*	*Check valve*	*Pitless adapter*		
Raw Water Pumping	*Pump*	*Motor*	*Column Pipe*	*Micro Strainer*						
Process Piping	*Pipe*	*valves*								
Chlorination	*Injection quill*	*Scale*	*Bulk tank*	*Day tanks*	*Pump*	*Piping*	*damper*	*mixer*	*meter*	
Corrosion Control	*Injection quill*	*Scale*	*Bulk tank*	*Day tanks*	*Pump*	*Piping*	*damper*	*mixer*	*meter*	
CIP Process	*Chem feed pumps*	*Recirc pumps*	*Control valves*	*Bulk tank*	*Day tanks*	*Pump*	*Piping*	*damper*	*mixer*	*meter*
Membrane Process										
Finish Water Pumping	*Air relief*	*Check valve*	*Pump*	*Motor*	*Air relief*	*Check valve*				
Residual Process	*Neutralization tank*	*Backwash tank*	*Infiltration lagoons*							
Architectural	*Foundation*	*Roof*	*Walls*	*Doors*	*Windows*					
Domestic Supply	*Air relief*	*Check valve*	*Pump*	*Motor*	*Meter*	*Backflow*				
Domestic Waste	*piping*	*septic field*	*leach field*							
HVAC	*fuel tank*	*blower ducts*	*piping*	*Furnace*	*Chiller*					
Security	*CP-x*	*Sensors*	*Wiring*							
Fire	*CP-x*	*Sensors*	*Wiring*							
SCADA	*CP-x*	*Radio*	*Level*	*Flow*	*pH*	*Chlorine*	*Status*	*Computer*		
Electrical	*MCC*	*3ph wire*	*1ph wire*	*LP*	*VFDs*	*M/ATS*	*Generator*			

Computers
Printers
Meter Readers
Phones
Air Driven Equipment
Calibration Equipment
Computers
Hand Tools
Heavy Equipment
Locators
Leak Detection
Power Tools
Pumps

[shaded box] These system components were not analyzed as part of the study

9.1.2 Likelihood of Failure

As a first step in determining risk, a system needs to look at what it knows about the likelihood that a given asset is going to fail. The four general models of asset failure are:

- *Mortality* - physical failure of the asset. This is the most common mode of failure.
- *Inefficiency* - the asset costs too much maintain operability and keep in service.
- *Capacity* – the asset is operational but is unable to deliver the required capacity
- *Level of Service* – the asset is operational but is unable to meet the required level of service

An asset may be highly likely to fail if it is old, has a long history of failure, has a known failure record in other locations, or has a poor condition rating. An asset may be much less likely to fail if it is newer, has little to no history of failure and has a good to excellent condition assessment rating.

9.1.3 Consequence of Failure

In terms of the consequence of failure, it is important to consider various possible costs of failure. The costs potentially include: loss of fire protection, public health impact, social cost associated with the loss of the asset, repair/replacement costs related to collateral damage caused by the failure, legal costs related to additional damage caused by the failure, environmental costs created by the failure, and any other associated costs or asset losses. The consequence of failure can be high if any of these costs are significant or if there are several of these costs that will occur with a failure.

9.1.4 Business Risk Exposure

Assessing risk requires an examination of the likelihood of failure and the consequence of failure as discussed above. The BRE score combines the two measures of failure into one number that can be used to sort and rank assets for further analysis.

BRE = LoF * CoF

Using this methodology, the OWD's exposure to the risk of failure for a given asset can be evaluated. Risk can be reduced by decreasing either the likelihood of failure through replacement or refurbishment or decreasing the consequence of failure through redundancy or relocation. In most cases it is not cost effective to install redundant infrastructure and sometimes, in the case of distribution systems and storage tanks, too much redundancy can often be detrimental to water quality in the system.

Normally, the most cost effective means of reducing business risk exposure on aging assets is to reduce the likelihood of failure through infrastructure replacement projects. The assets that have the greatest likelihood of failure and the greatest consequences associated with the failure will be the assets that have the greatest business risk exposure and should be further evaluated to determine ways to reduce the BRE through replacement, refurbishment, redundancy or relocation.

In most cases, a significant amount of risk can be mitigated through asset replacement. For example, BRE for a hypothetical existing 8-inch CI pipe with multiple breaks installed in 1960 will go from a BRE score of 27 to a BRE score of 10.2 after replacement with 12-inch DI pipe (Table 9-2). The replacement of an existing pipe with a new pipe reduces the LoF thus reducing the BRE score.

TABLE 9-2

IMPACT OF REPLACEMENT ON BRE SCORES

Description	Existing 8" CI Pipe Score	Proposed 12" DI Pipe Score
Likelihood of Failure Score	*4.5*	*1.7*
Consequence of Failure Score	*6*	*6*
Business Risk Exposure Score	**27**	**10.2**

Because the available data for the water facilities assets and the distribution system assets differs significantly, these two systems were evaluated for business risk exposure using two different sets of criteria summarized in Section 9.2 and 9.3.

9.2 FACILITY BUSINESS RISK EXPOSURE ASSESSMENT

Due to the variety of components that comprise the water system facilities, as indicated in Table 9-1, the categories used in analyzing facility assets need to be broad enough to assess performance of many different types of assets. Table 9-3 summarizes the categories used to determine business risk exposure for facility assets.

TABLE 9-3

BRE CATAGORIES FOR FACILITIES ANALYSIS

Likelihood of Failure	Consequence of Failure
Physical Condition	Social/ Community
Operational/ Process Performance	Economic/ Financial
Reliability	Environmental
Availability	
Maintainability	

9.2.1 Likelihood of Failure

As a first step in determining risk, a conditional assessment is needed to determine the likelihood that any asset is subject to failing. An asset may be highly likely to fail if it is old, has a long history of failure, has a known failure record in other locations, and has a poor condition rating. An asset may be much less likely to fail if it is newer, is highly reliable, has little to no history of failure and has a good to excellent condition rating. The existing facility condition assessment effort was referenced while developing this information. The LoF score is a sum of the factors listed below normalized to a 1-10 scale by weighting the factors per Table 9-4. These weighting factors have been selected by the OWD to appropriately reflect the potential risk for each factor in Orleans.

TABLE 9-4

LIKELIHOOD OF FAILURE FACTOR WEIGHTING

Factor	Weighting
Physical Condition	0.15
Operational/Technical Performance	0.30
Reliability	0.35
Maintainability	0.20

- *Physical condition* – this factor gives weight to the age and condition of an asset. This factor assumes an expected design lifespan depending on the type of asset.

TABLE 9-5
PHYSICAL CONDITION SCORING

Asset Life consumed %	Almost new; up to 10% physical life consumed	Up to 30% physical life consumed	Up to 50% physical life consumed	Up to 70% physical life consumed	Up to 90% physical life consumed	Virtually consumed, imminent failure
SCORE	1	3	5	7	9	10

- ***Operational/Technical Performance*** **–** This factor gives weight to the performance of an asset in terms of meeting demands, efficiency, and attention required.

TABLE 9-6:

OPERATIONAL PERFORMANCE SCORING

Operational Performance	Substantially exceeds current requirements. Negligible attention required.	Exceeds current requirements	Meets current requirements but with room for improvement	Obvious concerns: cost/benefit questions	Inefficient; becoming ineffective, obsolete. Difficult to sustain performance	Failing, not capable of sustaining required performance
SCORE	1	3	5	7	9	10

- ***Reliability* –** This factor relates the number of reported breakdowns or unplanned maintenance calls and potential downtime related to the availability of parts and service for the asset.

TABLE 9-7

RELIABILITY SCORING

Reliability	As specified by manufacturer	Infrequent breakdown	Occasional breakdown	Periodic breakdown	Continuous recurrent breakdown	Virtually inoperable
SCORE	1	3	5	7	9	10

- ***Maintainability***- This factor gives weight to the level and frequency of maintenance as well as the monitoring required to keep the asset operational.

TABLE 9-8

MAINTAINABILITY SCORING

Maintainability	Easily maintained; OEM maintenance is straightforward	Largely preventive maintenance with some corrective maintenance beginning to show up; baseline monitoring	Increasing minor maintenance required; periodic corrective maintenance including some repair shortening of monitoring intervals	Scheduled maintenance becoming frequent; more experienced trades people required for maintenance; frequency of work orders increasing substantially with short monitoring intervals	Work orders well above average for type of asset; recurrent minor repair; close monitoring required; most senior people required to sustain performance	Maintenance is frequent with recurrent patterns of failure; asset must be virtually constantly monitored to sustain performance
SCORE	1	3	5	7	9	10

9.2.2 Consequence of Failure

In terms of the consequence of failure, it is important to consider various possible costs of failure. The costs potentially include: social costs associated with the loss of the asset, repair/replacement costs related to collateral damage caused by the failure, legal costs related to additional damage caused by the failure, environmental costs created by the failure, and any other associated costs or asset losses. The consequence of failure can be high if any of these costs are significant or if there are several of these costs that will occur with a failure. The CoF score is a sum of the factors listed below normalized to a 1-10 scale. These weighting factors have been selected by the OWD to appropriately reflect the potential risk for each factor in Orleans.

TABLE 9-9

CONSEQUENCE OF FAILURE FACTOR WEIGHTING

Factor	Weighting
Social/Community	0.35
Economic/Financial	0.30
Environmental	0.35

- ***Social/Community* –** This factor gives weight to the social/community consequences that would occur if a given asset were to fail. Potential consequences included in this factor are of two types (Loss of Service, Safety, and Agency's Image).

TABLE 9-10

SOCIAL/COMMUNITY SCORING

Loss of Service	Can be out of service indefinitely	Cannot be down a month	Cannot be down a week	Cannot be down a day	Cannot be down 8 hours	Cannot be down one hour
Safety	No impact	Minor inconvenience	Minor injury	Moderate injury and some sickness	Major injury, sickness, some death	Substantial death, widespread injury and sickness
Agency's Image	No media or no consequence	Neutral coverage	Adverse media	Widely adverse media	Continual; political opposition	Nationally adverse media
Score	1	3	5	7	9	10

- ***Economic/Financial Scoring* –** This factor gives weight to the economic/financial consequences that would occur if a given asset were to fail. Potential consequences included in this factor are of two types (Economic and Financial).

TABLE 9-11

ECONOMIC/FINANCIAL SCORING

Financial impact	Low cost	Moderate cost	High cost	High cost; diverts $	Painful change of priorities	Likely to trigger rate increase, staff changes
Economic impact	Insignificant	<$10k	<$50k	<$100K	<$1 million	>$1 million
Score	1	3	5	7	9	10

- ***Environmental* –** This factor gives weight to the environmental consequences that would occur if a given asset were to fail. Potential consequences included in this factor are of two types (Spill/ Flood and Permit Compliance).

TABLE 9-12

ENVIRONMENTAL SCORING

Spill/ flood	**Short duration, small quantity onsite**	**Some flooding**	**Moderate flooding, some offsite spillage**	**Many inconvenienced; moderate health and habitat issues**	**Severe health and habitat issues; some mandatory vacation of premises**	**Large areas vacated and closed to public access; extensive specialized containment cleanup required**
Permit compliance	No consequence	Minor violation - reporting only	Regulatory sanction possible	Regulatory sanction likely; Damage reversible less than one year	Extensive regulatory sanction virtually assured; damage reversible in one to five years	Severe sanctions; damage reversible in five years or more
Score	1	3	5	7	9	10

9.2.3 Facilities Business Risk Exposure (BRE)

Plotting the Likelihood of Failure scores against the Consequence of Failure scores for all facilities assets in the Orleans system on a graph provides a visual means of reviewing this information (Figure 9-1). As shown in the figure, the BRE scores associated with the majority of individual assets is low. However there are also a number of assets that score in the medium and high risk category where risk should be further considered and mitigation measures such as enhanced monitoring, replacement or redundancy of the asset considered. In most cases, there is significant BRE that may be mitigated by asset replacement as the likelihood of failure scores for these assets is significant and the asset is nearing its expected service life.

The 15 individual facility components that have the highest BRE scores are listed in Table 9-13. This type of risk assessment also allows the OWD to aggregate the BRE scores for a facility and compare the risk associated with each facility (Table 9-16). For example, the facilities that have the greatest BRE are the two water storage tanks followed closely by the WTF. The consequence of these assets failing is very significant and this shows in the aggregate scores. This data also indicates that the WTF has significant BRE. Given that 11 of the individual top 15 BRE assets listed in this is expected and will be considered in the development of the CIP in Section 10. A copy of the facilities BRE spreadsheet is included in Appendix E.

TABLE 9-13

TOP 15 HIGHEST RISK FACILITY ASSETS

Rank	Asset Description	LoF	CoF	BRE	Failure Mode	Current Mitigation Measure
1	WTF VFDs	6.6	5.7	37.0	Mortality	Replacement
2	WTP Computer	5.0	5.2	25.8	Mortality	Replacement*
3	Well No. 1 Radio	5.0	5.2	25.8	LOS	Add Redundancy/ Emergency Power
4	WTF Radio	3.9	5.4	21.1	Mortality	Replacement*
5	WTF Control Panel	3.6	5.4	19.4	Mortality	Rehabilitation*
6	Well No. 1 CP-1	5.0	3.8	18.8	LOS	Add Redundancy/ Emergency Power
7	WTP Roof	3.2	5.6	17.6	Mortality	Monitor
8	Well No. 1 MCC	3.5	4.8	16.8	LOS	Add Redundancy/ Emergency Power
9	WTF Level	3.0	5.4	16.2	Mortality	Monitor
10	WTF Membrane Rack 1	4.3	3.6	15.5	Mortality	Scheduled Replacement
11	WTF Membrane Rack 2	4.3	3.6	15.5	Capacity	Scheduled Replacement
12	WTF Membrane Rack 3	4.3	3.6	15.5	Capacity	Scheduled Replacement
13	Well 2 Flow Meter	4.5	3.4	14.8	Capacity	Monitor
14	WTP Generator	6.3	2.4	13.8	Mortality	Replacement
15	WTP Building Envelope	3.0	4.6	13.7	Mortality	Monitor

*These assets are currently being replaced/renewed as part of the SCADA improvements at the WTF in 2014.

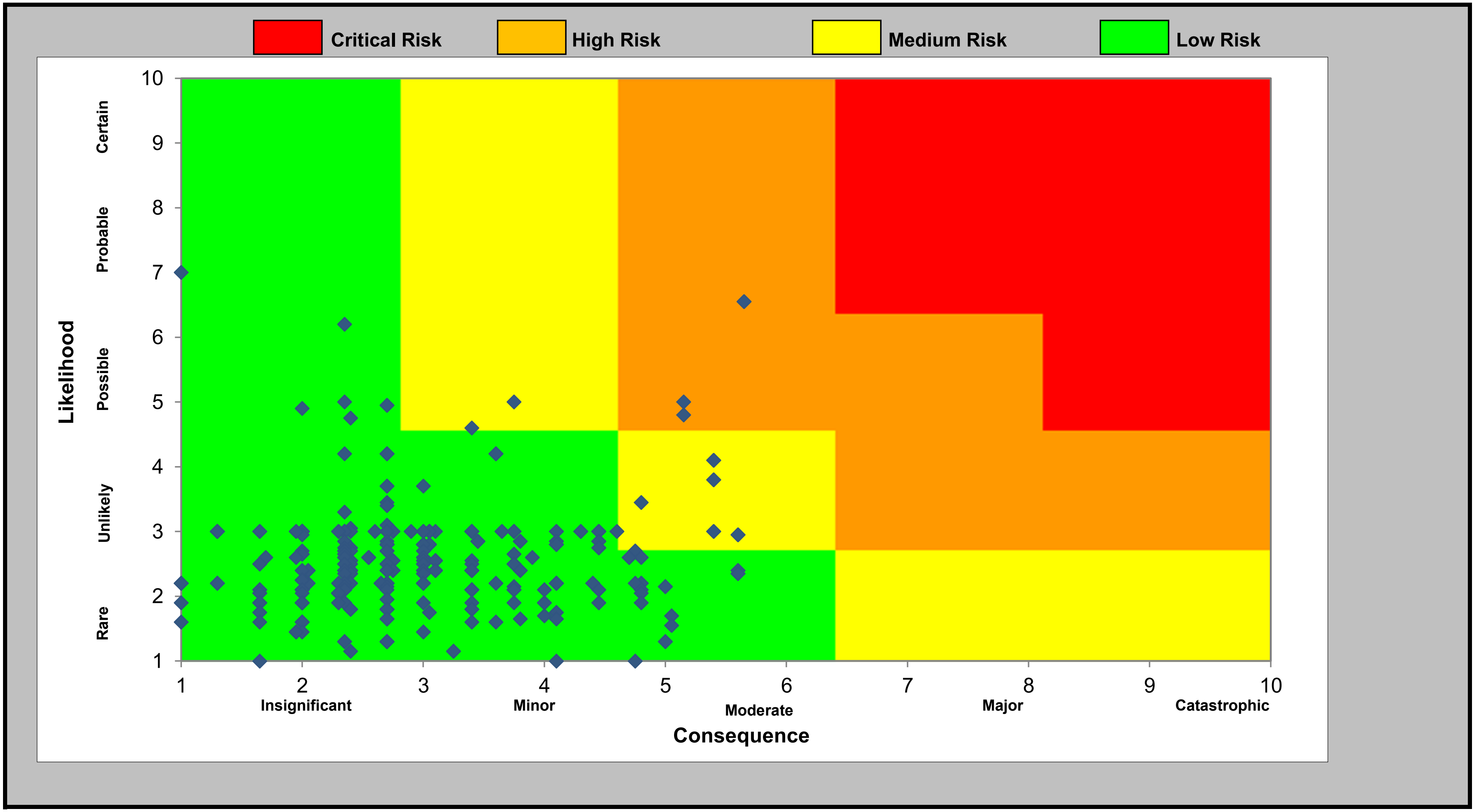
TABLE 9-14

FACILITY AGGREGATE BRE SCORE

Facility	BRE Score
Water Treatment Facility	9.4
Well No.1	7.6
Well No.2	7.3
Well No.3	7.4
Well No.4	6.5
Well No.5	6.5
Well No.6	6.6
Well No.7	6.1
Well No.8	5.5
Facility No.1	8.1
Standpipe No.1	9.6
Standpipe No.2	9.5

FIGURE 9-1

FACILITIES BUSINESS RISK EXPOSURE: ALL ASSETS



9.3 DISTRIBUTION SYSTEM BUSINESS RISK EXPOSURE ASSESSMENT

The distribution system BRE assessment was developed to utilize specific available GIS attributes to assign risk for each pipe segment in the water system network.

TABLE 9-15

BRE CATAGORIES FOR DISTRIBUTION SYSTEM ANALYSIS

Likelihood of Failure	Consequence of Failure
Asset Life Consumed	Business Interruption
Material	Traffic Interruption
Repair History	Fire Protection Disruption
Static Pressure	
Soil Type	
Freezing Potential	
Saltwater Intrusion	

9.3.1 Likelihood of Failure

As a first step in determining risk, a system needs to look at what it knows about the likelihood that a given water main is going to fail. An asset may be highly likely to fail if it is old, has a long history of failure, has a known failure record in other locations, and has a poor condition rating. An asset may be much less likely to fail if it is newer, is highly reliable, has little to no history of failure and has a good to excellent condition rating. The LoF score is a sum of the factors listed below normalized to a 1-10 scale by weighting the factors per Table 9-15. These weighting factors have been selected by the OWD to appropriately reflect the potential risk for each factor in Orleans.

TABLE 9-16

LIKELIHOOD OF FAILURE FACTOR WEIGHTING

Factor	Weighting
Asset Life Consumed	0.40
Material	0.10
Repair History	0.15
Static Pressure	0.10
Soil Type	0.10
Freezing Potential	0.05
Saltwater Intrusion	0.10

***Asset Life Consumed* –** This factor gives weight to the age of a pipe. This factor assumes a useful lifespan of 100 years for all types of pipe. The scoring is a ratio of current time in service for each pipe by the expected lifespan. This ratio is multiplied by 10 to adjust the ration to the 1-10 scoring mechanism as shown below. All pipes with unknown ages were assigned a score of 5. Figure 2-7 shows the distribution system by installation date.

Score = (Current Year - Installation Year)/100 years *10)

- ***Material Type* –** This factor gives weight to the different types of pipe material. Some types of pipe are more susceptible to failure than others. In this instance 10% of the distribution system material type is unknown but is either CI or DI as those are the only two types of pipe ever installed in the distribution system. All pipes with unknown material type were assigned a score of 5. Figure 2-6 shows the distribution system by material type.

TABLE 9-17

PIPE MATERIAL SCORING

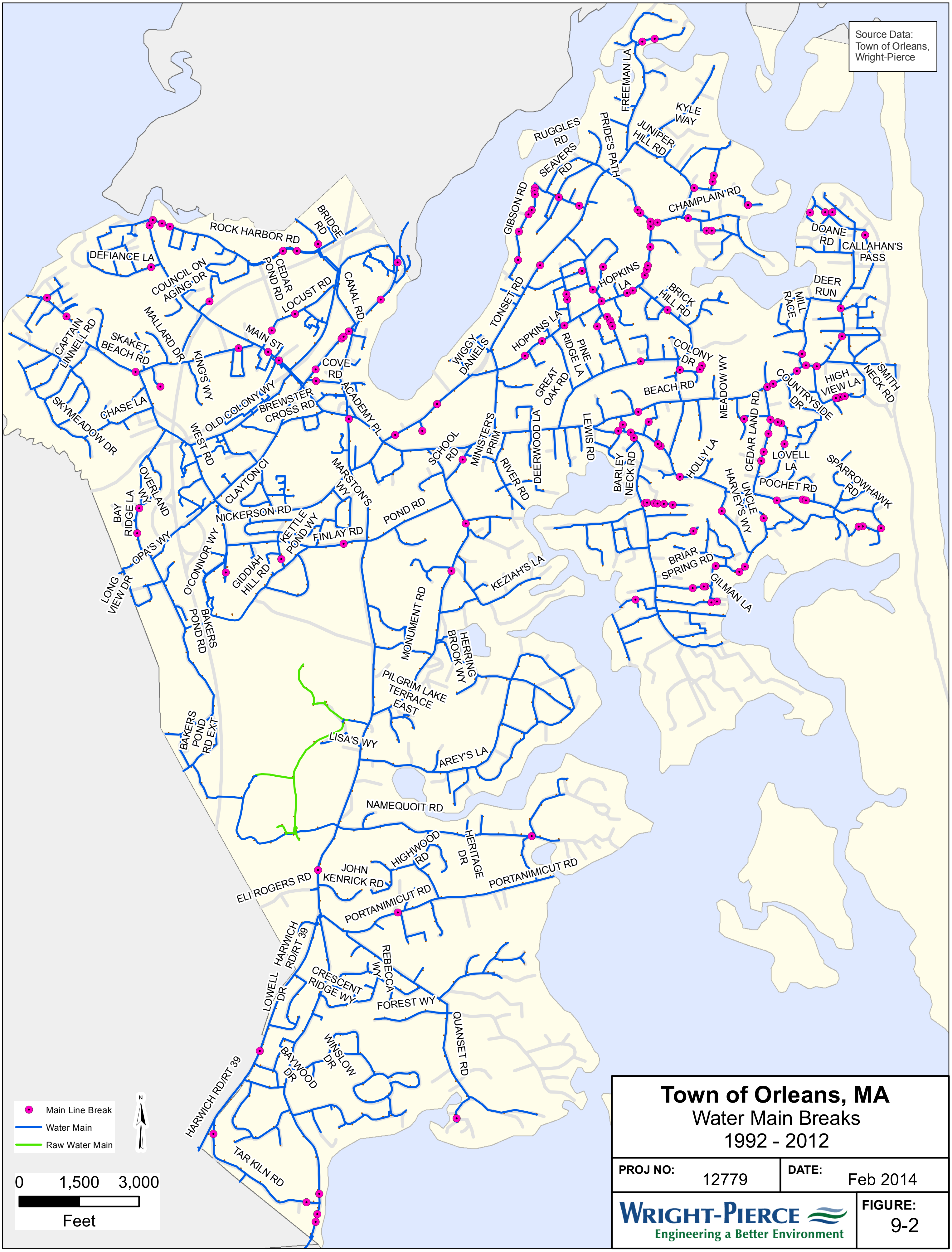
Material	Score
Ductile Iron	1
Lined Cast Iron	5
Unknown	5

- ***Repair History* –** Water mains like other mechanical systems have a tendency to fail at their weakest points and then fail again near the same location. These failures in a water system are often the result of improper water main installation or poor soil conditions. This factor relates the number of reported water main breaks to a specific water main and considers the potential for a break to occur in the same area. Repairs included in this analysis are limited to those that have occurred in the last 20 years. Figure 9-2 shows the recent distribution system main breaks.

TABLE 9-18

REPAIR HISTORY SCORING

Material	Score
0 breaks	1
1 break	2.5
2 breaks	5
3 breaks	7.5
>3 breaks	10



Town of Orleans, MA

Water Main Breaks

1992 - 2012

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FIGURE: 9-2

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- ***Static Pressure*** – This factor gives weight to areas where higher static pressures are present. High pressure adds additional stress on a pipe and can lead to failure. Figure 9-3 shows the normal distribution system pressure.

TABLE 9-19
STATIC PRESSURE SCORING

Static Pressure (psi)	Score
0-40	1
40-60	2.5
60-80	5
80-100	7.5
>100	10

Soil Type – Certain soil types create an environment where pipes may fail more frequently. Carver-Hinesburg Loamy Coarse Sand, which encompasses most of the Northern and Eastern portion of Town, has been reported to include areas where improperly bed water main has an increased potential to fail. Figure 9-4 delineates the extents of this soil type in Orleans.

TABLE 9-20

SOIL TYPE SCORING

Soil Type Present (Y/N)	Score
No	1
Yes	10

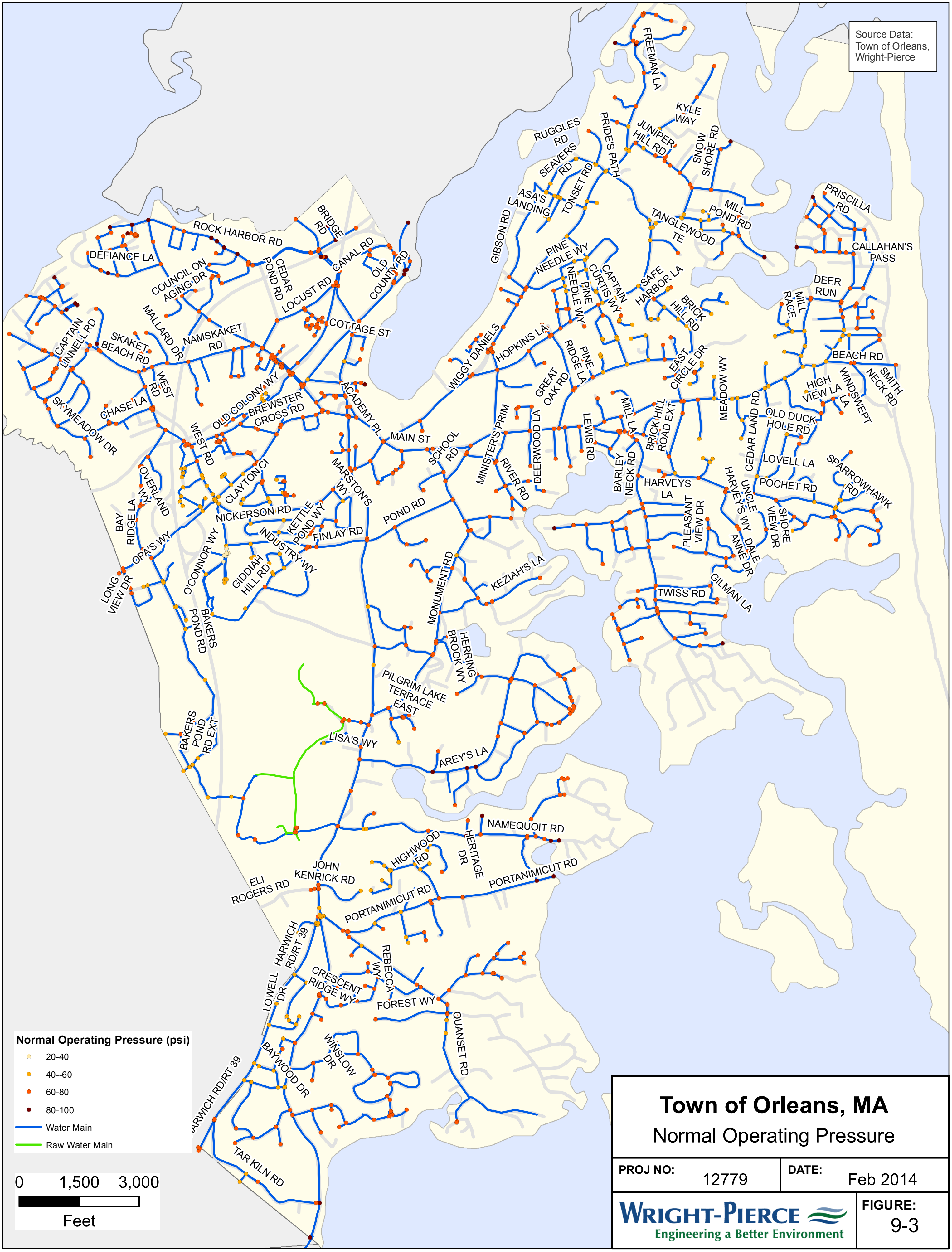
Source Data:
Town of Orleans,
Wright-Pierce
Town of Orleans, MA
Normal Operating Pressure
PROJ NO:
12779
DATE:
Feb 2014
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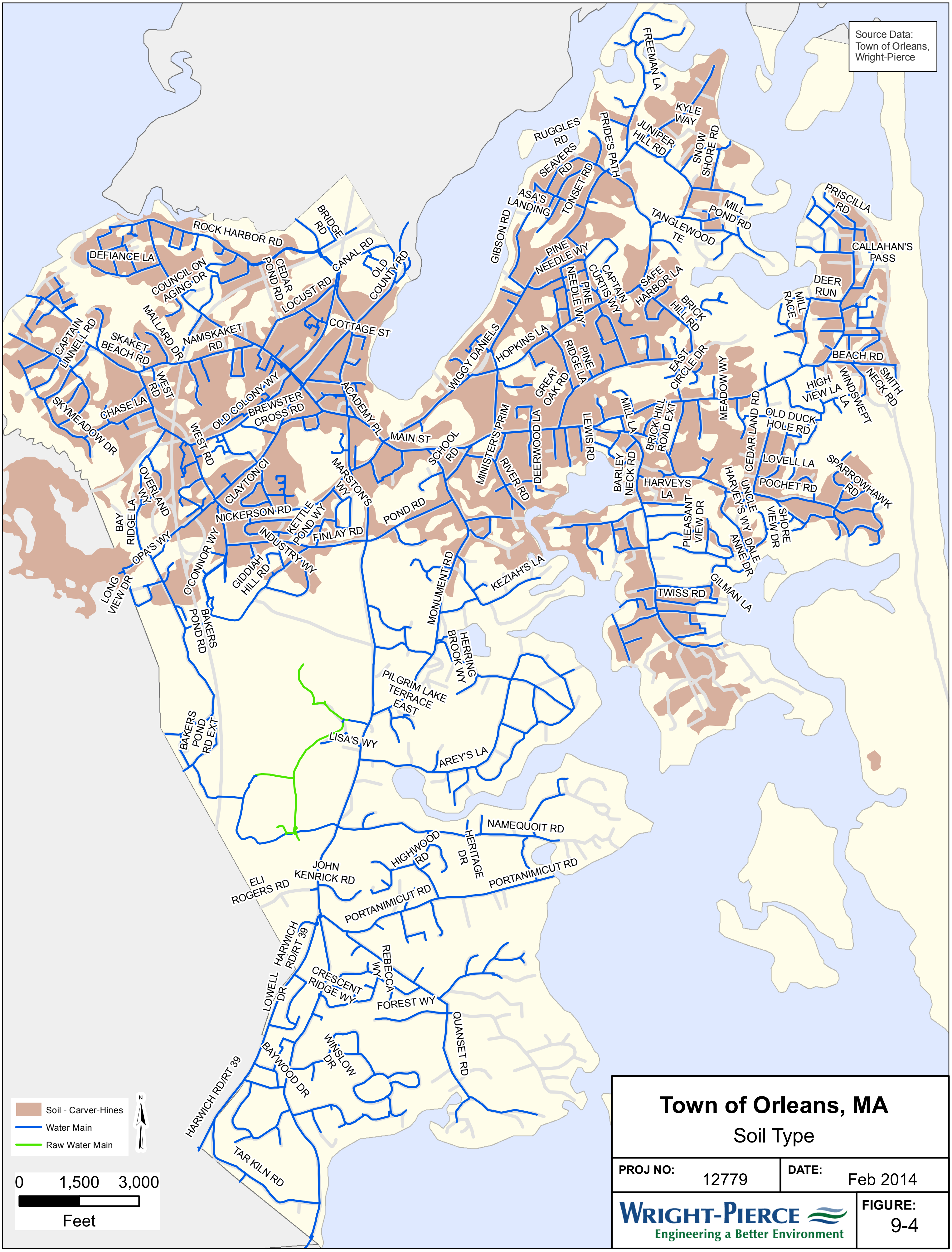
FIGURE:
9-3
Normal Operating Pressure (psi)
20-40
40--60
60-80
80-100
Water Main
Raw Water Main
0
1,500
3,000
Feet
CLM W:\GIS_Development\Projects\MA\Orleans\12779\MXDs\9-3_StaticPressure.mxd
FREEMAN LA
KYLE WAY
RUGGLES RD
PRIDE'S PATH
JUNIPER HILL RD
SNOW SHORE RD
SEAVERS RD
ASA'S LANDING
TONSET RD
GIBSON RD
MILL POND RD
TANGLEWOOD TE
PRISCILLA RD
CALLAHAN'S PASS
PINE NEEDLE WY
NEEDLE WY
PINE
CAPTAIN CURTIS WY
SAFE HARBOR LA
BRICK HILL RD
DEER RUN
MILL RACE
ROCK HARBOR RD
BRIDGE RD
DEFIANCE LA
CEDAR POND RD
CANAL RD
OLD COUNTY RD
COUNCIL ON AGING DR
LOCUST RD
COTTAGE ST
CAPTAIN LINNELL RD
SKAKET BEACH RD
MALLARD DR
NAMSKAKET RD
WIGGY DANIELS
HOPKINS LA
PINE RIDGE LA
EAST CIRCLE DR
MEADOW WY
BEACH RD
SMITH NECK RD
HIGH VIEW LA
WINDSWEPT LA
GREAT OAK RD
WEST RD
CHASE LA
OLD COLONY WY
BREWSTER CROSS RD
ACADEMY PL
MAIN ST
SCHOOL RD
MINISTER'S PRIM
DEERWOOD LA
LEWIS RD
MILL LA
BRICK HILL ROAD EXT
CEDAR LAND RD
OLD DUCK HOLE RD
SKYMEADOW DR
WEST RD
OVERLAND WY
CLAYTON CI
MARSTON'S WY
RIVER RD
BARLEY NECK RD
HARVEYS LA
LOVELL LA
POCHET RD
SPARROWHAWK RD
BAY RIDGE LA
NICKERSON RD
KETTLE POND WY
POND RD
PLEASANT VIEW DR
HARVEY'S WY
UNCLE
SHORE VIEW DR
OPA'S WY
FINLAY RD
INDUSTRY WY
ANNE DR
DALE
O'CONNOR WY
GIDDIAH HILL RD
KEZIAH'S LA
LONG VIEW DR
MONUMENT RD
TWISS RD
GILMAN LA
POND RD
BAKERS
HERRING BROOK WY
PILGRIM LAKE TERRACE EAST
BAKERS POND RD EXT
LISA'S WY
AREY'S LA
NAMEQUOIT RD
HIGHWOOD RD
HERITAGE DR
JOHN KENRICK RD
ELI ROGERS RD
PORTANIMICUT RD
PORTANIMICUT RD
HARWICH RD/RT 39
LOWELL DR
CRESCENT RIDGE WY
REBECCA WY
FOREST WY
QUANSET RD
BAYWOOD DR
WINSLOW DR
HARWICH RD/RT 39
TAR KILN RD



Town of Orleans, MA

Soil Type

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FIGURE: 9-4

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***Saltwater Intrusion* –** Portions of Orleans are affected by brackish tidal groundwater. Ferrous water mains installed in these areas are subject to accelerated corrosion. For the purposes of this analysis, the area of concern is delineated by the Sea, Lake, and Overland Surges from Hurricanes (SLOSH) Zone A area in Orleans. This delineation includes the areas in Orleans that are near sea level and have the potential for flooding in the event of severe storm event. Figure 9-5 shows the normal distribution system pressure.

TABLE 9-21

SALTWATER INTRUSION SCORING

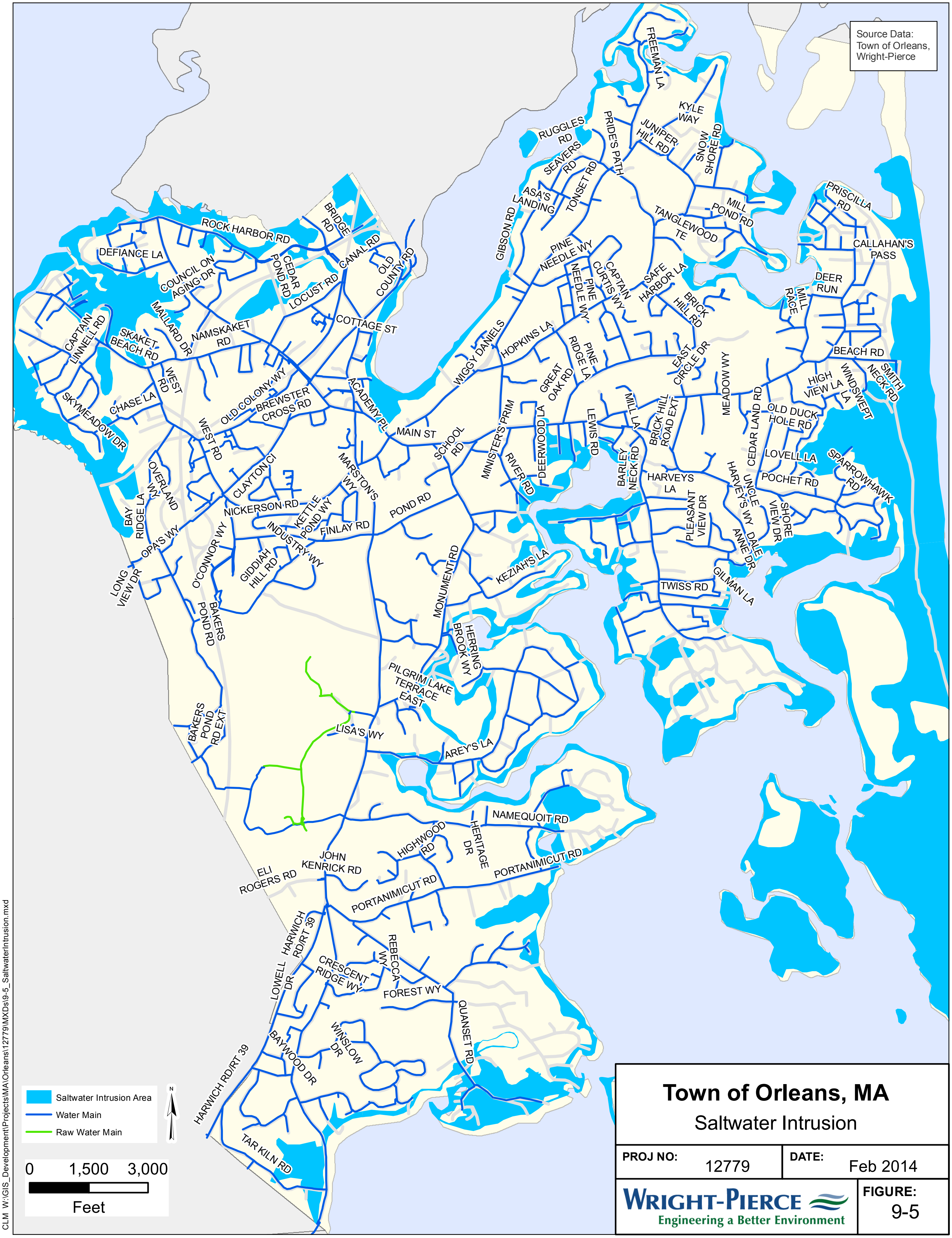
Saltwater Intrusion (Y/N)	Score
No	1
Yes	10

- ***Freezing Potential*** – In OWD's experience smaller diameter water mains have more potential to freeze and fail. This factor provides weight to the potential of these smaller diameter mains to freeze. Figure 2-5 shows the distribution system by pipe diameter.

TABLE 9-22

FREEZING POTENTIAL SCORING

Diameter (inch)	Score
2	10
4	8
6	7
8	5
10	3
12	2
16	1



Town of Orleans, MA

Saltwater Intrusion

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FIGURE:
9-5

9.3.2 Consequence of Failure

In terms of the consequence of failure, it is important to consider various possible costs of failure. The costs potentially include: loss of fire protection, social cost associated with the loss of the asset, repair/replacement costs related to collateral damage caused by the failure, legal costs related to additional damage caused by the failure, environmental costs created by the failure, and any other associated costs or asset losses. The consequence of failure can be high if any of these costs are significant or if there are several of these costs that will occur with a failure. The CoF score is a sum of the factors listed below normalized to a 1-10 scale. These weighting factors have been selected by the OWD to appropriately reflect the potential risk for each factor in Orleans.

TABLE 9-23

CONSEQUENCE OF FAILURE FACTOR WEIGHTING

Factor	Weighting
Business Interruption	0.2
Traffic Disruption	0.3
Fire Protection Disruption	0.5

- ***Business Interruption* –** This factor gives weight to sections of the distribution system that are necessary to supply water to large water users and facilities where water is of high importance such as school buildings and medical facilities. Figure 9-6 delineates the areas where business interruption was considered.

TABLE 9-24

BUSINESS INTERRUPTION SCORING

Business Interruption (Y/N)	Score
No	1
Yes	10

- ***Traffic Disruption*** **–** This factor gives weight to traffic issues that would occur if a given pipe were to fail. Disruptions were divided into three types (Major, Moderate and Minor). Figure 9-7 delineates the three traffic disruption classifications.

TABLE 9-25

TRAFFIC DISRUPTION SCORING

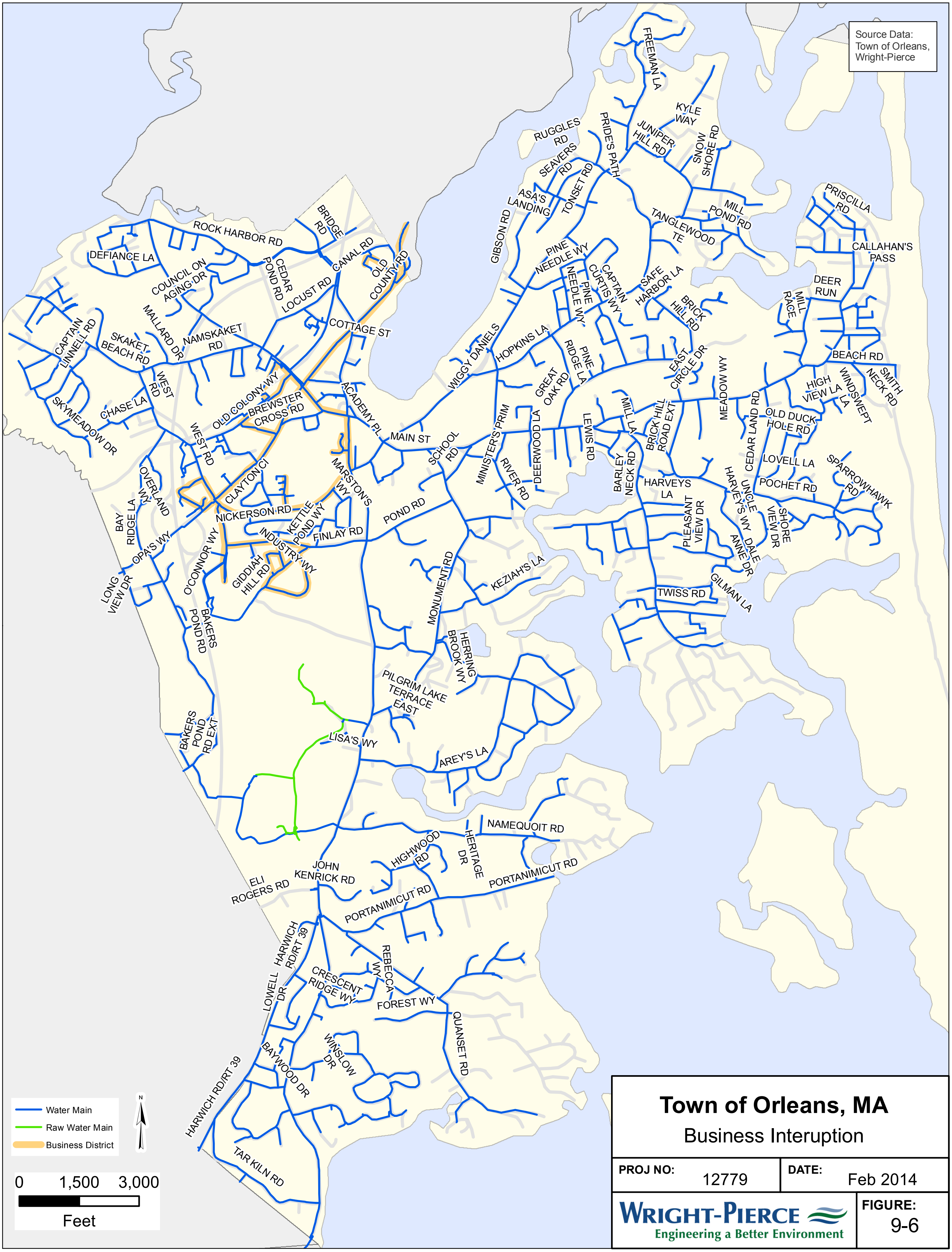
Soil Type	Score
Minor	1
Moderate	3
Major	7
Critical	10

- ***Fire Protection Disruption*** **–** Larger diameter water mains provide the backbone of the fire protection and water transmission for the system. Larger diameter pipes are also more difficult to repair in the event of a main break. This factor provides weight to the consequence of failure of the water mains based on the pipe diameter. Figure 2-5 shows the distribution system by pipe diameter.

TABLE 9-26

FIRE PROTECTION DISRUPTION SCORING

Diameter (inch)	Score
2	1
4	2
6	3
8	5
10	7
12	8
16	10



Town of Orleans, MA

Business Interuption

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FIGURE: 9-6

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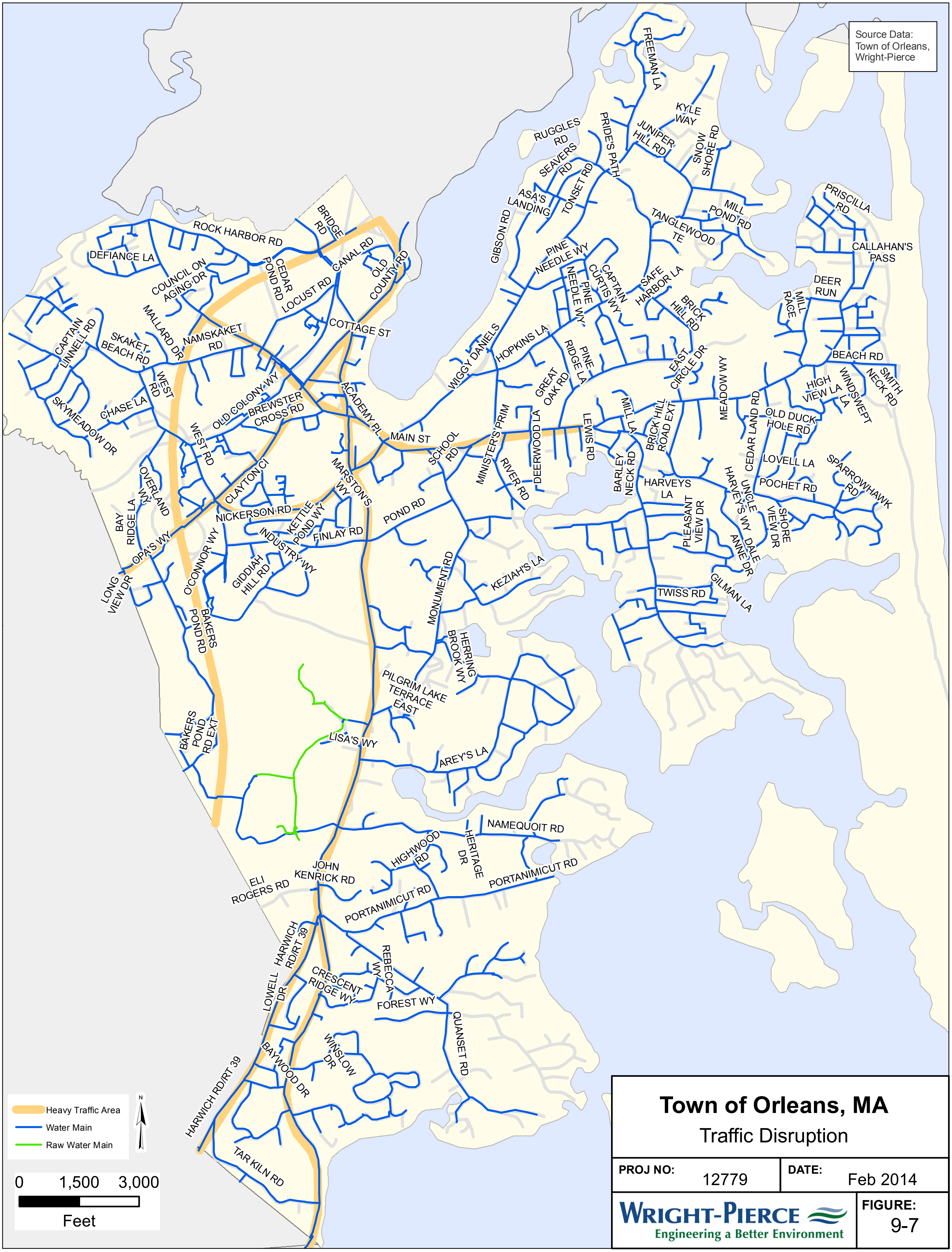

Town of Orleans, MA

Traffic Disruption

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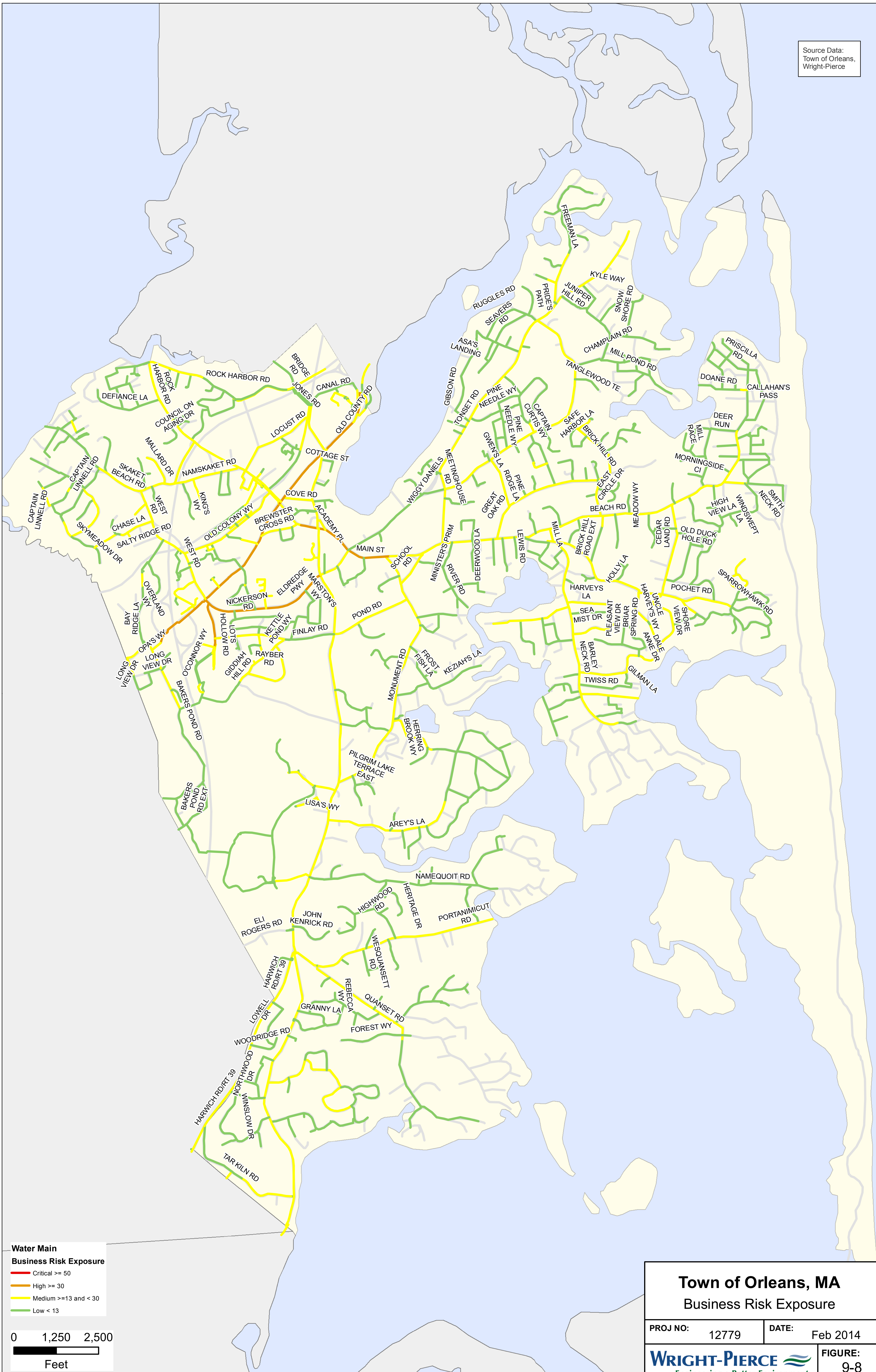
FIGURE: 9-7

9.3.3 Distribution System Business Risk Exposure (BRE)

Generally, the water mains in OWD have a low LoF score as the oldest pipes in the system are only ~50 years old and pipe age, the likelihood of failure factor with the most weight, has not become a risk factor that would dictate water main replacement in this planning cycle. This will change as the pipes continue to age and will likely be the driver for water main replacement in the next 20 year planning cycle.

Figure 9-8 shows the pipes with the highest ranking BRE scores in Orleans. As shown in the figure, the high risk water mains are located on Main St, Route 6A and Nickerson Road. Plotting the Likelihood of Failure scores against the Consequence of Failure scores for all pipes in the system on a graph provides another visual means of reviewing this information (Figure 9-9). As shown on the graph it is evident that there are a number of high and medium risk assets in the distribution system but most of the distribution system assets fall into the low risk category.

Most of the larger water mains in Town are located in the areas where failure of the water mains is of the most consequence. Most of the risk associated with these assets is associated with the consequence of failure factors, COF risk is not mitigated through replacement. Currently monitoring, not replacement, of these high and moderate risk assets is recommended as there is significant service life left in these water mains. There is significant service life remaining in the distribution system water mains and replacement of these water mains will be a priority in the next planning cycle. If the maintenance frequency of these assets starts to increase, replacement or relocation is recommended. A copy of the BRE water main spreadsheet is included in Appendix E.



Town of Orleans, MA

Business Risk Exposure

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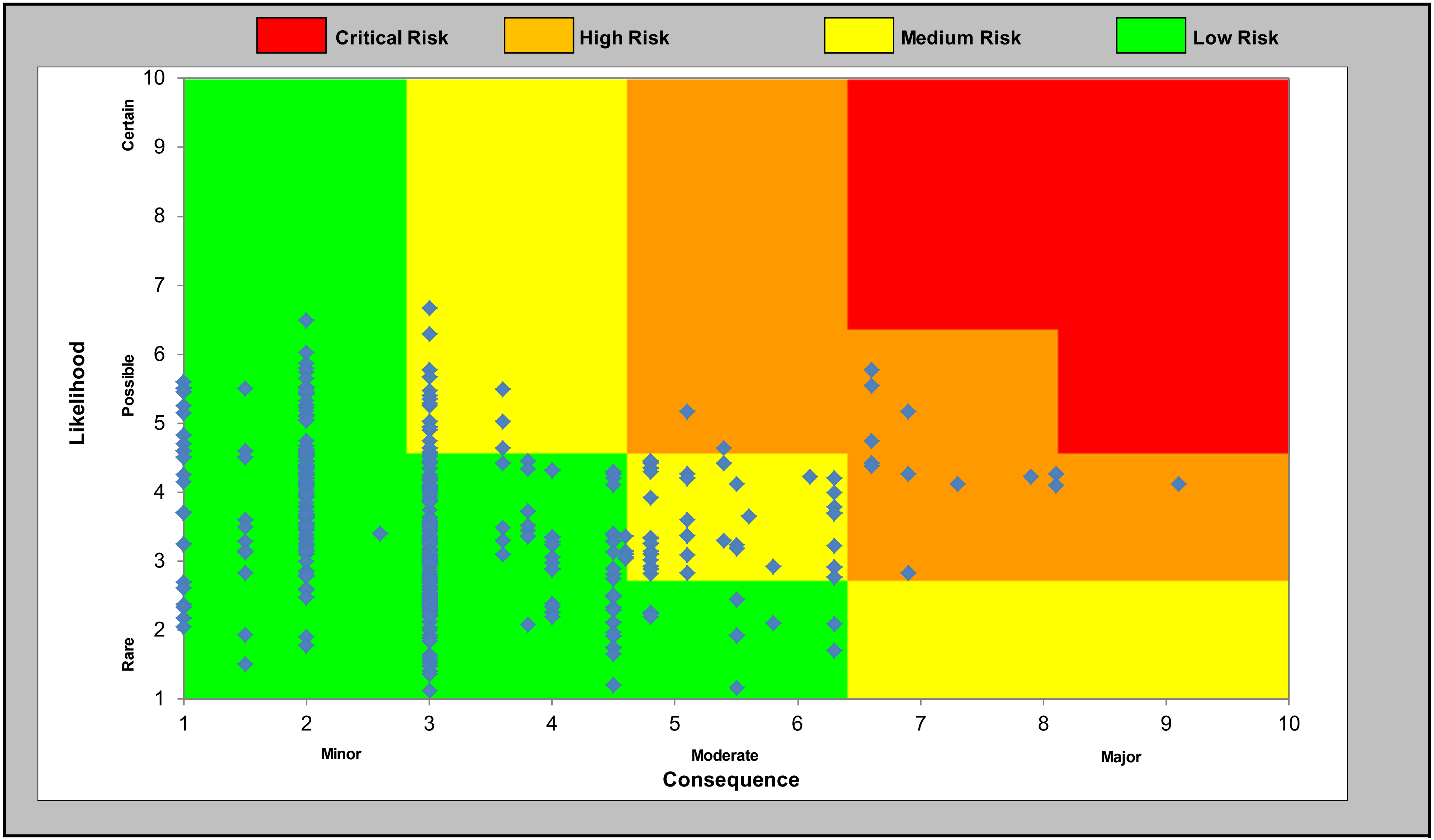
FIGURE: 9-8

FIGURE 9-9
DISTRIBUTION SYSTEM BUSINESS RISK EXPOSURE: ALL PIPES



Section 10

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Engineering a Better Environment

SECTION 10

CAPITAL IMROVEMENT PLAN

10.1 MEETING LEVEL OF SERVICE GOALS AND OBJECTIVES

The purpose of the asset management plan is to meet the vision established for the Orleans Water Department over the next 20 year period. The vision of the utility is embodied in level of service (LOS) goals and objectives. The LOS plan developed in Section 4 of this report is restated as Table 10-1 herein for reference purposes. The goals and objectives for the Orleans asset management plan were established in the following areas:

- Customer service
- Workplace environment
- Definition of critical assets
- Tools for assessing overall system performance
- Establishing links between costs and service
- Management and operational goals
- Regulatory goals
- Annual reporting

Benchmarks and metrics to measure and monitor success in these key areas is summarized in Table 10-1. In some instances, the Orleans Water Department has established procedures and resources to meet the established LOS goals and objectives. An example of this metric, would be hydrant inspection (LOS Category – Water Operations). The Orleans Water Department has an excellent, established program for hydrant inspections. This data is being integrated into the GIS system with the recent development of the Utility Cloud program (Another LOS goal in water operations).

In other instances, investment in new procedures or infrastructure is needed to meet the LOS goals and objectives. An example of this benchmark would be maintenance of infrastructure needed to comply with ISO standards throughout the community. To meet the limited ISO deficient areas in Town will require some additional investment in piping infrastructure.

TABLE 10-1
LEVEL OF SERVICE GOALS AND OBJECTIVES

	Operations	Target	Driver	Tracking Method	Frequency
1	Compliance with Safe Drinking Water Rules and Regulations*	100%	Safe drinking water act	Compliance reports	Annually
2	Compliance with USEPA Secondary Drinking Water Standards*	100%	Safe drinking water act	Sampling	Annually
3	Repair leaks within 24 hours*	>95%	MADEP	Work order records	Annually
4	Maintain a level of service where there are less than 1 break per 25 miles of distribution water main*	<5 /yr	Self imposed	Work order records	Annually
5	Maintain a full inventory of distribution system parts and for spare parts identified in operations manuals for supply/treatment	100%	MADEP	Work order records	Annually
6	Maintain water system facilities power and communications capacity	>95%	DEP/ Emergency Response Plan	SCADA	Annually
7	The Department shall maintain infrastructure that allows for fire flows that exceed ISO needed fire flows in the community.	100%	ISO insurance ratings	Flow testing	Bi-annually
8	Compliance with all the ISO water rating requirements	3/9 or better	ISO insurance ratings	ISO rating reviews	5-10 years
9	Deliver consistent, high quality water to all customers that meets both Primary and Secondary MCLs*	Zero Complaints	Mission Statement	Complaint Log	Annually
10	Maintain a highly functional fleet of vehicles and equipment*	< 10 years old	MADEP/ ERP	Equipment inventory	Annually
11	Ensure GIS and Utility Cloud data sets are aligned	100%	Records maintenance	Data set review	Annually
12	Inspect and maintain all hydrants in the distribution system	300/year	AWWA G200/M-17	Work order records	Annually
13	Inspect and maintain all valves in the distribution system*	100%	AWWA G200/M-17	Work order records	Annually

	Compliance with Water Management Act Regulations	Target	Driver	Tracking Method	Frequency
1	Replace all customer water meters in the system over a 15 year period	15 yrs	Water Management Act Permit	Work order records	Annually
2	Perform leak detection across the distribution system every 2 years*	2 yrs	Water Management Act Permit	Work order records	Bi-Annually
3	Ensure well pumping rates are less than the allowable rates at all times*	100%	Water Management Act Permit	Annual report	Annually
4	Minimize unaccounted for water in the water distribution system*	<10%	Water Management Act Permit	Annual report	Annually
5	Maintain residential water use to less than 65 gpd/person*	<65 GPD/person	Water Management Act Permit	Annual report	Annually
6	Water treatment plant production efficiency	>95%	Water Management Act Permit	Annual report	Annually
7	Periodically perform hydrant flushing in the water distribution system *	100%	MADEP	flushing records	Annually
8	Eliminate all cross connections in the system	0 cross connections	MADEP	Work order records	Annually
9	Meet Projected Maximum-day Demand with the Largest Source Off-line	Flow rate	MADEP	Annual Report	Annually

	Business	Target	Driver	Tracking Method	Frequency
1	Water rate increases below 5% per year	<5%	Self imposed	Budget review	Annually
2	Maintain an appropriate fund balance to maintain operations	25%	AWWA/MADEP guidance	Funding balance	Annually
3	Comply with all State regulations*	100%	State regulations	Compliance reports	Annually
4	Move to a quarterly billing frequency	Quarterly Billing	Department audit	Billing cycle	Annually

	Workplace Environment	Target	Driver	Tracking Method	Frequency
1	Maintain a safety committee and deliver service in the safest possible manner*	Zero accidents	DOL and OSHA regulations	Accident reports	Annually
2	Treatment Operator training level*	Grade 2	State regulations	Certification records	Annually
3	Distribution Operator training level*	Grade 3	State regulations	Certification records	Annually
4	Training level per operator*	100%	State regulations	Certification records	Annually
5	Cross training between treatment and distribution staff*	50%	DEP Regulations	Training Records	Annually

	Customer Service	Target	Driver	Tracking Method	Frequency
1	Respond to a customer by next business day of receiving inquiry*	>95%	MADEP	Work order records	Annually
2	Respond to water quality or pressure service complaints within 4 hours*	>95%	MADEP	Work order records	Annually
3	Contact affected customers prior to a water main shutdown in both planned and emergency situations*	>95%	Water Dept. regulations	Work order records	Annually

*Indicates this LOS goal is currently being met

10.2 RISK ASSESSMENT

Like most water utilities in New England, investment in the water system requires establishing priority. In Section 9 of this report, a risk analysis was conducted to create weighting criteria to establish priority in meeting the LOS goals and objectives. The risk analysis was conducted on all assets in the water supply, treatment facility, storage and water mains in the distribution system. This risk analysis provides the foundation for the development of the most cost effective CIP planning allowing the OWD to add business risk exposure reduction into capital planning.

10.3 RECOMMENDED CAPITAL IMPROVEMENTS AND FINDINGS

Cost estimates for the recommendations below are based upon costs incurred for similar publicly bid and constructed projects (unless otherwise noted). All of the project costs listed include a 15% construction contingency and 15% for engineering services unless otherwise noted. Costs are based on recent similar publicly bid construction project pricing referenced to the February 2014 Engineering News Record (ENR) 20 City construction cost index. This information was compiled and used to establish a capital improvement plan for the next 20-year period for the Orleans water system. Scheduling of these improvement projects is addressed in Section 11 and the escalation of project costs to include inflation is completed therein.

10.3.1 Well Supply and Water Treatment Facility Capital Needs

New capital projects to meet the level of service goals include improvements to the well supply and water treatment facility. This schedule reflects all the recommended improvements from the asset management plan and establishes order of priority based on the criticality analysis and consequence of failure analysis. The plan includes the following major capital projects:

- **Well Supply and Capacity** – A build-out analysis was conducted in Section 3 to estimate the maximum future water supply needs in the Town of Orleans. The analysis concluded that the existing supply of 8 wells are adequate to meet the projected demands in the Town of Orleans after build-out occurs while continuing to pump with wells in a safe, sustainable manner with some mechanical improvements (Section 5). This analysis considered mechanical and supply redundancy to meet emergency loss of a well from an emergency in accordance with Commonwealth of Massachusetts and industry standards for redundancy. **No additional supply development is needed in Orleans to meet the projected build-out demands in the community.**

- **Well Cleaning and Maintenance –** The Orleans Water Department budgets for biannual cleaning and inspection of each well, well pump and motor. This important routine maintenance should continue to be budgeted to assure that all wells remain serviceable at all times to meet projected peak demands during the summer months. Although the water system, can meet projected build-out demands with one well off-line for emergencies or maintenance, the Town's ability to continue to meet this strict standard requires confirming well reliability routinely. If well maintenance if not routinely completed, the OWD well supply will continue to lose well capacity and ultimately replacement wells will need to be developed at a significantly higher cost than the continued well maintenance.

- **Well Supply Reliability –** Several deficiencies were identified in the emergency power systems, well pumps and electric systems in the wells that compromise reliability of the well supply. The consequence of failure of these systems will be inadequate ability to meet peak summer demands because of a major regional power failure or inadequate emergency power at all the needed facilities. The following improvements were identified in Section 5 and are reiterated In Table 10-2.

TABLE 10-2

WELL SUPPLY IMPROVEMENT RECOMMENDATIONS

Well and Pumping Station	Assessment and Needs	Estimated Cost for Improvements
Well No 1	• Add emergency power system – Well No. 1 and FAC 1 • Review SCADA equipment and replace aging equipment	$375,000
Well No 2	• Remove remaining RAD appurtenances • Add new mag-meter and reconfigure lower level piping • Reconfigure generator at Well No. 2 to add Well No. 3	$20,000
Well No 3	• Replace and straighten lower level piping and add new mag-meter • Remove right angle drive unit and associated equipment • Replace MCC • Add common generator with Well No. 2	$250,000
Well No 4	• Replace well pump • Remove decoupled engine drive units and associated equipment	$55,000
Well No 5	• Remove decoupled engine drive units and associated equipment	$10,000
Well No 6	• Replace well pump with larger pump capable of pumping to distribution • Add generator • Replace ceiling and roof insulation	$225,000
Well No. 7	• Add generator • Interconnect Well No.7 to the WTP • Replace well pump to improve pumping capacity	(cost presented independent of these recommendations)
Well No. 8	• No improvements required	--
Summary		**$935,000**

The improvements will improve redundancy, reliability, increase pumping capacity in each well to the maximum amount allowed under the water management act permits and provide for emergency power generation at all well supplies. It is recommended that electrical and mechanical improvements be constructed as two construction contract. **This investment is recommended beginning in FY 2015 at a total estimated cost of $935,000.**

- **Well No**. **7 Improvements –** This project will incorporate Well No. 7 into the water treatment facility by extending a new raw water main from the well to the water treatment facility. The project will help the department meet several LOS objectives including improved reliability during peak summer demand periods and delivering consistent, high quality water to all the Town's customers. Presently, this source of supply has high iron concentrations which are an aesthetic concern during the well's occasional summer use. Treatment will also improve the water supply reliability and redundancy allowing this well to be used on a more regular basis.

  The department has also established a goal of complying with all EPA secondary standards for such nuisance contaminants such as high iron concentrations. Well No. 7 on occasion exceeds the recommended maximum contaminant level of 0.3 mg/L for iron when the well is needed during summer months. Pumping this well to the water treatment facility will remove iron from the source and allow this large, important well to be used routinely during the year while meeting all EPA secondary standards.

  The estimated capital cost for this project $1.95M including engineering and contingencies. It is recommended that this project be funded and designed in FY 2020.

- **WTF Improvements –** Reliability and criticality of the treatment was evaluated to determine if investment is needed to meet the LOS goal of reliable supply delivery. In addition, gaps in emergency power and equipment reliability were identified in the condition assessment. The following improvements are recommended at the water treatment facility:

- **Replace Raw and Finished Water VFDs –** The 18-pulse Robicon VFDs are old technology, have part availability issues and are at risk of failure. The immediate likelihood of failure of these systems is very high and the consequence of failure will be inability for

Orleans to meet MADEP regulations and peak summer demands in the system. The water treatment facility must have two raw water pumps and finished water pumps available to meet the system demands during the summer months and to maintain consistent reliable operations at the treatment facility. Replacement of these VFDs is needed immediately. The estimated cost for these improvements is estimated to be $300,000. **This investment is recommended for FY 2014.**

- **Containment in Chemical Storage Area –** The chemical storage area in the treatment facility is open to the main plant operating area and likely does not meet current building codes. The corrosive environment is leading to crazing and corrosion in electrical equipment housed in the main treatment room. The recommended improvements to this area of the facility include:

  - Installation of a containment wall and doors to isolate the chemical storage area from the main treatment area
  - Installation of a limited area sprinkler system
  - Updating the HVAC system to provide code compliant air exchange in the area.

  The consequence of not addressing these deficiencies will be continued corrosion of key system components and a reduction of reliability and the useful life of key control systems. The estimated cost for these improvements is $250,000 recommended in FY 2018.

- **Roof Replacement –** The current membrane roof system is 7 years old. A maximum useful life of about 20 years can be expected from a ballasted membrane roof system on this type of building. The current likelihood of failure of the existing roof is low but will continue to increase as the roof system ages and approaches the end of its useful life. The condition of the roof should be inspected in year 2016 and every 5 years and budgeted for replacement in FY 2026. The estimated cost to replace the roof is $150,000.

- **Establish Capital Reserve Fund Accounts for Membrane Replacement –** The existing water treatment facility has three membrane rack assemblies that will require sequential replacement in years 2019, 2020 and 2021 at an estimated cost in those years of approximately $362,000 for each assembly (Total - $1.086M). It is recommended that the Department establish a capital reserve fund in the amount of $179,000 per year to fund the next replacement cycle. This amount should be changed to $120,000 per year after FY 2021 for the next membrane replacement in 2029-2031. The initial annual allocations ($179,000/yr) are higher than the future allocations ($120,000/yr) as the time to replacement is much shorter in this period (Four years versus a normal 10 year cycle). The capital reserve fund for membranes replacement should be established beginning in FY 2015. Several LOS goals are impacted if these items are not maintained. If these membranes are not replaced as scheduled they will continue to lose throughput capacity at the WTF and the cost of treated water through this facility will increase as the treatment process becomes more difficult to operate and is cleaned more frequently.

- **Regulatory Compliance –** The Orleans Water Department currently complies with all EPA primary drinking water standards and MassDEP drinking water standards. A regulatory review did not identify any areas for changes in policy, procedures or infrastructure needs to maintain 100% compliance with all regulations. The department should continue to investigate sampling procedures at Wells No. 2, No. 3 and No. 1 that suggest manganese may be present in these wells.

- **Residuals Handling Optimization Study –** The MassDEP is requiring the Town to perform a study to reduce water loss and improve residuals disposal in the treatment facility. As such, the Orleans water department has established a goal of optimizing plant efficiency as a LOS goal for the system. The residuals handling system at the water treatment facility will be subject to future regulatory scrutiny to improve efficiency to meet proposed standards under the Massachusetts Sustainable Water Management Initiative (SWMI). The present infiltration system is limited and not performing well to direct backwash wastes and flux maintenance water from the membrane cleaning process to the groundwater table through an infiltration collection system. To meet the requirement of 95% recovery of raw water as finished water in the treatment facility, efficiency of the waste residuals systems needs to be improved.

Improving efficiency of this system will require additional study beyond the scope of this asset management plan. **We recommend that a budget of $75,000 be allocated to conduct an optimization study of the residuals handling system at the water treatment facility.** Given the existing deficiency and in anticipation of new regulation from the MassDEP in this area, we recommend that the study be conducted in FY 2015. Costs associated with capital recommendations from this study will need to be integrated into the financial implementation plan moving forward.

10.3.2 Distribution and Storage System Needs

- **Establish Capital Reserve Fund Accounts for Storage Tank Maintenance –** The two water storage tanks in the Orleans water system will require new coating systems in years 2027 and 2028. The estimated cost for a new coating system in year FY 2028 for Standpipe No. 1 is $1.057M. The estimated cost for a new coating system in FY 2027 for Standpipe No. 2 is $1.149M. It is recommended that the Department establish a capital reserve fund in the amount of $62,000 per year to fund the next replacement cycle for Standpipe No. 1 and $67,000 per year for Standpipe No. 2. The capital reserve fund should be established beginning in FY 2015. These amounts should be reviewed and adjusted accordingly after the FY 2027-2028 coatings replacement projects.

- **Managing Unaccounted-For and Lost Water –** The Orleans water system has maintained unaccounted-for water well below 10% in accordance with the standards established in the water management act permit. The system has benefitted from excellent management over the years and routine leak detection surveys of the system. The department has shared leak detection equipment with Harwich and conducts the survey with its own staff to save money, optimize use of internal staff during non-critical periods and to reduce disruption to the system. The department should continue biannual leak detection surveys and continue to minimize unaccounted for water in the system.

  In addition, the department continues to replace the older iron services that are found to have leaks during the year. As Orleans is currently managing unaccounted for water very well dedicating capital to replace iron services on an ongoing basis is not currently recommended the majority of these iron services are functioning well and have significant service life remaining. Replacement of leaking iron services should be completed as they are found as part of the leak detection program. Replacement of these service pipes should also be integrated into future water main replacement projects.

- **Demand Management –**The residential per capita consumption in Orleans is only 63 RPCPD, below the maximum allowed in the department's water management act permit. This data suggests excellent awareness in the community for water conservation. The department should continue efforts to manage summer lawn watering and other conservation measures included in the permit.

- **Water Main Renewals –** The work plan includes annual allocations for main replacements. The mains are required to meet the ISO requirements and to improve looping and service reliability in the distribution system, both LOS goals for the water system.

  As the water system was established in the 1960s, age of the water mains does not currently play a significant role in selection of the water main being replaced during this planning cycle. Pipe age will begin to be the driver for water main replacement in the next planning cycle as the ~50 miles of water mains initially installed in the water system begin to reach the end of their expected life span.

  The hydraulic improvements developed in Section 6 provide the logic for replacement in this planning cycle. These projects have been ranked using the BRE logic developed in Section 9. Table 10-3 lists the recommended projects in their ranked order.

TABLE 10-3
WATER MAIN RENEWAL RECOMMENDATIONS

Rank	Project	Project Cost	Existing Conditions			Post Improvements		
			Likelihood of Failure	Consequence of Failure	Business Risk Exposure	Likelihood of Failure	Consequence of Failure	Business Risk Exposure
1	Replace 8" Main on Beach Road with 16" Main	$2,048,000	5.9	5.3	31.0	3.2	4.0	12.6
1a	Replace 6" Main on Countryside Road with 8" Main	$78,000	4.7	2.0	9.4	1.9	3.0	5.6
2	Replace 12" Main on Beach Road with 16" Main	$228,000	4.4	6.8	29.7	1.6	7.8	12.4
3	Replace 12" Main on Route 28 with 16" Main	$59,000	3.5	6.8	23.6	1.6	7.8	12.4
4	Replace 6" on Tonset Road with 8" Main	$683,000	6.0	3.0	18.0	2.9	4.0	11.4
5	Replace Rock Harbor Road with 8" Main	$546,000	5.7	3.0	17.1	2.7	4.0	10.8
6	Replace 6" Main on Canal Road with 8" Main	$293,000	5.6	3.0	16.7	2.8	3.0	8.3
7	Replace 12" Well Discharge line with 16" Main	$286,000	3.5	4.5	15.8	2.7	3.0	8.1
9	Replace 6" Main on Lake Drive with 8" Main	$78,000	2.9	2.0	5.7	1.8	3.0	5.4
10	Connect Lake Drive and Quanset Road with 8" Main	$303,000	1.6	3.0	4.7	0.7	5.5	3.9

- **Cross Connection Control –** The department has established a goal of eliminating all cross connections in the water system as required by MADEP. The department should continue with the cross connection training and certifications for two operators and maintain this program into the future. The department should maintain and continue providing this service internally by cross training of key staff.

- **Hydrant and Valve Maintenance –** The department has an excellent valve and hydrant maintenance program that should continue during the planning period. Valve exercising and hydrant inspections are routinely conducted and should continue as a matter of practice to maintain these key assets in excellent condition to maximize ISO point allocations.

- **Hydrant Flushing Program –** The department has an excellent hydrant flushing program that should continue during the planning period. hydrant inspections are routinely conducted and should continue as a matter of practice to maintain these key assets in excellent condition to maximize ISO point allocations. An additional dechlorinator is needed to complete this annual program in the most cost and time efficient manner.

10.3.3 General Operations and Customer Service

- **Vehicles –** The water department maintains a fleet of vehicles described in Section 2 of this planning report. The cost to replace these vehicles is expensed in the given year of the expenditure. The department also installs water main and does service repairs at considerable savings to the customers.

  The current vehicles are required to meet several LOS objectives including:

  - Rapid response to leaks within 24 hours
  - Provide rapid customer response

  The department should continue to strive to maintain the fleet in excellent condition. It is understood that the Town is considering new storage and housing options for the vehicle fleet, which is presently housed at Well No. 1.

- **Customer Meters –** Maintaining accurate, modern customer meters is essential for maintaining accurate measurements of water use in any water system and to build credibility with your customer base. The water department has an ongoing program of acquiring 300 meters per year with the intent of full replacement of all meters in the system every 15 years. The annual cost of meters is allocated year to year with an appropriate inflation factor to reflect the incremental increase in the cost to purchase the meters annually. The new metering program uses automatic read technology which will allow remote collection and reporting of water use data without the need to enter private property. The cost for the meters is expensed annually without borrowing. **The continued annual funding and implementation of the metering program is recommended and required by MassDEP.**

- **Training, Safety and Operations Certifications –** The water department operates safely and maintains Grade 3 operator certifications to meet MassDEP requirements. The department monitors and requires routine training for each operator to meet minimal standards required by the Commonwealth of Massachusetts for licensed treatment and distribution operators of the water system and to meet OSHA requirements for safety. These procedures and investments should continue. **No new recommended procedures or investment is recommended.**

- **Customer Service –** The Orleans Water Department began implementing the Utility Cloud system to manage and track work orders in 2013. This investment will create a more streamlined work order process which will allow the department to enhance three important LOS goals; (1) Response to Customer inquiries within 24 hours, (2) Response to pressure or water quality complaints within a four hour period and (3) Efficient communication regarding interruption of service from main breaks or emergencies. **This annual investment for annual maintenance fees for this valuable asset management tool should continue.**

10.3.4 Considerations for Supplying Eastham

An analysis was conducted to determine the impact of a permanent inter-municipal interconnection to supply an average day 0.50 MGD, (Maximum day demand of 1.25 MGD) to Eastham on the Orleans water system. The following impacts and needs were identified:

- **Permitted Yield of Orleans Well Supply –** The current Orleans water management permit contains a reopener clause to expand the withdrawal limits on an annual basis in Orleans if a 0.5 MGD of average day demand is added to the system from Eastham. Because of this provision, the well supply in Orleans could meet the additional Eastham demand on an annual yield basis.

- **Supply Pumping Capacity –** The projected demands in Orleans at build-out, if a maximum day 1.25 MGD supply to Eastham was added to the system, would be approximately 4.4 MGD. The maximum-day pumping capacity of the Orleans well supply is about 3.36 MGD suggested a pumping deficit unless further investment is made to improve redundancy at the water treatment facility.

- **Storage** - A storage deficit of about 275,000 gallons would be created in the Orleans system if a 1.25 MGD interconnection to Eastham is made. The deficit would require additional storage capacity to be installed at either of the two storage tank locations in Orleans to prevent a reduction in available fire storage volume in the Orleans system with the addition of the proposed Eastham demands. A study should be conducted to determine the exact configuration of the new storage volume and if the existing sites can accommodate additional tanks. Any storage improvements required as a function of the additional demand from Eastham should be funded by the Town of Eastham.

- **Distribution System –** The distribution system in Orleans can deliver a sustained flow rate of 1.25 MGD to the Town of Eastham without compromising fire flow capacity in Orleans if an interconnection was constructed between the two communities in the vicinity of the

Route 6 roundabout. A fire flow analysis in the proposed Eastham water system was not completed as part of this report.

10.4 CAPITAL IMPROVMENT PLAN SCHEDULE

A capital improvement program has been developed for the capital needs described above. All improvements and recommendations have been prioritized based on projected growth of the water system, criticality analyses, and other criteria. Immediate and Short-term priority improvements are listed in FY 2014 through 2017, presented on Table 10-4, each have high likelihood or consequence of failure and should be implemented as recommended.

TABLE 10-4
ASSET MANAGEMENT PLAN RECOMMENDATIONS AND PRIORITY NEEDS

Project Description	Estimated Costs	Implementation Year (FY)	Risk Ranking	Goal and Objective
Treatment / Well Facility Improvements				
Replace Raw and Finished VFDs	$300,000	2014	High	Consequence of failure will be loss of treatment facility. Reduce immediate high risk of failure
Well No. 4 Pump, Motor and VFD	$55,000	2014	High	Improve available pumping capacity. Reduce risk of not meeting peak summer demands
Residuals Handling Study	$75,000	2015	High	Required by MassDEP. Reduce risk from regulatory action for management of backwash residuals
Well No. 1, 2, 3, 5 & 6 Improvements - Design	$100,000	2015	High	Improve available pumping capacity. Reduce risk of not meeting peak summer demands
Well No. 1, 2, & 3 Improvements - Construction	$535,000	2016	High	Improve available pumping capacity. Reduce risk of not meeting peak summer demands
Well No. 5 & 6 Improvements - Construction	$165,000	2017	High	Improve available pumping capacity. Reduce risk of not meeting peak summer demands
Chemical Containment/HVAC	$250,000	2018	Moderate	Reduce likelihood of failure of electrical systems from corrosion in WTF
Well No. 7 to WTP Raw Water Main Project	$1,953,000	2020	Moderate	Improve redundancy and reliability of water supply, Improves finished water quality
Membrane Rack Assembly Replacement	$1,086,000	2019-2021	High	Firm maintenance date for normal membrane replacement cycle
WTF Roof Replacement	$150,000	2026	Moderate	Firm maintenance date for normal roof replacement cycle
Membrane Rack Assembly Replacement	$1,380,000	2029-2031	High	Firm maintenance date for normal membrane replacement cycle
Storage Improvements				
Tank 1 Coatings Replacement	$1,057,000	2027	Low	Critical Facility. Project replaces tank coatings on a routine maintenance cycle
Tank 2 Coatings Replacement	$1,149,000	2028	Low	Critical Facility. Project replaces tank coatings on a routine maintenance cycle
Distribution System Improvements				
Replace 6-inch on Tonset Road with 12-inch Main	$683,000	2016	Low	Hydraulic Improvement. Increases system redundancy and reliability, Concurrent road reconstruction on Tonset Road
Replace 8-inch on Beach Road with 16-inch Main	$2,048,000	2019	Moderate	Hydraulic Improvement. Project will meet LOS goals of improved fire flow at ISO Location
Replace 6-inch on Countryside Road with 8-inch Main	$78,000	2021	Moderate	Hydraulic Improvement. Project will meet LOS goals of improved fire flow at ISO Location
Replace 12-inch on Beach Road with 16-inch Main	$228,000	2021	Moderate	Hydraulic Improvement. Project will meet LOS goals of improved fire flow at ISO Location
Replace 6-inch on Rock Harbor Road with 8-inch Main	$546,000	2023	Moderate	Hydraulic Improvement. Project will meet LOS goals of improved fire flow at ISO Location
Replace 12-inch on Route 28 with 16-inch Main	$59,000	2024	Moderate	Hydraulic Improvement. Project will meet LOS goals of improved fire flow
Replace 12-inch Well Discharge line 16-inch Main	$286,000	2024	Moderate	Hydraulic Improvement. Project will meet LOS goals of improved fire flow
Replace 6-inch on Canal Road with 8-inch Main	$293,000	2026	Low	Hydraulic Improvement. Project will meet LOS goals of improved looping and fire flow
Replace 6-inch on Lake Drive with 8-inch Main	$78,000	2032	Low	Hydraulic Improvement. Project will meet LOS goals of improved looping and fire flow
Connect Lake Drive and Quanset Road with 8-inch Main	$303,000	2032	Low	Hydraulic Improvement. Project will meet LOS goals of improved looping and fire flow

Section 11

WRIGHT-PIERCE
Engineering a Better Environment

SECTION 11

FINANCIAL IMPLEMENTATION PLAN

11.1 EXISTING FINANCIAL PLANNING IN ORLEANS

The Orleans Water Department manages financing for the special fund using the financial spreadsheet and forecasting tool shown in Table 11-1. Table 11-1 represents the current budget and debt obligations.

A brief explanation of expense and revenue assumptions in the existing 20-year financial model follows.

- **Revenue Assumptions –** The existing financial forecast assumes no changes in revenue through rate increases or changes in water use patterns extending forward past Fiscal Year (FY) 2014 revenue projection. In 2014, this revenue projection was based on stabilized income from water sales and a stabilization of declining water use over prior years. In FY 2014, the water department is estimating revenue from water sales to be $1,929,000.
- **Labor and Benefit Expenses –** The labor and benefits for existing staff are shown as an operating expense in the financial rate model. The 20-year forecast assumes that annual cost of living adjustments of 3.5% will occur in each year and that water department staffing levels will remain at current levels. Fringe benefits are assumed to remain at current levels of 32.6% of salary costs.
- **Administrative Expenses –** Administrative expenses are apportioned to the water department from the Town Director of Finance for costs associated with the managing the public works department, administering finances and other support services from general town government.
- **Other Operating Expenses –** The largest cost to operate the Orleans water system is for chemicals, electricity, propane and other fuels, well cleanings and routine maintenance.

TABLE 11-1
EXISTING FINANCIAL FORCASTING WORKSHEET
ORLEANS WATER DEPARTMENT - 20-YEAR PLANNING PERIOD (2014-2034)
NO FUTURE RATE INCREASES

Income								Expenses																Balance		
		Billable	Income	Added Income			Total	annual [5]	Operating Expense						Net	Capital Expense			Debt Service				Total	Income vs.	Fund	%
FY	rates	Gallons	Rates	Services	Other	WSC Xfer	Income	rate of	Budget	Salaries	Benefits [6]	Services [7]	Encumbr.	Total	Operating	Vehicles	Capital Inv	Meters	WTP	Well 8	Membranes	Tanks 1&2	Expenses	Expenses	Balance	Expense
04																				200K	3 X	1.5M			1,385,734	
05	1.5% [3]		1,223,512				1,223,512									48,000			429,955						1,307,246	
06			1,371,539			35,000	1,406,539	-	863,228		121,789	133,138	(89,682)	1,028,473	378,066	15,603	326,400 [a]		424,855				1,795,331	(388,792)	918,454	-
07			1,442,201			40,000	1,482,201	-5.9%	812,471		128,696	159,312	13,500	1,113,979	368,222	49,745			419,755				1,583,478	(101,278)	817,176	-
08	5.0% [3]		1,672,174		100,000	50,000	1,822,174	14.3%	928,350		143,056	159,323	(15,367)	1,215,362	606,812	18,121			413,380				1,646,863	175,311	992,487	-
09		301,545,792	1,847,130			50,000	1,897,130	16.3%	1,079,674		150,582	176,840	851	1,407,947	489,183	22000	12000	54,000	405,730	1,811 [d]			1,815,488	81,642	1,074,129	-
10		259,339,770	1,716,108			50,000	1,766,108	-15.3%	914,210		163,267	161,323	821	1,239,621	526,487	28,970	27,427 [b]	30,896	398,080	5,135	———		1,730,129	35,979	1,110,108	64%
11	5.0% [3]	313,357,349	2,035,011	14,200		25,000	2,074,000	-6.3%	856,863		161,253	179,345	30,869	1,228,000	846,000	-	36,852 [c]	51,145	389,793	20,741	———		1,726,861	347,000	1,457,000	84%
12		275,614,199	1,896,134	15,840	4,807	25,000	1,942,000	-64.9%	300,349	515,037	167,415	169,201	(8,878)	1,143,000	799,000	41,504	61,870	71,451	338,300	20,295	38,625 [e]		1,715,169	227,000	1,684,000	98%
13	1.8%		1,929,000	-		25,000	1,954,000	31.6%	395,182	507,166	186,000	171,000		1,259,000	695,000		24,000	54,000	335,838	19,580	111,825 [e]		1,804,591	149,000	1,833,000	102%
14			1,929,000	-			1,929,000	3.5%	371,000	539,846	176,000	160,000		1,247,000	682,000	100,000	12,000	73,000	337,300	19,355	83,186	77,185 [f]	1,948,872	(20,000)	1,813,000	93%
15	0.0%		1,929,000	-			1,929,000	3.5%	384,000	558,741	125,000	166,000		1,234,000	695,000	46,000	12,000	77,000	322,000	19,093	108,615	186,250	2,004,699	(76,000)	1,737,000	87%
16	0.0%		1,929,000	-			1,929,000	3.5%	397,000	578,297	129,000	172,000		1,276,000	653,000		12,000	81,000	310,575	18,793	106,005 [#]	181,900 [g]	1,986,570	(58,000)	1,679,000	85%
17	0.0%		1,929,000	-			1,929,000	3.5%	411,000	598,537	134,000	178,000		1,322,000	607,000	50,000	12,000	85,000	307,850	18,478	103,545	177,550	2,075,960	(147,000)	1,532,000	74%
18	0.0%		1,929,000	-			1,929,000	3.5%	425,000	619,486	139,000	184,000		1,367,000	562,000	25,000	12,000	89,000	290,200	18,103	100,935	173,200	2,075,924	(147,000)	1,385,000	67%
19	0.0%		1,929,000	-			1,929,000	3.5%	440,000	641,168	143,000	190,000		1,414,000	515,000	120,000		93,450	282,700	17,690	92,050	168,850	2,188,908	(260,000)	1,125,000	51%
20	0.0%		1,929,000	-			1,929,000	3.5%	455,000	663,609	148,000	197,000		1,464,000	465,000	35,000		98,123	270,275	17,240	90,665	164,500	2,139,412	(210,000)	915,000	43%
21	0.0%		1,929,000	-			1,929,000	3.5%	471,000	686,835	154,000	203,000		1,515,000	414,000	25,000		103,029	262,925	11,775	87,995	150,150	2,155,709	(227,000)	688,000	32%
22			1,929,000	-			1,929,000	3.5%	487,000	710,874	159,000	210,000		1,567,000	362,000	65,000		108,180	250,650	11,450	60,420	155,800	2,218,374	(289,000)	399,000	18%
23	0.0%		1,929,000	-			1,929,000	3.5%	504,000	735,755	164,000	218,000		1,622,000	307,000	-		113,589	238,525	11,100	58,710	151,250	2,194,929	(266,000)	133,000	6%
24			1,929,000	-			1,929,000	3.5%	522,000	761,506	170,000	226,000		1,680,000	249,000	135,000		119,269		10,750	135,000	72,100	2,151,625	(223,000)	(90,000)	-4%
25	0.0%		1,929,000	-			1,929,000	3.5%	540,000	788,159	176,000	233,000		1,737,000	192,000	62,000		125,232		10,375	135,000		2,069,766	(141,000)	(231,000)	-11%
26	0.0%		1,929,000	-			1,929,000	3.5%	559,000	815,744	182,000	241,000		1,798,000	131,000	-		131,494			135,000		2,064,238	(135,000)	(366,000)	-18%
27	0.0%		1,929,000	-			1,929,000	3.5%	579,000	844,295	189,000	250,000		1,862,000	67,000	68,000		138,068			135,000		2,203,363	(274,000)	(640,000)	-29%
28	0.0%		1,929,000	-			1,929,000	3.5%	599,000	873,846	195,000	259,000		1,927,000	2,000	34,000		144,972			135,000		2,240,818	(312,000)	(952,000)	-42%
29	0.0%		1,929,000	-			1,929,000	3.5%	620,000	904,430	202,000	268,000		1,994,000	(65,000)			152,220			135,000		2,281,650	(353,000)	(1,305,000)	-57%
30	0.0%		1,929,000	-			1,929,000	3.5%	642,000	936,085	209,000	277,000		2,064,000	(135,000)	47,000		159,831			135,000		2,405,916	(477,000)	(1,782,000)	-74%
31	0.0%		1,929,000	-			1,929,000	3.5%	664,000	968,848	216,000	287,000		2,136,000	(207,000)	34,000		167,823			135,000		2,472,671	(544,000)	(2,326,000)	-94%
32	0.0%		1,929,000	-			1,929,000	3.5%	687,000	1,002,758	224,000	297,000		2,211,000	(282,000)	88,000		176,214			135,000		2,609,972	(681,000)	(3,007,000)	-115%
33	0.0%		1,929,000	-			1,929,000	3.5%	711,000	1,037,855	232,000	307,000		2,288,000	(359,000)	-		185,025			135,000		2,607,880	(679,000)	(3,686,000)	-141%
34	0.0%		1,929,000	-			1,929,000	3.5%	736,000	1,074,180	240,000	318,000		2,368,000	(439,000)	182,000		194,276			135,000		2,879,456	(950,000)	(4,636,000)	-161%
Total, millions:							56.1							45.7	9.1			4.7				10.9	60.8		(4.7)	

Income data X 1000

FY	Aug	Feb	Total
06	564	833	$ 1,397
07	602	802	1,404
08	733	925	1,658
09	840	1,013	1,853
10	749	906	1,655
11	927	1,094	2,021
12	818	1,047	1,865

Variables - Income & Operating Expenses

5.0% [3]	Scheduled rate increases -FY05, FY08, FY11.	5,201	accounts
3.5% [4]	Rate increase -COLA.	2	billing periods
3.5% [5]	Rate of increase -expenses.	$ -	surcharge
36.6% [6]	Fringe Benefits as %expense salries.		
43.2% [7]	Admin. Services as %expense budget.		

Capital Expense

[a] WTP Improvements
[b] Capital Investment -small
[c] Small Main replacement
[d] New Well no. 8
[e] WTP Membrane replacement
[f] Tank Painting, Tank no. 2
[g] Tank Painting, Tank no. 1

Notes

FY08; +$100,000 added income from the wind turbine appropriation.

Budgetary Estimates

replace;	amount	year
tank no. 1	$ 2,800,000	2063
tank no. 2	$ 3,800,000	2074
system mains	$ 66,000,000	2063
wtp	$ 6,000,000	2063

The FY 2014 water department operating budget included an estimate of $371,000 for these expenses. The forecasting tool assumes an annual inflation of 3.5% for these expense items.

- **Net Operating Budget –** The net operating budget is reported as the difference between revenue and operating expenses for administration labor and benefits and operating expenses as described above.
- **Capital Budget –** The water department also tracks costs to service debt from various routine and periodic capital expenditures through borrowing or by expenses in the case of smaller costs such as vehicles. A brief explanation of existing debt service follows:
    - **Vehicles –** The water department maintains a fleet of vehicles described in Section 2 of this report. The cost to replace these vehicles is expensed in the given year of the expenditure.
    - **Customer Meters –** Maintaining accurate, modern customer meters is essential for maintaining accurate measurements of water use in any water system. The water department has an ongoing program of acquiring 300 meters per year with the intent of full replacement of all meters in the system every 15 years. The annual cost of meters is allocated year to year with an appropriate inflation factor to reflect the incremental increase in the cost to purchase the meters annually. The new metering program uses automatic read technology which will allow remote collection and reporting of water use data without the need to enter private property. The cost for the meters is expensed annually without borrowing.
    - **Existing Capital Project Debt Service –** The water department presently services debt for four capital projects:
        - **Water Treatment Facility –** The water treatment facility was funded with a 20-year note obligation which will be retired in year FY 2023.
        - **Membrane Replacement –** The water department completed its first 10-year, replacement cycle for membrane modules in the water treatment facility in years 2010 through 2012. This project was financed as a capital project. The debt obligation will be retired in year 2023. The budget also included anticipated annual debt service for a second set of membranes to be replaced starting FY 2023.

    - **Water Tank Rehabilitation** - The water department rehabilitated both its water storage tanks in the past 2 years. This project was financed as a capital project. The debt obligation will be retired in FY 2024.
    - **Construction of Well No. 8 –** Well No. 8 was constructed at an excellent value because of the in-kind contribution of water department staff to construct portions of the project. The debt obligation will be retired in year FY 2025.
- **Operating Fund Balance –** The water department currently operates the water system with a surplus or positive fund balance in its operating budget. As shown in Table 11-1 the FY 2013 fund balance of $1,833.000 is projected to trend to a deficit in outgoing years as operating expenses increase and revenue from the current rate base remains unchanged unless water rates increase in line with expenses.

11.2 OPERATING FUND BALANCE RECOMMENDATIONS

The use of an operating fund balance or working capital account is commonly used in municipal and utility financing. The term “fund balance” is often misunderstood. A fund balance is not a savings account or surplus cash reserve but instead an accounting construct to maintain adequate funding for month to month expenditures. A fund balance is the difference between current assets such as cash, short-term investments, accounts receivable and unrestricted assets used to fund immediate operations and current liabilities. A positive difference between current assets and current liabilities is immediately available to finance current operations.

The “MassDEP Drinking Water System Management Handbook, 2007” recommends that water utilities retain a minimum operating fund balance account of 1.5 months of operation expenses. 45 days of operating capital should be included as a fund balance in the water rate structure. This equates to approximately 12.5% of the annual operating budget. The estimated operations budget in the Orleans system for fiscal year 2013 was $1.929M, equating to a fund balance of approximately $240,000 (0.125 x 1.929M = $241,125).

The American Water Works Association Manual of Water Supply Practices “M35 -Revenue Requirements” recommends that water utilities retain a working capital or fund balance account equal to 1.5 times operation expenses within the billing cycle to ensure cash flow is not an issue for the utility. As part of the Level of Service goals, the OWD is looking to move to a quarterly billing cycle from its current semiannual billing cycle. For a utility that bills quarterly, 135 days of operating capital should be included as a fund balance in the water rate structure. This equates to approximately 37% of the annual operating budget. The estimated operations budget in the Orleans system for fiscal year 2013 was $1.929M, equating to a fund balance of approximately $710,000 (0.37 x 1.929M = $713,465) using this recommendation.

In the case of OWD, cash flow has largely not been an issue, (the main driver for maintaining a large fund balance) with its current semiannual billing cycle. Maintaining a reserve fund on the order of 37% of operating expenses would hinder the implementation of the recommended asset management plan.

On this basis, we recommend, and our financial plan includes, a target fund balance year to year equivalent to 25% while retaining a minimum fund balance of 12.5% of the projected operating expenses in the water system.

11.3 PROPOSED CAPITAL PROJECTS TO MEET ASSET MANAGEMENT OBJECTIVES

New capital projects and the recommended schedule for these improvements are shown in Table 11-2. This schedule reflects all the recommended improvements from the asset management plan beginning in the year recommended. Table 11-2 proposes three types of funding for specified projects:

- Operating funds
- Capital borrowing
- Capital reserve accounts using an interest bearing account

The recommend funding approach is listed for each of the following capital projects. Table 11-2 includes both current estimated project costs indexed to February 2014 and escalated costs based on a 3% annual inflation factor to the year design and construction activities are anticipated. A brief description of each project and the recommended funding mechanism follows.

TABLE 11-2
CAPITAL IMPROVEMENT PLAN AND CASH FLOW SCHEDULE
ORLEANS WATER DEPARTMENT

	2014		20 Year Planning Period (FY)																				
Project Description	**Estimated Project Cost**	**Escalated Costs**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**
Existing Debt Service																							
WTF			($337,300)	($322,000)	($310,575)	($307,850)	($290,200)	($282,700)	($270,275)	($262,925)	($250,650)	($238,525)											
Well 8			($19,355)	($19,093)	($18,793)	($18,478)	($18,103)	($17,690)	($17,240)	($11,775)	($11,450)	($11,100)	($10,750)	($10,375)									
Membrane Replacement			($83,186)	($108,615)	($106,005)	($103,545)	($100,935)	($92,050)	($90,665)	($87,995)	($60,420)	($58,710)											
Storage Tank Coatings			($77,185)	($186,250)	($181,900)	($177,550)	($173,200)	($168,850)	($164,500)	($150,150)	($155,800)	($151,250)	($72,100)										
			$517,026	**$635,958**	**$617,273**	**$607,423**	**$582,438**	**$561,290**	**$542,680**	**$512,845**	**$478,320**	**$459,585**	**$82,850**	**$10,375**									
Operating Fund Balance Funded																							
Well No. 4 Motor, Pump and VFD	$40,000	$40,000	($40,000)																				
Replace Raw and Finished VFDs at WTF	$50,000	$50,000	($50,000)																				
Replace Raw and Finished VFDs at WTF	$250,000	$250,000	($250,000)																				
Design/Bid-Well Improvements at Well No. 1, 2, and 3	$68,000	$70,040		($70,040)																			
Design/Bid-Well Improvements at Well No. 5, and 6	$32,000	$32,960		($32,960)																			
WTF Residuals Handling Study	$75,000	$77,250		($77,250)																			
WTF Chemical Containment/HVAC Improvements	$250,000	$273,182				($273,182)																	
WTF Roof Replacement	$150,000	$163,909													($163,909)								
Annual Operating Fund Balance Allocations			**$340,000**	**$180,250**	**$0**	**$273,182**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
Dedicated Reserve Funding																							
Membrane Rack 1 replacement	$362,000	$362,000		($72,000)	($72,000)	($72,000)	($72,000)	($72,000)	($40,000)	($40,000)	($40,000)	($40,000)	($40,000)	($40,000)	($40,000)	($40,000)	($40,000)	($45,000)	($45,000)	($45,000)	($45,000)	($45,000)	($45,000)
Membrane Rack 2 replacement	$362,000	$362,000		($58,000)	($58,000)	($58,000)	($58,000)	($58,000)	($58,000)	($40,000)	($40,000)	($40,000)	($40,000)	($40,000)	($40,000)	($40,000)	($40,000)	($40,000)	($45,000)	($45,000)	($45,000)	($45,000)	($45,000)
Membrane Rack 3 replacement	$362,000	$362,000		($49,000)	($49,000)	($49,000)	($49,000)	($49,000)	($49,000)	($49,000)	($40,000)	($40,000)	($40,000)	($40,000)	($40,000)	($40,000)	($40,000)	($40,000)	($40,000)	($45,000)	($45,000)	($45,000)	($45,000)
Tank 1 Coatings Replacement	$1,057,000	$1,057,000		($62,000)	($62,000)	($62,000)	($62,000)	($62,000)	($62,000)	($62,000)	($62,000)	($62,000)	($62,000)	($62,000)	($62,000)	($62,000)	($62,000)	($62,000)	($62,000)	($62,000)	($62,000)	($62,000)	($62,000)
Tank 2 Coatings Replacement	$1,149,000	$1,149,000		($67,000)	($67,000)	($67,000)	($67,000)	($67,000)	($67,000)	($67,000)	($67,000)	($67,000)	($67,000)	($67,000)	($67,000)	($67,000)	($67,000)	($67,000)	($67,000)	($67,000)	($67,000)	($67,000)	($67,000)
Annual Reserve Fund Allocations			**$0**	**$308,000**	**$308,000**	**$308,000**	**$308,000**	**$308,000**	**$276,000**	**$258,000**	**$249,000**	**$249,000**	**$249,000**	**$249,000**	**$249,000**	**$249,000**	**$249,000**	**$254,000**	**$259,000**	**$264,000**	**$264,000**	**$264,000**	**$264,000**
Bonded Projects																							
Replace 6-inch on Tonset Road with 12-inch Main	$683,000	$703,490		($60,000)	($43,253)	($43,253)	($43,253)	($43,253)	($43,253)	($43,253)	($43,253)	($43,253)	($43,253)	($43,253)	($43,253)	($43,253)	($43,253)	($43,253)	($43,253)	($43,253)	($43,253)	($43,253)	($43,253)
Well Improvements at Well No. 1, 2, and 3	$602,500	$639,192			($42,964)	($42,964)	($42,964)	($42,964)	($42,964)	($42,964)	($42,964)	($42,964)	($42,964)	($42,964)	($42,964)	($42,964)	($42,964)	($42,964)	($42,964)	($42,964)	($42,964)	($42,964)	($42,964)
Well Improvements at Well No. 5, and 6	$177,500	$193,959				($13,037)	($13,037)	($13,037)	($13,037)	($13,037)	($13,037)	($13,037)	($13,037)	($13,037)	($13,037)	($13,037)	($13,037)	($13,037)	($13,037)	($13,037)	($13,037)	($13,037)	($13,037)
Replace 8-inch on Beach Road with 16-inch Main	$2,048,000	$2,445,419							($164,371)	($164,371)	($164,371)	($164,371)	($164,371)	($164,371)	($164,371)	($164,371)	($164,371)	($164,371)	($164,371)	($164,371)	($164,371)	($164,371)	($164,371)
Well No. 7 to WTF Raw Water Main Project	$1,953,000	$2,331,984							($156,746)	($156,746)	($156,746)	($156,746)	($156,746)	($156,746)	($156,746)	($156,746)	($156,746)	($156,746)	($156,746)	($156,746)	($156,746)	($156,746)	($156,746)
Replace 6-inch on Countryside Road with 8-inch Main	$78,000	$95,930								($6,448)	($6,448)	($6,448)	($6,448)	($6,448)	($6,448)	($6,448)	($6,448)	($6,448)	($6,448)	($6,448)	($6,448)	($6,448)	($6,448)
Replace 12-inch on Beach Road with 16-inch Main	$228,000	$280,411								($18,848)	($18,848)	($18,848)	($18,848)	($18,848)	($18,848)	($18,848)	($18,848)	($18,848)	($18,848)	($18,848)	($18,848)	($18,848)	($18,848)
Replace 6-inch on Rock Harbor Road with 8-inch Main	$546,000	$712,406										($47,885)	($47,885)	($47,885)	($47,885)	($47,885)	($47,885)	($47,885)	($47,885)	($47,885)	($47,885)	($47,885)	($47,885)
Replace 12-inch on Route 28 with 16-inch Main	$59,000	$79,291											($5,330)	($5,330)	($5,330)	($5,330)	($5,330)	($5,330)	($5,330)	($5,330)	($5,330)	($5,330)	($5,330)
Replace 12-inch Well Discharge line 16-inch Main	$286,000	$407,768													($27,408)	($27,408)	($27,408)	($27,408)	($27,408)	($27,408)	($27,408)	($27,408)	($27,408)
Replace 6-inch on Canal Road with 8-inch Main	$293,000	$417,748													($28,079)	($28,079)	($28,079)	($28,079)	($28,079)	($28,079)	($28,079)	($28,079)	($28,079)
Replace 6-inch on Lake Drive with 8-inch Main	$78,000	$128,922																		($8,666)	($8,666)	($8,666)	($8,666)
Connect Lake Drive and Quanset Road with 8-inch Main	$303,000	$500,813																		($33,662)	($33,662)	($33,662)	($33,662)
Annual Debt Service Allocations			**$0**	**$60,000**	**$86,216**	**$99,253**	**$99,253**	**$99,253**	**$420,370**	**$445,666**	**$445,666**	**$493,551**	**$498,881**	**$498,881**	**$554,368**	**$554,368**	**$554,368**	**$554,368**	**$554,368**	**$596,696**	**$596,696**	**$596,696**	**$596,696**
Estimated New Annual Capital Improvement Plan Costs			***$340,000***	***$548,250***	***$394,216***	***$680,435***	***$407,253***	***$407,253***	***$696,370***	***$703,666***	***$694,666***	***$742,551***	***$747,881***	***$747,881***	***$803,368***	***$803,368***	***$803,368***	***$808,368***	***$813,368***	***$860,696***	***$860,696***	***$860,696***	***$860,696***

Capital Funded Projects - Assumed 20-year financing period at an interest rate of 3%
Capital Reserve Fund Annual Allocations
Projects Funded out of Operating Budget (Costs not included in Capital project totals)

- **VFD Replacement at the WTF –** This project will be funded by the existing fund balance. The cash flow projection shown in Figure 11-2 is based on a project cost of $300,000 expended in FY 2014. The existing VFDs are in need on replacement and represent a high risk to current operations if a failure were to occur.
- **Well Improvement Projects –** These projects are separated into three construction projects as follows:

  1. Improvements to Well No. 4
  2. Improvements to Well No. 1, 2, and 3
  3. Improvements to Well No. 5 and 6

  The Well No. 4 project is proposed for funding in FY14 from the existing operations budget. This total design and construction value of well No. 4 project is estimated to be $55,000. For the remaining projects, design engineering is proposed in FY 2015 and construction bonding in FY 2016. The total cost for the Well 1, 2, 3, 5 and 6 projects are estimated to be $870,000 for engineering and construction activities. The cash flow projection shown in Figure 11-2 is based on a 20-year note at an interest rate of 3%. As discussed in Section 10 of this report, these projects are needed to reduce the risk of not meeting summer demand requirements because of lack of back-up power systems and to restore needed well capacity.
- **Well No**. 7 **Improvements –** This project will incorporate Well No. 7 into the water treatment facility by constructing a raw water transmission main from the source to the treatment facility. The cash flow projection shown in Figure 11-2 is based on a $1.95M capital cost, funded over a 20-year period at an interest rate of 3%.
- **Capital Reserve Fund Accounts for Membrane Replacement and Storage Tank Maintenance –** The budget includes annual allocations for on-going membrane replacement and tank maintenance. An interest bearing capital reserve account makes the most sense for these projects for two reasons:
  - These projects are primarily maintenance projects.
  - A reserve account allows the current customer base to pay for wear and tear occurring from current use of the asset. Borrowing shifts the payment costs to future generations which may not have contributed to the degraded condition of the asset.

The decision to fund these costly reoccurring maintenance projects using a capital reserve fund in lieu of bonding the projects will allow the OWD to save substantial amounts of money in the long term and provides a means to have the customers benefiting from the use of the current assets financially responsible for these assets. We have assumed that interest earned in these accounts will be retained in an interest bearing account to help reduce the annual reserve amount through compounding interest.

- **Water Main Renewals –** The work plan includes annual allocations for debt service water main replacements as bonded projects. The cash flow projection assumes 20-year notes at an interest rate of 3% for each of these projects as listed in Table 10-4.

11.4 PROPOSED 20-YEAR FINANCIAL PRO-FORMA FOR THE ORLEANS WATER DEPARTMENT

Table 11-3 is a 20-year pro forma incorporating all the recommended capital projections in accordance with the schedule shown in Table 11-2. Aggregated annual obligations from the asset management program are included in the Proposed CIP column. This financial plan shows no revenue increases reflecting flat water usage during the 20-year planning period (2014-2034) and a 3.5% annual increase in operating expenses.

As shown in Table 11-3, water rate increases will be required in the initial years of the program to create a stable revenue stream, to fund the asset management plan and to keep the operating fund balance in line with the target LOS goals. Town meeting approval will be required for any annual increase in water rates which exceeds 5% per annum.

TABLE 11-3
PROPOSED FINANCIAL IMPLEMENTATION PLAN
ORLEANS WATER DEPARTMENT - 20-YEAR PLANNING PERIOD (2014-2034)

Income								Expenses																	Balance		
		Billable	Income	Added Income			Total	annual [5]	Operating Expense						Net	Capital Expense			Debt Service				**Proposed**	Total	Income vs.	Fund	%
FY	rates	Gallons	Rates	Services	Other	WSC Xfer	Income	rate of	Budget	Salaries	Benefits [6]	Services [7]	Encumbr.	Total	Operating	Vehicles	Capital Inv	Meters	WTP	Well 8	Membranes	Tanks 1&2	**CIP**	Expenses	Expenses	Balance	Expense
04																				200K	3 X	1.5M				1,385,734	
05	1.5% [3]		1,223,512				1,223,512									48,000			429,955							1,307,246	
06			1,371,539			35,000	1,406,539	-	863,228		121,789	133,138	(89,682)	1,028,473	378,066	15,603	326,400 [a]		424,855					1,795,331	(388,792)	918,454	-
07			1,442,201			40,000	1,482,201	-5.9%	812,471		128,696	159,312	13,500	1,113,979	368,222	49,745			419,755					1,583,478	(101,278)	817,176	-
08	5.0% [3]		1,672,174		100,000	50,000	1,822,174	14.3%	928,350		143,056	159,323	(15,367)	1,215,362	606,812	18,121			413,380					1,646,863	175,311	992,487	-
09		301,545,792	1,847,130			50,000	1,897,130	16.3%	1,079,674		150,582	176,840	851	1,407,947	489,183	22000	12000	54,000	405,730	1,811 [d]				1,815,488	81,642	1,074,129	-
10		259,339,770	1,716,108			50,000	1,766,108	-15.3%	914,210		163,267	161,323	821	1,239,621	526,487	28,970	27,427 [b]	30,896	398,080	5,135	-			1,730,129	35,979	1,110,108	64%
11	5.0% [3]	313,357,349	2,035,011	14,200		25,000	2,074,000	-6.3%	856,863		161,253	179,345	30,869	1,228,000	846,000	-	36,852 [c]	51,145	389,793	20,741	-			1,726,861	347,000	1,457,000	84%
12		275,614,199	1,896,134	15,840	4,807	25,000	1,942,000	-64.9%	300,349	515,037	167,415	169,201	(8,878)	1,143,000	799,000	41,504	61,870	71,451	338,300	20,295	38,625 [e]			1,715,169	227,000	1,684,000	98%
13	1.8%		1,929,000	-		25,000	1,954,000	31.6%	395,182	507,166	186,000	171,000		1,259,000	695,000		24,000	54,000	335,838	19,580	111,825 [e]			1,804,591	149,000	1,833,000	102%
14	0.0%		1,929,000	-			1,929,000	3.5%	371,000	539,846	176,000	160,000		1,247,000	682,000	100,000	12,000	73,000	337,300	19,355	83,186	77,185 [f]	$ 340,000	2,288,872	(360,000)	1,473,000	64%
15	7.0%		2,064,000	-			2,064,000	3.5%	384,000	558,741	125,000	166,000		1,234,000	830,000	46,000	12,000	77,000	322,000	19,093	108,615	186,250	$ 548,250	2,552,949	(489,000)	984,000	39%
16	7.0%		2,208,000	-			2,208,000	3.5%	397,000	578,297	129,000	172,000		1,276,000	932,000		12,000	81,000	310,575	18,793	106,005 [#]	181,900 [g]	$ 394,216	2,380,786	(173,000)	811,000	34%
17	7.0%		2,363,000	-			2,363,000	3.5%	411,000	598,537	134,000	178,000		1,322,000	1,041,000	50,000	12,000	85,000	307,850	18,478	103,545	177,550	$ 680,435	2,756,395	(393,000)	418,000	15%
18	5.0%		2,481,000	-			2,481,000	3.5%	425,000	619,486	139,000	184,000		1,367,000	1,114,000	25,000	12,000	89,000	290,200	18,103	100,935	173,200	$ 407,253	2,483,177	(2,000)	416,000	17%
19	5.0%		2,605,000	-			2,605,000	3.5%	440,000	641,168	143,000	190,000		1,414,000	1,191,000	120,000		93,450	282,700	17,690	92,050	168,850	$ 407,253	2,596,161	9,000	425,000	16%
20	5.0%		2,735,000	-			2,735,000	3.5%	455,000	663,609	148,000	197,000		1,464,000	1,271,000	35,000		98,123	270,275	17,240	90,665	164,500	$ 696,370	2,835,782	(101,000)	324,000	11%
21	3.5%		2,831,000	-			2,831,000	3.5%	471,000	686,835	154,000	203,000		1,515,000	1,316,000	25,000		103,029	262,925	11,775	87,995	150,150	$ 703,666	2,859,375	(28,000)	296,000	10%
22	3.5%		2,930,000	-			2,930,000	3.5%	487,000	710,874	159,000	210,000		1,567,000	1,363,000	65,000		108,180	250,650	11,450	60,420	155,800	$ 694,666	2,913,040	17,000	313,000	11%
23	3.5%		3,033,000	-			3,033,000	3.5%	504,000	735,755	164,000	218,000		1,622,000	1,411,000	-		113,589	238,525	11,100	58,710	151,250	$ 742,551	2,937,480	96,000	409,000	14%
24	0.0%		3,033,000	-			3,033,000	3.5%	522,000	761,506	170,000	226,000		1,680,000	1,353,000	135,000		119,269		10,750		72,100	$ 747,881	2,764,506	268,000	677,000	24%
25	0.0%		3,033,000	-			3,033,000	3.5%	540,000	788,159	176,000	233,000		1,737,000	1,296,000	62,000		125,232		10,375			$ 747,881	2,682,646	350,000	1,027,000	38%
26	0.0%		3,033,000	-			3,033,000	3.5%	559,000	815,744	182,000	241,000		1,798,000	1,235,000	-		131,494					$ 803,368	2,732,607	300,000	1,327,000	49%
27	0.0%		3,033,000	-			3,033,000	3.5%	579,000	844,295	189,000	250,000		1,862,000	1,171,000	68,000		138,068					$ 803,368	2,871,732	161,000	1,488,000	52%
28	0.0%		3,033,000	-			3,033,000	3.5%	599,000	873,846	195,000	259,000		1,927,000	1,106,000	34,000		144,972					$ 803,368	2,909,186	124,000	1,612,000	55%
29	0.0%		3,033,000	-			3,033,000	3.5%	620,000	904,430	202,000	268,000		1,994,000	1,039,000			152,220					$ 808,368	2,955,019	78,000	1,690,000	57%
30	0.0%		3,033,000	-			3,033,000	3.5%	642,000	936,085	209,000	277,000		2,064,000	969,000	47,000		159,831					$ 813,368	3,084,285	(51,000)	1,639,000	53%
31	0.0%		3,033,000	-			3,033,000	3.5%	664,000	968,848	216,000	287,000		2,136,000	897,000	34,000		167,823					$ 860,696	3,198,368	(165,000)	1,474,000	46%
32	0.0%		3,033,000	-			3,033,000	3.5%	687,000	1,002,758	224,000	297,000		2,211,000	822,000	88,000		176,214					$ 860,696	3,335,668	(303,000)	1,171,000	35%
33	0.0%		3,033,000	-			3,033,000	3.5%	711,000	1,037,855	232,000	307,000		2,288,000	745,000	-		185,025					$ 860,696	3,333,576	(301,000)	870,000	26%
34	0.0%		3,033,000	-			3,033,000	3.5%	736,000	1,074,180	240,000	318,000		2,368,000	665,000	182,000		194,276					$ 860,696	3,605,152	(572,000)	298,000	8%
Total, millions:							74.1							45.7	27.2			4.7				9.4		73.9		0.2	

Income data X 1000

FY	Aug	Feb	Total
06	564	833	$ 1,397
07	602	802	1,404
08	733	925	1,658
09	840	1,013	1,853
10	749	906	1,655
11	927	1,094	2,021
12	818	1,047	1,865

Variables - Income & Operating Expenses

5.0% [3] Scheduled rate increases -FY05, FY08, FY11.
3.5% [4] Rate increase -COLA.
3.5% [5] Rate of increase -expenses.
36.6% [6] Fringe Benefits as %expense salries.
43.2% [7] Admin. Services as %expense budget.

5,201 accounts
2 billing periods
$ - surcharge

Capital Expense

[a] WTP Improvements
[b] Capital Investment -small
[c] Small Main replacement
[d] New Well no. 8
[e] WTP Membrane replacement
[f] Tank Painting, Tank no. 2
[g] Tank Painting, Tank no. 1

Notes

FY08; +$100,000 added income from the wind turbine appropriation.

Budgetary Estimates

replace;	amount	year
tank no. 1	$ 2,800,000	2063
tank no. 2	$ 3,800,000	2074
system mains	$ 66,000,000	2063
wtp	$ 6,000,000	2063

Appendix A

WRIGHT-PIERCE
Engineering a Better Environment

HYDRANT FLOW TEST LOG

JOB NAME:	Orleans Asset Management Plan	TEST NO.:	1
JOB NO.:	12779A	TIME:	8:30 AM
PERFORMED BY:	Chris Berg/Dylan Thisse	DATE:	6.25.2013

FLOW TEST DATA

HYDRANT NO.	STATIC PRESSURE (PSI)	RESIDUAL* PRESSURE (PSI)	PITOT PRESSURE (PSI)	FLOW OPENING (IN.)	DISCHARGE COEF.	FLOW Qa (GPM)	REMARKS
1	77	60					#22
2	76		42	2.5	0.9	1,086	End of line

*Note: The pressure drop between the static and residual should be greater than 20 psi. If necessary, additional hydrants should be opened.

Flow - Qa

$$Q_a = 29.8 D^2 C \sqrt{P_p}$$

Qa=Test Flow, gpm
D=Flow Opening Diam. ,in.
Pp=Pitot Pressure, psi
C=Hydraulic Coef.
0.9 - Rounded
0.8 - Sharp
0.7 - Intruding

CALCULATED FLOWS

ASSUMED RESIDUAL (PSI)	STATIC PRESSURE (PSI)	FLOW Qc (GPM)
20	77	2,088
Total Calc. Flow @ 20 psi		**2,088**

Flow - Qc

$$Q_c = Q_a \left(\frac{P_s - P_f}{P_s - P_t} \right)^{0.54}$$

Qc=Flow@Pf,gpm
Qa=Test Flow,gpm
Ps=Static Pressure, psi
Pf= Assumed Residual Press., psi
Pt=Residual Pressure, psi

SKETCH OF TEST LOCATION

WRIGHT-PIERCE
Engineering a Better Environment

HYDRANT FLOW TEST LOG

JOB NAME: Orleans Asset Management Plan
JOB NO.: 12779A
PERFORMED BY: Chris Berg/Dylan Thisse

TEST NO.: 2
TIME: 9:30 AM
DATE: 6.25.2013

FLOW TEST DATA

HYDRANT NO.	STATIC PRESSURE (PSI)	RESIDUAL* PRESSURE (PSI)	PITOT PRESSURE (PSI)	FLOW OPENING (IN.)	DISCHARGE COEF.	FLOW Qa (GPM)	REMARKS
1	68	66					
2	60		47	2.5	0.9	1,149	
						0	
						0	
						0	

*Note: The pressure drop between the static and residual should be greater than 20 psi. If necessary, additional hydrants should be opened.

Flow - Qa

$$Q_a = 29.8 D^2 C \sqrt{P_p}$$

Qa=Test Flow, gpm
D=Flow Opening Diam. ,in.
Pp=Pitot Pressure, psi
C=Hydraulic Coef.
0.9 - Rounded
0.8 - Sharp
0.7 - Intruding

CALCULATED FLOWS

ASSUMED RESIDUAL (PSI)	STATIC PRESSURE (PSI)	FLOW Qc (GPM)
20	68	6,393
Total Calc. Flow @ 20 psi		**6,393**

Flow - Qc

$$Q_c = Q_a \left(\frac{P_s - P_f}{P_s - P_t} \right)^{0.54}$$

Qc=Flow@Pf,gpm
Qa=Test Flow,gpm
Ps=Static Pressure, psi
Pf= Assumed Residual Press., psi
Pt=Residual Pressure, psi

SKETCH OF TEST LOCATION

WRIGHT-PIERCE
Engineering a Better Environment

HYDRANT FLOW TEST LOG

JOB NAME: Orleans Asset Management Plan
JOB NO.: 12779A
PERFORMED BY: Chris Berg/Dylan Thisse

TEST NO.: 3
TIME: 11:20 AM
DATE: 6.25.2013

FLOW TEST DATA

HYDRANT NO.	STATIC PRESSURE (PSI)	RESIDUAL* PRESSURE (PSI)	PITOT PRESSURE (PSI)	FLOW OPENING (IN.)	DISCHARGE COEF.	FLOW Qa (GPM)	REMARKS
1	38	37					
2	48		38	2.5	0.9	1,033	
						0	
						0	
						0	

*Note: The pressure drop between the static and residual should be greater than 20 psi. If necessary, additional hydrants should be opened.

Flow - Qa

$$Q_a = 29.8D^2C\sqrt{P_p}$$

Qa=Test Flow, gpm
D=Flow Opening Diam. ,in.
Pp=Pitot Pressure, psi
C=Hydraulic Coef.
- 0.9 - Rounded
- 0.8 - Sharp
- 0.7 - Intruding

CALCULATED FLOWS

ASSUMED RESIDUAL (PSI)	STATIC PRESSURE (PSI)	FLOW Qc (GPM)
20	38	4,921
Total Calc. Flow @ 20 psi		**4,921**

Flow - Qc

$$Q_c = Q_a\left(\frac{P_s - P_f}{P_s - P_t}\right)^{0.54}$$

Qc=Flow@Pf,gpm
Qa=Test Flow,gpm
Ps=Static Pressure, psi
Pf= Assumed Residual Press., psi
Pt=Residual Pressure, psi

SKETCH OF TEST LOCATION

WRIGHT-PIERCE
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HYDRANT FLOW TEST LOG

JOB NAME:	Orleans Asset Management Plan	TEST NO.:	4
JOB NO.:	12779A	TIME:	10:22 AM
PERFORMED BY:	Chris Berg/Dylan Thisse	DATE:	6.25.2013

FLOW TEST DATA

HYDRANT NO.	STATIC PRESSURE (PSI)	RESIDUAL* PRESSURE (PSI)	PITOT PRESSURE (PSI)	FLOW OPENING (IN.)	DISCHARGE COEF.	FLOW Qa (GPM)	REMARKS
1	77						
2	77		42	2.5	0.9	1,086	
						0	
						0	
						0	

*Note: The pressure drop between the static and residual should be greater than 20 psi. If necessary, additional hydrants should be opened.

Flow - Qa

$$Q_a = 29.8 D^2 C \sqrt{P_p}$$

Qa=Test Flow, gpm
D=Flow Opening Diam. ,in.
Pp=Pitot Pressure, psi
C=Hydraulic Coef.
0.9 - Rounded
0.8 - Sharp
0.7 - Intruding

CALCULATED FLOWS

ASSUMED RESIDUAL (PSI)	STATIC PRESSURE (PSI)	FLOW Qc (GPM)
20	77	923
Total Calc. Flow @ 20 psi		**923**

Flow - Qc

$$Q_c = Q_a \left(\frac{P_s - P_f}{P_s - P_t} \right)^{0.54}$$

Qc=Flow@Pf,gpm
Qa=Test Flow,gpm
Ps=Static Pressure, psi
Pf= Assumed Residual Press., psi
Pt=Residual Pressure, psi

SKETCH OF TEST LOCATION

WRIGHT-PIERCE
Engineering a Better Environment

HYDRANT FLOW TEST LOG

JOB NAME: Orleans Asset Management Plan
JOB NO.: 12779A
PERFORMED BY: Chris Berg/Dylan Thisse

TEST NO.: 5
TIME: 1:40 PM
DATE: 6.25.2013

FLOW TEST DATA

HYDRANT NO.	STATIC PRESSURE (PSI)	RESIDUAL* PRESSURE (PSI)	PITOT PRESSURE (PSI)	FLOW OPENING (IN.)	DISCHARGE COEF.	FLOW Qa (GPM)	REMARKS
1	66	58					
2	68		46	2.5	0.9	1,137	
						0	
						0	
						0	

*Note: The pressure drop between the static and residual should be greater than 20 psi. If necessary, additional hydrants should be opened.

Flow - Qa

$$Q_a = 29.8 D^2 C \sqrt{P_p}$$

Qa=Test Flow, gpm
D=Flow Opening Diam. ,in.
Pp=Pitot Pressure, psi
C=Hydraulic Coef.
0.9 - Rounded
0.8 - Sharp
0.7 - Intruding

CALCULATED FLOWS

ASSUMED RESIDUAL (PSI)	STATIC PRESSURE (PSI)	FLOW Qc (GPM)
20	66	2,924
Total Calc. Flow @ 20 psi		**2,924**

Flow - Qc

$$Q_c = Q_a \left(\frac{P_s - P_f}{P_s - P_t} \right)^{0.54}$$

Qc=Flow@Pf,gpm
Qa=Test Flow,gpm
Ps=Static Pressure, psi
Pf= Assumed Residual Press., psi
Pt=Residual Pressure, psi

SKETCH OF TEST LOCATION

Wright-Pierce
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HYDRANT FLOW TEST LOG

JOB NAME:	Orleans Asset Management Plan	TEST NO.:	6
JOB NO.:	12779A	TIME:	9:45 AM
PERFORMED BY:	Chris Berg/Dylan Thisse	DATE:	6.25.2013

FLOW TEST DATA

HYDRANT NO.	STATIC PRESSURE (PSI)	RESIDUAL* PRESSURE (PSI)	PITOT PRESSURE (PSI)	FLOW OPENING (IN.)	DISCHARGE COEF.	FLOW Qa (GPM)	REMARKS
1	70	65					
2	75		55	2.5	0.9	1,243	
						0	
						0	
						0	

*Note: The pressure drop between the static and residual should be greater than 20 psi. If necessary, additional hydrants should be opened.

Flow - Qa

$$Q_a = 29.8 D^2 C \sqrt{P_p}$$

Qa=Test Flow, gpm
D=Flow Opening Diam. ,in.
Pp=Pitot Pressure, psi
C=Hydraulic Coef.
0.9 - Rounded
0.8 - Sharp
0.7 - Intruding

CALCULATED FLOWS

ASSUMED RESIDUAL (PSI)	STATIC PRESSURE (PSI)	FLOW Qc (GPM)
20	70	4,310
Total Calc. Flow @ 20 psi		**4,310**

Flow - Qc

$$Q_c = Q_a \left(\frac{P_s - P_f}{P_s - P_t} \right)^{0.54}$$

Qc=Flow@Pf,gpm
Qa=Test Flow,gpm
Ps=Static Pressure, psi
Pf= Assumed Residual Press., psi
Pt=Residual Pressure, psi

SKETCH OF TEST LOCATION

WRIGHT-PIERCE
Engineering a Better Environment

HYDRANT FLOW TEST LOG

JOB NAME: Orleans Asset Management Plan
JOB NO.: 12779A
PERFORMED BY: Chris Berg/Dylan Thisse

TEST NO.: 7
TIME: 10:50 AM
DATE: 6.25.2013

FLOW TEST DATA

HYDRANT NO.	STATIC PRESSURE (PSI)	RESIDUAL* PRESSURE (PSI)	PITOT PRESSURE (PSI)	FLOW OPENING (IN.)	DISCHARGE COEF.	FLOW Qa (GPM)	REMARKS
1	72	65					
2	70		48	2.5	0.9	1,161	
						0	
						0	
						0	

*Note: The pressure drop between the static and residual should be greater than 20 psi. If necessary, additional hydrants should be opened.

Flow - Qa

$$Q_a = 29.8 D^2 C \sqrt{P_p}$$

Qa=Test Flow, gpm
D=Flow Opening Diam. ,in.
Pp=Pitot Pressure, psi
C=Hydraulic Coef.
0.9 - Rounded
0.8 - Sharp
0.7 - Intruding

CALCULATED FLOWS

ASSUMED RESIDUAL (PSI)	STATIC PRESSURE (PSI)	FLOW Qc (GPM)
20	72	3,430
Total Calc. Flow @ 20 psi		**3,430**

Flow - Qc

$$Q_c = Q_a \left(\frac{P_s - P_f}{P_s - P_t} \right)^{0.54}$$

Qc=Flow@Pf,gpm
Qa=Test Flow,gpm
Ps=Static Pressure, psi
Pf= Assumed Residual Press., psi
Pt=Residual Pressure, psi

SKETCH OF TEST LOCATION

WRIGHT-PIERCE
Engineering a Better Environment

HYDRANT FLOW TEST LOG

JOB NAME: Orleans Asset Management Plan
JOB NO.: 12779A
PERFORMED BY: Chris Berg/Dylan Thisse

TEST NO.: 8
TIME: 11:00 AM
DATE: 6.25.2013

FLOW TEST DATA

HYDRANT NO.	STATIC PRESSURE (PSI)	RESIDUAL* PRESSURE (PSI)	PITOT PRESSURE (PSI)	FLOW OPENING (IN.)	DISCHARGE COEF.	FLOW Qa (GPM)	REMARKS
1	63	43					
2	77		38	2.5	0.9	1,033	
						0	
						0	
						0	

*Note: The pressure drop between the static and residual should be greater than 20 psi. If necessary, additional hydrants should be opened.

Flow - Qa

$$Q_a = 29.8D^2C\sqrt{P_p}$$

Qa=Test Flow, gpm
D=Flow Opening Diam. ,in.
Pp=Pitot Pressure, psi
C=Hydraulic Coef.
0.9 - Rounded
0.8 - Sharp
0.7 - Intruding

CALCULATED FLOWS

ASSUMED RESIDUAL (PSI)	STATIC PRESSURE (PSI)	FLOW Qc (GPM)
20	63	1,562
Total Calc. Flow @ 20 psi		**1,562**

Flow - Qc

$$Q_c = Q_a\left(\frac{P_s - P_f}{P_s - P_t}\right)^{0.54}$$

Qc=Flow@Pf,gpm
Qa=Test Flow,gpm
Ps=Static Pressure, psi
Pf= Assumed Residual Press., psi
Pt=Residual Pressure, psi

SKETCH OF TEST LOCATION

WRIGHT-PIERCE
Engineering a Better Environment

HYDRANT FLOW TEST LOG

JOB NAME:	Orleans Asset Management Plan	TEST NO.:	9
JOB NO.:	12779A	TIME:	11:20 AM
PERFORMED BY:	Chris Berg/Dylan Thisse	DATE:	6.25.2013

FLOW TEST DATA

HYDRANT NO.	STATIC PRESSURE (PSI)	RESIDUAL* PRESSURE (PSI)	PITOT PRESSURE (PSI)	FLOW OPENING (IN.)	DISCHARGE COEF.	FLOW Qa (GPM)	REMARKS
1	50	41					
2	58		30	2.5	0.9	918	
						0	
						0	
						0	

*Note: The pressure drop between the static and residual should be greater than 20 psi. If necessary, additional hydrants should be opened.

Flow - Qa

$$Q_a = 29.8 D^2 C \sqrt{P_p}$$

Qa=Test Flow, gpm
D=Flow Opening Diam. ,in.
Pp=Pitot Pressure, psi
C=Hydraulic Coef.
0.9 - Rounded
0.8 - Sharp
0.7 - Intruding

CALCULATED FLOWS

ASSUMED RESIDUAL (PSI)	STATIC PRESSURE (PSI)	FLOW Qc (GPM)
20	50	1,759
Total Calc. Flow @ 20 psi		**1,759**

Flow - Qc

$$Q_c = Q_a \left(\frac{P_s - P_f}{P_s - P_t} \right)^{0.54}$$

Qc=Flow@Pf,gpm
Qa=Test Flow,gpm
Ps=Static Pressure, psi
Pf= Assumed Residual Press., psi
Pt=Residual Pressure, psi

SKETCH OF TEST LOCATION

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HYDRANT FLOW TEST LOG

JOB NAME:	Orleans Asset Management Plan	TEST NO.:	10
JOB NO.:	12779A	TIME:	1:55 PM
PERFORMED BY:	Chris Berg/Dylan Thisse	DATE:	6.25.2013

FLOW TEST DATA

HYDRANT NO.	STATIC PRESSURE (PSI)	RESIDUAL* PRESSURE (PSI)	PITOT PRESSURE (PSI)	FLOW OPENING (IN.)	DISCHARGE COEF.	FLOW Qa (GPM)	REMARKS
1	73	50					
2	84		40	2.5	0.9	1,060	
						0	
						0	
						0	

*Note: The pressure drop between the static and residual should be greater than 20 psi. If necessary, additional hydrants should be opened.

Flow - Qa

$$Q_a = 29.8 D^2 C \sqrt{P_p}$$

Qa=Test Flow, gpm
D=Flow Opening Diam. ,in.
Pp=Pitot Pressure, psi
C=Hydraulic Coef.
- 0.9 - Rounded
- 0.8 - Sharp
- 0.7 - Intruding

CALCULATED FLOWS

ASSUMED RESIDUAL (PSI)	STATIC PRESSURE (PSI)	FLOW Qc (GPM)
20	73	1,664
Total Calc. Flow @ 20 psi		**1,664**

Flow - Qc

$$Q_c = Q_a \left(\frac{P_s - P_f}{P_s - P_t} \right)^{0.54}$$

Qc=Flow@Pf,gpm
Qa=Test Flow,gpm
Ps=Static Pressure, psi
Pf= Assumed Residual Press., psi
Pt=Residual Pressure, psi

SKETCH OF TEST LOCATION

WRIGHT-PIERCE
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HYDRANT FLOW TEST LOG

JOB NAME:	Orleans Asset Management Plan	TEST NO.:	11
JOB NO.:	12779A	TIME:	9:00 AM
PERFORMED BY:	Chris Berg/Dylan Thisse	DATE:	6.25.2013

FLOW TEST DATA

HYDRANT NO.	STATIC PRESSURE (PSI)	RESIDUAL* PRESSURE (PSI)	PITOT PRESSURE (PSI)	FLOW OPENING (IN.)	DISCHARGE COEF.	FLOW Qa (GPM)	REMARKS
1	59	44					
2	59		36	2.5	0.9	1,006	
						0	
						0	
						0	

*Note: The pressure drop between the static and residual should be greater than 20 psi. If necessary, additional hydrants should be opened.

Flow - Qa

$$Q_a = 29.8 D^2 C \sqrt{P_p}$$

Qa=Test Flow, gpm
D=Flow Opening Diam. ,in.
Pp=Pitot Pressure, psi
C=Hydraulic Coef.
0.9 - Rounded
0.8 - Sharp
0.7 - Intruding

CALCULATED FLOWS

ASSUMED RESIDUAL (PSI)	STATIC PRESSURE (PSI)	FLOW Qc (GPM)
20	59	1,685
Total Calc. Flow @ 20 psi		**1,685**

Flow - Qc

$$Q_c = Q_a \left(\frac{P_s - P_f}{P_s - P_t} \right)^{0.54}$$

Qc=Flow@Pf,gpm
Qa=Test Flow,gpm
Ps=Static Pressure, psi
Pf= Assumed Residual Press., psi
Pt=Residual Pressure, psi

SKETCH OF TEST LOCATION

WRIGHT-PIERCE
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HYDRANT FLOW TEST LOG

JOB NAME: Orleans Asset Management Plan
JOB NO.: 12779A
PERFORMED BY: Chris Berg/Dylan Thisse

TEST NO.: 12
TIME: 12:06 PM
DATE: 6.25.2013

FLOW TEST DATA

HYDRANT NO.	STATIC PRESSURE (PSI)	RESIDUAL* PRESSURE (PSI)	PITOT PRESSURE (PSI)	FLOW OPENING (IN.)	DISCHARGE COEF.	FLOW Qa (GPM)	REMARKS
1	68	57					
2	72		39	2.5	0.9	1,047	
			38			0	
						0	
						0	

*Note: The pressure drop between the static and residual should be greater than 20 psi. If necessary, additional hydrants should be opened.

Flow - Qa

$$Q_a = 29.8 D^2 C \sqrt{P_p}$$

Qa=Test Flow, gpm
D=Flow Opening Diam. ,in.
Pp=Pitot Pressure, psi
C=Hydraulic Coef.
0.9 - Rounded
0.8 - Sharp
0.7 - Intruding

CALCULATED FLOWS

ASSUMED RESIDUAL (PSI)	STATIC PRESSURE (PSI)	FLOW Qc (GPM)
20	68	2,319
Total Calc. Flow @ 20 psi		**2,319**

Flow - Qc

$$Q_c = Q_a \left(\frac{P_s - P_f}{P_s - P_t} \right)^{0.54}$$

Qc=Flow@Pf,gpm
Qa=Test Flow,gpm
Ps=Static Pressure, psi
Pf= Assumed Residual Press., psi
Pt=Residual Pressure, psi

SKETCH OF TEST LOCATION

WRIGHT-PIERCE
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HYDRANT FLOW TEST LOG

JOB NAME: Orleans Asset Management Plan
JOB NO.: 12779A
PERFORMED BY: Chris Berg/Dylan Thisse

TEST NO.: 13
TIME: 11:46 AM
DATE: 6.25.2013

FLOW TEST DATA

HYDRANT NO.	STATIC PRESSURE (PSI)	RESIDUAL* PRESSURE (PSI)	PITOT PRESSURE (PSI)	FLOW OPENING (IN.)	DISCHARGE COEF.	FLOW Qa (GPM)	REMARKS
1	62	38					
2	66		30	2.5	0.9	918	
						0	
						0	
						0	

*Note: The pressure drop between the static and residual should be greater than 20 psi. If necessary, additional hydrants should be opened.

Flow - Qa

$$Q_a = 29.8 D^2 C \sqrt{P_p}$$

Qa=Test Flow, gpm
D=Flow Opening Diam. ,in.
Pp=Pitot Pressure, psi
C=Hydraulic Coef.
0.9 - Rounded
0.8 - Sharp
0.7 - Intruding

CALCULATED FLOWS

ASSUMED RESIDUAL (PSI)	STATIC PRESSURE (PSI)	FLOW Qc (GPM)
20	62	1,242
Total Calc. Flow @ 20 psi		**1,242**

Flow - Qc

$$Q_c = Q_a \left(\frac{P_s - P_f}{P_s - P_t} \right)^{0.54}$$

Qc=Flow@Pf,gpm
Qa=Test Flow,gpm
Ps=Static Pressure, psi
Pf= Assumed Residual Press., psi
Pt=Residual Pressure, psi

SKETCH OF TEST LOCATION

WRIGHT-PIERCE
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HYDRANT FLOW TEST LOG

JOB NAME: Orleans Asset Management Plan
JOB NO.: 12779A
PERFORMED BY: Chris Berg/Dylan Thisse

TEST NO.: 14
TIME:
DATE: 6.25.2013

FLOW TEST DATA

HYDRANT NO.	STATIC PRESSURE (PSI)	RESIDUAL* PRESSURE (PSI)	PITOT PRESSURE (PSI)	FLOW OPENING (IN.)	DISCHARGE COEF.	FLOW Qa (GPM)	REMARKS
1	44	30					
2	52		30	2.5	0.9	918	
						0	
						0	
						0	

*Note: The pressure drop between the static and residual should be greater than 20 psi. If necessary, additional hydrants should be opened.

Flow - Qa

$$Q_a = 29.8 D^2 C \sqrt{P_p}$$

Qa=Test Flow, gpm
D=Flow Opening Diam. ,in.
Pp=Pitot Pressure, psi
C=Hydraulic Coef.
0.9 - Rounded
0.8 - Sharp
0.7 - Intruding

CALCULATED FLOWS

ASSUMED RESIDUAL (PSI)	STATIC PRESSURE (PSI)	FLOW Qc (GPM)
20	44	1,228
Total Calc. Flow @ 20 psi		**1,228**

Flow - Qc

$$Q_c = Q_a \left(\frac{P_s - P_f}{P_s - P_t} \right)^{0.54}$$

Qc=Flow@Pf,gpm
Qa=Test Flow,gpm
Ps=Static Pressure, psi
Pf= Assumed Residual Press., psi
Pt=Residual Pressure, psi

SKETCH OF TEST LOCATION

WRIGHT-PIERCE
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HYDRANT FLOW TEST LOG

JOB NAME: Orleans Asset Management Plan
JOB NO.: 12779A
PERFORMED BY: Chris Berg/Dylan Thisse

TEST NO.: 15
TIME: 10:00 AM
DATE: 6.25.2013

FLOW TEST DATA

HYDRANT NO.	STATIC PRESSURE (PSI)	RESIDUAL* PRESSURE (PSI)	PITOT PRESSURE (PSI)	FLOW OPENING (IN.)	DISCHARGE COEF.	FLOW Qa (GPM)	REMARKS
1	61	61					
2	60		45	2.5	0.9	1,124	
						0	
						0	
						0	

*Note: The pressure drop between the static and residual should be greater than 20 psi. If necessary, additional hydrants should be opened.

Flow - Qa

$$Q_a = 29.8 D^2 C \sqrt{P_p}$$

Qa=Test Flow, gpm
D=Flow Opening Diam. ,in.
Pp=Pitot Pressure, psi
C=Hydraulic Coef.
0.9 - Rounded
0.8 - Sharp
0.7 - Intruding

CALCULATED FLOWS

ASSUMED RESIDUAL (PSI)	STATIC PRESSURE (PSI)	FLOW Qc (GPM)
20	61	#DIV/0!
Total Calc. Flow @ 20 psi		**#DIV/0!**

Flow - Qc

$$Q_c = Q_a \left(\frac{P_s - P_f}{P_s - P_t} \right)^{0.54}$$

Qc=Flow@Pf,gpm
Qa=Test Flow,gpm
Ps=Static Pressure, psi
Pf= Assumed Residual Press., psi
Pt=Residual Pressure, psi

SKETCH OF TEST LOCATION

Appendix B

WRIGHT-PIERCE
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National Primary Drinking Water Regulations

	Contaminant	MCL or TT[1] (mg/L)[2]	Potential health effects from long-term[3] exposure above the MCL	Common sources of contaminant in drinking water	Public Health Goal (mg/L)[2]
OC	Acrylamide	TT[4]	Nervous system or blood problems; increased risk of cancer	Added to water during sewage/ wastewater treatment	zero
OC	Alachlor	0.002	Eye, liver, kidney or spleen problems; anemia; increased risk of cancer	Runoff from herbicide used on row crops	zero
R	Alpha/photon emitters	15 picocuries per Liter (pCi/L)	Increased risk of cancer	Erosion of natural deposits of certain minerals that are radioactive and may emit a form of radiation known as alpha radiation	zero
IOC	Antimony	0.006	Increase in blood cholesterol; decrease in blood sugar	Discharge from petroleum refineries; fire retardants; ceramics; electronics; solder	0.006
IOC	Arsenic	0.010	Skin damage or problems with circulatory systems, and may have increased risk of getting cancer	Erosion of natural deposits; runoff from orchards; runoff from glass & electronics production wastes	0
IOC	Asbestos (fibers >10 micrometers)	7 million fibers per Liter (MFL)	Increased risk of developing benign intestinal polyps	Decay of asbestos cement in water mains; erosion of natural deposits	7 MFL
OC	Atrazine	0.003	Cardiovascular system or reproductive problems	Runoff from herbicide used on row crops	0.003
IOC	Barium	2	Increase in blood pressure	Discharge of drilling wastes; discharge from metal refineries; erosion of natural deposits	2
OC	Benzene	0.005	Anemia; decrease in blood platelets; increased risk of cancer	Discharge from factories; leaching from gas storage tanks and landfills	zero
OC	Benzo(a)pyrene (PAHs)	0.0002	Reproductive difficulties; increased risk of cancer	Leaching from linings of water storage tanks and distribution lines	zero
IOC	Beryllium	0.004	Intestinal lesions	Discharge from metal refineries and coal-burning factories; discharge from electrical, aerospace, and defense industries	0.004
R	Beta photon emitters	4 millirems per year	Increased risk of cancer	Decay of natural and man-made deposits of certain minerals that are radioactive and may emit forms of radiation known as photons and beta radiation	zero
DBP	Bromate	0.010	Increased risk of cancer	Byproduct of drinking water disinfection	zero
IOC	Cadmium	0.005	Kidney damage	Corrosion of galvanized pipes; erosion of natural deposits; discharge from metal refineries; runoff from waste batteries and paints	0.005
OC	Carbofuran	0.04	Problems with blood, nervous system, or reproductive system	Leaching of soil fumigant used on rice and alfalfa	0.04
OC	Carbon tetrachloride	0.005	Liver problems; increased risk of cancer	Discharge from chemical plants and other industrial activities	zero
D	Chloramines (as Cl_2)	MRDL=4.0[1]	Eye/nose irritation; stomach discomfort; anemia	Water additive used to control microbes	MRDLG=4[1]
OC	Chlordane	0.002	Liver or nervous system problems; increased risk of cancer	Residue of banned termiticide	zero
D	Chlorine (as Cl_2)	MRDL=4.0[1]	Eye/nose irritation; stomach discomfort	Water additive used to control microbes	MRDLG=4[1]
D	Chlorine dioxide (as ClO_2)	MRDL=0.8[1]	Anemia; infants, young children, and fetuses of pregnant women: nervous system effects	Water additive used to control microbes	MRDLG=0.8[1]
DBP	Chlorite	1.0	Anemia; infants, young children, and fetuses of pregnant women: nervous system effects	Byproduct of drinking water disinfection	0.8
OC	Chlorobenzene	0.1	Liver or kidney problems	Discharge from chemical and agricultural chemical factories	0.1
IOC	Chromium (total)	0.1	Allergic dermatitis	Discharge from steel and pulp mills; erosion of natural deposits	0.1
IOC	Copper	TT[5]; Action Level = 1.3	Short-term exposure: Gastrointestinal distress. Long-term exposure: Liver or kidney damage. People with Wilson's Disease should consult their personal doctor if the amount of copper in their water exceeds the action level	Corrosion of household plumbing systems; erosion of natural deposits	1.3
M	*Cryptosporidium*	TT[7]	Short-term exposure: Gastrointestinal illness (e.g., diarrhea, vomiting, cramps)	Human and animal fecal waste	zero

LEGEND

- D — Disinfectant
- DBP — Disinfection Byproduct
- IOC — Inorganic Chemical
- M — Microorganism
- OC — Organic Chemical
- R — Radionuclides

	Contaminant	MCL or TT[1] (mg/L)[2]	Potential health effects from long-term[3] exposure above the MCL	Common sources of contaminant in drinking water	Public Health Goal (mg/L)[2]
IOC	Cyanide (as free cyanide)	0.2	Nerve damage or thyroid problems	Discharge from steel/metal factories; discharge from plastic and fertilizer factories	0.2
OC	2,4-D	0.07	Kidney, liver, or adrenal gland problems	Runoff from herbicide used on row crops	0.07
OC	Dalapon	0.2	Minor kidney changes	Runoff from herbicide used on rights of way	0.2
OC	1,2-Dibromo-3-chloropropane (DBCP)	0.0002	Reproductive difficulties; increased risk of cancer	Runoff/leaching from soil fumigant used on soybeans, cotton, pineapples, and orchards	zero
OC	o-Dichlorobenzene	0.6	Liver, kidney, or circulatory system problems	Discharge from industrial chemical factories	0.6
OC	p-Dichlorobenzene	0.075	Anemia; liver, kidney or spleen damage; changes in blood	Discharge from industrial chemical factories	0.075
OC	1,2-Dichloroethane	0.005	Increased risk of cancer	Discharge from industrial chemical factories	zero
OC	1,1-Dichloroethylene	0.007	Liver problems	Discharge from industrial chemical factories	0.007
OC	cis-1,2-Dichloroethylene	0.07	Liver problems	Discharge from industrial chemical factories	0.07
OC	trans-1,2-Dichloroethylene	0.1	Liver problems	Discharge from industrial chemical factories	0.1
OC	Dichloromethane	0.005	Liver problems; increased risk of cancer	Discharge from drug and chemical factories	zero
OC	1,2-Dichloropropane	0.005	Increased risk of cancer	Discharge from industrial chemical factories	zero
OC	Di(2-ethylhexyl) adipate	0.4	Weight loss, liver problems, or possible reproductive difficulties	Discharge from chemical factories	0.4
OC	Di(2-ethylhexyl) phthalate	0.006	Reproductive difficulties; liver problems; increased risk of cancer	Discharge from rubber and chemical factories	zero
OC	Dinoseb	0.007	Reproductive difficulties	Runoff from herbicide used on soybeans and vegetables	0.007
OC	Dioxin (2,3,7,8-TCDD)	0.00000003	Reproductive difficulties; increased risk of cancer	Emissions from waste incineration and other combustion; discharge from chemical factories	zero
OC	Diquat	0.02	Cataracts	Runoff from herbicide use	0.02
OC	Endothall	0.1	Stomach and intestinal problems	Runoff from herbicide use	0.1
OC	Endrin	0.002	Liver problems	Residue of banned insecticide	0.002
OC	Epichlorohydrin	TT[4]	Increased cancer risk; stomach problems	Discharge from industrial chemical factories; an impurity of some water treatment chemicals	zero
OC	Ethylbenzene	0.7	Liver or kidney problems	Discharge from petroleum refineries	0.7
OC	Ethylene dibromide	0.00005	Problems with liver, stomach, reproductive system, or kidneys; increased risk of cancer	Discharge from petroleum refineries	zero
M	Fecal coliform and *E. coli*	MCL[6]	Fecal coliforms and *E. coli* are bacteria whose presence indicates that the water may be contaminated with human or animal wastes. Microbes in these wastes may cause short term effects, such as diarrhea, cramps, nausea, headaches, or other symptoms. They may pose a special health risk for infants, young children, and people with severely compromised immune systems.	Human and animal fecal waste	zero[6]
IOC	Fluoride	4.0	Bone disease (pain and tenderness of the bones); children may get mottled teeth	Water additive which promotes strong teeth; erosion of natural deposits; discharge from fertilizer and aluminum factories	4.0
M	*Giardia lamblia*	TT[7]	Short-term exposure: Gastrointestinal illness (e.g., diarrhea, vomiting, cramps)	Human and animal fecal waste	zero
OC	Glyphosate	0.7	Kidney problems; reproductive difficulties	Runoff from herbicide use	0.7
DBP	Haloacetic acids (HAA5)	0.060	Increased risk of cancer	Byproduct of drinking water disinfection	n/a[9]
OC	Heptachlor	0.0004	Liver damage; increased risk of cancer	Residue of banned termiticide	zero
OC	Heptachlor epoxide	0.0002	Liver damage; increased risk of cancer	Breakdown of heptachlor	zero
M	Heterotrophic plate count (HPC)	TT[7]	HPC has no health effects; it is an analytic method used to measure the variety of bacteria that are common in water. The lower the concentration of bacteria in drinking water, the better maintained the water system is.	HPC measures a range of bacteria that are naturally present in the environment	n/a

LEGEND

D	Disinfectant	IOC	Inorganic Chemical	OC	Organic Chemical
DBP	Disinfection Byproduct	M	Microorganism	R	Radionuclides

Contaminant		MCL or TT[1] (mg/L)[2]	Potential health effects from long-term[3] exposure above the MCL	Common sources of contaminant in drinking water	Public Health Goal (mg/L)[2]
OC	Hexachlorobenzene	0.001	Liver or kidney problems; reproductive difficulties; increased risk of cancer	Discharge from metal refineries and agricultural chemical factories	zero
OC	Hexachlorocyclopentadiene	0.05	Kidney or stomach problems	Discharge from chemical factories	0.05
IOC	Lead	TT5; Action Level=0.015	Infants and children: Delays in physical or or mental development; children could show slight deficits in attention span and learning abilities; Adults: Kidney problems; high blood pressure	Corrosion of household plumbing systems; erosion of natural deposits	zero
M	*Legionella*	TT7	Legionnaire's Disease, a type of pneumonia	Found naturally in water; multiplies in heating systems	zero
OC	Lindane	0.0002	Liver or kidney problems	Runoff/leaching from insecticide used on cattle, lumber, gardens	0.0002
IOC	Mercury (inorganic)	0.002	Kidney damage	Erosion of natural deposits; discharge from refineries and factories; runoff from landfills and croplands	0.002
OC	Methoxychlor	0.04	Reproductive difficulties	Runoff/leaching from insecticide used on fruits, vegetables, alfalfa, livestock	0.04
IOC	Nitrate (measured as Nitrogen)	10	Infants below the age of six months who drink water containing nitrate in excess of the MCL could become seriously ill and, if untreated, may die. Symptoms include shortness of breath and blue-baby syndrome.	Runoff from fertilizer use; leaching from septic tanks, sewage; erosion of natural deposits	10
IOC	Nitrite (measured as Nitrogen)	1	Infants below the age of six months who drink water containing nitrite in excess of the MCL could become seriously ill and, if untreated, may die. Symptoms include shortness of breath and blue-baby syndrome.	Runoff from fertilizer use; leaching from septic tanks, sewage; erosion of natural deposits	1
OC	Oxamyl (Vydate)	0.2	Slight nervous system effects	Runoff/leaching from insecticide used on apples, potatoes, and tomatoes	0.2
OC	Pentachlorophenol	0.001	Liver or kidney problems; increased cancer risk	Discharge from wood-preserving factories	zero
OC	Picloram	0.5	Liver problems	Herbicide runoff	0.5
OC	Polychlorinated biphenyls (PCBs)	0.0005	Skin changes; thymus gland problems; immune deficiencies; reproductive or nervous system difficulties; increased risk of cancer	Runoff from landfills; discharge of waste chemicals	zero
R	Radium 226 and Radium 228 (combined)	5 pCi/L	Increased risk of cancer	Erosion of natural deposits	zero
IOC	Selenium	0.05	Hair or fingernail loss; numbness in fingers or toes; circulatory problems	Discharge from petroleum and metal refineries; erosion of natural deposits; discharge from mines	0.05
OC	Simazine	0.004	Problems with blood	Herbicide runoff	0.004
OC	Styrene	0.1	Liver, kidney, or circulatory system problems	Discharge from rubber and plastic factories; leaching from landfills	0.1
OC	Tetrachloroethylene	0.005	Liver problems; increased risk of cancer	Discharge from factories and dry cleaners	zero
IOC	Thallium	0.002	Hair loss; changes in blood; kidney, intestine, or liver problems	Leaching from ore-processing sites; discharge from electronics, glass, and drug factories	0.0005
OC	Toluene	1	Nervous system, kidney, or liver problems	Discharge from petroleum factories	1
M	Total Coliforms	5.0 percent[8]	Coliforms are bacteria that indicate that other, potentially harmful bacteria may be present. See fecal coliforms and *E. coli*	Naturally present in the environment	zero
DBP	Total Trihalomethanes (TTHMs)	0.080	Liver, kidney or central nervous system problems; increased risk of cancer	Byproduct of drinking water disinfection	n/a[9]
OC	Toxaphene	0.003	Kidney, liver, or thyroid problems; increased risk of cancer	Runoff/leaching from insecticide used on cotton and cattle	zero
OC	2,4,5-TP (Silvex)	0.05	Liver problems	Residue of banned herbicide	0.05
OC	1,2,4-Trichlorobenzene	0.07	Changes in adrenal glands	Discharge from textile finishing factories	0.07
OC	1,1,1-Trichloroethane	0.2	Liver, nervous system, or circulatory problems	Discharge from metal degreasing sites and other factories	0.2
OC	1,1,2-Trichloroethane	0.005	Liver, kidney, or immune system problems	Discharge from industrial chemical factories	0.003
OC	Trichloroethylene	0.005	Liver problems; increased risk of cancer	Discharge from metal degreasing sites and other factories	zero

LEGEND

D	Disinfectant	IOC	Inorganic Chemical	OC	Organic Chemical
DBP	Disinfection Byproduct	M	Microorganism	R	Radionuclides

Contaminant		MCL or TT[1] (mg/L)[2]	Potential health effects from long-term[3] exposure above the MCL	Common sources of contaminant in drinking water	Public Health Goal (mg/L)[2]
M	Turbidity	TT[7]	Turbidity is a measure of the cloudiness of water. It is used to indicate water quality and filtration effectiveness (e.g., whether disease-causing organisms are present). Higher turbidity levels are often associated with higher levels of disease-causing microorganisms such as viruses, parasites and some bacteria. These organisms can cause short term symptoms such as nausea, cramps, diarrhea, and associated headaches.	Soil runoff	n/a
R	Uranium	30µg/L	Increased risk of cancer, kidney toxicity	Erosion of natural deposits	zero
OC	Vinyl chloride	0.002	Increased risk of cancer	Leaching from PVC pipes; discharge from plastic factories	zero
M	Viruses (enteric)	TT[7]	Short-term exposure: Gastrointestinal illness (e.g., diarrhea, vomiting, cramps)	Human and animal fecal waste	zero
OC	Xylenes (total)	10	Nervous system damage	Discharge from petroleum factories; discharge from chemical factories	10

LEGEND

D	Disinfectant	IOC	Inorganic Chemical	OC	Organic Chemical
DBP	Disinfection Byproduct	M	Microorganism	R	Radionuclides

NOTES

1 Definitions

- Maximum Contaminant Level Goal (MCLG)—The level of a contaminant in drinking water below which there is no known or expected risk to health. MCLGs allow for a margin of safety and are non-enforceable public health goals.
- Maximum Contaminant Level (MCL)—The highest level of a contaminant that is allowed in drinking water. MCLs are set as close to MCLGs as feasible using the best available treatment technology and taking cost into consideration. MCLs are enforceable standards.
- Maximum Residual Disinfectant Level Goal (MRDLG)—The level of a drinking water disinfectant below which there is no known or expected risk to health. MRDLGs do not reflect the benefits of the use of disinfectants to control microbial contaminants.
- Maximum Residual Disinfectant Level (MRDL)—The highest level of a disinfectant allowed in drinking water. There is convincing evidence that addition of a disinfectant is necessary for control of microbial contaminants.
- Treatment Technique (TT)—A required process intended to reduce the level of a contaminant in drinking water.

2 Units are in milligrams per liter (mg/L) unless otherwise noted. Milligrams per liter are equivalent to parts per million (ppm).

3 Health effects are from long-term exposure unless specified as short-term exposure.

4 Each water system must certify annually, in writing, to the state (using third-party or manufacturers certification) that when it uses acrylamide and/or epichlorohydrin to treat water, the combination (or product) of dose and monomer level does not exceed the levels specified, as follows: Acrylamide = 0.05 percent dosed at 1 mg/L (or equivalent); Epichlorohydrin = 0.01 percent dosed at 20 mg/L (or equivalent).

5 Lead and copper are regulated by a Treatment Technique that requires systems to control the corrosiveness of their water. If more than 10 percent of tap water samples exceed the action level, water systems must take additional steps. For copper, the action level is 1.3 mg/L, and for lead is 0.015 mg/L.

6 A routine sample that is fecal coliform-positive or *E. coli*-positive triggers repeat samples--if any repeat sample is total coliform-positive, the system has an acute MCL violation. A routine sample that is total coliform-positive and fecal coliform-negative or *E. coli*-negative triggers repeat samples--if any repeat sample is fecal coliform-positive or *E. coli*-positive, the system has an acute MCL violation. See also Total Coliforms.

7 EPA's surface water treatment rules require systems using surface water or ground water under the direct influence of surface water to (1) disinfect their water, and (2) filter their water or meet criteria for avoiding filtration so that the following contaminants are controlled at the following levels:

- *Cryptosporidium*: 99 percent removal for systems that filter. Unfiltered systems are required to include Cryptosporidium in their existing watershed control provisions.
- Giardia lamblia: 99.9 percent removal/inactivation
- Viruses: 99.99 percent removal/inactivation
- *Legionella*: No limit, but EPA believes that if *Giardia* and viruses are removed/inactivated according to the treatment techniques in the surface water treatment rule, *Legionella* will also be controlled.
- Turbidity: For systems that use conventional or direct filtration, at no time can turbidity (cloudiness of water) go higher than 1 nephelolometric turbidity unit (NTU), and samples for turbidity must be less than or equal to 0.3 NTU in at least 95 percent of the samples in any month. Systems that use filtration other than conventional or direct filtration must follow state limits, which must include turbidity at no time exceeding 5 NTU.
- HPC: No more than 500 bacterial colonies per milliliter
- Long Term 1 Enhanced Surface Water Treatment; Surface water systems or ground water systems under the direct influence of surface water serving fewer than 10,000 people must comply with the applicable Long Term 1 Enhanced Surface Water Treatment Rule provisions (e.g. turbidity standards, individual filter monitoring, *Cryptosporidium* removal requirements, updated watershed control requirements for unfiltered systems).
- Long Term 2 Enhanced Surface Water Treatment; This rule applies to all surface water systems or ground water systems under the direct influence of surface water. The rule targets additional *Cryptosporidium* treatment requirements for higher risk systems and includes provisions to reduce risks from uncovered finished water storages facilities and to ensure that the systems maintain microbial protection as they take steps to reduce the formation of disinfection byproducts. (Monitoring start dates are staggered by system size. The largest systems (serving at least 100,000 people) will begin monitoring in October 2006 and the smallest systems (serving fewer than 10,000 people) will not begin monitoring until October 2008. After completing monitoring and determining their treatment bin, systems generally have three years to comply with any additional treatment requirements.)
- Filter Backwash Recycling: The Filter Backwash Recycling Rule requires systems that recycle to return specific recycle flows through all processes of the system's existing conventional or direct filtration system or at an alternate location approved by the state.

8 No more than 5.0 percent samples total coliform-positive in a month. (For water systems that collect fewer than 40 routine samples per month, no more than one sample can be total coliform-positive per month.) Every sample that has total coliform must be analyzed for either fecal coliforms or *E. coli*. If two consecutive TC-positive samples, and one is also positive for *E. coli* or fecal coliforms, system has an acute MCL violation.

9 Although there is no collective MCLG for this contaminant group, there are individual MCLGs for some of the individual contaminants:

- Haloacetic acids: dichloroacetic acid (zero); trichloroacetic acid (0.3 mg/L)
- Trihalomethanes: bromodichloromethane (zero); bromoform (zero); dibromochloromethane (0.06 mg/L)

National Secondary Drinking Water Regulation

National Secondary Drinking Water Regulations are non-enforceable guidelines regarding contaminants that may cause cosmetic effects (such as skin or tooth discoloration) or aesthetic effects (such as taste, odor, or color) in drinking water. EPA recommends secondary standards to water systems but does not require systems to comply. However, some states may choose to adopt them as enforceable standards.

Contaminant	Secondary Maximum Contaminant Level
Aluminum	0.05 to 0.2 mg/L
Chloride	250 mg/L
Color	15 (color units)
Copper	1.0 mg/L
Corrosivity	noncorrosive
Fluoride	2.0 mg/L
Foaming Agents	0.5 mg/L
Iron	0.3 mg/L
Manganese	0.05 mg/L
Odor	3 threshold odor number
pH	6.5-8.5
Silver	0.10 mg/L
Sulfate	250 mg/L
Total Dissolved Solids	500 mg/L
Zinc	5 mg/L

For More Information

EPA's Safe Drinking Water Web site:
http://www.epa.gov/safewater/

EPA's Safe Drinking Water Hotline:
(800) 426-4791

To order additional posters or other ground water and drinking water publications, please contact the National Service Center for Environmental Publications at :
(800) 490-9198, or
email: nscep@bps-lmit.com.

EPA United States Environmental Protection Agency

EPA 816-F-09-004
May 2009

Appendix C

SPRING 2012

STANDARDS AND GUIDELINES

FOR

CONTAMINANTS IN MASSACHUSETTS DRINKING WATERS

Commonwealth of Massachusetts
Executive Office of Energy and Environmental Affairs
Department of Environmental Protection
Office of Research and Standards
One Winter Street
Boston, MA 02108

Commonwealth of Massachusetts
Executive Office of Energy & Environmental Affairs

Department of Environmental Protection

DEVAL L. PATRICK
Governor

TIMOTHY P. MURRAY
Lieutenant Governor

RICHARD K. SULLIVAN JR.
Secretary

KENNETH L. KIMMELL
Commissioner

TO: Interested Parties

FROM: Carol Rowan West, Director, Office of Research and Standards

DATE: ***Spring 2012***

RE: Massachusetts Drinking Water Standards and Guidelines

Attached is the latest list of the Massachusetts Drinking Water Standards and Guidelines. The last issue was sent out in May of 2011. There is one change regarding part of the US EPA Health Advisory for manganese. The lifetime Health Advisory for manganese contains a precautionary statement that "for infants younger than 6 months, the lifetime Health Advisory of 0.3 mg/L be used even for an acute exposure of 10 days…" This cautionary advice is provided to address potential heightened susceptibility of infants to manganese toxicity because of higher water consumption rates, undeveloped systems for regulating body content of manganese and the fact that infant formulas may contain elevated manganese which, coupled with elevated manganese concentrations in drinking water used to prepare formula, may expose infants to higher concentrations of manganese than necessary. MassDEP is extending US EPA's age cutoff to one year out of concerns for formula use up to that age.

The standards and guidelines may not apply to all contaminant situations, so I urge you to continue to contact the Office of Research and Standards (ORS) with any questions regarding the application or interpretation of this information. Also, when a contaminant of interest is not on the list, please contact ORS for guidance (phone number 617-292-5998; email: michael.hutcheson@state.ma.us).

The list of Massachusetts standards and guidelines is available on the MassDEP Web Page at http://www.mass.gov/dep/water/drinking/standards/dwstand.htm with links to chemical-specific documentation. Users have the option of clicking on an individual chemical in the list to see the basis for the derivation of the drinking water criterion, along with other pertinent information. The Web Page also provides limits for some routinely used drinking water treatment chemicals. This information is presented in the Department's Office of Research and Standards (ORS) documentation for the Immediate Action Levels for Water Treatment Plant Chemicals (formerly referred to as "Memorandum on Treatment Chemicals as Do Not Drink or Use Guidance" located at: http://www.mass.gov/dep/water/laws/ialwtps.htm.

I. Introduction

The Drinking Water List of Standards and Guidelines is a convenient compendium of guidance values available for evaluating contaminants in drinking water in Massachusetts. The list is designed to be used by individuals or groups concerned with the integrity of drinking water, for example, water suppliers, homeowners, environmental groups, government regulators, boards of health, or private consultants.

Under the Safe Drinking Water Act (SDWA), a state may be granted primacy for implementing the provisions of the SDWA. The Massachusetts Department of Environmental Protection (MassDEP) has primacy for implementation. As part of that primacy, MassDEP is responsible for ensuring the quality of Massachusetts public drinking waters.

Four primary types of guidance are available for assessing drinking water quality in the Commonwealth:

<u>Standards</u>:	Massachusetts Maximum Contaminant Levels (MMCLs)
<u>Guidelines</u>:	ORS Guidelines
	US EPA Health Advisories
	Secondary Maximum Contaminant Levels

II. Standards

The Massachusetts Maximum Contaminant Levels (MMCLs) listed in the drinking water regulations (310 CMR 22.00) consist of promulgated US EPA MCLs which have become effective, plus a few MCLs set specifically by Massachusetts. The standards are enforced by the Drinking Water Program (DWP). Massachusetts may adopt a more stringent standard than the US EPA based on an independent review of primary or secondary data. The regulations were last promulgated on December 25, 2009.

The MMCLs listed in 310 CMR 22.00 apply to water that is delivered to any user of a public water system as defined in 310 CMR 22.02. More specific definitions and applications are in the regulations. Private residential wells are not subject to the requirements of 310 CMR 22.00. However, these drinking water standards are recommended for the evaluation of private drinking water and are often used to evaluate private residential contamination, especially in Federal Superfund and M.G.L Chapter 21E activities.

III. Guidelines

<u>ORS Guidelines</u>

ORS issues guidance for chemicals other than those with Massachusetts MCLs in drinking water. These ORS guidance values are known as ORS Guidelines or ORSG and are usually developed for use by Departmental programs in the absence of any other federal standards or guidance. ORSG may be based upon US EPA IRIS toxicity values or derived based on a review and evaluation of all available data for the chemical of interest. Some ORSG may be based on US

EPA Health Advisories. Standards promulgated by the US EPA but not yet effective may also be included on the list of Massachusetts Drinking Water Guidelines. ORSG are updated when IRIS toxicity values change so as to reflect the current toxicological guidance for the chemical.

ORS uses methodology similar to that used by the US EPA's Office of Groundwater and Drinking Water (OGWDW) when setting guidelines for chemicals in drinking water. Concentrations of chemicals having evidence of carcinogenicity are minimized as much as feasible; therefore, guidelines are set at a target excess lifetime cancer risk of one in one million (1×10^{-6}) or at the lowest practical quantitation limit (PQL) if the concentration at 1×10^{-6} is below the PQL. This practice applies to chemicals classified as A or B carcinogens under the old cancer classification scheme of US EPA (US EPA, 1986). Class C carcinogens are individually evaluated for a decision regarding whether to set the guidelines on cancer effects. For newly classified carcinogens under US EPA's new Carcinogen Risk Assessment Guidelines (US EPA, 2005), MassDEP will follow US EPA OGWDW's procedures for development of guidance.

To derive guidance for potential non-carcinogenic effects for a chemical, ORS applies a percentage (usually 20%) to published or derived route-specific reference doses and then uses standard exposure assumptions to convert the dose to a drinking water concentration. This practice allows for the possibility of human exposures from sources other than drinking water.

US EPA Health Advisories

The US EPA provides drinking water guidance in the form of Health Advisories for different durations of exposure (i.e., one-day, ten-day and lifetime). These are based upon non-cancer health effects. They are used by MassDEP when evaluating the potential health risks from chemicals in drinking water when no MMCL or ORSG is available.

Secondary Maximum Contaminant Levels (SMCLs)

SMCLs are guidance values issued by the US EPA representing levels of chemicals or parameters above which the aesthetic properties of the water can be affected (e.g., taste, odor, color) or cosmetic effects may occur (e.g., skin or tooth discoloration).

For more information

A more detailed description of the methodology used by ORS to derive water guidance can be found in Guide to the Regulation of Toxic Chemicals in Massachusetts Waters (ORS, 1990), available on MassDEP's website at: http://mass.gov/dep/water/laws/dwguide.doc.

IV. Spring 2012 Drinking Water Standards and Guidelines Lists Update

Changes to the 2012 List of Drinking Water Standards and Guidelines		
Contaminant	**Description of Change or Notation**	**Basis for Change or Notation**
Manganese	ORS has added a notation to the link to the US EPA list of Health Advisories regarding a recommended change in part of the Health Advisory language for manganese. Manganese has been listed under ORS guidelines with a cross reference to the SMCL and US EPA HA.	US EPA recommends that the lifetime HA value of 0.3 mg/L be used for infants up to 6-months of age even for an acute exposure of 10 days. This cautionary advice is provided to address potential heightened susceptibility of infants to manganese toxicity because of higher water consumption rates, undeveloped systems for regulating body content of manganese and the fact that infant formulas may contain elevated manganese which, coupled with elevated manganese concentrations in drinking water used to prepare formula, may expose infants to higher concentrations of manganese than necessary. MassDEP is extending US EPA's age cutoff to one year out of concerns for formula use up to that age.

V. References

Office of Research and Standards, 1990. *Guide to the Regulation of Toxic Chemicals in Massachusetts Waters.* Massachusetts Department of Environmental Protection. Boston, MA.

US EPA (US Environmental Protection Agency). 2005. Guidelines for Carcinogen Risk Assessment. EPA/630/P-03/001F. Risk Assessment Forum. US Environmental Protection Agency. Washington, D.C.

US EPA (US Environmental Protection Agency). 1986. Guidelines for Carcinogen Risk Assessment. Risk Assessment Forum. US Environmental Protection Agency. Washington, D.C.

Please note that drinking water guidance is contained in five separate lists, in the following order:
(1) Massachusetts Maximum Contaminant Levels – Inorganic/Organics; (2) Massachusetts Maximum Contaminant Levels – Radionuclides;
(3) Massachusetts Maximum Contaminant Levels – Biologicals; (4) Massachusetts Drinking Water Guidelines (ORSG);
(5) Secondary Maximum Contaminant Levels

SUBSTANCE	CASRN	MMCL (mg/L)
Acrylamide[1]	79061	Treatment Technique
Alachlor	15972608	0.002
Antimony	7440360	0.006
Arsenic	7440382	0.010
Asbestos[2]	1332214	7 million fibers/liter
Atrazine	1912249	0.003
Barium	7440393	2
Benzene	71432	0.005
Benzo(a)pyrene	50328	0.0002
Beryllium	7440417	0.004
Bromate	15541454	0.010
Cadmium	7440439	0.005
Carbofuran	1563662	0.04
Carbon tetrachloride	56235	0.005
Chloramines (as Cl_2)	N/A	4.0 (MRDL[3])
Chlordane	57749	0.002
Chlorine (as Cl_2)	7782505	4.0 (MRDL)
Chlorine dioxide (as ClO_2)	10049044	0.8 (MRDL)
Chlorite	7758192	1.0
Chlorobenzene	108907	0.1
Chromium (total)	7440473	0.1
Copper	7440508	Treatment Technique, 1.3 (Action Level)

SUBSTANCE	CASRN	MMCL (mg/L)
Cyanide (as free cyanide)	57125	0.2
2,4-D (2,4-Dichlorophenoxyacetic acid)	94757	0.07
Dalapon	75990	0.2
1,2-Dibromo-3-chloropropane (DBCP)	96128	0.0002
1,2-Dichlorobenzene (o-DCB)	95501	0.6
1,4-Dichlorobenzene (p-DCB)[4]	106467	0.005
1,2-Dichloroethane	107062	0.005
1,1-Dichloroethylene	75354	0.007
1,2-Dichloroethylene(*cis*)	156592	0.07
1,2-Dichloroethylene(*trans*)	156605	0.1
Dichloromethane	75092	0.005
1,2-Dichloropropane	78875	0.005
Di(2-ethylhexyl)-adipate	103231	0.4
Di(2-ethylhexyl)-phthalate	117817	0.006
Dinoseb	88857	0.007
Diquat	85007	0.02
Endothall	145733	0.1
Endrin	72208	0.002
Epichlorohydrin[5]	106898	Treatment Technique
Ethylbenzene	100414	0.7
Ethylene dibromide (EDB)[6]	106934	0.00002
Fluoride[7]	7782414	4.0
Glyphosate	1071536	0.7

SUBSTANCE	CASRN	MMCL (mg/L)
Haloacetic acids (HAA5) (for chlorinated supplies only): including monochloroacetic acid, dichloroacetic acid, trichloroacetic acid, bromoacetic acid and dibromoacetic acid	N/A	0.060
Heptachlor	76448	0.0004
Heptachlor epoxide	1024573	0.0002
Hexachlorobenzene	118741	0.001
Hexachlorocyclopentadiene	77474	0.05
Lead	7439921	Treatment Technique, 0.015 (Action Level)
Lindane	58899	0.0002
Mercury (inorganic)	7439976	0.002
Methoxychlor	72435	0.04
Nitrate (As N)	14797558	10
Nitrate/Nitrite (total)	N/A	10
Nitrite (As N)	14797650	1
Oxamyl (Vydate)	23135220	0.2
PCBs (Polychlorinated biphenyls)[8]	1336363	0.0005
Pentachlorophenol	87865	0.001
Perchlorate[9]		0.002
Picloram	1918021	0.5
Selenium	7782492	0.05
Simazine	122349	0.004
Styrene	100425	0.1
2,3,7,8-TCDD (Dioxin)	1746016	3×10^{-8}
Tetrachloroethylene	127184	0.005
Thallium	7440280	0.002
Toluene	108883	1

SUBSTANCE	CASRN	MMCL (mg/L)
Total trihalomethanes (for chlorinated supplies only)	N/A	0.080
Including: Chloroform	67663	N/A[10]
Chlorodibromomethane	124481	N/A
Bromodichloromethane	75274	N/A
Bromoform	75252	N/A
Toxaphene	8001352	0.003
2,4,5-TP (Silvex)	93721	0.05
1,2,4-Trichlorobenzene	120821	0.07
1,1,1-Trichloroethane	71556	0.2
1,1,2-Trichloroethane	79005	0.005
Trichloroethylene	79016	0.005
Vinyl chloride	75014	0.002
Xylenes (total)	1330207	10

[1] No numerical MCL is provided for these compounds. If detected, a treatment technique is specified. Each water system must certify, in writing, to the state (using third-party or manufacturer's certification) that when acrylamide and epichlorohydrin are used in drinking water systems, the combination (or product) of dose and monomer level does not exceed the levels specified, as follows:

- Acrylamide = 0.05% dosed at 1 mg/L (or equivalent)
- Epichlorohydrin = 0.01% dosed at 20 mg/L (or equivalent)

[2] For fibers longer than 10 microns.

[3] MRDL = maximum residual disinfectant level - the highest level of a disinfectant allowed in drinking water. There is convincing evidence that addition of a disinfectant is necessary for control of microbial contaminants.

[4] The MMCL for this chemical is more stringent than the federal MCL.

[5] See footnote 1 above.

[6] See footnote 4 above.

[7] The U.S. Environmental Protection Agency (US EPA) completed a scientific assessment of fluoride in response to a 2006 National Academy of Sciences (NAS) report recommending that US EPA update its fluoride health and exposure assessments to take into account bone and dental effects and to consider all sources of fluoride. Based upon the NAS and US EPA information and its own independent assessment, the U.S. Health and Human Services (HHS) recently recommended lowering the non-regulatory HHS limit for fluoride in drinking water to 0.7 mg/L, the lowest end of its previous recommended range of

0.7-1.2 mg/L. US EPA is currently considering whether to lower its fluoride MCL of 4 mg/L. (http://www.hhs.gov/news/press/2011pres/01/20110107a.html).
[8] The MCL for PCBs applies to the decachlorobiphenyl species.
[9] The MCL is directed at the sensitive subgroups of pregnant women, infants, children up to the age of 12, and individuals with hypothyroidism. They should not consume drinking water containing concentrations of perchlorate exceeding 2 µg/L. MassDEP recommends that no one consume water containing perchlorate concentrations greater than 18 µg/L.
[10] Not applicable

Please note that drinking water guidance is contained in five separate lists, in the following order:
(1) Massachusetts Maximum Contaminant Levels – Inorganic/Organics; (2) Massachusetts Maximum Contaminant Levels – Radionuclides;
(3) Massachusetts Maximum Contaminant Levels – Biologicals; (4) Massachusetts Drinking Water Guidelines (ORSG);
(5) Secondary Maximum Contaminant Levels

SUBSTANCE	**CASRN**	**TYPE OF GUIDANCE**	**MMCL (mg/L)**
Beta particle and photon radioactivity	N/A	MMCL	concentration which produces an annual dose of 4 millirem/yr
Gross alpha radiation	N/A	MMCL	15 pCi/L
Radium (226 + 228)	7440144	MMCL	5 pCi/L
Radon-222[1]	14859677	ORSG	10,000 pCi/L (ORSG)
Uranium	7440611	MMCL	0.030

[1] Exceedance of this guideline indicates that indoor air sampling for Radon-222 should be done. US EPA proposed guidelines for radon (64 FR 211; Tuesday, November 2, 1999) which have not been finalized.

Please note that drinking water guidance is contained in five separate lists, in the following order:
(1) Massachusetts Maximum Contaminant Levels – Inorganic/Organics; (2) Massachusetts Maximum Contaminant Levels – Radionuclides;
(3) Massachusetts Maximum Contaminant Levels – Biologicals; (4) Massachusetts Drinking Water Guidelines (ORSG);
(5) Secondary Maximum Contaminant Levels

SUBSTANCE	CASRN	MMCL
Cryptosporidium	N/A	Treatment Technique
Giardia lamblia	N/A	Treatment Technique
Heterotrophic plate count	N/A	Treatment Technique
Legionella	N/A	Treatment Technique
Total coliform bacteria (including fecal coliform and *E. coli*)	N/A	refer to 310 CMR 22.05
Turbidity	N/A	Treatment Technique
Viruses (enteric)	N/A	Treatment Technique

Please note that drinking water guidance is contained in five separate lists, in the following order:
(1) Massachusetts Maximum Contaminant Levels – Inorganic/Organics; (2) Massachusetts Maximum Contaminant Levels – Radionuclides; (3) Massachusetts Maximum Contaminant Levels – Biologicals; (4) Massachusetts Drinking Water Guidelines (ORSG); (5) Secondary Maximum Contaminant Levels

SUBSTANCE	CASRN	ORSG (mg/L)
Acetone	67641	6.3
Aldicarb[1]	116063	0.003
Aldicarb sulfone[2]	1646884	0.002
Aldicarb sulfoxide[3]	1646873	0.004
Bromomethane	74839	0.01
Chloroform[4]	67663	0.07
Dichlorodifluoromethane	75718	1.4
1,1-Dichloroethane	75343	0.07
1,3-Dichloropropene	542756	0.0004
1,4-Dioxane	123911	0.0003
Ethylene glycol	107211	14
Manganese[5]	7439965	see endnote
Methyl ethyl ketone	78933	4.0
Methyl isobutyl ketone	108101	0.35
Methyl *tertiary* butyl ether[6]	1634044	0.07
Metolachlor	51218452	0.1
Naphthalene	91203	0.140
Nickel[7]	7440020	0.1
n-Nitrosodimethylamine (NDMA)	62759	0.00001

SUBSTANCE	CASRN	ORSG (mg/L)
Petroleum hydrocarbons[8]	N/A	
TPH		0.2
Aliphatics		
C_5-C_8		0.3
C_9-C_{12}[9]		0.7
C_9-C_{18}[10]		0.7
C_{19}-C_{36}		14.0
Aromatics		
C_6-C_8		use guidance for individual chemicals
C_9-C_{10}		0.2
C_{11}-C_{22}		0.2
Sodium[11]	7440235	20
Tertiary-Amyl Methyl Ether (TAME)	994058	0.09
Tertiary Butyl Alcohol (TBA)	75650	0.12
Tetrahydrofuran[12]	109999	1.3
1,1,2-Trichloro-1,2,2-trifluoroethane (FREON 113)	76131	210

All guidelines are current with the information listed in IRIS as of May 1, 2012 except where noted.

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[1] The MCLs for aldicarb, aldicarb sulfone and aldicarb sulfoxide have been stayed.
[2] See footnote 1above.
[3] See footnote 1 above.
[4] This guideline applies to non-chlorinated water supplies. For chlorinated drinking water supplies, please contact the Drinking Water Program.
[5] See Secondary Maximum Contaminant Level listing on p. 14 and US EPA Health Advisory reference and modification on p. 15.
[6] The health-based guideline for MTBE was reviewed by ORS in 2000.
[7] The MCL for Nickel has been remanded and is no longer in effect, however the current US EPA IRIS chronic oral reference dose for soluble salts of nickel (http://www.epa.gov/iris/subst/0271.htm) supports this value and it is also the currently listed US EPA Life-time Health Advisory value (http://www.epa.gov/waterscience/criteria/drinking/standards/dwstandards.pdf).
[8] Monitoring for these compounds is not required but is done on a case-by-case basis. These limits may be used when evaluating health risks posed by clearly identified mixtures of petroleum hydrocarbon compounds. The analytical methods to use to generate data to compare to the Drinking Water Guidelines are the Volatile Petroleum Hydrocarbon (VPH) and the Extractable Petroleum Hydrocarbon (EPH) methods developed by the MassDEP (MassDEP 1998).
[9] The overlap in the C_9-C_{12} range is the result of the VPH and EPH analytical methods used to quantitate these ranges of petroleum hydrocarbons in drinking water. The choice of the most appropriate range to use is based on the identity of the petroleum product of concern and is therefore determined on a case-specific basis.
[10] See footnote 9 above.
[11] All detections of sodium must be reported. Please refer to 310 CMR 22.06A for the specific requirements. The sodium guideline of 20 mg/L is based on an eight (8) ounce serving.
[12] IRIS has updated the toxicity values for tetrahydrofuran. They are currently under review by ORS.

SECONDARY MAXIMUM CONTAMINANT LEVELS

Please note that drinking water guidance is contained in five separate lists, in the following order:
(1) Massachusetts Maximum Contaminant Levels – Inorganic/Organics; (2) Massachusetts Maximum Contaminant Levels – Radionuclides;
(3) Massachusetts Maximum Contaminant Levels – Biologicals; (4) Massachusetts Drinking Water Guidelines (ORSG);
(5) Secondary Maximum Contaminant Levels

Chemicals/Parameter	Status	SMCL (mg/L)
Aluminum	F[1]	0.05 to 0.2
Chloride	F	250
Color	F	15 Color Units
Copper	F	1.0
Corrosivity	F	non-corrosive
Fluoride	F	2.0
Foaming agents	F	0.5
Iron	F	0.3
Manganese	F	0.05
Methyl *tertiary* butyl ether[2]	A[3]	0.020-0.040
Odor	F	3 threshold odor numbers
pH[4]	F	6.5 - 8.5
Silver	F	0.10
Sulfate	F	250[5]
Total dissolved solids (TDS)	F	500
Zinc	F	5

Secondary Standards are referenced in the Massachusetts Drinking Water Regulations (310 CMR 22.07 (d)).

[1] Final
[2] The secondary MCL for MTBE is based on the Drinking Water Advisory set by US EPA and is based on taste and odor considerations.
[3] Advisory
[4] This range of values is set to avoid adverse aesthetic impacts. Alternate system-specific values for pH may be generated for other program areas (e.g., Lead and Copper Rule water quality parameters; Immediate Action Level for Water Treatment Plant Chemicals).
[5] An MCL of 500 mg/L has been proposed by US EPA (Federal Register 12/20/94).

A tabular compilation of **US EPA Health Advisories may be obtained at: http://water.epa.gov/action/advisories/drinking/upload/dwstandards2012.pdf.

**Notation Regarding Manganese: The lifetime Health Advisory for manganese contains a precautionary statement that "*for infants younger than 6 months, the lifetime Health Advisory of 0.3 mg/L be used even for an acute exposure of 10 days, because of the concerns for differences in manganese content in human milk and formula and the possibility of a higher absorption and lower excretion in young infants*." MassDEP is extending that age to one year out of concerns for formula use up to that age and the potential susceptibility of this early life stage to excessive manganese exposure and potential resultant toxicity.

Appendix D

WRIGHT-PIERCE
Engineering a Better Environment™

AWWA Benchmark Responses

Orleans Water Utility Benchmark Responses

Updated: 10/8/2013

		FY2012	FY2013
1) OSHA Form 300A Summary of Work-Related Injuries and Illnesses.	**Total**	**0**	**0**
Injury — Maintenance/Distribution			
Treatment/Resources			
Administration/Billing			
Illness — Maintenance/Distribution			
Treatment/Resources			
Administration/Billing			
2) Total Hours Worked by Employees. If the actual number of hours worked by employees is not available my intentions were to presume (X FTEs x 40 hours per week x 52 weeks) – (X FTEs x 8 hours x 10 Holidays) – (X FTEs x 80 hours, two week vacation average) = YY,YYY actual hours worked.	**Total**	**14,233**	**15,033**
Maintenance/Distribution		5,189	7,116
Treatment/Resources		3,583	3,154
Administration/Billing		5,461	4,763
3) Total Number of Customer Service Complaints logged by Utility. Billing, activation / shut-offs, communications.	**Total**	**40**	**40**
Maint./Dist. (Shut-off Complaints Only)		0	0
Treatment/Resources (Complaints About Incorrect Analyses Only)		0	0
Administration/Billing		40	40
Billing			
Activation (Complaints re. Problems with Activation, only)			
Shut-offs (Complaints About Errors, only)			
Transfers (Complaints About Errors, only)			
4) Total Number of Technical Quality Complaints logged by Utility. Water quality, pressure, taste and odor, service, facilities maintenance.	**Total**	**14**	**13**
Maintenance/Distribution - Pressure		5	7
Quality (Taste, Odor, Color)		4	4
Facilities (Hydrant Problem, Missing Stop Cover, etc.)		1	0
Responsiveness		0	0
Treatment/Resources		0	0
Administration/Billing		4	2
5) <u>Planned</u> Disruption of Service. Number of customers who experienced a planned disruption of service in the fiscal year of record.	**Total**	**2**	**0**
Administration: Non-payment		0	0
Meters			
Maintenance/Distribution - Less than 20 psi Pressure		0	0
Complete loss of water during new construction, valve / hydrant replacement requiring a shutdown		1	0
Service Replacement		1	0
6) <u>Unplanned</u> Disruption of Service. Number of customers who experienced an unplanned disruption of service in the fiscal year of record.	**Total**	**12**	**13**
Emergency repairs on the utility infrastructure		12	13
Service shutdowns on private side due to a leak		0	0
Complete loss of water or pressure below 20 psi resulting from a water main break			
7) Total Customer Service Costs. They are defined as direct salaries, employee benefits including contracts that are associated with the following services provided by the utility.	**Total**	**$110,910**	**$115,350**
a) Activation of New Accounts		$5,926	$6,698
b) Meter Reads, Repair and Replacement		$74,292	$74,008
c) Preparation and Delivery of Billings		$5,926	$6,698
d) Receipt and Processing of Payments		$5,926	$6,698
e) Records Maintenance		$5,926	$6,698
f) Collection of Delinquent Accounts		$5,926	$6,698
g) Processing of Bankruptcies		$0	$0
h) Activate / Terminate Service		$0	$0
i) Handling of Customer Complaints		$5,926	$6,698
j) Preparation of the Consumer Confidence Report		$1,062	$1,154
8) Billing Errors. Number of adjustments made to bills found to be erroneously issued to customer.	**Total**	**1**	**5**

9) Total Liabilities. Liabilities include outstanding bonds, long-term debt, short-term debt, payments owed to other entities, accounts payable and deposits collected from customers.	**Total**	**$3,845,083**	**$4,151,684**
10) Total Assets. Assets are both tangible and intangible. Accounts receivable, cash, inventories, service delivery facilities minus depreciation, cost of easements and water rights, other items of value.	**Total**	**$15,345,126**	**$15,923,731**
11) Annual Metered Use + Authorized Unbilled Use (MG). Authorized unbilled would be hydrant flushing, swimming pools, rinks, City crew construction perhaps.	**Total**	**284**	**310**
12) Annual Metered Residential Use (MG).	**Total**	**224**	**249**
13) Water Rates. $/100 cu ft.	**Unit Cost**	**$3.97**	**$3.91**
14) Annual treated water production (MG). Totalized volume as measured by plant finished water meter.	**Total**	**318**	**325**
15) Annual chemical costs for treatment and distribution.	**Total**	**$62,383**	**$61,463**
16) Annual labor costs for source protection and treatment.	**Total**	**$91,800**	**$95,200**
17) Annual power costs to produce and distribute treated water.	**Total**	**$108,651**	**$106,408**
18) Annual labor costs to maintain and distribute treated water.	**Total**	**$148,584**	**$189,178**
19) Annual labor costs for administration, billing and finance.	**Total**	**$180,653**	**$164,963**
20) Compliance Days. Number of days public water system was in compliance with State and Federal regulations. Information queried from EPA SDWIS.	**Total**	**365**	**365**
21) Number of Water Main Breaks and Service Leaks.	**Total**	**12**	**13**
22) Annual Operations and Maintenance Expenses.	**Total**	**$882,626**	**$882,626**
23) Planned and Corrective Maintenance. Number of hours spent performing predictive / preventative and responsive maintenance on assets.	**Total**	**160**	**170**
24) Number of Full-Time Equivalents (FTEs). Includes Resource Protection, Treatment, Distribution, Administration, Finance, Management.	**Total**	**9**	**9**
25) Number of Water Service Connections. Includes Industrial, Commercial, Institutional, Governmental, Residential Customers.	**Total**	**5,187**	**5,242**
26) Population Served. Taken from EPA SDWIS.	**Total**	**10,326**	**10,326**
27) Number of Delinquent Accounts. Includes Industrial, Commercial, Institutional, Governmental, Residential Customers.	**Total**	**587**	**628**
28) Number of Liened Properties. Includes Industrial, Commercial, Institutional, Governmental, Residential Customers.	**Total**	**0**	**0**
29) Household Median Income (HMI). Taken from 2010 US Census Statistics.	**HMI**	**$42,594**	**$42,594**
30) Number of Water Meters Replaced. Includes Industrial, Commercial, Institutional, Governmental, Residential Customers.	**Total**	**169**	**189**
31) Percent of Water Main replaced each year.	**Percent**	**1**	**1**
32) Number of Water Quality Bleeders in Distribution System.	**Total**	**0**	**0**
33) Miles of Transmission and Distribution Pipe.	**Total**	**106**	**108**

BENCHMARK CHARTS AND INDICIES

Performance Metric	Orleans			Northeast			National (10,001 - 50,000)		
	FY2011	FY2012	Average	Top Quartile	Median	Bottom Quartile	Top Quartile	Median	Bottom Quartile
Organizational Development									
Strategic Planning	4.0	4.0	4.0	4.0	4.0	4.0	4.3	4.0	3.8
Long-Term Finance Planning	5.0	5.0	5.0	5.0	4.0	3.3	5.0	4.0	4.0
Risk Management Planning	4.0	4.0	4.0	4.0	4.0	4.0	4.0	3.5	3.0
Optimized Asset Planning	3.5	3.5	3.5	3.8	3.0	2.3	4.0	3.0	2.0
Performance Measurement	4.0	4.0	4.0	4.0	4.0	3.0	3.0	2.0	1.8
Customer Involvement	3.0	3.0	3.0	4.0	3.0	3.0	3.0	2.5	1.0
Continuous Improvement	4.0	4.0	4.0	4.0	3.0	3.0	4.3	3.0	2.0
Health and Safety Severity Rate (200,000* Total Work Days Away from Work) / Total Hours by Employees	0	0	0.0	32.0	116.0	150.0	203.0	322.0	562.0
Customer Accts per Employee (#/FTEs)	576.3	582.4	579.4	744.0	528.0	400.0	576.0	439.5	355.3
Water Delivered Per Employee (MG/FTEs)	0.10	0.10	0.10	0.30	0.29	0.18	0.25	0.17	0.13
Customer Relations									
Customer Service Complaint Rate (1000*Customer Service Complaints / No. of Accounts)	7.70	7.63	7.67	1.13	15.29	191.44	0.86	3.64	20.35
Technical Quality Complaint Rate (1000*Tech Quality Complaints / No. of Accounts)	2.70	2.48	2.59	1.47	3.23	7.45	1.49	8.53	41.96
Planned Disruption Rate (1000*Unplanned Service Disruptions / No. of Accounts)	0.39	0.00	0.20	0.68	0.81	3.11	0.65	0.92	1.39
Unplanned Disruption Rate (1000*Unplanned Service Disruptions / No. of Accounts)	0.23	0.25	0.24	0.58	0.90	2.77	1.00	1.00	1.00
Residential Cost of Water (7,500 gal/month*User Rate, $)	39.80	39.20	39.50	25.51	28.72	42.00	28.24	39.68	42.78
Water Bill % of HMI - 7,500 gallons per month (%)	1.12	1.10	1.11	-	-	-	-	-	-
Customer Service Cost per Account ($/# Accts)	21.38	22.00	21.69	21.17	27.67	38.07	35.11	42.95	84.94
Billing Accuracy per 10,000 Bills	0.48	2.38	1.43	2.85	5.80	41.65	2.70	8.80	19.18
Water Operations									
Drinking Water Compliance Rate (%)	100.0	100.0	100.0	100.0	100.0	100.00	100.0	100.0	100.00
Distribution System Water Loss Rate (%)	10.7	4.6	7.7	12.2	19.4	26.79	3.3	5.2	19.60
Breaks / Leaks per mi. of pipe (#/mi.)	11.3	12.0	11.7	21.8	48.5	60.50	20.0	39.0	72.25
Total O&M Unit Costs ($/# Accts)	170.1	168.4	169.3	256.0	335.0	431.00	341.0	504.0	571.00
Total O&M Unit Costs ($/MG)	2776	2716	2746.0	2002.0	2558.0	3628.00	2379.0	3176.0	3795.00
Direct Cost of Treatment ($/MG)	460	460	460.0	346.0	614.0	720.00	312.0	434.0	775.00
Chemical Unit Costs ($/MG)	196	189	192.5	-	-	-	-	-	-
Power Unit Costs ($/MG)	342	327	334.5	-	-	-	-	-	-
Labor Unit Costs ($/MG)	1617	1584	1600.5	-	-	-	-	-	-
Residential Water Usage (gpcd)	59	66	62.5	-	-	-	-	-	-
Business Operations									
Debt Ratio (Liabilities / Assets)	0.25	0.26	0.26	0.32	0.38	0.65	0.24	0.39	0.46
Distribution Renewal / Replacement Rate (%)	1.00	1.00	1.00	3.00	1.60	0.80	6.40	5.70	1.40
Treatment and Pumping Renewal / Replacement Rate (%)	2.00	2.00	2.00	11.10	1.40	0.60	35.00	6.50	2.50
Return on Assets (%)	2.20	2.20	2.20	3.70	2.30	0.40	2.85	2.10	0.55
Delinquent Account Percent (%)	11.3	11.9	11.6	-	-	-	-	-	-
Liened Account Percent (%)	0.0	0.0	0.0	-	-	-	-	-	-

Appendix E

DISTRIBUTION BRE

Water Distribution System Business Risk Exposure Matrix

GIS Object ID	Street Name		Asset Life Consumed	Material	Repair History	Static Pressure	Soil Type	Freezing Potential	Saltwater Intrusion	Likelihood of Failure	Business Interruption	Traffic Issues	Fire Protection Disruption	Consequence of Failure	Business Risk Exposure
			0.4	0.1	0.15	0.1	0.1	0.05	0.1	1-10	0.2	0.3	0.5	1-10	LoF*CoF
676	CRANBERRY HIGHWAY		5.3	5	10	3	10	5	1	5.8	10	7	5	6.6	38.1
109	ELDREDGE PARK WAY		5.3	5	1	2	10	1	1	4.1	10	7	10	9.1	37.5
680	CRANBERRY HIGHWAY		5.3	5	2.5	3	10	5	10	5.5	10	7	5	6.6	36.6
65	MAIN STREET		5.3	5	1	3	10	2	10	5.2	10	3	8	6.9	35.7
41	CRANBERRY HIGHWAY		5.3	5	1	3	10	2	1	4.3	10	7	8	8.1	34.6
42	CRANBERRY HIGHWAY		5.3	5	1	3	10	2	1	4.3	10	7	8	8.1	34.6
59	CRANBERRY HIGHWAY		5.3	5	1	3	10	2	1	4.3	10	7	8	8.1	34.6
60	CRANBERRY HIGHWAY		5.3	5	1	3	10	2	1	4.3	10	7	8	8.1	34.6
61	CRANBERRY HIGHWAY		5.3	5	1	3	10	2	1	4.3	10	7	8	8.1	34.6
82	RAMP-RT 6 EB TO RT 6A		5	5.5	1	2	10	2	1	4.1	10	7	8	8.1	33.2
108	ELDREDGE PARK WAY		5.3	5	1	3	10	1	1	4.2	10	3	10	7.9	33.3
113	ELDREDGE PARK WAY		5.3	5	1	3	10	1	1	4.2	10	3	10	7.9	33.3
679	CRANBERRY HIGHWAY		5.3	5	2.5	4	1	5	10	4.7	10	7	5	6.6	31.3
677	SOUTH ORLEANS ROAD		5.3	5	1	3	10	5	1	4.4	10	7	5	6.6	29.2
794	SOUTH ORLEANS ROAD		5.3	5	1	3	10	5	1	4.4	10	7	5	6.6	29.2
62	MAIN STREET		5.3	5	1	3	10	2	1	4.3	10	3	8	6.9	29.5
936	CRANBERRY HIGHWAY		3.7	1	1	4	10	5	10	4.4	10	7	5	6.6	28.9
107	LOTS HOLLOW ROAD		5.3	5	1	2	10	1	1	4.1	10	1	10	7.3	30.1
115	LOTS HOLLOW ROAD		5.3	5	1	2	10	1	1	4.1	10	1	10	7.3	30.1
662	SOUTH ORLEANS ROAD		5.3	5	2.5	3	10	5	1	4.6	10	3	5	5.4	25.1
57	MAIN STREET		5.3	5	1	3	10	2	10	5.2	1	3	8	5.1	26.4
80	0		5	5.5	1	3	10	2	1	4.2	1	7	8	6.3	26.5
661	SOUTH ORLEANS ROAD		5.3	5	1	3	10	5	1	4.4	10	3	5	5.4	23.9
670	MAIN STREET		5.3	5	1	3	10	5	1	4.4	10	3	5	5.4	23.9
899	MAIN STREET		5.3	5	1	3	10	5	1	4.4	10	3	5	5.4	23.9
105	SOUTH ORLEANS ROAD		5.3	5	1	3	10	1	1	4.2	1	3	10	6.1	25.7
106	TONSET ROAD		5.3	5	1	3	10	1	1	4.2	1	3	10	6.1	25.7
68	LOTS HOLLOW ROAD		4.3	5	2.5	2	10	2	1	4.0	10	1	8	6.3	25.2
55	FINLAY ROAD		4.1	5	1	3	10	2	1	3.8	10	1	8	6.3	23.9
900	FINLAY ROAD		4.1	5	1	2	10	2	1	3.7	10	1	8	6.3	23.2
902	FINLAY ROAD		4.1	5	1	2	10	2	1	3.7	10	1	8	6.3	23.2
929	MAIN STREET		5.3	5	1	3	10	2	1	4.3	1	3	8	5.1	21.8
930	MAIN STREET		5.3	5	1	3	10	2	1	4.3	1	3	8	5.1	21.8
361	OLD STATE HIGHWAY		5	5.5	1	4	1	7	1	3.7	10	7	3	5.6	20.4
667	WEST ROAD		5.3	5	1	3	10	5	1	4.4	10	1	5	4.8	21.2
668	WEST ROAD		5.3	5	1	3	10	5	1	4.4	10	1	5	4.8	21.2
818	SOUTH ORLEANS ROAD		5.3	5	1	3	10	5	1	4.4	10	1	5	4.8	21.2
35	MAIN STREET		5	5.5	1	3	10	2	1	4.2	1	3	8	5.1	21.4
36	MAIN STREET		5	5.5	1	3	10	2	1	4.2	1	3	8	5.1	21.4
678	0		5	5.5	1	4	1	5	10	4.5	10	1	5	4.8	21.4
751	0		5	5.5	1	4	1	5	10	4.5	10	1	5	4.8	21.4
876	ROCK HARBOR ROAD		5	5.5	1	4	1	5	10	4.5	1	7	5	4.8	21.4
116	0		5.3	5	1	2	10	1	1	4.1	1	1	10	5.5	22.7
650	CRANBERRY HIGHTWAY		5	5.5	1	3	10	5	1	4.4	1	7	5	4.8	20.9
800	0		5	5.5	1	3	10	5	1	4.4	10	1	5	4.8	20.9
808	0		5	5.5	1	3	10	5	1	4.4	10	1	5	4.8	20.9
898	MAIN STREET		5	5.5	1	3	10	5	1	4.4	10	1	5	4.8	20.9
624	OLD COLONY WAY		5	5	1	3	10	5	1	4.3	10	1	5	4.8	20.6

Water Distribution System Business Risk Exposure Matrix

GIS Object ID	Street Name		Asset Life Consumed	Material	Repair History	Static Pressure	Soil Type	Freezing Potential	Saltwater Intrusion	Likelihood of Failure	Business Interruption	Traffic Issues	Fire Protection Disruption	Consequence of Failure	Business Risk Exposure
939	BAKERS POND ROAD		3.7	1	1	3	10	2	1	3.2	1	7	8	6.3	20.3
972	SOUTH ORLEANS ROAD		5.3	5	7.5	4	1	5	10	5.5	1	3	5	3.6	19.8
75	0		2.7	1	1	3	10	2	1	2.8	10	3	8	6.9	19.5
76	MAIN STREET		2.7	1	1	3	10	2	1	2.8	10	3	8	6.9	19.5
77	MAIN STREET		2.7	1	1	3	10	2	1	2.8	10	3	8	6.9	19.5
448	0		3.5	1	1	3	10	5	1	3.3	10	3	5	5.4	17.8
812	OCONNOR WAY		4.3	5	1	2	10	5	1	3.9	10	1	5	4.8	18.8
795	MAIN STREET		5.3	5	5	3	10	5	1	5.0	1	3	5	3.6	18.1
545	BRIAR SPRINGS ROAD		5.3	5	10	3	10	5	10	6.7	1	1	5	3.0	20.0
49	SOUTH ORLEANS ROAD		5.3	5	2.5	3	1	2	1	3.6	1	3	8	5.1	18.3
53	GIDDIAH HILL ROAD		2.9	1	1	3	10	2	1	2.9	10	1	8	6.3	18.3
54	GIDDAH HILL ROAD		2.9	1	1	3	10	2	1	2.9	10	1	8	6.3	18.3
43	BEACH ROAD		5.3	5	1	3	10	2	1	4.3	1	1	8	4.5	19.2
58	MONUMENT ROAD		5.3	5	1	3	10	2	1	4.3	1	1	8	4.5	19.2
63	BREWSTER CROSS ROAD		5.3	5	1	3	10	2	1	4.3	1	1	8	4.5	19.2
64	BREWSTER CROSS ROAD		5.3	5	1	3	10	2	1	4.3	1	1	8	4.5	19.2
70	CAPE COD RAIL TRAIL		5	5.5	1	4	10	2	1	4.3	1	1	8	4.5	19.4
71	CAPE COD RAIL TRAIL		5	5.5	1	4	10	2	1	4.3	1	1	8	4.5	19.4
92	CAPE COD RAIL TRAIL		5	5.5	1	4	10	2	1	4.3	1	1	8	4.5	19.4
73	0		2.8	1	1	2	10	2	1	2.8	10	1	8	6.3	17.5
74	0		2.8	1	1	2	10	2	1	2.8	10	1	8	6.3	17.5
81	BREWSTER CROSS ROAD		5	5.5	1	3	10	2	1	4.2	1	1	8	4.5	18.9
373	0		5	5.5	1	3	10	7	1	4.5	10	1	3	3.8	16.9
374	ELDREDGE PARK WAY		5	5.5	1	3	10	7	1	4.5	10	1	3	3.8	16.9
627	MID CAPE HIGHWAY		5.3	5	7.5	3	10	5	10	6.3	1	1	5	3.0	18.9
39	SOUTH ORLEANS ROAD		5.3	5	1	3	1	2	1	3.4	1	3	8	5.1	17.2
44	SOUTH ORLEANS ROAD		5.3	5	1	3	1	2	1	3.4	1	3	8	5.1	17.2
45	SOUTH ORLEANS ROAD		5.3	5	1	3	1	2	1	3.4	1	3	8	5.1	17.2
50	SOUTH ORLEANS ROAD		5.3	5	1	3	1	2	1	3.4	1	3	8	5.1	17.2
56	SOUTH ORLEANS ROAD		5.3	5	1	3	1	2	1	3.4	1	3	8	5.1	17.2
89	QUANSET ROAD		5.3	5	1	3	1	2	1	3.4	1	3	8	5.1	17.2
927	SOUTH ORLEANS ROAD		5.3	5	1	3	1	2	1	3.4	1	3	8	5.1	17.2
928	SOUTH ORLEANS ROAD		5.3	5	1	3	1	2	1	3.4	1	3	8	5.1	17.2
375	LOTS HOLLOW ROAD		5.1	5	1	2	10	7	1	4.3	10	1	3	3.8	16.5
872	ROCK HARBOR ROAD		5.3	5	2.5	3	10	5	1	4.6	1	3	5	3.6	16.7
17	0		2.8	1	1	3	10	3	1	2.9	10	1	7	5.8	16.9
118	0		5.1	5	1	3	1	1	1	3.2	1	1	10	5.5	17.8
121	0		5.1	5	1	3	1	1	1	3.2	1	1	10	5.5	17.8
946	0		5.2	5	1	2	1	1	1	3.2	1	1	10	5.5	17.5
475	0		3.6	1	1	3	10	5	1	3.3	10	1	5	4.8	16.0
784	0		3.6	1	1	3	10	5	1	3.3	10	1	5	4.8	16.0
785	0		3.6	1	1	3	10	5	1	3.3	10	1	5	4.8	16.0
786	0		3.6	1	1	3	10	5	1	3.3	10	1	5	4.8	16.0
787	0		3.6	1	1	3	10	5	1	3.3	10	1	5	4.8	16.0
788	0		3.6	1	1	3	10	5	1	3.3	10	1	5	4.8	16.0
99	ROCK HARBOR ROAD		1.9	1	5	4	10	2	10	4.1	1	1	8	4.5	18.5
566	SOUTH ORLEANS ROAD		5.3	5	1	3	1	5	10	4.4	1	3	5	3.6	15.9
674	SOUTH ORLEANS ROAD		5.3	5	1	3	10	5	1	4.4	1	3	5	3.6	15.9
656	0		3	1	2.5	3	10	5	1	3.3	10	1	5	4.8	16.0

Water Distribution System Business Risk Exposure Matrix

GIS Object ID	Street Name		Asset Life Consumed	Material	Repair History	Static Pressure	Soil Type	Freezing Potential	Saltwater Intrusion	Likelihood of Failure	Business Interruption	Traffic Issues	Fire Protection Disruption	Consequence of Failure	Business Risk Exposure
1	TONSET ROAD		5.3	5	1	3	10	3	1	4.3	1	1	7	4.0	17.3
2	TONSET ROAD		5.3	5	1	3	10	3	1	4.3	1	1	7	4.0	17.3
3	MEETINGHOUSE ROAD		5.3	5	1	3	10	3	1	4.3	1	1	7	4.0	17.3
4	MEETINGHOUSE ROAD		5.3	5	1	3	10	3	1	4.3	1	1	7	4.0	17.3
436	OLD STATE HIGHWAY		5	1	1	4	1	5	1	3.1	10	1	5	4.8	14.9
523	POCHET ROAD		5.3	5	10	3	10	5	1	5.8	1	1	5	3.0	17.3
526	CEDAR LAND ROAD		5.3	5	10	3	10	5	1	5.8	1	1	5	3.0	17.3
615	HOPKINS LANE		5.3	5	10	3	10	5	1	5.8	1	1	5	3.0	17.3
510	BEACH ROAD		5.3	5	10	2	10	5	1	5.7	1	1	5	3.0	17.0
88	SOUTH ORLEANS ROAD		4.6	5	1	3	1	2	1	3.1	1	3	8	5.1	15.8
20	SOUTH ORLEANS ROAD		4.6	5	2.5	3	1	3	1	3.4	1	3	7	4.6	15.5
414	0		4.4	5	1	4	1	5	1	3.3	10	1	5	4.8	15.6
415	0		4.4	5	1	4	1	5	1	3.3	10	1	5	4.8	15.6
416	0		4.4	5	1	4	1	5	1	3.3	10	1	5	4.8	15.6
417	0		4.4	5	1	4	1	5	1	3.3	10	1	5	4.8	15.6
418	0		4.4	5	1	4	1	5	1	3.3	10	1	5	4.8	15.6
419	0		4.4	5	1	4	1	5	1	3.3	10	1	5	4.8	15.6
420	0		4.4	5	1	4	1	5	1	3.3	10	1	5	4.8	15.6
422	0		4.4	5	1	4	1	5	1	3.3	10	1	5	4.8	15.6
428	0		4.4	5	1	4	1	5	1	3.3	10	1	5	4.8	15.6
429	0		4.4	5	1	4	1	5	1	3.3	10	1	5	4.8	15.6
790	0		3.1	1	1	3	10	5	1	3.1	10	1	5	4.8	15.1
895	SHORE VIEW DRIVE		5	5.5	2.5	3	10	5	10	5.5	1	1	5	3.0	16.4
655	0		3	1	1	3	10	5	1	3.1	10	1	5	4.8	14.9
539	POCHET ROAD		5.3	5	7.5	3	10	5	1	5.4	1	1	5	3.0	16.2
877	SEA BREEZE LANE		5	5.5	1	4	10	5	10	5.4	1	1	5	3.0	16.1
780	0		2.8	1	1	3	10	5	1	3.0	10	1	5	4.8	14.5
782	0		2.8	1	1	3	10	5	1	3.0	10	1	5	4.8	14.5
942	0		2.8	1	1	3	10	5	1	3.0	10	1	5	4.8	14.5
637	0		5	5.5	1	3	10	5	10	5.3	1	1	5	3.0	15.8
396	ROCK HARBOR ROAD		5.3	5	1	4	1	7	1	3.7	1	7	3	3.8	14.1
438	0		2.8	1	1	2	10	5	1	2.9	10	1	5	4.8	14.0
781	0		2.8	1	1	2	10	5	1	2.9	10	1	5	4.8	14.0
25	HARWICH ROAD		4.6	5	1	3	1	3	1	3.1	1	3	7	4.6	14.4
26	HARWICH ROAD		4.6	5	1	3	1	3	1	3.1	1	3	7	4.6	14.4
519	HARVEYS LANE		4.1	5	10	3	10	5	1	5.3	1	1	5	3.0	15.9
66	0		2.7	1	1	3	10	2	1	2.8	1	3	8	5.1	14.4
67	0		2.7	1	1	3	10	2	1	2.8	1	3	8	5.1	14.4
90	PORTANIMICUT ROAD		5.3	5	1	3	1	2	1	3.4	1	1	8	4.5	15.2
91	QUANSET ROAD		5.3	5	1	3	1	2	1	3.4	1	1	8	4.5	15.2
965	SOUTH ORLEANS ROAD		4.5	5	1	3	1	3	1	3.1	1	3	7	4.6	14.3
966	SOUTH ORLEANS ROAD		4.6	5	1	2	1	3	1	3.0	1	3	7	4.6	14.0
631	BLUEBERRY ISLAND ROAD		5	1	1	4	10	5	10	4.9	1	1	5	3.0	14.7
93	CAPE COD RAIL TRAIL		5	5.5	1	4	1	2	1	3.4	1	1	8	4.5	15.3
621	BRICK HILL ROAD		5.3	5	5	3	10	5	1	5.0	1	1	5	3.0	15.1
665	MONUMENT ROAD		5.3	5	5	3	10	5	1	5.0	1	1	5	3.0	15.1
27	FREEMANS WAY		4.4	5	1	3	1	3	1	3.1	1	3	7	4.6	14.1
367	0		3.6	1	1	3	10	7	1	3.4	10	1	3	3.8	13.1
85	0		5.1	5	1	3	1	2	1	3.3	1	1	8	4.5	14.8

Water Distribution System Business Risk Exposure Matrix

GIS Object ID	Street Name		Asset Life Consumed	Material	Repair History	Static Pressure	Soil Type	Freezing Potential	Saltwater Intrusion	Likelihood of Failure	Business Interruption	Traffic Issues	Fire Protection Disruption	Consequenc e of Failure	Business Risk Exposure
86	0		5.1	5	1	3	1	2	1	3.3	1	1	8	4.5	14.8
926	0		5.1	5	1	3	1	2	1	3.3	1	1	8	4.5	14.8
194	OLD STATE HIGHWAY		4.8	5	1	4	1	7	1	3.5	10	1	3	3.8	13.4
52	BAKERS POND ROAD		3.7	1	1	2	10	2	1	3.1	1	1	8	4.5	14.1
478	0		2.3	1	1	3	10	5	1	2.8	10	1	5	4.8	13.5
796	0		2.3	1	1	3	10	5	1	2.8	10	1	5	4.8	13.5
870	OLD COUNTY ROAD		2.2	1	1	4	1	5	10	2.9	10	1	5	4.8	13.8
632	CAPTAIN LINNELL ROAD		4.1	5	1	4	10	5	10	4.9	1	1	5	3.0	14.8
635	CAPTAIN LINNELL ROAD		4.1	5	1	4	10	5	10	4.9	1	1	5	3.0	14.8
938	RAMP-RT 6 EB TO RT 6A		3.1	1	1	3	1	2	1	2.1	1	7	8	6.3	13.2
684	0		5.3	5	2.5	4	10	5	1	4.7	1	1	5	3.0	14.2
117	0		4.1	1	1	3	1	1	1	2.4	1	1	10	5.5	13.4
122	0		4.1	1	1	3	1	1	1	2.4	1	1	10	5.5	13.4
973	SOUTH ORLEANS ROAD		5.2	5	1	3	1	5	1	3.5	1	3	5	3.6	12.5
505	BRICK HILL ROAD		5.3	5	2.5	3	10	5	1	4.6	1	1	5	3.0	13.9
506	GREAT OAK ROAD		5.3	5	2.5	3	10	5	1	4.6	1	1	5	3.0	13.9
525	UNCLE HARVEYS WAY		5.3	5	2.5	3	10	5	1	4.6	1	1	5	3.0	13.9
550	BARLEY NECK ROAD		5.3	5	2.5	3	10	5	1	4.6	1	1	5	3.0	13.9
559	SCHOOL ROAD		5.3	5	2.5	3	10	5	1	4.6	1	1	5	3.0	13.9
565	TAR KILN ROAD		5.3	5	2.5	3	1	5	10	4.6	1	1	5	3.0	13.9
591	PORTANIMICUT ROAD		5.3	5	2.5	3	1	5	10	4.6	1	1	5	3.0	13.9
606	NAUSET HEIGHTS ROAD		5.3	5	2.5	3	10	5	1	4.6	1	1	5	3.0	13.9
622	TONSET ROAD		5.3	5	2.5	3	10	5	1	4.6	1	1	5	3.0	13.9
675	COVE ROAD		5.3	5	2.5	3	10	5	1	4.6	1	1	5	3.0	13.9
722	MILL LANE		5.3	5	2.5	3	10	5	1	4.6	1	1	5	3.0	13.9
820	LOCUST ROAD		5.3	5	2.5	3	10	5	1	4.6	1	1	5	3.0	13.9
189	0		4.4	5	1	4	1	7	1	3.4	10	1	3	3.8	12.8
190	0		4.4	5	1	4	1	7	1	3.4	10	1	3	3.8	12.8
191	0		4.4	5	1	4	1	7	1	3.4	10	1	3	3.8	12.8
923	NAUSET HEIGHTS ROAD		5.3	5	2.5	2	10	5	1	4.5	1	1	5	3.0	13.6
945	0		5	1	1	2	1	2	1	2.8	1	1	8	4.5	12.4
518	0		5	5.5	2.5	3	10	5	1	4.6	1	1	5	3.0	13.7
801	CAPTAIN CURTIS WAY		5	5.5	2.5	3	10	5	1	4.6	1	1	5	3.0	13.7
13	SHOAL LANE		5	5.5	1	3	1	3	1	3.4	1	1	7	4.0	13.4
14	SHOAL LANE		5	5.5	1	3	1	3	1	3.4	1	1	7	4.0	13.4
15	BOULDER LANE		5	5.5	1	3	1	3	1	3.4	1	1	7	4.0	13.4
18	0		5	5.5	1	3	1	3	1	3.4	1	1	7	4.0	13.4
10	SHOAL LANE		5	5.5	1	3	1	3	1	3.4	1	1	7	4.0	13.4
11	LAKE DRIVE		5	5.5	1	3	1	3	1	3.4	1	1	7	4.0	13.4
12	BOULDER LANE		5	5.5	1	3	1	3	1	3.4	1	1	7	4.0	13.4
628	GULL LANE		5.3	5	1	4	1	5	10	4.5	1	1	5	3.0	13.6
683	CANAL ROAD		5.3	5	1	4	10	5	1	4.5	1	1	5	3.0	13.6
868	0		5.3	5	1	4	10	5	1	4.5	1	1	5	3.0	13.6
449	0		3.5	1	1	3	10	5	1	3.3	1	3	5	3.6	11.9
450	0		3.5	1	1	3	10	5	1	3.3	1	3	5	3.6	11.9
451	0		3.5	1	1	3	10	5	1	3.3	1	3	5	3.6	11.9
697	0		3.5	1	1	3	10	5	1	3.3	1	3	5	3.6	11.9
19	AREYS LANE		3.7	1	1	3	1	3	10	3.3	1	1	7	4.0	13.1
5	AREYS LANE		3.6	1	1	4	1	3	10	3.3	1	1	7	4.0	13.4

Water Distribution System Business Risk Exposure Matrix

GIS Object ID	Street Name		Asset Life Consumed	Material	Repair History	Static Pressure	Soil Type	Freezing Potential	Saltwater Intrusion	Likelihood of Failure	Business Interruption	Traffic Issues	Fire Protection Disruption	Consequence of Failure	Business Risk Exposure
9	HERRING BROOK WAY		3.7	1	1	3	1	3	10	3.3	1	1	7	4.0	13.1
493	NAUSET KNOLLS LANE		5.3	5	1	3	10	5	1	4.4	1	1	5	3.0	13.3
497	GREAT OAK ROAD		5.3	5	1	3	10	5	1	4.4	1	1	5	3.0	13.3
498	PINE RIDGE LANE		5.3	5	1	3	10	5	1	4.4	1	1	5	3.0	13.3
508	BEACH ROAD		5.3	5	1	3	10	5	1	4.4	1	1	5	3.0	13.3
514	BARLEY NECK ROAD		5.3	5	1	3	10	5	1	4.4	1	1	5	3.0	13.3
524	POCHET ROAD		5.3	5	1	3	10	5	1	4.4	1	1	5	3.0	13.3
527	UNCLE HARVEYS WAY		5.3	5	1	3	10	5	1	4.4	1	1	5	3.0	13.3
560	SCHOOL ROAD		5.3	5	1	3	10	5	1	4.4	1	1	5	3.0	13.3
584	MONUMENT ROAD		5.3	5	1	3	1	5	10	4.4	1	1	5	3.0	13.3
619	FREEMAN LANE		5.3	5	1	3	10	5	1	4.4	1	1	5	3.0	13.3
620	TONSET ROAD		5.3	5	1	3	10	5	1	4.4	1	1	5	3.0	13.3
625	SALTY RIDGE ROAD		5.3	5	1	3	10	5	1	4.4	1	1	5	3.0	13.3
666	POND ROAD		5.3	5	1	3	10	5	1	4.4	1	1	5	3.0	13.3
671	MAIN STREET		5.3	5	1	3	10	5	1	4.4	1	1	5	3.0	13.3
672	ACADEMY PLACE		5.3	5	1	3	10	5	1	4.4	1	1	5	3.0	13.3
673	ACADEMY PLACE		5.3	5	1	3	10	5	1	4.4	1	1	5	3.0	13.3
731	SALTY RIDGE ROAD		5.3	5	1	3	10	5	1	4.4	1	1	5	3.0	13.3
732	SALTY RIDGE ROAD		5.3	5	1	3	10	5	1	4.4	1	1	5	3.0	13.3
733	SKAKET BEACH ROAD		5.3	5	1	3	10	5	1	4.4	1	1	5	3.0	13.3
814	ROCK HARBOR ROAD		5.3	5	1	3	10	5	1	4.4	1	1	5	3.0	13.3
817	WEST ROAD		5.3	5	1	3	10	5	1	4.4	1	1	5	3.0	13.3
838	DOANE ROAD		5.3	5	1	3	10	5	1	4.4	1	1	5	3.0	13.3
847	SHORE VIEW DRIVE		5.3	5	1	3	10	5	1	4.4	1	1	5	3.0	13.3
850	BRIAR SPRINGS ROAD		5.3	5	1	3	10	5	1	4.4	1	1	5	3.0	13.3
975	BARLEY NECK ROAD		5.3	5	1	3	10	5	1	4.4	1	1	5	3.0	13.3
944	0		3	1	1	3	1	3	1	2.1	10	1	7	5.8	12.2
626	0		5	5.5	1	4	10	5	1	4.5	1	1	5	3.0	13.4
682	0		5	5.5	1	4	1	5	10	4.5	1	1	5	3.0	13.4
738	BLUEBERRY ISLAND ROAD		5	5.5	1	4	10	5	1	4.5	1	1	5	3.0	13.4
921	SOUTH ORLEANS ROAD		5	1	1	4	1	5	1	3.1	1	3	5	3.6	11.2
962	AREYS LANE		3.6	1	1	3	1	3	10	3.2	1	1	7	4.0	13.0
145	SAGES WAY		5	5.5	1	3	10	5	1	4.4	1	1	5	3.0	13.1
425	0		5	5.5	1	3	10	5	1	4.4	1	1	5	3.0	13.1
426	0		5	5.5	1	3	10	5	1	4.4	1	1	5	3.0	13.1
435	SKAKET BEACH ROAD		5	5.5	1	3	10	5	1	4.4	1	1	5	3.0	13.1
445	0		5	5.5	1	3	10	5	1	4.4	1	1	5	3.0	13.1
446	0		5	5.5	1	3	10	5	1	4.4	1	1	5	3.0	13.1
447	0		5	5.5	1	3	10	5	1	4.4	1	1	5	3.0	13.1
452	0		5	5.5	1	3	10	5	1	4.4	1	1	5	3.0	13.1
461	0		5	5.5	1	3	10	5	1	4.4	1	1	5	3.0	13.1
462	0		5	5.5	1	3	10	5	1	4.4	1	1	5	3.0	13.1
503	0		5	5.5	1	3	10	5	1	4.4	1	1	5	3.0	13.1
504	0		5	5.5	1	3	10	5	1	4.4	1	1	5	3.0	13.1
513	POCHET ROAD		5	5.5	1	3	10	5	1	4.4	1	1	5	3.0	13.1
528	BRIAR SPRINGS ROAD		5	5.5	1	3	10	5	1	4.4	1	1	5	3.0	13.1
529	BRIAR SPRINGS ROAD		5	5.5	1	3	10	5	1	4.4	1	1	5	3.0	13.1
540	SPARROWHAWK ROAD		5	5.5	1	3	10	5	1	4.4	1	1	5	3.0	13.1
542	SPARROWHAWK ROAD		5	5.5	1	3	10	5	1	4.4	1	1	5	3.0	13.1

Water Distribution System Business Risk Exposure Matrix

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638	CHASE LANE		5	5.5	1	3	10	5	1	4.4	1	1	5	3.0	13.1
639	CHASE LANE		5	5.5	1	3	10	5	1	4.4	1	1	5	3.0	13.1
641	0		5	5.5	1	3	10	5	1	4.4	1	1	5	3.0	13.1
649	0		5	5.5	1	3	10	5	1	4.4	1	1	5	3.0	13.1
660	SOUTH ORLEANS ROAD		5	5.5	1	3	10	5	1	4.4	1	1	5	3.0	13.1
753	CHICKADEE LANE		5	5.5	1	3	10	5	1	4.4	1	1	5	3.0	13.1
755	0		5	5.5	1	3	10	5	1	4.4	1	1	5	3.0	13.1
776	0		5	5.5	1	3	10	5	1	4.4	1	1	5	3.0	13.1
783	0		5	5.5	1	3	10	5	1	4.4	1	1	5	3.0	13.1
809	0		5	5.5	1	3	10	5	1	4.4	1	1	5	3.0	13.1
821	0		5	5.5	1	3	10	5	1	4.4	1	1	5	3.0	13.1
823	0		5	5.5	1	3	10	5	1	4.4	1	1	5	3.0	13.1
849	BRICK HILL ROAD		5	5.5	1	3	10	5	1	4.4	1	1	5	3.0	13.1
881	0		5	5.5	1	3	10	5	1	4.4	1	1	5	3.0	13.1
882	NAMSKAKET ROAD		5	5.5	1	3	10	5	1	4.4	1	1	5	3.0	13.1
775	TIDES END LANE		3.6	1	1	4	10	5	10	4.3	1	1	5	3.0	13.0
34	LOTS HOLLOW ROAD		2.9	1	1	2	10	2	1	2.8	1	1	8	4.5	12.6
405	ROCK HARBOR ROAD		5.3	5	7.5	4	10	7	10	6.5	1	1	3	2.0	13.0
532	WOODSNECK ROAD		3.6	1	1	3	10	5	10	4.2	1	1	5	3.0	12.7
533	WOODSNECK ROAD		3.6	1	1	3	10	5	10	4.2	1	1	5	3.0	12.7
549	ORIE LANE		3.6	1	1	3	10	5	10	4.2	1	1	5	3.0	12.7
845	TIDES END LANE		3.6	1	1	3	10	5	10	4.2	1	1	5	3.0	12.7
846	TIDES END LANE		3.6	1	1	3	10	5	10	4.2	1	1	5	3.0	12.7
875	CAPTAIN DOANES WAY		3.6	1	1	3	10	5	10	4.2	1	1	5	3.0	12.7
771	0		3.5	1	1	3	10	5	10	4.2	1	1	5	3.0	12.6
844	0		3.5	1	1	3	10	5	10	4.2	1	1	5	3.0	12.6
38	QUANSET ROAD		4.1	5	1	3	1	2	1	2.9	1	1	8	4.5	13.0
46	QUANSET ROAD		4.1	5	1	3	1	2	1	2.9	1	1	8	4.5	13.0
47	QUANSET ROAD		4.1	5	1	3	1	2	1	2.9	1	1	8	4.5	13.0
48	QUANSET ROAD		4.1	5	1	3	1	2	1	2.9	1	1	8	4.5	13.0
78	0		4.1	5	1	3	1	2	1	2.9	1	1	8	4.5	13.0
974	QUANSET ROAD		4.1	5	1	3	1	2	1	2.9	1	1	8	4.5	13.0
711	ROHMERS ROAD		5	1	1	3	1	5	10	3.9	1	1	5	3.0	11.7
885	QUANSET ROAD		5	1	1	3	1	5	10	3.9	1	1	5	3.0	11.7
467	SNOW GOOSE LANE		5	1	1	3	10	5	1	3.9	1	1	5	3.0	11.7
772	SNOW GOOSE LANE		5	1	1	3	10	5	1	3.9	1	1	5	3.0	11.7
535	GOSNOLD ROAD		4.7	5	1	3	10	5	1	4.2	1	1	5	3.0	12.5
916	SAGES WAY		5	1	1	3	10	5	1	3.9	1	1	5	3.0	11.7
937	BAY RIDGE LANE		4.2	5	2.5	3	10	5	1	4.2	1	1	5	3.0	12.6
719	0		3.2	1	1	3	10	5	10	4.1	1	1	5	3.0	12.2
663	FINLAY ROAD		4.1	5	2.5	3	10	5	1	4.2	1	1	5	3.0	12.5
430	0		4.4	5	1	4	1	5	10	4.2	1	1	5	3.0	12.5
605	NAUSET HEIGHTS ROAD		4.5	5	1	3	10	5	1	4.1	1	1	5	3.0	12.3
652	NICKERSON ROAD		4.5	5	1	3	10	5	1	4.1	1	1	5	3.0	12.3
653	NICKERSON ROAD		4.5	5	1	3	10	5	1	4.1	1	1	5	3.0	12.3
654	FINLAY ROAD		4.5	5	1	3	10	5	1	4.1	1	1	5	3.0	12.3
724	NICKERSON ROAD		4.5	5	1	3	10	5	1	4.1	1	1	5	3.0	12.3
725	NICKERSON ROAD		4.5	5	1	3	10	5	1	4.1	1	1	5	3.0	12.3
726	NICKERSON ROAD		4.5	5	1	3	10	5	1	4.1	1	1	5	3.0	12.3

Water Distribution System Business Risk Exposure Matrix

GIS Object ID	Street Name		Asset Life Consumed	Material	Repair History	Static Pressure	Soil Type	Freezing Potential	Saltwater Intrusion	Likelihood of Failure	Business Interruption	Traffic Issues	Fire Protection Disruption	Consequence of Failure	Business Risk Exposure
727	NICKERSON ROAD		4.5	5	1	3	10	5	1	4.1	1	1	5	3.0	12.3
728	NICKERSON ROAD		4.5	5	1	3	10	5	1	4.1	1	1	5	3.0	12.3
24	SOUTH ORLEANS ROAD		4.4	5	1	3	1	3	1	3.1	1	1	7	4.0	12.2
343	SNOW SHORE ROAD		5.3	5	5	3	10	7	10	6.0	1	1	3	2.0	12.0
657	KETTLE POND WAY		4.4	5	1	3	10	5	1	4.1	1	1	5	3.0	12.2
658	DALEYS TERRACE		4.4	5	1	3	10	5	1	4.1	1	1	5	3.0	12.2
659	DALEYS TERRACE		4.4	5	1	3	10	5	1	4.1	1	1	5	3.0	12.2
903	KEITH POND WAY		4.4	5	1	3	10	5	1	4.1	1	1	5	3.0	12.2
904	FINLAY ROAD		4.4	5	1	3	10	5	1	4.1	1	1	5	3.0	12.2
476	0		3.1	1	1	3	1	5	1	2.2	10	1	5	4.8	10.8
477	0		3.1	1	1	3	1	5	1	2.2	10	1	5	4.8	10.8
791	0		3.1	1	1	3	1	5	1	2.2	10	1	5	4.8	10.8
774	TONSET WOODS		4.3	5	1	3	10	5	1	4.0	1	1	5	3.0	12.1
87	0		4.1	1	1	3	1	2	1	2.5	1	1	8	4.5	11.2
304	GIBSON ROAD		5.3	5	10	3	10	7	1	5.9	1	1	3	2.0	11.7
633	CAPTAIN LINNELL ROAD		4.1	5	1	4	10	5	1	4.0	1	1	5	3.0	12.1
634	CAPTAIN LINNELL ROAD		4.1	5	1	4	10	5	1	4.0	1	1	5	3.0	12.1
640	SALTY RIDGE ROAD		4.2	5	1	3	10	5	1	4.0	1	1	5	3.0	11.9
643	BAY RIDGE LANE		4.2	5	1	3	10	5	1	4.0	1	1	5	3.0	11.9
644	OAK RIDGE LANE		4.2	5	1	3	10	5	1	4.0	1	1	5	3.0	11.9
645	OAK RIDGE LANE		4.2	5	1	3	10	5	1	4.0	1	1	5	3.0	11.9
646	BAY RIDGE LANE		4.2	5	1	3	10	5	1	4.0	1	1	5	3.0	11.9
935	OLD STATE HIGHWAY		2.9	1	1	4	1	5	1	2.3	10	1	5	4.8	10.8
813	0		3	1	1	3	1	5	1	2.2	10	1	5	4.8	10.6
29	LIBERTY LANE		2.7	1	1	4	10	3	1	3.0	1	1	7	4.0	11.9
227	CHICKADEE LANE		5	5.5	10	3	10	7	1	5.8	1	1	3	2.0	11.6
509	GREYMOOR WAY		4.2	5	1	2	10	5	1	3.9	1	1	5	3.0	11.6
578	QUANSET ROAD		4.1	5	1	3	1	5	10	3.9	1	1	5	3.0	11.8
901	FINLAY ROAD		4.1	5	1	3	10	5	1	3.9	1	1	5	3.0	11.8
905	SOUTH ORLEANS ROAD		4.1	5	1	3	10	5	1	3.9	1	1	5	3.0	11.8
21	CAPE COD RAIL TRAIL		2.7	1	1	3	10	3	1	2.9	1	1	7	4.0	11.5
22	CAPE COD RAIL TRAIL		2.7	1	1	3	10	3	1	2.9	1	1	7	4.0	11.5
23	MAIN STREET		2.7	1	1	3	10	3	1	2.9	1	1	7	4.0	11.5
28	LIBERTY LANE		2.7	1	1	3	10	3	1	2.9	1	1	7	4.0	11.5
285	SKAKET BEACH ROAD		5.3	5	2.5	4	10	7	10	5.7	1	1	3	2.0	11.5
403	DEFIANCE LANE		5.3	5	2.5	4	10	7	10	5.7	1	1	3	2.0	11.5
613	MILL POND ROAD		5.3	5	2.5	3	1	5	1	3.7	1	1	5	3.0	11.2
266	CHAMPLAIN ROAD		5.3	5	2.5	3	10	7	10	5.6	1	1	3	2.0	11.3
480	0		3.9	5	1	3	10	5	1	3.9	1	1	5	3.0	11.6
491	PENDLETON DRIVE		3.9	5	1	3	10	5	1	3.9	1	1	5	3.0	11.6
721	PENDLETON DRIVE		3.9	5	1	3	10	5	1	3.9	1	1	5	3.0	11.6
575	NAMEQUOIT ROAD		4.1	1	1	4	1	5	10	3.6	1	1	5	3.0	10.9
576	NAMEQUOIT ROAD		4.1	1	1	4	1	5	10	3.6	1	1	5	3.0	10.9
978	NAMEQUOIT ROAD		4.1	1	1	4	1	5	10	3.6	1	1	5	3.0	10.9
487	GRANDVIEW DRIVE		4.2	1	1	3	10	5	1	3.6	1	1	5	3.0	10.7
239	SAMOSET ROAD		5.3	5	7.5	3	10	7	1	5.5	1	1	3	2.0	11.0
404	ROCK HARBOR ROAD		5.3	5	1	4	10	7	10	5.5	1	1	3	2.0	11.0
409	ROCK HARBOR ROAD		5.3	5	1	4	10	7	10	5.5	1	1	3	2.0	11.0
874	CAPTAIN DOANES WAY		4.1	1	1	3	10	5	1	3.5	1	1	5	3.0	10.6

Water Distribution System Business Risk Exposure Matrix

GIS Object ID	Street Name		Asset Life Consumed	Material	Repair History	Static Pressure	Soil Type	Freezing Potential	Saltwater Intrusion	Likelihood of Failure	Business Interruption	Traffic Issues	Fire Protection Disruption	Consequence of Failure	Business Risk Exposure
879	ROCK HARBOR ROAD		5.3	5	1	4	10	7	10	5.5	1	1	3	2.0	11.0
880	ROCK HARBOR ROAD		5.3	5	1	4	10	7	10	5.5	1	1	3	2.0	11.0
887	BAY VIEW DRIVE		5.3	5	1	4	10	7	10	5.5	1	1	3	2.0	11.0
925	ROCK HARBOR ROAD		5.3	5	1	4	10	7	10	5.5	1	1	3	2.0	11.0
933	0		4.1	1	1	3	10	5	1	3.5	1	1	5	3.0	10.6
83	BAY RIDGE LANE		3.7	1	1	3	1	2	1	2.3	1	1	8	4.5	10.5
98	ROCK HARBOR ROAD		1.9	1	1	3	10	2	1	2.5	1	1	8	4.5	11.3
219	NAUSET KNOLLS LANE		5.3	5	1	3	10	7	10	5.4	1	1	3	2.0	10.8
234	CEDAR COVE ROAD		5.3	5	1	3	10	7	10	5.4	1	1	3	2.0	10.8
261	NAUSET HEIGHTS ROAD		5.3	5	1	3	10	7	10	5.4	1	1	3	2.0	10.8
389	GRIST ROAD		5.3	5	1	3	10	7	10	5.4	1	1	3	2.0	10.8
977	LUCYS LN		5.3	5	1	3	10	7	10	5.4	1	1	3	2.0	10.8
869	JONES ROAD		5.3	5	1	4	1	5	1	3.6	1	1	5	3.0	10.9
871	JONES ROAD		5.3	5	1	4	1	5	1	3.6	1	1	5	3.0	10.9
306	GULL LANE		5	5.5	1	4	10	7	10	5.5	1	1	3	2.0	10.9
357	DEFIANCE LANE		5	5.5	1	4	10	7	10	5.5	1	1	3	2.0	10.9
398	BAY VIEW DRIVE		5	5.5	1	4	10	7	10	5.5	1	1	3	2.0	10.9
402	ANCHOR DRIVE		5	5.5	1	4	10	7	10	5.5	1	1	3	2.0	10.9
516	0		4	1	1	3	10	5	1	3.5	1	1	5	3.0	10.5
517	0		4	1	1	3	10	5	1	3.5	1	1	5	3.0	10.5
878	UNCLE BENS WAY		5	5.5	1	4	10	7	10	5.5	1	1	3	2.0	10.9
886	BAY VIEW DRIVE		5	5.5	1	4	10	7	10	5.5	1	1	3	2.0	10.9
894	DEFIANCE LANE		5	5.5	1	4	10	7	10	5.5	1	1	3	2.0	10.9
84	OLD TIMERS LANE		3.6	1	1	3	1	2	1	2.3	1	1	8	4.5	10.3
96	ROCK HARBOR ROAD		1.9	1	1	4	1	2	1	1.7	1	7	8	6.3	10.8
507	GREAT OAK ROAD		5.3	5	1	3	1	5	1	3.5	1	1	5	3.0	10.6
590	PORTANIMICUT ROAD		5.3	5	1	3	1	5	1	3.5	1	1	5	3.0	10.6
614	CHAMPLAIN ROAD		5.3	5	1	3	1	5	1	3.5	1	1	5	3.0	10.6
636	0		3.8	1	1	4	10	5	1	3.5	1	1	5	3.0	10.6
806	CHAMPLAIN ROAD		5.3	5	1	3	1	5	1	3.5	1	1	5	3.0	10.6
807	FREEMAN LANE		5.3	5	1	3	1	5	1	3.5	1	1	5	3.0	10.6
851	BRIAR SPRINGS ROAD		5.3	5	1	3	1	5	1	3.5	1	1	5	3.0	10.6
888	TAR KILN ROAD		5.3	5	1	3	1	5	1	3.5	1	1	5	3.0	10.6
101	0		2.8	1	1	3	1	1	1	1.9	1	1	10	5.5	10.6
102	0		2.8	1	1	3	1	1	1	1.9	1	1	10	5.5	10.6
103	BAKERS POND ROAD		2.8	1	1	3	1	1	1	1.9	1	1	10	5.5	10.6
104	BAKERS POND ROAD		2.8	1	1	3	1	1	1	1.9	1	1	10	5.5	10.6
110	0		2.8	1	1	3	1	1	1	1.9	1	1	10	5.5	10.6
111	FLAX POND ROAD		2.8	1	1	3	1	1	1	1.9	1	1	10	5.5	10.6
112	0		2.8	1	1	3	1	1	1	1.9	1	1	10	5.5	10.6
114	0		2.8	1	1	3	1	1	1	1.9	1	1	10	5.5	10.6
123	0		2.8	1	1	3	1	1	1	1.9	1	1	10	5.5	10.6
124	0		2.8	1	1	3	1	1	1	1.9	1	1	10	5.5	10.6
564	TAR KILN ROAD		5	5.5	1	4	1	5	1	3.6	1	1	5	3.0	10.7
681	CANAL ROAD		5	5.5	1	4	1	5	1	3.6	1	1	5	3.0	10.7
247	THE LANE		4.5	5	2.5	3	10	7	10	5.3	1	1	3	2.0	10.7
511	0		3.8	1	1	3	10	5	1	3.4	1	1	5	3.0	10.3
220	CHENEY ROAD		4.9	5	1	3	10	7	10	5.3	1	1	3	2.0	10.5
440	0		5	5.5	1	3	1	5	1	3.5	1	1	5	3.0	10.4

Water Distribution System Business Risk Exposure Matrix

GIS Object ID	Street Name		Asset Life Consumed	Material	Repair History	Static Pressure	Soil Type	Freezing Potential	Saltwater Intrusion	Likelihood of Failure	Business Interruption	Traffic Issues	Fire Protection Disruption	Consequence of Failure	Business Risk Exposure
441	0		5	5.5	1	3	1	5	1	3.5	1	1	5	3.0	10.4
456	RICHWOOD FARM LANE		5	5.5	1	3	1	5	1	3.5	1	1	5	3.0	10.4
459	0		5	5.5	1	3	1	5	1	3.5	1	1	5	3.0	10.4
567	TWININGS LANE		5	5.5	1	3	1	5	1	3.5	1	1	5	3.0	10.4
568	BOULDER LANE		5	5.5	1	3	1	5	1	3.5	1	1	5	3.0	10.4
569	BOULDER LANE		5	5.5	1	3	1	5	1	3.5	1	1	5	3.0	10.4
588	BLACKBERRY LANE		5	5.5	1	3	1	5	1	3.5	1	1	5	3.0	10.4
589	UNCLE ISRAELS ROAD		5	5.5	1	3	1	5	1	3.5	1	1	5	3.0	10.4
599	0		5	5.5	1	3	1	5	1	3.5	1	1	5	3.0	10.4
600	0		5	5.5	1	3	1	5	1	3.5	1	1	5	3.0	10.4
642	0		5	5.5	1	3	1	5	1	3.5	1	1	5	3.0	10.4
698	BAYWOOD DRIVE		5	5.5	1	3	1	5	1	3.5	1	1	5	3.0	10.4
743	FREEMAN LANE		5	5.5	1	3	1	5	1	3.5	1	1	5	3.0	10.4
756	0		5	5.5	1	3	1	5	1	3.5	1	1	5	3.0	10.4
757	0		5	5.5	1	3	1	5	1	3.5	1	1	5	3.0	10.4
760	0		5	5.5	1	3	1	5	1	3.5	1	1	5	3.0	10.4
761	0		5	5.5	1	3	1	5	1	3.5	1	1	5	3.0	10.4
804	0		5	5.5	1	3	1	5	1	3.5	1	1	5	3.0	10.4
858	UNCLE ISRAELS ROAD		5	5.5	1	3	1	5	1	3.5	1	1	5	3.0	10.4
859	DAVIS ROAD		5	5.5	1	3	1	5	1	3.5	1	1	5	3.0	10.4
873	0		5	5.5	1	3	1	5	1	3.5	1	1	5	3.0	10.4
212	GOSNOLD ROAD		4.7	5	7.5	3	10	7	1	5.3	1	1	3	2.0	10.5
308	0		3.5	1	1	3	10	7	1	3.4	1	3	3	2.6	8.8
309	0		3.5	1	1	3	10	7	1	3.4	1	3	3	2.6	8.8
355	0		3.5	1	1	3	10	7	1	3.4	1	3	3	2.6	8.8
119	0		5.1	5	1	3	1	5	1	3.4	1	1	5	3.0	10.3
120	0		5.1	5	1	3	1	5	1	3.4	1	1	5	3.0	10.3
471	OPA'S WAY		3.7	1	1	3	10	5	1	3.4	1	1	5	3.0	10.1
486	0		3.7	1	1	3	10	5	1	3.4	1	1	5	3.0	10.1
629	WILLIE ATWOOD ROAD		3.6	1	1	4	10	5	1	3.4	1	1	5	3.0	10.3
648	LONG VIEW DRIVE		3.7	1	1	3	10	5	1	3.4	1	1	5	3.0	10.1
703	VIKING ROAD		3.6	1	1	4	1	5	10	3.4	1	1	5	3.0	10.3
803	SEAL LANE		3.6	1	1	4	10	5	1	3.4	1	1	5	3.0	10.3
852	BARLEY NECK ROAD		3.7	1	1	3	10	5	1	3.4	1	1	5	3.0	10.1
897	BARLEY NECK ROAD		3.7	1	1	3	10	5	1	3.4	1	1	5	3.0	10.1
332	COVE ROAD		4.8	5	1	3	10	7	10	5.2	1	1	3	2.0	10.4
811	0		5	5.5	1	2	1	5	1	3.4	1	1	5	3.0	10.1
866	BAYWOOD DRIVE		5	5.5	1	2	1	5	1	3.4	1	1	5	3.0	10.1
236	OLD DUCK HOLE ROAD		4.7	5	1	3	10	7	10	5.2	1	1	3	2.0	10.4
224	TONSET ROAD		5.3	5	5	3	10	7	1	5.1	1	1	3	2.0	10.2
273	PINE NEEDLE WAY		5.3	5	5	3	10	7	1	5.1	1	1	3	2.0	10.2
302	MILL POND ROAD		5.3	5	5	3	10	7	1	5.1	1	1	3	2.0	10.2
370	GIBSON ROAD		5.3	5	5	3	10	7	1	5.1	1	1	3	2.0	10.2
442	0		3.6	1	1	3	10	5	1	3.3	1	1	5	3.0	10.0
490	ASPINET ROAD		3.6	1	1	3	10	5	1	3.3	1	1	5	3.0	10.0
500	CHICKADEE LANE		3.6	1	1	3	10	5	1	3.3	1	1	5	3.0	10.0
530	GOSNOLD ROAD		3.6	1	1	3	10	5	1	3.3	1	1	5	3.0	10.0
531	WOODSNECK ROAD		3.6	1	1	3	10	5	1	3.3	1	1	5	3.0	10.0
534	WOODSNECK ROAD		3.6	1	1	3	10	5	1	3.3	1	1	5	3.0	10.0

Water Distribution System Business Risk Exposure Matrix

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536	POCHET ROAD		3.6	1	1	3	10	5	1	3.3	1	1	5	3.0	10.0
537	WOODSNECK ROAD		3.6	1	1	3	10	5	1	3.3	1	1	5	3.0	10.0
538	WOODSNECK ROAD		3.6	1	1	3	10	5	1	3.3	1	1	5	3.0	10.0
541	SPARROWHAWK ROAD		3.6	1	1	3	10	5	1	3.3	1	1	5	3.0	10.0
546	0		3.6	1	1	3	10	5	1	3.3	1	1	5	3.0	10.0
547	0		3.6	1	1	3	10	5	1	3.3	1	1	5	3.0	10.0
548	PRIMROSE LANE		3.6	1	1	3	10	5	1	3.3	1	1	5	3.0	10.0
603	CALLUM ROAD		3.6	1	1	3	10	5	1	3.3	1	1	5	3.0	10.0
610	0		3.6	1	1	3	10	5	1	3.3	1	1	5	3.0	10.0
612	CAMP ROAD		3.6	1	1	3	10	5	1	3.3	1	1	5	3.0	10.0
616	0		3.6	1	1	3	10	5	1	3.3	1	1	5	3.0	10.0
720	MONUMENT ROAD		3.6	1	1	3	10	5	1	3.3	1	1	5	3.0	10.0
734	WILLIE ATWOOD ROAD		3.6	1	1	3	10	5	1	3.3	1	1	5	3.0	10.0
735	WILLIE ATWOOD ROAD		3.6	1	1	3	10	5	1	3.3	1	1	5	3.0	10.0
736	WILLIE ATWOOD ROAD		3.6	1	1	3	10	5	1	3.3	1	1	5	3.0	10.0
789	0		3.6	1	1	3	10	5	1	3.3	1	1	5	3.0	10.0
792	0		3.6	1	1	3	10	5	1	3.3	1	1	5	3.0	10.0
793	0		3.6	1	1	3	10	5	1	3.3	1	1	5	3.0	10.0
802	SEAL LANE		3.6	1	1	3	10	5	1	3.3	1	1	5	3.0	10.0
819	CUMMINGS ROAD		3.6	1	1	3	10	5	1	3.3	1	1	5	3.0	10.0
825	0		3.6	1	1	3	10	5	1	3.3	1	1	5	3.0	10.0
830	0		3.6	1	1	3	10	5	1	3.3	1	1	5	3.0	10.0
831	HENSONS WAY		3.6	1	1	3	10	5	1	3.3	1	1	5	3.0	10.0
832	AUNT POLLYS LANE		3.6	1	1	3	10	5	1	3.3	1	1	5	3.0	10.0
853	COUNTRYSIDE DRIVE		3.6	1	1	3	10	5	1	3.3	1	1	5	3.0	10.0
953	PENDLETON DRIVE		3.6	1	1	3	10	5	1	3.3	1	1	5	3.0	10.0
957	POCHET ROAD		3.6	1	1	3	10	5	1	3.3	1	1	5	3.0	10.0
958	SPARROWHAWK LANE		3.6	1	1	3	10	5	1	3.3	1	1	5	3.0	10.0
260	ALDEN ROAD		5	5.5	5	3	1	7	10	5.1	1	1	3	2.0	10.1
685	ROCK HARBOR ROAD		3.5	1	1	3	10	5	1	3.3	1	1	5	3.0	9.9
324	DEER RUN		4.5	5	1	3	10	7	10	5.1	1	1	3	2.0	10.2
521	BLACK DUCK LANE		1.7	1	1	3	10	5	10	3.5	1	1	5	3.0	10.4
522	WALKER ROAD		1.7	1	1	3	10	5	10	3.5	1	1	5	3.0	10.4
51	0		3.4	1	1	2	1	2	1	2.1	1	1	8	4.5	9.5
908	0		3.4	1	1	2	1	2	1	2.1	1	1	8	4.5	9.5
909	0		3.4	1	1	2	1	2	1	2.1	1	1	8	4.5	9.5
563	TARKLIN ROAD		4.4	5	2.5	3	1	5	1	3.4	1	1	5	3.0	10.2
740	SKAKET BEACH ROAD		3	1	2.5	3	10	5	1	3.3	1	1	5	3.0	10.0
862	0		5	1	1	4	1	5	1	3.1	1	1	5	3.0	9.3
863	0		5	1	1	4	1	5	1	3.1	1	1	5	3.0	9.3
864	0		5	1	1	4	1	5	1	3.1	1	1	5	3.0	9.3
699	0		3.4	1	1	3	1	5	10	3.3	1	1	5	3.0	9.8
700	0		3.4	1	1	3	1	5	10	3.3	1	1	5	3.0	9.8
741	CHILDS HOMESTEAD ROAD		3.4	1	1	3	10	5	1	3.3	1	1	5	3.0	9.8
742	NAMSKAKET ROAD		3.4	1	1	3	10	5	1	3.3	1	1	5	3.0	9.8
810	CLAYTON CIRCLE		3.4	1	1	3	10	5	1	3.3	1	1	5	3.0	9.8
815	KINGS WAY		3.4	1	1	3	10	5	1	3.3	1	1	5	3.0	9.8
833	0		3.4	1	1	3	10	5	1	3.3	1	1	5	3.0	9.8
837	0		3.4	1	1	3	10	5	1	3.3	1	1	5	3.0	9.8

Water Distribution System Business Risk Exposure Matrix

GIS Object ID	Street Name		Asset Life Consumed	Material	Repair History	Static Pressure	Soil Type	Freezing Potential	Saltwater Intrusion	Likelihood of Failure	Business Interruption	Traffic Issues	Fire Protection Disruption	Consequence of Failure	Business Risk Exposure
841	MINISTERS PRIM		3.4	1	1	3	10	5	1	3.3	1	1	5	3.0	9.8
842	MINISTERS PRIM		3.4	1	1	3	10	5	1	3.3	1	1	5	3.0	9.8
906	CHILDS HOMESTEAD ROAD		3.4	1	1	3	10	5	1	3.3	1	1	5	3.0	9.8
910	0		3.4	1	1	3	10	5	1	3.3	1	1	5	3.0	9.8
911	0		3.4	1	1	3	10	5	1	3.3	1	1	5	3.0	9.8
912	0		3.4	1	1	3	10	5	1	3.3	1	1	5	3.0	9.8
913	0		3.4	1	1	3	10	5	1	3.3	1	1	5	3.0	9.8
914	0		3.4	1	1	3	10	5	1	3.3	1	1	5	3.0	9.8
915	0		3.4	1	1	3	10	5	1	3.3	1	1	5	3.0	9.8
8	KESCAYOGANSETT ROAD		3.7	1	1	3	1	3	1	2.4	1	1	7	4.0	9.5
408	0		4.1	5	1	4	10	7	10	5.0	1	1	3	2.0	10.1
439	0		3.2	1	1	4	10	5	1	3.3	1	1	5	3.0	9.8
920	0		5	1	1	3	1	5	1	3.0	1	1	5	3.0	9.0
922	AREYS LANE		5	1	1	3	1	5	1	3.0	1	1	5	3.0	9.0
6	AREYS LANE		3.6	1	1	3	1	3	1	2.3	1	1	7	4.0	9.4
7	AREYS LANE		3.6	1	1	3	1	3	1	2.3	1	1	7	4.0	9.4
623	RUGGLES ROAD		3.2	1	1	3	10	5	1	3.2	1	1	5	3.0	9.5
758	PILGRIM DRIVE		5	1	1	2	1	5	1	2.9	1	1	5	3.0	8.7
867	CROSS ROAD		4.6	5	1	3	1	5	1	3.2	1	1	5	3.0	9.7
651	BAY RIDGE LANE		4.1	5	2.5	3	1	5	1	3.3	1	1	5	3.0	9.8
246	TWISS ROAD		5.3	5	2.5	3	10	7	1	4.7	1	1	3	2.0	9.5
301	NAUSET ROAD		5.3	5	2.5	3	10	7	1	4.7	1	1	3	2.0	9.5
383	SEAVIEW ROAD		5.3	5	2.5	3	10	7	1	4.7	1	1	3	2.0	9.5
423	0		4.4	5	1	4	1	5	1	3.3	1	1	5	3.0	9.8
424	0		4.4	5	1	4	1	5	1	3.3	1	1	5	3.0	9.8
427	0		4.4	5	1	4	1	5	1	3.3	1	1	5	3.0	9.8
479	0		3.1	1	1	3	10	5	1	3.1	1	1	5	3.0	9.4
779	0		3.1	1	1	3	10	5	1	3.1	1	1	5	3.0	9.4
816	0		3.1	1	1	3	10	5	1	3.1	1	1	5	3.0	9.4
836	BRICK HILL ROAD		3.1	1	1	3	10	5	1	3.1	1	1	5	3.0	9.4
893	CHAMPLAIN ROAD		5	5.5	2.5	3	1	7	10	4.7	1	1	3	2.0	9.4
233	NATURAL DRIVE		5	5.5	2.5	3	10	7	1	4.7	1	1	3	2.0	9.4
259	IYANOUGH ROAD		5	5.5	2.5	3	10	7	1	4.7	1	1	3	2.0	9.4
948	CAPTAIN CURTIS WAY		5	5.5	2.5	3	10	7	1	4.7	1	1	3	2.0	9.4
494	0		3	1	1	3	10	5	1	3.1	1	1	5	3.0	9.3
777	0		3	1	1	3	10	5	1	3.1	1	1	5	3.0	9.3
778	0		3	1	1	3	10	5	1	3.1	1	1	5	3.0	9.3
959	0		4.4	5	1	3	1	5	1	3.2	1	1	5	3.0	9.5
967	TARKLIN ROAD		4.4	5	1	3	1	5	1	3.2	1	1	5	3.0	9.5
16	ELLERSIE ROAD		3.4	1	1	3	1	3	1	2.3	1	1	7	4.0	9.0
286	SKAKET BEACH ROAD		5.3	5	1	4	1	7	10	4.6	1	1	3	2.0	9.2
593	HERITAGE DRIVE		4.4	5	1	2	1	5	1	3.1	1	1	5	3.0	9.2
288	WILLIE ATWOOD ROAD		5.3	5	1	4	10	7	1	4.6	1	1	3	2.0	9.2
394	SKAKET BEACH ROAD		5.3	5	1	4	10	7	1	4.6	1	1	3	2.0	9.2
395	SKAKET BEACH ROAD		5.3	5	1	4	10	7	1	4.6	1	1	3	2.0	9.2
271	SAND HILL LANE		4.9	5	2.5	3	10	7	1	4.6	1	1	3	2.0	9.2
594	NAMEQUOIT ROAD		4.1	1	2.5	4	1	5	1	3.0	1	1	5	3.0	8.9
225	HOPKINS LANE		5.3	5	1	3	10	7	1	4.5	1	1	3	2.0	9.0
240	SAMOSET ROAD		5.3	5	1	3	10	7	1	4.5	1	1	3	2.0	9.0

Water Distribution System Business Risk Exposure Matrix

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245	TWISS ROAD		5.3	5	1	3	10	7	1	4.5	1	1	3	2.0	9.0
250	RIVER ROAD		5.3	5	1	3	10	7	1	4.5	1	1	3	2.0	9.0
267	CHAMPLAIN ROAD		5.3	5	1	3	10	7	1	4.5	1	1	3	2.0	9.0
275	HILLTOP LANE		5.3	5	1	3	10	7	1	4.5	1	1	3	2.0	9.0
276	HIDDEN VALLEY ROAD		5.3	5	1	3	10	7	1	4.5	1	1	3	2.0	9.0
282	RUGGLES ROAD		5.3	5	1	3	10	7	1	4.5	1	1	3	2.0	9.0
303	GIBSON ROAD		5.3	5	1	3	10	7	1	4.5	1	1	3	2.0	9.0
331	COTTAGE STREET		5.3	5	1	3	10	7	1	4.5	1	1	3	2.0	9.0
335	WILLIE ATWOOD ROAD		5.3	5	1	3	10	7	1	4.5	1	1	3	2.0	9.0
340	CHILDS HOMESTEAD ROAD		5.3	5	1	3	10	7	1	4.5	1	1	3	2.0	9.0
341	NAUSET ROAD		5.3	5	1	3	10	7	1	4.5	1	1	3	2.0	9.0
346	GIBSON ROAD		5.3	5	1	3	10	7	1	4.5	1	1	3	2.0	9.0
347	FINCH LANE		5.3	5	1	3	10	7	1	4.5	1	1	3	2.0	9.0
371	GIBSON ROAD		5.3	5	1	3	10	7	1	4.5	1	1	3	2.0	9.0
277	CAUSEWAY ROAD		5	5.5	1	4	1	7	10	4.6	1	1	3	2.0	9.1
305	GULL LANE		5	5.5	1	4	1	7	10	4.6	1	1	3	2.0	9.1
421	0		2.8	1	1	3	10	5	1	3.0	1	1	5	3.0	9.1
454	LOTS HOLLOW ROAD		4.3	5	1	2	1	5	1	3.0	1	1	5	3.0	9.1
460	LOTS HOLLOW ROAD		4.3	5	1	2	1	5	1	3.0	1	1	5	3.0	9.1
482	FREEDOM TRAIL		2.7	1	1	4	10	5	1	3.1	1	1	5	3.0	9.2
496	0		2.8	1	1	3	10	5	1	3.0	1	1	5	3.0	9.1
512	BRICK HILL ROAD		2.8	1	1	3	10	5	1	3.0	1	1	5	3.0	9.1
609	DOANE ROAD		2.8	1	1	3	10	5	1	3.0	1	1	5	3.0	9.1
690	FREEMAN LANE		4.1	5	1	4	1	5	1	3.1	1	1	5	3.0	9.4
750	SALT WORKS CIRCLE		2.8	1	1	3	10	5	1	3.0	1	1	5	3.0	9.1
754	0		2.8	1	1	3	10	5	1	3.0	1	1	5	3.0	9.1
307	WILDFLOWER LANE		5	5.5	1	4	10	7	1	4.6	1	1	3	2.0	9.1
338	ELLIS ROAD		5	5.5	1	4	10	7	1	4.6	1	1	3	2.0	9.1
339	ELLIS CIRCLE		5	5.5	1	4	10	7	1	4.6	1	1	3	2.0	9.1
350	SKAKET BEACH ROAD		5	5.5	1	4	10	7	1	4.6	1	1	3	2.0	9.1
351	0		5	5.5	1	4	10	7	1	4.6	1	1	3	2.0	9.1
352	0		5	5.5	1	4	10	7	1	4.6	1	1	3	2.0	9.1
397	UNCLE BENS WAY		5	5.5	1	4	10	7	1	4.6	1	1	3	2.0	9.1
399	UNCLE BENS WAY		5	5.5	1	4	10	7	1	4.6	1	1	3	2.0	9.1
400	ANCHOR DRIVE		5	5.5	1	4	10	7	1	4.6	1	1	3	2.0	9.1
401	BAY VIEW DRIVE		5	5.5	1	4	10	7	1	4.6	1	1	3	2.0	9.1
889	FREEMAN LANE		4.2	5	1	3	1	5	1	3.1	1	1	5	3.0	9.2
931	0		5	5.5	1	4	10	7	1	4.6	1	1	3	2.0	9.1
955	HIGHVIEW LANE		4.3	5	10	3	1	7	1	4.6	1	1	3	2.0	9.1
488	GRANDVIEW DRIVE		4.2	1	2.5	2	1	5	1	2.8	1	1	5	3.0	8.4
262	DOANE ROAD		5	5.5	1	3	1	7	10	4.5	1	1	3	2.0	8.9
311	BOULDER LANE		5	5.5	1	3	1	7	10	4.5	1	1	3	2.0	8.9
342	ALDEN ROAD		5	5.5	1	3	1	7	10	4.5	1	1	3	2.0	8.9
349	FRANZ ROAD		3.2	1	2.5	4	10	7	10	4.5	1	1	3	2.0	9.0
892	MILL POND ROAD		5	5.5	1	3	1	7	10	4.5	1	1	3	2.0	8.9
199	KAREN WAY		5	5.5	1	3	10	7	1	4.5	1	1	3	2.0	8.9
206	0		5	5.5	1	3	10	7	1	4.5	1	1	3	2.0	8.9
222	KAREN WAY		5	5.5	1	3	10	7	1	4.5	1	1	3	2.0	8.9
232	LARBOARD LANE		5	5.5	1	3	10	7	1	4.5	1	1	3	2.0	8.9

Water Distribution System Business Risk Exposure Matrix

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235	LOVELL LANE		5	5.5	1	3	10	7	1	4.5	1	1	3	2.0	8.9
238	OLD DUCK HOLE ROAD		5	5.5	1	3	10	7	1	4.5	1	1	3	2.0	8.9
241	GOSNOLD ROAD		5	5.5	1	3	10	7	1	4.5	1	1	3	2.0	8.9
248	JACK KNIFE POINT ROAD		5	5.5	1	3	10	7	1	4.5	1	1	3	2.0	8.9
249	JACK KNIFE POINT ROAD		5	5.5	1	3	10	7	1	4.5	1	1	3	2.0	8.9
269	CRANBERRY LANE		5	5.5	1	3	10	7	1	4.5	1	1	3	2.0	8.9
280	SEAVERS ROAD		5	5.5	1	3	10	7	1	4.5	1	1	3	2.0	8.9
281	RUGGLES ROAD		5	5.5	1	3	10	7	1	4.5	1	1	3	2.0	8.9
283	TONSET ROAD		5	5.5	1	3	10	7	1	4.5	1	1	3	2.0	8.9
289	CHASE LANE		5	5.5	1	3	10	7	1	4.5	1	1	3	2.0	8.9
292	DALEYS TERRACE		5	5.5	1	3	10	7	1	4.5	1	1	3	2.0	8.9
293	UNCLE VICKS WAY		5	5.5	1	3	10	7	1	4.5	1	1	3	2.0	8.9
294	OLD FARM ROAD		5	5.5	1	3	10	7	1	4.5	1	1	3	2.0	8.9
297	OLD TOTE ROAD		5	5.5	1	3	10	7	1	4.5	1	1	3	2.0	8.9
320	KAREN WAY		5	5.5	1	3	10	7	1	4.5	1	1	3	2.0	8.9
321	KAREN WAY		5	5.5	1	3	10	7	1	4.5	1	1	3	2.0	8.9
330	CLAYTON CIRCLE		5	5.5	1	3	10	7	1	4.5	1	1	3	2.0	8.9
345	CHICKADEE LANE		5	5.5	1	3	10	7	1	4.5	1	1	3	2.0	8.9
362	TONSET WOODS		5	5.5	1	3	10	7	1	4.5	1	1	3	2.0	8.9
365	0		5	5.5	1	3	10	7	1	4.5	1	1	3	2.0	8.9
366	0		5	5.5	1	3	10	7	1	4.5	1	1	3	2.0	8.9
369	0		5	5.5	1	3	10	7	1	4.5	1	1	3	2.0	8.9
379	0		5	5.5	1	3	10	7	1	4.5	1	1	3	2.0	8.9
380	CLAYTON CIRCLE		5	5.5	1	3	10	7	1	4.5	1	1	3	2.0	8.9
382	0		5	5.5	1	3	10	7	1	4.5	1	1	3	2.0	8.9
384	CHICKADEE LANE		5	5.5	1	3	10	7	1	4.5	1	1	3	2.0	8.9
388	NATURAL DRIVE		5	5.5	1	3	10	7	1	4.5	1	1	3	2.0	8.9
37	LOTS HOLLOW ROAD		2.9	1	1	2	1	2	1	1.9	1	1	8	4.5	8.6
40	0		2.8	1	1	3	1	2	1	2.0	1	1	8	4.5	8.9
79	0		2.9	1	1	2	1	2	1	1.9	1	1	8	4.5	8.6
943	0		2.9	1	1	2	1	2	1	1.9	1	1	8	4.5	8.6
218	SMITH NECK ROAD		3.7	1	1	3	10	7	10	4.4	1	1	3	2.0	8.8
437	FREEDOM TRAIL		2.7	1	1	3	10	5	1	3.0	1	1	5	3.0	8.9
465	FREEDOM TRAIL		2.7	1	1	3	10	5	1	3.0	1	1	5	3.0	8.9
579	QUANSET ROAD		4.1	5	1	3	1	5	1	3.0	1	1	5	3.0	9.1
585	FOREST WAY		4.1	5	1	3	1	5	1	3.0	1	1	5	3.0	9.1
608	ALDEN ROAD		4.1	5	1	3	1	5	1	3.0	1	1	5	3.0	9.1
617	FREEMAN LANE		4.1	5	1	3	1	5	1	3.0	1	1	5	3.0	9.1
664	0		2.7	1	1	3	10	5	1	3.0	1	1	5	3.0	8.9
688	FREEMAN LANE		4.1	5	1	3	1	5	1	3.0	1	1	5	3.0	9.1
689	FREEMAN LANE		4.1	5	1	3	1	5	1	3.0	1	1	5	3.0	9.1
744	FREEMAN LANE		4.1	5	1	3	1	5	1	3.0	1	1	5	3.0	9.1
747	ALDEN ROAD		4.1	5	1	3	1	5	1	3.0	1	1	5	3.0	9.1
764	FREEDOM TRAIL		2.7	1	1	3	10	5	1	3.0	1	1	5	3.0	8.9
765	FREEDOM TRAIL		2.7	1	1	3	10	5	1	3.0	1	1	5	3.0	8.9
766	PATRIOTS WAY		2.7	1	1	3	10	5	1	3.0	1	1	5	3.0	8.9
767	PATRIOTS WAY		2.7	1	1	3	10	5	1	3.0	1	1	5	3.0	8.9
768	FREEDOM TRAIL		2.7	1	1	3	10	5	1	3.0	1	1	5	3.0	8.9
769	LIBERTY LANE		2.7	1	1	3	10	5	1	3.0	1	1	5	3.0	8.9

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839	ALDEN ROAD		4.1	5	1	3	1	5	1	3.0	1	1	5	3.0	9.1
896	CAPTAIN DEAN ROAD		3.6	1	1	3	10	7	10	4.3	1	1	3	2.0	8.7
284	KINGS WAY		5	5	1	3	10	7	1	4.4	1	1	3	2.0	8.8
443	0		2.6	1	1	3	10	5	1	2.9	1	1	5	3.0	8.8
502	LITTLE COVE LANE		2.6	1	1	3	10	5	1	2.9	1	1	5	3.0	8.8
797	0		2.6	1	1	3	10	5	1	2.9	1	1	5	3.0	8.8
798	0		2.6	1	1	3	10	5	1	2.9	1	1	5	3.0	8.8
799	0		2.6	1	1	3	10	5	1	2.9	1	1	5	3.0	8.8
444	LOOMIS LANE		2.5	1	1	4	10	5	1	3.0	1	1	5	3.0	9.0
495	LOOMIS LANE		2.5	1	1	4	10	5	1	3.0	1	1	5	3.0	9.0
270	PINE NEEDLE WAY		4.9	5	1	3	10	7	1	4.4	1	1	3	2.0	8.7
272	SAND HILL LANE		4.9	5	1	3	10	7	1	4.4	1	1	3	2.0	8.7
891	PINE NEEDLE WAY		4.9	5	1	3	10	7	1	4.4	1	1	3	2.0	8.7
947	PINE NEEDLE WAY		4.9	5	1	3	10	7	1	4.4	1	1	3	2.0	8.7
949	CAPTAIN CURTIS WAY		4.9	5	1	3	10	7	1	4.4	1	1	3	2.0	8.7
205	EAST CIRCLE DRIVE		4.4	5	2.5	3	10	7	1	4.4	1	1	3	2.0	8.8
230	EAST CIRCLE DRIVE		4.4	5	2.5	3	10	7	1	4.4	1	1	3	2.0	8.8
274	CAPTAIN CURTIS WAY		4.4	5	2.5	3	10	7	1	4.4	1	1	3	2.0	8.8
287	BLUEBERRY ISLAND ROAD		5	1	1	4	10	7	1	4.1	1	1	3	2.0	8.2
492	SURF BOAT LANE		2.5	1	1	3	10	5	1	2.9	1	1	5	3.0	8.7
573	0		2.5	1	1	3	1	5	10	2.9	1	1	5	3.0	8.7
607	PRISCILLA ROAD		2.5	1	1	3	10	5	1	2.9	1	1	5	3.0	8.7
829	CRYSTAL LAKE DRIVE		3.9	5	1	3	1	5	1	3.0	1	1	5	3.0	8.9
333	COVE ROAD		4.8	5	1	3	10	7	1	4.3	1	1	3	2.0	8.6
242	GOSNOLD ROAD		4.7	5	1	3	10	7	1	4.3	1	1	3	2.0	8.6
243	GOSNOLD ROAD		4.7	5	1	3	10	7	1	4.3	1	1	3	2.0	8.6
197	0		5	1	1	3	10	7	1	4.0	1	1	3	2.0	8.0
198	0		5	1	1	3	10	7	1	4.0	1	1	3	2.0	8.0
577	LOCKWOOD LANE		4.1	1	1	4	1	5	1	2.7	1	1	5	3.0	8.2
763	NAMEQUOIT ROAD		4.1	1	1	4	1	5	1	2.7	1	1	5	3.0	8.2
854	NAUSET KNOLLS LANE		2.4	1	1	3	10	5	1	2.9	1	1	5	3.0	8.6
860	STURBRIDGE DRIVE		4.2	1	1	3	1	5	1	2.7	1	1	5	3.0	8.0
934	OLD COUNTY ROAD		2.2	1	1	4	1	7	1	2.1	10	1	3	3.8	7.9
226	WESTWOOD DRIVE		4.6	5	1	3	10	7	1	4.2	1	1	3	2.0	8.5
327	WESTWOOD DRIVE		4.6	5	1	3	10	7	1	4.2	1	1	3	2.0	8.5
334	OLD TOTE ROAD		4.6	5	1	3	10	7	1	4.2	1	1	3	2.0	8.5
737	BLUEBERRY ISLAND ROAD		2.3	1	1	3	10	5	1	2.8	1	1	5	3.0	8.5
739	BLUEBERRY ISLAND ROAD		2.3	1	1	3	10	5	1	2.8	1	1	5	3.0	8.5
202	QUAIL HILL LANE		4.5	5	1	3	10	7	1	4.2	1	1	3	2.0	8.4
203	QUAIL HILL LANE		4.5	5	1	3	10	7	1	4.2	1	1	3	2.0	8.4
204	QUAIL HILL LANE		4.5	5	1	3	10	7	1	4.2	1	1	3	2.0	8.4
278	BUFFLEHEAD LANE		3.7	1	5	3	1	7	10	4.1	1	1	3	2.0	8.2
290	NICKERSON ROAD		4.5	5	1	3	10	7	1	4.2	1	1	3	2.0	8.4
295	QUAIL HILL LANE		4.5	5	1	3	10	7	1	4.2	1	1	3	2.0	8.4
322	MORNINGSIDE CIRCLE		4.2	1	1	2	1	5	1	2.6	1	1	5	3.0	7.7
323	OVERLOOK CIRCLE		4.5	5	1	3	10	7	1	4.2	1	1	3	2.0	8.4
595	NAMEQUOIT ROAD		4.1	1	1	3	1	5	1	2.6	1	1	5	3.0	7.9
597	NAMEQUOIT ROAD		4.1	1	1	3	1	5	1	2.6	1	1	5	3.0	7.9
770	0		4.1	1	1	3	1	5	1	2.6	1	1	5	3.0	7.9

Water Distribution System Business Risk Exposure Matrix

GIS Object ID	Street Name		Asset Life Consumed	Material	Repair History	Static Pressure	Soil Type	Freezing Potential	Saltwater Intrusion	Likelihood of Failure	Business Interruption	Traffic Issues	Fire Protection Disruption	Consequence of Failure	Business Risk Exposure
861	STURBRIDGE DRIVE		4.2	1	1	2	1	5	1	2.6	1	1	5	3.0	7.7
960	NAMEQUOIT ROAD		4.1	1	1	3	1	5	1	2.6	1	1	5	3.0	7.9
291	NICKERSON ROAD		4.5	5	1	2	10	7	1	4.1	1	1	3	2.0	8.2
385	NAUSET FARMS WAY		4.4	5	1	3	10	7	1	4.2	1	1	3	2.0	8.3
328	WOODLAND PARK LANE		4.8	1	1	3	10	7	1	3.9	1	1	3	2.0	7.8
329	WOODLAND PARK LANE		4.8	1	1	3	10	7	1	3.9	1	1	3	2.0	7.8
187	DEFIANCE LANE		5	5.5	1	4	10	8	10	5.5	1	1	2	1.5	8.3
515	0		4	1	1	3	1	5	1	2.6	1	1	5	3.0	7.8
562	TOWHEE LANE		4	1	1	3	1	5	1	2.6	1	1	5	3.0	7.8
630	BEACH PLUM ROAD		2.2	1	1	3	10	5	1	2.8	1	1	5	3.0	8.3
843	0		4	1	1	3	1	5	1	2.6	1	1	5	3.0	7.8
215	TONSET WOODS		4.3	5	1	3	10	7	1	4.1	1	1	3	2.0	8.2
223	DRIFTWOOD LANE		4.3	5	1	3	10	7	1	4.1	1	1	3	2.0	8.2
940	0		1	1	1	3	10	3	1	2.2	1	1	7	4.0	8.8
501	BEGINNERS LANE		2.1	1	1	3	10	5	1	2.7	1	1	5	3.0	8.2
749	BEGINNERS LANE		2.1	1	1	3	10	5	1	2.7	1	1	5	3.0	8.2
826	CLAYTON CIRCLE		2.1	1	1	3	10	5	1	2.7	1	1	5	3.0	8.2
827	CLAYTON CIRCLE		2.1	1	1	3	10	5	1	2.7	1	1	5	3.0	8.2
337	0		4.1	5	1	4	10	7	1	4.1	1	1	3	2.0	8.3
381	MEGS LANE		4.2	5	1	3	10	7	1	4.1	1	1	3	2.0	8.2
221	DEERWOOD LANE		4.5	1	1	3	10	7	1	3.8	1	1	3	2.0	7.6
954	SMITH NECK ROAD		4.1	5	1	3	10	7	1	4.0	1	1	3	2.0	8.1
714	0		3.8	1	1	3	1	5	1	2.5	1	1	5	3.0	7.6
715	0		3.8	1	1	3	1	5	1	2.5	1	1	5	3.0	7.6
716	0		3.8	1	1	3	1	5	1	2.5	1	1	5	3.0	7.6
835	0		3.8	1	1	3	1	5	1	2.5	1	1	5	3.0	7.6
410	BRIDGE ROAD		5.3	5	2.5	4	1	7	1	3.9	1	1	3	2.0	7.9
773	0		2	1	1	3	10	5	1	2.7	1	1	5	3.0	8.1
824	0		1.9	1	1	4	10	5	1	2.8	1	1	5	3.0	8.3
244	TWISS ROAD		5.3	5	2.5	3	1	7	1	3.8	1	1	3	2.0	7.7
822	BAY RIDGE LANE		3.7	1	1	3	1	5	1	2.5	1	1	5	3.0	7.4
489	COUNTRYSIDE DRIVE		3.7	1	1	3	1	5	1	2.5	1	1	5	3.0	7.4
553	HERRING BROOK WAY		3.7	1	1	3	1	5	1	2.5	1	1	5	3.0	7.4
647	0		3.7	1	1	3	1	5	1	2.5	1	1	5	3.0	7.4
701	VIKING ROAD		3.6	1	1	4	1	5	1	2.5	1	1	5	3.0	7.6
702	DUCK MARSH LANE		3.6	1	1	4	1	5	1	2.5	1	1	5	3.0	7.6
707	PERSHING LANE		3.6	1	1	4	1	5	1	2.5	1	1	5	3.0	7.6
709	KENNETH LANE		3.6	1	1	4	1	5	1	2.5	1	1	5	3.0	7.6
710	KENNETH LANE		3.6	1	1	4	1	5	1	2.5	1	1	5	3.0	7.6
363	0		3.9	5	1	3	10	7	1	4.0	1	1	3	2.0	7.9
970	0		1.4	1	2.5	3	1	5	10	2.7	1	1	5	3.0	8.1
407	HARBOR HILL DRIVE		5	5.5	2.5	3	1	7	1	3.8	1	1	3	2.0	7.6
453	NORTHWOOD DRIVE		3.6	1	1	3	1	5	1	2.4	1	1	5	3.0	7.3
543	SIBSIE LANE		3.6	1	1	3	1	5	1	2.4	1	1	5	3.0	7.3
544	0		3.6	1	1	3	1	5	1	2.4	1	1	5	3.0	7.3
551	PERSHING LANE		3.6	1	1	3	1	5	1	2.4	1	1	5	3.0	7.3
552	PERSHING LANE		3.6	1	1	3	1	5	1	2.4	1	1	5	3.0	7.3
554	KEZIAHS LANE		3.6	1	1	3	1	5	1	2.4	1	1	5	3.0	7.3
555	KEZIAHS LANE		3.6	1	1	3	1	5	1	2.4	1	1	5	3.0	7.3

Water Distribution System Business Risk Exposure Matrix

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556	FROST FISH LANE		3.6	1	1	3	1	5	1	2.4	1	1	5	3.0	7.3
557	FROST FISH LANE		3.6	1	1	3	1	5	1	2.4	1	1	5	3.0	7.3
558	KEZIAHS LANE		3.6	1	1	3	1	5	1	2.4	1	1	5	3.0	7.3
561	TOWHEE LANE		3.6	1	1	3	1	5	1	2.4	1	1	5	3.0	7.3
570	KESCAYOGANSETT ROAD		3.6	1	1	3	1	5	1	2.4	1	1	5	3.0	7.3
571	LINNELL LANE		3.6	1	1	3	1	5	1	2.4	1	1	5	3.0	7.3
572	0		3.6	1	1	3	1	5	1	2.4	1	1	5	3.0	7.3
574	BLUE HERON WAY		3.6	1	1	3	1	5	1	2.4	1	1	5	3.0	7.3
611	CAMP ROAD		3.6	1	1	3	1	5	1	2.4	1	1	5	3.0	7.3
669	CENTER PLACE		1.8	1	1	3	10	5	1	2.6	1	1	5	3.0	7.9
686	KENNETH LANE		3.6	1	1	3	1	5	1	2.4	1	1	5	3.0	7.3
687	PERSHING LANE		3.6	1	1	3	1	5	1	2.4	1	1	5	3.0	7.3
704	KENNETH LANE		3.6	1	1	3	1	5	1	2.4	1	1	5	3.0	7.3
705	KENNETH LANE		3.6	1	1	3	1	5	1	2.4	1	1	5	3.0	7.3
706	LINNELL LANE		3.6	1	1	3	1	5	1	2.4	1	1	5	3.0	7.3
708	PERSHING LANE		3.6	1	1	3	1	5	1	2.4	1	1	5	3.0	7.3
746	CULLUM ROAD		3.6	1	1	3	1	5	1	2.4	1	1	5	3.0	7.3
805	0		3.6	1	1	3	1	5	1	2.4	1	1	5	3.0	7.3
828	JOY LANE		3.6	1	1	3	1	5	1	2.4	1	1	5	3.0	7.3
840	CULLUM ROAD		3.6	1	1	3	1	5	1	2.4	1	1	5	3.0	7.3
857	0		3.6	1	1	3	1	5	1	2.4	1	1	5	3.0	7.3
865	0		3.6	1	1	3	1	5	1	2.4	1	1	5	3.0	7.3
963	KENNETH LANE		3.6	1	1	3	1	5	1	2.4	1	1	5	3.0	7.3
969	TOWHEE LANE		3.6	1	1	3	1	5	1	2.4	1	1	5	3.0	7.3
729	0		3.7	1	1	2	1	5	1	2.4	1	1	5	3.0	7.1
730	0		3.7	1	1	2	1	5	1	2.4	1	1	5	3.0	7.1
386	OVERLOOK CIRCLE		4.1	1	1	3	10	7	1	3.6	1	1	3	2.0	7.3
586	0		3.5	1	1	3	1	5	1	2.4	1	1	5	3.0	7.2
587	0		3.5	1	1	3	1	5	1	2.4	1	1	5	3.0	7.2
618	0		3.5	1	1	3	1	5	1	2.4	1	1	5	3.0	7.2
762	0		3.5	1	1	3	1	5	1	2.4	1	1	5	3.0	7.2
964	0		3.5	1	1	3	1	5	1	2.4	1	1	5	3.0	7.2
299	CANAL ROAD		5.3	5	1	4	1	7	1	3.7	1	1	3	2.0	7.4
483	0		1.7	1	1	3	10	5	1	2.6	1	1	5	3.0	7.7
499	0		1.7	1	1	3	10	5	1	2.6	1	1	5	3.0	7.7
723	0		1.7	1	1	3	10	5	1	2.6	1	1	5	3.0	7.7
848	0		3.6	1	1	2	1	5	1	2.3	1	1	5	3.0	7.0
69	JONES ROAD		2	1	1	4	1	2	1	1.8	1	1	8	4.5	7.9
94	JONES ROAD		2	1	1	4	1	2	1	1.8	1	1	8	4.5	7.9
95	JONES ROAD		2	1	1	4	1	2	1	1.8	1	1	8	4.5	7.9
97	JONES ROAD		2	1	1	4	1	2	1	1.8	1	1	8	4.5	7.9
263	MILL POND ROAD		5.3	5	1	3	1	7	1	3.6	1	1	3	2.0	7.2
268	CHAMPLAIN ROAD		5.3	5	1	3	1	7	1	3.6	1	1	3	2.0	7.2
344	MILL POND ROAD		5.3	5	1	3	1	7	1	3.6	1	1	3	2.0	7.2
192	0		5	5.5	1	4	1	7	1	3.7	1	1	3	2.0	7.3
298	CANAL ROAD		5	5.5	1	4	1	7	1	3.7	1	1	3	2.0	7.3
336	BLUEBERRY ISLAND ROAD		5	5.5	1	4	1	7	1	3.7	1	1	3	2.0	7.3
358	0		5	5.5	1	4	1	7	1	3.7	1	1	3	2.0	7.3
359	0		5	5.5	1	4	1	7	1	3.7	1	1	3	2.0	7.3

Water Distribution System Business Risk Exposure Matrix

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474	JUNIPER HILL ROAD		3.4	1	1	3	1	5	1	2.4	1	1	5	3.0	7.1
580	0		3.4	1	1	3	1	5	1	2.4	1	1	5	3.0	7.1
581	0		3.4	1	1	3	1	5	1	2.4	1	1	5	3.0	7.1
582	ELLERSIE ROAD		3.4	1	1	3	1	5	1	2.4	1	1	5	3.0	7.1
691	GWENS LANE		1.6	1	1	3	10	5	1	2.5	1	1	5	3.0	7.6
692	GWENS LANE		1.6	1	1	3	10	5	1	2.5	1	1	5	3.0	7.6
693	GWENS LANE		1.6	1	1	3	10	5	1	2.5	1	1	5	3.0	7.6
694	GWENS LANE		1.6	1	1	3	10	5	1	2.5	1	1	5	3.0	7.6
695	GWENS LANE		1.6	1	1	3	10	5	1	2.5	1	1	5	3.0	7.6
696	GWENS LANE		1.6	1	1	3	10	5	1	2.5	1	1	5	3.0	7.6
718	0		3.5	1	1	2	1	5	1	2.3	1	1	5	3.0	6.9
748	0		3.4	1	1	3	1	5	1	2.4	1	1	5	3.0	7.1
976	ELLERSIE ROAD		3.4	1	1	3	1	5	1	2.4	1	1	5	3.0	7.1
325	BEACH ROAD		3.8	1	1	3	10	7	1	3.5	1	1	3	2.0	7.0
201	OLD TOTE ROAD		5	5.5	1	3	1	7	1	3.6	1	1	3	2.0	7.1
228	BLUEBERRY LANE		5	5.5	1	3	1	7	1	3.6	1	1	3	2.0	7.1
237	OLD DUCK HOLE ROAD		5	5.5	1	3	1	7	1	3.6	1	1	3	2.0	7.1
251	LAKE DRIVE		5	5.5	1	3	1	7	1	3.6	1	1	3	2.0	7.1
252	WINSLOW DRIVE		5	5.5	1	3	1	7	1	3.6	1	1	3	2.0	7.1
253	WINSLOW DRIVE		5	5.5	1	3	1	7	1	3.6	1	1	3	2.0	7.1
254	WINSLOW DRIVE		5	5.5	1	3	1	7	1	3.6	1	1	3	2.0	7.1
255	BOULDER LANE		5	5.5	1	3	1	7	1	3.6	1	1	3	2.0	7.1
256	BOULDER LANE		5	5.5	1	3	1	7	1	3.6	1	1	3	2.0	7.1
296	OLD TOTE ROAD		5	5.5	1	3	1	7	1	3.6	1	1	3	2.0	7.1
310	BOULDER LANE		5	5.5	1	3	1	7	1	3.6	1	1	3	2.0	7.1
313	NORTHWOOD DRIVE		5	5.5	1	3	1	7	1	3.6	1	1	3	2.0	7.1
406	HARBOR HILL DRIVE		5	5.5	1	3	1	7	1	3.6	1	1	3	2.0	7.1
484	OPA'S WAY		1.5	1	1	3	10	5	1	2.5	1	1	5	3.0	7.5
485	COLE PLACE		1.5	1	1	3	10	5	1	2.5	1	1	5	3.0	7.5
598	0		3.3	1	1	3	1	5	1	2.3	1	1	5	3.0	7.0
855	PILGRIM DRIVE		3.3	1	1	3	1	5	1	2.3	1	1	5	3.0	7.0
907	0		3.4	1	1	2	1	5	1	2.3	1	1	5	3.0	6.8
961	STURBRIDGE DRIVE		3.3	1	1	3	1	5	1	2.3	1	1	5	3.0	7.0
72	0		2	1	1	3	1	2	1	1.7	1	1	8	4.5	7.4
951	CAPTAIN CURTIS WAY		3.7	1	1	3	10	7	1	3.5	1	1	3	2.0	7.0
207	0		3.6	1	1	3	10	7	1	3.4	1	1	3	2.0	6.9
208	0		3.6	1	1	3	10	7	1	3.4	1	1	3	2.0	6.9
209	0		3.6	1	1	3	10	7	1	3.4	1	1	3	2.0	6.9
210	0		1.7	1	1	4	10	7	10	3.7	1	1	3	2.0	7.4
211	0		1.7	1	1	4	10	7	10	3.7	1	1	3	2.0	7.4
214	0		3.6	1	1	3	10	7	1	3.4	1	1	3	2.0	6.9
353	0		1.7	1	1	4	10	7	10	3.7	1	1	3	2.0	7.4
368	0		3.6	1	1	3	10	7	1	3.4	1	1	3	2.0	6.9
376	CUMMINGS ROAD		3.6	1	1	3	10	7	1	3.4	1	1	3	2.0	6.9
378	CUMMINGS ROAD		3.6	1	1	3	10	7	1	3.4	1	1	3	2.0	6.9
469	NAUSET HEIGHTS ROAD		1.4	1	1	3	10	5	1	2.5	1	1	5	3.0	7.4
472	0		1.4	1	1	3	1	5	10	2.5	1	1	5	3.0	7.4
583	0		3.2	1	1	3	1	5	1	2.3	1	1	5	3.0	6.8
604	SNOW GOOSE LANE		1.4	1	1	3	10	5	1	2.5	1	1	5	3.0	7.4

Water Distribution System Business Risk Exposure Matrix

GIS Object ID	Street Name		Asset Life Consumed	Material	Repair History	Static Pressure	Soil Type	Freezing Potential	Saltwater Intrusion	Likelihood of Failure	Business Interruption	Traffic Issues	Fire Protection Disruption	Consequence of Failure	Business Risk Exposure
712	MONUMENT ROAD		3.2	1	1	3	1	5	1	2.3	1	1	5	3.0	6.8
195	ELLIS ROAD		4.8	5	1	4	1	7	1	3.5	1	1	3	2.0	7.0
196	ELLIS ROAD		4.8	5	1	4	1	7	1	3.5	1	1	3	2.0	7.0
360	ELLIS ROAD		4.8	5	1	4	1	7	1	3.5	1	1	3	2.0	7.0
968	WINSLOW DRIVE		4.9	5	1	3	1	7	1	3.5	1	1	3	2.0	6.9
231	COLONY DRIVE		4.4	5	2.5	3	1	7	1	3.5	1	1	3	2.0	7.0
133	0		5	5.5	1	4	10	8	1	4.6	1	1	2	1.5	6.9
134	0		5	5.5	1	4	10	8	1	4.6	1	1	2	1.5	6.9
186	UNCLE BENS WAY		5	5.5	1	4	10	8	1	4.6	1	1	2	1.5	6.9
455	LOBSTER LANE		1.3	1	1	3	10	5	1	2.4	1	1	5	3.0	7.3
457	COLLINS LANE		1.3	1	1	3	10	5	1	2.4	1	1	5	3.0	7.3
130	CARVER ROAD		5	5.5	1	3	10	8	1	4.5	1	1	2	1.5	6.8
300	LOWELL DRIVE		4.7	5	1	3	1	7	1	3.4	1	1	3	2.0	6.8
315	LOWELL DRIVE		4.7	5	1	3	1	7	1	3.4	1	1	3	2.0	6.8
316	WESQUANSETT ROAD		4.7	5	1	3	1	7	1	3.4	1	1	3	2.0	6.8
348	FRANZ ROAD		3.2	1	1	4	10	7	1	3.4	1	1	3	2.0	6.8
356	LOWELL DRIVE		4.7	5	1	3	1	7	1	3.4	1	1	3	2.0	6.8
391	CHAPIN CIRCLE		4.7	5	1	3	1	7	1	3.4	1	1	3	2.0	6.8
312	0		5	1	1	3	1	7	1	3.1	1	1	3	2.0	6.2
393	PILGRIM DRIVE		5	1	1	3	1	7	1	3.1	1	1	3	2.0	6.2
432	FELLS LANE		1.2	1	1	3	10	5	1	2.4	1	1	5	3.0	7.1
434	DRUMMOND ROAD		1.2	1	1	3	10	5	1	2.4	1	1	5	3.0	7.1
601	0		3	1	1	3	1	5	1	2.2	1	1	5	3.0	6.6
200	OLD TOTE ROAD		4.6	5	1	3	1	7	1	3.3	1	1	3	2.0	6.7
387	0		4.2	5	2.5	2	1	7	1	3.3	1	1	3	2.0	6.6
433	0		1.2	1	1	2	10	5	1	2.3	1	1	5	3.0	6.8
229	COLONY DRIVE		4.4	5	1	3	1	7	1	3.3	1	1	3	2.0	6.5
326	COLONY DRIVE		4.4	5	1	3	1	7	1	3.3	1	1	3	2.0	6.5
592	RIDGEWOOD ROAD		2.8	1	1	3	1	5	1	2.1	1	1	5	3.0	6.4
602	HIGGINS POND ROAD		2.8	1	1	3	1	5	1	2.1	1	1	5	3.0	6.4
717	0		2.8	1	1	3	1	5	1	2.1	1	1	5	3.0	6.4
132	HOPKINS LANE		1	1	1	3	10	5	1	2.3	1	1	5	3.0	6.9
213	0		4.3	5	1	3	1	7	1	3.2	1	1	3	2.0	6.4
258	WOODRIDGE ROAD		4.3	5	1	3	1	7	1	3.2	1	1	3	2.0	6.4
319	COUNTRYSIDE DRIVE		4.3	5	1	3	1	7	1	3.2	1	1	3	2.0	6.4
354	OLD DUCK HOLE ROAD		4.3	5	1	3	1	7	1	3.2	1	1	3	2.0	6.4
364	HIGHVIEW LANE		4.3	5	1	3	1	7	1	3.2	1	1	3	2.0	6.4
390	WINDSWEPT LANE		4.3	5	1	3	1	7	1	3.2	1	1	3	2.0	6.4
924	COUNTRYSIDE DRIVE		4.3	5	1	3	1	7	1	3.2	1	1	3	2.0	6.4
956	COUNTRYSIDE DRIVE		4.3	5	1	3	1	7	1	3.2	1	1	3	2.0	6.4
279	WOODS COVE ROAD		4.2	5	1	3	1	7	1	3.2	1	1	3	2.0	6.4
317	WESQUANSETT ROAD		4.1	5	1	3	1	7	1	3.1	1	1	3	2.0	6.3
318	WESQUANSETT ROAD		4.1	5	1	3	1	7	1	3.1	1	1	3	2.0	6.3
950	CAPTAIN CURTIS WAY		4.1	5	1	3	1	7	1	3.1	1	1	3	2.0	6.3
468	HARRIS ROAD		0.8	1	1	3	10	5	1	2.2	1	1	5	3.0	6.7
481	0		2.6	1	1	3	1	5	1	2.0	1	1	5	3.0	6.1
314	BAMBI WAY		4.4	1	1	3	1	7	1	2.9	1	1	3	2.0	5.7
377	DOANE TERRACE		2.5	1	1	3	10	7	1	3.0	1	1	3	2.0	6.0
596	NAMEQUOIT ROAD		2.5	1	1	3	1	5	1	2.0	1	1	5	3.0	6.0

Water Distribution System Business Risk Exposure Matrix

GIS Object ID	Street Name		Asset Life Consumed	Material	Repair History	Static Pressure	Soil Type	Freezing Potential	Saltwater Intrusion	Likelihood of Failure	Business Interruption	Traffic Issues	Fire Protection Disruption	Consequence of Failure	Business Risk Exposure
257	RIVERVIEW WAY		4.1	1	1	4	1	7	1	2.8	1	1	3	2.0	5.7
856	SOUTH ORLEANS ROAD		2.3	1	1	3	1	5	1	1.9	1	1	5	3.0	5.8
182	SKAKET CIRCLE		5	5.5	1	4	10	10	10	5.6	1	1	1	1.0	5.6
183	SKAKET CIRCLE		5	5.5	1	4	10	10	10	5.6	1	1	1	1.0	5.6
184	SMITH BROTHERS WAY		5	5.5	1	4	10	10	10	5.6	1	1	1	1.0	5.6
185	BONNELL LANE		5	5.5	1	4	10	10	10	5.6	1	1	1	1.0	5.6
188	DEFIANCE LANE		5	5.5	1	4	10	10	10	5.6	1	1	1	1.0	5.6
135	ARCHER LANE		5	5.5	1	3	10	10	10	5.5	1	1	1	1.0	5.5
160	BLAKE LANE		5	5.5	1	3	10	10	10	5.5	1	1	1	1.0	5.5
164	JACK KNIFE POINT ROAD		5	5.5	1	3	10	10	10	5.5	1	1	1	1.0	5.5
168	MANITO ROAD		5	5.5	1	3	10	10	10	5.5	1	1	1	1.0	5.5
470	0		2.2	1	1	3	1	5	1	1.9	1	1	5	3.0	5.6
834	0		2.2	1	1	3	1	5	1	1.9	1	1	5	3.0	5.6
169	0		5	5	1	3	10	10	10	5.5	1	1	1	1.0	5.5
152	0		5	5.5	1	3	1	8	1	3.6	1	1	2	1.5	5.4
153	BAY RIDGE LANE		5	5.5	1	3	1	8	1	3.6	1	1	2	1.5	5.4
154	0		5	5.5	1	3	1	8	1	3.6	1	1	2	1.5	5.4
157	DYLAN WAY		5	5.5	1	3	1	8	1	3.6	1	1	2	1.5	5.4
100	0		0.9	1	1	3	1	1	1	1.2	1	1	10	5.5	6.4
952	SEAVIEW ROAD		2	1	1	3	10	7	1	2.8	1	1	3	2.0	5.6
175	0		5	5.5	1	2	1	8	1	3.5	1	1	2	1.5	5.3
392	AUNT ABIGAILS WAY		3.7	1	1	3	1	7	1	2.6	1	1	3	2.0	5.2
520	0		2.1	1	1	3	1	5	1	1.8	1	1	5	3.0	5.5
713	0		2.1	1	1	3	1	5	1	1.8	1	1	5	3.0	5.5
919	SEA BREEZE LANE		5	1	1	4	10	10	10	5.2	1	1	1	1.0	5.2
932	0		1.7	1	1	4	1	7	10	2.8	1	1	3	2.0	5.6
161	MAYONA CIRCLE		4.5	5	1	3	10	10	10	5.3	1	1	1	1.0	5.3
177	LITTLE MARSH LANE		5	1	1	3	1	8	1	3.2	1	1	2	1.5	4.7
142	0		3.1	1	1	3	10	8	1	3.3	1	1	2	1.5	4.9
216	0		1.5	1	1	3	10	7	1	2.6	1	1	3	2.0	5.2
217	0		1.5	1	1	3	10	7	1	2.6	1	1	3	2.0	5.2
155	0		5	5.5	2.5	3	10	10	1	4.8	1	1	1	1.0	4.8
30	0		0.9	1	1	3	1	2	1	1.2	1	1	8	4.5	5.4
31	0		0.9	1	1	3	1	2	1	1.2	1	1	8	4.5	5.4
32	0		0.9	1	1	3	1	2	1	1.2	1	1	8	4.5	5.4
33	0		0.9	1	1	3	1	2	1	1.2	1	1	8	4.5	5.4
126	ALDEN ROAD		5	5.5	1	4	1	10	10	4.7	1	1	1	1.0	4.7
138	LIBERTY LANE		2.7	1	1	3	10	8	1	3.1	1	1	2	1.5	4.7
139	0		2.7	1	1	3	10	8	1	3.1	1	1	2	1.5	4.7
193	HIDDEN VALLEY ROAD		1.2	1	1	3	10	7	1	2.5	1	1	3	2.0	5.0
372	HIDDEN VALLEY ROAD		1.2	1	1	3	10	7	1	2.5	1	1	3	2.0	5.0
148	HERRING BROOK WAY		5	5.5	1	3	1	10	10	4.6	1	1	1	1.0	4.6
156	MILL RACE		5	5.5	1	3	1	10	10	4.6	1	1	1	1.0	4.6
162	JACK KNIFE POINT ROAD		5	5.5	1	3	1	10	10	4.6	1	1	1	1.0	4.6
166	0		5	5.5	1	3	1	10	10	4.6	1	1	1	1.0	4.6
131	OAK LANE		5	5.5	1	3	10	10	1	4.6	1	1	1	1.0	4.6
136	0		5	5.5	1	3	10	10	1	4.6	1	1	1	1.0	4.6
140	0		5	5.5	1	3	10	10	1	4.6	1	1	1	1.0	4.6
141	0		5	5.5	1	3	10	10	1	4.6	1	1	1	1.0	4.6

Water Distribution System Business Risk Exposure Matrix

GIS Object ID	Street Name		Asset Life Consumed	Material	Repair History	Static Pressure	Soil Type	Freezing Potential	Saltwater Intrusion	Likelihood of Failure	Business Interruption	Traffic Issues	Fire Protection Disruption	Consequenc e of Failure	Business Risk Exposure
147	0		5	5.5	1	3	10	10	1	4.6	1	1	1	1.0	4.6
150	0		5	5.5	1	3	10	10	1	4.6	1	1	1	1.0	4.6
151	0		5	5.5	1	3	10	10	1	4.6	1	1	1	1.0	4.6
159	LUCYS LN		5	5.5	1	3	10	10	1	4.6	1	1	1	1.0	4.6
163	JACK KNIFE POINT ROAD		5	5.5	1	3	10	10	1	4.6	1	1	1	1.0	4.6
167	LEWIS ROAD		5	5.5	1	3	10	10	1	4.6	1	1	1	1.0	4.6
473	JUNIPER HILL ROAD		1.6	1	1	3	1	5	1	1.6	1	1	5	3.0	4.9
745	JUNIPER HILL ROAD		1.6	1	1	3	1	5	1	1.6	1	1	5	3.0	4.9
143	COMMERCE DRIVE		5	5.5	1	2	10	10	1	4.5	1	1	1	1.0	4.5
149	COMMERCE DRIVE		5	5.5	1	2	10	10	1	4.5	1	1	1	1.0	4.5
464	OPA'S WAY		1.5	1	1	3	1	5	1	1.6	1	1	5	3.0	4.8
144	BEACH PLUM ROAD		5	1	1	4	10	10	1	4.3	1	1	1	1.0	4.3
165	BLOSSOM LANE		5	1	1	3	10	10	1	4.2	1	1	1	1.0	4.2
463	BAKERS POND ROAD		1.4	1	1	3	1	5	1	1.6	1	1	5	3.0	4.7
466	BAKERS POND ROAD		1.4	1	1	3	1	5	1	1.6	1	1	5	3.0	4.7
971	FLAX POND ROAD		1.4	1	1	3	1	5	1	1.6	1	1	5	3.0	4.7
431	WINSLOW WAY		1.3	1	1	3	1	5	1	1.5	1	1	5	3.0	4.6
458	RICHWOOD FARM LANE		1.3	1	1	3	1	5	1	1.5	1	1	5	3.0	4.6
759	PORTANIMICUT ROAD		1.3	1	1	3	1	5	1	1.5	1	1	5	3.0	4.6
884	0		1.2	1	1	3	1	5	1	1.5	1	1	5	3.0	4.4
128	0		1.7	1	1	4	1	8	10	2.8	1	1	2	1.5	4.2
752	0		1.2	1	1	3	1	5	1	1.5	1	1	5	3.0	4.4
129	0		5	5.5	1	3	1	10	1	3.7	1	1	1	1.0	3.7
137	PORTANIMICUT ROAD		5	5.5	1	3	1	10	1	3.7	1	1	1	1.0	3.7
146	0		5	5.5	1	3	1	10	1	3.7	1	1	1	1.0	3.7
171	0		5	5.5	1	3	1	10	1	3.7	1	1	1	1.0	3.7
172	0		5	5.5	1	3	1	10	1	3.7	1	1	1	1.0	3.7
174	0		5	5.5	1	3	1	10	1	3.7	1	1	1	1.0	3.7
179	0		5	5.5	1	3	1	10	1	3.7	1	1	1	1.0	3.7
941	0		1	1	1	3	1	5	1	1.4	1	1	5	3.0	4.2
265	MILL POND ROAD		2	1	1	3	1	7	1	1.9	1	1	3	2.0	3.8
917	0		2	1	1	3	1	7	1	1.9	1	1	3	2.0	3.8
411	0		0.9	1	1	3	1	5	1	1.4	1	1	5	3.0	4.1
412	0		0.9	1	1	3	1	5	1	1.4	1	1	5	3.0	4.1
413	0		0.9	1	1	3	1	5	1	1.4	1	1	5	3.0	4.1
180	TOWHEE LANE		5	1	1	3	1	10	1	3.3	1	1	1	1.0	3.3
181	WHIPPORWILL LANE		5	1	1	3	1	10	1	3.3	1	1	1	1.0	3.3
264	NORSEMANS DRIVE		1.7	1	1	3	1	7	1	1.8	1	1	3	2.0	3.6
890	SEAVIEW ROAD		1.7	1	1	3	1	7	1	1.8	1	1	3	2.0	3.6
158	0		3.6	1	1	3	1	10	1	2.7	1	1	1	1.0	2.7
127	0		1.7	1	1	4	1	8	1	1.9	1	1	2	1.5	2.9
173	ELLERSIE ROAD		3.4	1	1	3	1	10	1	2.6	1	1	1	1.0	2.6
883	SPIDER WEB LANE		0.3	1	1	3	1	5	1	1.1	1	1	5	3.0	3.4
176	RIDGEWOOD ROAD		2.8	1	1	3	1	10	1	2.4	1	1	1	1.0	2.4
170	0		2.7	1	1	3	1	10	1	2.3	1	1	1	1.0	2.3
178	ELI ROGERS ROAD		2.3	1	1	3	1	10	1	2.2	1	1	1	1.0	2.2
125	0		0.9	1	1	3	1	8	1	1.5	1	1	2	1.5	2.3
918	0		2	1	1	3	1	10	1	2.1	1	1	1	1.0	2.1

FACILITY BRE

Asset Identification					Baseline Info			Current Yr:	2013	Performance Elements					Likelihood of Failure			Consequence of Failure				
Rank	Asset ID			Asset Name	Build / Install date	Refurb/ Replace Date	Mgt Strategy Group	Expected (Design) Life (Yrs)	Remaining Expected (Design) Life (Yrs)	Physical Condition	Operational/ Process Performance	Reliability	Maintainability	Asset Composite Performance Score	% Effective Life Consumed (based on composite performance score)	OVERRIDE FIELD* Expected Remaining Effective Life (Yrs)	LoF	Social/ Community	Economic/ Financial	Environmental	COF Score	Core Risk Score (worst = 100)
1	432	WTP	Electrical	VFDs	2005			20	12.0	7	7	4	10	6.6	66%		6.6	6	6	5	5.7	37.0
2	427	WTP	SCADA	Computer	2005			10	2.0	5	5	5	5	5.0	50%		5.0	8	2	5	5.2	25.8
3	33	Well 1	SCADA	Radio	1963	2007		10	4.0	5	5	5	5	5.0	50%		5.0	8	2	5	5.2	25.8
4	421	WTP	SCADA	Radio	2005			10	2.0	5	5	3	3	3.9	39%		3.9	8	4	4	5.4	21.1
5	420	WTP	SCADA	CP-x	2005			10	2.0	3	5	3	3	3.6	36%		3.6	8	4	4	5.4	19.4
6	32	Well 1	SCADA	CP-x	1963	2007		10	4.0	5	5	5	5	5.0	50%		5.0	8	2	1	3.8	18.8
7	398	WTP	Architectural	Roof	2005			50	42.0	4	3	3	3	3.2	32%		3.2	7	7	3	5.6	17.6
8	37	Well 1	Electrical	MCC	1963	2007		20	14.0	2	4	4	3	3.5	35%		3.5	7	2	5	4.8	16.8
9	422	WTP	SCADA	Level	2005			10	2.0	3	3	3	3	3.0	30%		3.0	8	4	4	5.4	16.2
10	387	WTP	Membrane Process	Membrane rack 1	2005	2009		10	6.0	5	5	3	5	4.3	43%		4.3	4	5	2	3.6	15.5
11	388	WTP	Membrane Process	Membrane rack 2	2005	2010		10	7.0	5	5	3	5	4.3	43%		4.3	4	5	2	3.6	15.5
12	389	WTP	Membrane Process	Membrane rack 3	2005	2011		10	8.0	5	5	3	5	4.3	43%		4.3	4	5	2	3.6	15.5
13	448	Treatment	Computers		2008			5	-	5	3	3	3	3.3	33%		3.3	7	2	1	3.4	11.2
14	71	Well 2	SCADA	Flow	1963	2007		10	4.0	7	7	5	7	6.3	63%		6.3	4	2	1	2.4	14.8
15	434	WTP	Electrical	Generator	2005			20	12.0	3	3	3	3	3.0	30%		3.0	5	6	3	4.6	13.8
16	399	WTP	Architectural	Walls	2005			50	42.0	4	3	1	3	2.5	25%		2.5	7	7	3	5.6	13.7
17	132	Well 4	Production Wells	Pump	2005			20	12.0	8	7	3	3	5.0	50%		5.0	3	2	3	2.7	13.4
18	217	Well 6	Production Wells	Pump	1986	2005		20	12.0	8	7	3	3	5.0	50%		5.0	3	2	3	2.7	13.4
19	491	Fac1	SCADA	CP-x	1990			10	(13.0)	3	3	3	3	3.0	30%		3.0	7	2	4	4.5	13.4
20	492	Fac1	SCADA	Level	1990			10	(13.0)	3	3	3	3	3.0	30%		3.0	7	2	4	4.5	13.4
21	493	Fac1	SCADA	Flow	1990			10	(13.0)	3	3	3	3	3.0	30%		3.0	7	2	4	4.5	13.4
22	494	Fac1	SCADA	Status	1990			10	(13.0)	3	3	3	3	3.0	30%		3.0	7	2	4	4.5	13.4
23	547	Tank 1	SCADA		2000			10	(3.0)	3	3	3	3	3.0	30%		3.0	6	2	5	4.5	13.4
24	433	WTP	Electrical	Transfer Switch	2005			20	12.0	3	3	3	3	3.0	30%		3.0	5	5	3	4.3	12.9
25	397	WTP	Architectural	Foundation	2005			50	42.0	3	2	3	1	2.3	23%		2.3	7	7	3	5.6	12.9
26	447	Treatment	Calibration Equipment		2008			10	5.0	3	3	2	3	2.7	27%		2.7	7	2	5	4.8	12.7
27	548	Tank 1	Electrical		2000			20	7.0	2	3	3	3	2.9	29%		2.9	6	2	5	4.5	12.7
28	558	Tank 2	Electrical		2000			20	7.0	2	3	3	3	2.9	29%		2.9	6	2	5	4.5	12.7
29	424	WTP	SCADA	pH	2005			10	2.0	2	3	3	3	2.9	29%		2.9	6	2	5	4.5	12.7
30	425	WTP	SCADA	Chlorine	2005			10	2.0	2	3	3	3	2.9	29%		2.9	6	2	5	4.5	12.7
31	557	Tank 2	SCADA		2000			10	(3.0)	2	3	3	3	2.9	29%		2.9	6	2	5	4.5	12.7
32	428	WTP	Electrical	MCC	2005			20	12.0	3	4	3	1	2.9	29%		2.9	5	5	3	4.3	12.5
33	394	WTP	Residual Process	Neutralization Tank	2005	2009		50	46.0	3	3	2	3	2.7	27%		2.7	7	4	3	4.7	12.5
34	395	WTP	Residual Process	Backwash tank	2005	2010		50	47.0	3	3	2	3	2.7	27%		2.7	7	4	3	4.7	12.5
35	396	WTP	Residual Process	Infiltration Lagoons	2005	2011		50	48.0	3	3	2	3	2.7	27%		2.7	7	4	3	4.7	12.5
36	226	Well 6	Architectural	Roof	1986			50	23.0	6	5	5	5	5.2	52%		5.2	5	1	1	2.4	12.4
37	495	Fac1	Electrical	MCC	1990			20	(3.0)	3	3	3	1	2.6	26%		2.6	7	3	4	4.8	12.4
38	423	WTP	SCADA	Flow	2005			10	2.0	3	3	3	3	3.0	30%		3.0	7	2	3	4.1	12.3
39	426	WTP	SCADA	Status	2005			10	2.0	3	3	3	3	3.0	30%		3.0	7	2	3	4.1	12.3
40	8	Well 1	Yard Piping	Valves	1963			75	25.0	3	3	3	3	3.0	30%		3.0	7	2	3	4.1	12.3
41	46	Well 2	Yard Piping	Valves	1963			50	-	3	3	3	3	3.0	30%		3.0	7	2	3	4.1	12.3
42	85	Well 3	Yard Piping	Valves	1963			50	-	3	3	3	3	3.0	30%		3.0	7	2	3	4.1	12.3
43	349	WTP	Yard Piping	Valves	2005			50	42.0	3	3	3	3	3.0	30%		3.0	7	2	3	4.1	12.3
44	96	Well 3	Process Piping	valves	1963			50	-	5	5	3	3	3.9	39%		3.9	3	3	3	3.0	11.7
45	114	Well 3	Electrical	MCC	1963			20	(30.0)	8	4	5	4	5.0	50%		5.0	4	2	1	2.4	11.6
46	378	WTP	CIP Process	Recirculation Pumps	2005			20	12.0	3	3	3	2	2.8	28%		2.8	7	2	3	4.1	11.5
47	379	WTP	CIP Process	Control Valves	2005			20	12.0	3	3	3	2	2.8	28%		2.8	7	2	3	4.1	11.5
48	130	Well 4	Production Wells	Screen	1976			50	13.0	3	7	2	5	4.3	43%		4.3	3	2	3	2.7	11.5
49	172	Well 5	Production Wells	Screen	1975			50	12.0	3	7	2	5	4.3	43%		4.3	3	2	3	2.7	11.5
50	498	Fac1	Electrical	MTS	1990			20	(3.0)	3	1	3	3	2.4	24%		2.4	7	3	4	4.8	11.4
51	133	Well 4	Production Wells	Motor	2005			10	2.0	3	7	3	3	4.2	42%		4.2	3	2	3	2.7	11.3
52	174	Well 5	Production Wells	Pump	1975	2005		20	12.0	3	7	3	3	4.2	42%		4.2	3	2	3	2.7	11.3
53	157	Well 4	Electrical	MCC	1976	2005		20	12.0	3	3	3	3	3.0	30%		3.0	4	2	5	3.8	11.3
54	70	Well 2	SCADA	Level	1963	2007		10	4.0	3	3	3	3	3.0	30%		3.0	4	2	5	3.8	11.3
55	113	Well 3	SCADA	Status	1963			10	(40.0)	3	3	3	3	3.0	30%		3.0	4	2	5	3.8	11.3
56	154	Well 4	SCADA	Level	1976	2005		10	2.0	3	3	3	3	3.0	30%		3.0	4	2	5	3.8	11.3
57	156	Well 4	SCADA	Status	1976	2005		10	2.0	3	3	3	3	3.0	30%		3.0	4	2	5	3.8	11.3
58	6	Well 1	Civil	Utility Poles	1963			50	-	3	3	1	3	2.3	23%		2.3	7	2	5	4.8	11.0
59	44	Well 2	Civil	Utility Poles	1963	2002		50	39.0	3	3	1	3	2.3	23%		2.3	7	2	5	4.8	11.0
60	83	Well 3	Civil	Utility Poles	1963			50	-	3	3	1	3	2.3	23%		2.3	7	2	5	4.8	11.0
61	457	Distribution	Interstate MFG I612S Trailer		2008			15	10.0	3	3	3	3	3.0	30%		3.0	5	4	2	3.7	11.0
62	454	Distribution	Sullivan Air Compressor		2005			15	7.0	3	3	3	3	3.0	30%		3.0	5	4	2	3.7	11.0
63	542	Tank 1	Tank Walls		1963			75	25.0	3	2	2	2	2.2	22%		2.2	3	5	7	5.0	10.8
64	552	Tank 2	Tank Walls		1974			75	36.0	3	2	2	2	2.2	22%		2.2	3	5	7	5.0	10.8

								Current Yr:	2013													
Asset Identification					Baseline Info					Performance Elements					Likelihood of Failure			Consequence of Failure				
Rank	Asset ID			Asset Name	Build / Install date	Refurb/ Replace Date	Mgt Strategy Group	Expected (Design) Life (Yrs)	Remaining Expected (Design) Life (Yrs)	Physical Condition	Operational/ Process Performance	Reliability	Maintainability	Asset Composite Performance Score	% Effective Life Consumed (based on composite performance score)	OVERRIDE FIELD* Expected Remaining Effective Life (Yrs)	LoF	Social/ Community	Economic/ Financial	Environmental	COF Score	Core Risk Score (worst = 100)
65	377	WTP	CIP Process	Chem feed Pumps	2005			10	2.0	3	3	3	2	2.8	28%		2.8	7	1	3	3.8	10.6
66	382	WTP	CIP Process	Pump	2005			10	2.0	3	3	3	2	2.8	28%		2.8	7	1	3	3.8	10.6
67	19	Well 1	Process Piping	valves	1963			50	-	5	5	3	3	3.9	39%		3.9	3	2	3	2.7	10.5
68	56	Well 2	Process Piping	valves	1963			50	-	5	5	3	3	3.9	39%		3.9	3	2	3	2.7	10.5
69	77	Well 2	Electrical	VFDs	1963	2007		20	14.0	3	3	3	2	2.8	28%		2.8	4	2	5	3.8	10.5
70	531	Garage	Architectural		1969			50	6.0	3	3	2	3	2.7	27%		2.7	5	6	1	3.9	10.3
71	196	Well 5	SCADA	Radio	1975	2005		10	2.0	3	3	3	3	3.0	30%		3.0	3	2	5	3.4	10.2
72	198	Well 5	SCADA	Flow	1975	2005		10	2.0	3	3	3	3	3.0	30%		3.0	3	2	5	3.4	10.2
73	199	Well 5	SCADA	Status	1975	2005		10	2.0	3	3	3	3	3.0	30%		3.0	3	2	5	3.4	10.2
74	239	Well 6	SCADA	Radio	1986			10	(17.0)	3	3	3	3	3.0	30%		3.0	3	2	5	3.4	10.2
75	241	Well 6	SCADA	Flow	1986			10	(17.0)	3	3	3	3	3.0	30%		3.0	3	2	5	3.4	10.2
76	242	Well 6	SCADA	Status	1986			10	(17.0)	3	3	3	3	3.0	30%		3.0	3	2	5	3.4	10.2
77	290	Well 7	SCADA	Flow	1994			10	(9.0)	3	3	3	3	3.0	30%		3.0	3	2	5	3.4	10.2
78	291	Well 7	SCADA	pH	1994			10	(9.0)	3	3	3	3	3.0	30%		3.0	3	2	5	3.4	10.2
79	292	Well 7	SCADA	Chlorine	1994			10	(9.0)	3	3	3	3	3.0	30%		3.0	3	2	5	3.4	10.2
80	112	Well 3	SCADA	Flow	1963			10	(40.0)	3	5	5	3	4.3	43%		4.3	4	2	1	2.4	10.1
81	460	Fac1	Civil	Culverts	1990	2002		50	39.0	3	3	1	2	2.1	21%		2.1	7	2	5	4.8	10.1
82	94	Well 3	Process Piping	Pipe	1963			100	50.0	3	3	5	3	3.7	37%		3.7	3	2	3	2.7	10.0
83	541	Tank 1	Yard Piping		1963			100	50.0	3	3	2	1	2.3	23%		2.3	3	3	7	4.4	9.9
84	551	Tank 2	Yard Piping		1974			100	61.0	3	3	2	1	2.3	23%		2.3	3	3	7	4.4	9.9
85	383	WTP	CIP Process	Piping	2005			25	17.0	3	3	3	2	2.8	28%		2.8	7	1	2	3.5	9.7
86	384	WTP	CIP Process	damper	2005			20	12.0	3	3	3	2	2.8	28%		2.8	7	1	2	3.5	9.7
87	385	WTP	CIP Process	mixer	2005			20	12.0	3	3	3	2	2.8	28%		2.8	7	1	2	3.5	9.7
88	386	WTP	CIP Process	meter	2005			10	2.0	3	3	3	2	2.8	28%		2.8	7	1	2	3.5	9.7
89	119	Well 3	Electrical	Right Angle Drive	1963			20	(30.0)	5	4	4	7	4.8	48%		4.8	3	2	1	2.0	9.5
90	347	WTP	Civil	Utility Poles	2005			50	42.0	3	3	1	3	2.3	23%		2.3	7	2	3	4.1	9.4
91	462	Fac1	Civil	Fence	1990	2002		20	9.0	3	3	1	3	2.3	23%		2.3	7	2	3	4.1	9.4
92	115	Well 3	Electrical	3ph wire	1963			20	(30.0)	7	3	1	1	2.5	25%		2.5	4	2	5	3.8	9.4
93	116	Well 3	Electrical	1ph wire	1963			20	(30.0)	7	3	1	1	2.5	25%		2.5	4	2	5	3.8	9.4
94	215	Well 6	Production Wells	Screen	1986			50	23.0	3	5	2	4	3.5	35%		3.5	3	2	3	2.7	9.3
95	442	Distribution	Hand Tools		2013			1	1.0	3	3	3	3	3.0	30%		3.0	7	1	1	3.1	9.3
96	7	Well 1	Yard Piping	Mains	1963			100	50.0	3	3	2	1	2.3	23%		2.3	7	2	3	4.1	9.2
97	45	Well 2	Yard Piping	Mains	1963			100	50.0	3	3	2	1	2.3	23%		2.3	7	2	3	4.1	9.2
98	84	Well 3	Yard Piping	Mains	1963			100	50.0	3	3	2	1	2.3	23%		2.3	7	2	3	4.1	9.2
99	348	WTP	Yard Piping	Mains	2005			100	92.0	3	3	2	1	2.3	23%		2.3	7	2	3	4.1	9.2
100	410	WTP	HVAC	blower ducts	2005			20	12.0	3	3	3	3	3.0	30%		3.0	5	2	2	3.1	9.2
101	355	WTP	Process Piping	Control Valves	2005			20	12.0	3	3	3	3	3.0	30%		3.0	5	2	2	3.1	9.2
102	356	WTP	Process Piping	Pipe	2005			100	92.0	3	3	3	3	3.0	30%		3.0	5	2	2	3.1	9.2
103	357	WTP	Process Piping	Check valves	2005			20	12.0	3	3	3	3	3.0	30%		3.0	5	2	2	3.1	9.2
104	358	WTP	Process Piping	valves	2005			50	42.0	3	3	3	3	3.0	30%		3.0	5	2	2	3.1	9.2
105	351	WTP	Raw Water Pumping	Pump	2005			20	12.0	3	3	3	3	3.0	30%		3.0	5	2	2	3.1	9.2
106	352	WTP	Raw Water Pumping	Motor	2005			10	2.0	3	3	3	3	3.0	30%		3.0	5	2	2	3.1	9.2
107	353	WTP	Raw Water Pumping	Column Pipe	2005			50	42.0	3	3	3	3	3.0	30%		3.0	5	2	2	3.1	9.2
108	354	WTP	Raw Water Pumping	Micro Strainer	2005			20	12.0	3	3	3	3	3.0	30%		3.0	5	2	2	3.1	9.2
109	488	Fac1	Security	CP-x	1990			10	(13.0)	3	3	3	3	3.0	30%		3.0	3	2	4	3.1	9.2
110	489	Fac1	Security	Sensors	1990			10	(13.0)	3	3	3	3	3.0	30%		3.0	3	2	4	3.1	9.2
111	490	Fac1	Security	Wiring	1990			10	(13.0)	3	3	3	3	3.0	30%		3.0	3	2	4	3.1	9.2
112	40	Well 1	Electrical	LP	1963	2007		20	14.0	3	3	1	1	1.9	19%		1.9	7	2	5	4.8	9.1
113	39	Well 1	Electrical	1ph wire	1963	2007		20	14.0	3	3	1	1	1.9	19%		1.9	7	2	5	4.8	9.1
114	401	WTP	Architectural	Windows	2005			50	42.0	3	3	2	3	2.7	27%		2.7	5	2	3	3.4	9.0
115	412	WTP	HVAC	Furnace	2005			20	12.0	3	3	3	3	3.0	30%		3.0	4	3	2	3.0	9.0
116	413	WTP	HVAC	Chiller	2005			20	12.0	3	3	3	3	3.0	30%		3.0	4	3	2	3.0	9.0
117	137	Well 4	Process Piping	Pipe	1976			100	63.0	3	3	3	3	3.0	30%		3.0	3	3	3	3.0	9.0
118	138	Well 4	Process Piping	Check valves	1976			20	(17.0)	3	3	3	3	3.0	30%		3.0	3	3	3	3.0	9.0
119	139	Well 4	Process Piping	valves	1976			50	13.0	3	3	3	3	3.0	30%		3.0	3	3	3	3.0	9.0
120	179	Well 5	Process Piping	Pipe	1975			100	62.0	3	3	3	3	3.0	30%		3.0	3	3	3	3.0	9.0
121	180	Well 5	Process Piping	Check valves	1975			20	(18.0)	3	3	3	3	3.0	30%		3.0	3	3	3	3.0	9.0
122	181	Well 5	Process Piping	valves	1975			50	12.0	3	3	3	3	3.0	30%		3.0	3	3	3	3.0	9.0
123	222	Well 6	Process Piping	Pipe	1986			100	73.0	3	3	3	3	3.0	30%		3.0	3	3	3	3.0	9.0
124	223	Well 6	Process Piping	Check valves	1986			20	(7.0)	3	3	3	3	3.0	30%		3.0	3	3	3	3.0	9.0
125	224	Well 6	Process Piping	valves	1986			50	23.0	3	3	3	3	3.0	30%		3.0	3	3	3	3.0	9.0
126	446	Distribution	Pumps		X				#VALUE!	3	3	3	3	3.0	30%		3.0	3	3	3	3.0	9.0
127	95	Well 3	Process Piping	Check valves	1963			20	(30.0)	5	3	3	3	3.3	33%		3.3	3	2	3	2.7	8.9
128	274	Well 7	Corrosion Control	Pump	1994			10	(9.0)	3	3	1	3	2.3	23%		2.3	5	1	5	3.8	8.7
129	485	Fac1	Corrosion Control	Pump	1990			10	(13.0)	3	3	1	3	2.3	23%		2.3	5	1	5	3.8	8.7

Asset Identification					Baseline Info			Current Yr:	2013	Performance Elements					Likelihood of Failure			Consequence of Failure				
Rank	Asset ID			Asset Name	Build / Install date	Refurb/ Replace Date	Mgt Strategy Group	Expected (Design) Life (Yrs)	Remaining Expected (Design) Life (Yrs)	Physical Condition	Operational/ Process Performance	Reliability	Maintainability	Asset Composite Performance Score	% Effective Life Consumed (based on composite performance score)	OVERRIDE FIELD* Expected Remaining Effective Life (Yrs)	LoF	Social/ Community	Economic/ Financial	Environmental	COF Score	Core Risk Score (worst = 100)
130	537	Garage	Electrical		1969			20	(24.0)	3	3	3	3	3.0	30%		3.0	3	5	1	2.9	8.7
131	360	WTP	Chlorination	Scale	2005			10	2.0	3	2	3	2	2.5	25%		2.5	5	2	3	3.4	8.5
132	497	Fac1	Electrical	LP	1990			20	(3.0)	3	3	1	1	1.9	19%		1.9	7	2	4	4.5	8.5
133	496	Fac1	Electrical	1ph wire	1990			20	(3.0)	3	3	1	1	1.9	19%		1.9	7	2	4	4.5	8.5
134	407	WTP	Domestic Waste	septic field	2005			20	12.0	3	3	1	3	2.3	23%		2.3	3	5	3	3.6	8.3
135	365	WTP	Chlorination	damper	2005			20	12.0	3	3	3	3	3.0	30%		3.0	5	1	2	2.8	8.3
136	49	Well 2	Production Wells	Screen	1963			50	-	3	3	2	5	3.1	31%		3.1	3	2	3	2.7	8.2
137	88	Well 3	Production Wells	Screen	1963			50	-	3	3	2	5	3.1	31%		3.1	3	2	3	2.7	8.2
138	187	Well 5	HVAC	LP Tank	1975			20	(18.0)	3	3	3	3	3.0	30%		3.0	5	2	1	2.7	8.1
139	230	Well 6	HVAC	LP Tank	1986			20	(7.0)	3	3	3	3	3.0	30%		3.0	5	2	1	2.7	8.1
140	535	Garage	Security		1969			10	(34.0)	3	3	3	3	3.0	30%		3.0	5	2	1	2.7	8.1
141	18	Well 1	Process Piping	Pipe	1963			100	50.0	3	3	3	3	3.0	30%		3.0	3	2	3	2.7	8.1
142	55	Well 2	Process Piping	Pipe	1963			100	50.0	3	3	3	3	3.0	30%		3.0	3	2	3	2.7	8.1
143	136	Well 4	Process Piping	Control Valves	1976			20	(17.0)	3	3	3	3	3.0	30%		3.0	3	2	3	2.7	8.1
144	178	Well 5	Process Piping	Control Valves	1975			20	(18.0)	3	3	3	3	3.0	30%		3.0	3	2	3	2.7	8.1
145	221	Well 6	Process Piping	Control Valves	1986			20	(7.0)	3	3	3	3	3.0	30%		3.0	3	2	3	2.7	8.1
146	264	Well 7	Process Piping	Pipe	1994			100	81.0	3	3	3	3	3.0	30%		3.0	3	2	3	2.7	8.1
147	265	Well 7	Process Piping	Check valves	1994			20	1.0	3	3	3	3	3.0	30%		3.0	3	2	3	2.7	8.1
148	266	Well 7	Process Piping	valves	1994			50	31.0	3	3	3	3	3.0	30%		3.0	3	2	3	2.7	8.1
149	320	Well 8	Process Piping	Control Valves	2002			20	9.0	3	3	3	3	3.0	30%		3.0	3	2	3	2.7	8.1
150	321	Well 8	Process Piping	Pipe	2002			100	89.0	3	3	3	3	3.0	30%		3.0	3	2	3	2.7	8.1
151	322	Well 8	Process Piping	Check valves	2002			20	9.0	3	3	3	3	3.0	30%		3.0	3	2	3	2.7	8.1
152	323	Well 8	Process Piping	valves	2002			50	39.0	3	3	3	3	3.0	30%		3.0	3	2	3	2.7	8.1
153	467	Fac1	Process Piping	Control Valves	1990	2002		20	9.0	3	3	3	3	3.0	30%		3.0	3	2	3	2.7	8.1
154	468	Fac1	Process Piping	Pipe	1990	2002		100	89.0	3	3	3	3	3.0	30%		3.0	3	2	3	2.7	8.1
155	469	Fac1	Process Piping	Check valves	1990	2002		20	9.0	3	3	3	3	3.0	30%		3.0	3	2	3	2.7	8.1
156	470	Fac1	Process Piping	valves	1990	2002		50	39.0	3	3	3	3	3.0	30%		3.0	3	2	3	2.7	8.1
157	13	Well 1	Production Wells	Pump	1963	2007		20	14.0	3	3	3	3	3.0	30%		3.0	3	2	3	2.7	8.1
158	14	Well 1	Production Wells	Motor	1963	2007		10	4.0	3	3	3	3	3.0	30%		3.0	3	2	3	2.7	8.1
159	17	Well 1	Production Wells	Pitless adapter	1963	2005		50	42.0	3	3	3	3	3.0	30%		3.0	3	2	3	2.7	8.1
160	51	Well 2	Production Wells	Pump	1963	2001		20	8.0	3	3	3	3	3.0	30%		3.0	3	2	3	2.7	8.1
161	52	Well 2	Production Wells	Motor	1963	2007		10	4.0	3	3	3	3	3.0	30%		3.0	3	2	3	2.7	8.1
162	90	Well 3	Production Wells	Pump	1963	2006		20	13.0	3	3	3	3	3.0	30%		3.0	3	2	3	2.7	8.1
163	91	Well 3	Production Wells	Motor	1963			10	(40.0)	3	3	3	3	3.0	30%		3.0	3	2	3	2.7	8.1
164	175	Well 5	Production Wells	Motor	1975	2005		10	2.0	3	3	3	3	3.0	30%		3.0	3	2	3	2.7	8.1
165	218	Well 6	Production Wells	Motor	1986	2005		10	2.0	3	3	3	3	3.0	30%		3.0	3	2	3	2.7	8.1
166	260	Well 7	Production Wells	Pump	1994			20	1.0	3	3	3	3	3.0	30%		3.0	3	2	3	2.7	8.1
167	261	Well 7	Production Wells	Motor	1994			10	(9.0)	3	3	3	3	3.0	30%		3.0	3	2	3	2.7	8.1
168	315	Well 8	Production Wells	Pump	2002			20	9.0	3	3	3	3	3.0	30%		3.0	3	2	3	2.7	8.1
169	316	Well 8	Production Wells	Motor	2002			10	(1.0)	3	3	3	3	3.0	30%		3.0	3	2	3	2.7	8.1
170	319	Well 8	Production Wells	Pitless adapter	2002			50	39.0	3	3	3	3	3.0	30%		3.0	3	2	3	2.7	8.1
171	9	Well 1	Yard Piping	Hydrants	1963			50	-	3	3	3	3	3.0	30%		3.0	3	2	3	2.7	8.1
172	47	Well 2	Yard Piping	Hydrants	1963			50	-	3	3	3	3	3.0	30%		3.0	3	2	3	2.7	8.1
173	86	Well 3	Yard Piping	Hydrants	1963			50	-	3	3	3	3	3.0	30%		3.0	3	2	3	2.7	8.1
174	127	Well 4	Yard Piping	Valves	1976			50	13.0	3	3	3	3	3.0	30%		3.0	3	2	3	2.7	8.1
175	128	Well 4	Yard Piping	Hydrants	1976			50	13.0	3	3	3	3	3.0	30%		3.0	3	2	3	2.7	8.1
176	169	Well 5	Yard Piping	Valves	1975			50	12.0	3	3	3	3	3.0	30%		3.0	3	2	3	2.7	8.1
177	170	Well 5	Yard Piping	Hydrants	1975			50	12.0	3	3	3	3	3.0	30%		3.0	3	2	3	2.7	8.1
178	212	Well 6	Yard Piping	Valves	1986			50	23.0	3	3	3	3	3.0	30%		3.0	3	2	3	2.7	8.1
179	213	Well 6	Yard Piping	Hydrants	1986			50	23.0	3	3	3	3	3.0	30%		3.0	3	2	3	2.7	8.1
180	255	Well 7	Yard Piping	Valves	1994			50	31.0	3	3	3	3	3.0	30%		3.0	3	2	3	2.7	8.1
181	256	Well 7	Yard Piping	Hydrants	1994			50	31.0	3	3	3	3	3.0	30%		3.0	3	2	3	2.7	8.1
182	307	Well 8	Yard Piping	Valves	2002			50	39.0	3	3	3	3	3.0	30%		3.0	3	2	3	2.7	8.1
183	350	WTP	Yard Piping	Hydrants	2005			50	42.0	3	3	3	3	3.0	30%		3.0	3	2	3	2.7	8.1
184	465	Fac1	Yard Piping	Valves	1990			50	27.0	3	3	3	3	3.0	30%		3.0	3	2	3	2.7	8.1
185	466	Fac1	Yard Piping	Hydrants	1990			50	27.0	3	3	3	3	3.0	30%		3.0	3	2	3	2.7	8.1
186	476	Fac1	Architectural	Meter Pit	1990			50	27.0	3	2	1	1	1.6	16%		1.6	7	4	4	5.1	8.1
187	131	Well 4	Production Wells	Gravel Pack	1976			50	13.0	3	4	2	3	3.0	30%		3.0	3	2	3	2.7	8.0
188	173	Well 5	Production Wells	Gravel Pack	1975			50	12.0	3	4	2	3	3.0	30%		3.0	3	2	3	2.7	8.0
189	314	Well 8	Production Wells	Gravel Pack	2002			50	39.0	3	4	2	3	3.0	30%		3.0	3	2	3	2.7	8.0
190	392	WTP	Finish Water Pumping	Pump	2005			20	12.0	3	3	2	3	2.7	27%		2.7	5	3	1	3.0	8.0
191	393	WTP	Finish Water Pumping	Motor	2005			10	2.0	3	3	2	3	2.7	27%		2.7	5	3	1	3.0	8.0
192	487	Fac1	HVAC	Electric Heater	1990			20	(3.0)	3	3	1	2	2.1	21%		2.1	5	2	4	3.8	7.9
193	369	WTP	Corrosion Control	Scale	2005			10	2.0	3	3	1	3	2.3	23%		2.3	5	2	3	3.4	7.8
194	370	WTP	Corrosion Control	Bulk Tank	2005			20	12.0	3	3	1	3	2.3	23%		2.3	5	2	3	3.4	7.8

Asset Identification					Baseline Info			Current Yr:	2013	Performance Elements					Likelihood of Failure			Consequence of Failure				
Rank	Asset ID			Asset Name	Build / Install date	Refurb/ Replace Date	Mgt Strategy Group	Expected (Design) Life (Yrs)	Remaining Expected (Design) Life (Yrs)	Physical Condition	Operational/ Process Performance	Reliability	Maintainability	Asset Composite Performance Score	% Effective Life Consumed (based on composite performance score)	OVERRIDE FIELD* Expected Remaining Effective Life (Yrs)	LoF	Social/ Community	Economic/ Financial	Environmental	COF Score	Core Risk Score (worst = 100)
195	371	WTP	Corrosion Control	Day tanks	2005			20	12.0	3	3	1	3	2.3	23%		2.3	5	2	3	3.4	7.8
196	403	WTP	Domestic Supply	Check Valve	2005			20	12.0	3	3	1	3	2.3	23%		2.3	5	2	3	3.4	7.8
197	404	WTP	Domestic Supply	Pump	2005			10	2.0	3	3	1	3	2.3	23%		2.3	5	2	3	3.4	7.8
198	405	WTP	Domestic Supply	Motor	2005			10	2.0	3	3	1	3	2.3	23%		2.3	5	2	3	3.4	7.8
199	21	Well 1	Architectural	Roof	1963			50	-	5	3	1	3	2.6	26%		2.6	3	3	3	3.0	7.8
200	22	Well 1	Architectural	Walls	1963			50	-	5	3	1	3	2.6	26%		2.6	3	3	3	3.0	7.8
201	59	Well 2	Architectural	Walls	1963			50	-	5	3	1	3	2.6	26%		2.6	3	3	3	3.0	7.8
202	530	Garage	Civil		1969			25	(19.0)	3	3	3	3	3.0	30%		3.0	3	4	1	2.6	7.8
203	475	Fac1	Architectural	Ladder	1990			25	2.0	3	3	3	1	2.6	26%		2.6	3	3	3	3.0	7.8
204	269	Well 7	Chlorination	Pump	1994			10	(9.0)	3	2	3	2	2.5	25%		2.5	5	1	3	3.1	7.8
205	359	WTP	Chlorination	Injection Quill	2005			10	2.0	3	2	3	2	2.5	25%		2.5	5	1	3	3.1	7.8
206	363	WTP	Chlorination	Pump	2005			10	2.0	3	2	3	2	2.5	25%		2.5	5	1	3	3.1	7.8
207	364	WTP	Chlorination	Piping	2005			25	17.0	3	2	3	2	2.5	25%		2.5	5	1	3	3.1	7.8
208	480	Fac1	Chlorination	Pump	1990			10	(13.0)	3	2	3	2	2.5	25%		2.5	5	1	3	3.1	7.8
209	313	Well 8	Production Wells	Screen	2002			50	39.0	3	3	2	4	2.9	29%		2.9	3	2	3	2.7	7.7
210	431	WTP	Electrical	LP	2005			20	12.0	3	3	1	1	1.9	19%		1.9	5	4	3	4.0	7.6
211	429	WTP	Electrical	3ph wire	2005			20	12.0	3	3	1	1	1.9	19%		1.9	5	4	3	4.0	7.6
212	430	WTP	Electrical	1ph wire	2005			20	12.0	3	3	1	1	1.9	19%		1.9	5	4	3	4.0	7.6
213	24	Well 1	Architectural	Windows	1963			50	-	5	3	2	4	3.2	32%		3.2	5	1	1	2.4	7.6
214	109	Well 3	Fire	Wiring	1963			10	(40.0)	3	2	1	3	2.0	20%		2.0	4	2	5	3.8	7.5
215	150	Well 4	Fire	CP-x	1976			10	(27.0)	3	2	1	3	2.0	20%		2.0	4	2	5	3.8	7.5
216	97	Well 3	Architectural	Foundation	1963			50	-	4	2	3	1	2.5	25%		2.5	3	3	3	3.0	7.4
217	58	Well 2	Architectural	Roof	1963			50	-	4	3	1	3	2.5	25%		2.5	3	3	3	3.0	7.4
218	98	Well 3	Architectural	Roof	1963			50	-	4	3	1	3	2.5	25%		2.5	3	3	3	3.0	7.4
219	477	Fac1	Architectural	Chem feed Pit	1990			50	27.0	2	2	1	1	1.5	15%		1.5	7	4	4	5.1	7.3
220	117	Well 3	Electrical	LP	1963			20	(30.0)	7	5	1	1	3.1	31%		3.1	4	2	1	2.4	7.3
221	461	Fac1	Civil	Gates	1990	2002		20	9.0	2	3	1	1	1.8	18%		1.8	7	2	3	4.1	7.2
222	11	Well 1	Production Wells	Screen	1963	2005		50	42.0	3	3	2	3	2.7	27%		2.7	3	2	3	2.7	7.2
223	16	Well 1	Production Wells	Check Valve	1963	2005		20	12.0	3	3	2	3	2.7	27%		2.7	3	2	3	2.7	7.2
224	216	Well 6	Production Wells	Gravel Pack	1986			50	23.0	3	3	2	3	2.7	27%		2.7	3	2	3	2.7	7.2
225	258	Well 7	Production Wells	Screen	1994			50	31.0	3	3	2	3	2.7	27%		2.7	3	2	3	2.7	7.2
226	259	Well 7	Production Wells	Gravel Pack	1994			50	31.0	3	3	2	3	2.7	27%		2.7	3	2	3	2.7	7.2
227	275	Well 7	Corrosion Control	Piping	1994			25	6.0	3	3	1	3	2.3	23%		2.3	3	1	5	3.1	7.1
228	368	WTP	Corrosion Control	Injection Quill	2005			10	2.0	3	3	1	3	2.3	23%		2.3	5	1	3	3.1	7.1
229	372	WTP	Corrosion Control	Pump	2005			10	2.0	3	3	1	3	2.3	23%		2.3	5	1	3	3.1	7.1
230	373	WTP	Corrosion Control	Piping	2005			25	17.0	3	3	1	3	2.3	23%		2.3	5	1	3	3.1	7.1
231	486	Fac1	Corrosion Control	Piping	1990			25	2.0	3	3	1	3	2.3	23%		2.3	3	1	5	3.1	7.1
232	76	Well 2	Electrical	LP	1963	2007		20	14.0	3	3	1	1	1.9	19%		1.9	4	2	5	3.8	7.1
233	74	Well 2	Electrical	3ph wire	1963	2007		20	14.0	3	3	1	1	1.9	19%		1.9	4	2	5	3.8	7.1
234	391	WTP	Finish Water Pumping	Check Valve	2005			20	12.0	3	3	3	3	3.0	30%		3.0	4	2	1	2.4	7.1
235	34	Well 1	SCADA	Level	1963	2007		10	4.0	3	3	3	3	3.0	30%		3.0	4	2	1	2.4	7.1
236	35	Well 1	SCADA	Flow	1963	2007		10	4.0	3	3	3	3	3.0	30%		3.0	4	2	1	2.4	7.1
237	36	Well 1	SCADA	Status	1963	2007		10	4.0	3	3	3	3	3.0	30%		3.0	4	2	1	2.4	7.1
238	69	Well 2	SCADA	CP-x	1963	2007		10	4.0	3	3	3	3	3.0	30%		3.0	4	2	1	2.4	7.1
239	72	Well 2	SCADA	Status	1963	2007		10	4.0	3	3	3	3	3.0	30%		3.0	4	2	1	2.4	7.1
240	110	Well 3	SCADA	CP-x	1963			10	(40.0)	3	3	3	3	3.0	30%		3.0	4	2	1	2.4	7.1
241	111	Well 3	SCADA	Level	1963			10	(40.0)	3	3	3	3	3.0	30%		3.0	4	2	1	2.4	7.1
242	153	Well 4	SCADA	CP-x	1976	2005		10	2.0	3	3	3	3	3.0	30%		3.0	4	2	1	2.4	7.1
243	155	Well 4	SCADA	Flow	1976	2005		10	2.0	3	3	3	3	3.0	30%		3.0	4	2	1	2.4	7.1
244	26	Well 1	Security	CP-x	1963			10	(40.0)	3	3	3	3	3.0	30%		3.0	4	2	1	2.4	7.1
245	27	Well 1	Security	Sensors	1963			10	(40.0)	3	3	3	3	3.0	30%		3.0	4	2	1	2.4	7.1
246	28	Well 1	Security	Wiring	1963			10	(40.0)	3	3	3	3	3.0	30%		3.0	4	2	1	2.4	7.1
247	63	Well 2	Security	CP-x	1963	2007		10	4.0	3	3	3	3	3.0	30%		3.0	4	2	1	2.4	7.1
248	64	Well 2	Security	Sensors	1963	2007		10	4.0	3	3	3	3	3.0	30%		3.0	4	2	1	2.4	7.1
249	65	Well 2	Security	Wiring	1963	2007		10	4.0	3	3	3	3	3.0	30%		3.0	4	2	1	2.4	7.1
250	104	Well 3	Security	CP-x	1963			10	(40.0)	3	3	3	3	3.0	30%		3.0	4	2	1	2.4	7.1
251	105	Well 3	Security	Sensors	1963			10	(40.0)	3	3	3	3	3.0	30%		3.0	4	2	1	2.4	7.1
252	106	Well 3	Security	Wiring	1963			10	(40.0)	3	3	3	3	3.0	30%		3.0	4	2	1	2.4	7.1
253	147	Well 4	Security	CP-x	1976			10	(27.0)	3	3	3	3	3.0	30%		3.0	4	2	1	2.4	7.1
254	148	Well 4	Security	Sensors	1976			10	(27.0)	3	3	3	3	3.0	30%		3.0	4	2	1	2.4	7.1
255	149	Well 4	Security	Wiring	1976			10	(27.0)	3	3	3	3	3.0	30%		3.0	4	2	1	2.4	7.1
256	188	Well 5	HVAC	LP Heater	1975			20	(18.0)	3	3	3	1	2.6	26%		2.6	5	2	1	2.7	7.0
257	231	Well 6	HVAC	LP Heater	1986			20	(7.0)	3	3	3	1	2.6	26%		2.6	5	2	1	2.7	7.0
258	308	Well 8	Yard Piping	Hydrants	2002			50	39.0	3	3	3	1	2.6	26%		2.6	3	2	3	2.7	7.0
259	80	Well 2	Electrical	Right Angle Drive	1963			20	(30.0)	7	7	7	7	7.0	70%		7.0	1	1	1	1.0	7.0

Asset Identification					Baseline Info			Current Yr:	2013	Performance Elements					Likelihood of Failure			Consequence of Failure				
Rank	Asset ID			Asset Name	Build / Install date	Refurb/ Replace Date	Mgt Strategy Group	Expected (Design) Life (Yrs)	Remaining Expected (Design) Life (Yrs)	Physical Condition	Operational/ Process Performance	Reliability	Maintainability	Asset Composite Performance Score	% Effective Life Consumed (based on composite performance score)	OVERRIDE FIELD* Expected Remaining Effective Life (Yrs)	LoF	Social/ Community	Economic/ Financial	Environmental	COF Score	Core Risk Score (worst = 100)
260	23	Well 1	Architectural	Doors	1963			50	-	3	4	3	1	2.9	29%		2.9	5	1	1	2.4	7.0
261	532	Garage	Domestic Supply		1969			50	6.0	3	3	1	3	2.3	23%		2.3	5	3	1	3.0	6.9
262	533	Garage	Domestic Waste		1969			50	6.0	3	3	1	3	2.3	23%		2.3	5	3	1	3.0	6.9
263	57	Well 2	Architectural	Foundation	1963			50	-	3	2	3	1	2.3	23%		2.3	3	3	3	3.0	6.9
264	474	Fac1	Architectural	Doors	1990			50	27.0	3	2	3	1	2.3	23%		2.3	3	3	3	3.0	6.9
265	473	Fac1	Architectural	Walls	1990			50	27.0	3	3	1	3	2.3	23%		2.3	3	3	3	3.0	6.9
266	540	Tank 1	Civil		1963			25	(25.0)	3	3	3	3	3.0	30%		3.0	3	3	1	2.3	6.9
267	550	Tank 2	Civil		1974			25	(14.0)	3	3	3	3	3.0	30%		3.0	3	3	1	2.3	6.9
268	366	WTP	Chlorination	mixer	2005			20	12.0	3	2	3	2	2.5	25%		2.5	5	1	2	2.8	6.9
269	367	WTP	Chlorination	meter	2005			10	2.0	3	2	3	2	2.5	25%		2.5	5	1	2	2.8	6.9
270	417	WTP	Fire	CP-x	2005			10	2.0	3	2	1	3	2.0	20%		2.0	3	2	5	3.4	6.8
271	192	Well 5	Fire	CP-x	1975			10	(28.0)	3	2	1	3	2.0	20%		2.0	3	2	5	3.4	6.8
272	235	Well 6	Fire	CP-x	1986			10	(17.0)	3	2	1	3	2.0	20%		2.0	3	2	5	3.4	6.8
273	284	Well 7	Fire	CP-x	1994			10	(9.0)	3	2	1	3	2.0	20%		2.0	3	2	5	3.4	6.8
274	502	Fac2	Architectural		1990			50	27.0	3	3	2	3	2.7	27%		2.7	2	5	1	2.6	6.8
275	512	Fac3	Architectural		1990			50	27.0	3	3	2	3	2.7	27%		2.7	2	5	1	2.6	6.8
276	522	Fac4	Architectural		1990			50	27.0	3	3	2	3	2.7	27%		2.7	2	5	1	2.6	6.8
277	61	Well 2	Architectural	Windows	1963			50	-	4	3	2	3	2.8	28%		2.8	5	1	1	2.4	6.7
278	101	Well 3	Architectural	Windows	1963			50	-	4	3	2	3	2.8	28%		2.8	4	2	1	2.4	6.6
279	327	Well 8	Architectural	Hatch	2002			50	39.0	3	3	3	2	2.8	28%		2.8	4	2	1	2.4	6.6
280	41	Well 1	Electrical	VFDs	1963	2007		20	14.0	3	3	3	2	2.8	28%		2.8	4	2	1	2.4	6.6
281	118	Well 3	Electrical	VFDs	1963	2006		20	13.0	3	3	3	2	2.8	28%		2.8	4	2	1	2.4	6.6
282	543	Tank 1	Tank Foundation		1963			75	25.0	3	1	1	1	1.3	13%		1.3	3	5	7	5.0	6.5
283	553	Tank 2	Tank Foundation		1974			75	36.0	3	1	1	1	1.3	13%		1.3	3	5	7	5.0	6.5
284	10	Well 1	Production Wells	Casing	1963	2005		50	42.0	3	1	3	3	2.4	24%		2.4	3	2	3	2.7	6.5
285	48	Well 2	Production Wells	Casing	1963			50	-	3	1	3	3	2.4	24%		2.4	3	2	3	2.7	6.5
286	87	Well 3	Production Wells	Casing	1963			50	-	3	1	3	3	2.4	24%		2.4	3	2	3	2.7	6.5
287	129	Well 4	Production Wells	Casing	1976			50	13.0	3	1	3	3	2.4	24%		2.4	3	2	3	2.7	6.5
288	171	Well 5	Production Wells	Casing	1975			50	12.0	3	1	3	3	2.4	24%		2.4	3	2	3	2.7	6.5
289	214	Well 6	Production Wells	Casing	1986			50	23.0	3	1	3	3	2.4	24%		2.4	3	2	3	2.7	6.5
290	257	Well 7	Production Wells	Casing	1994			50	31.0	3	1	3	3	2.4	24%		2.4	3	2	3	2.7	6.5
291	312	Well 8	Production Wells	Casing	2002			50	39.0	3	1	3	3	2.4	24%		2.4	3	2	3	2.7	6.5
292	38	Well 1	Electrical	3ph wire	1963	2007		20	14.0	3	3	1	1	1.9	19%		1.9	7	2	1	3.4	6.5
293	400	WTP	Architectural	Doors	2005			50	42.0	3	2	1	1	1.6	16%		1.6	5	4	3	4.0	6.4
294	78	Well 2	Electrical	ATS	1963	2007		20	14.0	1	3	3	3	2.7	27%		2.7	4	2	1	2.4	6.3
295	79	Well 2	Electrical	Generator	1963	2007		20	14.0	1	3	3	3	2.7	27%		2.7	4	2	1	2.4	6.3
296	12	Well 1	Production Wells	Gravel Pack	1963	2005		50	42.0	3	2	2	3	2.4	24%		2.4	3	2	3	2.7	6.3
297	50	Well 2	Production Wells	Gravel Pack	1963			50	-	3	2	2	3	2.4	24%		2.4	3	2	3	2.7	6.3
298	89	Well 3	Production Wells	Gravel Pack	1963			50	-	3	2	2	3	2.4	24%		2.4	3	2	3	2.7	6.3
299	374	WTP	Corrosion Control	damper	2005			20	12.0	3	3	1	3	2.3	23%		2.3	5	1	2	2.8	6.3
300	375	WTP	Corrosion Control	mixer	2005			20	12.0	3	3	1	3	2.3	23%		2.3	5	1	2	2.8	6.3
301	376	WTP	Corrosion Control	meter	2005			10	2.0	3	3	1	3	2.3	23%		2.3	5	1	2	2.8	6.3
302	277	Well 7	Architectural	Roof	1994			50	31.0	5	3	1	3	2.6	26%		2.6	5	1	1	2.4	6.2
303	483	Fac1	Corrosion Control	Bulk Tank	1990			20	(3.0)	5	3	1	3	2.6	26%		2.6	3	1	3	2.4	6.2
304	144	Well 4	Architectural	Windows	1976			50	13.0	3	3	2	3	2.7	27%		2.7	4	2	1	2.4	6.2
305	186	Well 5	Architectural	Windows	1975			50	12.0	3	3	2	3	2.7	27%		2.7	4	2	1	2.4	6.2
306	229	Well 6	Architectural	Windows	1986			50	23.0	3	3	2	3	2.7	27%		2.7	4	2	1	2.4	6.2
307	471	Fac1	Architectural	Foundation	1990			50	27.0	3	2	3	1	2.3	23%		2.3	3	2	3	2.7	6.2
308	472	Fac1	Architectural	Roof	1990			50	27.0	3	3	1	3	2.3	23%		2.3	3	2	3	2.7	6.2
309	54	Well 2	Production Wells	Check Valve	1963	2001		20	8.0	3	3	1	3	2.3	23%		2.3	3	2	3	2.7	6.2
310	299	Well 7	Electrical	VFDs	1994			20	1.0	5	3	3	2	3.1	31%		3.1	3	2	1	2.0	6.2
311	380	WTP	CIP Process	Bulk Tank	2005			20	12.0	3	1	1	2	1.5	15%		1.5	7	2	3	4.1	6.2
312	408	WTP	Domestic Waste	leach field	2005			20	12.0	3	1	1	3	1.7	17%		1.7	3	5	3	3.6	6.1
313	73	Well 2	Electrical	MCC	1963	2007		20	14.0	3	3	3	1	2.6	26%		2.6	4	2	1	2.4	6.1
314	62	Well 2	HVAC	LP Heater	1963	2007		20	14.0	3	3	3	1	2.6	26%		2.6	4	2	1	2.4	6.1
315	103	Well 3	HVAC	LP Heater	1963			20	(30.0)	3	3	3	1	2.6	26%		2.6	4	2	1	2.4	6.1
316	545	Tank 1	Mixing System		2013			10	10.0	1	3	3	1	2.3	23%		2.3	3	3	2	2.7	6.1
317	555	Tank 2	Mixing System		2012			10	9.0	1	3	3	1	2.3	23%		2.3	3	3	2	2.7	6.1
318	126	Well 4	Yard Piping	Mains	1976			100	63.0	3	3	2	1	2.3	23%		2.3	3	2	3	2.7	6.1
319	168	Well 5	Yard Piping	Mains	1975			100	62.0	3	3	2	1	2.3	23%		2.3	3	2	3	2.7	6.1
320	211	Well 6	Yard Piping	Mains	1986			100	73.0	3	3	2	1	2.3	23%		2.3	3	2	3	2.7	6.1
321	254	Well 7	Yard Piping	Mains	1994			100	81.0	3	3	2	1	2.3	23%		2.3	3	2	3	2.7	6.1
322	306	Well 8	Yard Piping	Mains	2002			100	89.0	3	3	2	1	2.3	23%		2.3	3	2	3	2.7	6.1
323	464	Fac1	Yard Piping	Mains	1990			100	77.0	3	3	2	1	2.3	23%		2.3	3	2	3	2.7	6.1
324	183	Well 5	Architectural	Roof	1975	2012		50	49.0	3	3	1	4	2.5	25%		2.5	5	1	1	2.4	6.0

Asset Identification					Baseline Info			Current Yr:	2013	Performance Elements					Likelihood of Failure			Consequence of Failure				
Rank	Asset ID			Asset Name	Build / Install date	Refurb/ Replace Date	Mgt Strategy Group	Expected (Design) Life (Yrs)	Remaining Expected (Design) Life (Yrs)	Physical Condition	Operational/ Process Performance	Reliability	Maintainability	Asset Composite Performance Score	% Effective Life Consumed (based on composite performance score)	OVERRIDE FIELD* Expected Remaining Effective Life (Yrs)	LoF	Social/ Community	Economic/ Financial	Environmental	COF Score	Core Risk Score (worst = 100)
325	200	Well 5	Electrical	MCC	1975			20	(18.0)	3	3	3	3	3.0	30%		3.0	3	2	1	2.0	6.0
326	243	Well 6	Electrical	MCC	1986			20	(7.0)	3	3	3	3	3.0	30%		3.0	3	2	1	2.0	6.0
327	337	Well 8	Electrical	MCC	2002			20	9.0	3	3	3	3	3.0	30%		3.0	3	2	1	2.0	6.0
328	195	Well 5	SCADA	CP-x	1975	2005		10	2.0	3	3	3	3	3.0	30%		3.0	3	2	1	2.0	6.0
329	197	Well 5	SCADA	Level	1975	2005		10	2.0	3	3	3	3	3.0	30%		3.0	3	2	1	2.0	6.0
330	238	Well 6	SCADA	CP-x	1986			10	(17.0)	3	3	3	3	3.0	30%		3.0	3	2	1	2.0	6.0
331	240	Well 6	SCADA	Level	1986			10	(17.0)	3	3	3	3	3.0	30%		3.0	3	2	1	2.0	6.0
332	287	Well 7	SCADA	CP-x	1994			10	(9.0)	3	3	3	3	3.0	30%		3.0	3	2	1	2.0	6.0
333	288	Well 7	SCADA	Radio	1994			10	(9.0)	3	3	3	3	3.0	30%		3.0	3	2	1	2.0	6.0
334	289	Well 7	SCADA	Level	1994			10	(9.0)	3	3	3	3	3.0	30%		3.0	3	2	1	2.0	6.0
335	293	Well 7	SCADA	Status	1994			10	(9.0)	3	3	3	3	3.0	30%		3.0	3	2	1	2.0	6.0
336	294	Well 7	SCADA	Computer	1994			10	(9.0)	3	3	3	3	3.0	30%		3.0	3	2	1	2.0	6.0
337	333	Well 8	SCADA	CP-x	2002			10	(1.0)	3	3	3	3	3.0	30%		3.0	3	2	1	2.0	6.0
338	334	Well 8	SCADA	Level	2002			10	(1.0)	3	3	3	3	3.0	30%		3.0	3	2	1	2.0	6.0
339	335	Well 8	SCADA	Flow	2002			10	(1.0)	3	3	3	3	3.0	30%		3.0	3	2	1	2.0	6.0
340	336	Well 8	SCADA	Status	2002			10	(1.0)	3	3	3	3	3.0	30%		3.0	3	2	1	2.0	6.0
341	189	Well 5	Security	CP-x	1975			10	(28.0)	3	3	3	3	3.0	30%		3.0	3	2	1	2.0	6.0
342	190	Well 5	Security	Sensors	1975			10	(28.0)	3	3	3	3	3.0	30%		3.0	3	2	1	2.0	6.0
343	191	Well 5	Security	Wiring	1975			10	(28.0)	3	3	3	3	3.0	30%		3.0	3	2	1	2.0	6.0
344	232	Well 6	Security	CP-x	1986			10	(17.0)	3	3	3	3	3.0	30%		3.0	3	2	1	2.0	6.0
345	233	Well 6	Security	Sensors	1986			10	(17.0)	3	3	3	3	3.0	30%		3.0	3	2	1	2.0	6.0
346	234	Well 6	Security	Wiring	1986			10	(17.0)	3	3	3	3	3.0	30%		3.0	3	2	1	2.0	6.0
347	281	Well 7	Security	CP-x	1994			10	(9.0)	3	3	3	3	3.0	30%		3.0	3	2	1	2.0	6.0
348	282	Well 7	Security	Sensors	1994			10	(9.0)	3	3	3	3	3.0	30%		3.0	3	2	1	2.0	6.0
349	283	Well 7	Security	Wiring	1994			10	(9.0)	3	3	3	3	3.0	30%		3.0	3	2	1	2.0	6.0
350	330	Well 8	Security	CP-x	2002			10	(1.0)	3	3	3	3	3.0	30%		3.0	3	2	1	2.0	6.0
351	331	Well 8	Security	Sensors	2002			10	(1.0)	3	3	3	3	3.0	30%		3.0	3	2	1	2.0	6.0
352	332	Well 8	Security	Wiring	2002			10	(1.0)	3	3	3	3	3.0	30%		3.0	3	2	1	2.0	6.0
353	414	WTP	Security	CP-x	2005			10	2.0	3	3	3	3	3.0	30%		3.0	3	2	1	2.0	6.0
354	415	WTP	Security	Sensors	2005			10	2.0	3	3	3	3	3.0	30%		3.0	3	2	1	2.0	6.0
355	416	WTP	Security	Wiring	2005			10	2.0	3	3	3	3	3.0	30%		3.0	3	2	1	2.0	6.0
356	546	Tank 1	Security		2000			10	(3.0)	3	3	3	3	3.0	30%		3.0	3	2	1	2.0	6.0
357	556	Tank 2	Security		2000			10	(3.0)	3	3	3	3	3.0	30%		3.0	3	2	1	2.0	6.0
358	267	Well 7	Chlorination	Injection Quill	1994			10	(9.0)	3	2	3	2	2.5	25%		2.5	3	1	3	2.4	6.0
359	270	Well 7	Chlorination	Piping	1994			25	6.0	3	2	3	2	2.5	25%		2.5	3	1	3	2.4	6.0
360	478	Fac1	Chlorination	Injection Quill	1990			10	(13.0)	3	2	3	2	2.5	25%		2.5	3	1	3	2.4	6.0
361	481	Fac1	Chlorination	Piping	1990			25	2.0	3	2	3	2	2.5	25%		2.5	3	1	3	2.4	6.0
362	60	Well 2	Architectural	Doors	1963			50	-	4	2	3	1	2.5	25%		2.5	5	1	1	2.4	5.9
363	100	Well 3	Architectural	Doors	1963			50	-	4	2	3	1	2.5	25%		2.5	5	1	1	2.4	5.9
364	99	Well 3	Architectural	Walls	1963			50	-	4	3	1	3	2.5	25%		2.5	5	1	1	2.4	5.9
365	509	Fac2	Electrical		1990			20	(3.0)	3	3	3	3	3.0	30%		3.0	2	3	1	2.0	5.9
366	519	Fac3	Electrical		1990			20	(3.0)	3	3	3	3	3.0	30%		3.0	2	3	1	2.0	5.9
367	361	WTP	Chlorination	Bulk Tank	2005			20	12.0	3	1	1	3	1.7	17%		1.7	5	2	3	3.4	5.8
368	362	WTP	Chlorination	Day tanks	2005			20	12.0	3	1	1	3	1.7	17%		1.7	5	2	3	3.4	5.8
369	406	WTP	Domestic Waste	piping	2005			50	42.0	3	1	1	3	1.7	17%		1.7	5	2	3	3.4	5.8
370	227	Well 6	Architectural	Walls	1986			50	23.0	4	3	1	3	2.5	25%		2.5	4	2	1	2.4	5.8
371	20	Well 1	Architectural	Foundation	1963			50	-	5	2	1	1	1.9	19%		1.9	3	3	3	3.0	5.7
372	381	WTP	CIP Process	Day tanks	2005			20	12.0	3	1	1	2	1.5	15%		1.5	7	1	3	3.8	5.7
373	280	Well 7	HVAC	Electric Heater	1994			20	1.0	3	3	1	2	2.1	21%		2.1	5	2	1	2.7	5.7
374	161	Well 4	Electrical	VFDs	1976	2005		20	12.0	3	3	3	2	2.8	28%		2.8	3	2	1	2.0	5.6
375	204	Well 5	Electrical	VFDs	1975	2005		20	12.0	3	3	3	2	2.8	28%		2.8	3	2	1	2.0	5.6
376	247	Well 6	Electrical	VFDs	1986	2005		20	12.0	3	3	3	2	2.8	28%		2.8	3	2	1	2.0	5.6
377	140	Well 4	Architectural	Foundation	1976			50	13.0	3	2	3	1	2.3	23%		2.3	5	1	1	2.4	5.5
378	182	Well 5	Architectural	Foundation	1975			50	12.0	3	2	3	1	2.3	23%		2.3	5	1	1	2.4	5.5
379	225	Well 6	Architectural	Foundation	1986			50	23.0	3	2	3	1	2.3	23%		2.3	5	1	1	2.4	5.5
380	276	Well 7	Architectural	Foundation	1994			50	31.0	3	2	3	1	2.3	23%		2.3	5	1	1	2.4	5.5
381	141	Well 4	Architectural	Roof	1976	2012		50	49.0	3	3	1	3	2.3	23%		2.3	5	1	1	2.4	5.5
382	271	Well 7	Corrosion Control	Injection Quill	1994			10	(9.0)	3	3	1	3	2.3	23%		2.3	3	1	3	2.4	5.5
383	272	Well 7	Corrosion Control	Bulk Tank	1994			20	1.0	3	3	1	3	2.3	23%		2.3	3	1	3	2.4	5.5
384	273	Well 7	Corrosion Control	Day tank	1994			20	1.0	3	3	1	3	2.3	23%		2.3	3	1	3	2.4	5.5
385	482	Fac1	Corrosion Control	Injection Quill	1990			10	(13.0)	3	3	1	3	2.3	23%		2.3	3	1	3	2.4	5.5
386	484	Fac1	Corrosion Control	Day tank	1990			20	(3.0)	3	3	1	3	2.3	23%		2.3	3	1	3	2.4	5.5
387	162	Well 5	Civil	Driveway	1975			20	(18.0)	4	4	1	3	2.8	28%		2.8	3	2	1	2.0	5.5
388	205	Well 6	Civil	Driveway	1986			20	(7.0)	4	4	1	3	2.8	28%		2.8	3	2	1	2.0	5.5
389	143	Well 4	Architectural	Doors	1976			50	13.0	3	2	3	1	2.3	23%		2.3	4	2	1	2.4	5.4

Asset Identification					Baseline Info			Current Yr:	2013	Performance Elements					Likelihood of Failure			Consequence of Failure				
Rank	Asset ID			Asset Name	Build / Install date	Refurb/ Replace Date	Mgt Strategy Group	Expected (Design) Life (Yrs)	Remaining Expected (Design) Life (Yrs)	Physical Condition	Operational/ Process Performance	Reliability	Maintainability	Asset Composite Performance Score	% Effective Life Consumed (based on composite performance score)	OVERRIDE FIELD* Expected Remaining Effective Life (Yrs)	LoF	Social/ Community	Economic/ Financial	Environmental	COF Score	Core Risk Score (worst = 100)
390	185	Well 5	Architectural	Doors	1975			50	12.0	3	2	3	1	2.3	23%		2.3	4	2	1	2.4	5.4
391	228	Well 6	Architectural	Doors	1986			50	23.0	3	2	3	1	2.3	23%		2.3	4	2	1	2.4	5.4
392	279	Well 7	Architectural	Doors	1994			50	31.0	3	2	3	1	2.3	23%		2.3	4	2	1	2.4	5.4
393	142	Well 4	Architectural	Walls	1976			50	13.0	3	3	1	3	2.3	23%		2.3	4	2	1	2.4	5.4
394	184	Well 5	Architectural	Walls	1975			50	12.0	3	3	1	3	2.3	23%		2.3	4	2	1	2.4	5.4
395	278	Well 7	Architectural	Walls	1994			50	31.0	3	3	1	3	2.3	23%		2.3	4	2	1	2.4	5.4
396	326	Well 8	Architectural	Walls	2002			50	39.0	3	3	1	3	2.3	23%		2.3	4	2	1	2.4	5.4
397	328	Well 8	Architectural	Ladder	2002			25	14.0	1	3	3	1	2.3	23%		2.3	4	2	1	2.4	5.4
398	536	Garage	Fire		1969			10	(34.0)	3	2	1	3	2.0	20%		2.0	5	2	1	2.7	5.4
399	295	Well 7	Electrical	MCC	1994			20	1.0	1	3	3	3	2.7	27%		2.7	3	2	1	2.0	5.4
400	409	WTP	HVAC	fuel tank	2005			20	12.0	2	3	1	1	1.8	18%		1.8	5	2	2	3.1	5.3
401	310	Well 8	Monitoring Wells	Screen	2002			50	39.0	3	3	1	3	2.3	23%		2.3	2	3	2	2.3	5.3
402	529	Fac4	Electrical		1990			20	(3.0)	3	3	2	3	2.7	27%		2.7	2	3	1	2.0	5.2
403	176	Well 5	Production Wells	Drop Pipe	1975			50	12.0	4	1	1	3	1.9	19%		1.9	3	2	3	2.7	5.0
404	262	Well 7	Production Wells	Drop Pipe	1994			50	31.0	4	1	1	3	1.9	19%		1.9	3	2	3	2.7	5.0
405	506	Fac2	Security		1990			10	(13.0)	3	3	3	3	3.0	30%		3.0	2	2	1	1.7	5.0
406	516	Fac3	Security		1990			10	(13.0)	3	3	3	3	3.0	30%		3.0	2	2	1	1.7	5.0
407	526	Fac4	Security		1990			10	(13.0)	3	3	3	3	3.0	30%		3.0	2	2	1	1.7	5.0
408	146	Well 4	HVAC	Electric Heater	1976			20	(17.0)	3	3	1	2	2.1	21%		2.1	4	2	1	2.4	4.9
409	329	Well 8	HVAC	Electric Heater	2002			20	9.0	3	3	1	2	2.1	21%		2.1	4	2	1	2.4	4.9
410	43	Well 2	Civil	Landscaping	1963	2002		40	29.0	3	3	1	2	2.1	21%		2.1	1	3	3	2.3	4.8
411	82	Well 3	Civil	Landscaping	1963	2002		40	29.0	3	3	1	2	2.1	21%		2.1	1	3	3	2.3	4.8
412	121	Well 4	Civil	Landscaping	1976	2002		40	29.0	3	3	1	2	2.1	21%		2.1	1	3	3	2.3	4.8
413	163	Well 5	Civil	Landscaping	1975			40	2.0	3	3	1	2	2.1	21%		2.1	1	3	3	2.3	4.8
414	206	Well 6	Civil	Landscaping	1986			40	13.0	3	3	1	2	2.1	21%		2.1	1	3	3	2.3	4.8
415	249	Well 7	Civil	Landscaping	1994			40	21.0	3	3	1	2	2.1	21%		2.1	1	3	3	2.3	4.8
416	301	Well 8	Civil	Landscaping	2002			40	29.0	3	3	1	2	2.1	21%		2.1	1	3	3	2.3	4.8
417	343	WTP	Civil	Landscaping	2005			40	32.0	3	3	1	2	2.1	21%		2.1	1	3	3	2.3	4.8
418	459	Fac1	Civil	Landscaping	1990	2002		40	29.0	3	3	1	2	2.1	21%		2.1	1	3	3	2.3	4.8
419	342	WTP	Civil	Driveway	2005			20	12.0	3	1	3	3	2.4	24%		2.4	3	2	1	2.0	4.8
420	458	Fac1	Civil	Driveway	1990	2002		20	9.0	3	1	3	3	2.4	24%		2.4	3	2	1	2.0	4.8
421	499	Fac1	Electrical	Portable generator	2012			10	9.0	1	1	1	1	1.0	10%		1.0	7	3	4	4.8	4.8
422	324	Well 8	Architectural	Foundation	2002			50	39.0	3	2	3	1	2.3	23%		2.3	4	1	1	2.1	4.7
423	325	Well 8	Architectural	Roof	2002			50	39.0	3	3	1	3	2.3	23%		2.3	4	1	1	2.1	4.7
424	402	WTP	Domestic Supply	Air relief	2005			20	12.0	3	3	1	3	2.3	23%		2.3	2	1	3	2.1	4.7
425	29	Well 1	Fire	CP-x	1963			10	(40.0)	3	2	1	3	2.0	20%		2.0	4	2	1	2.4	4.7
426	30	Well 1	Fire	Sensors	1963			10	(40.0)	3	2	1	3	2.0	20%		2.0	4	2	1	2.4	4.7
427	31	Well 1	Fire	Wiring	1963			10	(40.0)	3	2	1	3	2.0	20%		2.0	4	2	1	2.4	4.7
428	66	Well 2	Fire	CP-x	1963			10	(40.0)	3	2	1	3	2.0	20%		2.0	4	2	1	2.4	4.7
429	67	Well 2	Fire	Sensors	1963			10	(40.0)	3	2	1	3	2.0	20%		2.0	4	2	1	2.4	4.7
430	68	Well 2	Fire	Wiring	1963			10	(40.0)	3	2	1	3	2.0	20%		2.0	4	2	1	2.4	4.7
431	107	Well 3	Fire	CP-x	1963			10	(40.0)	3	2	1	3	2.0	20%		2.0	4	2	1	2.4	4.7
432	108	Well 3	Fire	Sensors	1963			10	(40.0)	3	2	1	3	2.0	20%		2.0	4	2	1	2.4	4.7
433	151	Well 4	Fire	Sensors	1976			10	(27.0)	3	2	1	3	2.0	20%		2.0	4	2	1	2.4	4.7
434	152	Well 4	Fire	Wiring	1976			10	(27.0)	3	2	1	3	2.0	20%		2.0	4	2	1	2.4	4.7
435	92	Well 3	Production Wells	Drop Pipe	1963	1992		50	29.0	3	1	1	3	1.7	17%		1.7	3	2	3	2.7	4.6
436	93	Well 3	Production Wells	Check Valve	1963	1992		20	(1.0)	3	1	1	3	1.7	17%		1.7	3	2	3	2.7	4.6
437	134	Well 4	Production Wells	Drop Pipe	2005			50	42.0	3	1	1	3	1.7	17%		1.7	3	2	3	2.7	4.6
438	135	Well 4	Production Wells	Check Valve	2005			20	12.0	3	1	1	3	1.7	17%		1.7	3	2	3	2.7	4.6
439	177	Well 5	Production Wells	Check Valve	1975			20	(18.0)	3	1	1	3	1.7	17%		1.7	3	2	3	2.7	4.6
440	219	Well 6	Production Wells	Drop Pipe	1986	2005		50	42.0	3	1	1	3	1.7	17%		1.7	3	2	3	2.7	4.6
441	220	Well 6	Production Wells	Check Valve	1986	2005		20	12.0	3	1	1	3	1.7	17%		1.7	3	2	3	2.7	4.6
442	263	Well 7	Production Wells	Check Valve	1994			20	1.0	3	1	1	3	1.7	17%		1.7	3	2	3	2.7	4.6
443	318	Well 8	Production Wells	Check Valve	2002			20	9.0	3	1	1	3	1.7	17%		1.7	3	2	3	2.7	4.6
444	390	WTP	Finish Water Pumping	Air relief	2005			20	12.0	3	3	2	3	2.7	27%		2.7	3	1	1	1.7	4.5
445	534	Garage	HVAC		1969			20	(24.0)	3	1	1	2	1.5	15%		1.5	5	3	1	3.0	4.5
446	75	Well 2	Electrical	1ph wire	1963	2007		20	14.0	3	3	1	1	1.9	19%		1.9	4	2	1	2.4	4.5
447	158	Well 4	Electrical	3ph wire	1976	2005		20	12.0	3	3	1	1	1.9	19%		1.9	4	2	1	2.4	4.5
448	159	Well 4	Electrical	1ph wire	1976	2005		20	12.0	3	3	1	1	1.9	19%		1.9	4	2	1	2.4	4.5
449	25	Well 1	HVAC	Propane Heater	1963			20	(30.0)	3	3	1	1	1.9	19%		1.9	4	2	1	2.4	4.5
450	309	Well 8	Monitoring Wells	Casing	2002			50	39.0	3	3	1	1	1.9	19%		1.9	2	3	2	2.3	4.4
451	341	Well 8	Electrical	VFDs	2002			20	9.0	1	3	2	2	2.2	22%		2.2	3	2	1	2.0	4.3
452	124	Well 4	Civil	Fence	1976			20	(17.0)	5	3	1	3	2.6	26%		2.6	2	2	1	1.7	4.3
453	166	Well 5	Civil	Fence	1975			20	(18.0)	5	3	1	3	2.6	26%		2.6	2	2	1	1.7	4.3
454	3	Well 1	Civil	Culverts	1963			50	-	3	3	1	2	2.1	21%		2.1	3	2	1	2.0	4.2

Asset Identification					Baseline Info			Current Yr:	2013	Performance Elements					Likelihood of Failure			Consequence of Failure				
Rank	Asset ID			Asset Name	Build / Install date	Refurb/ Replace Date	Mgt Strategy Group	Expected (Design) Life (Yrs)	Remaining Expected (Design) Life (Yrs)	Physical Condition	Operational/ Process Performance	Reliability	Maintainability	Asset Composite Performance Score	% Effective Life Consumed (based on composite performance score)	OVERRIDE FIELD* Expected Remaining Effective Life (Yrs)	LoF	Social/ Community	Economic/ Financial	Environmental	COF Score	Core Risk Score (worst = 100)
455	122	Well 4	Civil	Culverts	1976			50	13.0	3	3	1	2	2.1	21%		2.1	3	2	1	2.0	4.2
456	164	Well 5	Civil	Culverts	1975			50	12.0	3	3	1	2	2.1	21%		2.1	3	2	1	2.0	4.2
457	207	Well 6	Civil	Culverts	1986			50	23.0	3	3	1	2	2.1	21%		2.1	3	2	1	2.0	4.2
458	250	Well 7	Civil	Culverts	1994			50	31.0	3	3	1	2	2.1	21%		2.1	3	2	1	2.0	4.2
459	302	Well 8	Civil	Culverts	2002			50	39.0	3	3	1	2	2.1	21%		2.1	3	2	1	2.0	4.2
460	344	WTP	Civil	Culverts	2005			50	42.0	3	3	1	2	2.1	21%		2.1	3	2	1	2.0	4.2
461	15	Well 1	Production Wells	Drop Pipe	1963	2005		50	42.0	2	1	1	3	1.6	16%		1.6	3	2	3	2.7	4.2
462	53	Well 2	Production Wells	Drop Pipe	1963	2001		50	38.0	2	1	1	3	1.6	16%		1.6	3	2	3	2.7	4.2
463	317	Well 8	Production Wells	Drop Pipe	2002			50	39.0	2	1	1	3	1.6	16%		1.6	3	2	3	2.7	4.2
464	538	Land Holdings	Property		X				#VALUE!	1	1	1	1	1.0	10%		1.0	3	9	1	4.1	4.1
465	268	Well 7	Chlorination	Day tanks	1994			20	1.0	3	1	1	3	1.7	17%		1.7	3	1	3	2.4	4.1
466	479	Fac1	Chlorination	Day tanks	1990			20	(3.0)	3	1	1	3	1.7	17%		1.7	3	1	3	2.4	4.1
467	418	WTP	Fire	Sensors	2005			10	2.0	3	2	1	3	2.0	20%		2.0	3	2	1	2.0	4.0
468	419	WTP	Fire	Wiring	2005			10	2.0	3	2	1	3	2.0	20%		2.0	3	2	1	2.0	4.0
469	193	Well 5	Fire	Sensors	1975			10	(28.0)	3	2	1	3	2.0	20%		2.0	3	2	1	2.0	4.0
470	194	Well 5	Fire	Wiring	1975			10	(28.0)	3	2	1	3	2.0	20%		2.0	3	2	1	2.0	4.0
471	236	Well 6	Fire	Sensors	1986			10	(17.0)	3	2	1	3	2.0	20%		2.0	3	2	1	2.0	4.0
472	237	Well 6	Fire	Wiring	1986			10	(17.0)	3	2	1	3	2.0	20%		2.0	3	2	1	2.0	4.0
473	285	Well 7	Fire	Sensors	1994			10	(9.0)	3	2	1	3	2.0	20%		2.0	3	2	1	2.0	4.0
474	286	Well 7	Fire	Wiring	1994			10	(9.0)	3	2	1	3	2.0	20%		2.0	3	2	1	2.0	4.0
475	544	Tank 1	Coating System		1963	2013		20	20.0	1	1	1	2	1.2	12%		1.2	3	5	2	3.3	3.9
476	554	Tank 2	Coating System		1974	2012		20	19.0	1	1	1	2	1.2	12%		1.2	3	5	2	3.3	3.9
477	2	Well 1	Civil	Landscaping	1963	2002		40	29.0	3	3	3	3	3.0	30%		3.0	1	2	1	1.3	3.9
478	500	Fac2	Civil		1990			25	2.0	3	3	3	3	3.0	30%		3.0	1	2	1	1.3	3.9
479	510	Fac3	Civil		1990			25	2.0	3	3	3	3	3.0	30%		3.0	1	2	1	1.3	3.9
480	520	Fac4	Civil		1990			25	2.0	3	3	3	3	3.0	30%		3.0	1	2	1	1.3	3.9
481	508	Fac2	SCADA		1990			10	(13.0)	3	3	3	3	3.0	30%		3.0	1	2	1	1.3	3.9
482	518	Fac3	SCADA		1990			10	(13.0)	3	3	3	3	3.0	30%		3.0	1	2	1	1.3	3.9
483	528	Fac4	SCADA		1990			10	(13.0)	3	3	3	3	3.0	30%		3.0	1	2	1	1.3	3.9
484	160	Well 4	Electrical	LP	1976	2005		20	12.0	3	3	1	1	1.9	19%		1.9	3	2	1	2.0	3.8
485	203	Well 5	Electrical	LP	1975			20	(18.0)	3	3	1	1	1.9	19%		1.9	3	2	1	2.0	3.8
486	246	Well 6	Electrical	LP	1986			20	(7.0)	3	3	1	1	1.9	19%		1.9	3	2	1	2.0	3.8
487	298	Well 7	Electrical	LP	1994			20	1.0	3	3	1	1	1.9	19%		1.9	3	2	1	2.0	3.8
488	340	Well 8	Electrical	LP	2002			20	9.0	3	3	1	1	1.9	19%		1.9	3	2	1	2.0	3.8
489	201	Well 5	Electrical	3ph wire	1975			20	(18.0)	3	3	1	1	1.9	19%		1.9	3	2	1	2.0	3.8
490	202	Well 5	Electrical	1ph wire	1975			20	(18.0)	3	3	1	1	1.9	19%		1.9	3	2	1	2.0	3.8
491	244	Well 6	Electrical	3ph wire	1986			20	(7.0)	3	3	1	1	1.9	19%		1.9	3	2	1	2.0	3.8
492	245	Well 6	Electrical	1ph wire	1986			20	(7.0)	3	3	1	1	1.9	19%		1.9	3	2	1	2.0	3.8
493	296	Well 7	Electrical	3ph wire	1994			20	1.0	3	3	1	1	1.9	19%		1.9	3	2	1	2.0	3.8
494	297	Well 7	Electrical	1ph wire	1994			20	1.0	3	3	1	1	1.9	19%		1.9	3	2	1	2.0	3.8
495	338	Well 8	Electrical	3ph wire	2002			20	9.0	3	3	1	1	1.9	19%		1.9	3	2	1	2.0	3.8
496	339	Well 8	Electrical	1ph wire	2002			20	9.0	3	3	1	1	1.9	19%		1.9	3	2	1	2.0	3.8
497	411	WTP	HVAC	piping	2005			20	12.0	1	2	1	1	1.3	13%		1.3	4	2	2	2.7	3.5
498	125	Well 4	Civil	Utility Poles	1976			50	13.0	3	1	1	1	1.3	13%		1.3	3	2	3	2.7	3.5
499	167	Well 5	Civil	Utility Poles	1975			50	12.0	3	1	1	1	1.3	13%		1.3	3	2	3	2.7	3.5
500	210	Well 6	Civil	Utility Poles	1986			50	23.0	3	1	1	1	1.3	13%		1.3	3	2	3	2.7	3.5
501	253	Well 7	Civil	Utility Poles	1994			50	31.0	3	1	1	1	1.3	13%		1.3	3	2	3	2.7	3.5
502	305	Well 8	Civil	Utility Poles	2002			50	39.0	3	1	1	1	1.3	13%		1.3	3	2	3	2.7	3.5
503	463	Fac1	Civil	Utility Poles	1990	2002		50	39.0	3	1	1	1	1.3	13%		1.3	3	2	3	2.7	3.5
504	1	Well 1	Civil	Driveway	1963	2002		20	9.0	3	1	1	3	1.7	17%		1.7	3	2	1	2.0	3.4
505	42	Well 2	Civil	Driveway	1963	2002		20	9.0	3	1	1	3	1.7	17%		1.7	3	2	1	2.0	3.4
506	81	Well 3	Civil	Driveway	1963	2002		20	9.0	3	1	1	3	1.7	17%		1.7	3	2	1	2.0	3.4
507	120	Well 4	Civil	Driveway	1976	2002		20	9.0	3	1	1	3	1.7	17%		1.7	3	2	1	2.0	3.4
508	248	Well 7	Civil	Driveway	1994			20	1.0	3	1	1	3	1.7	17%		1.7	3	2	1	2.0	3.4
509	123	Well 4	Civil	Gates	1976			20	(17.0)	4	3	1	1	2.1	21%		2.1	2	2	1	1.7	3.4
510	165	Well 5	Civil	Gates	1975			20	(18.0)	4	3	1	1	2.1	21%		2.1	2	2	1	1.7	3.4
511	209	Well 6	Civil	Fence	1986			20	(7.0)	4	3	1	1	2.1	21%		2.1	2	2	1	1.7	3.4
512	507	Fac2	Fire		1990			10	(13.0)	3	2	1	3	2.0	20%		2.0	2	2	1	1.7	3.3
513	517	Fac3	Fire		1990			10	(13.0)	3	2	1	3	2.0	20%		2.0	2	2	1	1.7	3.3
514	527	Fac4	Fire		1990			10	(13.0)	3	2	1	3	2.0	20%		2.0	2	2	1	1.7	3.3
515	5	Well 1	Civil	Fence	1963	2005		20	12.0	3	3	1	1	1.9	19%		1.9	2	2	1	1.7	3.1
516	208	Well 6	Civil	Gates	1986			20	(7.0)	3	3	1	1	1.9	19%		1.9	2	2	1	1.7	3.1
517	251	Well 7	Civil	Gates	1994			20	1.0	3	3	1	1	1.9	19%		1.9	2	2	1	1.7	3.1
518	252	Well 7	Civil	Fence	1994			20	1.0	3	3	1	1	1.9	19%		1.9	2	2	1	1.7	3.1
519	345	WTP	Civil	Gates	2005			20	12.0	3	3	1	1	1.9	19%		1.9	2	2	1	1.7	3.1

Asset Identification					Baseline Info			Current Yr:	2013	Performance Elements					Likelihood of Failure			Consequence of Failure				
Rank	Asset ID			Asset Name	Build / Install date	Refurb/ Replace Date	Mgt Strategy Group	Expected (Design) Life (Yrs)	Remaining Expected (Design) Life (Yrs)	Physical Condition	Operational/ Process Performance	Reliability	Maintainability	Asset Composite Performance Score	% Effective Life Consumed (based on composite performance score)	**OVERRIDE FIELD*** Expected Remaining Effective Life (Yrs)	LoF	Social/ Community	Economic/ Financial	Environmental	COF Score	Core Risk Score (worst = 100)
520	102	Well 3	HVAC	LP Tank	1963			20	(30.0)	3	1	1	1	**1.3**	13%		**1.3**	4	2	1	**2.4**	**3.1**
521	145	Well 4	HVAC	LP tank	1976			20	(17.0)	3	1	1	1	**1.3**	13%		**1.3**	4	2	1	**2.4**	**3.1**
522	300	Well 8	Civil	Driveway	2002			20	9.0	3	1	1	2	**1.5**	15%		**1.5**	3	2	1	**2.0**	**3.0**
523	505	Fac2	HVAC		1990			20	(3.0)	3	1	1	2	**1.5**	15%		**1.5**	2	3	1	**2.0**	**2.9**
524	515	Fac3	HVAC		1990			20	(3.0)	3	1	1	2	**1.5**	15%		**1.5**	2	3	1	**2.0**	**2.9**
525	525	Fac4	HVAC		1990			20	(3.0)	3	1	1	2	**1.5**	15%		**1.5**	2	3	1	**2.0**	**2.9**
526	501	Fac2	Yard Piping		1990			75	52.0	3	3	2	1	**2.3**	23%		**2.3**	1	2	1	**1.3**	**2.9**
527	511	Fac3	Yard Piping		1990			75	52.0	3	3	2	1	**2.3**	23%		**2.3**	1	2	1	**1.3**	**2.9**
528	521	Fac4	Yard Piping		1990			75	52.0	3	3	2	1	**2.3**	23%		**2.3**	1	2	1	**1.3**	**2.9**
529	4	Well 1	Civil	Gates	1963	2005		20	12.0	2	3	1	1	**1.8**	18%		**1.8**	2	2	1	**1.7**	**2.9**
530	346	WTP	Civil	Fence	2005			20	12.0	2	3	1	1	**1.8**	18%		**1.8**	2	2	1	**1.7**	**2.9**
531	311	Well 8	Monitoring Wells	Cover	2002			50	39.0	2	1	1	1	**1.2**	12%		**1.2**	4	1	2	**2.4**	**2.8**
532	304	Well 8	Civil	Fence	2002			20	9.0	1	3	1	1	**1.6**	16%		**1.6**	2	2	1	**1.7**	**2.6**
533	503	Fac2	Domestic Supply		1990				(23.0)	3	3	1	3	**2.3**	23%		**2.3**	1	1	1	**1.0**	**2.3**
534	513	Fac3	Domestic Supply		1990				(23.0)	3	3	1	3	**2.3**	23%		**2.3**	1	1	1	**1.0**	**2.3**
535	504	Fac2	Domestic Waste		1990				(23.0)	3	3	1	3	**2.3**	23%		**2.3**	1	1	1	**1.0**	**2.3**
536	514	Fac3	Domestic Waste		1990				(23.0)	3	3	1	3	**2.3**	23%		**2.3**	1	1	1	**1.0**	**2.3**
537	524	Fac4	Domestic Waste		1990				(23.0)	3	3	1	1	**1.9**	19%		**1.9**	1	1	1	**1.0**	**1.9**
538	523	Fac4	Domestic Supply		1990				(23.0)	3	1	1	3	**1.7**	17%		**1.7**	1	1	1	**1.0**	**1.7**
539	303	Well 8	Civil	Gates	2002			20	9.0	1	1	1	1	**1.0**	10%		**1.0**	2	2	1	**1.7**	**1.7**

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