SECTION 3

EXISTING WATER SUPPLY SYSTEMS

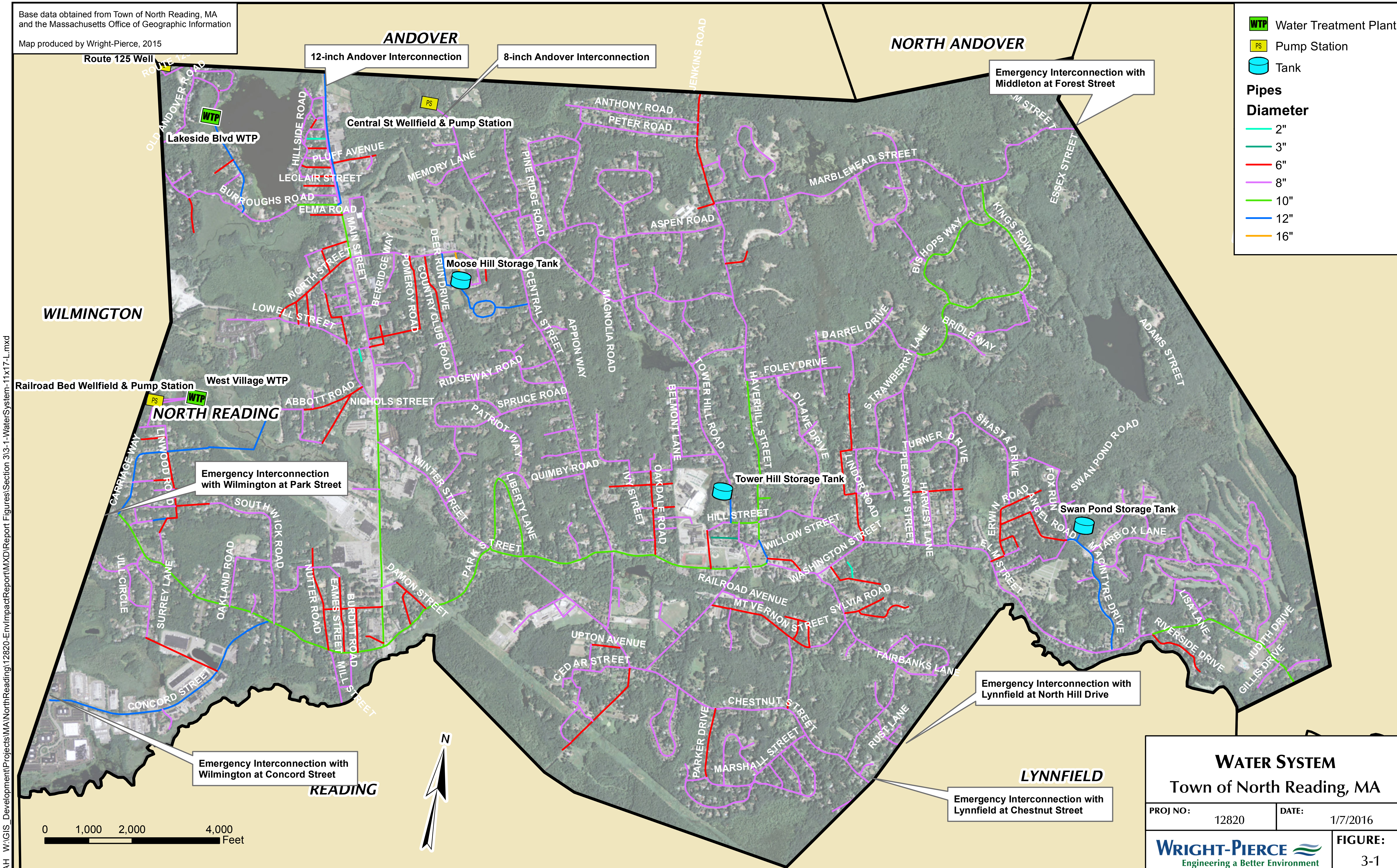
This section will detail the Town of North Reading's (Town) existing water system including water sources, distribution, and storage systems.

3.1 WATER SUPPLY AND INTERCONNECTIONS

The Water Division of the Town's Department of Public Works is responsible for the operation and maintenance of two water treatment plants, six water supply wells and three pumping stations, three water storage tanks, approximately 80 miles of water mains, 750 fire hydrants and 4,600 water service connections and water meters. Water is supplied from local groundwater sources and an interconnection with the Town of Andover. A map of North Reading's system that details the distribution and transmission piping, wells and pump stations, treatment facilities, storage tanks and interconnections with Andover is presented in Figure 3-1. A brief description of each component of the water system follows.

3.1.1 Local Sources

The Town of North Reading owns and operates four groundwater supplies with a combined capacity of 0.96 million gallons per day (MGD). This rate was grandfathered and the right to withdraw this amount was issued in perpetuity by a Massachusetts Water Management Act (WMA) registration. In 1991, the Town was issued a permit under the WMA to withdraw additional amounts above the registered volume in increasing amounts beginning in 1991 through 2009. The permit resulted in a total withdrawal (registered and permitted) volume of 1.21 MGD in 2009.



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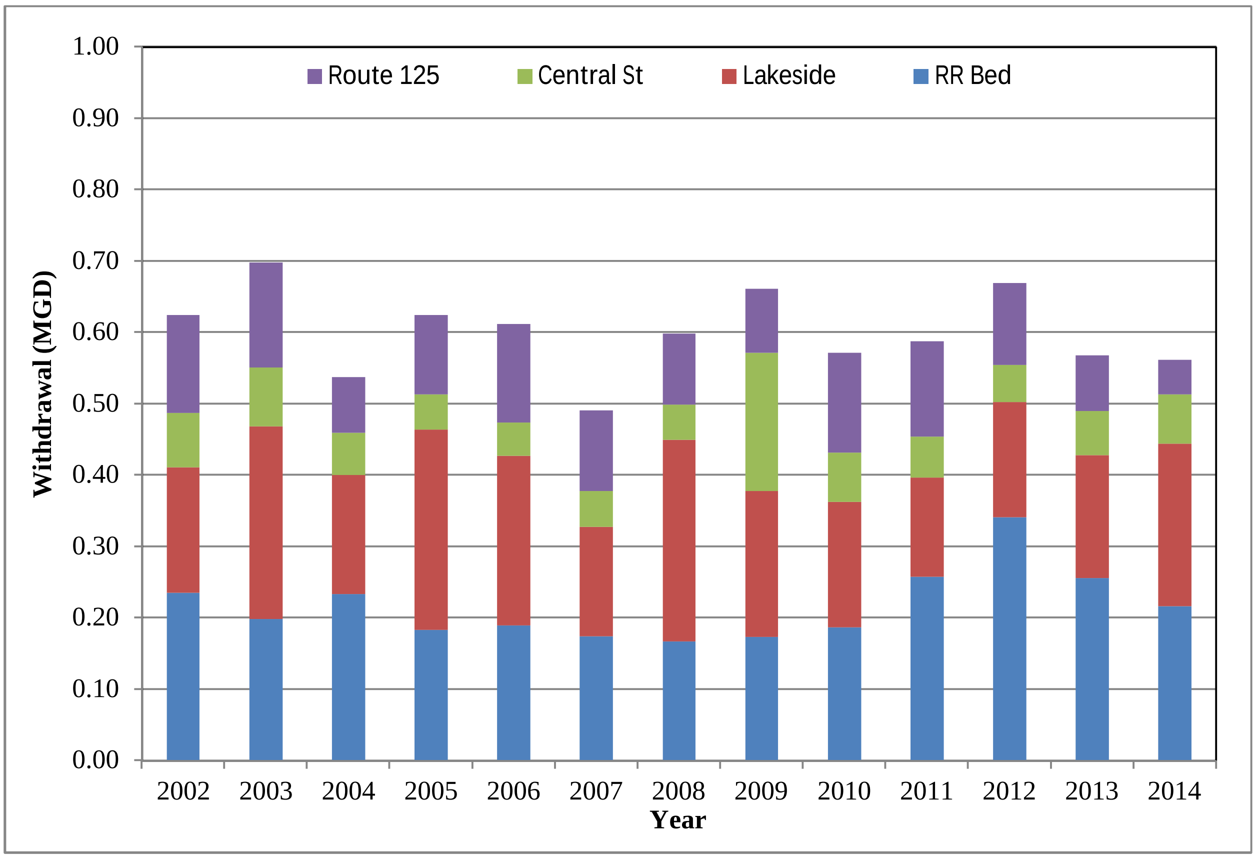
As a result of a MassDEP permit review, a modified WMA permit was issued in 2003 which eliminated the existing incremental withdrawal structure and imposed a static withdrawal limit of 0.15 MGD above the registered withdrawal limit. The modified permit resulted in a total withdrawal (registered and permitted) volume of 1.11 MGD. In addition to reducing the withdrawal limits, the modified permit included stringent water use restrictions which at certain times of year effectively reduced the allowable withdrawal to amounts less than the Town's registered withdrawal volumes.

The Town's four permitted groundwater sources include the Lakeside, Route 125, Central Street and Railroad bed wells. Figure 3-2 details the historical withdrawals from Town sources.

FIGURE 3-2
HISTORICAL WITHDRAWALS FROM TOWN SOURCES



As a result of the additional restrictions imposed by the permit, the Town elected to relinquish its WMA permit. The Town retained its registered withdrawal volume of 0.96 MGD and is no longer subject to the restrictions placed in the former WMA permit. This amounts to a total annual volume of 350.4 MG.

Table 3-1 represents the Town's treatment capacity from each of its water sources.

TABLE 3-1
TREATMENT DESIGN CAPACITY

Source	Treatment Design Capacity (MGD)
Lakeside	0.9
Railroad Bed	0.5
Central Street	0.4
From Andover	1.5

3.1.1.1 Lakeside Boulevard Wellfield and Water Treatment Plant (WTP)

The Lakeside Boulevard wellfield and Route 125 well are the largest combined supply owned by the Town. The site is located on Lakeside Boulevard in the northwest area of the community. The Lakeside wellfield consists of three individual wells; the Route 125 well is located approximately a half of a mile from the site. A water treatment plant designed to remove iron and manganese from the groundwater sources is located adjacent to the Lakeside wellfield and treats the groundwater from all four sources. Figure 3-3 presents a site plan of the Lakeside Boulevard water treatment site and wells. Figure 3-4 details the Route 125 well site.

3.1.1.2 Lakeside Boulevard Wellfield and Route 125 Well

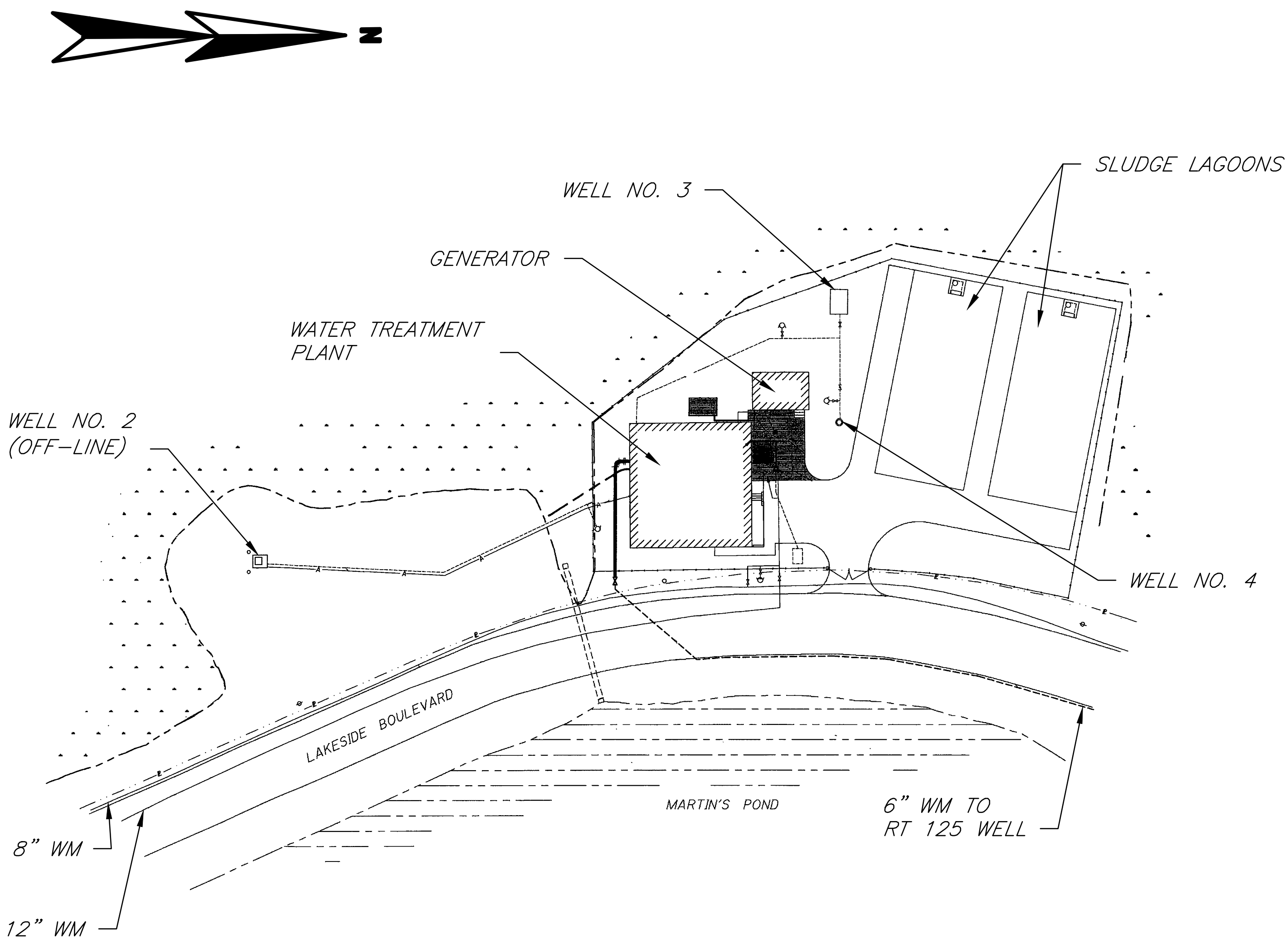
The Lakeside Boulevard wellfield has two active wells (wells # 3 and 4), and two wells that are currently inactive (wells #1 and 2) due to poor source water quality.

Water from the Route 125 Well is also treated at the Lakeside WTP. The well is located on Route 125 along the North Reading/Andover town line. The well is permitted for a maximum withdrawal rate of 130 gpm. It currently produces approximately 0.189 MGD.

Staff reports that the wells are operated 24 hours per day, 7 days per week. The wells are generally cleaned and redeveloped on a yearly cycle. The characteristics of each well and well pump are presented in Table 3-2.

TABLE 3-2
LAKESIDE BOULEVARD SOURCES AND PUMP DATA

Details	Well #2	Well #3	Well #4	Route 125 Well
Year Constructed	1956	1979	1984	1970
Status	Off-line	Active	Active	Active
Type	Gravel pack	Gravel pack	Gravel pack	Gravel pack
Diameter (inch)	24	18	12	12
Depth (feet)	42	38	59	35
Casing (feet)	32	28	44	26
Screen (feet)	10	10	15	9
Pump Type	Submersible	Submersible	Submersible	Submersible



LAKESIDE BOULEVARD WATER TREATMENT PLANT SITE PLAN

SCALE: "SCANNED"
(APPROX. 1"=70')

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PROJ NO:	DATE:	FIGURE:
12820	Jan. 2016	3-3

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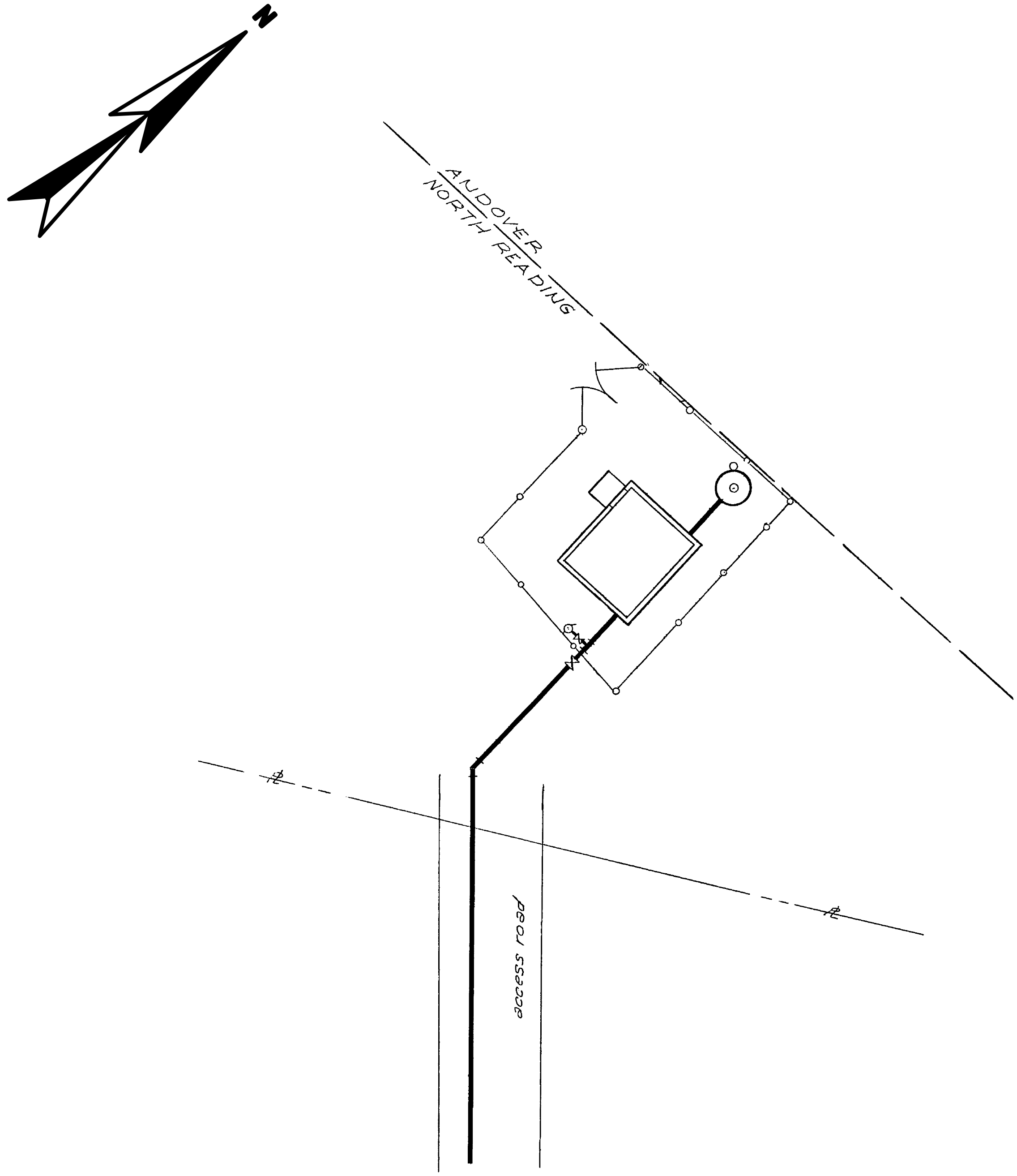

ROUTE 125 WELL SITE PLAN

SCALE: "SCANNED"
(APPROX. 1"=50')

North Reading
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12820	Jan. 2016	3-4

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3.1.1.3 Lakeside Water Treatment Plant

The Lakeside Water Treatment Plant was constructed in 1980 and is designed to remove naturally occurring iron and manganese from the Lakeside and Route 125 wells through Greensand filtration. The filter system consists of three 12 foot diameter vertical steel pressure filters. The filter system is rated for a peak flow of 0.9 MGD. However, staff report that the plant can only produce about 300,000 gpd or finished water quality becomes compromised.

The treatment process consists of several steps, the first of which is the wells pump groundwater to the water treatment plant. Prior to entering the filters, 45 percent potassium hydroxide (KOH) is introduced for pH adjustment followed by 12.5 percent sodium hypochlorite (NaOCl) for oxidation and disinfection. Potassium permanganate ($KMnO_4$) is added continuously for oxidation of iron and manganese. Oxidized iron and manganese is filtered on the filter media. Any remaining manganese is oxidized directly on the filter media. The original manganese greensand media is still in use.

Following filtration, the water is treated with KOH for pH adjustment, NaOCl for disinfection and fluoride (NaF) for public health purposes. The finished water enters the distribution system with a target pH of 8.5.

The filters are backwashed on a daily basis to maintain the performance of the media. Backwash wastes are discharged to one of two lagoons located on the site. The recycle pump system is not in use and settled water currently overflows the lagoons on-site.

The plant SCADA system operates remotely from the main distribution system SCADA system, inter-connection is not available. The facility includes an emergency generator and automatic transfer switch (ATS) which can power the facility and local well pumps upon a loss of primary power. The Route 125 well does not have stand-by power.

3.1.1.4 Railroad Bed Wellfield and West Village Water Treatment Plant

The Railroad Bed wellfield and West Village treatment plant site is located on Martins Brook off of Salem Street near the Wilmington town line. The facility consists of a wellfield and water treatment plant. Figure 3-5 presents a site plan of the Railroad Bed wellfield site. Figure 3-6 details the West Village water treatment plant site.

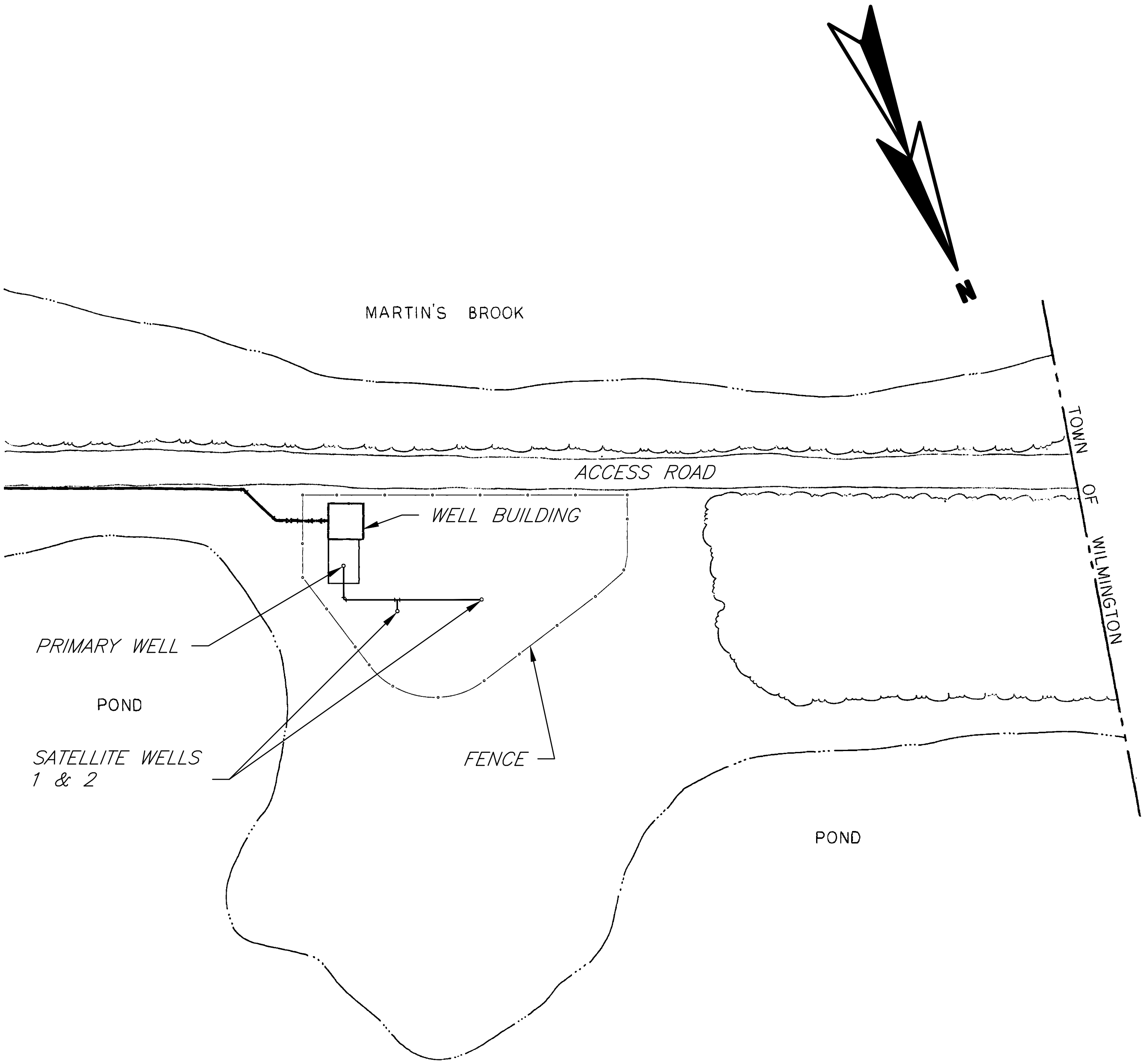
3.1.1.5 Railroad Bed Wellfield

The wellfield consists of a primary gravel-packed well (#1) and two naturally developed satellite wells (#2 and #3). The primary well is located in a small concrete building. The wells were originally constructed in 1981 following the contamination of the Stickney wellfield. The Railroad Bed supply was originally intended to be a temporary source until a more permanent supply could be identified. However, they have remained in service since being activated.

The wells are operated 24 hours per day, 7 days per week. The wells are generally cleaned and redeveloped on a yearly cycle during periods of low system demand. Staff reports that the primary well motor fails almost consistently every three years due to a short on the motor. The characteristics of each well and well pump are presented in Table 3-3.

TABLE 3-3
RAILROAD WELL SOURCES AND PUMP DATA

Details	Well #1	Well #2	Well #3
Year Constructed	1981	1981	1981
Type	Gravel pack	Naturally developed	Naturally developed
Diameter (inch)	18	12	12
Depth (feet)	50.5	43	47
Casing (feet)	42	31	32
Screen (feet)	8.5	12	15



RAILROAD BED WELLFIELD SITE PLAN

SCALE: "SCANNED"
(APPROX. 1"=50')

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PROJ NO: 12820
DATE: Jan. 2016
FIGURE: 3-5

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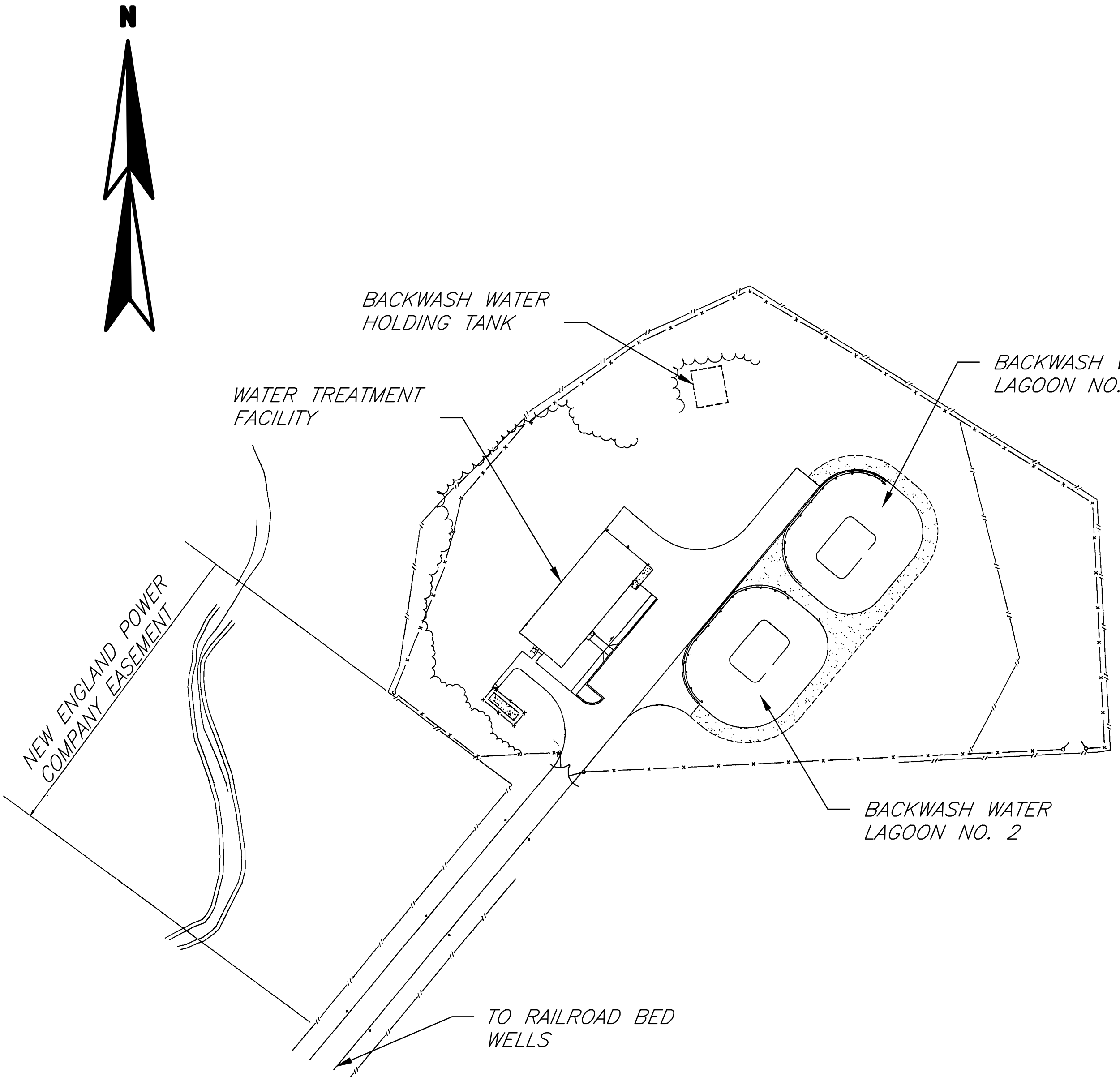

WEST VILLAGE WATER TREATMENT PLANT SITE PLAN

SCALE: "SCANNED"
(APPROX. 1"=70')

North Reading
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PROJ NO: 12820 | DATE: Jan. 2016 | FIGURE: 3-6

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3.1.1.6 West Village Water Treatment Plant

The West Village water treatment plant was constructed in 1999 and is designed to remove iron and manganese from the Railroad Bed wells groundwater through GreendsandPlus® filtration system. The system is rated for a peak flow of 0.5 MGD. Staff reports that the system is limited to a maximum output of 300,000 gpd or source water quality becomes compromised.

Prior to entering the filters, KOH is introduced for pH adjustment followed by NaOCl for oxidation as well as for disinfection. $KMnO_4$ is added continuously for oxidation of iron and manganese. Following filtration, the filtered water is treated with KOH for pH adjustment, NaOCl for disinfection and NaF for dental health purposes. The finished water enters the distribution system with a target pH of 8.5. Some of the finished water is directed to a large clearwell located on site. The clearwell is used exclusively for holding filtered water for the backwash cycle. The filters are backwashed on a daily basis to maintain the performance of the media. Backwash wastes are discharged to one of two lagoons located on the site.

The facility includes an emergency generator which can power the facility upon a loss of primary power. This unit does not power the well pumps.

3.1.1.7 Central Street Wellfield and Pump Station

The Central Street Wellfield and Pump Station include a well point groundwater system and a pump station. The wellfield and pump station was the original source for the Town and was constructed in 1954. Water from the 8-inch Andover connection is blended at the station with the groundwater. The site is located off of Central Street along the Skug River near the Andover town line. Figure 3-7 presents a site plan of the wellfield and pump station.

3.1.1.8 Central Street Wellfield

The Central Street Wellfield consists of a single 36x54 inch well surrounded by 15 - two and a half inch diameter well points. The original system consisted of nine well points which were constructed south of the pump station. At a later date, six more well points were added to the north of the pump station. The wellfield is permitted for a maximum of 0.40 MGD, but currently the Town is only able to pump approximately 70,000 - 80,000 gpd because the well points have become clogged and some of the screens have indications of failure.

The wells are operated 24 hours per day, 7 days per week. The primary well is cleaned and re-developed every year. The well points are cleaned on a yearly basis by blowing out silt from each. The characteristics of the well and well pump are presented in Table 3-4.

TABLE 3-4
CENTRAL STREET WELL AND PUMP DATA

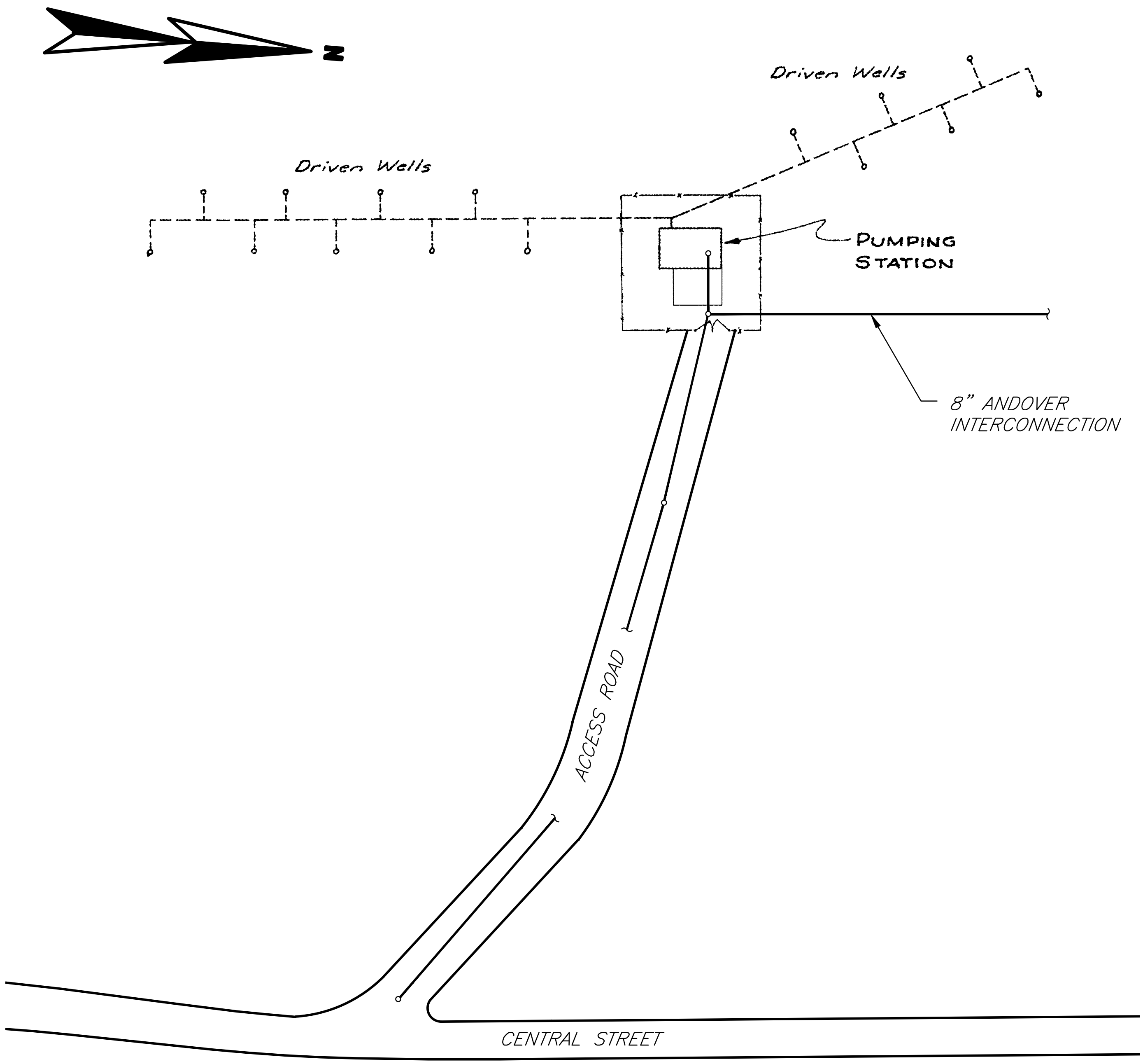
Details	Well #1
Year Constructed	Unknown
Type	Gravel pack
Diameter (inch)	36
Depth (feet)	28
Casing (feet)	24
Screen (feet)	4
Pump Type	Vertical turbine
HP	15
Capacity	150
TDH	270

3.1.1.9 Central Street Pump Station

The station currently includes a vertical turbine pump unit which is installed in the gravel packed well, and chemical feed systems including KOH used for pH adjustment, NaOCl for disinfection and NaF for dental health.

Following chemical treatment, the groundwater is blended with water from one of two Andover interconnections where it is treated with NaOCl for disinfection prior to being discharged into the distribution system.

The station includes all of the electrical gear required for the equipment, a security and video security system and other minor amenities. There is no back-up power at this site.



CENTRAL STREET WELLFIELD AND PUMPING STATION SITE PLAN

SCALE: "SCANNED"
(APPROX. 1"=30')

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3.1.2 Interconnections

In addition to its own supplies, the Town supplements demands above the available capacity from the Town of Andover through an interconnection agreement. The agreement stipulates a maximum daily withdrawal of 1.5 MGD. Approval for the purchase of water from Andover was issued under an Interbasin Transfer Act (IBTA) Permit by the MassDEP (formerly the Water Resources Commission) in 1991 under the provisions of the 1983 Water Management Act. The municipal management of the IBTA system is through an Inter-Municipal Agreement (IMA) enacted between the two towns. In Spring of 2015, North Reading and Andover renewed their agreement. A copy of the current IBTA is included in Appendix C.

An interconnection was first developed in 1958 with the construction of an 8-inch main located on Central Street near the town line. As noted previously, water purchased from this location is metered and blended with groundwater at the Central Street pumping station. Due to increasing water demands; a second 12-inch interconnection was constructed in 1990. This connection is located on Main Street near the town line and includes a meter pit and control panel.

Both interconnections are used on a continual basis to supplement the Town's groundwater supplies. The flow through both interconnections is regulated by modulating butterfly valves. The Town operates the Central Street Pump Station flow at a constant rate and averages 250 gpm during lower demand periods and up to 400 gpm during the warmer summer months. Flow through the Main Street meter varies depending upon water levels in the Tower Hill tank up to a maximum flow of 750 gpm.

3.1.3 Emergency Interconnections

The Town maintains hard piped emergency interconnections with the neighboring communities of Middleton, Reading, two with Wilmington and two with Lynnfield. These connections are rarely used. The connecting communities are operated at lower pressures and the use of them requires temporary booster pumps to be installed.

3.2 WATER DISTRIBUTION STORAGE

Storage of water within the distribution system is provided for peak hourly demands, firefighting needs, and emergencies. Storage volume which is depleted during periods of high demand is replenished daily during periods of low demand. Peak hourly demand is defined at the highest demand that occurs in a single hour expressed in MGD.

The North Reading water system includes three distribution storage tanks. Table 3-5 presents a summary of each of the tanks' physical properties.

TABLE 3-5
STORAGE FACILITIES

Storage Facility	Date Constructed	Total Storage Capacity (MG)	Tank Diameter (Feet)	Tank Height (Feet)	Base Elevation (Feet)	Overflow Elevation (Feet)
Tower Hill	1936	0.525	28	114	187	301
Moose Hill	1959	1.580	49	112	189	301
Swan Pond	2002	1.300	52	89	212	301

Note: Elevations presented in feet above mean sea level (MSL).

All water storage tanks are protected with a chain link fence. The tank interior and exterior coating for the Tower Hill and Moose Hill storage tanks was replaced in 2000/2001.

An onsite propane generator is available at the Tower Hill standpipe to power the telemetry devices in the event of a power outage.

3.3 WATER DISTRIBUTION PIPING

The North Reading distribution system consists of one primary service area (pressure zone). The service area operates on a maximum hydraulic gradeline elevation of 301 feet. The highest known service in the system is located on Red Hill Road at an approximate elevation of 192.6 feet USGS. Storage in the service zone is provided by water storage tanks.

The existing system of transmission and distribution water mains of the North Reading Water System is presented in Figure 3-1. The information shown is based on the Town’s most recent Geographic Information System (GIS) data and was verified with water department staff.

The distribution system includes approximately 90 miles of water main. In general, the service area is well looped; however, much of the transmission piping is small diameter. The majority of the system is supplied by 6-inch and 8-inch diameter mains with the exception of 10-inch diameter main along Park Street and sections of Main Street and some smaller 2-inch piping. The length of distribution mains by diameter, installation year and material is presented in Table 3-6. A database of the distribution piping was developed for the Master Plan based on as-built drawings and personnel knowledge from Water Department staff. The data includes length, water main age and material. This data was utilized to create the hydraulic model of the distribution system.

For fire protection, the distribution system includes approximately 750 fire hydrants. The hydrants are widely distributed throughout the town.

TABLE 3-6
WATER MAIN INVENTORY

Diameter (in)	Length (feet)	Percent of Total
2	1174	0.24
3	620	0.13
6	69994	14.63
8	333,036	69.61
10	46,927	9.81
12	26,026	5.44
16	685	0.14

Year Built	Length (feet)	Percent of Total
1935-1939	71,401	15
1940-1949	56,986	12
1950-1959	77,334	16
1960-1969	42,949	9
1970-1979	35,909	7.5
1980-1989	69,607	14.5
1990-1999	81,331	17
2000-2010	40,728	8.5
Unknown	2,217	0.5

Pipe Material	Length (feet)	Percent of Total
Cast Iron	126,102	26.33
Cement Lined Cast Iron	128,389	26.81
Cement Lined Ductile Iron	108,086	22.57
Copper	418	0.09
DI	88,579	18.50
DIP	25,101	5.24
Other	2,217	0.46

3.4 WATER SYSTEM MANAGEMENT

As part of the 2014 Water Master Plan a water system evaluation was conducted which evaluated North Reading’s system against a number of engineering principles and industry standards. These include system pressure, pipeline velocity, headloss, pipe looping, piping redundancy/reliability, fire flow, and water age.

Pressures throughout North Reading’s system are generally adequate. Currently, hydraulic simulations indicate that all areas of the system can maintain a minimum of 35 psi during average day, maximum and peak-hour demands.

Optimally, pipe velocities should be maintained below 2 feet per second (fps) to prevent re-suspension of accumulated sediments in the pipeline which can cause aesthetic problems. Velocities of 2 - 5 feet per second (fps) are accepted during stressed conditions such as a fire condition. Velocities greater than 5 fps contribute to increased headloss which in turn requires pumps to work harder and results in higher energy costs. Higher velocities can also scour the interior of the pipe, reducing its useful life.

Pipe velocities were evaluated and analysis found that there are no velocities above 5 fps in the system under existing or future demand conditions. However, as is typical of many systems, velocity through the majority of the system is less than 1 fps. As noted, low velocities can result in the deposition of sediment in the pipes which reduces the interior diameter of the pipe and can be re-suspended during higher demands and cause water quality issues.

North Reading's distribution system is generally well looped, yet there are many dead-end mains spread throughout the system. There were no significant looping opportunities identified that would improve system hydraulics. However, the Town should take advantage of future opportunities to eliminate dead-end mains.

3.5 HISTORICAL WATER USE

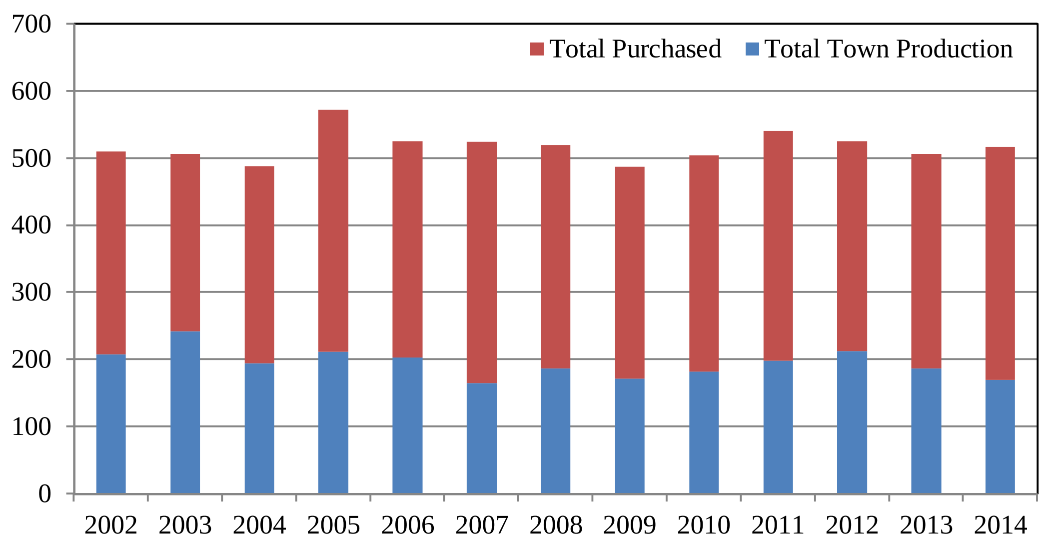
Historical water usage in North Reading is presented in this section. Historical water use data was obtained from the Town's Annual Statistical Reports (ASRs) which is submitted each year to the MassDEP. Table 3-7 presents a summary of system-wide demand conditions from 2002 through 2014. The ASR for 2015 was unavailable at the time of the preparation of this report. The Town’s total raw water production and total purchased amounts are presented in Figure 3-8. Historical water demands will be examined in more detail in the Water Supply Needs section. Copies of North Reading’s most recent ASR are included in Appendix D.

TABLE 3-7
HISTORICAL WATER DEMAND*

Year	Total Production (Town Sources) (MG/year)	Total Purchased (MG/year)	Total Demand (MG/year)
2002	207.8	302.6	510.4
2003	242.5	263.9	506.4
2004	194.5	293.5	488.0
2005	211.7	360.2	571.9
2006	203.5	321.6	525.1
2007	164.9	359.9	524.8
2008	187.2	332.9	520.1
2009	171.8	315.2	487.0
2010	181.7	322.9	504.6
2011	198.7	342.3	541.0
2012	212.6	313.0	525.6
2013	186.8	319.4	506.2
2014	169.8	346.9	516.7

* Data as reported in the 2002 – 2014 Massachusetts DEP Annual Reports.

FIGURE 3-8
TOWN WATER PRODUCTION VS. PURCHASED WATER



3.6 WATER QUALITY

This section presents a discussion of raw and finished water quality, the distribution system, regulatory compliance, and costumer complaints. Information about the existing water quality in North Reading provides a basis for determining future water needs. Further discussion on water quality and capacity needs is presented in Section 4.

3.6.1 Raw Water Quality

The Town's two water treatment plants primarily treat for iron and manganese. Table 3-8 presents raw water data from the Towns sources. This information was collected most recently as part of the Town's recent Water Treatment Plant Optimization study. MassDEP limits for finished water iron and manganese are 0.3 and 0.05 mg/L, respectively. Note that water quality data for the Central Street wells is not usually collected.

TABLE 3-8
HISTORICAL AND CURRENT RAW WATER QUALITY DATA (mg/L)

Well	1993[a]		2014[b]		2014[c]	
	Fe	Mn	Fe	Mn	Fe	Mn
Railroad Bed	1.78	0.67	1.6	0.8	5.83 +/- 0.72	0.828 +/- 0.118
Lakeside Well 2[d]	4.60	0.33	----	----	----	----
Lakeside Well 4[e]	3.35	0.49	4.5	0.8	10.34 +/- 1.21	1.552 +/- 0.253
Route 125	2.61	0.04	0.5	0.14	1.35 +/- 0.18	0.224 +/- 0.028

[a] Reported in *Water Supply Source Optimization Analysis* (CDM) in January 1993
[b] As reported in 2014 Master Plan
[c] Data collected by Operators between 10/21/14 and 11/14/14.
[d] Well 2 is currently inactive
[e] Samples collected in 2014 are a combination of Wells 3 and 4

The Railroad Bed Wells have experienced a moderate increase in manganese concentration, but more significant increase in iron concentration since being placed into service. The magnitude of the iron concentration increase would be expected to have an impact on the chemical dosing and removal capacity of the filtration system at the West Village WTP.

Both iron and manganese concentrations in the active Lakeside Wells have increased significantly since being placed into service. The Route 125 Well has also seen a considerable increase in manganese concentration, while iron concentration has decreased slightly. The increases and changes in raw water chemistry would be expected to have a significant impact on the chemical dosing and removal capacity of the filtration system at the Lakeside WTP.

Based on the Annual Statistical Reports for 2012 and 2013, the blend of water at the Lakeside WTP consists of 37% Route 125 Well water and 63% Lakeside Well water on average. Fluctuations and variability in this blend can have considerable impacts on the required chemical dosing for proper treatment.

3.6.2 Filtered Water Quality

The treatment goals are the same for both the West Village WTP and the Lakeside WTP and are as follows:

- Iron <0.3 mg/L
- Manganese <0.05 mg/L
- Target pH is 8.5
- Target fluoride is 1.0 mg/L
- Target Chlorine is 0.5 mg/L carried through the filters. Also, finished water chlorine is needed for distribution system residual.

The finished water quality at the West Village WTP as measured onsite by the operators is presented in Table 3-9. This data was collected in 2014 and presents averages from January to October.

TABLE 3-9
FINISHED WATER QUALITY - WEST VILLAGE

Month	pH	Fluoride	Total Cl	Free Cl	Iron	Manganese
AVERAGE	8.67	1.10	1.19	0.72	0.012	0.011
MINIMUM	7.35	0.29	0.44	0.03	0.000	0.000
MAXIMUM	9.13	1.38	3.16	2.18	0.290	0.088

[a] The plant was off-line for almost the entire month of September 2014.

The pH of the finished water, on average, is close to the target of 8.5, however, there appears to be a some variability. The average fluoride concentration is close to the target of 1.0 mg/L, also with some variability. The level of chlorine carried through the filters was not readily available. The average iron and manganese concentrations are below the treatment target level. However, it appears that the manganese concentration has exceeded the limit on a couple occasions as can be seen in Figure 2. Overall, the treatment performance at the West Village WTP is good.

The finished water quality at the Lakeside WTP as measured onsite by the operators is presented in Table 3-10. This data was collected in 2014 and presents averages from January to October.

TABLE 3-10
FINISHED WATER QUALITY - LAKESIDE

Month	pH	Fluoride	Total Cl	Free Cl	Iron	Manganese
AVERAGE	8.81	1.06	0.94	0.77	0.220	0.039
MINIMUM	7.62	0.67	0.38	0.20	0.000	0.001
MAXIMUM	9.12	1.33	1.91	1.69	1.400	0.430

The pH and fluoride concentrations are close to their target levels. The average iron and manganese concentrations are below the treatment target level. However, there is more iron and manganese concentrations that have exceeded the limit as can be seen in Table 3-10 above. Overall, the treatment performance at the Lakeside WTP is adequate. Because the water treated at this facility is a blend of the Lakeside Wells and Route 125 Well, which have very different levels of iron and manganese, changes in the ratio of the blend can significantly impact the chemical dosing required for effective treatment.

3.6.3 Distribution and Storage

Dead end mains in a water system can lead to poor water quality. The Master Plan evaluated distribution system water age and found about twelve locations with a water age in excess of ten days, many of which are dead end mains. This is a primarily a consideration when monitoring for disinfection by-products.

Additionally, water quality issues typically stem from poor tank turnover. Due to the sheer volume and configuration of the tanks and the inlet/outlet pipe (standpipe style) and the absence of a mixing system, turnover of water in the Tower Hill and Moose Hill tanks is limited, with Swan Pond having a similar issue, but perhaps to a lesser degree. Water enters and exits each tank from a single pipe, which studies have shown results in very little exchange or mixing. This is simulated in the model as a last in, first out mixing model. As reported in the Master Plan, it was apparent in the water age simulation that poor tank mixing is the cause of higher water age in the middle of the distribution system (i.e. areas surrounding the Tower Hill and Moose Hill tanks.)

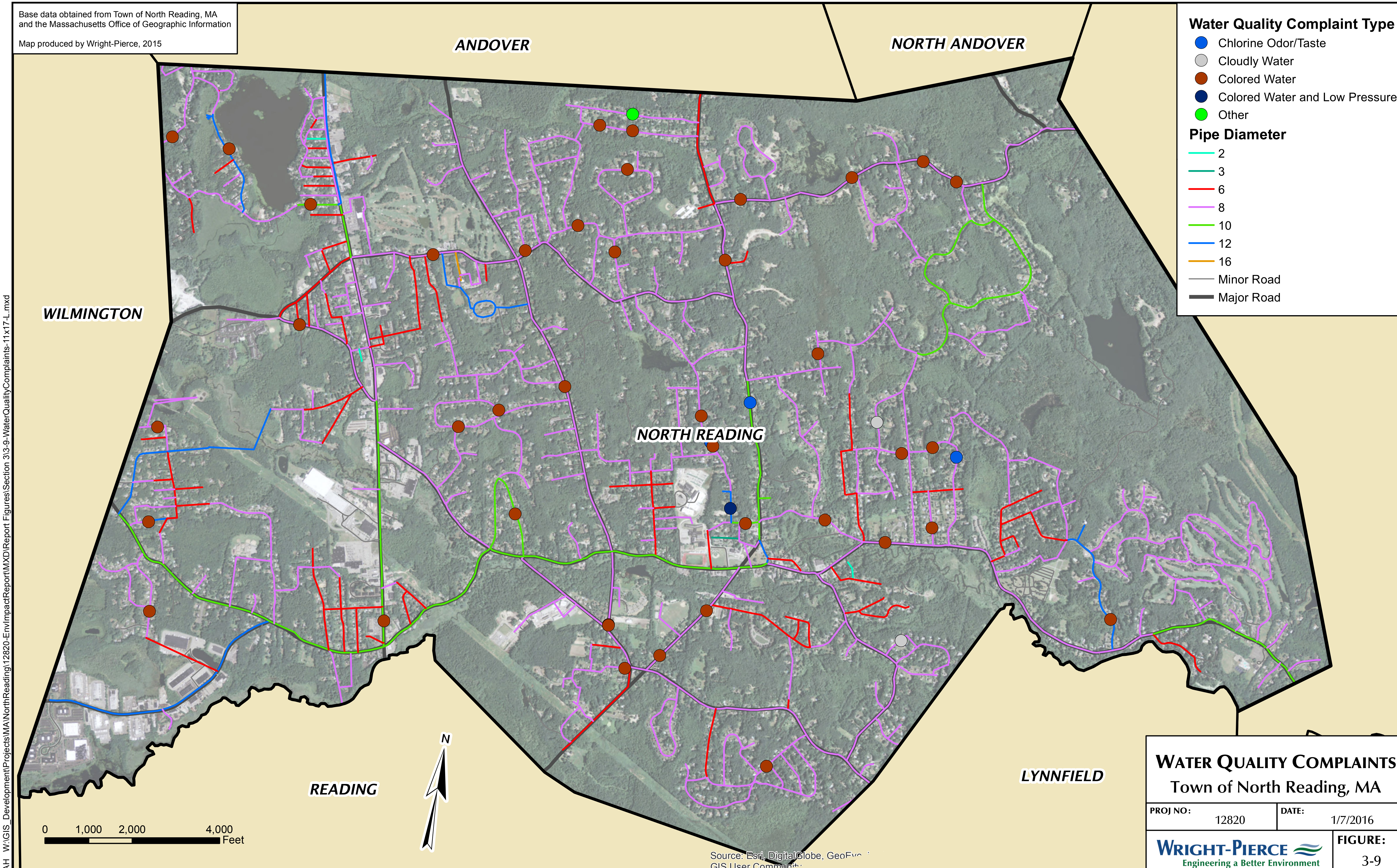
3.6.4 Regulatory Compliance

As reported in the 2014 Water Master Plan, North Reading has historically been in compliance with the lead and copper rule, arsenic rule, and radionuclides rule. The Town has met unregulated contaminant monitoring rule requirements. The Town has met compliance standards for manganese removal. They are generally in compliance with the disinfection by-product rule, though some violations were reported in 2014 with the Stage 1 Disinfection By-Product (DBP) rule.

Samples collected as part of the recent water treatment optimization study were also analyzed for Total Organic Carbon (TOC). Although the treatment system is not designed specifically for the removal of this parameter, this was required to get a better understanding of the organics levels at each facility given the Trihalomethane (THM) concerns, a DBP, in the distribution system (chlorine and organics react to form THM's in the distribution system). The raw water at the West Village WTP contained 6.5 mg/L TOC and the finished water contained 4.2 mg/L TOC. The reduction in TOC is likely due to reactions with chlorine (forming THMs) and potassium permanganate (oxidation). The levels of THM's observed are fairly high and likely contributors to the distribution system THM concerns. The raw water at the Lakeside WTP contained approximately 2.5 mg/L TOC and the finished water contained 1.8 mg/L TOC. Similar to the West Village WTP, the reduction in TOC is likely due to reactions with chlorine and potassium permanganate. While the levels observed are much lower than the levels at the West Village WTP, they are elevated and also likely contributors to the distribution system THM concerns.

3.6.5 Customer Complaints

The Town tracks customer complaints regarding water quality which are received at the Department office. Historically, complaints have consisted of reports of brown/discolored water, chlorine taste and smell, low pressure, etc., and have been associated with large demand variations during peak summer demands, fire hydrant use during flushing operations, main breaks, and firefighting. Figure 3-9 presents the locations that water quality complaints were received from 2010 to 2012.



Water Quality Complaints
Town of North Reading, MA

PROJ NO: 12820
DATE: 1/7/2016

WRIGHT-PIERCE
Engineering a Better Environment

FIGURE: 3-9

3.7 SOURCE WATER PROTECTION

Wellhead protection areas are important for protecting the recharge area around public water supply (PWS) groundwater sources. A review of North Reading's wellhead protection areas was conducted based on information obtained in the ASRs and Source Waters Assessment and Protection (SWAP) Report. As previously noted North Reading's sources are located within the Ipswich River Basin and all active sources including Railroad Bed well, Lakeside Wells (Well No. 2, 3, and 4), Central Street wellfield, and Route 125 well have wellhead protection areas located in the towns of Andover and Wilmington in addition to North Reading.

The Town's wells have a 400-foot Zone I wellhead protection area and the Town's wellfield (Central Street) has a 250-foot Zone I protection area. The Town does not have complete control within the Zone I areas for any of their sources and the susceptibility to contamination is noted as being High due to the lack of a hydrogeologic barrier that can prevent contamination migration to the wells.

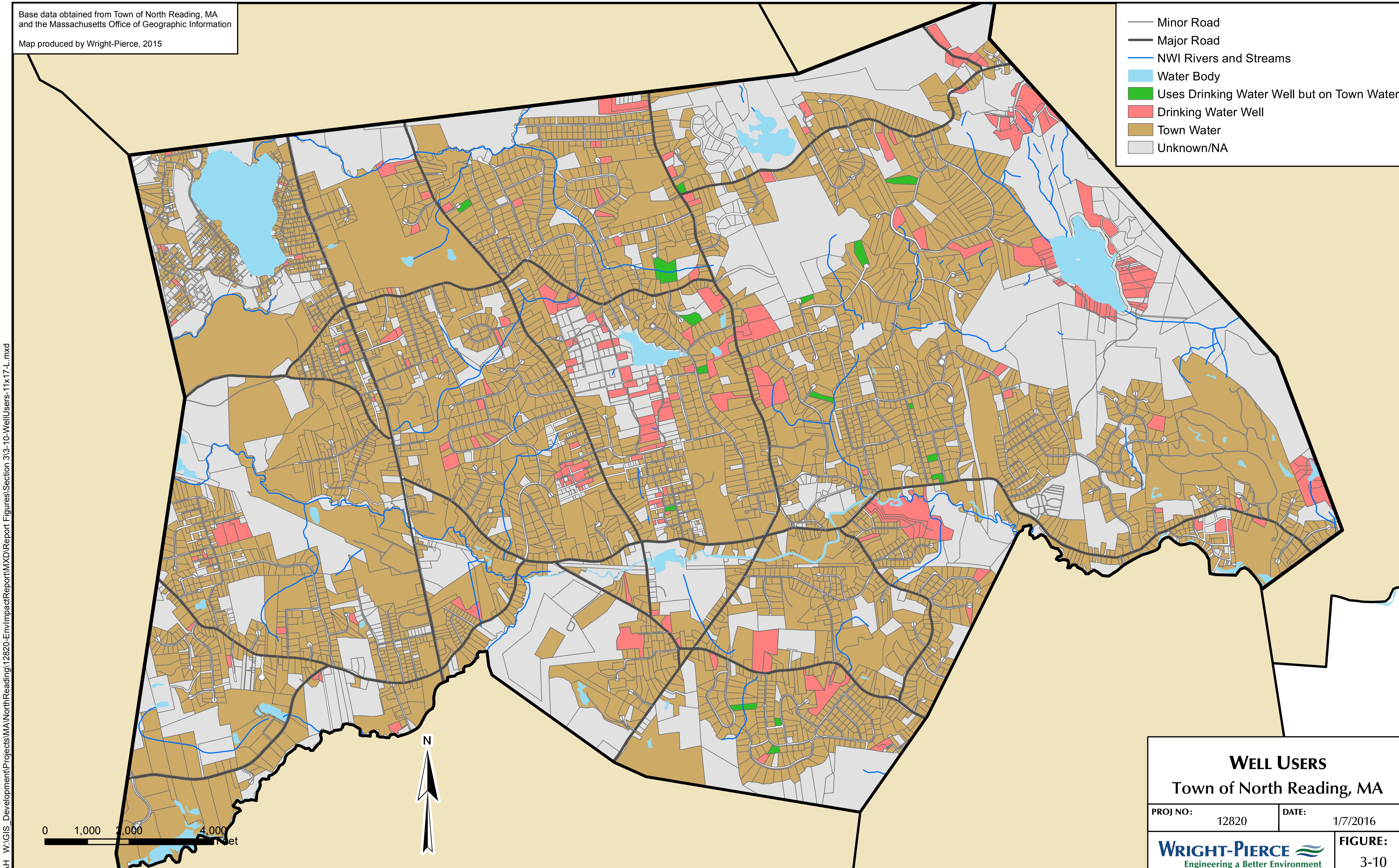
The Lakeside wells' protection areas contain potential pollution sources from five (5) residential homes, septic systems and local roads. Route 125 well potential pollution source is Route 125 that intersects the Zone I. The Railroad Bed well's potential pollution source is a transmission line right-of-way that crosses the Zone I. The Central Street wellfield's potential pollution source is one residential property located within its Zone I.

Section 2 of the report also provides a listing of hazardous releases and spills located in Zone II protection areas.

3.8 PRIVATE WELLS

The ASR identifies that approximately 229 homes on private wells. Assuming a household size of 2.71 people, this would calculate to approximately 621 people on private wells in Town.

Well users are scattered throughout Town. Figure 3-10 shows the location of well users in Town. As shown, Swan Pond is surrounded by well users, and it appears that there is a concentration of well users surrounding Eisenhaures Pond.



WELL USERS

Town of North Reading, MA

PROJ NO:	DATE:
12820	1/7/2016

WRIGHT-PIERCE
Engineering a Better Environment

FIGURE: 3-10

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3.9 EXISTING WATER CONSERVATION MEASURES

North Reading actively promotes water conservation in town and is working its way towards residential water use of 65 gpcd. The following sections outline the current practices undertaken to achieve this goal. Some examples of water conservation effort by the Town are included in Appendix E.

3.9.1 Billing

North Reading issues water bills quarterly, typically on or about August 15, November 15, February 15 and May 15. Water bills are due one month after the issue date. Bills are based on actual water meter readings and collected fees fund the water enterprise fund to cover the costs of purchasing water, operation and maintenance of the water distribution system and planned capital improvements to the system.

North Reading has a three tier, increasing block water rate structure. Under this rate structure as of March 2, 2016, water consumption up to 10,000 gallons per quarter is charged at the first tier rate of $8.08 per 1,000 gallons. If water consumption exceeds 10,000 gallons per quarter, the customer enters the second tier, and the water used in excess of 10,000 gallons per quarter is charged at the second tier rate of $11.85 per 1,000 gallons. If water consumption exceeds 22,500 gallons per quarter, the customer enters the third tier, and the water use in excess of 22,500 gallons per quarter is charged at $16.15 per 1,000 gallons. In addition to the usage based charges, there is a $5.00 service charge per bill.

The rates and tiered structure serve as incentive for users to reduce the amount of water they purchase. North Reading has a water rate which is above average for Massachusetts. The high rates and tiered nature of the billing system promote water conservation.

The Massachusetts Water and Wastewater Rates Dashboard, which uses data from a 2014 statewide rate survey conducted by Tighe & Bond, was used to compare North Reading to other community in Massachusetts. North Reading customers would pay an average monthly bill of $65 for 7,500 gallons which is significantly higher than the State median of $42.

To determine the potential impact rate structures have on conservation, the Massachusetts Water and Wastewater Rates Dashboard compares the cost per 1,000 gallons for water use over 10,000 gallons. According to the tool, the State median cost at the higher use is approximately $6 which is substantially lower than North Reading’s second tier of approximately $12.

3.9.2 Comprehensive Planning & Drought Management Planning

North Reading is continuously evaluating water management and addressing needs through local regulations. North Readings updated its Water Use Restrictions rules & regulations (R&R) in October 2010, April 2012 and March 2014. North Reading also updated its Demand/Drought Management Plan (DMP) in November 2013.

The Town also has an Emergency Response Plan that was last updated in 2009 which serve as the contingency planning document. North Reading also maintains emergency connections to neighboring communities to be used during emergencies.

Finally, at Fall 2014 Town meeting North Reading approved DPW enforcement authority which will aid in the enforcement of the local regulations, especially regarding the implementation of the DMP.

3.9.3 Water Audit

Water system audits can help water conservation through the identification of the causes for unaccounted for water (UAW). The Town of North Reading has not completed a town wide water audit recently. The Town plans to appropriate approximately $50,000 in funds for this project at Town meeting for fiscal year 2017.

3.9.4 Leak Detection

As a key component of UAW, identifying and repairing leaks can reduce UAW and improve water conservation in a community. North Reading completed a leak detection survey on the entire water distribution system on 12/3/14. The survey identified 25 leaking services & 11 leaking hydrants. The repairs were completed in 2015.

3.9.5 Metering

Master & sub-master meter calibration is an important process to reduce unaccounted for water and ensure accurate production and use calculations. Calibration of 11 meters across 6 sites was completed in February 2016.

Accurate residential meters are also important. North Reading has approved $1,700,000 in funding for an Advanced Metering Infrastructure (AMI) system. This will replace all meters in the distribution system and provide for remote reading. The data will provide the Town with more timely billing as well as faster access to accounts that are using high volumes of water or exhibit signs of leaks.

3.9.6 Public Sector

North Reading completed an audit of Public Building Water Use in December of 2014. The audit identified short and long term retrofit projects. The improvements will be completed in phases, and North Reading plans to appropriate $26,000 for the first phase of improvements at the fiscal year 2017 town meeting.

3.9.7 Lawn & Landscape

North Reading mitigates the impacts of lawn and landscaping irrigation through their seasonal demand management plan. North Reading has adopted Water Use Restriction Bylaw (191-6) and associated Rules & Regulations (see 1.b.) In Fall 2014, North Reading approved DPW enforcements of the water use restriction policies.

3.9.8 Public Education & Outreach

North Reading is working towards improved water conservation through public outreach and communication. North Reading has several pages of their Town website dedicated to water conservation education. The website includes links information regarding:

- How Much To Water Your Lawn
- When To Water Your Lawn
- How To Water Your Lawn
- Watering Techniques
- Mowing Your Lawn
- Water Conserving Soils
- Planting to Conserve Water
- Saving Water Indoors
- Rain Barrels
- Drought Management Plan
- 2014 Leak Detection Report
- Automatic Meter Reading Evaluation
- Town Building Water Conservation Assessment
- Ipswich River Watershed

North Reading plans to improve outreach through the development of a water conservation public education plan.