

**ENGINEERING REPORT  
ON THE  
WATER SUPPLY AND DISTRIBUTION  
SYSTEM  
FOR THE  
TOWN OF BELMONT, NEW HAMPSHIRE**



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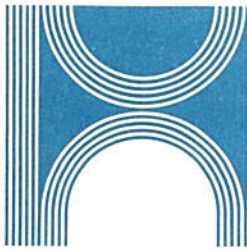
OCTOBER 1968

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Mr. Russell H. Cushing, Superintendent  
Belmont Water Works  
Belmont, New Hampshire

Dear Mr. Cushing:

In accordance with your instructions we are pleased to submit the following brief Engineering Report on the Water Supply and Distribution System of the Belmont Water Works.

Generally we find the distribution system to be excellent. The Water Works should continue to diligently pursue the location and development of a new well water supply and should give careful consideration to the construction of a new 500,000 gallon capacity storage facility. A complete metering program is contemplated, this is highly recommended and should be completed as soon as possible.

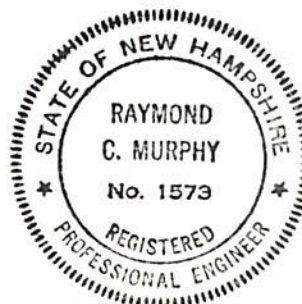
We have appreciated this opportunity to serve you and will be pleased to work further with you in the development of the several recommendations.

Very truly yours,

FENTON G. KEYES ASSOCIATES

  
Raymond C. Murphy

RCM:pe



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THE REPORT

## 1. PURPOSE OF THE REPORT

This engineering report was authorized for the purpose of obtaining an evaluation of the physical plant of the Belmont Water Works, particularly in the areas of water supply and storage of water in the system. The report was also undertaken for the purpose of evaluating the desirability and worth of installing meters on all service connections in the system. The report sets down findings in regard to these several items and makes recommendations as to possible future courses of action to be taken to accomplish the necessary improvements in and additions to the water supply and distribution system and in regard to general operation and management of the system.

## 2. THE EXISTING SYSTEM

The water supply and distribution system of the Belmont Water Works serves the Belmont Village Area of the Town of Belmont. The water supply source is a well located on Shaker Road and the system's only storage facility is a ground-level reservoir located on the Gilmanton Road, Route No. 140.

The distribution system is shown schematically on Plate Number 1 bound at the rear of the report. The original distribution system was installed in 1893. During the period between 1950 and 1953 the system was completely renewed. The system now consists of 6, 8 and 10 inch cement-lined cast iron pipe with a very short footage of 3/4 and 2 inch pipe. The 2 inch pipe is wrought iron and the 3/4 inch pipe

is copper. The cost to renew the system was \$120,000.00. An additional \$10,000.00 was spent to install the 10 inch line to the well and raise all valve boxes to grade.

The system has 29 fire hydrants in the public streets and three hydrants on mill property. Static water pressure in the system is generally good varying from a low of 30 p.s.i. at the hydrant on Route No. 140 immediately below the reservoir to a high of 85 p.s.i. in the Shaker Road-Concord Street area. Pressures are excellent, generally between 60 and 80 p.s.i., in the village center area. Actually nowhere in the system are pressures poor, however, expansion of the system into the surrounding higher areas would create pressure problems if use of the existing reservoir is continued.

Insofar as the existing water distribution system is concerned its condition is considered to be excellent. Pressures are good, pipe sizes are adequate and there are a sufficient number of hydrants. Pipe sizes on the extremities of the system are sufficient to permit expansion without undue problems. A connection in Dearborn Street between Johnson Street and Route No. 140 would strengthen the system and eliminate a deadend.

### 3. THE EXISTING WATER SUPPLY

The existing water supply of the Belmont Water Works is a well located just west of Shaker Road and south of Pumping Station Brook in the vicinity of Bout Pond. The

well was installed in 1937 and no work has been accomplished on the well since it was put in service other than to change or repair the pump when necessary. The well is of the gravel-packed type with a depth of about 65 feet. It has a 12 inch inner casing. The static water elevation in the well is 501.40 and the normal drawdown when pumping at full capacity is about eight feet. The well is a sand pumper and this condition creates continuing mechanical (wear) problems with the pumping equipment. The installed pump capacity, when new, is 200 gallons per minute. The theoretical capacity of the well assuming a maximum pumping period of 16 hours per day is 192,000 gallons.

The continuous pumping of sand is causing a serious problem with the well itself, as well as with the pumping equipment. The continuous removal of fines from the material surrounding the gravel pack will undoubtedly cause the well to collapse. An indication that the physical failure of the well is occurring is the surface settling taking place immediately surrounding the well casing. This very serious situation is further aggravated by this well being the system's only source of supply.

Discussions with a competent well driller indicate that the repair of this well is impractical. The repairs would cost almost as much as a replacement well and the results could not be assured. Insofar as this well is concerned it should be replaced, taken out of continuous service and

held as a reserve or standby supply. Under these conditions of much reduced use the well would continue to be usable for an extended period.

The quality of water from this supply has generally been very satisfactory with the exception of the sand pumped and a variation in the iron content. The iron content usually holds below the permissible upper limit of 0.30 p.p.m. but readings as high as 0.54 up to 2.20 p.p.m. have been recorded. This variation in the iron content has been a major deterrent to location of a new supply well in the vicinity of this existing well.

#### 4. THE EXISTING STORAGE FACILITY

The existing storage facility is a ground surface reservoir located on the south side of Route No. 140. The basin of the tank is 110 feet long, 19 feet wide and 8 feet deep. The walls and floor are concrete and the entire tank is covered by a pitched corrugated metal roof. The reservoir has a capacity of 100,000 gallons. A float control in this reservoir actuates the supply pump in the well. The pump is actuated when the reservoir level drops 8 or 9 inches which constitutes a water usage of between 10,475 and 11,725 gallons. The maximum water surface elevation in this reservoir is elevation 713.80.

#### 5. Water Consumption

The records of the Belmont Water Works indicate that water consumption has steadily increased both from the stand-

point of overall consumption and more importantly from the standpoint of per capita consumption. The increase in overall consumption has been due primarily to an increase in per capita use rather than by the increase in the number of people served. Table Number One below shows the comparison, for selected years, between the number of people served and the per capita consumption

Table No. 1  
Comparison of People Connected and Per  
Capita Consumption

<u>Year</u>	<u>People Served</u>	<u>Per Capita Consumption</u>
1951	674	67 G.P.D.
1953	682	96
1963	700	111
1964	720	127
1965	720	123
1966	730	129
1967	730	137

It will be readily noted from the above table the per capita consumption has more than doubled in a 16 year period while the number of people served has risen about 10% over the same period. In other words the growth of the system has been very moderate while the use within the system has increased at a very substantial rate.

Table Number Two below lists the total annual gallonage pumped and the steady increase in average daily water consumption which has taken place.

Table No. 2  
Total Annual and Average Daily Water  
Usage

<u>Year</u>	<u>Annual Pumpage</u>	<u>Avg. Daily Use</u>
1951	15,733,800 gals.	44,954 gals.
1953	21,712,800	65,400

1963	27,241,042	97,603
1964	33,174,931	91,145
1965	32,268,200	88,382
1966	34,319,690	93,883
1967	36,987,700	101,868
1968 (6 mths.)	19,099,500	105,286

During the period of July 16, 1968 through July 23, 1968 the daily quantity pumped ranged from 112,200 gallons to 188,000 gallons. July 22 and 23 would be considered peak days and the amount pumped was 188,000 and 184,000 gallons respectively. These amounts are precariously close to the design capacity of the existing well of 192,000 gallons and it is reasonable to assume this figure has been exceeded on many days. In fact records show usage on July 8, 1968 to have been 211,900 gallons, on July 12, 1968 - 199,400 gallons and again on July 15, 1968 a day's use of 201,900 gallons.

The major consumer on the Belmont Water Works system is the mill. Records from a two and one half month period in 1968, May 6 through July 19, indicate the average daily mill use varies from a low of 25,766 gallons per day to a high of 66,800 gallons per day. On the basis of 300 working days per year the annual use of water by the mill would approximate 14,000,000 gallons per year. This amount represents about 37% of the total annual pumpage.

The foregoing figures indicate a high per capita consumption of water. The figure for 1967 of 137 gallons per capita per day is about twice the national average figure. This figure is tempered somewhat by eliminating the mill use which is condiered to be an abnormal use when computing the resi-

dential per capita use. With the mill use not taken into account the residential per capita figure reduces to about 86 gallons per capita per day which still must be considered high for purely residential use in a town of the character of Belmont.

#### 6. A New Water Supply

The Belmont Water Works must continue to actively undertake the development of a new water supply source. The existing well supply is definitely inadequate both from the standpoint of capacity and physical condition. The safe continuous yield of this well, assuming it to be in good condition, is 192,000 gallons per day. The records indicate that this yield has been approached on many occasions and has been exceeded on several days during this past summer. When a situation such as this occurs on a relatively frequent basis the time has arrived to augment the supply. In the case of the Belmont Water Works this situation is gravely aggravated by this being the only source of supply and the condition of the well. Failure of this well, and this could occur almost without warning, would leave the town without a water supply.

In the spring of 1967 exploratory work was undertaken to develop a new well water supply. A good site was discovered just off the gravel road which runs westerly off Route No. 106 just south of the intersection of Route No. 106 and Concord Street. An eight inch test well was installed in this site and a pumping test run from June 9, 1967 to June 16, 1967. The results of this test showed the capacity

of a permanent well on this site would be 500 gallons per minute or a safe yield of about 480,000 gallons per day. The general quality of the water was excellent, the iron content was less than 0.10 p.p.m. and the manganese content was less than 0.05 p.p.m. This well would be a very adequate prime water supply for the system. Unfortunately the owner of the property would not sell and the town meeting action refused permission to undertake condemnation proceedings.

At the present time the Water Department is considering investigating other possible sites, one in the general vicinity of the above discussed site and one in the vicinity of Badger Pond. It is hoped one of these sites will be as or nearly as productive as the first site. If this does not become the case it is strongly recommended the town immediately undertake condemnation proceedings on the first site. The town can no longer with any degree of safety, delay the acquisition and development of a new water supply.

#### 7. A New Storage Facility

The existing storage facility has a total capacity of 100,000 gallons. At the present rate of consumption this capacity, in practically every instance, represents less than a full day's storage and on several peak days during the past summer this storage would not have lasted 12 hours had there been a pump failure or a break in the main feeding the reservoir. This storage capacity is very inadequate from the standpoint of providing sufficient time to locate and rectify

the interruption to the source of supply. It is recognized that once it is known that a problem exists the use of water can be drastically reduced, however, it is considered reasonable that the storage facility have capacity to provide sufficient quantity to provide for "average" consumption for a 2 or 3 day period. On this basis a storage tank with a capacity of 300,000 gallons would be desirable.

Storage capacity is also governed by fire flows. In a built up area of the character of Belmont, mostly one or two story separated structures, a fire flow of 1500 gallons per minute for a four hour period is considered adequate. This flow must be provided, uninterrupted, during the peak day flow with all supply pumps running and not deplete storage capacity by more than one third. The records indicate that during last summer a peak day flow was about 210,000 gallons, or 146 gallons per minute. This flow, together with the fire flow, would make a total draw on the system of 1646 gallons per minute. The existing well pump would, at the same time, deliver 200 gallons per minute into the system resulting in a net draw from storage of 1446 gallons per minute or a total quantity of 347,000 gallons for the four hour period. This usage would therefore dictate a storage tank with a capacity of 1,000,000 gallons. The foregoing does not consider the installation of another well, however. Assuming the new well capacity to be 500 gallons per minute the net draw from storage would be at the rate of 946 gallons per minute or a total draw of 227,000 gallons.

The above figures are considered to be conservative, particularly the fire flow of 1500 gallons per minute; a somewhat lower figure could be tolerated. On this basis then a storage facility with a capacity of 500,000 gallons is considered to be necessary and adequate to meet all basic requirements. A good location for this tank would be on the north side of Route No. 140 a few hundred feet east of the present storage reservoir. The main at this point is 10 inches in size and could readily be extended to the new tank site. The ground elevation at this site is about 810.0. It is recommended a steel, standpipe type of storage facility be erected. This would be the most economical means of obtaining this amount of storage. The tank would be constructed of steel plate with a domed roof and would be set on a concrete foundation. The tank would be approximately 50 feet in diameter and would have a height of about 34 feet. The estimated construction cost of this facility including extension of the 10 inch connecting main is -----\$60,000.00.

#### 8. METERS

The Belmont Water Works is contemplating the installation of water meters on all connections over the next two or three year period. This step is strongly recommended and in complete accordance with good water works practice. The system presently has between 275 and 280 customers or connections. The estimated cost to meter the entire system has been stated to be \$15,000.00. Outside reading meters

would be installed. It is anticipated that this metering program will be underwritten out of present earnings. Between now and June 1969 it is expected an amount between \$7,000.00 and \$8,000.00 can be set aside from earnings for this program.

The value of meters is two-fold, they almost invariably increase revenue at the same time they reduce water consumption. The increase in revenue is, of course, due to a much more realistic rate schedule in comparison to a rate schedule based on a flat rate or a fixture rate schedule. Six trial meters have been installed in the system and Table Number 3 below shows the variation in revenue as a result.

Table No. 3  
Comparison of Charges-Flat Rate vs. Meters

<u>Meter No.</u>	<u>Flat Charge</u>	<u>Meter Charge</u>	<u>Difference</u>
1	\$ 42.00	\$ 63.88	+\$ 21.88
2	50.76	94.33	+ 43.57
3	80.00	63.34	- 16.66
4	54.50	88.18	+ 33.68
5	41.00	26.00	- 15.00
6	<u>56.00</u>	<u>60.22</u>	<u>+ 4.22</u>
Totals	\$324.26	\$395.95	+\$ 71.69

These six trial meters show an increase in revenue of 22 percent. The present annual income is about \$15,000.00; \$1406.00 from the mill, \$3400.00 from hydrant rental and about \$10,200.00 from residential charges. If this sample increase in revenue continues across the board it can be anticipated that total revenue will increase about \$2200.00.

Total revenue after metering should be in the range of \$17,000.00 to \$17,500.00 per year. Payment on the outstanding indebtedness will amount to \$6100.00 in 1968 and will continue to decrease leaving an annual sum between \$11,000.00 and \$12,000.00 for operation, maintenance and improvement of the system.

Another source of revenue which should be investigated is the annual charge made to the mill. At the present time the mill is paying an annual bill of \$1406.00 for an estimated total quantity of water consumed of 14,000,000 gallons. Under a more realistic rate schedule the annual billing for this quantity of water would be in the range of \$2500.00 to \$3,000.00. This increase would raise the estimated total annual income of the Belmont Water Works to between \$18,000.00 and \$19,000.00.

#### 9. SUMMARY

This brief study of the Belmont Water Works has resulted in the following general conclusions. The distribution portion of the system is very adequate and in excellent condition. Pipe sizes, pressures and number and location of hydrants are good. Some looping to eliminate deadends is desirable, but this can be accomplished at any time and is in no way critical. The water supply well is no longer adequate and the well itself is in a deteriorating condition due to the pumpage of sand. Steps are presently being taken to discover and develop a new well water supply.

These steps should be continued at all deliberate speed. If the steps presently being taken do not prove fruitful the well site proven in the 1967 test program should be taken by condemnation proceedings.

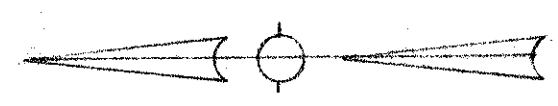
The system's existing storage facility has inadequate capacity. A fire or a failure of the supply or a main break would deplete the total storage in a matter of hours. A failure of the well would be particularly critical leaving the system without water in less than a day. It is strongly recommended the existing storage facility be augmented by the construction of a new 500,000 gallon steel standpipe. This new facility would provide excellent fire protection and sufficient storage to carry the system over a short-time supply failure.

The Water Works is presently contemplating a two year program of installation of meters on all service connections. It is anticipated that this program can be paid for from income over this period. In any event this program is strongly recommended, meters increase revenue and decrease water consumption, both of which are beneficial to the operation of a public water system. With the installation of meters the annual charge for water levied against the mill should be reviewed. It appears the present charge of \$1406.00 should be more in the range of \$2500.00 to \$3,000.00.

The installation of a new well supply, with the present well held in reserve, construction of a new storage

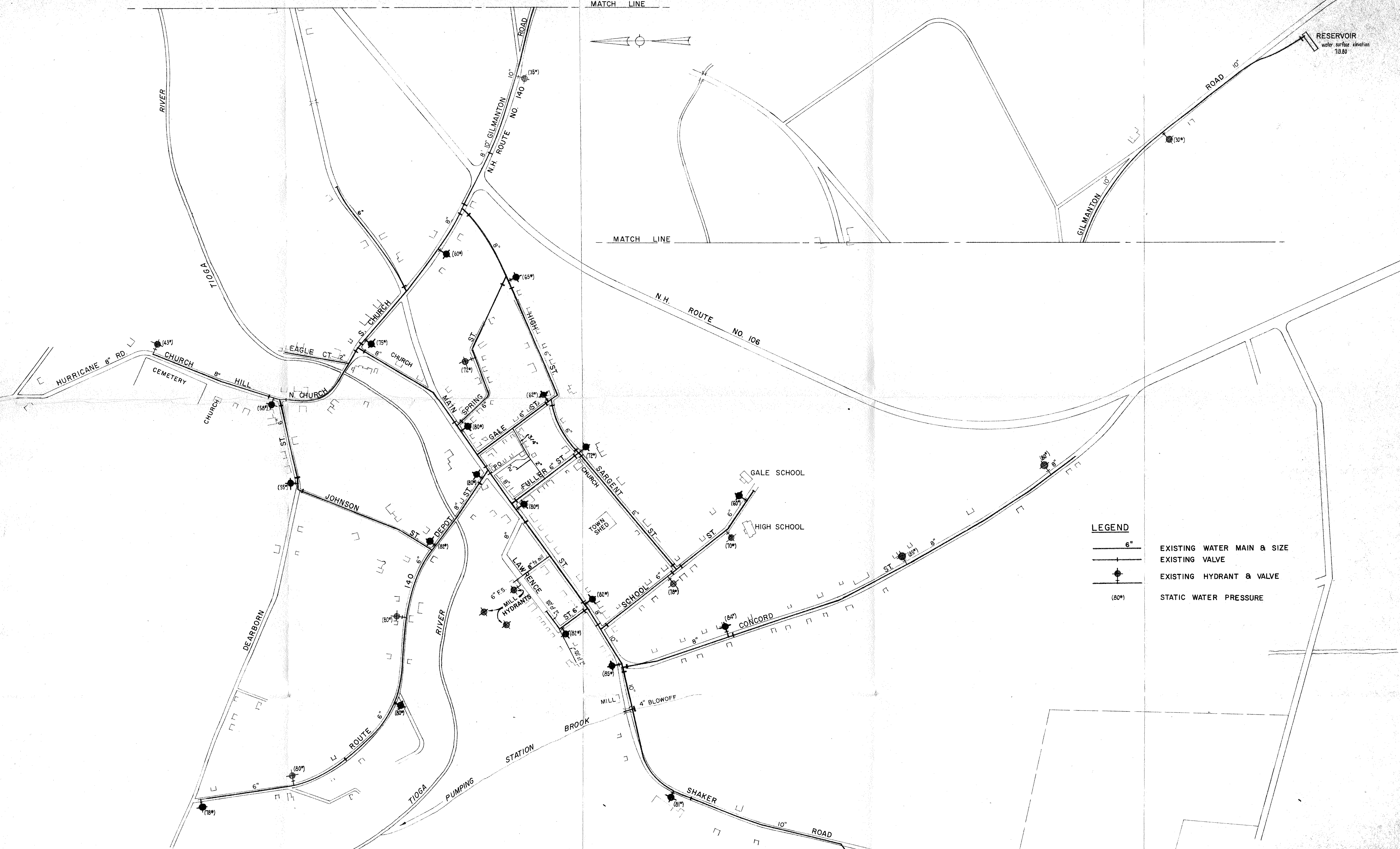
facility, installation of meters and a review of the rate structure will place the Belmont Water Works in a very satisfactory overall condition for a considerable period in the future.

MATCH LINE



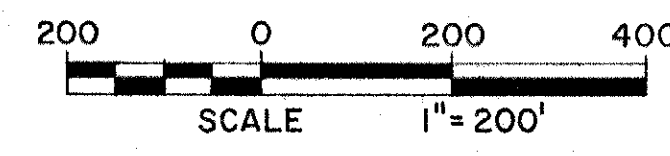
MATCH LINE

RESERVOIR  
water surface elevation  
118.80



LEGEND

- 6" EXISTING WATER MAIN & SIZE
- EXISTING VALVE
- EXISTING HYDRANT & VALVE
- (80') STATIC WATER PRESSURE



4" METER  
PUMPING STATION  
drawdown 8' static water level of well elevation 501.40

<b>F.G.M.</b>	<b>FENTON G. KEYES ASSOCIATES</b>		DESIGNED BY
	<b>ARCHITECT</b>		DRAWN BY
	<b>ENGINEERS</b>		D.S.
	PROVIDENCE, RHODE ISLAND      WALTHAM, MASSACHUSETTS		
<b>EXISTING WATER SUPPLY and DISTRIBUTION SYSTEM</b>			ORDERED BY
			R.C.M.
			DATE
			10/11/68
			JOB NO.
			CO67A
TOWN OF BELMONT NEW HAMPSHIRE			PLATE
			NO. 1