Chapter

7

WATER RESOURCES

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Chapter

7

I. Introduction

The new Master Plan will be challenged to address an issue that weighs more heavily these days than it has in the past -- the issue of our water supply, not only in the aquifers that supply our municipal system, but also in the bedrock that supplies private wells. In the past, we have been able to take water for granted; but, with our growing population, the hazards to both the quality and the quantity of our water are becoming more numerous. The fact that our Master Plan will undertake this challenge was commended by two water experts, a hydrogeologist, and a water resource engineer, who have helped our committee in an advisory capacity. We are foresighted to do this, they say.

The municipal water supply of Peterborough -- which at present is pumped from only three of the five town wells at rates varying from 570,000 to 675,000 gallons per day -- issues from one of the two gravel aquifers, North and South, that are often (misleadingly) called the "town aquifers." The name would suggest that the Town owns them. However, the Town merely owns or controls small areas of them. Otherwise, they are owned piecemeal as the private property of individuals or businesses which may be unaware of them and are under no special obligation to protect them. This being so, the future of the municipal water supply may be somewhat precarious. For example, some years ago, the Town's most productive well became contaminated by industrial pollution and was closed, which ended the Town's use of the South Aquifer. Since then, the Town has drawn water only from the North Aquifer.

An equal uncertainty surrounds the bedrock water that supplies private wells. Traditionally, a house lot is sold before its water supply is ascertained, on the assumption that water will be available. While up to now, this has been more or less true in Peterborough, we have been lucky. Other communities proceeding on the same assumption have been less lucky. As new construction continued beyond what the bedrock could supply, the new homeowners began to find themselves with inadequate water. This situation will only deteriorate as development continues.

In 1993, a comprehensive study of the Peterborough water supply was made by James MacCartney, a graduate student at Antioch New England Graduate School, who later

became a hydrogeologist with the State. His work resulted in a document known as Water Resource Management and Protection Plan, Peterborough, New Hampshire, 1993. Little attention was paid to the study at the time, and most of its recommendations were not followed. However, our committee finds the MacCartney Report to be both accurate and thorough, and as relevant today as it was when it was first compiled. It has become the basis for our report to the Master Plan Steering Committee, and, following its guidelines, we identify the major issues surrounding our water, along with the infrastructure that supplies it and later disposes of it as runoff and sewage. We have divided these issues into sections to be studied by various members of our committee, and we present them here in bullet form for brevity, with supporting documentation included as photos, figures, and appendices. A list of selected references is also included.

II. History of Municipal Water Works and Water Resources

The first official act taken to provide the Peterborough townspeople with a public water supply was the incorporation in 1891 of the Peterborough Water-Works Company. This corporation had the right to issue stock, own real estate, lay pipe in streets and ways, and had the right of eminent domain.

Having taken no action within the time limit set forth by the original legislation however, Chapter 177, "An Act to Establish Water-Works in the Town of Peterborough," was enacted in 1895. This act authorized the Town to own property, construct and operate a water supply system, and the right of eminent domain. The act gave the Town authority to enter into contracts for the sale of water and to establish regulations. The Town could also levy taxes, borrow money on the credit of the Town, and pay the interest on notes and bonds from tax revenue. The act provided for the management of the water works by a three-person board of commissioners, which beginning in 1936 became the responsibility of the Board of Selectmen.

The argument favoring municipal control of the water works was eloquently presented in the way of the following, as part of an engineering report submitted to the Town by Mr. E.A. Ellsworth in March of 1894:

"Upon the primary question of whether or not an abundant and permanent supply of water is needed, there ought to be no difference of opinion. No town can long submit to a continued want of an adequate water supply without receiving a serious check to its prosperity. Capital is always a wary investment, and outside industries cannot be induced to locate where such facilities for fire protection as a good water supply can give are not present. Having admitted and acknowledged this want the question then arises; shall the construction, operation and control of such works be given over to private capital or remain under the patronage of the people, and be built and operated by a commission delegated by the people to perform this duty? Experience elsewhere has shown that no single improvement in all the list that a civilized community taxes itself to build and maintain, bring better and more immediate results than an abundant supply of pure water. If the works should be given into the hands of private capital it is but natural that the true interests of the people should be subordinated to the considerations of private profits, and the long list of towns and cities who are either submitting to the indifferent service that a private company will give, or have gone through the costly experience of purchasing the private works and franchise at exorbitant rates, should serve as a warning to any people yet free to decide on the question of ownership. The comprehensive plan that the public will adopt, that believes rather in provisions for future growth than in the immediate percentage of profit that private capital

naturally seeks, always insures better service as the years go by, and if the field is sufficiently inviting to attract private capital it is of promise enough to warrant the investment of other capital that any town can secure by offering its name and credit in the market, at the lowest possible rates."

E.A. Ellsworth
Holyoke, MA

A. Taking concepts to reality

From the onset of consideration for establishing and maintaining a municipal water supply in Peterborough, the following fundamental conditions have formed the foundation for examination, study, and sustainability.

Conditions to be fulfilled in any suitable source of public water supply are:

1. The water shall be pure and wholesome, and that the source from which it is drawn shall be free from possible contamination.
2. The supply shall be so abundant under every adverse condition that it can be safely relied upon by the community to be served as never failing.
3. The natural conditions should be such that the natural supply can be increased by a moderate outlay, if a large surplus is not already in sight, to meet such a future demand as the growth of the village might make upon it.
4. The supply should be so located that the cost of introducing and distributing it shall bear a proper proportion to the revenue to be reasonably expected, given due allowance to those public benefits for which no direct pecuniary return can be expected – like fire protection, street watering, etc.

With regard to the original design, technological limitations greatly dictated source and supply options. As represented by Ellsworth in his 1894 engineering report, the public water system would begin by harnessing surface water resources and would rely upon gravity for distribution. Specifically, he proposed Cunningham Pond to the east of Town and the Nubanusit River to the west. Sanitary analyses of water samples from each source found both to be of exceptionable quality as far as the purity of the water is concerned. *"This water compares very favorably with the best waters in the state used for public supply,"* reported Mr. Edmund R. Angell of Derry, NH, in a Sanitary Analysis of Water report dated September 30, 1893.

As for the potential for contamination, a thorough examination of the Nubanusit was not undertaken since, through early measurements, it was determined to be of too low an elevation to give good service upon the higher levels of the village. The Cunningham Pond drainage area on the other hand was given careful review and found to be remarkably free from objectionable surroundings.

"*The quantity of cultivated ground draining into the pond is very small; the farm buildings are few and widely scattered; the soil of the whole district is thin and light and the territory wild and mountainous.*" It was concluded therefore, *"...with reasonable and proper regulations it will remain an easy matter to preserve the whole drainage basin free from contamination influences for an indefinite future."*

It is interesting to note the similarity of concerns between today and those considered more than 100 years ago.

B. Sizing the system

Initially, it was determined that the daily quantity of water *"the village"* will require cannot be more than 150,000 gallons, which is the maximum allowance of 100 gallons per day for 1,500 people. Beyond domestic use, the principal other consideration was to provide fire protection. To that end, Mr. Ellsworth represented that*, "I should propose to lay the main 12" pipe from the reservoir to the Morison corner, and continue the main down Pine Street to the village. If future growth should then require a larger main, the 8" pipe at the intersection of Bridge and Granite streets might be extended by the lower route to the Morison corner, tapping the larger supply and giving a desirable increase in the supply through Grove Street to Main Street instead of bringing the entire supply by the single route now proposed. Such a plan is very desirable in assisting to equalize and properly distribute the supply."*

The distribution system as proposed would consist of some six miles of pipe (not including about one mile of six-inch pipe from the pond to the reservoir) and 63 hydrants. Cost for carrying out the work to build the reservoir, install all piping, etc., including materials, engineering, supervision, and inspection of work totaled $46,388!

Ultimately, the first Peterborough water works system was constructed in 1896, but was somewhat different from Ellsworth's proposed design. Specifically, it was decided to use Town Line Brook and not Cunningham Pond as the primary source of supply. Water from Town Line Brook was transported to the Cheney Reservoir and, in turn, supplied the central part of town. In 1906, however, the system underwent revision in order that the water supply from the Town Line Brook be supplemented by water from Cunningham Pond. Throughout the period that it served as a municipal water resource, Cunningham Pond was also used jointly by private owners.

In 1926, the distribution system was extended to supply water to South Peterborough, and then in 1932 to West Peterborough via the construction of an additional reservoir and pipeline. In 1936, a six-inch main was constructed along Concord Street to the Monadnock Hospital, which was further extended in 1952 to North Peterborough.

C. New sources through Technological Advances

A March 1945 report on "Water and Sewerage Improvements" by Thomas R. Camp, a Consulting Engineer of Boston, MA, advised the Town that*; "We find that your drinking water is contaminated and of poor quality and is unsafe for use even following chlorination."*

The Cheney and West Peterborough reservoirs, being open, earth-based systems had come to exhibit high levels of sediments, iron rust, and objectionable odors. Additionally, due to what was attributed to the ever increasing influence of sewage pollution, water samples tested between 1942 and 1945 showed bacteria counts at four to five times the levels considered as safe, even with chlorine treatment.

Corrective measures called for abandoning both of the open distributing reservoirs and replacing them with closed steel standpipes (water towers). Additionally, it was pointed up that the Town needed to step up and better manage the treatment process and facilities.

Finally, and with equal priority given to addressing water quality issues, it was recommended that the Town initiate development of a sewerage treatment facility.

And while these issues were seemingly deserving of immediate attention, it was not until the 1952 to 1954 time period (nearly ten years later) that the recommended changes to infrastructure and development of new water sources actually came into being. Steel standpipes, replacing the Cheney and West Peterborough open reservoirs, were installed in 1954 having 600,000 and 300,000 gallon capacities respectively, as was the installation of the South Peterborough well and pumping station. The South Well was the first of what would become a series of gravel packed wells, many of which remain today as the exclusive source of municipal water. Gravel wells in the Peterborough network are at depths of 40' to 60', which is typical for this type of well.

Population growth projections since 1954 coupled with real and measurable incremental increases in demand, necessitated the addition of several gravel wells. Also contributing to the need for additional sources, the South Well had to be taken out of service in 1982. This was due to contamination attributed to improper disposal by New Hampshire Ball Bearing, Inc. of industrial solvents.

Peterborough municipal well evolution:

Year(s)	Location	Current Pump Rate
'52 –'53	South Well	300gpm
'66	North Well	540gpm (originally at 600gpm)
'81	Summer Street Well	200gpm (originally at 300gpm)
'82 –'83	South Well	Shut down due to contamination
'91	Tarbell Well	320gpm
'98 –'99	Hunt Road Well	300-450gpm (shut down 3/00 - high manganese)
'02	South Well	300gpm potential (currently considering re-start)

The combined output of the North, Summer Street, and Tarbell Wells currently represents a potential of 750Kgal/day. Were the Hunt Road and South Wells reinstated at ~300 gpm rates each, the Town has the potential of ~1,200K gal/day supply. Usage for the months of Aug '02 and Sept '02 was 585Kgal/day and 536Kgal/day, respectively.

III. Status of Recommendations From1993 Water Resources Management and Protection Plan

RECOMMENDATION	IMPLEMENTED			Comments
	Yes	No	Partially	
Non-Regulatory Programs				
Maintain a close working relationship with the SWRPC/Merrimack River Initiative/Contoocook Advisory Committee to develop and coordinate regional plans for water resource management				No current work on regional plans. Town was consulted on regional master plan however.
Encourage public education programs to increase public interest and awareness of water resource management				Town periodically notifies homeowners/businesses in wellhead areas only.
Coordinate management programs with adjacent communities		•		No active coordination.
Private Septic system maintenance and inspection requirements		•		
Household hazardous waste collections				
Non-fee or fee based land acquisition programs to protect critical water resources.			•	Not specifically targeted at water resources.
Regulatory Programs-Subdivision Regulations/Health Ordinance				
Notification of Subdivision Application to Health Officer/Conservation Commission		•		
Addition of technical standards to the Site Plan Review regulations for erosion, sedimentation, and storm water management	•			§233-15B "Sedimentation and Erosion Control"
Amend Subdivision bond requirements to include erosion/sedimentation control and storm water management		•		
Authorize on-site inspections for Subdivision Reviews		•		May be authorized elsewhere?
Authorize special investigative studies for Subdivision Reviews		•		
Enable Planning Board to require compliance with a storm water management manual		•		
Adopt Health Ordinance		•		

Site Plan Review Regulations				
Numerous recommendations that have not been viewed yet				
General Zoning Ordinance				
Amend Zoning to require unsewered areas within aquifer area subject to Rural District minimum lot size/frontage/setback				
Set standards for the maximum amount of coverage by impervious materials or buildings in Zoning Ordinances §245-6, 245-8, 245-9, and §245-10			•	Was implemented in Section 11 (Office) and Section 14 (Aquifer Protection)
Conservation Zone				
Modify the provisions of the conservation zone, §245-12, to include the requirements of the New Hampshire Shoreland Protection Act (RSA 483-B)		•		Not implemented. Section was renamed Shoreland Conservation Zone, however.
Floodplain/Aquifer Protection/Wetlands District/Steep Slopes/Excavation				
Introduce a statement of purpose to the Floodplain District,§245-13		•		
Delete §245-14D (1) (g) of the Aquifer Protection District for the storage, use, and handling of hazardous or toxic materials within the primary and secondary aquifer zones.		•		Still allowed with ZBA approval
Amend the Wetlands Protection District, §245-15-F(1) to include specific setbacks for septic systems		•		New septic systems are not allowed in the district (wetlands and within 50 feet)
Develop a wetlands rating system		•		
Addition of a Steep Slopes Overlay district		•		Only as related to driveways and access for fire protection
Control of erosion technical standards				
Storm water management technical standards				
Bonding requirements covering erosion/sediment control and storm water management				
Authorize special investigative studies				

This information was tabulated by John Morison, III and Richard Pendleton. The information was gathered from MacCartney, 1993, the current town ordinances, and interviews with Carol Ogilvie and Tom Weeks of the Peterborough Office of Community Development.

IV. Surface Water

Who are the registered users of surface water in Town? What is the state of the surface water quality? What surface water sources are available? What should the Town be doing to achieve its goals? How do withdrawals affect surface water, including nearby wetlands and the life within?

Surface water systems are subject to the climactic effects of precipitation, wind, and temperature. The quality and quantity of surface water are also affected by human activities such as the introduction of pollutants, storage of water for hydroelectric power, and withdrawals for irrigation or public water supply. Groundwater is not as susceptible as surface water.

Who are the users of surface water within Town? According to the Water Resources Division records dated 02/10/93, there are six registered users of surface water. Naturally, there are other users of surface water bodies within the Town, too. Important considerations for ecological communities and recreational users must be accounted for, as well.

In review of the surface water resources within the town boundaries of Peterborough, the majority of surface water is in the form of riverine networks comprised of brooks, streams, and one major river, the Contoocook River. Other sources include MacDowell Lake, Cranberry Meadow Pond, Topside Pond, and Cunningham Pond.

As reported in the 1993 Peterborough Water Resource Management Plan, the use of Cunningham Pond, the only Class "A" surface water resource in Town, as a source of water supply for purposes other than emergencies was discontinued in 1997. Cunningham Pond was officially removed from the municipal water supply system on July 1, 1992. These remaining surface water sources are class "B" waters. What this means is that research would have to be conducted to see if there is a favorable cost/benefit ratio and that there is a sufficient supply to meet a demand for return on investment in creating treatment facilities to adequately bring the source water to quality drinking water standards.

Thus, yes, there are other surface water bodies within the Town of Peterborough. However, their remoteness and the small amount of water they could offer, does not really benefit the Town by drawing water from them, especially from the view point of an economy of scale.

It is probably in the best interest of the Town to continue its exploration of new groundwater resources and to effectively manage and protect those aquifers that exist today. It is not to say that surface water resources could be used during emergencies or to offset peak periods. There are many impacts to consider on surface water utilization with wildlife, recreation, and the benefits derived in the local economy. There are many costs associated with surface water municipal use: water quality protection, security from sabotage, daily testing, sophisticated treatment facilities, additional conveyance works, additional pipelines and pump plants, diversion works and inter-basin transfers.

In general, towns are continuously trying to meet the growing demands for water; in doing so, we have excelled in developing and manipulating our water supply. However, the general acceptance of a supply management philosophy has contributed to high rates of water use, degradation of the water resource, and a disregard for the vital role of water in the ecosystem. Recently, in the face of shortages of supply and concerns over water quality and rising costs, water managers and the public have begun to recognize that demands can be altered by policy and behavioral changes. It is not always necessary to develop costly new supplies.

This approach, known as demand management, is the key to achieving more efficient use of water through water conservation. Central to a successful water conservation program is an understanding of the water resource itself (baseline data and monitoring); how, when, and why water is used (water audits and metering); the full cost of providing water of suitable quality and disposing of wastewater; alternative water-efficient technologies and processes; and practices, attitudes, and values related to water and the environment. Public education and awareness are necessary tools in implementing water conservation. However, they may need to be supplemented by state and federal legislation and regulations and/or economic incentives and disincentives, including consumption-based pricing.

V. Groundwater Resources

As noted in the historical section of this report, Peterborough has drawn drinking water from the ground since 1953. Currently, all municipal water and presumably all private water uses intended for consumption come from groundwater. The purpose of this section is to generally document groundwater occurrence in terms of types of aquifers, locations, extents, and yields. Specifically, as charged by the MPSC:

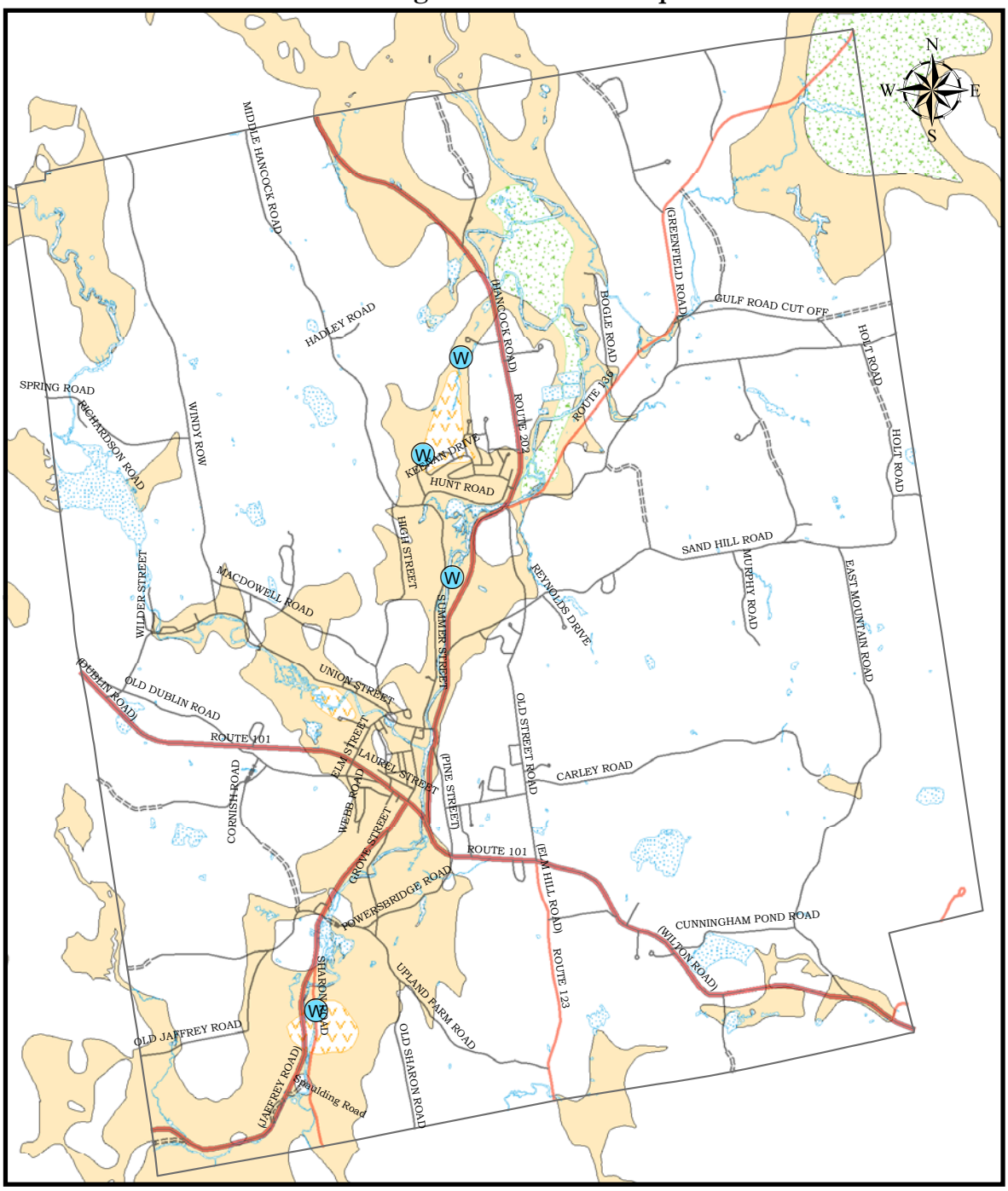
1. establish and define the Town's groundwater resources;
2. define the area and yield of unconsolidated deposits as municipal supplies; and
3. establish and define the Town's capacity of bedrock water supplies in the rural areas.

While groundwater is present beneath the ground surface throughout the Town of Peterborough, an aquifer is a geologic formation from which water of a sufficient quantity can be drawn economically relative to its intended use. Groundwater occurs in two types of aquifers in Peterborough: (1) Stratified Drift and (2) Bedrock Aquifers.

A. Groundwater Occurrence in Stratified Drift Aquifers

Stratified drift aquifers consist of water contained in sand and gravel. The groundwater occurs in the pore spaces between the grains of sand and gravel. A 1985 groundwater report (Whitman and Howard) mapped Peterborough's aquifers in terms of "primary" and "secondary" aquifers, where primary aquifers were defined as having a saturated thickness of 25 to 70 feet thick and secondary aquifers as having a 5 to 25 foot saturated thickness (thickness of water zone from bedrock to top of water table). However, updated mapping was published in 1994 (Harte and Johnson) by the US Geological Survey, which showed estimated transmissivity values for the aquifers.

Peterborough Stratified Drift Aquifer



Material Composition

- stratified-drift aquifer
- stratified-drift aquifer beneath till
- stratified-drift aquifer overlaying glacial lake bottom
- stratified-drift aquifer within or beneath glacial-lake

Legend

- Surface Water
- Public Well

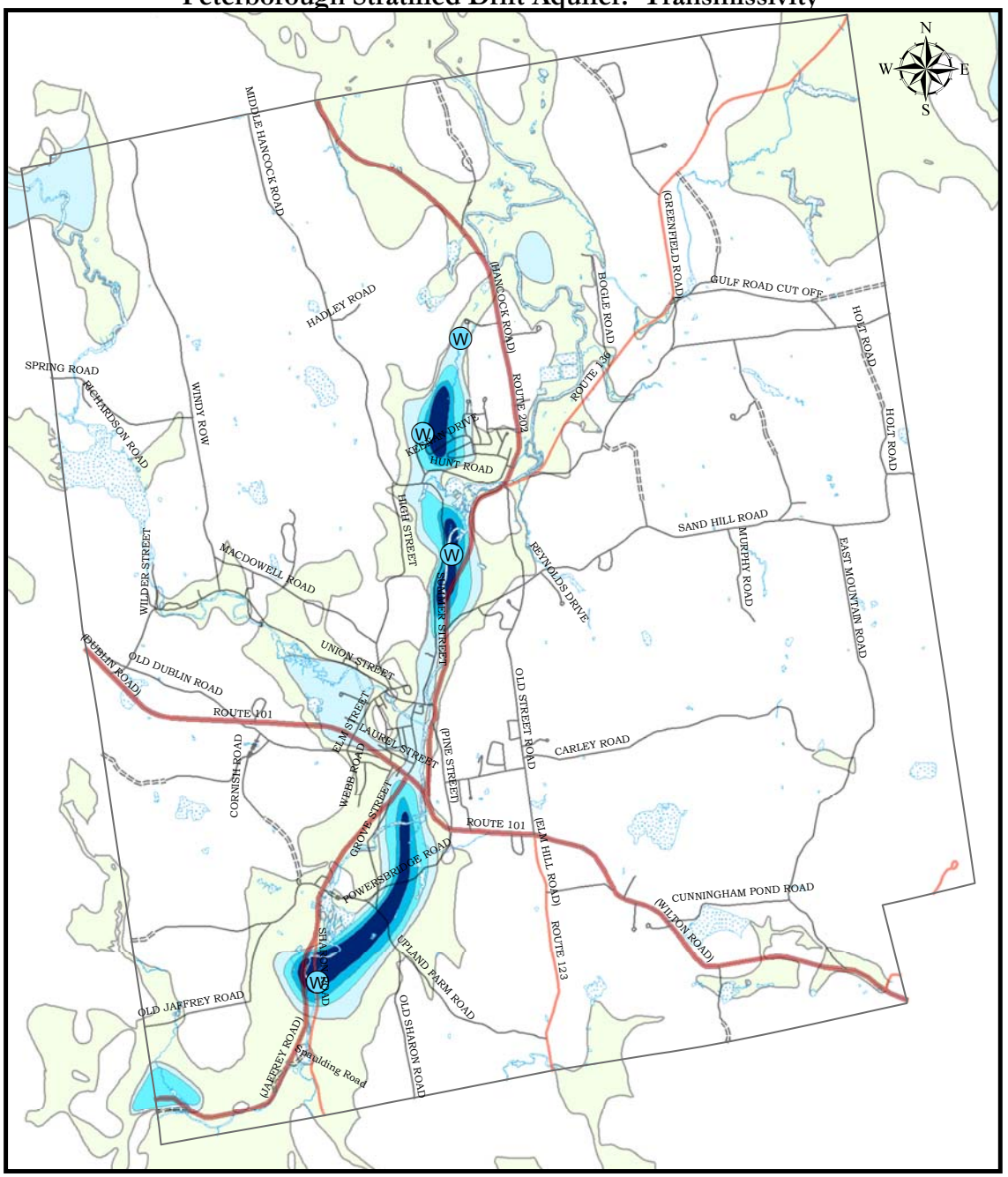
1:55,000

0 875 1,750 3,500 5,250 7,000 Feet

0 385 770 1,540 2,310 Meters

Printed by Peterborough Office of Community Development, 2003. Stratified Drift data from USGS Aquifer Study of the Contoocook River.

Peterborough Stratified Drift Aquifer: Transmissivity



Legend

Transmissivity Square Feet per day

- 0 to 1000
- 1000 to 2000
- 2000 to 4000
- 4000 to 8000
- greater than 8000

Surface Water

Public Well

1:55,000

0 850 1,700 3,400 5,100 6,800 Feet

0 375 750 1,500 2,250 Meters

Printed by Peterborough Office of Community Development, 2003. Transmissvity data from USGS Aquifer Study of the Contoocook River.

Transmissivity is the ability of an aquifer to transmit water based not only on thickness but grain size as well; higher transmissivity is a more "productive" aquifer. Figure 2 shows the locations of the stratified drift aquifers with their relative transmissivity values. Peterborough's best aquifers are located in the Contoocook River Valley and known as the South and North Aquifers. Other potential municipal sand and gravel aquifers have been mapped in the northwest part of town in the area of Sargent Camp, the far south of Town on the Jaffrey town line, and in the northeast part of Town near the Greenfield town line. The Water Resources Subcommittee has not studied the future usage of these aquifers.

B. Groundwater Occurrence in Bedrock Aquifers

Groundwater occurs in joints, voids, and fractures in bedrock. The potential for bedrock to produce water at sufficient quantity to justify extraction is dependent on factors including bedrock type, the frequency interconnectedness and dimensions of joints and fractures, and the watershed area. Historically, drilled bedrock wells to 100-400 feet in Peterborough typically provide sufficient quantity (at least five gallons per minute) for a home. However, there is no guideline for the minimum density of homes (in the absence of other large withdrawals) that will ensure adequate supply. No specific studies have been completed to date on the potential for bedrock supplies in Peterborough. However, Weston and Sampson Engineers are currently doing a study of the bedrock aquifer potential in east Peterborough for the Town of Peterborough. This study should result in a ranking of areas by water supply potential.

Peterborough lies in a fairly wide valley, unlike many Fall Line towns, built specifically to take advantage of water power for fueling their industries. Antrim and Harrisville are close, hilly neighbors with substantial dams and abandoned factory buildings looking for new uses. Peterborough has only the Noone Dam as a remnant of past industrial use. On the other hand, Peterborough has large sand and gravel pits, which are still being mined for their mineral resources.

The Town is built on top of a chain of aquifers along the Contoocook River from north to south. Some activities have threatened the integrity of the town water supply. Protection of and future supply of water are important considerations to any future growth. Peterborough's water resources are self-contained in that there is no reservoir on which to draw, and aquifers are dependent on rainfall and snowmelt for replenishment.

Peterborough has five primary aquifers of sufficient depth to tap for a public water system. At present, the Town draws water from three wells along a narrow north-south aquifer running approximately from Sand Hill Road north past the ConVal playground.

There is a fourth well in the primary aquifer south of Noone Falls. This well produced contaminated water from a major plant just west of Route 202. Cleaning up the aquifer was a long and expensive job, but it now appears to have succeeded. The three wells in the north of Town currently supply needs, and the Town is working on activating the South Well for future use.

C. Groundwater Usage

All of Peterborough's three active municipal supplies are located in the North Aquifer. These are the (1) North, (2) Summer Street, and (3) Tarbell wells. The infrastructure section of this report states the current maximum output of each of these wells. As shown, if pumping 12 hours per day, the safe yield of all three wells is 770,400 gallons per day (gpd). As discussed in more detail in the infrastructure section below, the average day demand in 2002 was 467,000 gpd.

Additionally, the Town has two other supplies not currently used: (1) the South Well located east of Route 202 in South Peterborough, and (2) the Hunt Road Well, also located in the North Aquifer. The South Well was shut down in 1982 due to industrial contamination. A pumping, treatment and monitoring system currently contains the contamination. The effectiveness of this system is supported by the fact that the South Well was pumped continuously for 63 days in 1999 and no contamination was detected during or after the test. The Hunt Road Well was found to have unacceptably high levels of naturally occurring manganese. The Town Engineering Department is currently working on a plan to treat the Hunt Road Well water and hopes to have it on line again by 2007.

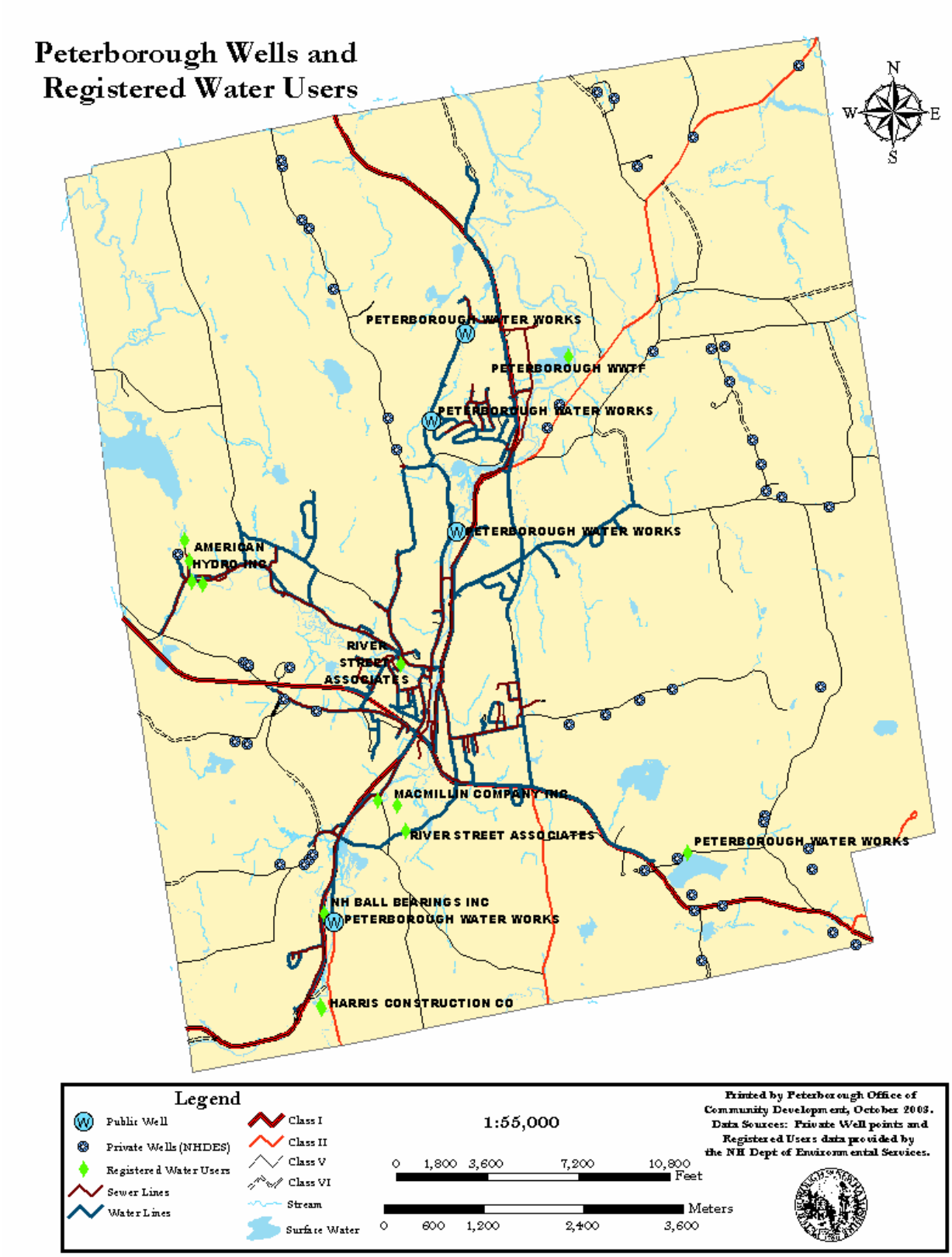
The sand and gravel aquifers are also tapped by various commercial and non-residential water supplies. The one bottled water source that taps sand and gravel in Town, Upland Farm Spring Water, is permitted to make 30 truckloads (roughly equivalent to 240,000 to 300,000 gpd assuming 8,000-10,000 gallons per truck) from well(s) in the South Aquifer. Other potential sand and gravel withdrawals (it is not known at this time if they are tapping the sand and gravel or bedrock aquifers) include the Episcopal Church on Concord Street (believed to be for fire protection) and the Peterborough Car Wash at the former A&P Plaza. Figure 3 and the accompanying table (Appendix F) show the known locations of private and public wells, broken out by type in Peterborough. Information on the estimated withdrawal rates by private sources is also provided.

Locations of known bedrock water withdrawals are also shown on Figure 3. Richard Freeman and the Office of Community Development collected this information from various sources. However, there is no system in place for updating this information.

VI. Tabulation of Private Wells in Peterborough

In 1984-85, New Hampshire began requiring well drillers to complete and file data on all wells drilled. As expected, this entailed some data filed precisely, some data filed haphazardly, and some data not filed at all until the system became well known. It is required for all wells now drilled in New Hampshire, and is the responsibility of the driller.

The WRS was fortunate enough to be able to borrow and comb personal data cards on all wells drilled by John McKenna of Dublin, starting about 1950. They have selected only the ones that seem to be in Peterborough. They also uncovered a few statistics from Contoocook Valley Artesian Well Company.


Peterborough Wells and
Registered Water Users
N
W
E
S
PETERBOROUGH WATER WORKS
PETERBOROUGH WWTF
PETERBOROUGH WATER WORKS
PETERBOROUGH WATER WORKS
AMERICAN
HYDRO INC
RIVER
STREET
ASSOCIATES
MACMILLIN COMPANY INC
RIVER STREET ASSOCIATES
PETERBOROUGH WATER WORKS
NH BALL BEARINGS INC
PETERBOROUGH WATER WORKS
HARRIS CONSTRUCTION CO
Legend
Public Well
Private Wells (NHDES)
Registered Water Users
Sewer Lines
Water Lines
Class I
Class II
Class V
Class VI
Stream
Surface Water
1:55,000
0 1,800 3,600 7,200 10,800
Feet
Meters
0 600 1,200 2,400 3,600
Printed by Peterborough Office of
Community Development, October 2003.
Data Sources: Private Well points and
Registered Users data provided by
the NH Dept of Environmental Services.

There are obviously more, but the subcommittee feels quite comfortable that this tabulation represents the great majority of private, residential wells in Town, until it blends with the State tabulation which begins about 1984-85. This tabulation lacks some specifics that would be desirable, but it is the best available at this time. It is hoped that with time, means can be found to tie down the wells to tax lot numbers, thereby giving the Town the precise locations of the 200+ wells drilled before the state records start. There were probably not many wells drilled prior to 1930, due to low population. The Great Depression and World War II would not have created a demand for more wells. This tabulation, therefore, starts with 1950 as the beginning of the expansion of Peterborough's private water supplies.

Future Objectives:
1) Try to identify tax lot numbers for individual well locations.
2) Refer to topographic maps to estimate elevations of these wells.
3) Reference elevations along with total depths and depth of bedrock to mean sea level.
4) Look for any indications of bedrock water storage enhancement areas for future use in considering development.

VII. Municipal Water System and Supply

The town water system is served by five (5) wells, only three (3) of which are actively used. The Hunt Well was used for a period of 95 days starting on December 24, 1999. It was taken off-line because of high manganese (0.82 mg/l) levels and complaints of poor water quality. A pilot test in 2002 indicated that manganese can be successfully removed. Plans are underway to turn the South Well back on-line in the autumn of 2003. This well had become contaminated with VOC's (volatile organic compounds) in the early 1980's. However, a 63 day pump test in 1999 indicated that no VOC's were present in the well as a result of extensive cleanup efforts by New Hampshire Ball Bearings (NHBB) throughout the 1990's. The long-term impacts of NHBB's VOC pump-and-treat containment system with the South Well back on-line is unknown at this time. The Summer, North, and Tarbell Wells are all located in the north aquifer, as shown in a map elsewhere in this report. Within the north aquifer wellhead protection area there are individual on-site septic systems in the Pine Ridge subdivision, Hunt Road, and along Summer Street. There are no other known potential contaminated sites in the north aquifer. The roads in this area are not salted by the Town.

TABLE #1:
TOWN OF PETERBOROUGH GRAVEL WELLS

Well Name	Year Built	Pump Rate (GPM)	Safe Yield* (GPD)	Safe Yield as of May 1, 2003** (GPD)
South Well	1953	300	216,000	-
North Well	1966	540	388,800	388,800
Summer Street	1981	200	144,000	144,000
Tarbell Well	1991	300	237,600	237,600
Hunt Road	1999	400	288,000	-
Totals			**1,274,400 GPD**	**770,400 GPD**

*****Pumping a maximum of 12 hours per day.
******Total with South and Hunt wells out of service.

A. Water Demands and Usage

Based upon individual user meter data, the water system sales was approximately 410,000 gpd for the past 12 months for 1,586 water connections. The town wells pumped the following quantities of water in the past ten years as shown in Table #2 below.

TABLE #2:
WELL PUMPING RATES

Year	Average Daily Pumping Rate (GPD)	Year	Average Daily Pumping Rate (GPD)
1993	569,063	1998	675,800
1994	626,849	1999	616,383
1995	606,032	2000	567,422
1996	634,632	2001	512,580
1997	614,934	2002	466,850

A comparison of pumping data in Table 2 indicates that 76,000,000 gallons less water was pumped in 2002 than in 1998. The savings can be partially attributed to repairing major leaks at Rite Aid and at the Grove Street Bridge. Further, a comparison of metered sales of 410,000 gpd versus pumped water of 466,850 gpd in 2002 indicated a loss or unaccounted for water of 56,850 gpd (or 12% of pumped water). Unaccounted for water is normally associated with leaks, under-registration of revenue meters, and fire hydrant usage (such as hydrant flushing of water mains in the spring and fall). For a water system of Peterborough's age, the American Waterworks Association recommends a maximum unaccounted for water loss of 10-12%.

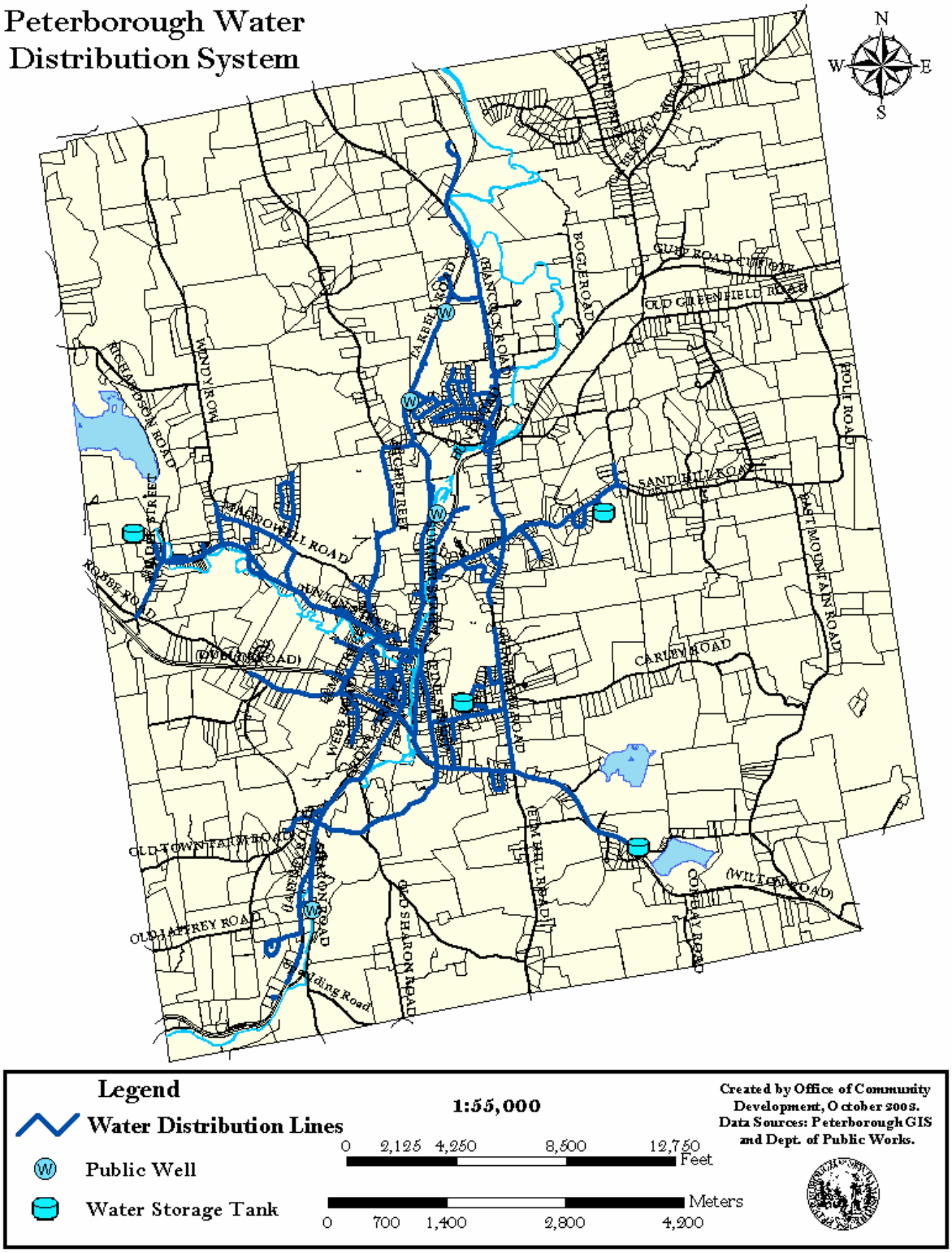
B. Excess Well Capacity

If all three of the town wells are operating, by applying the New Hampshire Department of Environmental Service (NHDES) average usage of 275 gallons per day per residential unit and a water pumping rate of 466,850 GPD in 2002, Peterborough could increase available housing as follows:

$$\text{Additional Single Family Homes} = \frac{748{,}800 - 466{,}850 \text{ GPD}}{275 \text{ GPD/unit}} = 1025 \text{ Homes}$$

However, the NHDES design standard for an adequate municipal water supply is based upon the design premise that a municipal system should be capable of supplying the average day demand with the largest well (North) out of service. The North well could be disabled for an extended period by a lightning strike, contamination, vandalism, or for well cleaning, etc. By the below calculation, Peterborough falls short of being able to meet this design criterion:

Available Supply = 144,000 (Summer) + 216,000 (Tarbell) = 360,000 GPD
Average Daily Usage = 466,850 GPD in 2002


Peterborough Water
Distribution System
N
W
E
S
BOGLE ROAD
GULF ROAD
OLD GREENFIELD ROAD
HOLT ROAD
SAND HILL ROAD
EAST MOUNTAIN ROAD
CARLEY ROAD
(WILTON ROAD)
CONWAY ROAD
OLD SHARON ROAD
OLD JAFFREY ROAD
OLD TOWN FARM ROAD
ROBBE ROAD
MACDOWELL ROAD
WINDY ROW
RICHARDSON ROAD
Legend
Water Distribution Lines
Public Well
Water Storage Tank
1:55,000
0 2,125 4,250 8,500 12,750 Feet
0 700 1,400 2,800 4,200 Meters
Created by Office of Community Development, October 2003.
Data Sources: Peterborough GIS and Dept. of Public Works.

C. Over-Pumping Gravel Wells

Throughout the 1990's the Town's gravel wells were over pumped, i.e. they were in continuous 24-hour operation or operated more than 12 hours per day to meet water system demands. Fine graded silts can be drawn into the well field from over-pumping. Likewise, poorer quality water, such as water high in iron and manganese, can be drawn into the well from remote areas. Redevelopment of gravel wells through surging and chemical treatment will increase capacity, but they rarely return to former levels. For instance, the North Well produced 600 gpm in 1977; Summer Street yielded 350 gpm in 1982; and Tarbell 375 gpm in 1991. By 1999 North, Summer, and Tarbell had dropped to 375,160, and 135 gpm, respectively. In 2000, the three wells were able to be redeveloped with the Hunt Well operating. Well yields shown in the preceding Table were never able to reach prior levels.

D. Water Storage

There are four (4) water storage tanks in the Town of Peterborough with a total storage of 2,150,000 gallons (Table 3). Based on a three-hour fire flow of 3,500 gallons per minute as required by the Insurance Services Office 1995 Report and a maximum days usage of twice the average daily usage, or 933,700 gallons per day, the needed storage would be the sum of the two, or 1,564,000 gallons. The Town appears to have adequate amounts of storage with a reasonable amount of room for growth, assuming that modifications are made such that the Cunningham tank is allowed to back-feed the rest of the Town.

TABLE #3:
WATER STROAGE TANKS IN PETERBOROUGH

Tank	Capacity (Gallons)	Overflow Elevation (USGS Datum)
Sand Hill Tank	720,000	1020
Cheney Ave Tank	630,000	1022
W. Peterborough Tank	316,000	1070
Cunningham Tank	500,000	1214
Total	**2,166,000 Gallons**	

The West Peterborough tank is a glass-fused steel tank which will not require painting. This tank is scheduled to go on-line in late May 2003 and it will serve the high elevation areas of Hunter Farm and upper Union Street in West Peterborough, using a booster pumping station at Steele Road. The Cheney Avenue welded steel tank was recently painted and is in good condition. Cheney, along with Sand Hill, serves the downtown and lower elevation service areas of Peterborough.

The Sand Hill welded steel tank painting system contains lead and is in poor condition as evidenced by an underwater TV inspection in 2001. The estimated cost to paint Sand Hill in 2001 was $175,000. The Sand Hill tank cannot be taken out of service for painting without adversely affecting water service and pressure along Route 202 north and at the Hospital. Construction of a 1,000 foot loop feed along Old Street Road would correct this problem.

The Cunningham tank serves the upper elevations of East Peterborough along the Wilton Road and Old Street Road. This pre-stressed concrete tank is in good condition.

E. Inventory

The oldest portions of the water system were constructed in the 1890's using unlined cast iron (C. I.) pipe with leaded pipe joints. Through the years, asbestos cements (A. C.) (1970's) and small diameter galvanized pipe were incorporated into the distribution system. It was not until the 1970's and early 80's that cast iron pipe and asbestos cement were replaced by cement coated ductile iron pipe. Unlike cast iron pipe, ductile iron pipe joints can deflect without leakage due to their unique gasket bell and socket design. Further, with the cement lining, ductile iron pipe does not become tuberculated. Tuberculation, or irregular deposits of sediments and slag, often builds up in unlined cast iron pipe and galvanized pipe. The tuberculation restricts flow and causes poor water quality. Tuberculation is particularly a problem where there is little water movement, or slow velocities, such as in dead-end or un-looped pipes.

TABLE #4:
INVENTORY OF WATER MAIN BY SIZE AND LENGTH

Diameter	Length (Feet)	Diameter	Length (Feet)
2 inch	1,163	8	105,035
2 inch	762	10	25,664
4 inch	2,479	12	17,327
6 inch	68,105	16	8,020

Total Length of Water Main = 228,555 ft = 43.29 miles

F. Water System Reliability

From December 2002 to April 2003 there were sixteen (16) water main breaks as shown elsewhere in this report. Most of the breaks occurred in the areas of asbestos cement and cast iron pipe, in which the trench had been improperly backfilled with large boulders. Frost movement exerted downward force on the boulders which, in turn, applied pressure against these pipes causing breakage. The problem was exacerbated by gate valves that did not work or gate valves buried below the pavement surface. When breaks occurred, too often wide areas of the water system had to be shut down to stop the flow and make repairs. An extensive gate valve exercising and/or replacement program should be undertaken to increase water system reliability.

G. Asbestos Cement Pipe

There are approximately 1.7 miles of asbestos cement pipe in service in Peterborough. This type of pipe is often brittle and is subject to breakage. Concern has been expressed by Public Health Officials that breaking down of asbestos pipe can release fibers into the water.

H. Small Diameter Pipes

As noted in the preceding inventory, there are approximately 1,900 feet of small diameter pipe in the distribution system. Two and three inch galvanized pipes cannot

be flushed and cleaned properly, and this results in poor water quality and taste and odor complaints. Galvanized pipe should be replaced on the Old Jaffrey Road, Ames Court, Mercer Avenue, and other selected areas.

I. Hydraulic Modeling of the Municipal Water System

Modeling of the Peterborough water system has been completed using the Haestad Water CAD Steady State Analysis software. This model is very powerful, and information can be presented in tabular form or in a graphical interface, such that fire flows and available pressures can be mapped on the Town's GIS system using contour intervals (much like USGS contour elevations). For instance, a cursor can be placed on any house on the Town's water system and the available pressure flow is displayed. There are many other uses for the Town, including locating problem or deficient areas in the water system such as in locating closed or partially closed gate valves. This software was used to develop "what if" scenarios, whereby the impact of a new subdivision, or a new tank at a certain elevation on the water system could be made. Also, the model was used to perform a fire flow analysis, which was used to determine how the water system will behave under extreme conditions, and finally, the model can be used to assist the Town in prioritizing water capital improvements.

J. Maximum Day Demand

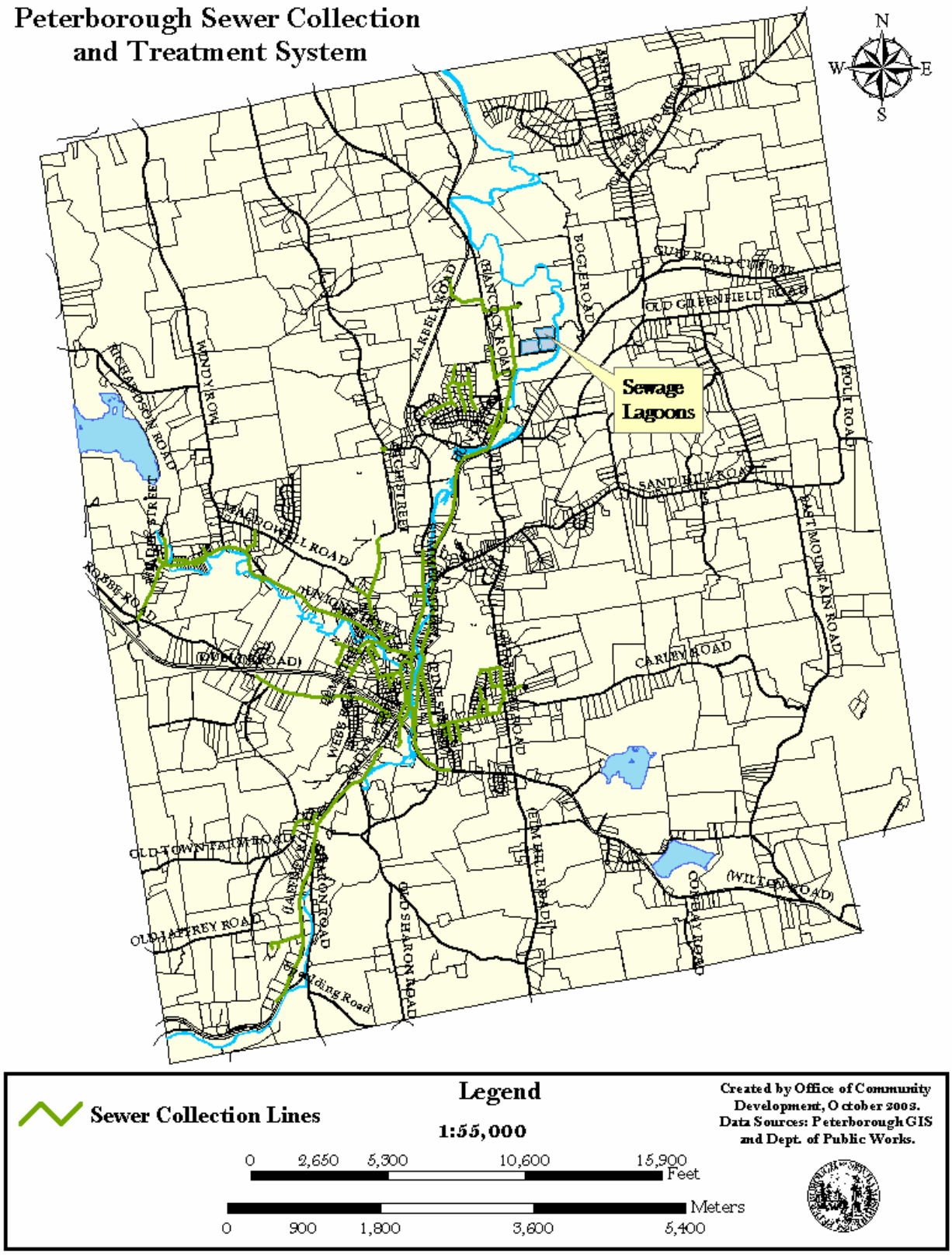
Maximum day demand is defined as the highest 24-hour demand during the year and is commonly expressed as a factor times the average day demand. In the past, this day has been related to large summer usage, and the factor has been in the range of 1.8 to 2.2. Peak. Maximum day demands can also occur due to water main breaks and/or extensive fires in combination with periods of extended dry, hot weather. The maximum day demand can usually be met if the average day demand is satisfied by 12 hours of well pumping.

VIII. Municipal Sewer Collection and Treatment System

The Peterborough sanitary sewer collection system consists of approximately 23.6 miles of sewers and five lift (pump) stations. A map of the system showing the sewers and lift stations is presented in Table #5. The majority of the collection system flows by gravity to the Wastewater Treatment Facility (WWTF) located at the end of Pheasant Road. Much of the collection system consists of asbestos cement pipe that is approximately 30 years old.

TABLE #5:
LOCATION OF SEWER LIFT STATIONS & PUMPING CAPACITY

Southfield Lane	204 gallons per minute (gpm)	Cheney Ave	125 gpm
Vose Farm Road	157 gpm	South Peterborough	155 gpm
Taylor Court	151 gpm		


Peterborough Sewer Collection
and Treatment System
N
W
E
S
Sewage
Lagoons
BOGLE ROAD
GULF ROAD CUT OFF
OLD GREENFIELD ROAD
TARBELL ROAD
(HANCOCK ROAD)
WINDY ROW
RICHARDSON ROAD
HOLT ROAD
SAND HILL ROAD
EAST MOUNTAIN ROAD
MACDOWELL ROAD
ROBBE ROAD
(DUBLIN ROAD)
CARLEY ROAD
OLD TOWN FARM ROAD
OLD JAFFREY ROAD
(JAFFREY ROAD)
SHARON ROAD
OLD SHARON ROAD
(ELM HILL ROAD)
(WILTON ROAD)
CONDAY ROAD
Legend
Sewer Collection Lines
1:55,000
0
2,650
5,300
10,600
15,900
Feet
Meters
0
900
1,800
3,600
5,400
Created by Office of Community
Development, October 2003.
Data Sources: Peterborough GIS
and Dept. of Public Works.

Flows into the WWTF are variable depending upon rainfall precipitation and groundwater levels, as shown in the following table taken from the May 2002 Woodard & Curran Peterborough WWTF Evaluation engineering study.

TABLE #6:
SUMMARY OF WWTF INFLUENT/EFFLUENT FLOWS

	1999	2000	2001	2002
Effluent Avg. Daily Flow (MGD)*	0.33	0.37	0.38	0.50
Effluent Max. Avg. Daily Flow (MGD)	0.61	0.66	0.81	0.63
Effluent Mi. Avg. Daily Flow (MD)	0.25	0.28	0.24	0.25
Avg. Base Flow (MGD)	—	—	0.30	—

*MGD – Million Gallons per Day

Highest influent flows occurred in the spring months when the groundwater table was at its highest level. Also, in 2002 the Town smoke tested downtown catch basins and found that stormwater runoff from catch basins on Grove Street and private parking lots was entering the sanitary sewer system. Woodard & Curran concluded that 518 gallons per day per inch diameter sewer per miles entered the sewer system in the spring of 2002. The State Standard calls for a maximum of 300 gallons/day/inch/mile. High infiltration and inflow is expensive to pump and treat and needlessly uses up WWTF capacity. It has been recommended by Woodard & Curran that 10 to 20% of the sanitary sewers be inspected with a TV camera each year to identify infiltration sources such as leaky pipe joints, cracked sewers, and leaky service connections. The investigation should be coordinated with Highway reconstruction. The Town is in the process of mapping stormwater catch basins and developing a plan to separate out stormwater from the sewer system.

A. Industrial Lagoon

An old industrial lagoon is located at the WWTF near the influent pump station. The industrial lagoon received flow from a circuit board manufacturer formerly located at the present day South Meadow School. New discharges to the industrial lagoon were discontinued approximately 30 years ago; however, the metal beryllium was found to be present in the lagoon sediments at levels exceeding the State's standards. Thus, the NH Department of Environmental Services (NHDES) has asked that the Town proceed with a remedial action and closure plan.

The sediment can be remediated either by 1) leaving the beryllium in place and capping the site, or 2) removing the contaminated material.

B. Wastewater Treatment Facility (WWTF)

The WWTF consists of an influent pump station, headworks, one unlined aerated lagoon, two unlined stabilization lagoons, chlorination, and dechlorination facilities. The WWTF is approximately 30 years old and discharges directly into the Contoocook River. The WWTF will have to be upgraded in the near future, for the facility exceeds 80% of the design flow (of 500,000 gallons per day) for 90 consecutive days (see Table #6). Therefore, all new connections onto the Town's municipal sewer system must be approved by the NHDES. Once 500,000 gpd is reached, there can be no further connections onto the Town's sewer system without improvements. Based upon 20-year growth projections provided by the Town's Office of Community Development, the facility should have a capacity to treat 630,000 gpd.

Presently the Town of Peterborough does not accept septage at the wastewater plant because of the high BOD loading of septage and lack of proper receiving facilities. With the upgrade of the plant, proper septage receiving facilities should be incorporated.

Further, an ecological model of the Contoocook River by the NHDES showed the River as being in non-attainments of dissolved oxygen standards downstream of Peterborough's WWTF discharge point. It can reasonably be expected in the near future that the present waste discharge permit license will be stiffened, which would result in more stringent effluent limits for total suspended solids (TSS), biological oxygen demand (BOD), and the addition of new nutrient parameter limits, including ammonia and phosphorus. Both of these nutrients stimulate algae and plant growth in the River, which is potentially toxic to aquatic life. Current and estimated future effluent limits are shown below.

TABLE #7:
SUMMARY OF CURRENT & ESTIMATED FUTURE EFFLUENT LIMITS

Parameter	Units	Current Effluent Flows	Estimated Effluent Limits
Daily Flow	MGD	0.5	0.63 (202 S)
BOD's	Mg/l	30	15 – 30
TSS	Mg/l	30	15 – 30
Ammonia	Mg/l	None	10
Phosphorus	Mg/l	None	0.20 – 0.30

Additionally, the lagoons are unlined, and the WWTF does not have a groundwater discharge permit. A groundwater monitoring program will be undertaken in 2003 to determine to what extent groundwater quality is being adversely affected and whether the lagoons will have to be lined. Of the 132,700,000 gallons of sewage annually coming into the WWTF, Woodard & Curran has calculated that 29,900,000 gallons per year is infiltrating into the groundwater.

TABLE #8:
WATER BALANCE OF WWTF LAGOONS
Annual Flow (gallons/yr)

WWTF Influent Flow	+132,700,000
Annual Precipitation into Lagoons	+ 27,700,000
WWTF Effluent Flow	- 114,300,000
Annual Evaporation from Lagoons	- 16,100,000
Infiltration to Groundwater	**29,900,000**

C. WWTF Capital Improvement

Based upon discussions with the NHDES, it is anticipated that within two to three years the existing WWTF will have to be upgraded to meet effluent discharge permit requirements. The list below presents alternatives for upgrading the WWTF. The facilities required for Rapid Infiltration Basins (RIBS) and upgrading the lagoons include:

- Land acquisition
- Effluent pump station at the WWTF
- Force main and river crossing to transport the effluent to the infiltration basins
- Infiltration basins
- Effluent distribution system consisting of pipes and valves
- Controls, alarms, and telemetry system
- Ground water monitoring wells at RIBS
- Site work at RIBS, including erosion control, access road, fencing, landscaping, providing electrical power to the site, etc.
- Upgrade of existing influent pumps
- Upgrade existing screening/grinding equipment
- Administration building
- Upgrade aeration in lagoon 1
- Septage receiving station
- Increase treatment capacity of system
- Monitoring well(s) for lagoons
- Rebuild or replace existing site piping and valves
- Rebuild effluent structures in each lagoon

The estimated costs for design and construction of RIBS and the associated improvements at the WWTF as described above are presented in Table #9. The estimated annual operations & maintenance cost for the lagoons and RIBS is $270,000.

TABLE #9:
CAPITAL COST ESTIMATE OF RAPID INFILTRATION BASINS

ITEM	ESTIMATED COST
Land	$300,000
Construction	$1,500,000
Contingency (25%)	$375,000
Hydro-geo investigation & permits	$200,000
Sub-total	**$2,375,000**
Engineering (12.5%)	$187,500
Engineering (12.5%)	$187,500
Total project cost	**$2,750,000**
Liner for all lagoons	$1,000,000
Total project cost with liners	**$3,750,000**