
Final Report

Report on Groundwater Observation Wells



Volume I

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**Stone & Webster Civil &
Transportation Services, Inc.** 

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VOLUME I

REPORT ON
GROUNDWATER OBSERVATION WELLS
FOR THE
INSPECTIONAL SERVICES DEPARTMENT
OF THE
CITY OF BOSTON
AND
THE GROUNDWATER TRUST

Prepared by P.K. Taylor
Project Manager/Engineer

Prepared by A.F. Brown
Lead Geotechnical Engineer

Reviewed by S.M. Washburn
Assistant Chief Geotechnical Engineer

Approved by J.L. Rosenblatt
Chief Geotechnical Engineer

by

Stone and Webster Civil and Transportation Services, Inc.
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1.0 EXECUTIVE SUMMARY

Stone and Webster Civil and Transportation Services Corporation is pleased to have had the opportunity to perform this interesting study for the Department of Inspectional Services and the Groundwater Trust.

The study area included the neighborhoods of Beacon Hill, Back Bay, Chinatown, Fenway and the South End.

This report documents the location of 757 groundwater observation wells, 657 of which were surveyed in the field and 308 which were field tested. There are 189 functioning wells located on well location maps, and 159 wells which are identified as non functioning or plugged. The non functioning or plugged wells may be located by field sketches which are included with the field data sheets in Volume II. All of the wells can be located on maps provided in this report by a unique numbering system.

This report also includes recommendations for developing an observation well network. Specifically it is recommended that a well network of 869 wells be installed in the study area. This network would include the 189 working wells, resulting in the need for an additional 680 wells. This report also includes general recommendations for locations considered to be first priority for new well installation and includes a list of other actions considered necessary to effectively implement this program. It is also recommended that a trial cleaning be performed on the plugged and non functioning wells to determine the cost effectiveness of cleaning as opposed to installing new wells.

A sample specification for installing a well is included as Appendix B to this report.

2.0 INTRODUCTION

2.1 Purpose

Many areas within the City of Boston are built on filled land over what was once marshland and tidal estuaries. Typically the soil underlying the fill is soft organics and is unsuitable for the support of structures. Because of this many residential and commercial structures are built on pile foundations. Prior to the early 1900's untreated timber piles were in common use. These piles may behave satisfactorily for centuries, however, decay of untreated piles causes a dramatic loss of strength and subsequent damage to buildings. Decay of untreated timber piles may occur if they are exposed to air in a moist environment. This condition occurs when the groundwater falls below the top of the pile.

Throughout the past 100 years the City of Boston has periodically experienced the problem of a falling water table and deterioration of untreated timber piles. In the 1930's the Boston Public Library was underpinned at significant expense to prevent collapse of the building due to deterioration of untreated timber piles. Currently there are several known areas of deterioration of piling which have necessitated remedial actions. These include residential properties in the vicinity of Brimmer Street at the base of Beacon Hill, Hudson Street in

Chinatown, and Hemenway Street near Northeastern University. Undoubtedly other areas of deteriorating piling exist undetected at this time.

In 1986 Mayor Flynn appointed a committee known as the Groundwater Trust whose charge was to "develop solutions and recommendations as to how to raise the groundwater table in areas where it has fallen". The committee consists of representatives from the affected neighborhoods as well as one representative of the Boston City Council and several representatives of concerned city agencies. The membership of this committee is given in Appendix A. The initial action of the Ground Water Trust was to recommend that a consultant be hired to inventory all existing observation wells in the affected areas of the City and to recommend the location of new wells. Certain other assignments were also identified and these are itemized under Section 2.3. It is understood that this is the first step towards obtaining comprehensive groundwater data to identify areas of low groundwater and to develop remedial actions to prevent further deterioration of piling and collapse of structures. In June of 1989 Stone and Webster Civil and Transportation Corporation signed a contract with the Inspectional Services Department of the City of Boston to provide these services. This report describes the work accomplished by Stone & Webster under the contract.

The purpose of this study was to provide the basis for planning the future expansion of the groundwater monitoring system for the City of Boston. It's primary function was to locate, test and tabulate existing wells. Because the present study did not include significant interpretation of groundwater data, specific locations of new wells have not been determined. The first priority for the next phase of this project should be to engage a consultant with appropriate experience to provide a groundwater data base management system and to evaluate and interpret the existing data. As a result of their evaluation, new wells should be located and installed in a phased approach. The location of the first phase of new wells should be determined based on evaluation of existing data, which was beyond the scope of this study. Subsequent planning of additional well locations will be very much influenced by the data provided by new wells installed in earlier phases of the study.

2.2 Study Area

The area studied included the Back Bay, Beacon Hill, South End, Chinatown and Fenway neighborhoods and is shown on Figure 1. These areas were identified by the Ground Water Trust as requiring investigation. The actual bounds of this area were established by Stone and Webster in consultation with the Trust. As part of this study Stone and Webster was required to identify other areas of the City which may contain structures supported on timber piles and which may also require groundwater monitoring. This is addressed in Sections 5.0 and 6.0.

2.3 Scope

The following has been taken directly from Attachment A of the Contract titled Scope of Services:

1. Develop a list of existing observation wells, including those installed by the W.P.A. and other Public and Private organizations.
2. Locate in the field existing wells and then determine if those wells are operable. This would entail no digging, pavement removal or other subsurface exploration.
3. Perform field tests at each accessible well to verify the quality of each observation well found.
4. Prepare a written summary which would include a summary of those wells that are found to be operable.
5. Prepare a table summarizing information on the functioning observation wells, including locations, top elevations if known, well depth, depth to water level and elevation if known, date installed (if known) and other pertinent comments.
6. Prepare a table outlining locations of observation wells that were found and determined not to be operable, and the course of action necessary to make them usable.
7. Recommend locations for additional observation wells needed to monitor accurately the ground water in the affected areas.
8. Recommend a timetable for reading the wells.
9. Establish a framework for monitoring the data, including method of recording, presenting and evaluating all relevant data.
10. Establish technical specifications for new observation wells for use by the City in soliciting bids for well installation and in monitoring the work performed.
11. Train City of Boston employees in the accurate measuring, monitoring and recording of ground water levels.
12. The consultant shall attend meetings held in conjunction with the work described herein (up to four meetings).
13. Delineate any other service that the consultant believes would benefit the City in its analysis of the ground water problem.
14. Prepare base maps on mylar. Prepare three presentation boards and a summary report.

2.4 Acknowledgements

Stone & Webster gratefully acknowledges the special help it has received from all the members of the Groundwater Trust in completing this assignment. The efforts of Councilman David Scondras, Mr. Thomas McNicholas, Commissioner of the Inspectional Services Department, Mr. William Rizzo, Chairman of the Groundwater Trust, and Mr. William Corcoran, representative of the Boston Trust Department were particularly helpful. The interest and support of the Facilities and Planning Group of the Fenway Program is also recognized and appreciated.

Stone & Webster also acknowledges the support of Asaf Qazilbash & Associates in performing the field survey, as well as co-op college students Chris Burke and Roger Babb for their enthusiastic and perceptive contributions.

3.0 INVENTORY OF EXISTING WELLS

3.1 Methodology

The methodology and procedures used to record, find and test observation wells included the following steps:

- * Review available records
- * Solicit data from agencies, institutions and private firms.
- * Plot and number each well
- * Input well data into data base
- * Field search to locate each well not currently being monitored by others.
- * Field test each well for operability
- * Input results of field search and test into data base

A discussion of these steps follows in the various subsections.

3.1.1 Collection of Observation Well Data

Sources of observation well data included a report by Lambrechts et al (6) to the Boston Redevelopment Authority entitled "Report on Groundwater in Back Bay Boston" (1985) and a report compiled by Cotton and Delaney, (4) entitled "Groundwater Levels on Boston Peninsula, Massachusetts-Hydraulic Atlas 513" (1975).

In addition, a letter requesting any available observation well information was sent to public agencies, institutions and private firms. A meeting was held with the Facilities and Planning Group - Fenway Program, Inc., and all of their

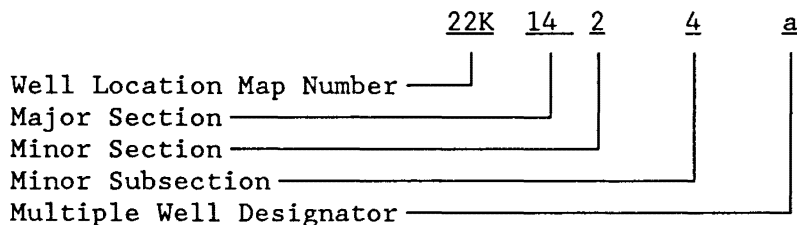
membership was solicited for information on observation wells. A list of those who have contributed is given on Table 1.

In addition, 14 unrecorded wells were found by Stone and Webster personnel while performing other field tasks.

3.1.2 Initial Data Input

The first step in the organization of the database was to plot the location of recorded observation wells on a set of Well Location Maps derived from Boston Water and Sewer (BW&S) maps. These maps were prepared by the BW&S from aerial photographs taken in 1982 and developed to a scale of 1"-100'. These maps include building footprints and street address numbers, as well as spot elevations. The building footprints and addresses were particularly useful in the location of the wells, while spot elevations were convenient for estimation of surface elevations for wells with none on record. In total, 757 observation well records are included in the database.

To facilitate development and use of the database, a unique number was assigned to each well. This number was obtained by overlaying a transparent numbering template over the area of the Well Location Map (see Figure 2). Assigned numbers took the form:



- used if more than 1 well is found in a particular minor subsection

This numbering system was developed to give the observation wells surveyed a geographic identity. This identity was helpful in developing the observation well database, and will greatly facilitate its use. This number along with the well source and previous well number were entered into the database

3.1.3 Field Survey

The Field survey work entailed searching for documented wells as plotted on the Well Location Maps. Inspectors would look for "street boxes" in the general area of each plotted observation well. Street boxes are typically a circular steel casting approximately 9 inches in diameter and 3 feet in length with a locking cap placed flush with the ground surface. These boxes are used to protect the vertical access piping to underground utility connections such as gas valves or water services, or as in this case to protect the vertical standpipe of an

observation well.

The locking cap of a street box is typically embossed with lettering to identify the vertical piping below it. Many of the street boxes covering wells were embossed with such designations as "Boston Building Department-Water Level," "Guild Instrumentation" and "Carr-Dee Drilling." Other street boxes were embossed with "water" or some other designation. Where a street box with a water designation was the only street box in the general area of a plotted well, inspectors had to conclude the street box might actually be the observation well being investigated. Obvious water service valves or water main junctions were not investigated. Where it was concluded that a street box was an observation well, a sketch of the street box location was prepared on a field data form unless the location as shown on the Well Location Map was considered sufficiently accurate. This sketch together with the Well Location Map were eventually used by a two man team to locate the street box and test the well.

In total, 657 observation well locations were field surveyed and 308 were identified as wells. No observation wells were found in 349 locations.

3.1.4 Test for Operability

All observation wells which were found were tested using a slug test to determine if they are functioning. The object of the slug test is to cause a lowering of the groundwater level inside the observation well and then to measure and record the time rate of recovery of the groundwater as it returns to the original level.

Prior to testing, well specific information was obtained. This information included the condition of the cover plate, the depth of the groundwater level, the total depth of the well, the inside diameter of the well and the condition of the top of the standpipe.

Lowering the groundwater level was accomplished by placing a bailer into the well and removing groundwater from the well. Typically the water level in the stand pipe was lowered a distance of several ft. The rate of groundwater recovery was measured using an electronic water level indicator and a stop watch.

Groundwater level readings were taken until the groundwater returned to the original level or for 30 minutes, whichever occurred first. In those cases where the groundwater level returned to the original level, the well was classified as functioning. In those cases where a groundwater level showed no discernable recovery in 30 minutes, the well was classified as non functioning. Where a groundwater level showed signs of recovering to its original level, but did not recover fully in 30 minutes, a groundwater level reading was taken at least 24 hours later. At this reading, if the groundwater level had recovered to the original level, the well was classified as functioning. If the groundwater level had not recovered to the original level it was classified as non functioning.

Observation wells currently being monitored by others were not tested and were assumed to be functioning.

3.1.5 Final Database Update

Results of the field survey and testing were input as a final update to the database. Field survey notes such as the general location of the well, if found, the condition of the cover plate and any other information relevant to locating the well for future readings are shown on the field forms which are included in Volume II.

3.2 Datum For Elevations

Elevations referenced are in the Boston City Base (BCB) datum which is 5.65 feet below the National Geodetic Vertical Datum (NGVD) at mean sea level. Mean tide levels in Boston Harbor are: high tide at elevation +10.54 BCB and low tide at elevation +1.06 BCB.

3.3 Summary of Results

A total of 657 wells were identified from the two major sources [references (4) and (7)] and 100 well locations were identified by other parties. Since the 100 wells are understood to be monitored currently, no effort was made to either locate or field test these wells. A total of 189 wells were judged to be functioning and their approximate location is shown on Figure 3. There were 139 wells which were found to be plugged or otherwise obstructed and could not be tested, and 20 wells which failed to pass the slug test. The detailed location of the functioning wells are shown on the Well Location Maps on Figures 9 through 26.

The results of the data collection, field surveying and testing are summarized as follows:

Wells field surveyed	657
<u>Operating wells by others (Not field surveyed)</u>	<u>100</u>
Total Wells in Database	757

Surveyed Wells

Wells found	308
<u>Wells not found</u>	<u>349</u>
Total Surveyed Wells	657

Tested Wells

Wells tested operable	89
Wells did not respond	20
Wells damaged/plugged	91
<u>Miscellaneous*</u>	<u>108</u>
Total Tested Wells	308

Total Operating Wells

Wells tested operable	89
<u>Operating wells by others (not field surveyed)</u>	<u>100</u>
Total Operating Wells	189

Detailed results of this survey are given on Tables 2 and 3.

* This category includes gate boxes which turned out to be water services, deep wells, small diameter wells that could not be slug tested, piezometers and wells that could not be opened.

4.0 REVIEW OF FACTORS AFFECTING GROUNDWATER LEVELS

Planning an observation well network requires a review of the surficial geology, groundwater fluctuations, sources of groundwater losses and obstructions to groundwater flow as well as an understanding of the areas where untreated timber piles are to be found. This information, together with knowledge of where functioning wells currently exist, as shown on Figure 3, is necessary in order to plan a well network. This section of the report is a review of earlier publications concerning groundwater conditions and related issues in the City of Boston. All sources of data are referenced.

4.1 Groundwater Conditions

4.1.1 General

Any discussion of the groundwater history of the City of Boston must include the extensive land filling which occurred, as well as the surficial geology, the deleterious effects of the groundwater table drawdown and the several attempts to monitor the groundwater table over the years.

The following history is necessarily brief and does not include the complete historical record. Those interested in more details are invited to study the references at the conclusion of this report.

4.1.2 Land Filling

The original shoreline for Boston in colonial times is shown on Figure 4. Only a narrow causeway of land running about where Washington Street is now connected the several hills of Boston to the mainland. Most of the Back Bay, Lower Beacon Hill, Chinatown, and portions of the Fenway and the South End were a tidal estuary until landfilling began about the turn of the nineteenth century.

The first major structure to be constructed in the Back Bay was the Mill Dam which was completed in about 1821. The dam carried a toll road and was built on what is now Beacon Street, extending from the Public Gardens to Brookline Street. The dam consisted of two parallel masonry block walls about 15 feet in height and 50 ft. apart, built on a grillage of timbers with the space between filled with mud and sand. The purpose of the dam was to use tidal water to power machinery in mills located along the cross dam on Gravelly Point.

In 1831 two rail lines, the Boston & Providence and the Boston and Worcester were chartered and construction of their embankments across the tidal estuaries was begun almost immediately. The Boston & Worcester crossed the tidal flats at the location of the present Boston & Albany tracks, while the Boston & Providence Line crossed in northwest-southeast orientation, terminating at Park Square. The two lines intersected at what is now Back Bay Station. Quoting from Aldrich (1) "The railroads influenced the growth of Back Bay in two important ways. First they greatly interfered with the flow of water, hence reducing the usefulness of the area as a power project, increasing its undesirable aspects and hastening the day of its filling. Second, they influenced materially the ultimate layout of streets in the Back Bay, which factor had a tremendous impact on its physical and sociological development."

Major filling of the tidelands began in the late 1850's. Fill for the decades long project came from Needham and consisted of clean sand and gravel. Filling was completed in the late 1800's and as sections were completed land was sold for residential and commercial development. In 1910 a tidal dam was built across the Charles River to control the height of the water in the river at about el +8, and in 1951 the Storrow Drive was built.

4.1.3 Surficial Geology

Typical soil profiles in the Back Bay are illustrated on Figure 5. Starting from the bedrock and extending upward the soil generally consists of a variable thickness of glacial till, stiff to medium gray clay, varying in thickness from 40 ft. to over 100 ft., a relatively thin and discontinuous deposit of sand, overlain by peat and organic silt, which in turn is overlain by the granular fill.

The following detailed description of the various soil types which constitute the surficial soils in the Back Bay area of Boston are taken from Aldrich (1).

The glacial till which overlies bedrock consists of a random mixture of rock fragments of all sizes, varying from cobbles and boulders down to sand, silt and clay sizes. The till is very compact and extremely competent. In the Back Bay the till is relatively thin and no more than 30 ft. in thickness.

The clay which in turn overlies the till is called the Boston Blue Clay. The actual color is blue-gray to drab olive green, and in the Back Bay it varies in thickness from 50 to 125 ft. Clay was encountered as deep as 180 ft. in borings at the corner of Beacon and Fairfield Streets. The clay commonly has a stiff yellow crust which was caused by drying out during periods when the sea level was greatly lowered. The stiff crust of the Blue Clay is typically the supporting stratum for many of the timber pile foundations.

Overlying the Boston Blue Clay in an irregular fashion is the sand and gravel outwash. This was deposited by swiftly moving streams of the glacial melt water about twelve to fourteen thousand years ago. The deposit of well stratified sand and fine gravel is generally medium compact, highly pervious and easily excavated. The outwash deposit begins to increase in thickness around Dartmouth and Exeter Streets, and at Massachusetts Avenue on the old colonial peninsula it has been termed appropriately Gravelly Point. At the Christian Science Church the sand and gravel outwash is approximately 20 ft. thick, and east of Copley Square it occurs only irregularly.

The organic soils are found above the outwash or in some instances directly overlying the Boston Blue Clay. These soils vary in composition from organic silt to peat and in the Back Bay area they are continuous and range in thickness from 5 to 25 ft. The top surface of organic soils varies from below el. 0 to el. +9. [Kaye(6)]

Overlying the organics is the fill which for the most part is granular in nature, highly permeable, and of variable density.

4.1.4 Groundwater Monitoring Programs

There have been only two major groundwater monitoring programs in the past 60 years. The first effort occurred between the years of 1936 and 1940 and was conducted by the Works Progress Administration (9). Approximately 1300 wells were installed by either the WPA or the Boston Sewer Department. The need for this monitoring effort probably grew out of concern about the untreated timber piles in the city as exemplified by the problems of the Boston Public Library (Section 5.1).

While the actual water level readings from the 1936 - 1940 survey are available at the Boston Public Library, the extreme highs and extreme lows have been included by Cotton and Delaney (4) in the second major monitoring program. This was sponsored by the US Geological Survey and was published in 1975. This project was based on data from about 400 wells remaining from the WPA survey. Two readings were taken, one in September of 1967 and the other in March of 1968. These were plotted as groundwater contours and compared with the extremes of the 1936 - 1940 survey.

In 1985, Lambrechts et al (6) reviewed and augmented the above mentioned data as it pertained to a more limited study area bounded by Albany Street on the South, Massachusetts Avenue on the West, the Charles River on the North and extending East to Charles Street. This report included considerable discussion about construction activity and some additional water level information together with a listing of all known observation wells in the area of concern. That report did not include any field surveys or testing, and it was the starting point for this report.

4.1.5 Groundwater Table

The groundwater table may be defined as the elevation to which water will rise in a standpipe which is open ended and is embedded in an aquifer. An aquifer

is a relatively permeable soil, such as sand or gravel, through which water may travel relatively easily. Conversely an aquitard is a soil of low permeability such as a clay or a silt which is resistant to the flow of water. Generally the water table is expressed as an elevation and if sufficient data is known isochrones or contours of equal elevation may be constructed. There are both confined and unconfined aquifers. A confined aquifer is an aquifer which is confined between two aquitards. Usually the water table in a confined aquifer will rise above the top of the aquifer. An unconfined aquifer, or water table aquifer, is an aquifer in which the water table forms the upper boundary.

In Boston there are at least three water tables. The first water table is in the fill and the fill can be called an unconfined aquifer. The second water table is in the sand outwash which is overlain by the organic silt and or peat and is considered a confined aquifer. While this aquifer may be connected to the fill locally by excavations made for the infrastructure which have been backfilled with granular soils, it typically is considered to be isolated from the groundwater table in the fill. The third aquifer in the Boston profile is in the granular portions of the glacial till. This is frequently found just overlying bedrock. Other localized aquifers may exist in sand lenses which may occur within the Blue Clay.

While these various aquifers are important for some engineering considerations, the only one of importance with respect to timber piling, which has been identified to date, is the unconfined aquifer in the fill. The following discussion pertains to that aquifer.

The normal groundwater level prior to filling is assumed to have been at least equal to the mean tide level, or el. 5.7. About 1878, after substantial filling of the Back Bay was completed, according to Snow (7), the groundwater table was about el. 7.7. In 1910 the Charles River Dam was completed and the river was maintained at about el. 8. While it may have been assumed that the dam would have a positive effect on groundwater tables throughout the Back Bay area, the effects were really quite limited to the immediate proximity of the river itself. This limitation on the Charles as a significant source of groundwater recharge is probably due to the Mill Dam which underlies Beacon Street, as well as the Boston Marginal Conduit which parallels the river about where Storrow Drive is today.

In 1894, Mr. Frederick P. Stearns, reporting to the Joint Board on the Improvement of the Charles River, stated that "The lower level of the groundwater at a considerable distance from the river ... indicates clearly that the height of the groundwater is governed for the most part by leakage into sewers and not by the height of the water in the Charles River." (7) In a general sense this continues to be true to this day.

In the three definitive reports on groundwater conditions in the Back Bay Area (4) (7) (10), the groundwater table varies from a high of about el. 10 to a low of el. +2 to 0, omitting local extremes. Review of the reports indicates certain areas which were low in the 1936-1940 survey, in the 1967-1968 survey, and in the report by Lambrechts et al (6) for the period between 1968 and 1985. A composite of these areas are shown on figure 7. These areas include lower Beacon Hill, an area between Boylston Street and Columbus Avenue, an area on either side

of the Southwest Corridor Project, an area just east of the Muddy River in the Fenway and an area centered on Tremont Street between Concord Street and the Massachusetts Turnpike Extension.

4.1.6 Sources of Groundwater Drawdown and Recharge

Lambrechts et al (6) have a detailed discussion of the various sources of groundwater losses. The following review has been taken in part from that report.

Sewers

All studies to date of the cause of groundwater drawdown attribute a significant influence to the local sewer system. A discussion of the influence of the sewer system on the groundwater table by Snow (7) in 1936 follows:

"With the filling of the basin came the construction of drains and sewers emptying into either the South Bay or the Charles River. Plans in 1863 show that by that time an extensive system had been constructed, but definite records as to location have been since either lost or destroyed. This, together with the fact that they have settled several feet in places, makes the present location of these drains entirely a matter of conjecture, except where they have been uncovered by recent construction. These sewers and drains were the beginning of the present maze of underground channels of which little or nothing is known, but which form channels by or along which the groundwater can escape to sewers in which the gradient is at a sufficiently low elevation to help drain the area." In the opinion of Mr. Snow, the city was underlain by a maze of subterranean channels leading groundwater off to the Harbor.

All of the early sewers were constructed on top of an 8 to 12 inch underdrain which was designed to collect and control groundwater during construction. These remain in place to this day and are capable of transporting significant quantities of groundwater.

The West Side Interceptor was a part of the Boston Main Drainage System that was constructed from 1877 to 1884. It is an egg shaped sewer, 57 in. wide and 66 in. high, constructed with a double or triple row of mortared bricks. It was constructed down Charles Street to Beacon, down Beacon to Hereford, down Hereford and Dalton to Falmouth, then west to Gainsborough Street. The invert grade varies from approximately el. 0 at Beacon and Arlington to el. - 5.5 at Huntington and Gainsborough, and was designed to intercept combined sewers which formerly discharged into the Charles River at Beaver, Berkeley, Dartmouth, Fairfield and Hereford Streets. Excess storm flow and sewage could still overflow into the Charles at numerous overflow outlets.

The Boston Marginal Conduit was constructed in 1910 as part of the project which constructed the new dam and lock on the Charles River. The Marginal Conduit was intended to collect flow from Stony Brook and mixed sewage and storm water overflows from the West Side Interceptor which used to discharge to the river. It was constructed in a reinforced concrete horse shoe shaped section 76 in. wide and 92 in. high, supported on wood piles, and located immediately north of Back Street, and today it is below Storrow Drive. It was built between two rows of

wood sheeting which was driven into the organic silt and left in place. A portion of the Marginal Conduit was relocated inland when the Storrow Drive Underpass was built in 1951. The relocated section is an 8 ft. diameter reinforced concrete pipe with an invert el. of -1.5 which extends from Dartmouth to Mr. Vernon Street. Beneath the sewer line is the underdrain line which ties into the old underdrain line under Storrow Drive.

Both the West Side Interceptor and the Boston Marginal Conduit impeded the flow of groundwater into the Back Bay from the Charles River. They also have the ability to transport water rapidly along their length via their underdrain system.

The St. James Avenue sewer has been the source of groundwater table drawdown since it was investigated as a result of concern for the foundations of the Trinity Church during the 30's. The installation of a dam in the sewer caused nearby groundwater to return to acceptable levels, but the dam requires periodic maintenance and when it does not function the local groundwater falls.

Subways, Railroads and Depressed Arteries

The Boylston and Huntington Avenue Subways were constructed in 1914 and 1940 respectively. During Construction the groundwater table was undoubtedly drawn down to new lows [the maximum depth of excavation of both projects is about el. -19] for the period of the construction. Since then the subways undoubtedly act as an impediment to ground water flow and also as a drain depending upon how much water leaks into the subways.

The Southwest Corridor Project which has been under construction during the 1980's has two tracks for the relocated Orange Line Subway and three tracks for commuter rail and AMTRAK service. The corridor is located on the former Penn Central alignment from Forest Hills to the South Cove area, and also coincides with the two original railroad embankments which crossed the Back Bay. For over 2100 feet it is constructed with two reinforced concrete slurry walls penetrating 8 to 15 ft. into the underlying clay. Efforts were made to permit lateral groundwater flow by the use of a groundwater equalization underdrain system but it was reported in 1985 (6) that the groundwater on both sides of the Southwest Corridor East of the Back Bay Railroad Station are several feet below el +5.

The Massachusetts Turnpike Extension was built between 1963 and 1966 and is just north of the Conrail railroad alignment. The highway is depressed about 15 to 20 ft. below adjacent city streets, ascending from about el. 6 at Tremont to about el. 11 at Massachusetts Avenue. The project was designed to prevent groundwater flow into an underdrain system by use of two rows of sheeting which penetrate into clay in the vicinity of the Prudential Center. It is not clear how effectively the sheet piling prevents the loss of groundwater into the underdrain system. Again, the structure is another impediment to the flow of groundwater.

The Storrow Drive underpass was built in the early '50's and is approximately 1300 ft long with 300 ft approach ramps at either end. The road surface is about 15 to 17 feet below the ground surface. The underpass never proved to be very water tight, and it was believed in 1985 (7) to be pumping 20,000 gpd from

each of several wet wells. This structure is consequently a barrier to the recharge of the Back Bay groundwater system as well as a groundwater sink.

Sources of Groundwater Recharge

A discussion of the various sources of groundwater recharge follows:

1. Surface infiltration - Over 80% of the area in question is paved. Consequently only a small amount of recharge can be expected from surface infiltration.
2. Recharge from the local rivers - The largest local body of water is the Charles River. The West Side Interceptor, the Boston Marginal Conduit and the Mill Dam effectively isolate the Boston Peninsula from significant recharge from the Charles River. The Muddy River is a groundwater source in the Fenway.
3. Recharge from leaking water mains - This has proved in the past to be a significant source of localized recharge. Currently the BW&S is aggressively finding and repairing leaking pipes to minimize losses.
4. Permanent recharge systems - Two known systems are installed at Copley Square and Trinity Church. These systems are very local and do not effect groundwater conditions beyond their immediate vicinity.

4.2 Summary

In order to propose additional well locations it is important to understand certain factors which affect the groundwater history of the Boston Peninsula. Review of these factors indicates that numerous reasons exist for a lowered groundwater table, including the following:

- * Paving has reduced recharge to a minimum
- * Leaking sewers
- * Subways, depressed expressways and railroads act as an impediment to groundwater flow and in some instances as a groundwater sink
- * Leaking pressurized distribution lines which acted as a source of groundwater recharge have been repaired.

Review of the data also indicates certain areas which were low in the 1936-1940 survey and in the 1967-1968 survey as shown on figure 7. These areas include lower Beacon Hill, an area between Boylston Street and Columbus Avenue, an area on either side of the Southwest Corridor Project, an area just east of the Muddy River in the Fenway and an area centered on Tremont Street between Concord Street and the Massachusetts Turnpike Extension.

5.0 TIMBER PILE FOUNDATIONS

Certain areas of the Boston Peninsula include structures supported on untreated timber piles which were built prior to the early 20th century. Those areas which were included in this study are Back Bay, Beacon Hill, South End, Chinatown, and the Fenway. Other areas of the City which have timber pile foundations include South Boston and parts of the North End. A report by Thompson and Lichtner (8) was prepared for the BRA for the rehabilitation of the South End in 1963. In this study the foundations of 15 structures were investigated. The intent was to determine both the type of foundation as well as the condition. Eight of the structures were on original land within the old shore line and seven were on filled land either west (6 structures) or east (1 structure) of the old peninsula. Interestingly, of the 8 structures within the old shoreline, all were founded on shallow foundations and 4 of the seven on fill were also on shallow foundations. One of the 4 which were shallow was supposed to be on piles but the piles were not found. While this is certainly not definitive, it does raise some question as to the number of pile supported structures that actually were built in the South End.

By 1890 building department regulations (7) required all untreated timber piles to be cut off below el. + 5 and no basements to be constructed below el. +12. It has been commonly accepted that if the groundwater is maintained at or above el. +5, no pile deterioration will occur. In actuality a number of piles were cutoff above el. +5, as noted by remedial work in the Brimmer Street area where piling was found cut off at el. +7.

5.1 Deleterious Effects of Groundwater Table Drawdown in Boston

There are several deleterious effects of groundwater table drawdown as follows:

Subsidence - This is settlement of the ground surface due to an increase in the effective stress on soft and compressible deposits. Subsidence will cause all structures such as pipelines and conduits which are not supported on piles to settle. Subsidence may cause negative skin friction on pile foundations.

Negative Skin Friction - This is downdrag on piles due to settlement of the soil surrounding the pile. This downdrag increases the load on the pile which in turn increases the settlement of the pile and could result in pile failure.

Deterioration of untreated timber piles - Untreated timber piles deteriorate when exposed to moist air. The following discussion is taken from Chellis (3). "All decay in wood piles is caused by the growth of fungus, a form of plant life which, by deriving its food from the wood, break down the cellular structure. Fungi must have moisture, air, favorable temperature and food in order to exist. By depriving the fungi of any of these elements, decay can be prevented. For example, if wood can be kept dry, or if it can be kept continuously submerged at a low temperature, or rendered unsuitable for food by poisoning, it will not decay." The time rate of deterioration is variable depending upon the type of soil in which it is embedded and the type of wood. For instance, a pile which is embedded in an organic clay silt might have a much longer life after groundwater table drawdown than a pile embedded in a sandy fill. The fine grained soil will retain the water longer, which will act as a

preservative. On average, a spruce pile above the groundwater table will lose about 50% of its cross sectional area in 3 to 7 years.

Damage to Boston Structures

No major failures in the city are known to have been related to subsidence. This does not mean that numerous broken or leaking pipes and dipping roadways and sidewalks could not be attributed to this cause. It is just that no serious effort has been made to document the cause and effect. The effect of negative skin friction is also difficult to isolate from that of the damage caused by deteriorating piling.

Effort has been made from time to time to document damage due to deteriorating pile foundations. The first significant failure was the Boston Public Library which was discussed by Snow (7). "About seven years ago (1929) the Boston Public Library, built in the heart of the land developed in one of the old basins, showed several alarming cracks. After investigation by the City Building Department and their consulting engineers, it was found necessary to cut off decayed pile heads and replace them with concrete. The tops of some of the piles were completely gone and others were very badly decayed so that for about 40 percent of the area of the building underpinning was necessary." The cost of these repairs was approximately \$250,000 (1929 dollars).

The report by Lambrecht et al (6) for the BRA indicated that there were records of 32 buildings which had decayed wood piling in the lower Beacon Hill area between 1927 and the early 1980's. Seventeen buildings required underpinning in the 1980's in the vicinity of Brimmer Street in Lower Beacon Hill.

In Chinatown, four Hudson Street buildings have recently collapsed and several others are severely damaged, all reportedly due to deterioration of the foundation piling. An Inspectional Services Department survey of 160 buildings on three Chinatown Streets have shown signs of damage which may be caused by deteriorating foundations.

Northeastern University has reported underpinning two residential buildings on Hemenway Street within the past several years at their Huntington Avenue Campus.

Undoubtedly other unreported cases exist.

6.0 RECOMMENDATIONS

6.1 GENERAL

The purpose of this study was to provide the basis for planning the future expansion of the groundwater monitoring system for the City of Boston. It's primary function was to locate, test and tabulate existing wells. Because the present study did not include significant interpretation of groundwater data, specific locations of new wells have not been determined. However certain general recommendations have been made regarding an observation well network. The first priority for the next phase of this project should be to engage a consultant with appropriate experience to provide a groundwater data base management system and to evaluate and interpret the existing data. As a result of their evaluation, new wells should be located and installed in a phased approach. The location of the first phase of new wells should be determined based on evaluation of existing data, which was beyond the scope of this study. Subsequent planning of additional well locations will be very much influenced by the data provided by new wells installed in earlier phases of the study.

6.2 OBSERVATION WELL NETWORK

This section includes general recommendations resulting from this study for a groundwater observation well network. These recommendations are based upon the results of the field survey and records of others which indicate a total of 189 wells are functioning in the study area in locations as identified on Figure 3. In order to plan the well network an average density of 2.5 acres per well is recommended. This is similar to the WPA study and is considered appropriate for this project. This is an average density and should vary as groundwater data in specific areas becomes available.

1. Total Number of Wells

The total study area is approximately 2100 acres. A total of 189 wells have been identified as working in an area roughly equal to 400 acres. Assuming a density of 2.5 acres per well, the balance of the area (2100-400) will require 680 wells. This would provide a network of 869 working wells.

2. Modifications to an Average Well Density

Areas of steep gradients would require more wells per acre than areas of very flat gradient. Areas with few structures (such as the parking lots at Northeastern University) would require fewer wells per acre than typical residential areas. Areas close to the Charles which have not historically been below el. +5 (such as the area North of Commonwealth Avenue between Charlesgate and Arlington Streets as shown on Figure 8) could have a lower density than the average, assuming groundwater levels are found to be above el. + 5.

3. Priority of Well Installation

First priority should be defining the groundwater table in areas with timber pile foundations and suspected low groundwater levels. Areas of high priority are shown on figure 8. Chinatown was not given high priority because it is believed that construction of the Central Artery will result in construction of a number of observation wells in that area of the city. The area north of Commonwealth Avenue is recommended as a priority area because it has a high percentage of timber pile supported residential structures and very few observation wells, not because it has been identified as an area of low groundwater. As stated in item 3 above, the density of wells in this area may be less than the average recommended density.

While the South End and parts of the North End have been identified as having untreated timber pile foundations, it does not appear justified at this time to recommend the installation of wells in these areas. It is believed that a number of new wells will be installed in conjunction with the construction of the Central Artery.

4. Plugged Wells

159 wells were found to be plugged or did not function. This represents a substantial increase in the current operating well network if they can be made operable at a reasonable cost. It is recommended that a well drilling contractor be hired for a trial to establish the cost and effectiveness of well cleaning. The fundamental approach to be used will involve jetting a smaller (nominal 1 in OD) pipe down the standpipe, which is typically a steel 2. in. OD pipe. Water or air may be used, and the jet should be directed directly down until the screen is reached, and then directed to the openings. It will not be clear until this trial is run for several days whether cleaning will be cheaper than installing a new well. It is important that a qualified person witness the cleaning and document the results. The final approved well will pass a slug test as described in Section 3.1.4.

6.3 OTHER ACTIONS

Certain other actions are recommended to maximize the value and minimize the cost of an observation well network. The following recommendations should be considered as an integral part of a well network.

1. Obtain the services of a competent consulting engineer. Services to be provided should include:
 - * Develop software for the database to produce time plots and groundwater contours.
 - * Read all existing wells and input to data base and produce first cut at groundwater contour data. (alternatively the city will read the wells and input the data to the data base). It is recommended that initially all wells be read four times (winter, spring, summer

and fall) and twice yearly (fall and spring) thereafter.

- * Review building permit records to determine location of timber pile foundations. (review of Thompson and Lichtner Report (9) indicates an effort should be made to confirm the presence of timber piling.)
 - * Survey elevations of all wells for which no data is available.
 - * Review new groundwater data and location of timber pile foundations to confirm first priority locations of groundwater wells as identified in this report.
 - * Develop trial program to clean plugged wells. Based on this program certain wells may become operative. This program should be controlled to ensure that the result is less expensive than installing new wells. Both location of the well and cost of cleaning must be considered.
 - * Install new wells. New wells should include a boring log and an installation record.
 - * Update groundwater map as new data is available.
 - * Revise priority locations on the basis of new data.
 - * Study and recommend remedial measures to raise the groundwater table in affected areas. This study to be provided to an interagency task force (Item 4 below)
2. Create new regulations requiring installation of permanent observation wells as part of any new construction.
 3. Interagency coordination to require the MWRA and BW&S and other pertinent state and municipal agencies to install permanent observation wells as part of any new construction.
 4. Interagency task force to review the cause of lowered groundwater and determine and implement remediation measures.

LIST OF REFERENCES

1. Aldrich, H. P., 1970, Back Bay Boston, Part I, Journal of the Boston Society of Civil Engineers, Volume 57, Number 1.
2. Aldrich, H. P., Lambrechts, J. R., 1986, Back Bay Boston, Part II, Groundwater Levels, Civil Engineering Practice, Journal of the Boston Society of Civil Engineers, Volume 1, Number 2.
3. Chellis, 1961 Pile Foundations, McGraw & Hill Book Company
4. Cotton, J. E., and Delaney, D. F., 1975, Groundwater Levels on the Boston Peninsula, Massachusetts, Hydrologic Investigations Atlas HA-513, U.S. Geological Survey, Reston VA, 4 sheets.
5. Kaye, C. A. 1961, Pleistocene Stratigraphy of Boston, Massachusetts, Professional Paper 424-B, U.S. Geological Survey, pp B-732 to B-76,.
6. Lambrechts, J. R., Gevalt, D. H., Aldrich, H., 1985, Report on Groundwater in Back Bay Boston, Boston, Massachusetts, for the Boston Redevelopment Authority.
7. Snow, B. F., 1936, Tracing Loss of Groundwater, Engineering News Record, July 2, 1936.
8. The Thompson and Lichtner Company, Inc, December, 1963 Investigation of Subsoil and Foundation Conditions, for the Boston Redevelopment Authority.
9. Works Progress Administration Program, 1941, Final Report of the Groundwater Level Survey of Certain Areas of the City of Boston, Project Number W.P. 5325, and Supplemental Official Project Number W.P. 18868.

TABLE 1

FIRMS PROVIDING INFORMATION FOR THE DATA BASE

<u>Company</u>	<u>Contact</u>
Boston Public Library	Mr. John J. Doherty
Boston Redevelopment Authority Engineering	Mr. William Barbato
Boston University	Mr. James Keating
First Church of Christ	Mr. Gary McKean
Ziner and Rosetti - Gardner Museum	Mr. Erwin Ziner
Gilbert Small Co. - Church of the Advent - Lenox Hotel	Mr. William Rogers
J.M.B. Properties - Copley Place	Mr. Frank Shea
MASCO	Mr. Brian Luke
Massachusetts Bay Trans- portation Authority: Southwest Corridor Project	Mr. William Quinlain
Massachusetts Turnpike Authority	Mr. John Grimm
Museum of Fine Arts	Mr. Warren Young
Northeastern Univ.	Mr. Cliff Fralen
R.M. Bradley - Prudential Center	Ms. Pam Galeota
Trinity Church	Mr. Richard Merrill
Wentworth Institute of Technology	Mr. Kevin Fuchs

TABLE 2
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S&W NO.	PREVIOUS NO.	(*) DATA SOURCE	NEIGHBORHOOD	LOCATION	TEST DATE	GROUNDWATER DEPTH (FT)	GROUNDWATER ELEVATION (FT)	GROUND SURFACE ELEVATION (FT)	WELL DEPTH (FT)
1910611		3	BACK BAY	WILLIAMS ST. & SHAWMUT AV	08/15/89	11.80	0.00	0.00	14.90
20H1216		3	SOUTH END	HUNTINGTON & VANCOUVER	08/14/89	8.80	0.00	0.00	13.80
20H1424		3	SOUTH END	RUGGLES ST & PARKER ST	08/14/89	7.30	0.00	0.00	11.80
20H1528	B89-10W	16	FENWAY	ON SHATTUCK ST	05/12/89	20.50	17.70	38.20	25.00
20H1529	B89-20W	16	FENWAY	ON SHATTUCK ST	05/12/89	16.60	22.20	38.80	35.00
2010142	88-16	12	FENWAY	NORTHEASTERN UNIV.	10/23/89	9.20	7.90	17.10	0.00
2010168	88-17	12	SOUTH END	NORTHEASTERN UNIV.	10/23/89	11.90	6.80	18.70	0.00
2010213		3	SOUTH END	GREENLEAF & FORSYTH ST	08/15/89	9.30	0.00	0.00	19.60
2010284	88-19	12	FENWAY	NORTHEASTERN UNIV.	10/23/89	11.20	7.40	18.60	0.00
2010396	88-24	12	FENWAY	NORTHEASTERN UNIV.	10/23/89	10.10	5.20	15.30	0.00
2010868	88-20	12	FENWAY	NORTHEASTERN UNIV.	10/23/89	9.20	7.20	16.40	0.00
21H2176	B-3	11	FENWAY	MUSEUM OF FINE ARTS					
21H2182	B-4	11	FENWAY	MUSEUM OF FINE ARTS					
21H2586A	A	10	FENWAY	280 FENWAY	10/28/86	12.75	4.63	17.38	0.00
21H2586B	B	10	FENWAY	280 FENWAY	10/28/86	11.75	6.71	18.46	0.00
21H2589A	C	10	FENWAY	280 FENWAY	10/28/86	13.88	5.10	18.98	0.00
21H2589B	D	10	FENWAY	280 FENWAY	10/28/86	14.00	4.81	18.81	0.00
21H2595	E	10	FENWAY	280 FENWAY	10/28/86	13.75	5.48	19.23	0.00
21H2597A	F	10	FENWAY	280 FENWAY	10/28/86	3.25	4.85	8.10	0.00
21H2597B	G	10	FENWAY	280 FENWAY	10/28/86	3.42	5.80	9.22	0.00
21H2728	B-1	11	FENWAY	MUSEUM OF FINE ARTS					
21H2729	B-2	11	FENWAY	MUSEUM OF FINE ARTS					
2110248	88-1	12	FENWAY	OFF HEMENWAY STREET	10/23/89	7.60	4.60	12.20	0.00
2110249	88-2	12	FENWAY	NORTHEASTERN UNIV.	10/23/89	12.50	4.70	17.20	0.00
2110432	T1	12	BACK BAY	CHRISTIAN SCIENCE CENTER	08/14/89	5.40	4.98	10.38	0.00
2110436	OW5	12	BACK BAY	CHRISTIAN SCIENCE CENTER					
2110629	III-W-35	1	BACK BAY	138 ST BOTOLPH ST	08/11/89	9.30	0.00	0.00	18.80
2110837	88-5	12	FENWAY	84 FENWAY WAY	10/23/89	10.60	5.80	16.40	0.00
2110838	88-5A	12	FENWAY	ON FENWAY WAY	10/23/89	11.70	5.00	16.70	0.00
2110885	88-7	12	FENWAY	110 FENWAY	10/23/89	13.00	4.60	17.60	0.00
2110896	88-6	12	FENWAY	163 HEMENWAY STREET	10/23/89	12.50	5.20	17.70	0.00
2110912	88-3	12	FENWAY	129 HEMENWAY STREET	10/23/89	12.90	4.70	17.60	0.00
2110941	88-4	12	FENWAY	OFF HEMENWAY STREET	10/23/89	13.30	4.10	17.40	0.00
2110942	88-4A	12	FENWAY	143 HEMENWAY STREET	10/23/89	12.70	4.60	17.30	0.00

* DATA SOURCE: 1 - H&A GROUNDWATER BACK BAY; 2 - CHRISTIAN SCIENCE CENTER; 3 - USGS HYDROLOGIC ATLAS-513; 4 - MASS TURNPIKE AUTHORITY; 5 - IDENTIFIED BY STONE & WEBSTER; 6 - QAZILBASH; 7 - GEO. ENG. INC.; 8 - URBAN ENGINEERING; 9 - BRA; 10 - ZINER & ROSSETTI INC; 11 - MUSEAUM OF FINE ARTS; 12 - NORTHEASTERN UNIVERSITY; 13 - R.M. BRADLEY; 14 - GILBERT SMALL & CO.; 15 - BOSTON WATER & SEWER; 16 - BRIGHAM & WOMAN'S HOSPITAL

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2110985	88-9	12	FENWAY	NORTHEASTERN UNIV.	10/23/89	10.30	7.60	17.90	0.00
2111252	1106	12	BACK BAY	ON MASSACHUSETTS AVE					
2111256	1104A	12	BACK BAY	353 MASSACHUSETTS AVE					
2111563	88-8	12	FENWAY	ON FORSYTH STREET	10/23/89	12.70	4.50	17.20	0.00
2111584	88-10	12	FENWAY	ON HEMENWAY STREET	10/23/89	11.90	5.80	17.70	0.00
2111587	88-10A	12	FENWAY	ON HEMENWAY STREET	10/23/89	9.30	8.30	17.60	0.00
2111598	88-12	12	FENWAY	ON FORSYTH STREET	10/23/89	12.60	4.90	17.50	0.00
2111643	88-11	12	FENWAY	ON ST. STEPHEN STREET	10/23/89	12.50	4.80	17.30	0.00
2111646	88-11A	12	FENWAY	ON ST. STEPHEN STREET	10/23/89	12.80	4.70	17.50	0.00
2111666	88-13	12	FENWAY	NORTHEASTERN UNIV.	10/23/89	10.00	7.30	17.30	0.00
2111747	88-13A	12	FENWAY	HUNTINGTON & OPERA PL.	10/23/89	13.00	4.30	17.30	0.00
2111863	88-23	12	BACK BAY	ON GAINSBOROUGH STREET	10/23/89	9.60	6.60	16.20	0.00
2111875	88-22	12	FENWAY	NORTHEASTERN UNIV.	10/23/89	0.00	17.70	17.70	0.00
2111878	88-22A	12	FENWAY	NORTHEASTERN UNIV.	10/23/89	13.60	4.10	17.70	0.00
2111979	T1840	12	BACK BAY	ON GAINSBOROUGH STREET					
2112243	88-15	12	FENWAY	NORTHEASTERN UNIV.	10/23/89	13.30	4.60	17.90	0.00
2112275	88-14	12	BACK BAY	NORTHEASTERN UNIV.	10/23/89	9.70	8.00	17.70	0.00
2112439	88-21	12	FENWAY	NORTHEASTERN UNIV.	10/23/89	7.60	5.70	13.30	0.00
2112472	88-27	12	FENWAY	NORTHEASTERN UNIV.					
2112473	89-29	12	FENWAY	NORTHEASTERN UNIV.					
2112592	88-25	12	BACK BAY	WILLIAM E. CARTER	10/23/89	9.40	6.30	15.70	0.00
21J0298	V-34	1	BACK BAY	176 WEST BROOKLINE ST.	08/10/89	11.60	6.10	17.70	14.70
22H0146		5	BACK BAY	COMM. AVE & CUMMINGTON ST	08/10/89	16.40	0.00	0.00	19.00
22H0841	B-3	6	BACK BAY	509 PARK DRIVE	08/09/89	12.00	0.00	0.00	17.60
22H1096	BB-1	6	FENWAY	RR TRACKS & BROKLINE AVE.	08/10/89	9.80	3.70	13.50	15.00
22H1098	BB-3	6	FENWAY	RR TRACK & BROOKLINE AVE	08/10/89	8.00	0.00	5.00	14.50
22H1527		3	BACK BAY	879 BEACON ST.	08/10/89	12.00	0.00	0.00	13.00
2210546	11-W-44	1	BACK BAY	290 NEWBURY ST	08/08/89	11.10	0.00	7.20	12.90
2210566	11-W-B-2	1	BACK BAY	ALLEY 442 274 NEWBURY ST	08/08/89	7.80	7.10	14.90	18.80
2210754	NE7	13	BACK BAY	PRUDENTIAL CENTER					
2210756	NE11	13	BACK BAY	PRUDENTIAL CENTER					
2210766	FE19	13	BACK BAY	PRUDENTIAL CENTER					
2210767	FE12	13	BACK BAY	PRUDENTIAL CENTER					
2210768	FE16	13	BACK BAY	PRUDENTIAL CENTER					

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2210793	FE20	13	BACK BAY	PRUDENTIAL CENTER					
2210794	FE13	13	BACK BAY	PRUDENTIAL CENTER					
2210796	FE17	13	BACK BAY	PRUDENTIAL CENTER					
2211227	NC2	13	BACK BAY	PRUDENTIAL CENTER					
2211238	NE1	13	BACK BAY	PRUDENTIAL CENTER					
2211239	NE3	13	BACK BAY	PRUDENTIAL CENTER					
2211278	III-W-10	1	BACK BAY	DALTON & SCOTIA ST	08/08/89	18.70	0.00	0.00	24.80
2211326	NE5	13	BACK BAY	PRUDENTIAL CENTER					
2211364	SE2	13	BACK BAY	PRUDENTIAL CENTER					
2211383	SC2	13	BACK BAY	PRUDENTIAL CENTER					
2211398	SE11	13	BACK BAY	PRUDENTIAL CENTER					
2211421	NE10	13	BACK BAY	PRUDENTIAL CENTER					
2211423	FE14	13	BACK BAY	PRUDENTIAL CENTER					
2211443	SE5	13	BACK BAY	PRUDENTIAL CENTER					
2211444	SE4	13	BACK BAY	PRUDENTIAL CENTER					
2211456	SE6	13	BACK BAY	PRUDENTIAL CENTER					
2211663		3	FENWAY	ON HAVILAND ST.	08/08/89	11.90	0.00	0.00	28.90
2211878	III-W-13	1	BACK BAY	4-6 CLEARWAY ST.	08/08/89	13.00	4.30	17.30	17.50
2211923	N2	13	BACK BAY	PRUDENTIAL CENTER					
2211953	N1	13	BACK BAY	PRUDENTIAL CENTER					
2212033	SC5	13	BACK BAY	PRUDENTIAL CENTER					
2212068	SC4	13	BACK BAY	PRUDENTIAL CENTER					
2212077	PT3	2	BACK BAY	CHRISTIAN SCIENCE CENTER	08/14/89	1.45	5.81	7.26	0.00
2212513	MASSAVE#3	1	BACK BAY	CHRISTIAN SCIENCE CENTER	08/14/89	9.05	8.59	17.64	0.00
2212561	CSPS#10	2	BACK BAY	CHRISTIAN SCIENCE CENTER	08/14/89	2.70	5.75	8.45	0.00
2212599	ST.PAUL#5	2	BACK BAY	CHRISTIAN SCIENCE CENTER	08/14/89	10.10	7.77	17.87	0.00
2212615A	CLWAY#2	2	BACK BAY	48 CLEARWAY ST	08/14/89	12.05	5.76	17.81	0.00
2212648	TP#3	2	BACK BAY	CHRISTIAN SCIENCE CENTER	08/14/89	4.45	5.29	9.74	0.00
2212657	TP#1(9)	2	BACK BAY	CHRISTIAN SCIENCE CENTER	08/14/89	3.10	5.36	8.46	0.00
2212659A	CH#8	2	BACK BAY	CHRISTIAN SCIENCE CENTER	08/14/89	5.30	4.92	10.22	0.00
2212659B	CH#8A	1	BACK BAY	CHRISTIAN SCIENCE CENTER	08/14/89	4.45	5.74	10.19	0.00
2212669	PT5	2	BACK BAY	CHRISTIAN SCIENCE CENTER	08/14/89	0.80	6.51	7.31	0.00
2212677A	TP#4	2	BACK BAY	CHRISTIAN SCIENCE CENTER	08/14/89	5.10	5.59	10.69	0.00
2212677B	PT1	2	BACK BAY	CHRISTIAN SCIENCE CENTER	08/14/89	1.30	6.08	7.38	0.00

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TABLE 2
FUNCTIONING OBSERVATION WELL SUMMARY

S&W NO.	PREVIOUS NO.	(*) DATA SOURCE	NEIGHBORHOOD	LOCATION	TEST DATE	GROUNDWATER DEPTH (FT)	GROUNDWATER ELEVATION (FT)	GROUND SURFACE ELEVATION (FT)	WELL DEPTH (FT)
2212678	TP#2	2	BACK BAY	CHRISTIAN SCIENCE CENTER	08/14/89	5.00	5.65	10.65	0.00
2212724	PT6	2	BACK BAY	CHRISTIAN SCIENCE CENTER	08/14/89	2.05	5.14	7.19	0.00
2212834A	III-W-B-4	2	BACK BAY	FOLLEN & ST BOTOLPH ST	07/06/89	17.00	0.20	17.20	17.00
22J0294A	III-E-H-1	1	BACK BAY	DARTMOUTH & STUART ST.	11/21/89	16.50	0.80	17.30	24.30
22J0365	III-E-28	1	BACK BAY	STUART & CLARENDON ST.	07/13/89	13.10	3.50	16.60	15.50
22J0433	III-E-B-12	1	BACK BAY	350 STUART ST	07/12/89	15.80	4.00	19.80	18.80
22J0582		5	SOUTH END	36 ISABELLA ST.	11/21/89	15.50	0.00	0.00	19.00
22J0596	III-E-36	1	BACK BAY	21 CORTES ST	07/12/89	15.70	3.70	19.40	18.60
22J0674	III-E-A-5	1	BACK BAY	19 CORTES ST.	11/21/89	15.00	3.00	18.00	17.40
22J0928	OW	8	BACK BAY	COPLEY PLACE					
22J1195		5	SOUTH END	2 CAZENOVE ST.	08/04/89	13.40	0.00	0.00	14.30
22J1272	V-16	1	SOUTH END	3 ST CHARLES ST	07/13/89	13.60	0.00	0.00	21.00
22J1278		5	SOUTH END	CHANDLER & ST CHARLES ST	07/13/89	13.00	0.00	0.00	19.80
22J1286		5	SOUTH END	76 BERKELEY ST	08/03/89	14.70	0.00	0.00	21.40
22J1349	IV-3	1	SOUTH END	CHANDLER ST	07/12/89	16.90	1.00	17.90	20.90
22J1691	V-11	1	BACK BAY	8 YARMOUTH ST	07/13/89	11.70	6.40	18.10	19.60
22J1763	V-14	1	SOUTH END	ACROSS 132 CHANDLER ST	07/13/89	11.30	0.00	0.00	15.00
22J1996	V-43	1	BACK BAY	13 WARREN ST	07/12/89	13.00	4.20	17.20	15.20
22J2047	IV-5	1	BACK BAY	41 BERKELEY ST	08/02/89	12.80	0.00	0.00	14.70
22K0888	OW-9	4	SOUTH END	HEARLD ST & SHAMMUT AVE	08/07/89	13.00	0.00	0.00	14.70
22K1615	OW11	4	SOUTH END	ON WASHINGTON ST.	08/07/89	19.70	0.00	0.00	11.30
22K1689	OW14	4	SOUTH END	HARRISON & W.M. MULLINS W	08/07/89	7.40	0.00	0.00	17.40
23H2691		3	BACK BAY	86 BAYSTATE RD.	08/07/89	10.80	0.00	0.00	17.10
23I2044	II-W-22	1	BACK BAY	MARLBOROUGH ST	08/04/89	11.00	6.10	17.10	13.10
23I2189	II-W-37	1	BACK BAY	496 COMM AVE	08/04/89	9.80	0.00	0.00	14.90
23I2743	II-W-36	1	BACK BAY	246 COMM AVE	08/04/89	10.00	0.00	0.00	15.80
23I2849	II-W-46	1	BACK BAY	201 NEWBURY ST	08/04/89	11.10	6.80	17.90	23.40
23I2887	II-W-51	1	BACK BAY	220 NEWBURY ST ALLEY 441	08/04/89	6.00	7.70	13.70	14.80
23J0172	II-W-8A	1	BACK BAY	DARTMOUTH ST	07/07/89	8.10	4.80	12.90	13.00
23J0254	II-E-3	1	BACK BAY	CLARENDON ST	07/07/89	8.00	7.00	15.00	14.30
23J1171	II-E-18	1	BACK BAY	50 COMM AVE	07/14/89	10.00	0.00	0.00	16.00
23J1633	II-E-17	1	BACK BAY	COMM AVE & CLARENDON ST	07/14/89	9.30	0.00	0.00	19.00
23J1674	II-E-23	1	BACK BAY	277 DARTMOUTH ST	06/05/89	10.00	6.20	16.20	14.80
23J1771	II-E-24	1	BACK BAY	108 NEWBURY ST	08/04/89	10.40	7.10	17.50	17.00

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S&W NO.	PREVIOUS NO.	(*) DATA SOURCE	NEIGHBORHOOD	LOCATION	TEST DATE	GROUNDWATER DEPTH (FT)	GROUNDWATER ELEVATION (FT)	GROUND SURFACE ELEVATION (FT)	WELL DEPTH (FT)
23J1787	II-E-29	1	BACK BAY	CLARENDON ST	06/05/89	10.00	0.00	0.00	17.00
23J1796		5	BACK BAY	ACROSS 494 BOYLSTON ST.	08/15/89	10.00	0.00	0.00	19.60
23J1819	II-E-A-2	1	BACK BAY	NEWBURY & BERKELEY ST	06/05/89	10.00	7.60	17.60	17.10
23J1838	II-E-A-1	1	BACK BAY	ALLEY 438	06/05/89	7.80	0.00	0.00	19.60
23J1946	III-E-3	1	BACK BAY	NEAR 376 BOYLSTON ST	08/15/89	12.90	5.90	18.80	19.70
23J1947		5	BACK BAY	396 BOYLSTON ST.	08/15/89	12.00	0.00	0.00	19.00
23J1965	III-E-B-6	1	BACK BAY	ARLINGTON ST	07/13/89	9.60	7.50	17.10	19.70
23J1999		5	BACK BAY	ST. JAMES & ARLINGTON ST	08/18/89	12.00	0.00	0.00	19.50
23J2037	III-E-C-14	1	BACK BAY	HADASSAH WAY	07/13/89	9.30	5.00	14.30	15.50
23J2343A	II-E-28	1	BACK BAY	BOYLSTON & DARTMOUTH ST	06/05/89	11.00	0.00	0.00	13.00
23J2343B	II-E-A-3	1	BACK BAY	BOYLSTON & DARTMOUTH ST	06/05/89	11.00	6.10	17.10	18.10
23J2419	III-E-I-1	1	BACK BAY	BOYLSTON ST	07/14/89	10.00	8.08	18.08	13.80
23J2421	II-E-A-4	1	BACK BAY	CLARENDON & BOYLSTON ST	06/05/89	10.00	7.50	17.50	22.50
23J2443	III-E-I-8	1	BACK BAY	ACROSS 545 BOYLSTON ST	07/14/89	10.10	0.00	0.00	17.80
23J2455	III-E-B-5	1	BACK BAY	CLARENDON ST	07/14/89	0.00	17.40	17.40	16.00
23J2471		5	BACK BAY	IN FRONT OF TRINITY CHUR.	08/15/89	10.10	7.37	17.47	16.80
23J2472	III-E-I-4	1	BACK BAY	ST JAMES AVE	07/14/89	11.00	7.14	18.14	18.30
23J2481A	III-E-I-2	1	BACK BAY	ST JAMES AVE	07/14/89	10.00	7.73	17.73	18.90
23J2492	III-E-11	1	BACK BAY	ST JAMES AVE	07/14/89	12.80	0.00	0.00	18.50
23J2529	III-E-B-4	1	BACK BAY	ST JAMES AVE & BERKLEY	07/14/89	14.00	4.60	18.60	19.30
23J2561A	III-E-14	1	BACK BAY	BERKELEY ST	07/14/89	13.70	0.00	0.00	14.30
23J2616		1	BACK BAY	ACROSS 35 ST. JAMES AVE.	08/15/89	12.70	0.00	0.00	19.90
23J2621		1	BACK BAY	31 ST. JAMES AVE	08/15/89	13.10	0.00	0.00	17.90
23J2745		5	BACK BAY	STUART & ARLINGTON ST.	08/15/89	12.10	0.00	0.00	19.90
23K1478		5	CHINATOWN	SUMMER ST & ATLANTIC AVE	11/21/89	13.80	0.00	0.00	18.20
23K2044		3	CHINATOWN	ACROSS 107 SOUTH ST.	07/24/89	7.90	0.00	0.00	20.00
23K2082		3	CHINATOWN	EAST ST & ATLANTIC AVE	08/21/89	8.90	0.00	0.00	0.00
23K2085		5	CHINATOWN	711 ATLANTIC AVE	11/21/89	9.60	0.00	0.00	26.10
23K2721		5	CHINATOWN	729 ATLANTIC AVE	11/30/89	11.50	0.00	0.00	29.90
23K2772		5	CHINATOWN	ON ATLANTIC AVE	11/30/89	9.00	0.00	0.00	30.00
23K2775B		5	CHINATOWN	ON KNEELAND ST.	11/30/89	9.80	0.00	0.00	14.10
24J0516		5	LOWER BEACON HILL	22 EMBANKMENT ROAD	08/15/89	9.70	0.00	0.00	17.30
24J1126	OW-D	15	LOWER BEACON HILL	ALONG CHARLES RIVER					
24J1214	I-B-2	1	LOWER BEACON HILL	PINCKNEY ST	06/02/89	10.50	3.70	14.20	19.00

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24J1237	I-B-1	1	LOWER BEACON HILL	ACROSS 127 PINCKNEY ST	07/24/89	13.40	4.60	18.00	16.30
24J1238		5	LOWER BEACON HILL	PINCKNEY ST	08/15/89	12.90	0.00	0.00	20.00
24J1278		5	LOWER BEACON HILL	30 BRIMMER ST	08/15/89	11.40	0.00	0.00	14.20
24J1279	PIPE 2	14	LOWER BEACON HILL	CHURCH OF THE ADVENT					
24J1284	I-A-3		LOWER BEACON HILL	CHURCH OF THE ADVENT	06/02/89	10.10	9.90	20.00	16.10
24J1287	PIPE 1	14	LOWER BEACON HILL	CHURCH OF THE ADVENT					
24J1813	OW-B	15	LOWER BEACON HILL	ALONG CHARLES RIVER					
24J1825	OW-C	15	LOWER BEACON HILL	ALONG CHARLES RIVER					
24J1838	I-B-3	1	LOWER BEACON HILL	MT VERNON ST	06/02/89	10.50	3.80	14.30	19.00
24J1912	I-A-4	1	LOWER BEACON HILL	MT VERNON & BRIMMER ST	07/11/89	11.10	8.90	20.00	18.50
24J1913	PIPE 3	14	LOWER BEACON HILL	CHURCH OF THE ADVENT	07/02/89	0.00	0.00	0.00	0.00
24J1921	PIPE 4	14	LOWER BEACON HILL	CHURCH OF THE ADVENT	07/02/89	0.00	0.00	0.00	0.00
24J1923	OW-10	15	LOWER BEACON HILL	CHARLES & MT. VERNON ST					
24J1979		5	LOWER BEACON HILL	69 BRIMMER ST	08/15/89	8.60	0.00	0.00	18.00
24J2088	I-1	1	LOWER BEACON HILL	7 CHARLES ST	07/24/89	10.50	6.41	16.91	11.70
24J2513	OW-A	15	LOWER BEACON HILL	ALONG CHARLES RIVER					
24J2529	I-B-4	1	LOWER BEACON HILL	BEAVER PLACE	06/02/89	13.10	2.00	15.10	14.30
24J2651	OW-5	15	LOWER BEACON HILL	BRIMMER & BEACON ST					
24J2721	OW-6	15	LOWER BEACON HILL	4 CHARLES ST					

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TABLE 3
NON FUNCTIONING OBSERVATION WELL SUMMARY

S&W NO.	PREVIOUS NO.	(*) DATA SOURCE	NEIGHBORHOOD	LOCATION	FOUND (YES/NO)	TEST DATE	COMMENTS
19I0688		3	BACK BAY		NO	07/25/89	
19I1343		3	BACK BAY		NO	07/25/89	
19J0291		3	BACK BAY		NO	08/01/89	
20G0583		7	SOUTH END		NO	08/18/89	
20G0591		7	SOUTH END		NO	08/18/89	
20G0596			SOUTH END		NO	08/18/89	
20G0626		7	SOUTH END		NO	08/18/89	
20G1986		7	SOUTH END		NO	12/27/89	
20G2064			SOUTH END	58 FENWOOD ST	YES	11/21/89	WATER SERVICE
20G2068			SOUTH END	56 FENWOOD ST	YES	11/21/89	WATER SERVICE
20G2079		7	SOUTH END		NO	08/18/89	
20G2098			SOUTH END	20 KEMPTON ST	YES	12/26/89	WATER SERVICE
20G2619		7	SOUTH END		NO	12/26/89	
20G2647		7	SOUTH END		NO	08/18/89	
20G2686			SOUTH END	56 WHITNEY ST	YES	12/27/89	CANNOT OPEN
20G2687		7	SOUTH END		NO	08/18/89	
20G2727		7	SOUTH END	9 KEMPTON ST	YES	12/27/89	CANNOT OPEN
20H0527		3	SOUTH END		NO	07/31/89	
20H0565			SOUTH END		NO	07/31/89	
20H0853		7	SOUTH END		NO	08/18/89	
20H0855		7	SOUTH END		NO	08/18/89	
20H0858		7	SOUTH END		NO	08/18/89	
20I0111			SOUTH END		NO	07/25/89	
20I0132		3	SOUTH END		NO	07/25/89	
20I0151		3	SOUTH END	ON FIELD ST.	YES	07/25/89	PLUGGED
20I2058		3	SOUTH END		NO	07/25/89	
20I2133		3	SOUTH END	31 LENOX ST.	YES	07/25/89	PLUGGED APPROXIMATELY 5 F DOWN WELL
20I2336		3	SOUTH END		NO	07/25/89	
20I2732		3	SOUTH END		NO	07/25/89	
20J0154	V-61	1	BACK BAY	563 MASS AVE	YES	08/14/89	PLUGGED
20J0223	V-57	1	BACK BAY	WORCESTER ST	YES	08/14/89	PLUGGED
20J0243	V-56	1	BACK BAY		NO	07/11/89	
20J0328	V-60	1	BACK BAY		NO	07/11/89	
20J0898		3	SOUTH END	1819 WASHINGTON ST.	YES	08/14/89	PLUGGED
20J1692		3	SOUTH END		NO	08/01/89	
20J1755		3	SOUTH END	ON HARRISON AVE.	YES	08/14/89	PLUGGED
20J2355		5	SOUTH END	MASS AVE & HARR.AVE	YES	08/14/89	PLUGGED
20J2433		3	SOUTH END		NO	08/14/89	
21G2683		3	FENWAY		NO	07/31/89	
21G2786		7	FENWAY		NO	08/18/89	
21G2798		7	FENWAY	BROOKLINE AVE.	YES	12/27/89	WATER SERVICE
21H0379		3	FENWAY		NO	07/31/89	
21H0586		3	FENWAY	112 JERSEY ST.	YES	08/10/89	PLUGGED APPROXIMATELY 5 F DOWN
21H0998		3	FENWAY	ON THE FENWAY (RIVERWAY)	YES	07/31/89	CANNOT OPEN
21H1058		3	FENWAY	ON QUEENSBERRY ST.	YES	08/10/89	PLUGGED
21H2213		7	FENWAY		NO	08/18/89	
21H2239		7	FENWAY		NO	08/18/89	

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21H2253		7	FENWAY	PARKING LOT @ BETH ISRAEL	YES	08/18/89	CANNOT OPEN
21H2433		3	FENWAY		NO	08/18/89	
21H2582		3	FENWAY		YES	08/10/89	WATER SERVICE
2110463	III-W-D-1	1	BACK BAY	FALMOUTH ST	YES	08/11/89	WATER SERVICE
2110572	III-W-D-2	1	BACK BAY		NO	07/07/89	
2110589	III-W-31	1	BACK BAY		NO	07/07/89	ALLEY HAS BITUMINOUS CONCRETE OVERLAY
2110644	III-W-32	1	BACK BAY		NO	07/07/89	
2110673A	III-W-B-7	1	BACK BAY		NO	07/07/89	
2110673B	III-W-B-7A	1	BACK BAY		NO	07/07/89	NEW SIDEWALKS IN AREA
2110697	III-W-39	1	BACK BAY		NO	07/07/89	PARK AREA BUILT AT THE END OF THE STREET
2110698	V-A-1	1	BACK BAY		NO	07/07/89	
2110721	III-W-41	1	BACK BAY		NO	07/07/89	
2110727	III-W-B-5	1	BACK BAY		NO	07/07/89	
2110744	III-W-40	1	BACK BAY	30 CUMBERLAND ST	YES	08/11/89	CANNOT OPEN
2110748	V-3	1	BACK BAY		NO	07/07/89	
2110762	V-7	1	BACK BAY	213 WEST NEWTON ST	YES	08/11/89	WATER SERVICE
2110767A	V-A-8	1	BACK BAY		NO	07/07/89	
2110767B	V-A-8A	1	BACK BAY		NO	07/07/89	
2110816		3	SOUTH END		NO	07/25/89	
2111245		3	SOUTH END		NO	07/25/89	
2111256A	III-W-B-8	1	BACK BAY		NO	07/07/89	
2111256B	III-W-B-8A	1	BACK BAY		NO	07/07/89	
2111277		3	SOUTH END	238 ST. BOLOTPH ST.	YES	08/11/89	PLUGGED
2111292	III-W-B-9	1	BACK BAY	363 MASS AVE	YES	08/11/89	WATER SERVICE
2111331	V-A-11	1	BACK BAY		NO	07/07/89	NEW SIDEWALKS IN THE AREA
2111331A	III-W-B-10	1	BACK BAY		NO	07/13/89	
2111331B	III-W-B-10A	1	BACK BAY		NO	07/07/89	
2111332	V-2	1	BACK BAY		NO	07/07/89	NEW SIDEWALKS IN THE AREA
2111355	V-1	1	BACK BAY		NO	08/11/89	
2111438	V-20	1	BACK BAY		NO	07/07/89	
2111442A	V-A-9	1	BACK BAY	16 CLAREMONT PARK	YES	08/11/89	CANNOT OPEN
2111442B	V-A-9A	1	BACK BAY	16 CLAREMONT PARK	YES	08/11/89	PLUGGED
2111454	V-6	1	BACK BAY		NO	07/07/89	
2111477	V-5	1	BACK BAY		NO	07/07/89	
2111497	V-19	1	BACK BAY	NEAR 156 WORCESTER ST	YES	08/11/89	WATER SERVICE
2111538		3	FENWAY	FORSYTH & HEMENWAY ST	YES	08/11/89	CANNOT TEST STAND PIPE TO SMALL
2111547		3	FENWAY		NO	07/25/89	
2111596		3	FENWAY	ON FORSYTH ST	YES	08/11/89	PLUGGED
2111635		3	FENWAY	ST. STEPHEN & SPEAR ST	YES	08/11/89	PLUGGED
2111856		3	FENWAY	288 ST. BOTOLPH ST.	YES	08/11/89	FAILED TEST
2112024A	V-A-10	1	BACK BAY		NO	07/07/89	
2112024B	V-A-10A	1	BACK BAY		NO	07/07/89	
2112064		3	SOUTH END		NO	08/11/89	
2112119	V-18	1	BACK BAY		NO	08/21/89	
2112144	V-17	1	BACK BAY		NO	07/07/89	
2112837	T-2	9	BACK BAY		NO	08/21/89	

* DATA SOURCE: 1 - H&A GROUNDWATER BACK BAY; 2 - CHRISTIAN SCIENCE CENTER; 3 - USGS HYDROLOGIC ATLAS-513; 4 - MASS TURNPIKE AUTHORITY; 5 - IDENTIFIED BY STONE & WEBSTER; 6 - QAZILBASH; 7 - GEO. ENG. INC.; 8 - URBAN ENGINEERING; 9 - BRA; 10 - ZINER & ROSSETTI INC; 11 - MUSEUM OF FINE ARTS; 12 - NORTHEASTERN UNIVERSITY; 13 - R.M. BRADLEY; 14 - GILBERT SMALL & CO.; 15 - BOSTON WATER & SEWER; 16 - BRIGHAM & WOMAN'S HOSPITAL

TABLE 3
NON FUNCTIONING OBSERVATION WELL SUMMARY

S&W NO.	PREVIOUS NO.	(*) DATA SOURCE	NEIGHBORHOOD	LOCATION	FOUND (YES/NO)	TEST DATE	COMMENTS
21I2865	V-28	1	BACK BAY	MASS AVE & TREMONT ST	YES	08/11/89	PLUGGED
21J0158	V-21	1	SOUTH END		NO	07/06/89	NEW SIDEWALKS IN THE AREA
21J0174	V-8	1	SOUTH END		NO	07/06/89	NEW SIDEWALKS IN THE AREA
21J0229	V-23	1	SOUTH END		NO	07/06/89	NEW SIDEWALKS IN THE AREA
21J0243	V-22	1	SOUTH END		NO	07/06/89	
21J0315	V-24	1	SOUTH END		NO	07/06/89	NEW SIDEWALK IN THE AREA
21J0339	V-36	1	SOUTH END		NO	07/06/89	NEW SIDEWALK IN THE AREA
21J0357	V-35	1	SOUTH END	MONTGOMERY ST \$ W.CANTON	YES	08/11/89	PLUGGED
21J0431	V-51	1	SOUTH END		NO	07/06/89	
21J0474	V-50	1	SOUTH END		NO	07/06/89	
21J0699	V-68	1	SOUTH END		NO	07/06/89	
21J0864	V-62	1	SOUTH END		NO	08/21/89	
21J0865	V-31	1	SOUTH END		NO	07/06/89	
21J0929	V-33	1	SOUTH END		NO	07/06/89	
21J0942	V-32	1	SOUTH END	142 WEST NEWTON ST.	YES	08/10/89	PLUGGED
21J1011	V-48	1	SOUTH END		NO	07/06/89	
21J1038	V-49	1	SOUTH END		NO	07/06/89	NEW SIDEWALKS IN THE AREA
21J1055	V-47	1	SOUTH END		NO	07/06/89	
21J1193	V-55	1	SOUTH END		NO	07/06/89	NEW SIDEWALKS IN THE AREA
21J1376	V-67	1	SOUTH END		NO	07/06/89	
21J1522	V-30	1	SOUTH END		NO	07/06/89	
21J1549	V-29	1	SOUTH END		NO	07/06/89	NEW SIDEWALKS IN THE AREA
21J1569	V-45	1	SOUTH END		NO	07/06/89	NEW SIDEWALKS IN THE AREA
21J1631	V-46	1	SOUTH END	TREMONT & W. NEWTON ST.	YES	08/10/89	PLUGGED
21J1733	V-54	1	SOUTH END		NO	07/06/89	NEW SIDEWALKS IN THE AREA
21J2257	V-44	1	SOUTH END		NO	07/06/89	
21J2364	V-53	1	SOUTH END		NO	08/21/89	
21J2435	V-59	1	SOUTH END	435 SHAMMUT AVE.	YES	08/11/89	WATER SERVICE
21J2451	V-58	1	SOUTH END		NO	07/06/89	NEW SIDEWALKS IN THE AREA
21K0196		3	SOUTH END	434 HARRASION AVE	YES	07/31/89	PLUGGED
21K0372		3	SOUTH END		NO	07/31/89	
21K0879		3	SOUTH END	AT L.J. ROTCH PLAYGROUND	YES	10/21/89	PLUGGED
21K1634		3	SOUTH END	ALBANY ST & RANDOLPH ST	YES	10/21/89	FAILED TEST
22H0145		3	BACK BAY	CUMMINGTON & COMM. AVE	YES	08/09/89	PLUGGED
22H0257		3	FENWAY		NO	07/31/89	
22H0353		3	BACK BAY	COMM. AVE & BLANSFORD ST	YES	08/08/89	FAILED TEST
22H0767		3	FENWAY	COMM. AVE & W.CHARLES GATE	YES	08/08/89	WATER SERVICE
22H0812	B-1		BACK BAY		NO	08/09/89	
22H0845		3	BACK BAY		NO	07/31/89	
22H1094	BB-4		FENWAY	RR TRACKS & BROOKLINE AVE	NO	08/10/89	
22H1395		3	FENWAY	IPSWICH & LANSLOWNE ST.	YES	08/10/89	PLUGGED
22H1455		3	FENWAY	120 IPSWICH ST.	YES	08/10/89	PLUGGED
22H1616		3	FENWAY		NO	07/31/89	
22H1827		3	FENWAY	78 BROOKLINE AVE	YES	08/10/89	CANNOT OPEN
22H1847		3	FENWAY		NO	07/31/89	
22H1892		3	FENWAY	ACROSS 27 YAWKEY WAY	YES	08/10/89	PLUGGED
22H2124		3	FENWAY	1191 BOYLSTON ST.	YES	08/10/89	FAILED TEST
22H2212		3	FENWAY		NO	07/31/89	
22H2788		3	FENWAY	ACROSS 1 PETERBOROUGH ST.	YES	08/10/89	PLUGGED APPROXIMATELY 5 FT

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2210216		3	FENWAY	387 COMMONWEALTH AVE.	YES	08/08/89	DOWN PLUGGED
2210312	II-W-30	1	BACK BAY	COMM AVE	YES	08/08/89	PLUGGED
2210346	II-W-34	1	BACK BAY	COMM AVE	YES	08/08/89	CANNOT TEST - STANDPIPE BENT
2210421	II-W-35	1	BACK BAY		NO	07/07/89	
2210436	II-W-39	1	BACK BAY		NO	07/07/89	
2210444	II-W-38	1	BACK BAY		NO	07/07/89	
2210477	II-W-43	1	BACK BAY	338 NEWBURY ST	YES	08/08/89	PLUGGED
2210573	II-W-50	1	BACK BAY	ALLEY 443 927 BOYLSTON ST	YES	08/08/89	CANNOT OPEN
2210592	II-W-53	1	BACK BAY		NO	07/07/89	
2210598	III-W-F-22	1	BACK BAY		NO	08/18/89	
2210612	II-W-45	1	BACK BAY	262 NEWBURY ST	YES	08/08/89	PLUGGED
2210649	II-W-B-1	1	BACK BAY	829 BOYLSTON ST	YES	08/08/89	WATER SERVICE
2210661	II-W-54	1	BACK BAY	FAIRFIELD ST	YES	08/08/89	FAILED TEST
2210667	III-W-2	1	BACK BAY		NO	08/18/89	
2210676	III-W-F-23	1	BACK BAY		NO	08/18/89	
2210691	III-W-F-5	1	BACK BAY		NO	08/18/89	
2210698	III-W-F-24	1	BACK BAY		NO	08/18/89	
2210734	III-W-3	1	BACK BAY		NO	08/18/89	
2210735	III-W-4	1	BACK BAY		NO	08/18/89	
2210736	III-W-H-1	1	BACK BAY		NO	08/18/89	
2210755	III-W-F-27	1	BACK BAY		NO	08/18/89	
2210774	III-W-F-25	1	BACK BAY		NO	08/18/89	
2210859		3	BACK BAY	IPSWICH & BOYLSTON ST	YES	08/08/89	FAILED TEST
2210877		3	BACK BAY		NO	08/18/89	
2211113	II-W-48	1	BACK BAY		NO	07/07/89	
2211139	III-W-F-4	1	BACK BAY		NO	08/18/89	IN PRUDENTIAL AREA
2211184	III-W-9	1	BACK BAY	SCOTIA ST	YES	08/08/89	PLUGGED
2211211	II-W-49	1	BACK BAY	BOYLSTON ST	YES	08/08/89	FAILED TEST
2211216	III-W-1	1	BACK BAY		NO	08/18/89	
2211218	III-W-C-1	1	BACK BAY		NO	08/18/89	
2211288	III-W-F-13	1	BACK BAY		NO	08/18/89	
2211295	III-W-F-6	1	BACK BAY		NO	08/18/89	
2211436	III-W-F-28	1	BACK BAY		NO	08/18/89	
2211479	III-W-F-21	1	BACK BAY		NO	08/18/89	
2211736	III-W-8	1	BACK BAY		NO	07/06/89	
2211913	III-W-F-8	1	BACK BAY		NO	07/25/89	
2211932	III-W-F-15	1	BACK BAY		NO	07/25/89	
2211942	III-W-14	1	BACK BAY	BELVIDERE ST	YES	08/18/89	PLUGGED
2211952	III-W-F-12	1	BACK BAY	BELVIDERE & DALTON ST	YES	08/18/89	CANNOT OPEN
2211965	III-W-F-14	1	BACK BAY		NO	07/06/89	
2211966	III-W-F-10	1	BACK BAY		NO	07/06/89	
2212034	III-W-F-17	1	BACK BAY		NO	07/06/89	
2212057	III-W-18	1	BACK BAY		NO	07/06/89	
2212092	III-W-F-18	1	BACK BAY		NO	07/06/89	
2212127	III-W-F-1	1	BACK BAY	RING RD	YES	07/06/89	PIEZOMETER
2212133	III-W-A-9	1	BACK BAY		NO	07/06/89	CONSTRUCTION IN THE AREA
2212137	III-W-19	1	BACK BAY		NO	07/06/89	CONSTRUCTION IN THE AREA

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S&W NO.	PREVIOUS NO.	(*) DATA SOURCE	NEIGHBORHOOD	LOCATION	FOUND (YES/NO)	TEST DATE	COMMENTS
22J0891	III-W-21	1	BACK BAY		NO	08/18/89	
22J0894	III-W-27	1	BACK BAY		NO	08/18/89	
22J0898	V-B-1	1	BACK BAY		NO	08/18/89	
22J1022	III-E-32	1	BACK BAY		NO	08/18/89	
22J1032	III-E-E-4	1	BACK BAY		NO	08/18/89	
22J1041	III-E-A-3	1	BACK BAY		NO	08/18/89	
22J1059	V-A-4	1	BACK BAY		NO	07/13/89	IN THE VICINITY OF THE ORANGE LINE
22J1117	III-E-E-3	1	BACK BAY		NO	07/13/89	
22J1131	III-E-A-4	1	BACK BAY	223 COLUMBUS AVE	YES	08/18/89	WATER MAIN
22J1144	V-B-2	1	BACK BAY		NO	07/13/89	IN THE VICINITY OF THE ORANGE LINE
22J1164A	V-A-5	1	BACK BAY		NO	07/13/89	IN THE VICINITY OF THE ORANGE LINE
22J1164B	V-B-4	1	BACK BAY		NO	07/13/89	IN THE VICINITY OF THE ORANGE LINE
22J1172A	V-A-6	1	BACK BAY	285 COLUMBUS AVE	YES	07/13/89	PLUGGED
22J1172B	V-A-6A	1	BACK BAY		NO	07/13/89	
22J1174	V-B-3	1	BACK BAY		NO	07/13/89	
22J1265	IV-A-1	1	BACK BAY		NO	08/18/89	
22J1393	IV-6	1	BACK BAY		NO	07/12/89	
22J1447	IV-D-1	1	BACK BAY		NO	07/12/89	
22J1457	IV-7	1	BACK BAY		NO	07/12/89	
22J1515	III-W-20	1	BACK BAY		NO	07/13/89	CONSTRUCTION IN AREA
22J1527A	III-W-B-2	1	BACK BAY	ST BOTOLPH & HARCOURT ST	YES	08/02/89	FAILED TEST
22J1527B	III-W-B-2A	1	BACK BAY		NO	07/13/89	NEW SIDEWALK IN AREA
22J1527C	III-W-I-5	1	BACK BAY		NO	07/13/89	NEW SIDEWALK IN AREA
22J1532	III-W-A-7	1	BACK BAY		NO	08/18/89	
22J1565	III-W-B-14	1	BACK BAY		NO	08/18/89	
22J1567A	III-W-I-7	1	BACK BAY	11 HARCOURT ST.	YES	07/13/89	WATER SERVICE
22J1567B	III-W-A-10	1	BACK BAY	13 HARCOURT ST	YES	07/13/89	WATER SERVICE
22J1567C	III-W-37	1	BACK BAY	15 HARCOURT ST	YES	07/13/89	WATER SERVICE
22J1568	III-W-B-13	1	BACK BAY	17 HARCOURT ST	YES	07/13/89	WATER SERVICE
22J1593	V-4	1	BACK BAY	243 WEST CANTON ST	YES	07/13/89	WATER SERVICE
22J1618	III-W-38	1	BACK BAY		NO	07/13/89	NEW SIDEWALK IN AREA
22J1627A	V-A-3	1	BACK BAY		NO	07/13/89	NEW SIDEWALK IN AREA
22J1627B	V-A-3A	1	BACK BAY		NO	07/13/89	NEW SIDEWALK IN THE AREA
22J1637	V-66	1	BACK BAY		NO	07/13/89	NEW SIDEWALK IN THE AREA
22J1692	V-12	1	BACK BAY		NO	07/13/89	NEW SIDEWALK IN AREA
22J1749	V-13	1	BACK BAY		NO	07/13/89	NEW SIDEWALK IN AREA
22J1825		5	SOUTH END	62 CLARENDON ST.	YES	11/21/89	PLUGGED
22J1832	V-15	1	BACK BAY		NO	07/13/89	
22J1847	V-26	1	BACK BAY		NO	07/13/89	
22J1878	V-39	1	BACK BAY		NO	07/12/89	
22J1892	V-41	1	BACK BAY		NO	07/12/89	
22J1915	V-27		BACK BAY	10 LAWRENCE ST	YES	07/13/89	WATER SERVICE
22J1938	OW-3	4	SOUTH END	BERKLY & APPLETON ST.	YES	08/18/89	CANNOT TEST-STANDPIPE DIAMETER TOO SMALL
22J1992	V-42	1	BACK BAY		NO	07/12/89	

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S&W NO.	PREVIOUS NO.	(*) DATA SOURCE	NEIGHBORHOOD	LOCATION	FOUND (YES/NO)	TEST DATE	COMMENTS
22J2021	IV-4	1	BACK BAY		NO	07/12/89	
22J2048	IV-C-1	1	BACK BAY		NO	07/12/89	
22J2065	IV-10	1	BACK BAY		NO	07/12/89	
22J2088	IV-9	1	BACK BAY		NO	07/12/89	
22J2116	IV-11	1	BACK BAY	PARKING AREA AT PAUL PL	YES	07/12/89	PLUGGED
22J2162	IV-14	1	BACK BAY		NO	07/12/89	
22J2181	IV-13	1	BACK BAY	NEAR EMERALD COURT	YES	07/12/89	PIEZOMETER
22J2216A	III-W-B-3	1	BACK BAY		NO	07/13/89	CONSTRUCTION IN AREA
22J2216B	III-W-B-3A	1	BACK BAY		NO	07/13/89	CONSTRUCTION IN AREA
22J2224	III-W-B-12	1	BACK BAY		NO	07/13/89	CONSTRUCTION IN AREA
22J2245	V-A-2	1	BACK BAY		NO	07/13/89	NEW SIDEWALK IN AREA
22J2246	V-A-13	1	BACK BAY	BRADDOCK PARK	YES	07/13/89	WATER SERVICE
22J2248	V-63	1	BACK BAY		NO	07/13/89	NEW SIDEWALK IN AREA
22J2266	V-9	1	BACK BAY		NO	07/13/89	
22J2271	V-A-12	1	BACK BAY		NO	07/13/89	NEW SIDEWALK IN AREA
22J2288A	V-A-7	1	BACK BAY	BRADDOCK PARK	YES	07/13/89	CANNOT TEST-STANDPIPE TO SMALL
22J2288B	V-A-7A	1	BACK BAY	BRADDOCK PARK	YES	07/13/89	
22J2294	V-64	1	BACK BAY	BRADDOCK PARK	YES	07/13/89	WATER SERVICE
22J2321	V-10	1	BACK BAY		NO	07/13/89	
22J2329	T-7	9	BACK BAY		NO	08/21/89	
22J2373	V-65	1	BACK BAY		NO	07/13/89	NEW SIDEWALK IN AREA
22J2428	V-25	1	BACK BAY	ACROSS 73 DARTMOUTH ST	YES	07/12/89	WATER SERVICE
22J2524	V-38	1	BACK BAY		NO	07/12/89	
22J2538	V-40	1	BACK BAY	59 WARREN AVE	YES	07/12/89	WATER SERVICE
22J2559	V-37	1	BACK BAY		NO	07/12/89	
22J2681	V-52	1	BACK BAY		NO	07/12/89	
22J2832	IV-16		BACK BAY		NO	07/12/89	
22J2841	IV-12		BACK BAY		NO	07/12/89	
22K0151	IV-8	1	BACK BAY	TREMONT ST	YES	07/06/89	WATER SERVICE
22K0284		3	SOUTH END		NO	12/27/89	
22K0875	IV-15	1	BACK BAY		NO	07/12/89	
22K0948	OW12	4	SOUTH END	MARGINAL & WASHINGTON ST	YES	08/07/89	FAILED TEST
22K1524	IV-B-1	1	BACK BAY	SHAWMUT AVE	YES	08/07/89	CANNOT OPEN-BIT CONC OVERLAY COVERING BOLT
22K1552	IV-B-2	1	BACK BAY		NO	07/05/89	
22K1644	116-H	4	SOUTH END	ACROSS 1000 WASHINGTON ST	YES	08/07/89	FAILED TEST
22K1741	109-H	4	SOUTH END	HARRISON AVE & HEARLD ST	YES	08/07/89	FAILED TEST
22K1768	OW15	4	SOUTH END	HEARLD ST & ALBANY ST	YES	08/07/89	FAILED TEST
23H2293		3	BACK BAY	GRANBY & COMM AVE	YES	08/07/89	PLUGGED 12.4' DOWN
23H2347		3	BACK BAY	ON GRANBY ST.	YES	08/07/89	PLUGGED
23H2492		3	BACK BAY	ON SHERBORN ST.	YES	08/07/89	CANNOT OPEN
23H2494		3	BACK BAY		NO	07/31/89	
23H2497		3	BACK BAY		NO	08/18/89	
23H2644		3	BACK BAY		NO	08/18/89	
23H2758		3	BACK BAY	RALEIGH & BAY ST	YES	08/07/89	PLUGGED
23H2867		3	BACK BAY	CHARLES GATE & BAY ST	YES	08/07/89	PLUGGED
23I0788	II-W-7	1	BACK BAY	BACK ST PARKING AREA	YES	08/04/89	CANNOT OPEN
23I1189	II-W-2	1	BACK BAY		NO	06/05/89	

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2311194	II-W-3	1	BACK BAY		NO	06/05/89	
2311267	II-W-4	1	BACK BAY		NO	06/05/89	
2311295	II-W-11	1	BACK BAY	334 BEACON ST	YES	08/04/89	PLUGGED
2311333	II-W-6	1	BACK BAY		NO	06/05/89	
2311334	II-W-5	1	BACK BAY		NO	06/05/89	
2311397	II-W-17	1	BACK BAY		NO	06/05/89	
2311441	II-W-12	1	BACK BAY	782 EXETER ST	YES	08/04/89	PLUGGED
2311465	II-W-18	1	BACK BAY		NO	06/05/89	
2311697	II-W-9	1	BACK BAY		NO	06/05/89	
2311729	II-W-1	1	BACK BAY		NO	06/05/89	
2311766	II-W-10	1	BACK BAY	448 HEREFORD ST	YES	06/05/89	FAILED TEST
2311859	II-W-14	1	BACK BAY	415 BEACONST ALLEY 415	YES	08/04/89	PLUGGED
2311862	II-W-15	1	BACK BAY	401 BEACON ST	YES	08/04/89	PLUGGED
2311899	II-W-21	1	BACK BAY		NO	06/05/89	
2311929	II-W-16	1	BACK BAY		NO	06/05/89	
2311994	II-W-27	1	BACK BAY	261 COMM AVE ALLEY 425	YES	08/04/89	PLUGGED
2312066	II-W-28	1	BACK BAY	242 MARLBOROUGH ALLEY 426	YES	08/04/89	PLUGGED
2312113	II-W-23	1	BACK BAY	220 MARLBOROUGH ST	YES	08/04/89	PLUGGED
2312318		3	BACK BAY	515 BEACON ST.	YES	08/07/89	PLUGGED
2312422	II-W-13	1	BACK BAY	465 BEACON ST ALLEY 414	YES	08/04/89	CANNOT OPEN-COVER PARTIALLY COVERED WITH BIT CONC PAVEMENT
2312447	II-W-19	1	BACK BAY		NO	06/05/89	NEW SIDEWALK IN AREA
2312467	II-W-25	1	BACK BAY	323 COMM AVE ALLEY 429	YES	08/04/89	PLUGGED
2312474		3	BACK BAY	OFF MARLBOROUGH ALLEY 908	YES	08/07/89	PLUGGED
2312518	II-W-20	1	BACK BAY	MARLBOROUGH & HEREFORD ST	YES	08/04/89	PLUGGED
2312529	II-W-26	1	BACK BAY		NO	06/05/89	
2312648	II-W-31	1	BACK BAY	284 COMM AVE	YES	08/04/89	WATER SERVICE
2312771	II-W-40	1	BACK BAY		NO	07/11/89	
2312843	II-W-41	1	BACK BAY	209 NEWBURY ST ALLEY 433	YES	08/04/89	PLUGGED
2312893	II-W-A-5	1	BACK BAY		NO	07/11/89	
2312899	II-W-55	1	BACK BAY		NO	07/11/89	
23J0162	II-E-2	1	BACK BAY	200 BEACON ST	YES	07/07/89	PLUGGED
23J0171	II-W-8	1	BACK BAY		NO	07/07/89	
23J0329	II-E-7	1	BACK BAY		NO	07/07/89	
23J0348	II-E-6	1	BACK BAY		NO	07/07/89	
23J0394	II-E-11	1	BACK BAY		NO	07/07/89	
23J0397	II-E-C-1	1	BACK BAY		NO	07/07/89	
23J0416	II-E-8	1	BACK BAY		NO	07/07/89	
23J0463	II-E-12	1	BACK BAY	MARLBOROUGH ST	YES	07/07/89	PLUGGED NEEDS NEW COVER
23J0482	II-E-15	1	BACK BAY	16 MARLBOROUGH ALLEY 422	YES	07/07/89	PLUGGED
23J0575	II-E-1	1	BACK BAY		NO	07/07/89	
23J0828	II-E-10	1	BACK BAY	108 MARLBOROUGH ST	YES	07/07/89	PLUGGED
23J0833	II-E-5	1	BACK BAY	127 MARLBOROUGH ALLEY 419	YES	07/07/89	PLUGGED NEEDS NEW COVER
23J0848	II-E-13	1	BACK BAY	134 MARLBOROUGH ALLEY 424	YES	07/07/89	PLUGGED NEEDS NEW COVER
23J0881	II-W-24	1	BACK BAY	172 MARLBOROUGH ST	YES	07/07/89	CANNOT OPEN
23J1022	II-E-C-2	1	BACK BAY		NO	07/07/89	
23J1024	II-E-14	1	BACK BAY		NO	07/07/89	
23J1129	II-E-B-4	1	BACK BAY		NO	08/21/89	

* DATA SOURCE: 1 - H&A GROUNDWATER BACK BAY; 2 - CHRISTIAN SCIENCE CENTER; 3 - USGS HYDROLOGIC ATLAS-513;
4 - MASS TURNPIKE AUTHORITY; 5 - IDENTIFIED BY STONE & WEBSTER; 6 - QAZILBASH; 7 - GEO. ENG. INC.; 8 - URBAN ENGINEERING;
9 - BRA; 10 - ZINER & ROSSETTI INC; 11 - MUSEUM OF FINE ARTS; 12 - NORTHEASTERN UNIVERSITY; 13 - R.M. BRADLEY;
14 - GILBERT SMALL & CO.; 15 - BOSTON WATER & SEWER; 16 - BRIGHAM & WOMAN'S HOSPITAL

TABLE 3
NON FUNCTIONING OBSERVATION WELL SUMMARY

S&W NO.	PREVIOUS NO.	(*) DATA SOURCE	NEIGHBORHOOD	LOCATION	FOUND (YES/NO)	TEST DATE	COMMENTS
23J1189	II-E-B-3	1	BACK BAY	29 NEWBURY ST.	YES	06/05/89	CANNOT OPEN
23J1216A	II-E-19	1	BACK BAY		NO	07/14/89	
23J1216B	II-E-B-1	1	BACK BAY		NO	07/14/89	
23J1245A	II-E-22	1	BACK BAY	ALLEY 437	YES	06/05/89	PLUGGED NEEDS COVER
23J1245B	II-E-B-2	1	BACK BAY		NO	06/05/89	
23J1285	II-E-25	1	BACK BAY	NEWBURY ST	YES	06/05/89	CANNOT TEST DAMAGED
23J1386	III-E-C-18	1	BACK BAY		NO	07/13/89	
23J1471	III-E-C-9	1	BACK BAY		NO	07/13/89	
23J1476	III-E-C-10	1	BACK BAY		NO	07/13/89	
23J1477	III-E-C-1	1	BACK BAY		NO	07/13/89	
23J1478A	III-E-C-19	1	BACK BAY		NO	07/13/89	
23J1478B	III-E-C-21	1	BACK BAY		NO	07/13/89	
23J1488	III-E-G-4	1	BACK BAY	CHARLES ST. SOUTH	YES	07/13/89	WATER SERVICE
23J1511	II-W-29	1	BACK BAY	173 COMM AVE ALLEY 425	YES	07/07/89	PLUGGED NEEDS COVER
23J1545	II-W-32	1	BACK BAY		NO	08/21/89	
23J1553	II-W-33	1	BACK BAY		NO	07/14/89	
23J1587	II-W-42	1	BACK BAY		NO	07/14/89	
23J1628	II-E-16	1	BACK BAY	120 COMM AVE	YES	07/14/89	CANNOT OPEN - CONCRETE OVERLAY
23J1656	II-E-20	1	BACK BAY	125 NEWBURY ST ALLEY 435	YES	06/05/89	PLUGGED NEEDS COVER
23J1698	II-E-26	1	BACK BAY	ALLEY 439	YES	08/04/89	PLUGGED
23J1723	II-E-21	1	BACK BAY	83 NEWBURY ST ALLEY 436	YES	06/05/89	CANNOT OPEN, BIT CONC OVERLAY
23J1855	II-E-27	1	BACK BAY	BERKLEY ST	YES	06/05/89	PLUGGED
23J1857	II-E-30	1	BACK BAY		NO	06/05/89	
23J1881	II-E-A-5	1	BACK BAY		NO	07/14/89	
23J1884	III-E-B-2	1	BACK BAY		NO	07/14/89	CONSTRUCTION IN AREA
23J1921	II-E-D-1	1	BACK BAY	ALLEY 438	YES	06/05/89	CANNOT OPEN
23J1939	III-E-J-3	1	BACK BAY	302 BOYLSTON ST	YES	08/03/89	PLUGGED
23J1966	III-E-J-4	1	BACK BAY	ARLINGTON ST	YES	07/13/89	CANNOT TEST - PIPE TOO SMALL
23J2016	III-E-J-2	1	BACK BAY		NO	07/13/89	
23J2022	III-E-C-17	1	BACK BAY		NO	07/13/89	
23J2023	III-E-J-1	1	BACK BAY		NO	07/13/89	
23J2026	III-E-C-16	1	BACK BAY	HADASSAH WAY	YES	08/01/89	PLUGGED
23J2028	III-E-J-7	1	BACK BAY		NO	07/13/89	
23J2031	III-E-C-7	1	BACK BAY		NO	07/13/89	
23J2032	III-E-C-8	1	BACK BAY		NO	07/13/89	
23J2046	III-E-J-5	1	BACK BAY		NO	07/13/89	
23J2047	III-E-5	1	BACK BAY		NO	07/13/89	
23J2052	III-E-J-6	1	BACK BAY		NO	07/13/89	
23J2053	III-E-C-15	1	BACK BAY	HADASSAH WAY & PARK PLACE	YES	08/01/89	WATER SERVICE
23J2062	III-E-C-6	1	BACK BAY		NO	08/21/89	
23J2066	III-E-C-13	1	BACK BAY		NO	08/21/89	
23J2113	III-E-C-3	1	BACK BAY		NO	08/21/89	
23J2117	III-E-C-4	1	BACK BAY		NO	08/21/89	
23J2119	III-E-C-12	1	BACK BAY		NO	08/21/89	
23J2121	III-E-C-2	1	BACK BAY		NO	08/21/89	
23J2124	III-E-C-20	1	BACK BAY		NO	08/21/89	

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TABLE 3
NON FUNCTIONING OBSERVATION WELL SUMMARY

S&W NO.	PREVIOUS NO.	(*) DATA SOURCE	NEIGHBORHOOD	LOCATION	FOUND (YES/NO)	TEST DATE	COMMENTS
23J2126	III-E-G-1	1	BACK BAY		NO	08/21/89	
23J2128A	III-E-G-5	1	BACK BAY		NO	07/13/89	
23J2128B	III-E-C-11	1	BACK BAY	CHARLES ST SO & PARK PL	YES	07/13/89	WATER SERVICE
23J2141	III-E-C-5	1	BACK BAY		NO	08/21/89	
23J2151A	III-E-6	1	BACK BAY	PARK PLAZA	YES	07/13/89	WATER SERVICE
23J2151B	III-E-G-6	1	BACK BAY		NO	07/13/89	NEW SIDEWALK IN AREA
23J2159	III-E-G-7	1	BACK BAY	CHARLES ST SOUTH	YES	07/13/89	WATER SERVICE
23J2161	III-E-G-3	1	BACK BAY		NO	07/13/89	NEW SIDEWALK IN AREA
23J2193	III-E-16	1	BACK BAY		NO	07/13/89	NEW SIDEWALK IN AREA
23J2227	II-W-47	1	BACK BAY		NO	07/14/89	
23J2241	II-W-A-3	1	BACK BAY	186 NEWBURY ST	YES	07/14/89	CANNOT OPEN
23J2249	II-W-A-2	1	BACK BAY		NO	07/14/89	
23J2255	II-W-52	1	BACK BAY	166 NEWBURY ST ALLEY 440	YES	07/14/89	CANNOT TEST - STANDPIPE BENT
23J2278	II-W-A-1	1	BACK BAY	BOYLSTON ST	YES	07/14/89	CANNOT OPEN
23J2288	III-W-6	1	BACK BAY	ACROSS 655 BOYLSTON ST	YES	07/14/89	PLUGGED
23J2291	II-W-A-4	1	BACK BAY	655 BOYLSTON ST	YES	07/14/89	PLUGGED NEEDS COVER
23J2357	III-E-1	1	BACK BAY		NO	07/14/89	NEW SIDEWALK IN THE AREA
23J2363	III-E-2	1	BACK BAY		NO	07/14/89	NEW SIDEWALK IN AREA
23J2367	III-E-4	1	BACK BAY	ACROSS 583 BOYLSTON ST	YES	07/14/89	WATER SERVICE
23J2371	III-W-7	1	BACK BAY	BOYLSTON & DARTMOUTH ST	YES	07/14/89	PLUGGED
23J2381	III-E-B-7	1	BACK BAY	DARTMOUTH ST	YES	07/14/89	WATER SERVICE
23J2388	III-E-7	1	BACK BAY		NO	07/14/89	NEW SIDEWALK IN THE AREA
23J2395	III-E-9	1	BACK BAY		NO	07/14/89	NEW SIDEWALK IN AREA
23J2397	III-E-8	1	BACK BAY		NO	07/14/89	NEW SIDEWALK IN AREA
23J2412	II-E-31	1	BACK BAY	541 BOYLSTON ST	YES	06/05/89	WATER SERVICE
23J2425	III-E-B-1	1	BACK BAY		NO	07/14/89	NEW SIDEWALK IN AREA
23J2427	III-E-I-9	1	BACK BAY	CLARENDON & BOYLSTON ST	YES	07/14/89	CANNOT TEST - PIPE TOO SMALL
23J2444	III-E-I-7	1	BACK BAY	BOYLSTON ST	YES	07/14/89	WATER SERVICE
23J2447	III-E-I-5	1	BACK BAY		NO	07/14/89	
23J2448	III-E-I-6	1	BACK BAY		NO	07/14/89	
23J2454	III-E-I-10	1	BACK BAY	CLARENDON ST	YES	07/14/89	PIEZOMETER
23J2458	III-E-I-11	1	BACK BAY		NO	07/14/89	
23J2459	III-E-B-9	1	BACK BAY		NO	07/14/89	NEW SIDEWALK IN AREA
23J2473	III-E-I-12	1	BACK BAY	ST JAMES AVE	YES	07/14/89	PIEZOMETER
23J2481B	III-E-I-13	1	BACK BAY		NO	07/14/89	
23J2481C	III-E-I-14	1	BACK BAY		NO	07/14/89	
23J2482	III-E-I-15	1	BACK BAY	CLARENDON ST	YES	07/14/89	CANNOT TEST - BAILER TO LARGE FOR STANDPIPE
23J2485	III-E-B-8	1	BACK BAY		NO	08/21/89	
23J2494	III-E-F-10	1	BACK BAY		NO	08/18/89	
23J2496	III-E-F-8	1	BACK BAY		NO	08/18/89	
23J2517	III-E-B-3	1	BACK BAY		NO	07/14/89	
23J2548	III-E-12	1	BACK BAY	ST JAMES AVE	YES	07/14/89	WATER SERVICE
23J2554	III-E-13	1	BACK BAY	ST JAMES AVE	YES	07/14/89	WATER SERVICE
23J2561B	III-E-B-10	1	BACK BAY	ST JAMES AVE	YES	07/14/89	FAILED TEST NEEDS COVER
23J2571	III-E-F-11	1	BACK BAY	ST JAMES AVE	YES	07/14/89	WATER SERVICE
23J2572	III-E-F-9	1	BACK BAY		NO	08/18/89	

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NON FUNCTIONING OBSERVATION WELL SUMMARY

S&W NO.	PREVIOUS NO.	(*) DATA SOURCE	NEIGHBORHOOD	LOCATION	FOUND (YES/NO)	TEST DATE	COMMENTS
23J2573A	III-E-39	1	BACK BAY		NO	08/18/89	
23J2573B	III-E-F-7	1	BACK BAY		NO	08/18/89	
23J2584	III-E-F-4	1	BACK BAY		NO	08/18/89	
23J2592	III-E-B-11	1	BACK BAY		NO	08/21/89	
23J2595	III-E-20	1	BACK BAY		NO	08/21/89	
23J2631	III-E-15	1	BACK BAY		NO	07/14/89	
23J2748	III-E-21	1	BACK BAY	ARLINGTON ST	YES	07/14/89	PLUGGED
23J2753	III-E-D-1	1	BACK BAY	250 STUART ST	YES	07/14/89	CANNOT OPEN
23J2766	III-E-D-2	1	BACK BAY		NO	07/14/89	NEW SIDEWALK IN AREA
23J2831	III-E-G-9	1	BACK BAY	STUART ST	YES	07/13/89	WATER SERVICE
23J2897	III-E-27	1	BACK BAY	2 MELROSE	YES	07/14/89	FAILED TEST NEEDS COVER
23K0385		5	CHINATOWN	ON AVENUE DE LAFAYETTE	YES	12/26/89	PIEZOMETER
23K0443		5	CHINATOWN	34 CHAUNCY STREET	YES	12/27/89	WATER MAIN
23K0712A		5	DOWNTOWN BOSTON	ACROSS FROM 99 HIGH ST.	YES	12/26/89	PLUGGED. BOTTOM OF WELL IS 20 FEET DOWN THE WELL
23K0712B		5	DOWNTOWN BOSTON	ACROSS FROM 99 HIGH ST.	YES	12/26/89	DEEP WELL
23K0722		5	DOWNTOWN BOSTON	126 HIGH STREET	YES	12/26/89	CANNOT TEST - PIPE TOO SMALL
23K0733		5	DOWNTOWN BOSTON	125 PEARL STREET	YES	12/26/89	TWO SMALL WELLS LOCATED IN THIS WELL SPOT. DIAMETER OF WELLS
23K0776		5	DOWNTOWN BOSTON	ON PURCHASE STREET	YES	12/26/89	PLUGGED 10' DOWN WELL. NO GWT
23K0777		5	DOWNTOWN BOSTON	ON PURCHASE STREET	YES	12/26/89	CAN NOT OPEN, NEW BRICK SIDEWALK
23K0995		5	CHINATOWN	ON ESSEX STREET	YES	12/26/89	NEAR ESSEX STATION - DEEP WELL
23K1012		5	CHINATOWN	569 WASHINGTON STREET	YES	12/26/89	DEEP WELL. PVC TUBE IN WELL
23K1036		5	CHINATOWN	ON AVENUE DE LAFAYETTE	YES	12/26/89	PIEZOMETER
23K1792		5	CHINATOWN	75 HARRISON AVE.	YES	11/30/89	CANNOT OPEN
23K1845		3	CHINATOWN	52 BEACH ST	YES	08/18/89	CANNOT OPEN
23K1886		5	CHINATOWN	3 HUDSON ST.	YES	11/22/89	PLUGGED 3.8 FEET DOWN
23K1889		5	CHINATOWN	13 HUDSON ST.	YES	11/22/89	PLUGGED
23K1929		3	CHINATOWN	88 LINCOLN ST	YES	09/18/89	FAILED TEST
23K1982		5	CHINATOWN	144 LINCOLN ST.	YES	11/22/89	WATER SERVICE
23K2047		5	CHINATOWN	123 SOUTH ST.	YES	11/22/89	PLUGGED
23K2048		5	CHINATOWN	90 SOUTH ST.	YES	11/22/89	FAILED TEST
23K2217	III-E-G-10	1	BACK BAY	CHARLES ST	YES	11/30/89	PLUGGED
23K2526		5	CHINATOWN	18 HUDSON ST.	YES	11/30/89	WATER SERVICE
23K2566		5	CHINATOWN	ON KNEELAND ST.	YES	11/22/89	CANNOT OPEN
23K2624		3	CHINATOWN	182 LINCOLN ST	YES	07/25/89	FAILED TEST
23K2647		5	CHINATOWN	ON KNEELAND ST.	YES	11/22/89	COULD NOT OPEN
23K2668		3	CHINATOWN	SOUTH ST	YES	11/30/89	PLUGGED
23K2741A		5	CHINATOWN	ACROSS FROM 179 SOUTH ST.	YES	11/30/89	WATER SERVICE
23K2741B		5	CHINATOWN	ACROSS FROM 179 SOUTH ST.	YES	11/30/89	WATER SERVICE
23K2775A		5	CHINATOWN	ON KNEELAND ST.	YES	11/30/89	FAILED TEST
24J0537	I-3	1	LOWER BEACON HILL	137 CHARLES ST	YES	07/24/89	CANNOT OPEN
24J0542	I-2	1	LOWER BEACON HILL	32 EMBANKMENT ROAD	YES	07/24/89	DAMAGED

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TABLE 3
NON FUNCTIONING OBSERVATION WELL SUMMARY

S&W NO.	PREVIOUS NO.	(*) DATA SOURCE	NEIGHBORHOOD	LOCATION	FOUND (YES/NO)	TEST DATE	COMMENTS
24J0577	I-5	1	LOWER BEACON HILL		NO	06/02/89	
24J0583	I-4	1	LOWER BEACON HILL	ACROSS 112 REVERE ST	YES	07/24/89	PLUGGED
24J1196	I-8	1	LOWER BEACON HILL		NO	06/02/89	
24J1217	I-6	1	LOWER BEACON HILL		NO	06/02/89	
24J1234	I-7	1	LOWER BEACON HILL	127 CHARLES ST	YES	07/24/89	PLUGGED
24J1285	I-A-2	1	LOWER BEACON HILL		NO	06/02/89	
24J1894	I-10	1	LOWER BEACON HILL		NO	06/02/89	
24J1933	I-9	1	LOWER BEACON HILL		NO	06/02/89	ROAD RECENTLY PAVED - MAY HAVE BEEN BURIED
24J1973	I-11	1	LOWER BEACON HILL	BRIMMER ST	YES	07/26/89	PLUGGED
24J1976			LOWER BEACON HILL	CHESTNUT STREET	YES	08/15/89	NEEDS KEY TO OPEN
24J2045	OW-7	1	LOWER BEACON HILL	CHARLES & CHESTNUT ST	YES	06/02/89	PLUGGED
24J2482	II-E-4	1	BACK BAY	BERKELEY ST	YES	07/11/89	FAILED TEST
24J2595	II-E-9	1	BACK BAY	ARLINGTON ST	YES	06/02/89	PLUGGED
24J2624	I-13	1	LOWER BEACON HILL	71 BRIMMER ST.	YES	12/27/89	CANNOT OPEN
24J2626	I-14	1	LOWER BEACON HILL		NO	06/02/89	
24J2627		5	LOWER BEACON HILL	BRIMMER ST	YES	08/15/89	FAILED TEST

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APPENDIX A

THE GROUNDWATER TRUST

Members

Chairman William Rizzo, Beacon Hill Civic Association

Trustee Alden Gifford, Greater Boston Real Estate Board

Trustee James Knox, Neighborhood Association of the Back Bay

Trustee Galen Gilbet, Fenway Community Development Corporation

Trustee Todd Saunders, Vault Coordinating Committee

Vacant - Representative of the Back Bay Association

EX officio

Thomas Mc Nicholas, Commissioner of the Inspectional Services Department,

Councillor David Scondras, designee of the president of the Boston City Council,

William Corcoran, representative of the Collector-Treasurer of the City of Boston,

Peter Scarpignato, representative of the City of Boston Department of Public Works

1.0 SCOPE

This scope of work details the technical and quality assurance requirements for the installation of shallow observation wells throughout the City of Boston

The work consists of drilling borings to an estimated depth of 20 ft., installing observation wells and performing slug tests.

The observation wells will be installed at street intersections at the most convenient sidewalk location. Certain areas of the City may require observation wells at locations other than at intersections, such as the back alleys of Chinatown and the Back Bay.

2.0 APPLICABLE DOCUMENTS

The following documents are a part of this specification to the extent specified. Unless otherwise stated, the issue in effect on the date of the order shall apply. In the event of conflict between the referenced document and this specifications, the conflict shall be referred to the Engineers for resolution.

American Society of Testing and Materials

ASTM D 1586 1967 Penetration Test and Split-Barrel Sampling of Soils

2.1 Definitions

The following definition shall apply to this specification:

Engineers - The authorized engineering representative of the City

The City - The Inspectional Services Department of the City of Boston

3.0 REQUIREMENTS

3.1 Safety

(To be provided by the City)

3.2 Underground Utilities

Before drilling is performed, the Contractor shall locate all existing underground utilities adjacent to the location of the observation wells. The Contractor shall consult with the Dig Safe Center before proceeding with any drilling activities.

3.3 Restoration of Surfaces, Underground Utilities and Property

The Contractor shall take reasonable precaution against damaging adjacent or adjoining surfaces, paving, utilities or property. The Contractor shall promptly repair at his own expense all such damage to the satisfaction of the City and the property owner. All excess soil and debris from the borings shall be properly disposed of and all surfaces shall be restored to their original condition by the Contractor at no additional expense to the City.

3.4 Test Borings

3.4.1 General

Equipment may consist of power-driven rigs of the type or types approved by the Engineers and capable of driving casing or augering and of taking split-barrel samples.

The use of drilling fluids other than water may be permitted with the approval of the Engineer. The drilling fluid shall be either water or a self destructing drilling fluid such as "Revert," or equal as approved by the Engineer.

The necessary equipment and supplies shall be provided to recirculate or clarify return water. Pump supply lines shall be equipped with a bypass valve so that when pumped water is not being used for drilling, it may be discharged at a suitable location.

The Contractor shall measure the depth that the groundwater table is first encountered in each boring.

The Engineer will maintain a log as a part of Attachment 1 for each subsurface exploration. The Contractor shall assist the Engineer in obtaining the information required to complete this log.

3.4.2 Access and Setup for Borings

The Contractor shall be responsible for setting up all drilling, pumping, and associated equipment at each borehole location. The Contractor shall obtain approval from the Engineer before attempting to gain access to any location.

3.4.3 Split-Barrel Sampling

3.4.3.1. General

The purpose of these samples is to determine the soil classification of the various soil strata as they exist in the ground. It is necessary to locate and record the depth at which any change in stratification occurs and to obtain and classify samples representative of the material comprising each stratum as it exists in the ground.

3.4.3.2 Boring Procedure

Each boring shall be advanced by using either a cutting or chopping bit or a hollow stem auger with a minimum inner diameter of 4 inches. The borehole shall have a minimum diameter of 4 in nominal.

A casing shall be advanced closely following the bit to exclude overlying soils from the boring. Casing may be omitted if drilling mud is used or where a hollow stem auger is used.

3.4.3.3 Sampling Procedure

Equipment for obtaining split-barrel samples shall conform to the requirements of ASTM D 1586.

Samples shall be taken at depths designated by the engineers. The sample interval shall not exceed depths of 5 ft.

Before taking a sample, the boring shall be cleaned using equipment that will not disturb the material to be sampled. The drill bit shall be withdrawn slowly to prevent loosening of the soil around the borehole. The level of drilling fluid in the boring shall be kept at, or slightly above, the natural groundwater level during sampling operations. When casing is used, it shall not be advanced below the top elevation of the next sample.

With the sampler resting on the bottom of the borehole, the sampler shall be driven with blows from the drive hammer falling 30 inches. The drive hammer shall be lifted by a rope wrapped around a rotating drum or "cathead." The sampler shall be driven 18 inches or until 75 blows have been applied for a penetration of 12 inches or less.

If sample recovery is unsatisfactory, a second attempt shall be made before advancing the borehole.

The Engineers may request deviations from the above procedures. In very hard soils, a drive hammer of nominal 300 lb weight may be employed to increase sample recovery.

3.4.3.4 Sample Deposition

When the sampler is brought to the ground surface, the sample shall be carefully removed. The top of the sample will generally be disturbed due to the cleaning out of the borehole and shall be discarded. The remaining sample shall then be classified according to the Uniform Soil Classification System, by an individual experienced in soil classification. The samples may then be discarded.

3.5 Installing Observation Wells

3.5.1 General

Observation wells shall be installed in specific locations designated by the

Engineers. The Contractor shall supply all materials required for the observation wells. Installation and testing records will be kept by the Engineer, (Attachment 1), and the Contractor shall assist the Engineer in obtaining the data required.

3.5.2 Materials

The observation well shall consist of a commercially available slotted PVC plastic pipe, schedule 40, with a nominal 2 in OD. The length of the screened area shall be determined by the Engineer. The slotted screen shall have factory cut slots between 0.01 and 0.02 inches in width. Unslotted 2 in OD PVC plastic pipe, schedule 40, shall be used to complete the piezometer to ground surface.

The pipe shall be protected by a cast iron road box, with a minimum 5.25" ID, 25" long, furnished with a lid fastened by a five-sided bolt.

Filter sand shall be a clean, well graded coarse to fine sand with 3 % passing the number 200 mesh sieve.

3.5.3 Installation Procedure

The depth at which the observation well tip is to be set will be determined by the engineer, but typically will be between 20 and 25 ft. The following paragraphs outline a recommended installation method. Modification of these procedures may be permitted or required for certain soil conditions. The Engineers will give detailed instructions at the time of installation should any such changes be required.

- a. The borehole shall be flushed with a side discharge bit to develop a clean and uniform hole. Flushing shall be continued until the return water is clear. The drilling fluid shall be water or a self-destructing drilling mud ("Revert' or equal as approved by the Engineers). No casing shall be left in the borehole unless specifically requested by the Engineers.
- b. The borehole may be grouted or backfilled with sand filter to the piezometer tip elevation as directed by the Engineers.
- c. The depth to the piezometer tip shall be controlled by measuring the standpipe as it is inserted.
- d. The borehole shall be backfilled with clean, dry, medium to coarse sand to a depth specified by the Engineers.

The depth to the top of the sand backfill shall be measured using a weighted measuring tape. The Engineers may require that the sand backfill be placed in increments and tamped with a tamping hammer.

- e. After the sand filter has been placed, the piezometer standpipe shall be filled with clean water and the drop in water level shall be observed to ensure that the piezometer is functioning. If the water level does not drop at a rate consistent with the soil type at the tip, the piezometer shall be removed and the borehole washed before the piezometer is

reinstalled.

- f. A seal consisting of bentonite pellets may be required on top of the sand. The Engineers will give detailed instructions at the time if sealing off of the tip is required.
- g. The remaining length of borehole shall be backfilled with sand to within approximately 2 ft. of the ground surface. Alternatively, the borehole may be tremie grouted to the surface.
- h. A roadbox of the type shown in Attachment 1 shall be placed flush with the road/sidewalk grade, to protect the observation well and allow easy access for groundwater measurements. At the completion of the installation, a detailed sketch shall be made of the observation well location.

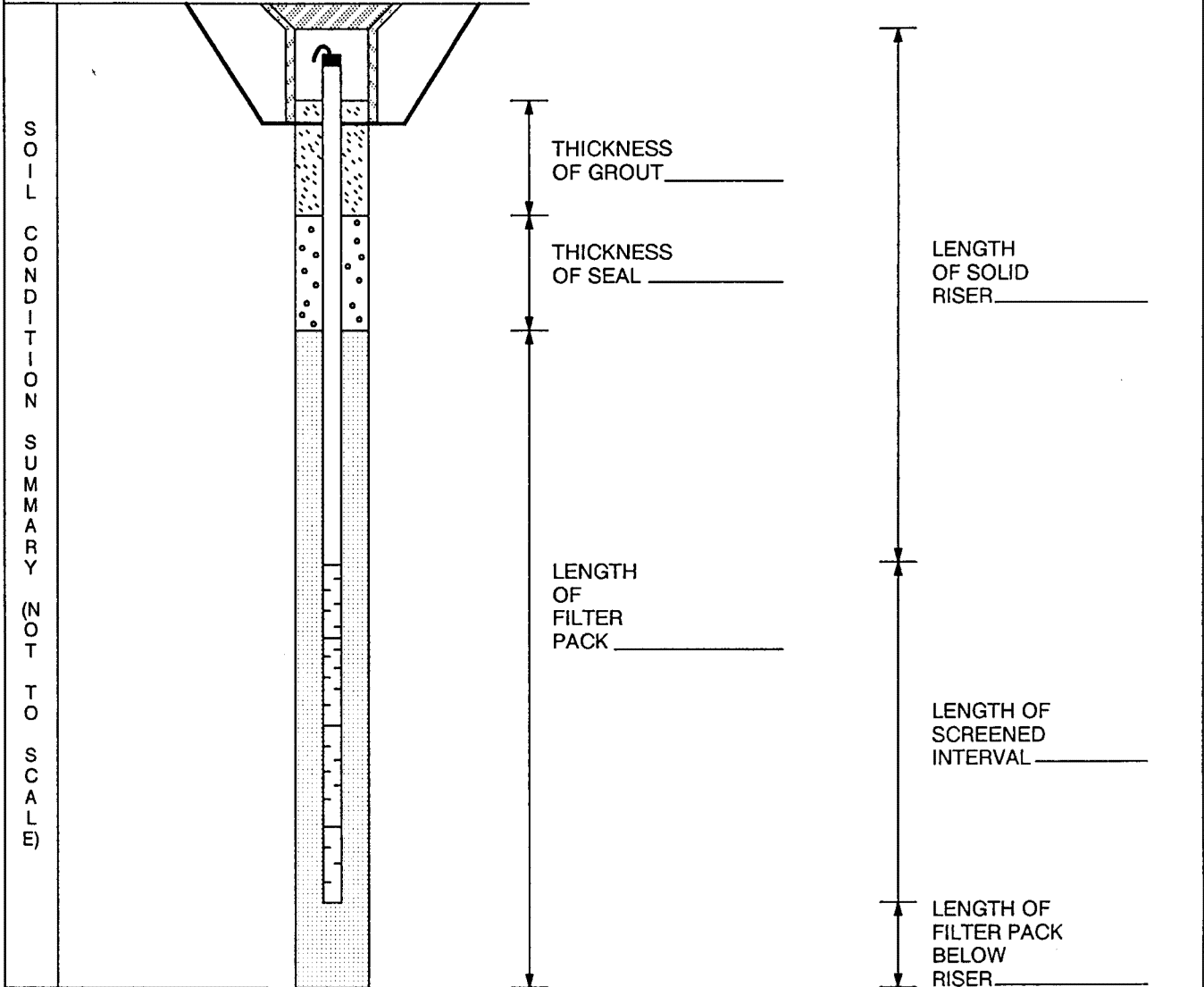
OBSERVATION WELL INSTALLATION REPORT
STONE & WEBSTER CIVIL AND TRANSPORTATION SERVICES, INC.

MAP NO.
WELL NO.
J.O. NO.

LOCATION _____

SURVEY DATUM _____

SURFACE ELEVATION = _____



WELL DATA

Method of Drilling
Diameter of Borehole
Depth of Borehole
Riser Material
Riser Diameter
Screen Gauge
Type of Filter Sand
Elev./Depth to Well Point
Elev./Depth to Groundwater

ROADBOX DATA

Roadbox Designation
Roadbox Diameter
Roadbox Length

SLUG TEST DATA

Elapsed Time	Groundwater Level