

N00639.AR.001863
NSA MID SOUTH
5090.3a

FINAL GROUNDWATER MONITORING WELL MANAGEMENT PLAN PHASE 1 MILLINGTON
SUPPACT TN
10/26/1994
ENSAFE ALLEN AND HOSHALL

00337

FINAL

**GROUNDWATER MONITORING WELL
MANAGEMENT PLAN
PHASE I**

**NAVAL AIR STATION
MEMPHIS, TENNESSEE**



Prepared for:

**DEPARTMENT OF THE NAVY
SOUTHERN DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
CHARLESTON, S.C.
CONTRACT NUMBER: N62467-89-D-0318**

Prepared by:

**EnSafe/Allen & Hoshall
5720 Summer Trees Drive, Suite 8
Memphis, Tennessee 38134
(901) 383-9115
Project Number CTO-079**



Joe Matthews 10/26/94

Joe Matthews,
PG TN1112

Date

John Stedman, Jr. 10/26/94

John Stedman, Jr.
Task Order Manager

Date

October 26, 1994

Release of this document requires the prior notification of the Commanding Officer of Naval Air Station Memphis, Millington, Tennessee.

Table of Contents

EXECUTIVE SUMMARY	i
1.0 INTRODUCTION	1
2.0 BACKGROUND RESEARCH	2
2.1 Monitoring Wells	2
2.1.1 SWMU Investigations — G&M	2
2.1.2 Leak Detection Wells — EDGE	3
2.1.3 UST and Miscellaneous Investigations	3
2.2 Production Wells	4
3.0 WELL INSPECTION CRITERIA	5
4.0 FINDINGS AND RECOMMENDATIONS	7
4.1 Monitoring and Leak Detection Wells	7
4.1.1 SWMU — Site 2, Southside Landfill	7
4.1.2 SWMU — Site 3, N-121 Dry Well Disposal	9
4.1.3 SWMU — Site 7, N-126 Dry Well Disposal	9
4.1.4 SWMU — Site 8, Cemetery Disposal Site	9
4.1.5 Navy Flying Club	13
4.1.6 N-126, North Fuel Farm	15
4.1.7 N-94, North Fuel Farm	15
4.1.8 Aircraft Fire Fighter Training Facility	16
4.1.9 Navy Hospital	16
4.1.10 Navy Exchange, Building 757	19
4.1.11 Building S-50	19
4.1.12 Building S-376	22
4.1.13 Building S-237	22
4.1.14 JP-5 Fuel Farm, T336 and T337	22
4.1.15 T1637, Building 774	26
4.2 Other Water Wells	26
4.2.1 Production Potable Water Wells	26
4.2.2 Nonpotable Water Wells	28
4.2.3 Abandoned Production Wells and Test Holes	29
5.0 REPAIR COST ESTIMATE	30
6.0 GROUNDWATER MONITORING WELL MANAGEMENT	33

List of Figures

Figure 4-1	SWMU — Site 2, Southside Landfill	8
Figure 4-2	SWMU — Site 3, N-121 Dry Well Disposal	10
Figure 4-3	SWMU — Site 7, N-126, and North Fuel Farm	11
Figure 4-4	SWMU — Site 8, Cemetery Disposal Site	12
Figure 4-5	Navy Flying Club	14
Figure 4-6	Aircraft Fire Fighter Training Facility	17
Figure 4-7	Navy Hospital	19
Figure 4-8	Navy Exchange, Building 757	20
Figure 4-9	Building S-50	21
Figure 4-10	Building S-376	23
Figure 4-11	Building S-237	24
Figure 4-12	JP-5 Fuel Farm, T336 and T337	25
Figure 4-13	T1637, Building	27
Plate 1	Base Map of Well Site Locations	

List of Tables

Table 2-1	SWMU Sites	2
Table 2-2	Leak Detection Wells	3
Table 2-3	E/A&H UST Investigations	4
Table 3-1	Monitoring Well Specifications (Target Inspection Items)	6
Table 4-1	Production Well Data	28
Table 5-1	Summary of Estimated Material Costs	31
Table 5-1	Summary of Estimated Labor Costs	32

List of Appendices

Appendix A	Monitoring Well ARARs
Appendix B	Summary of Well Inspection Findings

EXECUTIVE SUMMARY

This Groundwater Monitoring Well Management Plan (GMWMP), Phase I, was completed to locate, inspect, and assess all groundwater monitoring wells and other water wells at the Naval Air Station (NAS) Memphis, Millington, Tennessee. EnSafe/Allen & Hoshall (E/A&H) reviewed groundwater investigation and underground storage tank (UST) related reports and determined that 118 monitoring wells have been installed at NAS Memphis as of April 20, 1994. Six monitoring wells were not located during the field survey. These wells are presumed to have been removed along with their associated USTs. Eleven additional water wells currently exist on the facility. Five wells are production wells supplying potable water to the base, two wells have limited nonpotable uses, and four are temporarily out-of-service.

Recommendations are made herein regarding well repair, modification, and closure. The estimated cost to implement these recommendations is \$13,898. These actions will be completed in Phase II of the GMWMP.

Each well was located using Global Positioning System (GPS) technologies. These data are presented along with the field inspection results in Appendix B. Additional data were collected to calibrate the base grid to longitude and latitude coordinates, and are included in this report.

1.0 INTRODUCTION

At the request of the Southern Division Naval Facility Engineering Command (SOUTHDIV), Charleston, South Carolina, EnSafe/Allen & Hoshall (E/A&H) inspected and located 112 groundwater monitoring wells and 11 water wells at the Naval Air Station (NAS) Memphis, Millington, Tennessee. Data collected during this action are presented herein, along with recommendations for repairing, replacing, upgrading, or closing wells. The estimated costs for each action are included with the recommendations.

2.0 BACKGROUND RESEARCH

2.1 Monitoring Wells

Research was completed to locate all monitoring wells on the base, and to determine the status of each site. Research indicated 118 monitoring wells at the base — 112 of which were located during the field survey. Plate 1 shows the location of each monitoring well site at NAS Memphis. Wells were inspected and assessed for general condition, compliance, and usefulness. Each well was located using Global Positioning System (GPS) technology to determine latitude, longitude and elevation relative to mean sea level (msl).

Two well types were identified — leak detection wells and monitoring wells. All leak detection wells (sometimes called observation wells or release detection wells) were at underground storage tank (UST) sites. Monitoring wells at sites investigated for possible groundwater contamination were generally either a UST site or a solid waste management unit (SWMU).

2.1.1 SWMU Investigations — G&M

Geraghty & Miller (G&M) completed a Verification Study in 1984 and 1985 and installed 12 wells at four SMWUs. The site name and number of wells at each SMWU are presented in Table 2-1. These SMWUs are subject to more investigation currently scheduled for late 1994 or early 1995.

Table 2-1 SWMU Sites		
Site No.	Site Name	No. Wells
Site 2	South Landfill	5
Site 3	N-121, Dry Well	3
Site 7	N-126, Dry Well	1
Site 8	Cemetery Disposal Area	3

2.1.2 Leak Detection Wells — EDGE

Engineering, Design, and Geosciences Group, Inc. (EDGE) (currently known as Ogden Engineering and Environmental Services, Inc.) prepared a Release Detection Manual for regulated USTs at NAS Memphis. This function required upgrading each UST system as needed to comply with current regulations. This included installing 37 leak detection wells at seven UST sites. These wells were installed in late 1989 and early 1990. The USTs (identified by the tank number) and the number of leak detection wells at each site are indicated in Table 2-2. Subsequent groundwater investigations were completed at all but two locations and additional monitoring wells were installed during each investigation.

Table 2-2 Leak Detection Wells			
Tank No.	Wells/Tank	Tank No.	Wells/Tank
T301	3	T1205N	2
T1242	2	T1205S	2
T1243	2	T1482	3
T304	2	T1249	2
T1239	3	T1508	3
T336	3	T1489	4
T337	3	T1637	3

Tanks shown in **Bold** are scheduled for removal in late 1994 under BRAC III

2.1.3 UST and Miscellaneous Investigations

A large petroleum release was discovered at the Navy Exchange, Building 757, in 1986. Many investigations were completed over the following few years. Twenty-four monitoring wells were installed by three different consulting firms, Pittsburgh Testing Laboratories (now Professional Service Industries [PSI]), Harding-Lawson Associates (HLA), and EDGE. A search of the activity files and Memphis/Shelby County Health Department (MSCHD) only recovered boring and wells logs for 15 of the monitoring wells.

Memphis Environmental Center (MEC) completed a UST investigation at Building S-237. Six monitoring wells were installed in September 1992. No report was located during this survey; however, well permits and well logs were on file at the Memphis/Shelby County Health Department, Division of Groundwater Protection.

E/A&H completed seven UST-related investigations and installed 39 monitoring wells. Each site includes one or more UST systems with leak detection wells. The sites investigated by E/A&H are indicated in Table 2-3. The Navy Hospital site does not include any leak detection wells, since tanks T106 and T107 are non-regulated; however, four monitoring wells are at this site.

Table 2-3 E/A&H UST Investigations		
Site/Date	Number Wells	Associated Tank(s)
Navy Flying Club/May 1993	6	T1205N, T1205S
N-126/May 1993	6	T304, T1239
N-94/Jan 1992	3	T301, T1242, T1243
AFFTF/July 1992	11	T1489, T1508
Navy Hospital/May 1992	4	T106, T107 (non-regulated)
S-50/June 1993	5	Not Listed
S-376/July 1992	4	T1249, T1482

2.2 Production Wells

A background review of the production wells revealed five wells currently supply potable water to the base. Six additional wells were located, four of which are currently classified as out-of-service and two are apparently for nonpotable supplies. Background information indicates four production wells were abandoned in 1983 during upgrading of the base water supply system. These locations are included to assess the integrity of the well closures.

3.0 WELL INSPECTION CRITERIA

Each well was assessed for compliance under the applicable or relevant and appropriate requirements (ARARs), including SOUTHDIV *Guidelines for Groundwater Monitoring Well Installations*; Naval Energy and Environmental Support Activity (NEESA) *Ground-water Monitoring Guide*, NEESA 20.2-031A, February 1985; Rules of the Tennessee Department of the Environment and Conservation (TDEC), Division of Water Supply, Chapter 1200-4-10 entitled *Well Construction and Abandonment Standards*; TDEC UST regulations; and Memphis-Shelby County Health Department (MSCHD) *Shelby County Well Construction Code*. The relevant sections of the documents are included as Appendix A.

Each monitoring well and leak detection well was inspected using standardized criteria. An assessment was completed of the general condition, the wellhead condition, the well annulus condition, and well construction specifications. A list of target inspection items is presented in Table 3-1.

Appendix B summarizes the general inspection findings and includes tabulated data of reported and observed well specifications. Wellhead conditions were indicated as follows:

- 1) Good
- 2) Acceptable
- 3) Minor damage/disrepair
- 4) Moderate damage/disrepair
- 5) Severe damage/disrepair

The reported construction of each well is included in the summary. This information consists of the reported top of casing (TOC) elevation, well screen length and slot size, and the total well depth. Section 4.0 provides a site-by-site discussion of the findings and recommendations. The estimated costs to implement these recommendations are presented in Section 5.0.

Table 3-1 Monitoring Well Specifications (Target Inspection Items)	
<p>Above-Grade Mounts:</p> <p>Well pad: Condition Size (4 X 4 X 0.5 ft)</p> <p>Well Head/Security Casing: Condition Brass, keyed-alike locks Leak-resistant well cap (Hex-key type) Paint — condition and color (high-visibility yellow epoxy AASHTO* — M220)</p> <p>Guard post: Condition Number (4 required) Cement filled</p>	<p>Flush-Grade Mounts:</p> <p>Well pad: Condition Size (2.0 X 2.0 X 0.5 ft)</p> <p>Well Head/Manhole cover: Condition Leak-resistant well cap (Hex-key type) 22-gauge steel, load-bearing Bolt down Gasket — condition Labeled - "Monitoring Well Do Not Fill"</p>
<p>Well Annulus:</p> <p>Riser pipe: Condition (at surface and above grade)</p> <p>Total depth: Well open to reported construction depth</p>	<p>Well Data:</p> <p>Water level Headspace-organic vapor concentration Odor Significant sediment accumulation</p>

Notes:

* AASHTO — American Association of State Highway and Transportation Officials, SOUTHDIV specifications.

Under current *Shelby County Well Construction Codes* (June 1994), well repair, closure, or modification requires a well permit. There was no indication of a "grandfather" provision for wells installed before 1988, when the well codes were established.

4.0 FINDINGS AND RECOMMENDATIONS

4.1 Monitoring and Leak Detection Wells

Most wells are 2-inch polyvinyl chloride (PVC), typically with 0.010-inch slot well screens, but there are exceptions as indicated in Appendix B. The reported well configurations are presented in Appendix B. Well screen length varied from site to site, ranging from 5 feet to 25 feet.

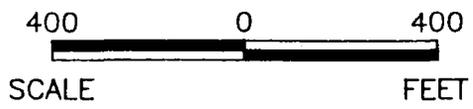
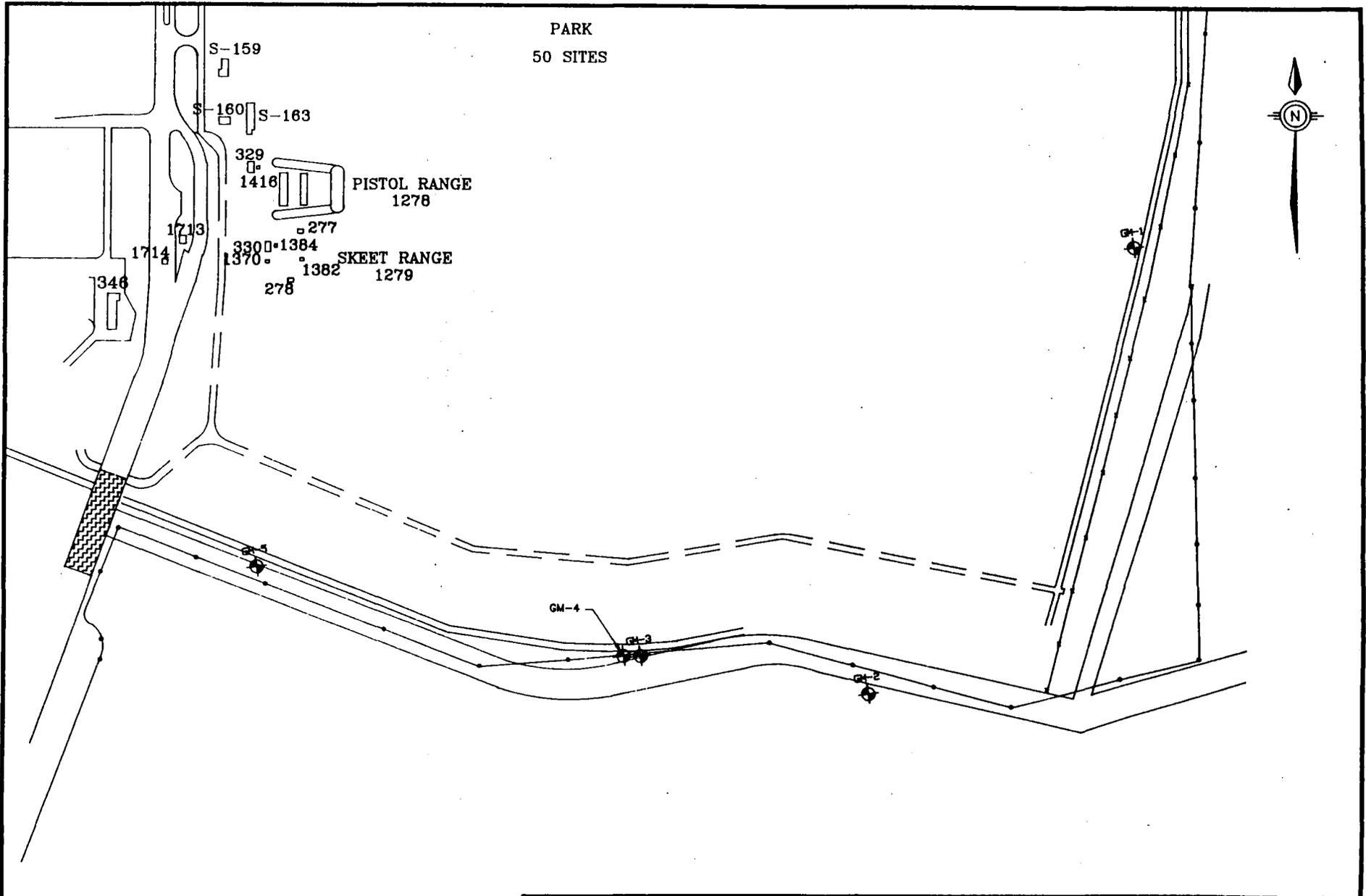
Some general recommendations include:

- Install all brass, keyed-alike locks on all above-grade mount wells.
- Properly label all wells, including well number, longitude, latitude, elevation to 0.01 feet msl, and the total well depth.
- Routinely inspect of each well.

4.1.1 SWMU — Site 2, Southside Landfill

Five monitoring wells (GM-1 through GM-5) were installed at the Southside Landfill Site by G&M in 1984 (Figure 4-1). These wells were installed before the current *Shelby County Well Construction Codes* were established. This site is scheduled for additional investigation under a RCRA Facility Investigation (RFI) scheduled for late 1994 or early 1995.

All wells are above-grade mounts and need well pads, guard posts, new security casings, and to comply with SOUTHDIV specifications. The riser pipes of wells GM-3 and GM-4 need repair. The upper portion should be replaced from just below the surface to at least 2.5 feet above-grade; a flush-grade mount is not acceptable at the landfill site. Leak-resistant well caps should be installed on each well. The wells appear operable; however, they should be fully redeveloped before sampling.



NAS MEMPHIS
 GROUNDWATER
 MONITORING WELL
 MANAGEMENT PLAN

FIGURE 4-1
 SWMU
 SITE 2

4.1.2 SWMU — Site 3, N-121 Dry Well Disposal

Three monitoring wells (GM-6 through GM-8) were installed at Building N-121 by G&M in 1984 (Figure 4-2). These wells were installed before the current *Shelby County Well Construction Codes* were established. This site is scheduled for additional investigation under an RFI.

The wells are above-grade mounts and need well pads, guard posts, and paint to comply with SOUTHDIV specifications. Well GM-6 has a damaged riser and security casing, and both need replacing. The riser may be replaced from just below grade to at least 2.5 feet above grade and a new security casing installed, or a flush-grade mount may be installed at this site. A leak-resistant well cap should be installed on each well. These wells appear operable; however, they should be fully redeveloped before sampling.

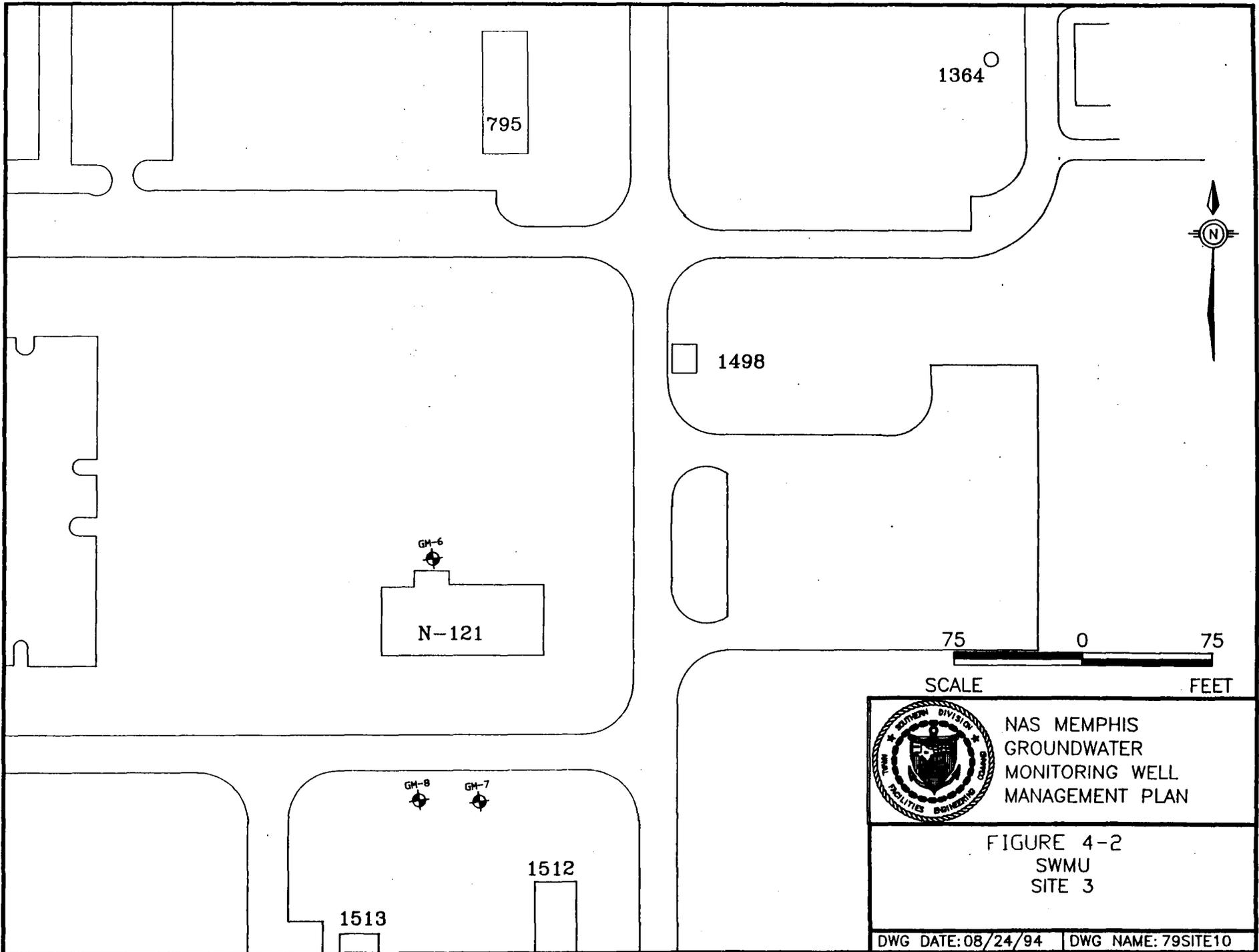
4.1.3 SWMU — Site 7, N-126 Dry Well Disposal

One monitoring well (GM-9) was installed at the N-126 dry well by G&M in 1985 (Figure 4-3). This well was installed before the current *Shelby County Well Construction Codes* were established. This site is scheduled for additional investigation under an RFI.

Well GM-9 is a flush-grade mount well installed directly through the center of the former dry well location, east of Building N-126. The manhole cover does not satisfy current SOUTHDIV specifications; however, it is in good condition and does not require replacing. A leak-resistant well cap should be installed. GM-9 appears operable; however, it should be fully redeveloped before sampling.

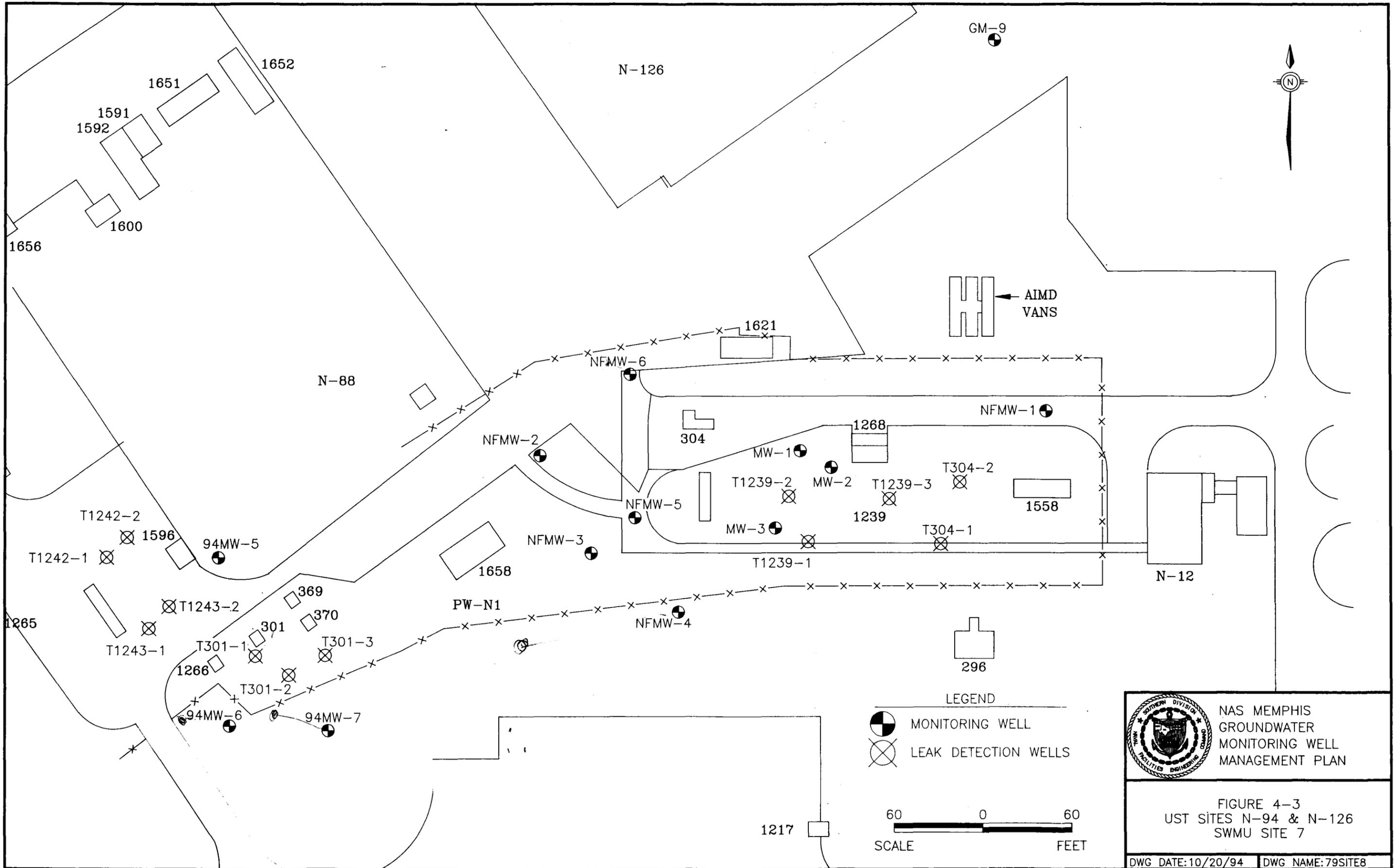
4.1.4 SWMU — Site 8, Cemetery Disposal Site

Three wells (GM-10 through GM-12) were installed at the Cemetery Disposal Site by G&M in 1985 (Figure 4-4). These wells were installed before the current *Shelby County Well Construction Codes* were established. This site is scheduled for additional investigation under a RFI.



NAS MEMPHIS
GROUNDWATER
MONITORING WELL
MANAGEMENT PLAN

FIGURE 4-2
SWMU
SITE 3

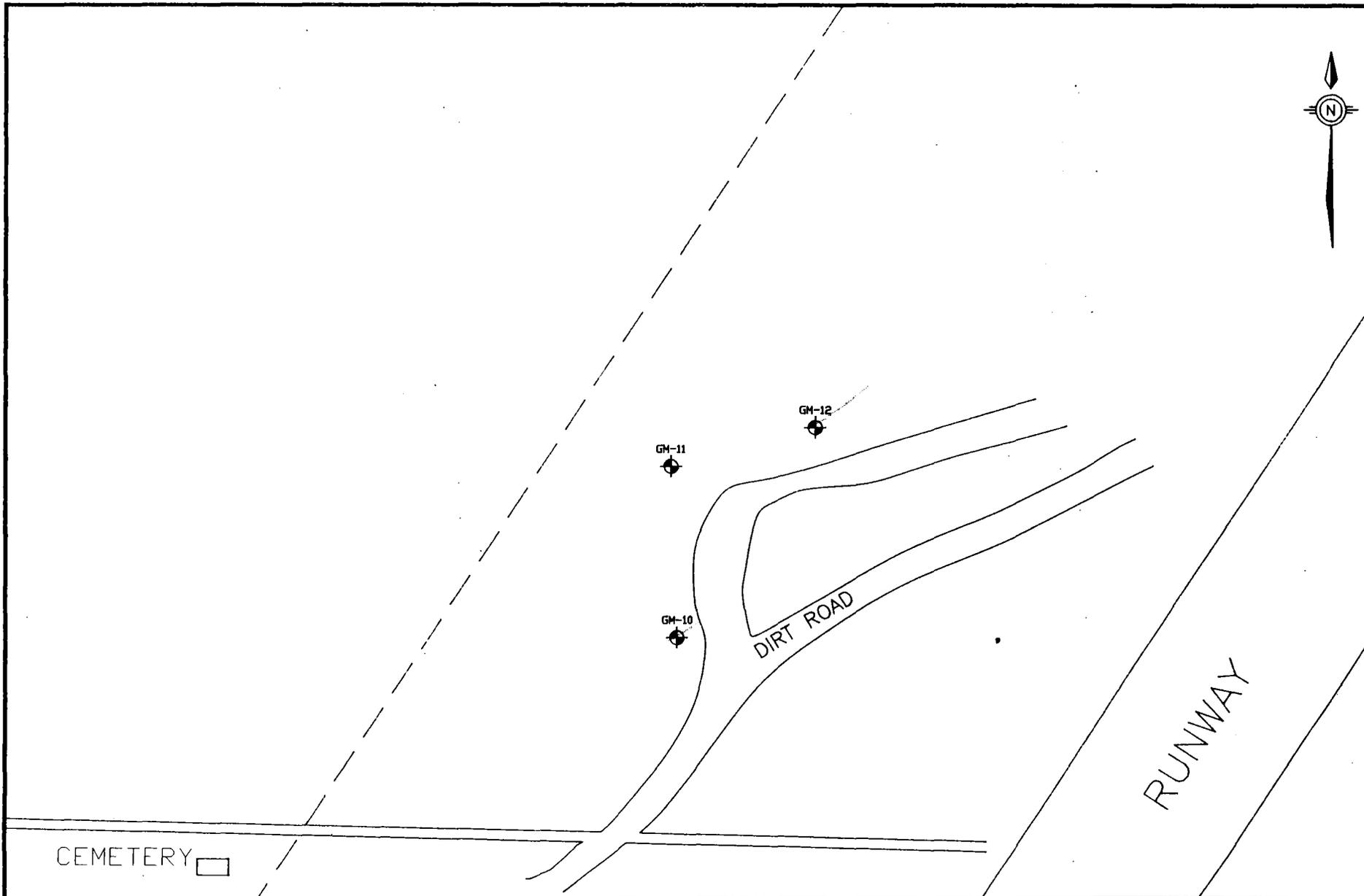



**NAS MEMPHIS
GROUNDWATER
MONITORING WELL
MANAGEMENT PLAN**

**FIGURE 4-3
UST SITES N-94 & N-126
SWMU SITE 7**

DWG DATE: 10/20/94 DWG NAME: 79SITE8

003374012



CEMETERY



NAS MEMPHIS
GROUNDWATER
MONITORING WELL
MANAGEMENT PLAN

FIGURE 4-4
SWMU
SITE 8

DWG DATE: 08/24/94 DWG NAME: 79SITE12

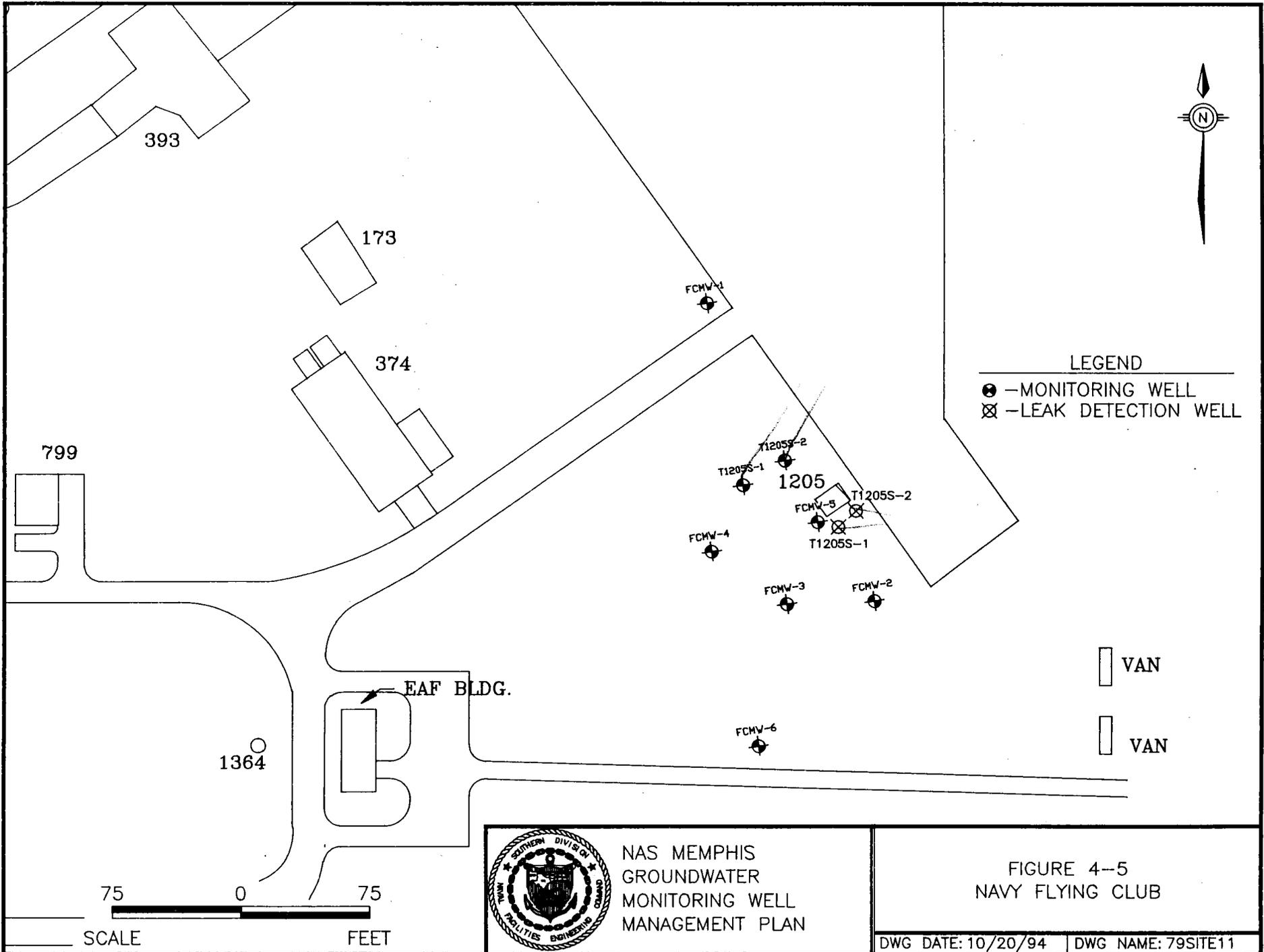
These wells need well pads, guard posts, riser pipe repair, new security casings, and paint to comply with SOUTHDIV specifications. A flush-grade mount is not acceptable for this site. Leak-resistant well caps should be installed on each well. Each well appears operable; however, they should be fully redeveloped before sampling.

4.1.5 Navy Flying Club

E/A&H assessed the shallow groundwater zone at the Navy Flying Club — UST sites T1205N and T1205S. Six above-grade mount monitoring wells were installed during this investigation (Figure 4-5). All wells appear to be in good condition, operable, and to meet current ARARs. A Corrective Action Plan (CAP) recommending recovery and treatment was submitted to TDEC; approval is pending.

EDGE installed four leak-detection wells around USTs T1205N and T1205S at the Navy Flying Club in 1990. The USTs were removed in October 1991 and two wells, T1205N-1 and T1205N-2 apparently were removed with the tanks. Two leak-detection wells remain, T1205S-1 and T1205S-2. Both are flush-grade mounts; however, neither had a well pad or manhole cover, and neither were they adequately secured from surface runoff infiltration.

The two remaining leak detection wells should be closed. The relative location of the leak detection wells to the monitoring wells suggests that they are not critical to any additional investigation or groundwater monitoring at the site. Two methods of closure are recommended: 1) the wells may be overdrilled, removed and the resulting borehole grouted to the surface with a 97/3 percent Portland cement/bentonite grout; 2) the well annulus may be grouted to the surface with a 97/3 percent Portland cement/bentonite grout. Method 1 is preferred, but is more expensive than method 2.



4.1.6 N-126, North Fuel Farm

E/A&H completed a limited groundwater assessment at the North Fuel Farm near N-126 in 1993. Five above-grade wells and one flush-mount well were installed during the N-126 assessment (Figure 4-3). All wells appear to be in good condition, operable and to meet current ARARs. A submittal to TDEC requested site-specific standards, and no further action. Approval is pending. An additional UST investigation was completed by E/A&H in August 1994 to assess a possible petroleum release from USTs T304 and T1239, and three additional monitoring wells were installed near T304.

EDGE installed five leak-detection wells around the tank pit of USTs T304 and T1239 in 1990. All wells appear to be in good condition, operable, and to meet ARARs, with the following exceptions: none have bolt-down manhole covers, nor were they labeled "*MONITORING WELL — DO NOT FILL.*" USTs T304 and T1239 are scheduled for removal and replacement with upgraded systems. The leak detection wells should be closed before the USTs are removed and new leak detection wells properly installed with the new tank systems as required. This is recommended because it is doubtful the integrity of the leak detection wells can be maintained during the removal. Furthermore, UST regulations require leak detection wells to be installed within the fill around the tank.

4.1.7 N-94, North Fuel Farm

E/A&H installed three monitoring wells during a limited groundwater assessment in 1992 around USTs T301, T1242, and T1243 and near Building N-94 (Figure 4-3). These monitoring wells are above-grade mounts and appear in good condition. They should be painted to comply with SOUTHDIIV specifications.

EDGE installed three leak-detection wells around UST T301 and four around USTs T1242 and T1243 in 1990. All wells appear to be in good condition, operable, and to meet ARARs, with the following exceptions: none have bolt-down manhole covers, nor were they labeled "*MONITORING WELL — DO NOT FILL.*" USTs T301, T1242, and T1243 are scheduled for

removal and replacement with upgraded systems. The leak detection wells should be closed before the USTs are removed and new leak detection wells properly installed with the new tank systems. This is recommended because it is doubtful the integrity of the leak detection wells can be maintained during the removal. Furthermore, UST regulations require leak detection wells to be installed within the fill around the tank.

4.1.8 Aircraft Fire Fighter Training Facility

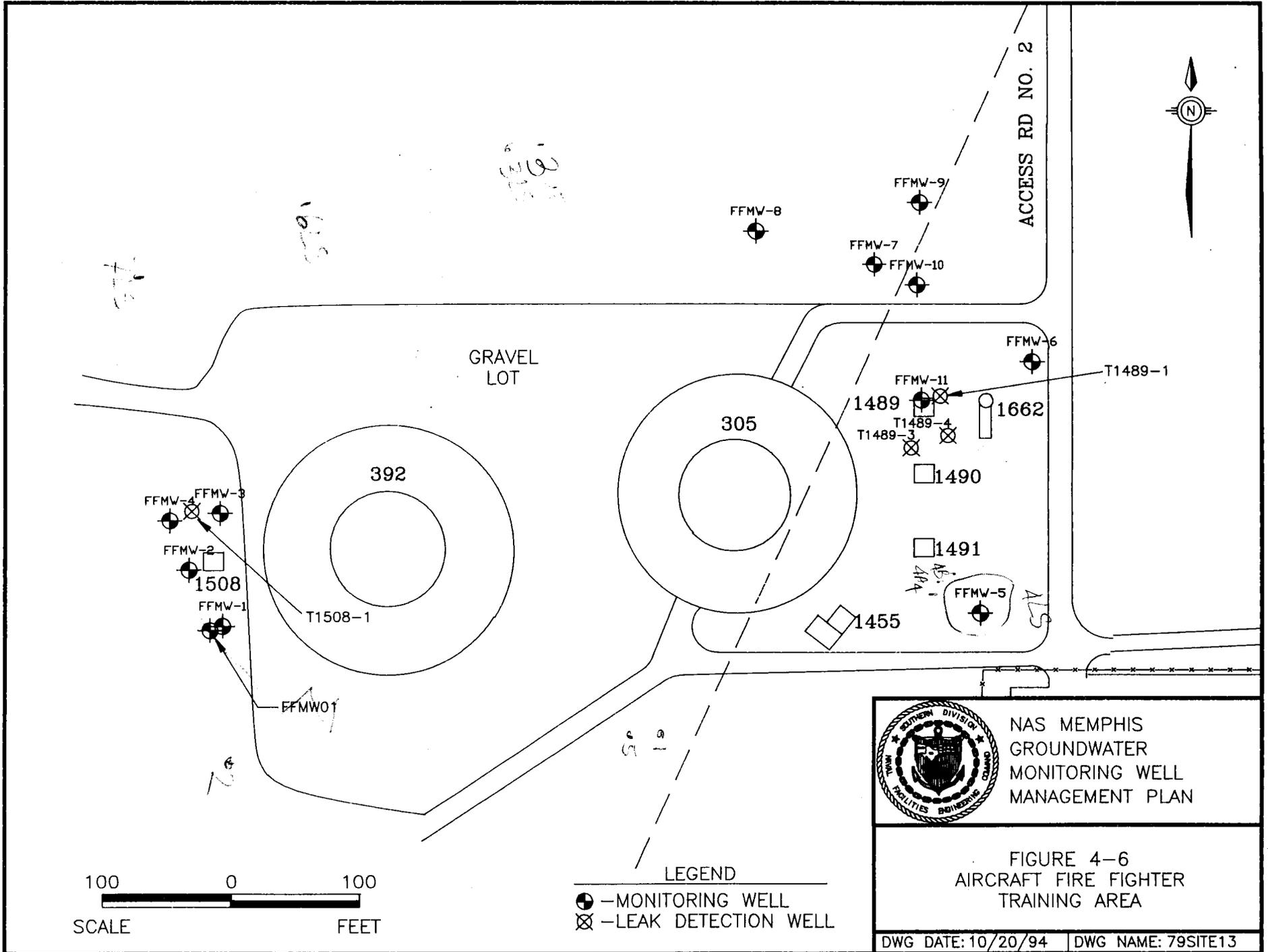
E/A&H completed a limited groundwater assessment at the Aircraft Fire Fighter Training Facility (AFFTF) in 1992 and installed 11 above-grade monitoring wells (Figure 4-6). All wells appear to be in good condition, operable and to meet current ARARs; however, they should be repainted to comply with SOUTHDIV specifications.

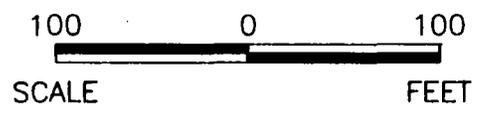
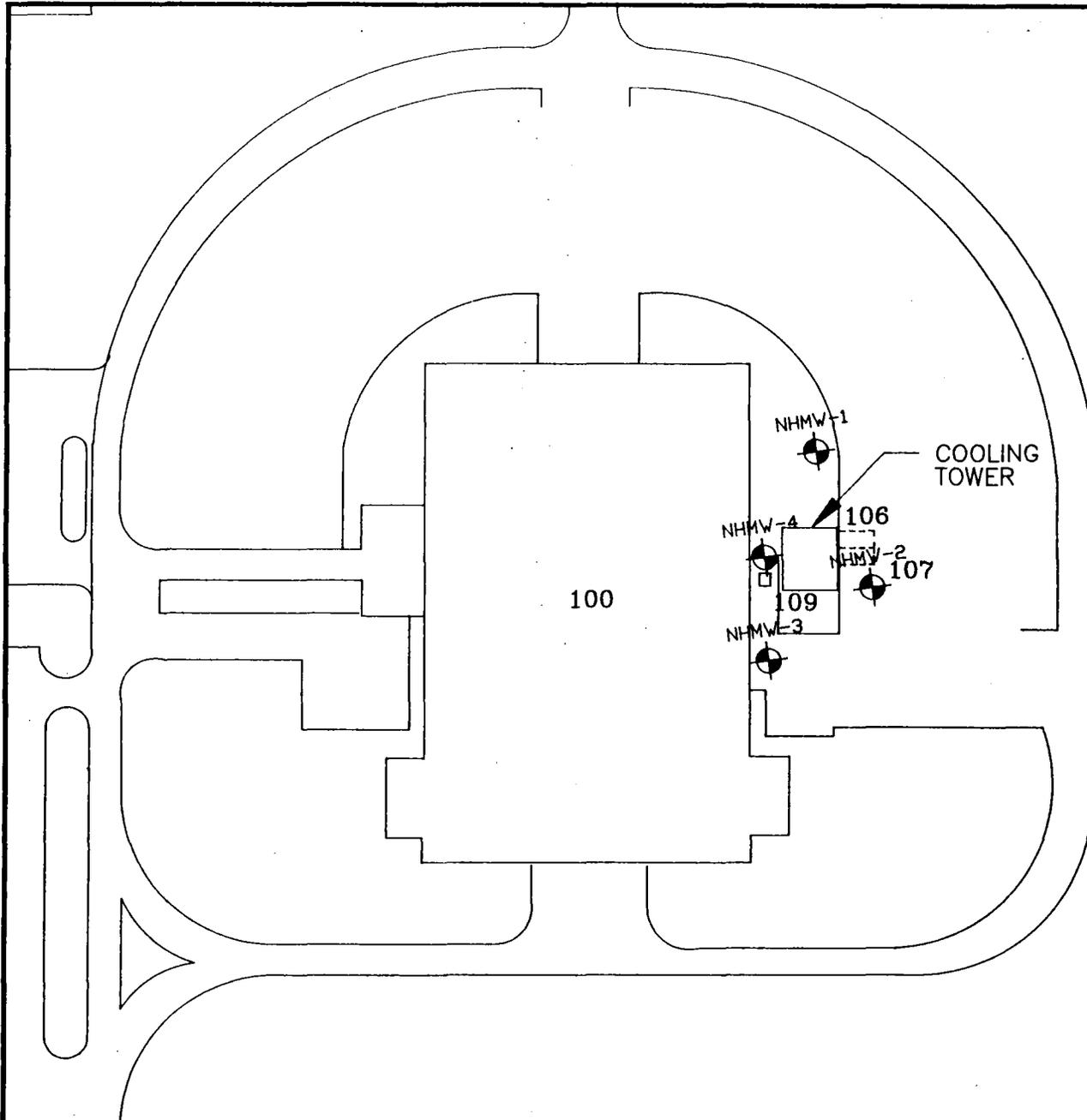
EDGE installed four leak-detection wells around UST T1489 and three around UST T1508 in 1989. One well at T1489 (well T1489-2) and two wells at T1508 (T1508-2 and T1508-3) were not located. T1489-2 was assumed to have been removed, and T1508-2 and T1508-3 were reportedly removed with the tank; however, no well closure report was found in the activity files.

The remaining leak-detection wells appear to be in good condition, operable and to meet ARARs with the following exceptions: none have bolt-down manhole covers, nor were they labeled "*MONITORING WELL — DO NOT FILL.*" A label or tag should be mounted on each manhole cover or well pad identifying it as a monitoring well. Leak detection wells T1508-1 and T1508-4 should be closed by grouting the well casing to the surface or over-drilling. Apparently, these wells are no longer required.

4.1.9 Navy Hospital

E/A&H completed a limited groundwater assessment at the Navy Hospital in 1992 and installed four flush-grade monitoring wells (Figure 4-7). All wells appear to be in good condition, operable and in general compliance with current ARARs. The well pads are not the specified





NAS MEMPHIS
GROUNDWATER
MONITORING WELL
MANAGEMENT PLAN

FIGURE 4-7
BUILDING H-100
NAVAL HOSPITAL

size, but two were mounted in asphalt and two were mounted in concrete and the wellhead integrity appeared protected.

4.1.10 Navy Exchange, Building 757

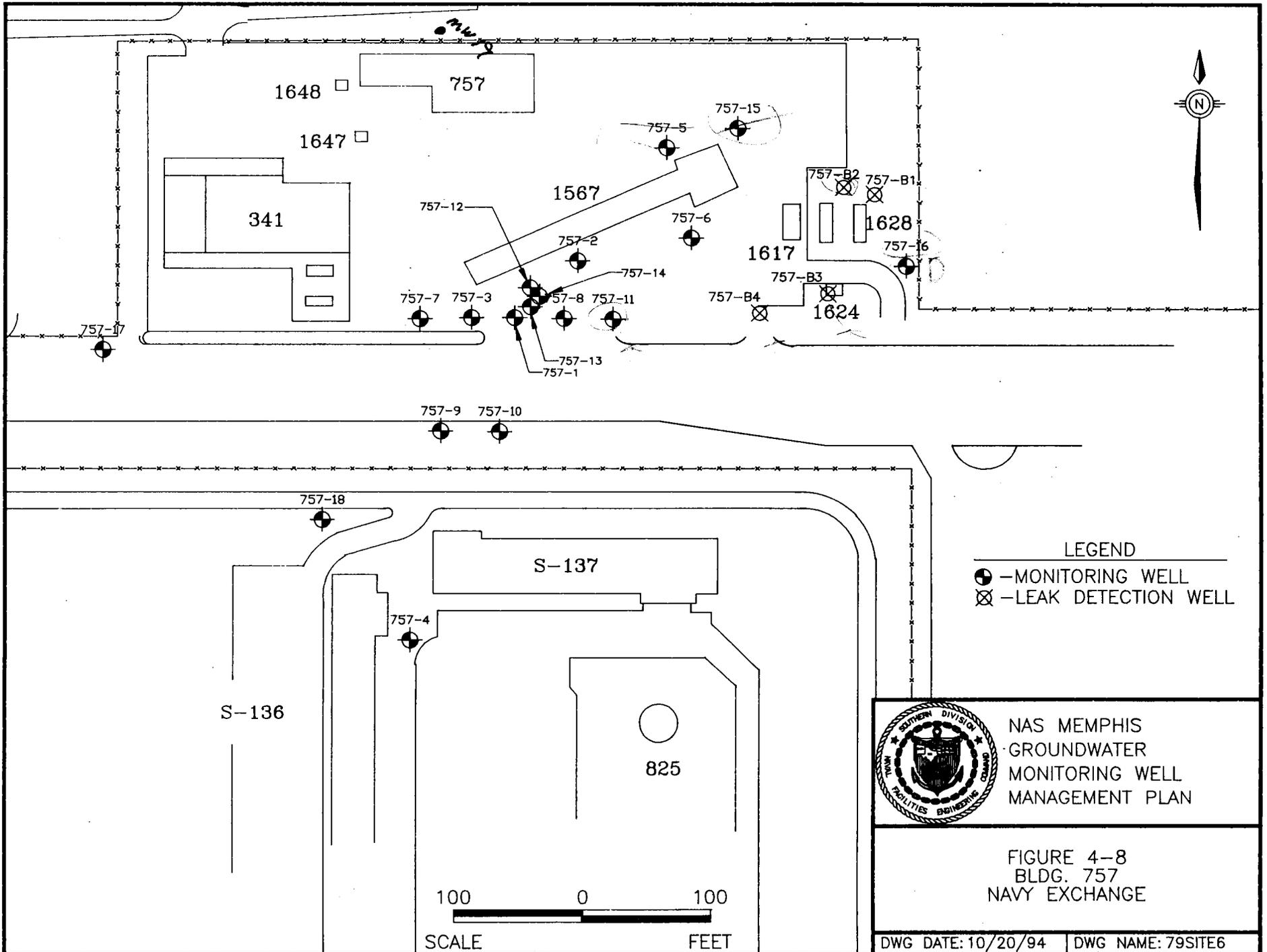
Twenty-four monitoring wells were installed during a groundwater assessment investigation at the Navy Exchange, Building 757 (Figure 4-8). Twenty are flush-grade mounts and four are above-grade mounts. All monitoring wells except one appear to be in good condition, operable and in general compliance with current ARARs. Most of these wells were installed before the current *Shelby County Well Construction Codes* were established. Well pads are not the specified size; however, all but four were mounted in asphalt or concrete and the wellhead integrity of each appeared protected.

One wellhead, 757-11, was moderately damaged. The well riser pipe is in good condition and the well properly protected with a leak-resistant cap; however, the manhole casing was damaged and the cover was missing. This well is in a very high traffic area at the entrance to the Navy Exchange from Navy Road. A new manhole casing and well pad must be installed.

PSI installed four above-grade wells in 1986 in the grassy area around two large USTs (the numbers of which were not reported). None of these above-grade wells has steel surface protectors, pads, or guard posts. These features must be installed to bring the wells into compliance or converted to flush-grade mounts.

4.1.11 Building S-50

E/A&H completed a limited groundwater assessment at Building S-50 in 1993 and installed four flush-grade mount monitoring wells (Figure 4-9). These wells were closed by E/A&H on August 15, 1994, in accordance with MSCHD requirements.



LEGEND

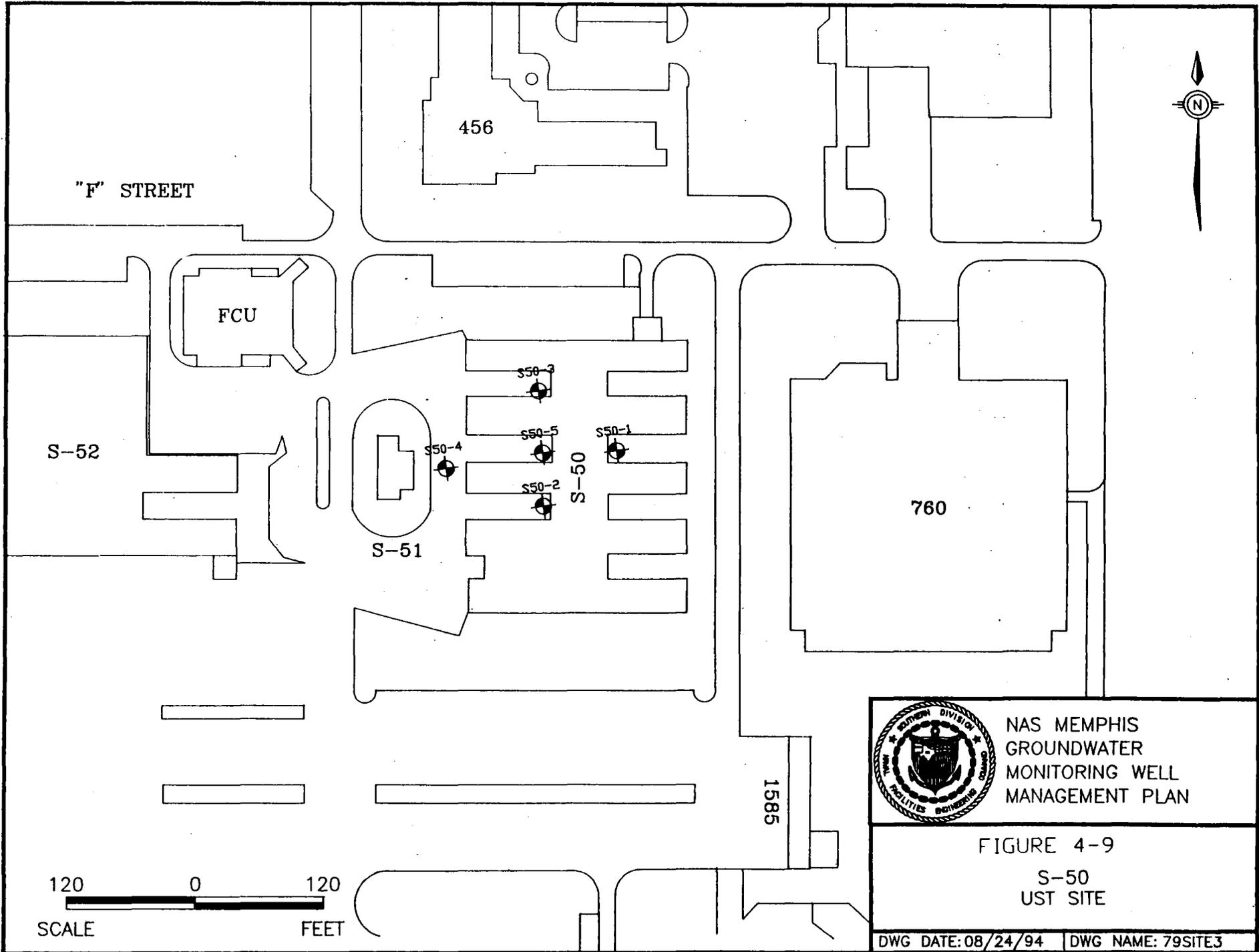
- - MONITORING WELL
- ⊗ - LEAK DETECTION WELL



NAS MEMPHIS
GROUNDWATER
MONITORING WELL
MANAGEMENT PLAN

FIGURE 4-8
BLDG. 757
NAVY EXCHANGE

100 0 100
SCALE FEET



"F" STREET

456

FCU

S-52

S-51

S-50

760

1585



NAS MEMPHIS
GROUNDWATER
MONITORING WELL
MANAGEMENT PLAN

FIGURE 4-9
S-50
UST SITE

120 0 120
SCALE FEET

DWG DATE: 08/24/94 | DWG NAME: 79SITE3

4.1.12 Building S-376

E/A&H completed a limited groundwater assessment in 1992 at Building S-376, around USTs T1249 and T1482 (Figure 4-10). Four flush-grade mount monitoring wells were installed during that assessment. All wells appear to be in good condition, operable, and in general compliance with current ARARs. The well pads are adequate in size and the wellhead integrity appears acceptable.

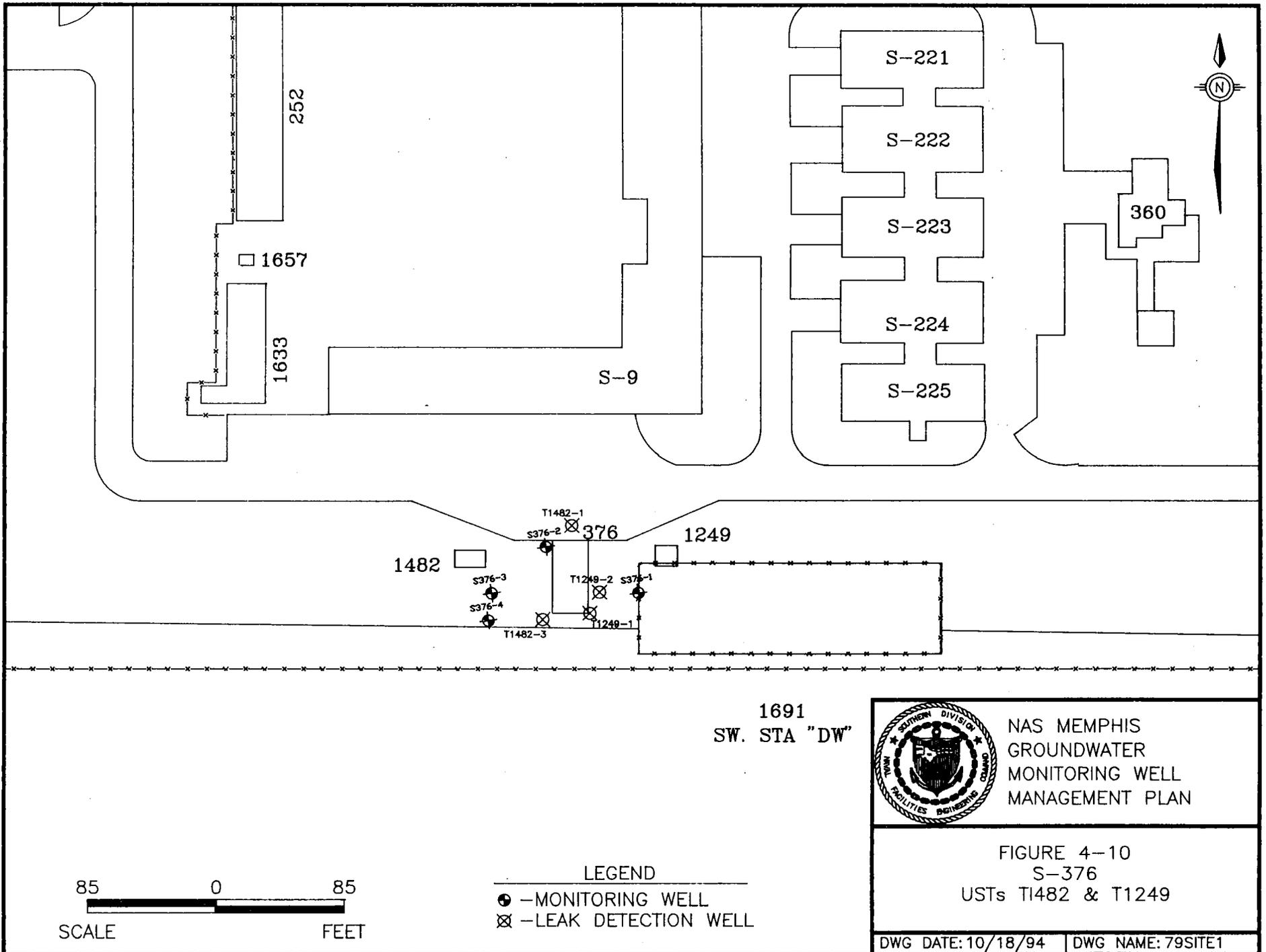
EDGE installed two leak-detection wells near T1249 and three around T1482 in 1990. One leak detection well at T1482 (well T1482-2) was not located. According to activity personnel, this well was removed along with UST T1482 in 1993. The remaining leak-detection wells appear to be in acceptable condition, operable and to meet ARARs, with the following exceptions: none have a bolt-down manhole cover, nor were they labeled "*MONITORING WELL — DO NOT FILL.*" A label or tag should be mounted on each manhole cover or well pad identifying it as a monitoring well. The two remaining leak detection wells for T1482 are not required and may be closed by grouting the well casing or over-drilling and grouting the open hole.

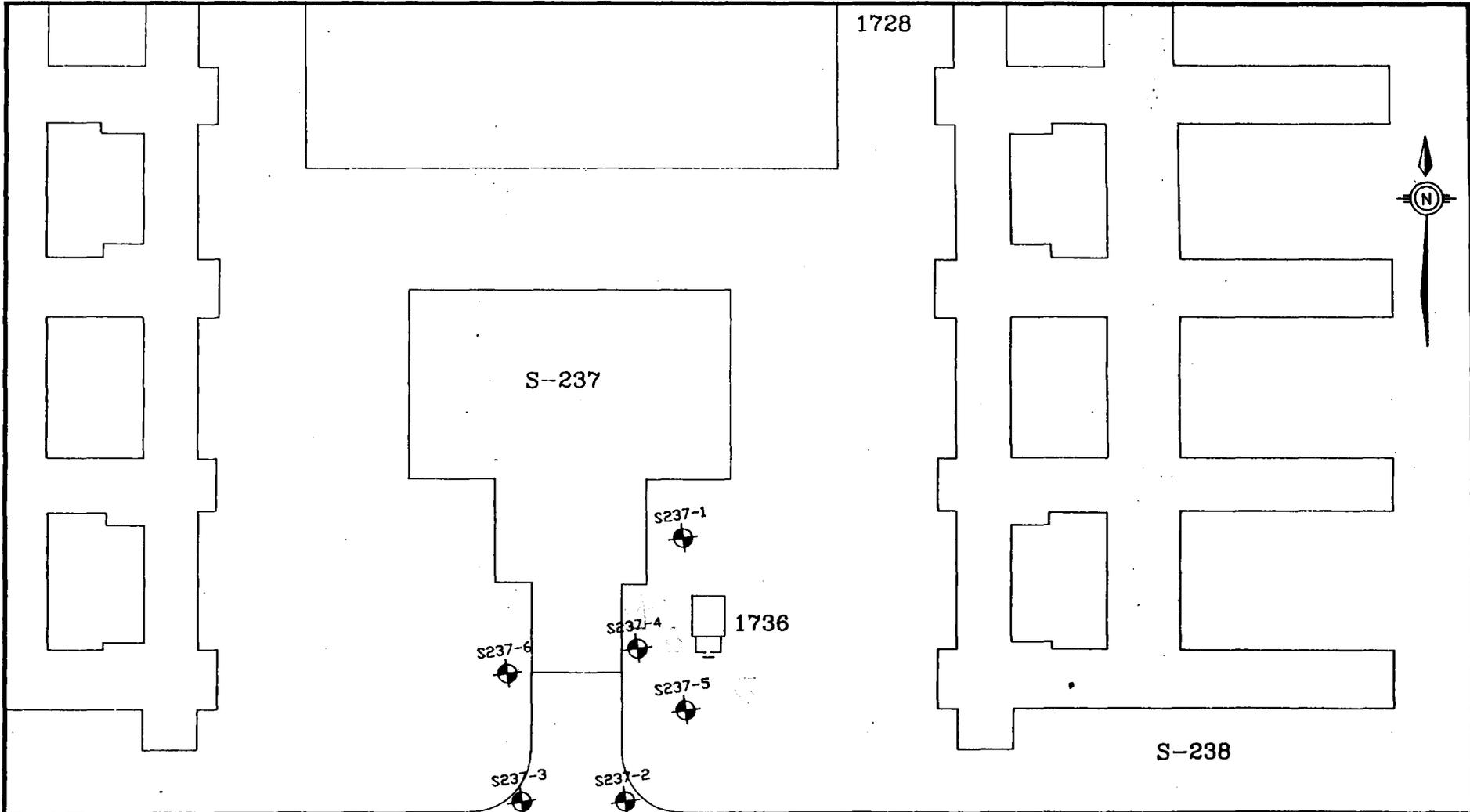
4.1.13 Building S-237

Memphis Environmental Center (MEC) completed a limited groundwater assessment at Building S-237 in 1992 (Figure 4-11) installing three above-grade mount and three flush-grade mount monitoring wells. All wells appear to be in good condition, operable, and in general compliance with current ARARs, but with some exceptions. Three above-grade wells do not have guard post, nor are they properly painted. The flush-grade well pads were not the specified size; however, two wells were mounted in asphalt and one was mounted in concrete. Wellhead integrity appeared protected.

4.1.14 JP-5 Fuel Farm, T336 and T337

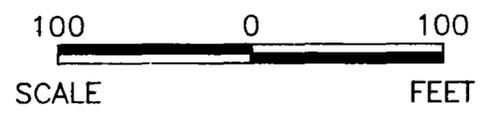
EDGE installed three leak-detection wells around T336 and three around T337 in 1990 at the JP-5 Fuel Farm, west of the airfield (Figure 4-12). All six leak-detection wells appear to be in good condition, operable, and in general compliance with ARARs, with the following

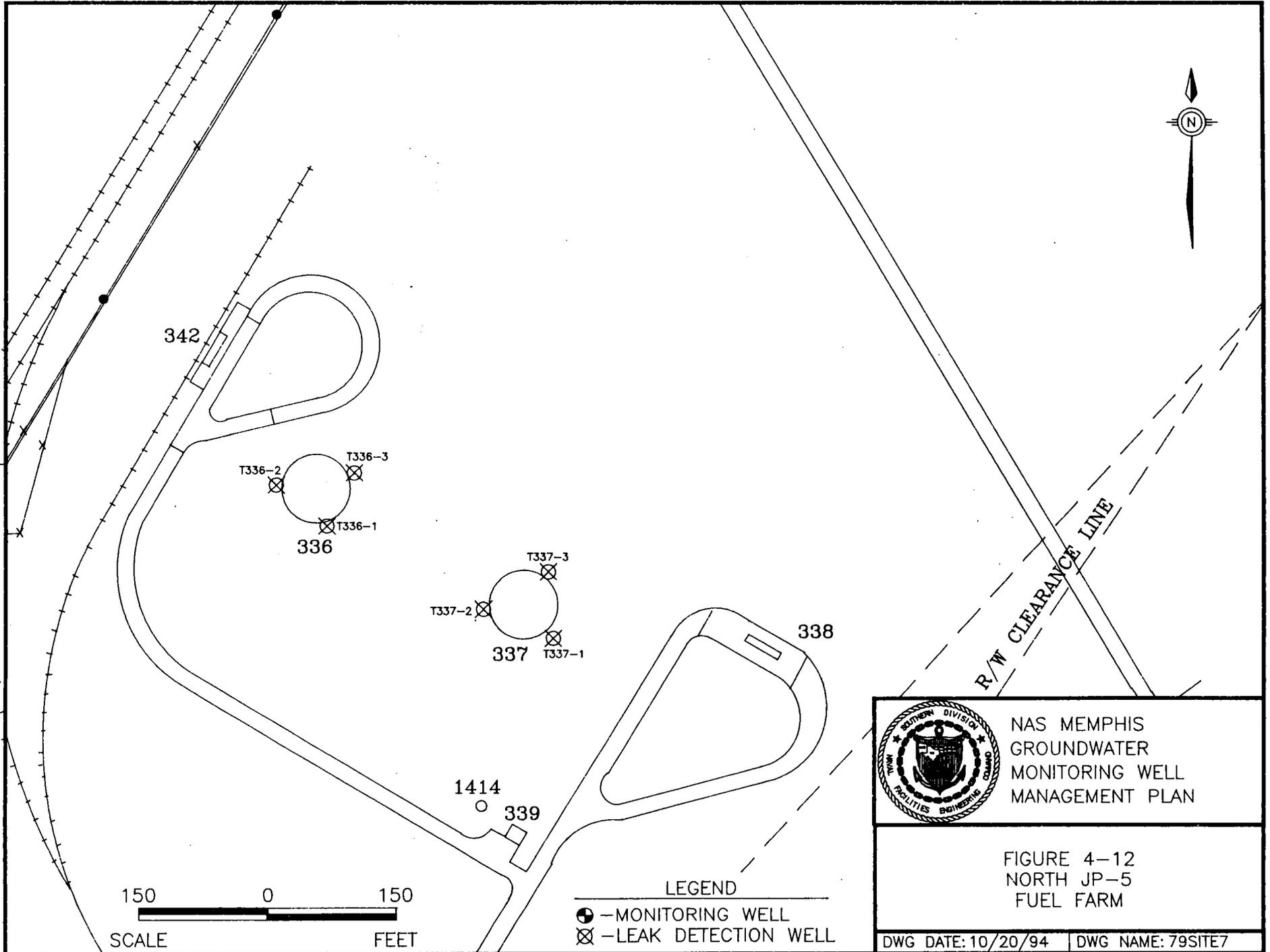




NAS MEMPHIS
GROUNDWATER
MONITORING WELL
MANAGEMENT PLAN

FIGURE 4-11
S-237
UST SITE





NAS MEMPHIS
GROUNDWATER
MONITORING WELL
MANAGEMENT PLAN

FIGURE 4-12
NORTH JP-5
FUEL FARM

DWG DATE: 10/20/94 | DWG NAME: 79SITE7

150 0 150
SCALE FEET

LEGEND
● - MONITORING WELL
⊗ - LEAK DETECTION WELL

exceptions: none has a bolt-down manhole cover, nor were they labeled "*MONITORING WELL — DO NOT FILL.*" A label or tag should be mounted on each manhole cover or well pad identifying it as a monitoring well.

4.1.15 T1637, Building 774

EDGE installed three leak detection wells around UST T1637 at Building 774 in 1990 (Figure 4-13). Two wells appear to be in good condition, operable and in general compliance with ARARs, with the following exceptions: none has a bolt-down manhole cover, nor are they labeled "*MONITORING WELL — DO NOT FILL.*" A label or tag should be mounted on each manhole cover or well pad identifying it as a monitoring well. The well pad for T1637-1 was noted to have minor damage. The well pad was tilted, suggesting it has been disturbed. The well integrity appears protected; however, repair is recommended.

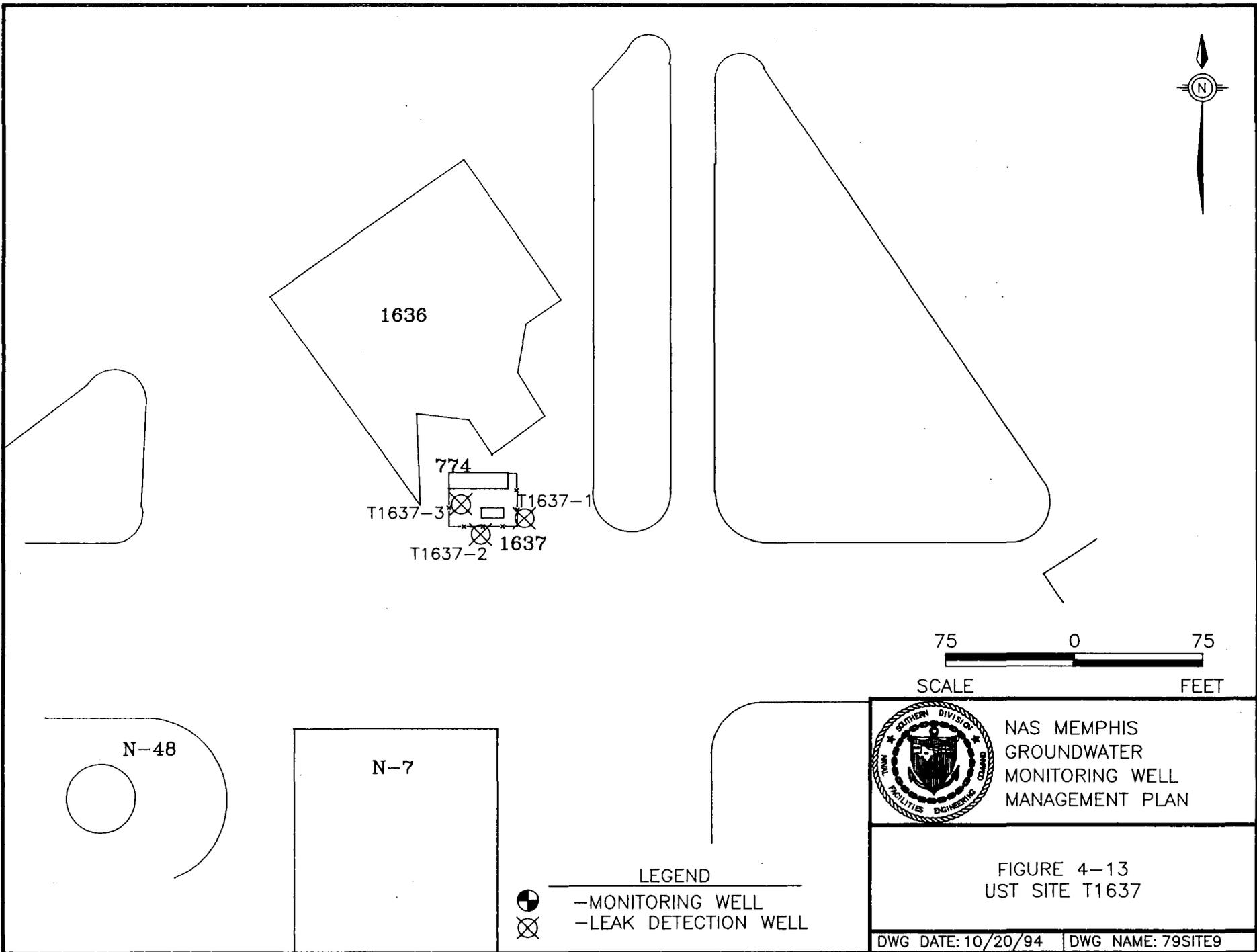
Approximately 3 feet of sediment were noted at the bottom of well T1637-2. The sediment should not affect the well function for leak detection from UST T1637. The sediment may be removed by jetting the well or by surging and pumping.

4.2 Other Water Wells

The facility production wells and several miscellaneous wells were added to this survey under a scope modification. The primary source of information for these wells was an intraoffice memorandum on file at the Public Works Office, dated May 4, 1994.

4.2.1 Production Potable Water Wells

There are five production water wells at NAS Memphis, all of which were inspected for this action. Each well appeared to be in good condition and was secured by chain-link fences and locked gates. No attempt was made to measure water levels in these wells since they are active. Table 4-1 includes total well depth and production capacity.



1636

774

T1637-3

T1637-1

T1637-2

1637

N-48

N-7

75 0 75
SCALE FEET



NAS MEMPHIS
GROUNDWATER
MONITORING WELL
MANAGEMENT PLAN

LEGEND
 ○ — MONITORING WELL
 ⊗ — LEAK DETECTION WELL

FIGURE 4-13
UST SITE T1637

DWG DATE: 10/20/94 | DWG NAME: 79SITE9

Table 4-1 Production Well Data		
Production Wells	Depth Feet	Capacity CPM*
No. 1	523	700-1000
No. 2	466	700-1000
No. 3	1450	1000-1476
No. 4	1450	900-1404
No. 5	1435	1400-1823

Notes:

*GPM — Gallons per minute

4.2.2 Nonpotable Water Wells

Six nonpotable water wells were inspected for this action. Four are temporarily out-of-service including test well No. 1 (TW-1); Building N-761 (the Lakehouse) well number N761-1; well S172-1 at Building S-172 near the Lakehouse; and the well near the end of Runway 9, RWY-9. The two remaining nonpotable water wells include well OCP-1 at the Officers Club Poolhouse, and GC-1 at the golf course across the road from the club house.

TW-1 was completed during the potable water system upgrade in 1983. The wellhead is an 8-inch steel casing and is welded closed. This wellhead is secured, but should be routinely inspected for competency.

N-761 This well is located in a closet in the dining room of the Lakehouse. The casing is made of 4-inch PVC and is flush mounted with the floor. An expandable well cap and lock were installed by the USGS in April 1994. The age and purpose of this well was not determined. The expandable cap should be replaced with a hex-key cap and a label or tag should be mounted on the well pad indicating "*MONITORING WELL — DO NOT FILL.*"

S172-1 This well is in a small storage yard just east of the Lakehouse. The well is a 2-inch galvanized steel pipe and has a 4-inch PVC surface casing. There is no well pad or steel protective casing. An expandable well cap with a lock was installed by the USGS in April 1994.

The purpose and age of this well was not determined. A complete above-grade well pad is required including four guard posts, a hex-key well cap, and a label or tag should be mounted on the well pad indicating "*MONITORING WELL — DO NOT FILL.*"

RWY-9 This well is at the edge of the farmed field near the end of Runway 9. The well is 4-inch PVC and has a plastic "box-like" cover. Parts of a pump mount were still in place, but the pump appeared to have been removed. The age and use of this well was not determined, however, based on the relative location to the farmed area and the shallow depth, this well was likely used for irrigation. A complete above-grade well pad is required including four guard posts, a hex-key well cap, and a label or tag should be mounted on the well pad indicating "*MONITORING WELL — DO NOT FILL.*"

OCP-1 in the Bathhouse (Building S-198) is next to a small boiler. Water conditioning additives are improperly stored in this area and apparently have caused the floor to rot away and many pipes to corrode. A pump is mounted at the wellhead of OCP-1 but the pad has been undercut by weathering, indicating well integrity may be in jeopardy. The wellhead should be repaired to prevent surface runoff from entering the well casing.

GC-1 is across the road from the club house. A pump is mounted at the wellhead. This well produces irrigation water for the golf course and reportedly is not connected to the potable water system. The wellhead appeared in good condition.

4.2.3 Abandoned Production Wells and Test Holes

Six production wells supplied potable water to NAS Memphis from 1942 until 1983. Four wells (N-2, S-1, S-2, and S-3) were closed as part of the potable water system upgrade due to poor water quality. The reported well depths ranged from 340 to 510 feet and were reportedly screened in the "500 Foot Sands" aquifer, a.k.a. the Memphis Sand Formation. The closure procedure reportedly involved completely filling the total depth of each well casing with concrete. The two remaining wells (No. 1 and No. 2) were upgraded and three new potable wells were installed. These wells were previously discussed in Section 4.2.1.

5.0 REPAIR COST ESTIMATE

The unit cost for each recommended action is presented in Table 5-1 and the associated labor cost estimate is presented in Table 5-2. The estimated time to complete these tasks is approximately four weeks, weather permitting. All repairs should be completed by a drilling contractor licensed in the State of Tennessee, a Tennessee State registered geologist or professional engineer. The proper well permits should be obtained before any well modifications or repairs are begun.

The total cost for recommended material is \$10,428 and for labor is \$3,470 making the total estimated costs for Phase II of \$13,898.

The costs for each repair item are:

Brass Keyed-alike locks	8.00
Monitoring well labels MONITORING WELL — DO NOT FILL	5.00
Hex-key well caps	
2-inch	10.00
4-inch	15.00
Above-grade well pads	350.00
With riser repair	425.00
Flush-grade well pads	150.00
Flush-grade pad repairs	50.00
Paint above-grade pad repairs	80.00
Geologist labor rate per hour	30.68

Table 5-1 Summary of Estimated Material Costs		
Site	Remedial Action	Est. Costs \$
SWMU - SITE 2 Southside Landfill	Repair riser and above-grade well pad — 2 wells	850
	Replace above-grade well pad — 3 wells	1050
	Replace well cap and lock — 5 wells	90
SWMU - SITE 3 N-121, Dry Well	Repair riser and above-grade well pad — 1 well	425
	Replace above-grade well pad — 2 wells	700
	Replace well cap and lock — 3 wells	54
SWMU - SITE 7	Replace well cap	10
SWMU - SITE 8 Cemetery Disposal	Repair riser and above-grade well pad — 3 wells	1275
	Replace well cap and lock — 3 wells	54
Navy Flying Club	Close 15 ft well by over-drilling — 2 wells	1000
	Replace locks — 6 wells	48
N-126, North Fuel Farm	Label 5 leak-detection wells	25
	Replace locks — 6 wells	48
N-94, North Fuel Farm	Paint above-grade wellheads — 3 wells	240
	Label 7 leak detection wells	35
	Replace locks — 3 wells	24
AFFTF	Paint above-grade wellheads — 11 wells	880
	Label 4 leak-detection wells	20
	Replace locks — 11 wells	88
Navy Exchange Building 757	Replace 1 flush-grade well pad and manhole	150
	Install 4 above-grade wellheads	1400
	Replace locks - 4 wells	32
Building S-378	Label 4 leak-detection wells	20
Building S-237	Paint 3 above-grade wellheads	240
	Replace locks - 3 wells	24
JP-5 Fuel Farm	Label 6 leak-detection wells	30
UST T1637 Building 774	Replace 1 flush-grade well pad and manhole	150
	Label 3 leak-detection wells	15
N761-1	Replace well cap	10
	Label well	5
S172-1	Install above-grade well pad	350
	Replace well cap and lock	13
	Label well	5
RWY-9	Install above-grade well pad	350
	Replace well cap and lock	13
	Label well	5
OCP-1	Repair well pad	300
Miscellaneous	Field Supplies/Equipment Rental/Shipping/Mileage	400
Total Estimate		10,428

Table 5-1 Summary of Estimated Costs		
Site	Labor	Est. Costs \$
SWMU - SITE 2 Southside Landfill	E/A&H oversight — Geologist 20 hr @ 30.68/hr	614
SWMU - SITE 3 N-121, Dry Well	E/A&H oversight — Geologist 16 hr @ 30.68/hr	491
SWMU - SITE 8 Cemetery Disposal	E/A&H oversight — Geologist 10 hr @ 30.68/hr	307
Navy Flying Club	E/A&H oversight — Geologist 8 hr @ 30.68/hr	246
N-94, North Fuel Farm	E/A&H oversight — Geologist 6 hr @ 30.68/hr	123
AFFTF	E/A&H oversight — Geologist 12 hr @ 30.68/hr	368
Navy Exchange Building 757	E/A&H oversight — Geologist 20 hr @ 30.68/hr	614
Building S-237	E/A&H oversight — Geologist 4 hr @ 30.68/hr	123
UST T1637 Building 774	E/A&H oversight — Geologist 6 hr @ 30.68/hr	92
S172-1	E/A&H oversight — Geologist 4 hr @ 30.68/hr	123
RWY-9	E/A&H oversight — Geologist 4 hr @ 30.68/hr	123
OCP-1	E/A&H oversight — Geologist 4 hr @ 30.68/hr	123
Replace well caps, locks and well labels^a	E/A&H oversight — Geologist 4 hr @ 30.68/hr	123
Total Labor Estimate		3,470

^a This applies to site recommended for well cap and lock replacement, and labelling only.

SWMU-Site 7
 N-126
 S-376
 JP-5 Fuel Farm
 N761-1

6.0 GROUNDWATER MONITORING WELL MANAGEMENT

Each groundwater monitoring well should be routinely inspected for integrity at least once every six months. This inspection may be waived if the wells were sampled or installed within six months of the planned inspection date. The following items should be assessed during each inspection:

- 1) Well pad condition — inspect for damage and/or weathering.
- 2) Surface casing condition and security — inspect for damage.
- 3) Manhole and pad condition — inspect for damage, weathering and leak protection.
- 4) Well caps condition and security — inspect for integrity of leak protection.
- 5) General condition.

The soil beneath many leak-detection wells is eroding. Routine inspection should include assessing the potential breach of well integrity by erosion at these wells. All new well installations should be constructed to the specifications outlined in the ARARs presented Appendix A.

APPENDIX A

ARARs

**Applicable or Relevant
and
Appropriate Requirements**

**SOUTHERN DIVISION NAVAL FACILITIES
ENGINEERING COMMAND**

**GUIDELINES FOR GROUNDWATER MONITORING
WELL INSTALLATION**

PART 1: GENERAL

1.1 INTRODUCTION

Groundwater monitoring wells shall be located at sites approved by the Southern Division Engineer-In-Charge (EIC) and the Activity Environmental Coordinator (EC). All applicable local, state and federal regulations concerning well installations or soil borings shall be followed.

1.2 APPLICABLE PUBLICATIONS

The publications listed below form a part of this guideline to the extent referenced. The publications are referred to in this text by designation only. The latest revision of the specifications shall be followed.

**1.2.1 American Association of State Highway and Transportation
Officials (AASHTO)**

M 220 Epoxy Coatings Specifications

1.2.2 American Society of Testing and Materials (ASTM)

A 120 Pipe, Steel, Black and Hot-dipped, Zinc coated, welded and seamless

A 312 Seamless and Welded Austenitic Stainless Steel Pipe

B 209 Aluminum and Aluminum-alloy Sheet and Plate

C 150 Portland Cement

C 778 Standard Sand

D 1457 Polytetrafluoroethylene (PTFE) Molding and Extrusion Materials

D 1785 Standard Specification of Polyvinyl Chloride Pipe (PVC Pipe, Schedules 40, 80, 120)

D 1586 Method for Penetration Test and Split Barrel Sampling of Soils

GUIDELINES FOR GROUNDWATER MONITORING WELL INSTALLATION (cont'd)

2.1.6 Annular Space Fill Materials

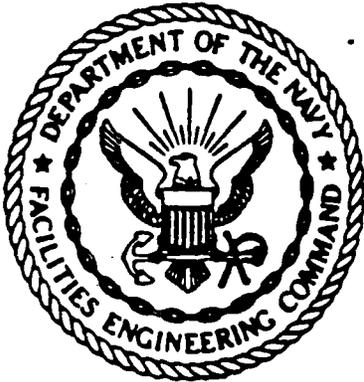
- a. Filter pack shall be 98% pure silica, cleaned with potable water, have a uniformity coefficient of 1-3, and a specific gravity of 2.6 - 2.7. The filter pack shall meet ASTM C 775 standard sand specifications.
- b. 1/4-inch bentonite pellets shall be 90% montmorillonite clay, with a bulk dry density 80 lbs/cu ft, a specific gravity 1.2, and a pH of 8.5-10.5.
- c. Granular bentonite shall conform to API std 13-A for bentonite.
- d. Portland Cement shall conform to ASTM C 150 Type I.

2.1.7 Surface Casing: shall be constructed of steel meeting ASTM A 120 and shall have a wall thickness as specified below.

- a. 24 inch diameter 0.25 inch wall thickness
- b. 20 inch diameter 0.25 inch wall thickness
- c. 16 inch diameter 0.25 inch wall thickness
- d. 10.75 inch diameter 0.25 inch wall thickness
- e. 24 inch diameter 0.50 inch wall thickness
- f. 20 inch diameter 0.50 inch wall thickness
- g. 16 inch diameter 0.50 inch wall thickness
- h. 10.75 inch diameter 0.365 inch wall thickness

2.1.8 Surface Completion: all materials provided for a well surface completion shall conform to the specifications listed below.

- a. Locking 16-gauge steel protective well cover, round or square and 5-ft in length
- b. Flush mount 22-gauge steel, water resistant welded box with 3/8-inch steel lid, locking device and padlock guard
- c. Concrete pad at ground surface (3' X 4' X 6") ASTM C 150
- d. Padlock (brass, corrosion resistant, keyed alike) ASTM F 883
- e. Steel protective post (4-inch diameter, 6-ft length, 1/4-inch thickness, concrete filled) ASTM A 120.
- f. Well designation sign, sheet aluminum, ASTM B 209, 1/8 inch by 18 inch by 6 inch, anchors and fasteners compatible with sign, designation to be provided by EIC, the designation shall be stamped into the plate with 4-inch letters and numbers.
- g. High visibility yellow epoxy paint AASHTO M220.



FEBRUARY 1985

GROUND-WATER MONITORING GUIDE

NEESA 20.2-031A



**NAVAL ENERGY AND ENVIRONMENTAL
SUPPORT ACTIVITY**

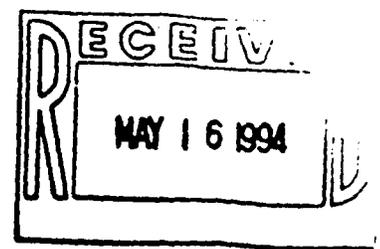
Port Hueneme, California 93043

shrink and crack upon curing (Barcelona, Gibb, and Miller, 1983) and that the seal between the casing and grout may not be perfect, but the procedure described is generally accepted as the safest method of preventing downhole migration of contaminants. Expanding cements are being considered (Barcelona, Gibb, and Miller, 1983), but experimental data that compares the performance of different grout mixtures are not available.

5.5 SURFACE PROTECTION. The surface extension of the monitoring well is protected by an oversize, steel casing approximately 5 feet long. This casing is sleeved over the monitoring well and grouted from 2 feet below the ground surface to the ground surface. Three feet of the oversize casing extends to slightly above the top of the monitoring well cap. The protective casing may be set and grouted in place during monitor well completion; otherwise, the grouting of the annulus should be stopped about 2 feet below the surface to leave room for grouting the protective casing. A drain hole just above the final grout level will permit the escape of any water that might collect between the well casing and the protective casing. This drain is especially important if the well casing is plastic because during the winter season trapped water might freeze and rupture the well casing. Even during warm or cool seasons, trapped water would be stagnant, malodorous, and encourage pest growth.

If the ground-water monitoring well is located in a trafficked area, three or four protective posts in a triangular or rectangular pattern 3 to 4 feet from the well will protect the well from damage. Steel pipe, 4 to 6 inches in diameter, set 3 to 4 ft in concrete or cement grout and extending 4 to 5 feet above ground is sufficient protection. Larger diameter pipe, later filled with concrete, or steel I beams set 6 to 8 feet in concrete can be used in high threat areas. Treated posts set 2 to 3 feet in soil will protect the well from incidental traffic. All protective post, and casing, should be painted for both visibility and protection from the environment.

5.6 AQUIFER PROTECTION. Primary aquifer protection is afforded by the downhole bentonite sealer and grouted annulus, but repetitive sampling and the attendant foot traffic in the immediate vicinity of the well can encourage



STATE OF TENNESSEE
DEPARTMENT OF ENVIRONMENT AND CONSERVATION
Division of Water Supply
401 Church Street, L & C Tower 6th Floor
Nashville Tennessee 37243-1549

ANNOUNCEMENT

NEW RULES FOR WATER WELL CONSTRUCTION
TO BECOME EFFECTIVE AUGUST 5 1993

THE DEPARTMENT'S PROPOSED NEW RULES FOR WATER WELL CONSTRUCTION HAVE BEEN APPROVED BY THE ATTORNEY GENERAL AND FILED WITH THE SECRETARY OF STATE. THEY WILL BECOME EFFECTIVE AUGUST 5, 1993.

The most drastic change to be wrought by these new rules is the requirement for payment of a one-time registration/inspection fee of \$ 75.00 to be paid to the Department by the supervising driller when he files his report of well completion. All water wells drilled on or after August 5, 1993 must have the seventy five dollar (\$75) registration/inspection fee submitted with the well completion report. These reports must also be submitted within thirty days from date of completion of drilling each water well. Other major changes include increasing the minimum standards for steel well casing. For example, the nominal six-inch I.D. steel casing must have a minimum wall thickness of .185 inch and weigh almost 13 pounds per foot. The .155 inch wall thickness, 11-pound-per-foot, well casing can no longer be used.

Rules for disinfection and repair of water wells have also been revised and made more specific as to when and how water wells must be treated to avoid bacterial contamination. Similarly, requirements for well development have been strengthened to avoid "muddy wells."

Official copies of the new rules are being printed and will be circulated to all concerned as soon as they become available. In the meantime, the enclosed copy, which is a duplicate of the rules as they were submitted to the Attorney General's office, are essentially complete and correct. Please note that the old set of rules known as chapter 400-4-2 will be repealed in their entirety when the new rules become effective.

Instructions and guidelines will be forthcoming to assist all concerned in complying with the new rules for constructing and repairing "wells for the production of water." Please bear with us in this time for change. There are, to be sure, many questions to be answered and many procedures to be worked out to the satisfaction of all concerned. Hopefully, both the resource and the business will benefit.

4. Cathodic protection wells.
 5. Wells used for dewatering purposes in construction work.
 6. Monitor wells, geotechnical test borings and piezometers that are regulated by rules of the Water Quality Control Board or otherwise by the Department.
 7. Ponds, pits, sumps and drainage trenches.
 8. Contaminant recovery wells otherwise regulated by the Department.
- (27) "Pumps" and "pumping equipment" means any equipment or materials utilized or intended for use in withdrawing or obtaining ground-water, including well seals.
- (28) "Recovery well" means any well constructed for the purpose of removing contaminated ground water or other liquids from the subsurface.
- (29) "Repair" means work involved in deepening, reaming, sealing, installing, or changing casing depths, perforating, screening, or cleaning, acidizing, or redevelopment of a well excavation, or any other work which results in breaking or opening a well seal.
- (30) "Standard Dimension Ratio (SDR)" means the quotient obtained when the outside diameter of thermoplastic well casing is divided by the wall thickness.
- (31) "Static water level" means the level at which the water stands in the well when the well is not being pumped and is expressed as the distance from a fixed reference point to the water level in the well.
- (32) "Supervision" means the act of overseeing, directing and managing workers engaged in the business of constructing wells, or installing pumps or installing water treatment equipment on well or spring supplies.
- (33) "Well" or "water well" means a hole drilled, re-drilled or dug into the earth, by boring or otherwise, for the production of water.
- (34) "Well construction" means all acts necessary to construct wells for the production of water including but not limited to the location and excavation of the well; placement of casings, screens and fittings; development and testing.
- (35) "Well development" means the procedures used to remove mud or fine material from the drilled borehole, correct any damage to the aquifer that occurred during drilling and improve the water passageways into the well from the aquifer.
- (36) "Well driller" or "water-well contractor" means any individual, firm or corporation engaged in the business of constructing wells.

- (37) "Well head" means the upper terminal of the well including adapters, ports, valves, seals, and other attachments.
- (38) "Well seal" means an approved arrangement or device used to cap a well or to establish and maintain a junction between the casing of a well and the piping or equipment installed therein, the purpose or function of which is to prevent pollutants from entering the well at the upper terminal.

Statutory Authority: T.C.A. 69-11-106 and T.C.A. 4-5-201 et. seq.

NEW RULES

TABLE OF CONTENTS

	<u>PAGE NO.</u>
1200-4-9-.10	WELL CONSTRUCTION STANDARDS 6
	(1) Requirements 6
	(2) Location 7
	(3) Source of Water Supply 8
	(4) Drilling Fluids 8
	(5) Casing 8
	(6) Backfilling and Grouting 10
	(7) Well Screens 11
	(8) Gravel-Packed Wells 11
	(9) Large Diameter Wells 12
	(10) Well Development 12
	(11) Wellhead Completion 13
1200-4-9-.11	INSTALLATION OF PUMPS, FILTERS AND WATER TREATMENT UNITS 13
1200-4-9-.12	DISINFECTION OF WATER SUPPLY WELLS 14
1200-4-9-.13	REPAIR OF WATER WELLS. 17
1200-4-9-.14	WELL REGISTRATION - IDENTIFICATION 17
1200-4-9-.15	DATA AND REPORTS REQUIRED 18

1200-4-9-.10 WELL CONSTRUCTION STANDARDS

These rules will apply solely to wells constructed for the production of water from underground sources and have no application to wells constructed for quarry blast holes or mineral prospecting, or any purpose other than production of water.

(1) Requirements

- (a) No person shall construct, reconstruct, or repair, or cause to be constructed, reconstructed or repaired any water well; nor shall any person install, repair, or cause to be installed or repaired any pump, pumping equipment, water filter or water treatment device to be used on a water well except in accordance with the provisions of the Water Wells Act (T.C.A. 69-11-101 et. seq.) and these rules.
- (b) Every well driller, within thirty (30) days after completion of a water well, shall submit a report on the construction or reconstruction of the well to the Department. The well completion report shall be made on a form provided by the Department or a reasonable facsimile approved by the Department.

- (c) For each water well completed in Tennessee after the effective date of this rule, a one-time registration/inspection fee of seventy five dollars (\$75.00) shall be paid to the Department by the driller or contractor who supervised the drilling of the well.
1. The fee shall be submitted to the Department by the driller at the time of submission of the well completion report.
 2. The amount of the registration/inspection fee shall be reviewed annually by the Board and their recommendations for adjustment of the fee shall be presented to the Commissioner for final action.
 3. The requirement of payment to the Department of a one-time registration/inspection fee shall not apply to water wells drilled in any local jurisdiction which is authorized, by private act or pursuant to the provisions of an adopted "home rule" charter, to regulate the location and construction of water wells and which has established a fee for the inspection of water wells.
- (d) When strict compliance with these standards is impractical, the driller or installer shall make application to the Department for approval of equivalent alternative standards (a variance) prior to the work being done. The Department may grant the request for a variance based on if it determines the proposed standards offer an equivalent or higher level of protection to the environment. In an emergency or in exceptional instances, the Department will respond to a verbal request provided the applicant submits a written application within ten (10) days of the verbal application.

Statutory Authority: T.C.A. 69-11-106, T.C.A. 69-1-1303 and T.C.A. 4-5-201 et. seq.

(2) Location

- (a) The construction of a water well is prohibited at other than a safe distance from any known potential source of contamination. The minimum safe distances shown in Table A shall apply for the sources of contamination listed therein:
- (b) A water-supply well may be constructed in an area subject to flooding provided the top of the water tight casing terminates not less than two (2) feet above the maximum recorded flood elevation.
- (c) ~~Location~~ buildings, pits, and basements:
1. A well located adjacent to a building shall be so located that the center line of the well extended vertically will clear any projection from the building by not less than five (5) feet.
 2. New wells shall not be constructed in pits or basements.
- (d) New wells shall not be constructed closer than 25 feet from property lines or highway rights-of-way.

TABLE A

**MINIMUM DISTANCES TO SEPARATE WATER WELLS
FROM POTENTIAL SOURCES OF CONTAMINATION**

SOURCES OF CONTAMINATION	MINIMUM DISTANCES
Animal pens or feed lots	100 feet
Leaching Pits sewage lagoons	100 feet
Fit Privys or sewer lines	75 feet
Sludge disposal sites	100 feet
Subsurface Sewage Disposal Systems	50 feet
Septic tanks and drain fields	50 feet

(3) Source of Water Supply

- (a) The source of water for any well shall be at least twenty (20) feet below the surface of the ground.
- (b) The driller shall develop the most favorable water-bearing zone(s) and seal off any source(s) of less desirable quality.
- (c) It shall be the duty of any person attempting to construct a water well to seal off salt water, oil, gas, or any other fluid or material which might contaminate a source of fresh water.

(4) Drilling Fluids

- (a) Water used for drilling shall be obtained from a potable water source, or shall be treated with enough liquid bleach or hypochlorite granules to retain a free-chlorine residual content of at least 5 parts per million (ppm).
- (b) Drilling fluids and additives shall be materials specified by the manufacturer for use in water well construction and approved by the Department.
- (c) During the course of drilling a water well with air rotary equipment, a minimum of three (3) gallons per minute of water must be injected or added into the air stream.

(5) Casing

- (a) Wells drilled for the production of water shall be cased with watertight casing extending from at least six (6) inches above to at least twenty (20) feet below the land surface. For wells located in areas subject to flooding, see rule 1200-4-9-.10(2)(b).
 - 1. The watertight casing in wells constructed to obtain water from a consolidated rock formation shall be firmly seated and sealed below all crevices that release inferior quality water or mud into the well or to a depth of at least five (5) feet below the top of the consolidated rock whichever is greater.

2. The watertight casing in wells constructed to produce water from an unconsolidated aquifer (such as saturated gravel or sand) shall extend at least to the top of the aquifer or to a depth of 20 feet which ever is greater.
- (b) Except as otherwise specified in these regulations, the permanent well casing shall:
1. Be new, seamless or welded, black or galvanized steel pipe conforming to the weights and dimensions given in Table B and meeting the American Society for Testing and Materials (ASTM) Standards A53-87b or A589-85. Used or reject pipe shall not be used;
 2. Have water-tight joints that may be welded, or threaded and coupled; and
 3. Be equipped with a drive shoe if the casing is to be driven.
 4. Pipe sizes that are not listed in Table B and are less than ten (10) inches in diameter shall match listed values as closely as possible.
 5. Pipe sizes that are ten (10) inches in diameter or larger shall be Schedule 20 pipe as a minimum.

TABLE B

MINIMUM DIMENSIONS AND WEIGHTS FOR WATER WELL CASING

Diameters in inches		Minimum Wall Thickness in Inches	Weights in Pounds per Foot Plain Ends Only
External	Internal		
3.500	3.250	0.125	4.51
4.000	3.732	0.134	5.53
4.500	4.216	0.142	6.61
5.500	5.192	0.154	8.79
6.000	5.672	0.164	10.22
6.625	6.255	0.185	12.72
8.625	8.249	0.188	16.90

- (c) Thermoplastic well casing may be installed in wells constructed to obtain water from unconsolidated aquifers (such as saturated gravel, sand or overburden) provided:
1. The casing is new;
 2. The casing meets or exceeds the requirements of ASTM Standard F-480-88 and bears the NSF (National Sanitation Foundation) seal in each section of casing;
 3. The Standard Dimension Ratio (SDR) shall not exceed 26;

4. The casing is installed after the borehole has been drilled to the final depth of the finished well, and no additional drilling takes place after the casing has been installed; and
 5. Joints shall be solvent cemented with a quick-setting cement, or threaded and coupled.
- (d) In areas where the water is obtained from overburden above the consolidated rock surface, the casing shall be set at or just above the consolidated rock. A screen may be attached to the bottom of the casing or the lowermost few feet of the casing may be slotted or perforated to allow water to enter the well provided the top of the screen or the topmost perforation in the casing is at least 20 feet below land surface. The completed well shall be finished so that extraneous material such as sediment cannot enter the well.

(6) Backfilling and Grouting

- (a) The annular space between the casing and borehole wall of the well shall be backfilled with an impervious material such as grout, bentonite chips or cuttings mixed with bentonite granules or pellets.
- (b) Placement of the backfill material shall be done in such a way that there are no bridges or gaps in the annulus. The top of the backfill material shall remain level with the land surface surrounding the well.
- (c) If bentonite-based grout is used for backfill, it shall be placed in accordance with the manufacturers recommendations.
- (d) If cement-based grout is used for backfill, it shall be placed around the casing by one of the following methods:

1. Pressure

The annular space between the casing and the borehole wall shall be a minimum of one and five-tenths (1.5) inches, and grout shall be pumped or forced under pressure through the bottom of the casing until it fills the annular space around the casing and overflows at the surface; or

2. Pumping

The annular space between the casing and formation shall be a minimum of two (2) inches and grout shall be pumped into place through a pipe or hose extended to the bottom of the annular space which can be raised as the grout is applied, but the grout pipe or hose shall remain submerged in grout during the entire application; or

3. Other

The annular space between the casing and the borehole wall shall be a minimum of three (3) inches and the annular space shall be completely filled with grout by any method that will insure

complete filling of the space, provided the annular area does not contain water or other fluid. If the annular area contains water or other fluid, it shall be evacuated of fluid or the grout shall be placed by the pumping or pressure method.

(7) Well Screens

- (a) Any water well finished in an unconsolidated rock formation shall be equipped with a screen or perforated pipe that will adequately prevent the entrance of soil or formation material into the well after the well has been developed and completed by the well contractor.
- (b) - The well screen shall:
1. Be of steel, stainless steel, plastic or other Department approved material and shall be of a strength to satisfactorily withstand chemical and physical forces applied to it during and after installation;
 2. Be of a design to permit optimum development of the aquifer with minimum head loss consistent with the intended use of the well;
 3. Have openings designed to prevent clogging and shall be free of rough edges, irregularities or other defects that may accelerate or contribute to corrosion or clogging; and
 4. Be provided with such fittings as are necessary to seal the top of the screen to the watertight casing and to close the bottom. If the screen is installed through the casing, a packer, seal or other approved design shall be used to prevent the entry of ground water into the well through any openings other than the screen.
- (c) Multi-screened wells shall not connect aquifers or zones which have differences in:
1. Water quality to the extent that intermixing of the waters would result in deterioration of the water quality in any aquifer or zone.
 2. Static water levels that would result in depletion of water from any aquifer or zone, or significant loss of head in any aquifer or zone.

(8) Gravel-Packed Wells

- (a) In constructing a gravel-packed well:
1. The gravel shall be composed of quartz, granite, or similar rock material and shall be clean, rounded, uniform, water-washed and free from clay, silt, or other deleterious material.
 2. The gravel shall be placed in the annular space around the screens and casing by any method that will insure accurate placement and avoid bridging or segregation.

3. The gravel pack shall have a minimum thickness of at least two (2) inches and shall not extend more than ten (10) feet above the top of the screen or perforated pipe.
 4. The gravel shall be disinfected using water with a free chlorine residual of at least 50 parts per million (ppm).
- (b) The gravel pack shall not connect aquifers or zones which have differences:
1. In water quality that would result in deterioration of the water quality in any aquifer or zone.
 2. In static water levels that would result in depletion of water from any aquifer or significant loss of head in any aquifer or zone.

(9) Large Diameter Wells

- (a) Large-diameter bored or augered wells may be cased with concrete pipe provided such wells are constructed as follows:
1. The bore hole shall have a minimum diameter of six (6) inches larger than the outside diameter of the casing.
 2. The annular space around the casing shall be filled with grout to a depth at least five feet below the static water level or twenty (20) feet below land surface, whichever is greater. The grout shall be placed in accordance with the requirements of rule 1200-4-9-.10(6)(d).
 3. The annular space around the casing below the grout shall be completely filled with sand or gravel that has been disinfected with water containing a free-chlorine residual of at least 50 parts per million (ppm).
 4. The sand or gravel material shall be composed of quartz, granite, or similar rock material and shall be clean, rounded, uniform, water-washed and free from clay, silt, or other deleterious material.
- (b) The wellhead shall be completed in the same manner as required for other water-supply wells.

(10) Well Development

Prior to completion of a well for water supply, the driller shall take all steps necessary to:

- (a) Remove any mud, drill cuttings, or other foreign matter from the entire depth of the well;
- (b) Correct any damage to the aquifer that might have occurred during drilling; and
- (c) Disinfect the well.

(11) Wellhead Completion

- (a) The top of the casing shall be cut off smooth and level, be free from dents and cracks, and shall terminate at least six (6) inches above the land surface except in areas subject to flooding. See Rule 1200-4-9-.10(2)(b).
- (b) No well casing shall be cut off or cut into below ground surface except by a licensed driller or licensed installer to install a pitless unit or adapter. Pitless units or adapters shall comply with the Water Systems Council's Pitless Adapter Division (PAD) PAS-1 (6th Ed., March 1987) and shall bear the PAD symbol of certification or shall otherwise have been approved by the Department.
- (c) Pitless units or adapters shall be constructed and installed so as to prevent the entrance of contaminants into the well or potable water supply, conduct water from the well, protect the water from freezing, and provide access to water system parts within the well.
- (d) The surface surrounding the well head shall slope away from the well head in all directions.
- (e) Every water well that flows under natural artesian pressure shall be equipped with a valve so that the flow can be completely stopped.

Statutory Authority: T.C.A. 69-11-106 and T.C.A. 4-5-201 et. seg.

1200-4-9-.11 INSTALLATION OF PUMPS, FILTERS AND WATER TREATMENT UNITS

Primary responsibility for compliance with the provisions set forth herein for the installation of water well pumps, filters and water treatment units rests with the installer of these devices.

- (1) The capacity of the pump shall be consistent with the intended use and yield characteristics of the well.
- (2) The pump and related equipment for the well shall be conveniently located to permit easy access and removal for repair and maintenance.
- (3) The base plate of a pump placed directly over the well shall be designed to form a watertight seal with the well casing or pump foundation.
- (4) In installations where the pump is not located directly over the well, the annular space between the casing and pump intake or discharge piping shall be closed with a watertight seal designed specifically for this purpose.
- (5) The well shall be properly vented at the wellhead to allow for pressure changes within the well. The vent shall be screened to prevent entry of insects.

- (6) Any suction line installed underground between the well and pump shall be surrounded by six (6) inches of impervious material such as cement, or encased in a larger pipe that is sealed at each end.
- (7) All conduits, valves and other plumbing fixtures used to convey water from a water-supply well to any building or other outlet shall be installed in accordance with manufacturer's requirements.
- (8) All pressure tanks shall be installed above ground unless the tank is specifically designated by the manufacturer for below ground burial.
- (9) The electrical wiring and equipment used in connection with the installation of a water well pump shall:
 - (a) Meet underwriters specifications;
 - (b) Be installed in accordance with the National Electrical Code or local codes and ordinances if the latter are more restrictive;
 - (c) Be equipped with a fused or circuit breaker disconnect switch.
 - (d) Be served by an entirely separate circuit from other equipment.
- (10) Water filters and water treatment units shall be installed and serviced to accommodate water quality problems as determined by physical, chemical or bacteriological evaluation or field test; and the function of the equipment shall achieve the results specified by the manufacturer. In servicing and installing treatment units the sanitation of the water supply shall be protected.

Statutory Authority: T.C.A. 69-11-106 and T.C.A. 4-5-201 et. seq.

1200-4-9-.12 DISINFECTION OF WATER WELLS

- (1) All water wells shall be disinfected upon completion of construction, reworking, pump installation or repairs as follows:
 - (a) A chlorine solution shall be placed in the well in sufficient dosage to produce a chlorine residual of at least one hundred (100) parts per million (ppm) in the water standing in the well (see Tables C and D for the correct amount). A chlorine solution may be prepared by dissolving dry hypochlorite granules (trade names include HTH, Chlor-Tabs, etc.) in water or by liquid bleach (trade names include Clorox, Purex, etc.). (CAUTION: When working with chlorine, persons should be in a well ventilated place. The powder or strong liquid should not come in contact with skin or clothing. Solutions are best handled in wood, plastic or crockery containers because metals are corroded by strong chlorine solutions).

Table C - Quantity of disinfectant required to produce a free chlorine residual of 100 parts per million (ppm) in drilled wells

Feet of Water	Liquid Bleach (Clorox, Purex, etc.) (5.25 % Chlorine)			Dry Granules (HTH, Clor-Tabs, etc.) (70% Chlorine)			Feet of Water
	Well Diameter			Well Diameter			
	4-inch	6-inch	8-inch	4-inch	6-inch	8-inch	
10	1/4 cup	1/2 cup	1 cup	1 tab.	2 tabs.	1/2 oz.	10
20	1/2 cup	1 cup	1 pt.	2 tabs.	4 tabs.	1 oz.	20
30	3/4 cup	1 1/2 cups	1 1/2 pts.	3 tabs.	1 oz.	1 1/2 ozs.	30
40	1 cup	1 pt.	1 3/4 pts.	4 tabs.	1 1/4 ozs.	2 ozs.	40
50	1 1/4 cups	1 1/4 pts.	1 qt.	5 tabs.	1 1/2 ozs.	2 1/2 ozs.	50
60	1 1/3 cups	1 1/2 pts.	1 1/4 qts.	6 tabs.	1 3/4 ozs.	3 ozs.	60
70	1 1/2 cups	1 3/4 pts.	1 1/2 qts.	1 oz.	2 ozs.	3 1/2 ozs.	70
80	1 3/4 cups	1 qt.	1 3/4 qts.	1 oz.	2 1/4 ozs.	4 ozs.	80
90	1 pt.	1 1/4 qts.	2 qts.	1 1/4 ozs.	2 1/2 ozs.	4 1/2 ozs.	90
100	1 1/4 pt.	1 1/4 qts.	2 1/4 qts.	1 1/4 ozs.	3 ozs.	5 ozs.	100
120	1 1/3 pts.	1 1/2 qts.	2 1/2 qts.	1 1/2 ozs.	3 1/2 ozs.	6 ozs.	120
140	1 1/2 pts.	1 3/4 qts.	3 qts.	1 3/4 ozs.	4 ozs.	7 ozs.	140
160	1 3/4 pts.	2 qts.	3 1/2 qts.	2 ozs.	4 1/2 ozs.	1/2 lbs.	160
180	1 qt.	2 1/4 qts.	1 gal.	2 1/4 ozs.	5 ozs.	2/3 lbs.	180
200	1 1/4 qts.	2 1/2 qts.	1 1/4 gal.	2 1/2 ozs.	6 ozs.	3/4 lbs.	200
250	1 1/2 qts.	3 qts.	1 1/2 gals.	3 1/4 ozs.	1/2 lb.	1 lbs.	250
300	2 qts.	1 gal.	1 3/4 gals.	5 ozs.	2/3 lb.	1 lbs.	300
400	9 1/2 qts.	1 1/4 gal.	2 1/4 gals.	6 1/4 ozs.	3/4 lbs.	1 1/2 lbs.	400
500	2 3/4 qts.	1 1/2 gal.	2 3/4 gals.		1 lbs.	2 lbs.	500

Measures: 2 cups = 1 pint (pt)
 2 pints = 1 quart (qt)
 4 quarts = 1 gallon (gal)

7 tablets = 1 ounce (oz)
 8 ounces = 1/2 pound (lb)
 16 ounces = 1 pound (lb)

Equations for calculating amount of disinfectant required to chlorinate drilled wells with diameters larger than 8 inches:

Pints of liquid bleach = $D^2 h + 1500$

Ounces of dry granules = $D^2 h + 1300$,

where: D = Diameter of well in inches

h = height of water above bottom of well in feet.

- (b) Place the required amount of liquid bleach or dry granules in the well by one of the following methods:
 - 1. Dry granules or tablets may be dropped in the top of the well and allowed to settle to the bottom; or
 - 2. Liquid bleach may be mixed with water and poured in the top of the well and allowed to settle to the bottom.
- (c) Agitate the water in the well to insure thorough dispersion of the chlorine throughout the entire length of the well.
- (d) The well casing, pump column and any other equipment above the water level in the well, shall be thoroughly rinsed with the chlorine solution as a part of the disinfecting process.
- (e) The chlorine treated water shall stand in the well for a period not less than twelve (12) hours. The well shall, thereafter, be pumped until the odor of the chlorine is no longer detectable.

1200-4-9-.13 REPAIR OF WATER WELLS

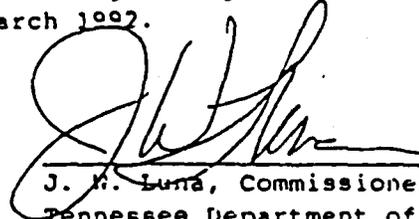
- (1) All materials used in the replacement or repair of any water well shall meet the requirements for a new installation.
- (2) Plastic pipe approved by the National Sanitation Foundation (NSF) and rated at 160 psi (SDR = 26) may be used for liner casing. The liner casing shall be installed with centering guides to insure proper centering in the well and the annular space around the liner casing shall be completely sealed at both ends to repel the inflow of extraneous material from the lined interval.
- (3) Repairs to wells completed with the top of the well casing terminating below ground shall include extending the well casing above land surface in accordance with rule 1200-4-9-.10(5)(a).

Statutory Authority: T.C.A. 69-11-106 and T.C.A. 4-5-201 et. seq.

1200-4-9-.14 WELL REGISTRATION - IDENTIFICATION

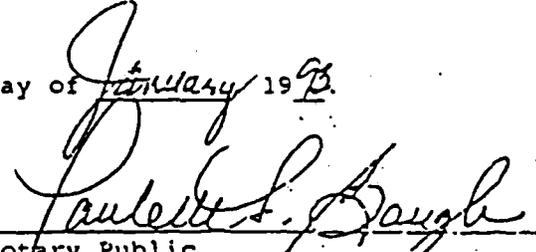
- (1) Each water well constructed or reconstructed after the effective date of this rule shall be equipped immediately upon completion by the driller of the well with an identification tag or decal bearing a registration number to be supplied by the Department.
- (2) The identification tag or decal shall be securely attached to the well casing or other appurtenance where it is readily visible.
- (3) The identification tag or decal shall not be removed from the well unless otherwise approved by the Department.

I certify that this is an accurate and complete copy of rulemaking hearing rules, lawfully promulgated and adopted by the Department of Environment and Conservation on the 21st day of January, 1993. Further, I certify that these rules are properly presented for filing, a notice of rulemaking hearing has been filed in the Department of State on the 27th day of January, 1992 and such notice of rulemaking hearing having been published in the February, 1992, issue of the Tennessee Administrative Register, and such rulemaking hearing having been conducted pursuant thereto on the 17th, 18th, and 19th day of March 1992.



J. N. Luna, Commissioner
Tennessee Department of Environment
and Conservation

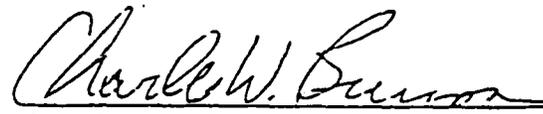
Subscribed and sworn to before me this the 21st day of January 1993.



Pauline S. Baugh
Notary Public

My commission expires on the 27th day of July, 1996.

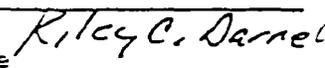
All rulemaking hearing rules provided for herein have been examined by the Attorney General and Reporter of the State of Tennessee and are approved as to legality pursuant to the provisions of the Administrative Procedures Act, Tennessee Code Annotated, Title 4, Chapter 5.



Charles W. Burson
Attorney General and Reporter

The rulemaking hearing rules set out herein were properly filed in the Department of State and will be effective on the 5 day of August, 1993.

12/25/93
1993 JUN 21 PM 1:32
SECRET



Riley C. Darnel
Secretary of State

By: 

**TENNESSEE DEPARTMENT OF
ENVIRONMENT AND CONSERVATION
DIVISION OF UNDERGROUND
STORAGE TANKS**



**ENVIRONMENTAL
ASSESSMENT
GUIDELINES**

JANUARY 1994

II. GROUND WATER INVESTIGATION PROCEDURES

A. Number, Type and Location of Monitoring Wells

A minimum of four (4) single cased or open hole monitoring wells shall be required to begin the ground water investigation. These wells shall be constructed by converting borings B-1 through B-4 into monitoring wells.

All single cased or open hole monitoring wells shall be installed to monitor the uppermost water bearing zone.

If site specific data or geologic conditions require the monitoring of aquifers other than the uppermost, then double cased monitoring wells shall be required. To prevent the vertical movement of contaminants within a borehole or to prevent the cross contamination of multiple aquifers, double cased monitoring wells shall be installed when monitoring a separate, deeper aquifer for contamination. If conditions exist where double cased monitoring wells are required to seal off contaminant zones, the Division shall be contacted and prior approval received before proceeding.

After the installation and sampling of the first four (4) soil borings and monitoring wells the site shall be ranked in accordance with Technical Guidance Document - 014. If the owner/operator decides to proceed with the investigation or is required to based on the site ranking, additional monitoring wells may be required. These additional monitoring wells will be required if the ground water contamination has not been defined to the applicable cleanup levels. If additional monitoring wells are installed they shall not be placed within fifty (50) feet of any other monitoring wells unless prior approval has been granted by the Division.

Prior to installing additional ground water monitoring wells, the following innovative ground water investigative technologies may be used if site conditions are suitable:

1. A soil vapor survey, either active or passive, to estimate the size and location of the ground water contaminant plume and optimize the placement of additional monitoring wells; or,

2. A direct push or hydraulic push instrument to retrieve ground water samples. Once the extent of the ground water contamination is defined, additional ground water wells shall be required for future monitoring.

The Environmental Assessment Report (EAR) shall contain written documentation of the order in which each additional monitoring well was installed, the date of installation, and the rationale for the placement of each monitoring well. The rationale shall include, but not be limited to the distance, depth, and direction of the monitoring wells from all previous monitoring well, taking into consideration:

1. The estimated and/or known contaminant levels in all previously installed monitoring wells;
2. The estimated rate of contaminant migration based on site specific data gathered from all previously installed monitoring wells;
3. The estimated or known ground water flow direction and other factors that could influence the direction of the ground water contaminant plume migration;
4. The estimated and/or known rate of the decline of contaminant levels between all previously installed monitoring wells; and
5. The results of a soil vapor survey, if performed.

The objective in selecting the additional monitoring well locations is to define the outer limits of the ground water contaminant plume without installing a number of intermediate monitoring wells. Without proper rationale for the placement of additional monitoring wells, the cost of the work may not be reimbursed from the Petroleum Underground Storage Tank Fund.

B. Drilling Methods

The following drilling methods are acceptable to the Division:

1. Hollow Stem Auger
2. Air Rotary(downhole hammer or tri-cone)

The following drilling methods shall be allowed only upon special approval of the Division:

1. Mud Rotary
2. Cable Tool

3. Rock Coring
4. Wash Rotary (Tri-Cone)

C. Special Procedures for Documenting Results of Bedrock Sections

1. Camera Logging Procedures

Approval shall be received from the Division prior to camera logging any bedrock wells. Approval shall be granted on a well by well basis. All bedrock wells allowed to be camera logged shall be properly developed prior to logging. The development shall consist of purging the well with a pump to remove particulate matter derived from the drilling process. The pump shall be raised and lowered throughout the water column during purging operations. A minimum of three (3) well volumes shall be purged from the well and the well shall remain undisturbed for a minimum of twenty four (24) hours prior to logging.

All video tapes produced shall be labeled with the following information: facility name, facility ID, monitoring well number, date, time, logging company name and name of professional in charge. All logs shall have a depth indicator visible on the video image. A copy of each log shall be submitted with the EAR.

2. Rock Coring

Approval shall be received from the Division prior to rock coring any bedrock wells. Approval shall be granted on a well by well basis. The core shall be logged and photographed.

D. Single Cased Monitoring Well Installation Procedures

1. Casing and Screen Type

The casing and screen shall be constructed of two (2) inch I.D., pre-cleaned, flush threaded, Schedule 40 PVC. The screen shall have 0.01 inch factory milled slots. The well screen shall be terminated with a threaded end cap and the casing shall be terminated with a locking, watertight cap. If free product is encountered, larger diameter wells may be installed for free product recovery.

2. Screen Length and Placement

The screen length and placement shall be such that the screen intersects the water table at all times. If the screen is placed such so that ground water does not enter the well, the cost for the installation of the monitoring well may not be reimbursed from the Petroleum Underground Storage Tank Fund. Typical placement is such that seven (7) feet of screen is in the water table within three (3) feet of screen above or ten (10) feet of screen in the water table and five (5) feet of screen above. Longer screen lengths may be necessary for areas with large seasonal ground water fluctuations. A centralizer shall be used in all single cased monitoring wells with a total depth greater than twenty (20) feet.

If free product is encountered, greater screen lengths (i.e. 20 feet) may be warranted in order to allow for depression of the water table during free product removal operations provided the extra depth does not result in the breaching of a confining unit.

If a confined aquifer is encountered, the water bearing section of the aquifer shall be screened.

3. Minimum Borehole Diameter

The borehole diameter shall be a minimum of four (4) inches larger than the outside diameter (O.D.) of the well casing. For example, a 2.5 inch O.D. casing would require a 6.5 inch diameter borehole. A waiver is granted in cases if a 5.5 inch O.D. or larger core barrel will be used to drill the bedrock portion of the hole.

4. Placement and Type of Filter Pack

A minimum of six (6) inches of the filter pack material shall be placed under the bottom of the well screen to provide a firm footing. The filter pack shall extend two (2) feet above the top of the screened section. A weighted tape shall be used to help prevent bridging and ensure the proper placement of the filter pack. If the total depth of the borehole exceeds thirty (30) feet, a tremie pipe shall be utilized to properly place

the filter pack unless the well is being installed through a hollow stem auger. The filter pack shall consist of clean, washed, well sorted silica sand.

5. Placement and Type of Filter Pack Seal

The filter pack seal shall be placed atop the filter pack and have a minimum thickness of two (2) feet. The filter pack seal shall consist of a high solids, pure bentonite material. A weighted tape shall be used to help prevent bridging and ensure the proper placement of the filter pack seal. If the total depth to the top of the filter pack exceeds thirty (30) feet, a tremie pipe shall be utilized to place the filter pack seal unless the well is being installed through a hollow stem auger. If the bentonite seal is placed above the water table, two (2) gallons of potable water shall be used to hydrate the pellets. The hydration time for the bentonite pellets shall be a minimum of one (1) hour.

6. Placement and Type of Annular Grout

The annular grout shall extend from the top of the filter pack seal to within two feet of the surface. The annular grout shall consist of a mixture of Portland cement and 4%-6% powdered bentonite. A grout density of 13.5 to 14.1 lbs/gal shall be obtained and verified with a mud balance prior to placement. If water is present in the boring or the depth to the filter pack seal is greater than thirty (30) feet, a tremie pipe shall be used to place the annular grout unless the well is being installed through a hollow stem auger.

7. Surface Completion

The final two (2) feet of the annular space shall be filled with concrete terminating with a flush-mounted manhole with a watertight, bolt-down loadbearing cover unless alternate construction is approved by the Division in writing. These manholes shall be concreted in place and sloped so that surface drainage will be diverted. A locking, watertight cap shall be used if surface completion is below grade. A locking cap shall be used on all wells completed above ground level. Above ground protective covers may be used if required by site conditions. All

monitoring wells shall be clearly marked as monitoring wells and numbered.

E. Double Cased Monitoring Well Installation Procedures

1. Casing and Screen Type

The outer casing shall be decontaminated black steel. If site specific conditions and drilling methods are compatible (i.e. hollow stem auger drilling) schedule 80 PVC may be used in lieu of black steel with prior approval by the Division. The inner casing and screen shall be constructed of pre-cleaned, flush threaded, Schedule 40 PVC. The screen shall have 0.01 inch factory milled slots. The screened section shall be terminated with a threaded end cap and the casing shall be terminated with a locking, watertight cap.

2. Outer Casing Placement

The outer casing shall be set at least two (2) feet into competent bedrock, the confining layer or five (5) feet below the last indication of soil contamination, if applicable. The casing shall then be grouted into place using a bentonite/cement grout. The grout shall consist of a mixture of Portland cement and 4%-6% powdered bentonite. A grout density of 13.5 to 14.1 lbs/gal shall be used. If water is present in the boring or the total depth of the borehole is greater than thirty (30) feet, a tremie pipe shall be used to place the grout unless the well is being installed through a hollow stem auger. The grout shall be allowed to set for a minimum of 24 hours before continuation of drilling activities.

3. Screen Length and Placement

The screen length and placement shall be such that the screen intersects the water table at all times. If the screen is placed so such that ground water does not enter the well, the cost for the installation of the monitoring well may not be reimbursed from the Petroleum Underground Storage Tank Fund. Typical placement is such that seven (7) feet of screen is in the water table with three (3) feet of screen above or ten (10) feet of screen in the water table and five (5) feet of screen above. Longer screen lengths may be necessary for areas with large seasonal ground water fluctuations. A centralizer shall be used in all

monitoring wells greater than twenty (20) feet in depth. The centralizer shall be placed below the screened interval at the bottom of the well.

If free product is encountered, greater screen lengths (i.e. 20 feet) may be warranted in order to allow for depression of the water table during free product removal operations provided the extra depth does not result in the breaching of a confining unit.

If a confined aquifer is encountered, the water bearing section of the aquifer shall be screened.

4. Minimum Borehole Diameter

The outer borehole diameter shall be a minimum of 4.0 inches larger than the outside diameter (O.D.) of the well casing. For example, a 8.0 inch O.D. casing would require a 12.0 inch diameter borehole. The annular space between the inner casing and the outer casing shall also be 4.0 inches. A waiver is granted in cases where a 5.5 inch O.D. or larger core barrel will be used to drill the bedrock portion of the hole.

5. Placement and Type of the Filter Pack

A minimum of 6.0 inches of the filter pack material shall be placed under the bottom of the well screen to provide a firm footing. The filter pack shall extend two (2) feet above the top of the screened section. A weighted tape shall be used to help prevent bridging and ensure the proper placement of the filter pack. If the total depth of the borehole exceeds thirty (30) feet, a tremie pipe shall be utilized to properly place the filter pack unless the well is being installed through a hollow stem auger. The filter pack shall consist of clean, washed, well sorted silica sand.

6. Placement and Type of the Filter Pack Seal

The filter pack seal shall be placed atop the filter pack and have a thickness of two (2) feet. The filter pack seal shall consist of a high solids, pure bentonite material. A weighted tape shall be used to help prevent bridging and ensure the proper placement of the filter pack seal. If the total depth to the filter pack exceeds thirty (30) feet, a tremie pipe

shall be utilized to place the filter pack seal unless the well is being installed through a hollow stem auger. If the bentonite seal is placed above the water table, two (2) gallons of potable water shall be used to hydrate the pellets. The hydration time for the bentonite pellets shall be a minimum of one (1) hour.

7. Placement and Type of the Inner Annular Grout

The inner annular grout shall extend from the top of the filter pack seal to within two (2) feet of the surface. The annular grout shall consist of a mixture of Portland cement and 4%-6% powdered bentonite. A grout density of 13.5 to 14.1 lbs/gal shall be used. If water is present in the boring above the filter pack seal or the depth to the filter pack seal is greater than thirty (30) feet, a tremie pipe shall be used to place the annular grout unless the well is being installed through a hollow stem auger.

8. Surface Completion

The final two feet of the annular space shall be filled with concrete terminating with a flush-mounted manhole with watertight, bolt-down loadbearing cover unless alternate construction is approved by the Division in writing. These manholes shall be concreted in place and sloped so that surface drainage will be diverted. A locking, watertight cap shall be used if surface completion is below grade. A locking cap shall be used on all wells completed above ground level. Above ground protective covers may be used if required by site conditions. All monitoring wells shall be clearly marked as monitoring wells and numbered.

F. Open-Hole Well Installation Procedures

Open hole monitoring wells may be used in areas where competent bedrock is encountered and geologic conditions (e.g. karst terrain) dictate their use.

In constructing an open hole monitoring well, the surface casing shall be set at least two (2) feet into competent bedrock. The surface casing shall be black steel in all cases. The casing shall be grouted into place using a bentonite/cement grout. The grout shall consist of a mixture of Portland cement

and 4%-6% powdered bentonite. A grout density of 13.5 to 14.1 lbs/gal shall be used. If water is present in the boring or the total depth of the borehole is greater than thirty (30) feet, a tremie pipe shall be used to place the grout. The grout shall be allowed to set for a minimum of 24 hours before continuation of drilling activities.

Upon setting the surface casing, a borehole with a minimum diameter of three and one-half (3.5) inches shall be advanced to the desired depth.

The final two (2) feet of the annular space shall be filled with concrete terminating with a flush-mounted manhole with a watertight, bolt-down loadbearing cover unless alternate construction is approved by the Division in writing. These manholes shall be concreted in place and sloped so that surface drainage will be diverted. A locking, watertight cap shall be used if surface completion is below grade. A locking cap shall be used on all wells completed above ground level. All monitoring wells shall be clearly marked as monitoring wells and numbered.

G. Well Development

Monitoring well development shall not begin until at least 24 hours following completion of the well and shall continue until such time as the water column is free of visible sediment. Should development procedures not produce a water column that is sediment free, development shall continue until pH, specific conductance, and temperature have stabilized.

The following methods shall be used individually or in combination for well development:

1. Bailing
2. Pumping
3. Surging

All down-hole equipment shall be new and disposable or shall be properly decontaminated.

MEMPHIS/SHELBY COUNTY
WATER WELL REGULATIONS

JUNE 1994

TABLE OF CONTENTS

Section		Page
1	GENERAL PROVISIONS	1
1.01	Statutory Authority	1
1.02	Scope and Applicability	1-2
1.03	Health Department Powers and Duties	2
2	SHORT TITLE	2
3	DEFINITIONS	3-9
4	GENERAL REQUIREMENTS AND PROCEDURES	9
4.01	Applications	9-10
4.02	Permits Required	10-11
4.03	Fees Required	11-12
4.04	Well Driller	12-13
5	WELL CONSTRUCTION STANDARDS FOR WATER WELL	13
5.01	General	13
5.02	Siting Criteria	13-15
5.03	Sanitary Protection of Wells	15-17
5.04	Construction Materials and Other Requirements	17
5.05	Sanitary Protection of the Well Pumping Facilities	17-18
5.06	Maintenance of Wells	18
5.07	Disinfection of Wells	18-19
5.08	Sampling of a Well	19
6	MONITORING AND RECOVERY WELLS CONSTRUCTION STANDARDS	19
6.01	General	19-20
6.02	Siting Criteria	20
6.03	Sanitary Protection of Wells	20-22
6.04	Construction Materials and Other Requirements	22
6.05	Protection of the Well	22-23
6.06	Maintenance of Wells	23

TABLE OF CONTENTS
(continued)

Section		Page
7	SOIL BORINGS	23
7.01	Regulations	23-24
7.02	Closure of Boreholes	24-25
8	INSPECTIONS	25-26
9	ABANDONMENT OF WELLS	26
9.01	General Requirements	26-28
9.02	Sealing and Fill Materials	28-29
9.03	Abandonment Procedures	29
10	CROSS CONNECTION CONTROL	29-30
11	LIMITATION ON USE OF WATER	30-31
12	AVAILABILITY OF PUBLIC WATER	31
12.01	Public Water Available to a Premise	31-33
12.02	Public Water not Available to a Premise	33
12.03	Auxiliary Intake	33
13	INJECTION WELLS	33
14	VARIANCES	33
14.01	Existing Wells	33-34
14.02	Appeals--Procedure	34-35
15	RULES AND REGULATIONS OF THE DEPARTMENT	35
16	CONSTITUTIONALITY OF ORDINANCE	35
17	CONFLICT OF LAWS	35
18	ENFORCEMENT AND PENALTIES	35
18.01	Enforcement	35-36
18.02	Penalties	36

RULES AND REGULATIONS OF WELLS
IN
SHELBY COUNTY

PURSUANT TO THE AUTHORITY GIVEN IN THE ORDINANCES OF SHELBY COUNTY AND THE MUNICIPALITIES THEREIN WHICH ESTABLISHED THE GROUND WATER QUALITY CONTROL BOARD FOR SHELBY COUNTY; TO ESTABLISH INSPECTION AND PERMIT FEES; TO CONTROL AND REGULATE THE LOCATION, CONSTRUCTION, AND MODIFICATION OF ALL TYPES OF WELLS IN SHELBY COUNTY; AND TO PROVIDE PENALTIES FOR THE VIOLATION THEREOF.

SECTION 1 -- GENERAL PROVISIONS

1.01 -- Statutory Authority

The Ground Water Quality Control Board for Shelby County establishes and adopts the following regulations in accordance with the authority granted by the ordinances of Shelby County and the municipalities therein which established the Ground Water Quality Control Board for Shelby County:

1.02 -- Scope and Applicability

- A. Minimum requirements are hereby prescribed in these Rules and Regulations governing the location, design, installation, use, disinfection, modification, repair and abandonment of water wells and associated pumping equipment, or any other type of well. No person shall conduct any activity contrary to the provisions of these regulations, and all such activities which are contracted for shall be carried out only by those persons having a valid Tennessee License for Water Well Drillers, and Pump Installers and/or those engineers or geologists registered in the State of Tennessee. These regulations supersede all other well construction regulations.
- B. These regulations apply to well construction activities from the initial penetration or excavation of the ground, through development, modification, equipment installation, repair and disinfection. Set up of construction equipment before actual penetration or excavation is not considered part of the construction.
- C. The regulations apply to the construction activities of any and all types of wells.

- D. The installation of all wells or other activities conducted for the purpose of obtaining geologic or hydrologic information shall receive prior approval from the Department in the form of a Well Construction Permit.
- E. Amendments may be made to inspection and permit fees to reflect reasonable costs of services provided by the Memphis and Shelby County Health Department and to establish well water conservation fees as a means of controlling the usage of water or waste of groundwater by way of private wells.

1.03 -- Health Department Powers and Duties

The Department has general supervision and authority over water quality matters as they relate to the protection and conservation of the groundwater; over the location, construction, repair, and modification of water wells and all other types of wells and for the administration of these Rules and Regulations. The Board shall adopt and amend rules and regulations; establish policies declared by these Rules and Regulations and establish policies reasonably necessary to effectuate the statement of policy declared by these Rules and Regulations. Such rules, regulations and policies shall provide criteria for the proper location and construction of any type of well in Shelby County; to safeguard the public health against problems which pertain to water quality; and for the protection and conservation of groundwater. The Board shall conduct public hearings, upon not less than thirty (30) days prior notice, in connection with proposed rules and regulations and amendments thereto; and exercise such other powers as are practical and reasonably necessary to carry out and enforce the provisions of these Rules and Regulations.

Section 2 -- SHORT TITLE

Shelby County Well Construction Code

Section 3 -- DEFINITIONS

- 3.01 -- Abandoned Well: Any type of well that has been permanently discontinued for further use. A well shall be declared abandoned when the pump has been disconnected or removed for reasons other than repair or replacement; when the well is in such a state of disrepair that continued use for the purpose intended is impracticable; or when the well is not maintained in such a condition that allows for periodic sampling and testing by the Department.
- 3.02 -- Abandonment: The act of properly sealing an abandoned well.
- 3.03 -- Adequate Water Supply: A well which after installation will supply enough water in a capacity so that the well can be used for drinking, culinary, food processing and other purposes.
- 3.04 -- Agricultural Well: A well constructed for the primary purpose of providing a source of water for agriculture.
- 3.05 -- Agriculture: The term agriculture is defined as the art of being engaged in farming as the leading pursuit and includes cultivating the soil; producing crops; and/or raising livestock, poultry, or fish; and in varying degrees the preparation of these products for human use.
- 3.06 -- Aquifer: A geologic formation, group of formations or part of a formation capable of yielding a significant amount of groundwater to wells, springs, or surface water.
- 3.07 -- Auxiliary Intake: Any source of water system, piping, connection, or device whereby water may be secured other than that normally used.
- 3.08 -- Bentonite Grouts: A Bentonite grout shall consist of a high solid sodium montmorillonite. The grout shall yield solids ranging from twenty to thirty (20-30%) percent, with a minimum density equal to or greater than 9.4 pounds per gallon, and a permeability of

approximately 1×10^{-7} centimeters per second or less. The manufacturers mixing instructions shall be followed and any polymer added to bentonite slurry mixes must be approved by the Department prior to use.

- 3.09 -- Board: The Ground Water Quality Control Board for Shelby County.
- 3.10 -- Commercial Well: A well constructed for the purpose of providing groundwater to a commercial business, facility, or premise for use as a potable water supply when public water is not available; for air conditioning, and other heat exchange systems; sprinkler systems for landscaping and other land beautification uses; nurseries; filling and retaining levels of lakes in subdivisions, apartment complexes, and similar multiple dwelling facilities; and any other such commercial uses.
- 3.11 -- Contaminated Well: Any type of well containing a foreign substance, either chemical, radiological, or biological, which tends to degrade the quality of the water so as to constitute a hazard or impair the usefulness of the water.
- 3.12 -- Contamination: Alteration of the physical, chemical, or biological quality of the water so that it is harmful or potentially injurious to the health of the users or for the intended use of the water, or to the extent it poses a danger of polluting the groundwater aquifers.
- 3.13 -- Cross Connection: An actual or potential connection, arrangement or condition by or through which a supply of potable water could be contaminated, polluted or infected.
- 3.14 -- Deep Well: Any type of well constructed to a depth that penetrates the stratum of clay known as the Jackson Formation, the water bearing formation known as the Memphis Sands, or the water bearing formation known as the Fort Pillow Sands. Any well is considered a deep well if the Jackson Formation is not found to exist at the construction site.
- 3.15 -- Delinquent: Unpaid or past due well fees that are subject to additional fees or penalties.
- 3.16 -- Department: The Memphis and Shelby County Health Department.

- 3.17 -- Dewatering or Drainage Well: A well constructed for the primary purpose of lowering the water table for the construction of footings, sewer lines, building foundations, elevator shafts, etc.
- 3.18 -- Domestic Well: A well constructed for the primary purpose of providing a source of drinking water to a single family residence.
- 3.19 -- Emergency: Unforeseen circumstances that exist beyond the control of the applicant.
- 3.20 -- Geothermal Well: A well constructed for the primary purpose of adding or removing British Thermal Units (Btu) from groundwater for heating or cooling purposes.
- 3.21 -- Groundwater: Water occurring naturally in underground formations that are saturated with water and includes but is not limited to perched water tables and aquifers or zones that are seasonally, periodically or permanently saturated.
- 3.22 -- Groundwater Heat Pump: Any mechanical device used for heating or cooling, which adds or removes British Thermal Units (Btu) from groundwater.
- 3.23 -- Grout: A stable, impervious, minimum-shrinkage bonding material that is capable of producing a water tight seal required to protect against the intrusion of contamination.
- 3.24 -- Health Director: The Director of the Memphis and Shelby County Health Department.
- 3.25 -- Industrial Well: A well constructed for the purpose of providing water for use in processing, washing, packaging or manufacturing of a product.
- 3.26 -- Injection Well: A well used to inject fluid into the subsurface.
- 3.27 -- Irrigation Well: A well constructed for the primary purpose of providing a source of water by way of sprinklers, artificial ditches or channels, or by any other means for use in nurseries, golf courses, land beautification, silviculture, growing sod, greenhouses, and any other such uses.
- 3.28 -- Justifiable Need: A genuine need for a private water supply as determined by the Board and, which need is based upon the availability of an adequate water

supply to the premise whether from a public source or from an existing well that can be modified to produce the needed volume of water.

- 3.29 -- Modification: Alteration, rework or repair involving a material change in the design or construction of a well including but not limited to deepening, reaming, casing, re-casing, perforating, re-perforating, installation of liner pipe, packers and seals, screen removal and replacement, or redeveloping a well by surging, chemical treatment, jetting, etc.
- 3.30 -- Monitoring Well: A well constructed for monitoring Groundwater quality and/or water level.
- 3.31 -- Municipality: A political unit having corporate status and powers of self-government and, includes any other form of government within the political jurisdiction of Shelby County.
- 3.32 -- Observation Well: A well constructed for the primary purpose of obtaining accurate, periodic measurements of groundwater.
- 3.33 -- Owner: Any person or his legal representative, agent, or assign who owns, leases, operates, or controls any parcel of land where a well is or may be located.
- 3.34 -- Permit: An official document issued by the Department granting the specific activity set forth in the document.
- 3.35 -- Person: Any individual, firm, association, organization, partnership, business, institution, enterprise, municipality, commission, political subdivision or duly established entity, trust, corporation, company, contractor, supplier, installer, user or owner, or any Federal, State or Local government agency or public district or any officer or employee thereof.
- 3.36 -- Potable Water Supply: Any source of water which is satisfactory for drinking, culinary, and domestic purposes, and meets the requirements of the Department.
- 3.37 -- Premise: A tract of land with the buildings thereon.
- 3.38 -- Private Water Supply: Any groundwater supply located on

a premise that is not obtained from a public water system.

- 3.39 -- Public Water Supply: Any publicly or privately owned water system operating as a public utility which operates fifteen (15) or more service connections or regularly serves twenty-five (25) people sixty (60) or more days per year.
- 3.40 -- Pump Installer: Any person who installs or repairs water well pumps or who installs filters and water treatment devices.
- 3.41 -- Quasi-Public Water Supply: A water supply used or made available by a person to his employees, tenants, members or guests for drinking; or in connection with the manufacturing or handling of ice, foods, or drinks, such as candy, ice cream, milk, ice bottled drinks, and any other food or drink products. The source of quasi-public water supply may be a private well, or the public water supply.
- 3.42 -- Reasonable Use: That use of water which is ordinarily required by industries, firms, and individuals in the usual operation of their business or residence.
- 3.43 -- Recovery Well: A well constructed for the purpose of recovering products which have intersected the water table by way of leaking underground storage tanks, surface spills, etc.
- 3.44 -- Repair: Any modification, replacement, or other alteration of any well, or pumping equipment which requires a breaking or opening of the well seal or any waterlines up to and including the pressure tank and any coupling appurtenant thereto.
- 3.45 -- Shallow Well: Any type of well constructed to a depth shallower than the stratum of clay known as the Jackson Formation which is found just above the water bearing sands known as the Memphis Sands.
- 3.46 -- Site: Any one legal unit of a subdivision, parcel of land, or location where drilling activities are to take place.
- 3.47 -- Soil Boring: Any hole that is drilled, cored, dug, washed, driven, jetted, redrilled, bored, or otherwise constructed, which exceeds thirty (30) feet, for the purpose of determining geological formations, water level, or for the purpose of founding structures.

- 3.48 -- Temporary Abandonment: Means any observation or monitoring well covered with a secure cap that is water tight and which is being used for the investigation or management of groundwater by a governmental agency.
- 3.49 -- Test Well : Any excavation, either cased or uncased, that is constructed for the purpose of determining the location or physical characteristics of underground formations or for evaluating or monitoring the characteristics or behavior of the formations or the water contained therein, or for obtaining the information needed to design a well prior to its construction.
- 3.50 -- Utilities: Any power lines or underground cables which supply electrical power, telephone lines, cable television lines, natural gas lines, water mains, water lines, or sewer lines.
- 3.51 -- Water Well: Wells which are constructed and so equipped with casings, screens, pumps, fittings, etc., and have been developed for the primary purpose of producing a supply of water regardless of the intended usage for said supply.
- 3.52 -- Water Well Contractor: Any person, firm, or corporation who has duly registered as such with the State of Tennessee and shall have paid the annual registration fee and obtained a permit to contract for construction of wells as therein provided and, who has obtained the necessary privilege license to construct, repair, and service wells in Shelby County.
- 3.53 -- Well: A well is any hole that is drilled, cored, dug, washed, driven, jetted, redrilled, bored, or otherwise constructed which intersects the water table for: the production of water; monitoring of contaminants; recovering product; dewatering or drainage purposes; determining water levels; lowering the water table; or any boring into the subsurface thirty (30) feet or deeper.
- 3.54 -- Well Construction: Any type of work that is performed on a well including but not limited to the installation of new wells; the modification, alteration, or repair of existing wells; or, their abandonment.
- 3.55 -- Well Driller: Any person who manages or supervises the digging, drilling or redrilling of well.

- 3.56 -- Well Logs: A record of geologic formations penetrated in drilling a water well, monitoring, recovery, dewatering, observation or any other type of well; or any boring into the subsurface thirty (30) feet or deeper.

Section 4 GENERAL REQUIREMENTS AND PROCEDURES

4.01 -- Applications

- A. Any person requesting the installation, modification, repair, or abandonment of a water well or any other type well shall make application to the Department.
- B. All applications requesting new well installation or the modification of an existing well shall be accompanied by a plot plan showing the location of all underground utilities within fifty (50) feet of the proposed well; grade elevations in relation to adjoining areas and drainage patterns of the area; location of the residence, business, etc.; locations of septic tanks and field lines when applicable; other existing and proposed buildings and structures; any water service lines that may exist on the premises; any drainage ditches, lakes, ponds, streams, etc., that may exist at the premise; any roads or dedicated right-of-ways or easements; and any other pertinent information deemed necessary by the Department. The application shall also include a sketch of how the well is to be constructed.
- C. A water well cannot be sited or placed in service within a half-mile of the designated boundaries of a listed federal or State Superfund site or Resource Conservation and Recovery Act corrective action site, unless the well owner can make a demonstration that the well will not enhance the movement of contaminated groundwater or materials into the shallow or deep aquifer.
- D. An application may be obtained from the Department, and if approved, such application shall be in force and in effect for ninety (90) days from the date of its issuance. If work has not commenced within ninety (90) days of issuance, an extension may be granted by the Department upon request by the applicant.
- E. A processing fee shall be submitted with all

applications for new wells and said fee is not refundable, regardless of the status of approval.

- F. The Department shall issue a notice of rejection whenever it determines that an application for a permit fails to meet the requirements of these Rules and Regulations, or any rules, order, regulation or standard adopted pursuant thereto; or that the proposed well will be harmful or potentially harmful to the water resources of Shelby County or, if it is determined by the Department that an adequate water supply is available to the premise without the need to construct a well. Said water supply may be from an existing water well or from a public system. Permits for wells to supply water for purely aesthetic purposes (i.e. waterfalls, landscaping enhancement, fountains, etc.) may be approved by the Department if conservation steps are taken to limit water usage as established by the Board.

4.02 -- Permits Required

- A. A permit shall be obtained from the Department prior to beginning the installation, modification, repair, or abandonment of a water well or any other type of well, soil boring or pumping equipment within Shelby County.
- B. The issuance of a construction permit is dependent upon:
1. the application being on the proper form and containing the required information, provided that the proposed construction or repair will not be contrary to applicable laws, rules, orders, or regulations of the Department or other government agencies;
 2. additional information which may be required as the Department deems necessary such as geophysical logs, geologic samples and logs, and well pumping tests; and
 3. the justifiable need for a well.
- C. If a well application is approved by the Department, the well driller shall be issued a permit. Receipt of the permit shall constitute permission to begin well construction upon prior notification to the Department.

- D. Permission to begin construction of a water well or any other type of well may be applied for by telephone when emergency conditions exist which would justify such a request. The Department may, at its discretion, grant such emergency permits with an additional fee of fifty (\$50) dollars.
- E. A written permit shall be obtained from the Department and renewed annually to operate or maintain a commercial or industrial well regardless of the intended usage of said well.
- F. A written permit shall be obtained from the Department and renewed annually for wells constructed at residential premises where public water is available regardless of the intended usage of said supply.
- G. A written permit shall be obtained from the Department and renewed annually to operate or maintain a quasi-public water supply.
- H. All renewable permits shall be valid for one year, and, may be renewed at the expiration thereof upon payment of the fees hereinafter set forth. Such permits may be revoked by the Department upon the violation by the holder of any terms of the permit or these Rules and Regulations or in any emergency when, in the judgement of the Department, the continued operation of the quasi-public or private water supply or maintenance of a well for any reason shall constitute a health hazard. The holder of such permit, after such revocation, shall have the right of appeal.

4.03 -- Fees Required

- A. All applications requesting a permit to construct water wells or any other wells shall require a processing fee of twenty-five (\$25.00) dollars be paid to the Department when such applications are submitted. The processing fee is not refundable, regardless of the status of approval.
- B. The yearly permit to operate or maintain a quasi-public or a private water supply or well, other than a domestic well shall not be issued until an inspection fee of one hundred (\$100.00) dollars per well is paid each year to the Department.
- C. An inspection fee of one hundred (\$100.00) dollars

per site shall be paid to the Department for wells constructed for the primary purpose of monitoring, observation, testing, recovery, and/or any other usage which does not require the permanent installation of a pump within the well casing.

- D. Dewatering or drainage wells require an inspection fee of one hundred (\$100.00) dollars per site.
- E. Owners of domestic wells shall not be liable for an annual inspection fee, except when public water becomes available to a residential premise, then the well being used at said premise shall be subject to applicable fees being paid.
- F. Any new water wells constructed within the calendar year shall be subject to the inspection fee being paid at the time the well construction permit is issued. This fee will be prorated on a quarterly basis.
- G. Any construction permits issued on an emergency basis require an additional processing fee of fifty (\$50.00) dollars be paid to the Department.
- H. All inspection fees are due upon notification by the Department and are delinquent thirty (30) days after said notification.
- I. An annual fee of twenty (\$20.00) dollars per well shall be assessed for all active monitoring, vent, air sparging and recovery wells, or any other type well related to the remediation of groundwater at a site located within Shelby County.

4.04 -- Well Driller

- A. All water production wells to be constructed in Memphis and Shelby County shall be constructed only by persons having a valid license under the TENNESSEE DEPARTMENT OF ENVIRONMENT AND CONSERVATION, Division of Groundwater Protection.
- B. A well driller shall have in his possession a valid well construction permit before any construction is to begin.
- C. The well driller to whom a well construction permit is issued is responsible for the construction of the well in accordance with the permit and

applicable laws and regulations.

- D. It shall be the well driller's duty to inform persons requesting the services of his company, to construct, repair, alter, modify, or to perform any other service related to a well of the requirements of these Rules and Regulations.
- E. The well driller shall be held liable for any type of well work initiated prior to the Department issuing a written permit.
- F. It shall be the duty of the well driller to notify the Department when construction on a well is to begin and when the work is completed so that proper inspections can be made during and after construction, and for the purpose of collecting samples from production wells.
- G. The well driller shall notify the Department when repair or modification work, as directed within these Rules and Regulations, is done on a well.
- H. Within thirty (30) days after a well has been constructed or modified, the well driller shall submit a report of construction (well log) to the Department on such forms as are prescribed or which may be furnished by the Department.
- I. The well driller shall notify the Department prior to beginning abandonment procedures on a well.

Section 5 -- WELL CONSTRUCTION STANDARDS FOR WATER WELL

5.01 -- General

- A. All wells shall be constructed in a manner that will guard against waste and contamination of the groundwater aquifers underlying Memphis and Shelby County. No person shall construct, repair, modify, or abandon or cause to be constructed, repaired, modified, or abandoned any well contrary to the provisions of these Rules and Regulations.

5.02 -- Siting Criteria

A proposed well location shall satisfy the following minimum horizontal separation distance requirements:

- 1. Fifty (50) feet from a property line, to allow access to the well without encroaching on adjoining properties; to provide adequate

distance from field lines and other sources of contamination that may exist or may be planned on adjacent properties; and, to reduce the potential for interfering with other wells drilled on other properties.

2. Twenty-five (25) feet from a road or dedicated right-of-way or easement.
 3. Fifteen (15) feet from a building foundation for the purpose of protecting the well from a foundation of soil treated to control pests, insects, or vermin.
 4. One hundred (100) feet from any subsurface sewage disposal system such as a septic tank and/or field lines.
 5. One hundred (100) feet from any identifiable sources of contamination such as but not limited to disposal fields, seepage pits, manure piles, barns, underground fuel tanks, etc.
 6. Fifty (50) feet from any storm drain or sanitary sewer that flows by gravity.
 7. One hundred (100) feet from any sewage force main.
 8. Fifty (50) feet from any drainage canal, ditch, stream, lake, or similar body of water.
 9. Fifteen (15) feet from power lines and underground cables for electrical power.
 10. Twenty-five (25) feet from natural gas lines.
 11. Twenty-five (25) feet from any water main as defined by the utility owner.
- B. The well site shall not be subject to flooding and shall be at least two (2) feet above the 100-year recurrence flood level for the area. If necessary, the area shall be filled with material approved by the Department, properly graded and maintained to prevent the accumulation or retention of surface water.
- C. Lots requiring a well for a potable water supply and a septic tank system for sewage disposal shall be a minimum of four (4) acres in size.

- D. All parcels of land requiring a well for a source of potable water shall be self-supporting in that sharing a water supply shall not be allowed. A water line shall not cross property boundaries for the purpose of providing potable water to a premise on a permanent basis.
- E. A well cannot be sited or placed in service within a half-mile of the designated boundaries of a listed federal or State Superfund site or Resource Conservation and Recovery Act corrective action site, unless the well owner can make a demonstration that the well will not enhance the movement of contaminated groundwater or materials into the shallow or deep aquifer.

5.03 -- Sanitary Protection of Wells

- A. All water used in the construction of a well shall be from an approved potable water supply. Water obtained from lakes, ponds, streams, and other such surface water sources is not approved and shall not be used in the well construction process.
- B. It shall be the responsibility of the well driller to protect the opening made in drilling the well against any foreign material or any other type of contamination from entering the opening.
- C. In the event a well becomes contaminated or obstructed, the well driller shall take whatever measures necessary to clear the well of contamination or obstruction. Should he decide to abandon the well for any reason, the well shall be filled in a manner prescribed by Section 9 of these Rules and Regulations.
- D. Whenever construction stops before the well is grouted and pumping equipment is installed, the open annular space shall be covered and the well casing capped. The cap shall be either threaded onto the casing secured by a friction type device which locks onto the casing, welded, or secured by such other device or method as may be approved by the Department. It shall be the responsibility of the owner to maintain the integrity of the protective device placed on the well opening by the well driller.
- E. A well shall be drilled to a size that will permit the outer casing to be surrounded by a water tight seal a minimum of two (2) inches thick. All wells

shall be grouted as soon as possible but not later than twenty-four (24) hours after the well casing has been set in place and all drilling has been completed.

- F. The well driller shall notify the Department at least twenty-four (24) hours in advance of grouting wells to provide the Department the opportunity to observe the procedure. Such a condition shall be specified on the well construction permit. The grout material shall consist of a mixture of neat Portland Class A Cement or quick setting cement in a ratio of not over six (6.0) gallons of water per ninety-four (94) pound sack of cement, or a coarse grained high solids non drilling mud grade bentonite slurry, such as Baroid Benseal, American Colloid or equal. The bentonite slurry shall be mixed in accordance with the manufacturers recommendations. Bentonite alone is not an acceptable grouting material. The relative proportion by weight for each component shall meet the following requirements:

Portland Cement:	92%	Portland Cement:	74%
Bentonite:	8%	or Bentonite:	6%
		Sand:	20%

For each two (2) percent addition of bentonite an additional (1.3) gallons of water should be added to the slurry mixture. A maximum of two (2) percent by weight of calcium chloride may be added. Other grouting materials or methods or any special conditions for grouting a well may be made by the Department within the well construction permit. The use of bentonite drilling clay as a grouting material is prohibited, except as an additive to neat cement grout. Only bentonite grout approved by the National Sanitation Foundation (NSF) shall be approved by the Department as appropriate grouting material.

- G. The method of grouting the annular space of a well shall be throughout the entire length of the casing from the bottom of the casing to the ground surface and shall be pressure grouted through a tremmie pipe from the bottom to the top in one continuous operation in order to avoid gapping or dilution of grout material. The return at the top shall be of the same consistency as the material that is pumped

into the tremmie pipe. During the grouting procedure any proposed changes to the approved grouting material will not be allowed by the Department.

- H. Upon completion, the well shall be treated with a sufficient dosage of chlorine so that a concentration of at least fifty (50 ppm) parts per million free chlorine shall be obtained in all parts of the well for a period of twenty-four (24) hours. The well is then to be pumped free of chlorine and a water sample collected for bacteriological analysis. The result shall be required to be negative for E. coliform bacteria prior to putting the well into service.

5.04 -- Construction Materials And Other Requirements

All materials, components, parts, etc., used in the installation of a water well or any other type of well, such as the casing, screen, pumping equipment, pressure tank, wiring, pipe, and any other such components, must comply with the standards as established in the ,RULES OF THE TENNESSEE DEPARTMENT OF ENVIRONMENT AND CONSERVATION, DIVISION OF WATER SUPPLY, CHAPTER 1200-4-9, entitled WATER WELL LICENSING REGULATIONS AND WELL CONSTRUCTION STANDARDS. When deemed necessary, the Department may require standards and specifications to be more stringent than those required by the State of Tennessee.

5.05 -- Sanitary Protection Of The Well Pumping Facilities

- A. A sanitary well seal that is water tight shall be provided at the terminal of any well casing in order to prevent any contamination from entering the well casing. The well casing shall terminate no less than one (1) inch above the foundation of the well.
- B. If the well is to be vented, it shall be required to have an inverted screened vent.
- C. The pump base foundation shall be reinforced, if the forces exerted are such that reinforcement is required, and shall be a minimum of two (2) inches larger than the base plate. The concrete used shall be of a strength suitable to withstand any vibrations, etc., to which it may be subjected.

- D. All water wells shall be provided with a readily accessible faucet or tap on the well discharge line at the well head for the collection of water samples.
- E. Where pitless adapters are used, they shall be required to meet National Sanitation Foundation (NSF) specifications for subsurface installations and shall bear the NSF seal.
- F. The water tight casing or curbing of any well shall extend not less than six (6) inches above the established ground surface or twenty-four (24) inches above the maximum high water level where flooding occurs.
- G. Any oil-lubricated pump installed in a well shall utilize oil or grease lubricants which carry a USDA H-1 rating. The installer must supply the Department documentation to verify that the lubricant used has an H-1 rating.

5.06 -- Maintenance of Wells

- A. Wells shall be maintained in an operative condition at all times in order for water samples to be collected for analytical purposes.
- B. A source of power shall be made available to the well either by a permanent connection or by way of a temporary source such as a generator.
- C. All wells shall be maintained in a condition whereby they are not a hazard to health or environment nor a source of potential contamination to the groundwater aquifers.
- D. When a well is determined to be abandoned as defined by these Rules and Regulations, the owner shall be ordered to seal the well in accordance with the requirements of the Department.

5.07 -- Disinfection of Wells

Every newly constructed well, modified well, or well that has been repaired shall be assumed to be contaminated by microorganisms. Before initiation of use each well must be thoroughly and carefully cleaned and treated to ensure that all pathogenic organisms are eliminated. Care shall be exercised to make certain that all areas of a well come in

full contact with a solution containing enough available chlorine to completely destroy all pathogenic microorganisms. An initial chlorine concentration of fifty (50 ppm) parts per million with a residual chlorine requirement of twenty-five (25 ppm) parts per million after twenty-four (24) hours is considered adequate for this purpose. Domestic laundry bleaches containing sodium hypochlorite either in powder or tablet form may be used. The well shall be allowed to remain undisturbed after the treatment for a period of twenty-four (24) hours and then tested for residual chlorine of at least twenty-five (25 ppm) parts per million must remain. After successful treatment all water remaining in the well and supply system shall be pumped free of residual chlorine and a sample of fresh water from the well shall be collected by and tested by the Department for bacteriological purity.

5.08 -- Sampling of a Well

- A. After a well has been drilled, modified, or repaired, a negative bacteriological sample shall be obtained prior to placing the well into service.
- B. A well shall not be connected into a premise until a sample has been collected which produces negative bacteriological results.
- C. If a sample collected from a newly constructed well is positive for E. coliform bacteria, it shall be the well driller's responsibility to take whatever steps are necessary to properly disinfect the well. Two (2) consecutive bacteriological samples producing negative results must be obtained prior to placing the well into service.
- D. Whenever a well is repaired or modified, it shall be the responsibility of the well driller to notify the Department upon completion of work to sample the well for bacteriological purity. It shall be the well driller's responsibility to properly disinfect the well upon completion.

Section 6 -- MONITORING AND RECOVERY WELLS CONSTRUCTION STANDARDS

6.01 General

- A. A construction permit is required for monitoring and recovery wells.

- B. All wells shall be constructed in a manner that will guard against contamination of the groundwater aquifers underlying Shelby County. No person shall construct, repair, modify, or abandon or cause to be constructed, repaired, modified, or abandoned any well contrary to the provisions of these Rules and Regulations.
- C. Within thirty (30) days after well construction the well driller or authorized contractor responsible for well installation shall submit a well drillers log for every well installed at a site. Any sample analysis results for a monitoring or recovery well shall be submitted with the logs of the well.

6.02

Siting Criteria

When a well site is subject to flooding it shall be cased to a point at least two (2) feet above the 100-year recurrence flood level for the area. In the case of a flush mount, the well shall have a waterproof seal with a lockable leakproof inner cap. If necessary, the area shall be filled with material approved by the Department, properly graded and maintained to prevent the accumulation or retention of surface water.

6.03

Sanitary Protection of Wells

- A. All water used in the construction of a well shall be from an approved potable water supply. Water obtained from lakes, ponds, streams and other such surface water sources is not approved and shall not be used in the well construction process.
- B. It shall be the responsibility of the well driller to protect the opening made during the drilling and to prevent any type of contamination from entering.
- C. Should a well be abandoned for any reason, the well shall be filled in a manner prescribed by Section 9 of these Rules and Regulations.
- D. Whenever construction stops before the well is grouted the open annular space shall be covered and the casing capped. The casing cap shall be either threaded onto the casing, secured by a friction type device which locks onto the casing welded or secured by such other device or method as may be approved by the Department. It shall be the responsibility of the owner to maintain the integrity of the protective device placed on the

well opening by the well driller.

- E. A well shall be drilled to a size that will permit the outer casing to be surrounded by a water tight seal, a minimum of two (2) inches thick. All wells shall be grouted as soon as possible but not later than twenty-four (24) hours after the well casing has been set in place and all drilling has been completed.
- F. The well driller shall notify the Department at least twenty-four (24) hours in advance of grouting wells to provide the Department the opportunity to observe the procedure. Such a condition shall be specified on the well construction permit. The grout material shall consist of a mixture of neat Portland Class A Cement or quick setting cement and water in a ratio of six (6.0) gallons of water per ninety-four pound sack of cement, or a coarse grained high solids non drilling mud grade bentonite slurry, such as Baroid Benseal, American Colloid or equal. The bentonite slurry shall be mixed in accordance with the manufacturers recommendations. A portland cement grout and bentonite combination is acceptable. The relative proportion by weight for each component of the cement grout bentonite combination shall meet the following requirements:

Portland Cement: 92%	Portland Cement: 74%
Bentonite: 8%	or Bentonite: 6%
	Sand: 20%

For each two (2) percent addition of bentonite an additional 1.3 gallons of water should be added to the slurry mixture. A maximum of two (2) percent of calcium chloride may be added. Any special conditions for grouting a well may be made by the Department within the well construction permit. The use of bentonite drilling clay as a grouting material is prohibited, except as an additive to neat cement grout. Only bentonite grout approved by the National Sanitation Foundation (NSF) shall be approved by the Department as appropriate grouting material.

- G. The method of grouting the annular space of a well shall be throughout the entire length of the casing in one continuous operation from the top of the screen or bentonite seal to the ground surface.

The grout mixture may be pumped from the surface when:

- (a) water will not be encountered, and
- (b) the depth is less than twenty (20) feet.

Pressure grouting is required if the aforementioned conditions are not met. Pressure grouting will be accomplished using a tremmie pipe. When the tremmie pipe is encased in the grout, it must have the same protection as the casing. (refer to paragraph 6.03 D)

- H. The borehole shall not hydraulically connect separate aquifers.

6.04 -- Construction Materials And Other Requirements

- A. All materials, components, parts, etc., used in the installation of a monitoring or recovery well, such as the casing, screen, pumping equipment, pressure tank, wiring, pipe and other such components, must comply with the standards as established in the RULES OF THE TENNESSEE DEPARTMENT OF ENVIRONMENT AND CONSERVATION, DIVISION OF WATER SUPPLY, CHAPTER 1200-4-10, entitled WELL CONSTRUCTION AND ABANDONMENT STANDARDS. When deemed necessary, the Department may require standards and specifications to be more stringent than those required by the State of Tennessee.
- B. The well shall be backfilled to a point, a minimum of two (2) feet above the top of the screen with filter sand, followed by a minimum of two (2) feet bentonite pellet seal above, which shall be grouted in accordance with Section 6.03.
- C. All piping materials shall be flush joint and threaded pipe. No solvent weld cements or other components shall be allowed. End points shall have threaded ends or be riveted on. Slip on ends are not allowed. Top caps shall be threaded or have some type of locking feature.
- D. Bentonite pellets shall have a maximum size of one quarter (1/4) inch to prevent bridging and shall then be activated with potable water.

6.05 -- Protection of the Well

- A. When a well site is to be subject to flooding, it shall be cased to a point: 1. at least two (2)

feet above the 100-year recurrence flood level for the area, or, 2. in the case of flush mount, have a waterproof seal with a lockable leakproof inner cap. When necessary the area shall be filled with material approved by the Department, properly graded and maintained to prevent the accumulation of retention of surface water.

- B. Until the well is abandoned and closed in accordance with these regulations, that portion of the well above the ground level shall be protected against tampering or destruction.

6.06 -- Maintenance of Wells

- A. Wells shall be maintained in an operative condition at all times in order for water samples to be collected for analytical purposes and shall have at least one (1) keyed lock to prevent tampering. Because of the potential for surface runoff to enter the below grade protective structure and/or well, installation of a removable cover with a flexible o-ring or gasket attached at the point where the cover fits over the protective structure and/or well will be necessary to prevent surface runoff from entering the well.
- B. All wells shall be maintained in a condition whereby they are not a hazard to health or environment nor a source of contamination to the groundwater aquifers.
- C. When a well is determined to be abandoned, as defined by these rules and regulations, the owner shall be ordered to seal the well in accordance with the requirements of Section 9 of these regulations.

Section 7 -- SOIL BORINGS

7.01 -- Regulations

- A. Any soil boring of thirty (30) feet or less shall not require a permit or require professional supervision for the purposes of this ordinance.
- B. All borings to a depth greater than thirty (30) feet but less than one hundred (100) feet shall require a permit and must be under the supervision of a licensed water well driller or an engineer or geologist registered in the

State of Tennessee. An application must be submitted to the Department prior to the permit being issued. A plot plan showing the proposed soil boring must also be submitted along with the application.

- C. Modifications to the permit related to the number of borings and depth not to exceed one hundred (100) feet, may be made at the discretion of the licensed well driller, engineer or geologist on the site. Details of these changes shall be included in the final report within thirty (30) days of job completion.
- D. All borings in excess of one hundred (100) feet must be permitted by the Memphis and Shelby County Health Department and be under the supervision of a licensed well driller, an engineer or a geologist registered in the State of Tennessee.
- E. Any soil boring that is converted to a monitoring well after being permitted as a soil boring will be required to apply for a permit as a monitoring well.

7.02 -- Closure of Boreholes

- A. All shallow boreholes, up to thirty (30) feet, shall be filled with the material taken from the hole or like material.
- B. For medium depth holes, thirty (30) feet to one hundred (100) feet, the log may be consulted before the method of filling is determined. For cases when the boring does not encounter water, fill shall be as noted in Section 7.02 A. above. When water is encountered the boring shall be filled in accordance with Section 7.03 C. below, or with bentonite pellets which will not dissolve for a minimum of thirty (30) minutes, to a depth of not less than two (2) feet above the upper stratum in which the water was encountered. Completion of the filling of the borehole shall be with the material from the boring as in 7.02 A above. The placement of the bentonite shall depend upon the method of drilling and whether the hole stands open. When the hole is open above the water bearing material the bentonite pellets may be dropped

into the hole. When the hole does not stand open it will be necessary to pressure grout from the top of the water bearing material as required in Section 7.03 C. below. In all cases the driller shall ascertain that the bentonite pellets are in fact filling the hole from the bottom up to the required elevation. When the borings are made using a drilling fluid to keep the hole open the boring shall be filled as specified in 7.03 C. below.

- C. For deep borings, greater than one hundred (100) feet, the borehole shall be sealed by pressure grouting through a tremmie pipe from the bottom upward in one (1) continuous operation. The grouting materials shall be neat Portland Class A or quick setting cement in a ratio of not over seven (7) gallons of water per ninety-four pounds of cement; or a coarse grained high solids non drilling mud grade bentonite grout slurry, such as Baroid Benseal, American Colloid, or equal. The bentonite grout shall be mixed in accordance with the manufacturers recommendations. A Portland cement grout and bentonite combination is acceptable. The relative proportion of each component shall meet the following requirement:

	Portland cement	=	92%
	Bentonite	=	8%
or:	Portland cement	=	74%
	Bentonite	=	6%
	Sand	=	24%

For each two (2) percent addition of bentonite an additional 1.3 gallons of water should be added to the slurry mixture. A maximum of two (2) percent by weight of calcium chloride may be added. The use of bentonite drilling clay as a grouting material is prohibited except as an additive to neat cement grout. Only bentonite grout approved by the National Sanitation Foundation (NSF) shall be approved by the Department as appropriate grouting material.

Section 8 -- INSPECTIONS

- A. During the construction, modification, repair, or abandonment of any well the Department may conduct such periodic inspections as it deems

necessary to insure conformity with applicable standards. Duly authorized representatives of the Department may, at reasonable times, enter upon and shall be given access to any premise for the purpose of such inspection.

- B. When during construction, modification, repair, or abandonment of any well the Department finds the work is not being done in accordance with rules, regulations and standards as required the Department shall give the owner and well driller written notice stating which rules, regulations or standards are being violated. At such time the Department may order that necessary corrective action be taken within a reasonable time to be prescribed in such order. Any such order shall become final unless the person or persons named therein requests, by written petition, a hearing before the Board no later than fourteen (14) days after the date such order is served. Failure to act in accordance with the order of the Department after receipt of written notice shall be grounds for revocation of the permit.
- C. All private water supplies shall be subject to inspection by the Department and when deemed necessary, said supplies shall be made available for the collection of samples in order to determine the purity of the supply. When a water sample is found to have contamination the owner shall be required to take whatever steps necessary to correct the contamination problem.
- D. All wells shall be subject to inspection by the Department and shall be made available for the collection of samples in order to determine the purity of the supply.

Section 9 -- ABANDONMENT OF WELLS

9.01 -- General Requirements

The objective of the requirements described in this Section is to restore as nearly as possible those subsurface conditions which existed before the well was constructed. A well penetrating several aquifers or formations, must be filled and sealed in such a way as to prevent the vertical movement of water from one aquifer to another. The

Department shall require that certain abandonment procedures be followed in order to avoid or reduce water quality and/or water quantity problems.

- A. All abandoned wells shall be filled with Portland cement grout, a high solids bentonite grout, or a Portland cement grout and bentonite combination in such a way that they do not produce water or act as a conduit for the interchange of waters of undesirable quality with those whose quality is desirable, or present a hazard to the safety and well being of people and/or animals.
- B. The owner shall submit a plan to fill at the owners expense any abandoned or condemned well within thirty (30) days after receipt of notice from the Department.
- C. All abandoned wells shall be filled only by a person having a valid drillers license from the Tennessee Department of Environment and Conservation, or be an engineer or geologist registered with the State of Tennessee.
- D. Within thirty (30) days of filling an abandoned well, the driller, engineer or geologist responsible for the well abandonment shall submit to the Department a well abandonment report. The report must be completely filled out and signed by the authorized contractor responsible for well abandonment.
- E. The Department may require any well owner to have an abandoned well sealed when the well:
 - 1. is contaminated;
 - 2. is a potential source of contamination to the groundwater aquifers underlying Shelby County;
 - 3. is not maintained in an operative condition for the purpose of collecting samples.
- F. Observation and monitoring wells being actively used for the investigation or management of groundwater by federal, state or local governmental agencies or research

organizations may be classified as temporarily abandoned and shall be covered with a secure cap such that the cover is water tight and cannot be removed except with the aid of equipment or the use of tools.

- G. All wells for which a replacement well construction permit has been issued, must be abandoned as set forth in these regulations unless specific written approval for maintaining the replaced well is granted by the Department.

9.02 -- Sealing And Fill Materials

- A. Portland Class A cement grout, a high solids bentonite grout, or a Portland cement grout and bentonite combination are considered sealing material and may be used to fill an abandoned well.
- B. The grouting materials shall be neat Portland Class A or quick setting cement in a ratio of not over seven (7.0) gallons of water per ninety-four (94) pounds of cement; or a coarse grained high solids non drilling mud grade bentonite slurry such as Baroid Benseal, American Colloid or equal. The bentonite grout shall be mixed in accordance with the manufacturers recommendations. Bentonite alone is not an acceptable grouting material. A Portland cement grout and bentonite combination is also acceptable. The relative proportion for each component shall meet the following requirements:

Portland cement	=	92%
Bentonite	=	8%
or: Portland cement	=	74%
Bentonite	=	6%
Sand	=	20%

For each two (2) percent addition of bentonite an additional 1.3 gallons of water should be added to the slurry mixture. A maximum two (2) percent by weight of calcium chloride may be added. The use of bentonite drilling clay as a grouting material is prohibited except as an additive to neat cement grout. Only bentonite grout approved by the National Sanitation Foundation (NSF) shall be approved by the

Department as appropriate grouting material.

- C. Other grouting materials and methods may be used, if approved by the Department.

9.03 -- Abandonment Procedures

- A. Prior to filling the well, a plan shall be submitted within thirty (30) days containing a description of the general condition of the well. All available information about the construction of the well or information that any obstructions exist which would interfere with the filling and sealing process of the well shall be submitted with the application. Should any obstructions exist they shall, if practical as determined by the Department, be removed by cleaning out the hole or re-drilling.
- B. All wells shall be filled with the required sealing or fill materials from the bottom of the well up, by methods that avoid separation or dilution of the seal material.
- C. The grout shall be pumped into the well through a tremmie pipe in one continuous operation.
- D. The tremmie pipe may be moved upward as the well is filled from the bottom up, if the pipe extends at least one (1) foot into the seal material.
- E. Before abandonment procedures begin an abandoned well shall have all pumping or plumbing equipment removed to insure freedom from obstructions that may interfere with the sealing operation.
- F. The well shall be chlorinated prior to sealing by addition of sufficient quantities of liquid bleach or dry hypochlorite granules.

Section 10 -- CROSS CONNECTION CONTROL

All groundwater in Shelby County is deemed potable and shall be protected against contamination by way of backflow through private water supplies.

- A. All cross connection requirements for private

water supplies, quasi-public water supplies, public water supplies, and all other potable water supplies shall fall within the guidelines of the Memphis and Shelby County Cross Connection Board, as established by City and County Resolution in October 1980, or as later modified.

Section 11 -- LIMITATION ON USE OF WATER

- A. Water pumped by private and/or quasi-public water supplies for residential, commercial and industrial purposes shall be limited to reasonable use.
- B. The waste of groundwater from water wells by way of continual discharges or from any type of equipment utilizing well water shall not be permitted.
 - 1. Any person requesting a permit to construct a water well for use in an underground heat pump system; in retaining levels of lakes, ponds, or similar bodies of water; in commercial and industrial processes; irrigation; or in any other uses whereby a continual groundwater discharge may occur shall limit such discharges by taking conservation steps established by the Department. Failure to comply with this section shall result in the rejection of the permit application.
 - 2. Any person having an existing well whereby a continual discharge occurs shall be required to take whatever conservation steps the Department may deem necessary to prevent such discharges. Failure to comply with this section is a misdemeanor and upon conviction the violator shall be fined a minimum of twenty-five (\$25.00) dollars per day up to a maximum of five hundred (\$500.00) dollars per day with each day such violation of this section occurs constituting a separate offense.
- C. The Department shall take whatever steps it deems necessary to conserve groundwater obtained by way of private water supplies for cooling, refrigeration and air conditioning

systems. The Department shall require the reuse of water for cooling through the use of cooling towers, evaporative condensers, or some other such device or method approved by the applicable code.

- D. All residential, commercial and industrial heat pump systems, shall be a horizontal closed loop system with no discharge. The design of such heat pump systems, shall be approved by the applicable code, and the owner shall have a valid mechanical permit.
- E. Non-aqueous heat pump systems shall be prohibited.

Section 12 -- AVAILABILITY OF PUBLIC WATER

12.01 -- Public Water Available To A Premise

- A. Public water shall be deemed available to a premise other than a subdivision when it is located within three hundred (300) feet of said premise.
- B. When proposed subdivisions are comprised of premises used or intended for human habitation or other establishments where a water supply is or may be used for human consumption and where such subdivision is located within one quarter (1/4) mile of public water distribution facilities in existence in a dedicated right-of-way, the developer of such subdivision shall extend the water supply mains and connect all lots thereto.
- C. The distance between an existing water main in a dedicated right-of-way and a premise or proposed subdivision shall be measured by an actual or imaginary straight line upon the ground or in the air between the point within the premise or subdivision nearest to the existing water main in dedicated right-of-way and the point where the existing water main in a dedicated right-of-way comes into closest proximity with the premise or proposed subdivision.
- D. The connection to a public water supply shall be made in accordance with the requirements of all applicable rules and regulations of any

county, state, or municipal agency having jurisdiction thereof.

- E. The provisions of this section relate to single-family, multi-family, commercial and industrial-zoned lots and are applicable to new subdivisions, and existing subdivisions which are unplatted or unrecorded.
- F. The provisions of this section shall not apply when a utility cannot provide a public water distribution system due to the utility's franchise limitation or the inability or unwillingness of a city to extend its public water distribution system.
- G. The construction of a well shall not be permitted at a premise where public water is available and which said water supply has a yield and pump capacity to provide the quantity of water which the user has stated is necessary for purposes for which the water is intended to be used unless otherwise provided by this code.
- H. When a public water system (pws) is available to a residential premise the potable water shall be obtained from the public water system. A well may be approved by the Department for construction on a residential premise where public water is available under the following circumstances:
 - 1. For filling a lake, providing such lake, pond or similar continuous body of water is not less than one (1) acre in size, with the total parcel of land being no less than four (4) acres in size.
 - 2. For irrigation, provided such parcel of land is no less than four (4) acres in size.
 - 3. For watering livestock, provided the parcel of land to be served is no less than four (4) acres in size.
- I. A well may be approved by the Department for construction on a commercial and/or industrially zoned premise where public water is available, provided the owner demonstrates to the Department that no reasonable

alternative water supply to the proposed well exists. The potable water supply shall be obtained from the public water system.

- J. The construction of a water well or any other type of well regardless of use on a lot or premise less than four (4) acres in size utilizing a septic tank system for sewage disposal, shall not be permitted by the Department.

12.02 -- Public Water Not Available To A Premise

- A. Public water shall be deemed not available to a premise if it is located a distance greater than three hundred (300) feet of said premise.
- B. Public water may be deemed not available to a premise if the topography and land surface features are such that they economically or structurally prevent connecting to public water.

12.03 -- Auxiliary Intake

No auxiliary intake for a potable water supply shall be made or permitted unless the source and use of the auxiliary supply and the location and arrangement of the intake are approved by the Department in writing.

Section 13 -- INJECTION WELLS

No injection wells of any type shall be allowed in Memphis and Shelby County for the injection of surface or groundwater, or chemically or thermally altered water, or any other fluids into the underground formations. No well constructed shall be used for recharge, injection, or disposal purposes. Injection wells for the purpose of improving groundwater quality may be considered under Section 14.02, but approval of these wells will not release the appellant of any applicable requirements under state or federal law for the remediation of contaminated groundwater or materials at the site.

Section 14 -- VARIANCES

14.01 -- Existing Wells

Wells in existence on the effective date of this Act shall be required to conform to the provisions of these Rules and Regulations, or any rules or regulations

adopted pursuant thereto, where such provisions relate to assessment of fees, cross connection control, improperly maintained wells, abandoned wells, and wells constructed in such a way that create serious health hazards, and any other items deemed necessary by the Department.

14.02 -- Appeals -- Procedure

Any person who feels aggrieved by an order of the Department issued pursuant to these Rules and Regulations shall be entitled to a hearing before the Board upon request.

- A. The Board shall have and exercise the power, duty and responsibility to hear and decide all matters concerning a variance to or an exception taken to any decision, ruling, requirement, rule, regulations or order of the Board or the Department. Such appeal shall be made within fifteen (15) days after receiving notice of such decision, ruling, requirement, rule, regulation, or order by filing a written notice of appeal directly to the Board specifying the grounds thereof and the relief requested. Such an appeal shall act as a stay of decision, ruling, requirement, rule, regulation, or order in question until the Board has taken final action on the appeal, except when the Department has determined that a health hazard exists. The Board shall, not less than thirty (30) days after the date of the receipt of the notice of appeal, set a date for the hearing and shall give notice thereof by certified mail to the interested parties.
- B. Hearing before the Board shall be conducted in the following manner:
 - (1) The technical secretary of the Board or his/her representative shall act as the hearing officer to conduct such hearing.
 - (2) Any person making an appeal may appear in person or by agent or attorney and present evidence, both written and/or oral, pertinent to the issues involved and may examine and cross-examine witnesses.
 - (3) All testimony shall be presented under oath and recorded. The Board is

authorized to have all such testimony transcribed and a transcript of such testimony shall be made available to the appellant or any party to the hearing upon payment of the normal fee established by the Department.

- (4) After due consideration of the written and oral statements and the testimony and arguments submitted at the hearing upon such appeal or upon default in appearance of the appealing party on the date specified in the formal notice of the hearing, the Board shall issue and enter such final order to make such final determination as it shall deem appropriate, within thirty (30) days of the hearing date and shall immediately notify all interested parties thereof in writing by certified mail.

- C. An appeal from the Board shall be to a court of competent jurisdiction in Shelby County, Tennessee.

Section 15 -- RULES AND REGULATIONS OF THE DEPARTMENT

The Board shall adopt and amend rules and regulations reasonably necessary to effectuate the policy and standards and intent declared by these Rules and Regulations, not inconsistent with these Rules and Regulations or with the Constitution or laws of the State.

Section 16 -- CONSTITUTIONALITY OF ORDINANCE

If any part or parts of these Rules and Regulations shall be declared unconstitutional it shall not affect the validity of any other part of these Rules and Regulations.

Section 17 -- CONFLICT OF LAWS

All laws and parts of laws in conflict with the provisions of these Rules and Regulations shall be repealed upon adoption of these Rules and Regulations.

Section 18 -- ENFORCEMENT AND PENALTIES

18.01 -- Enforcement

- A. If the Department determines that the holder

of any permit issued pursuant to these Rules and Regulations has violated any provisions of this act, or any rule or regulation adopted pursuant thereto, the Department may suspend or revoke any such permit. The Department may place on probation a person whose permit has been suspended. The Department may reprimand a permittee for a violation of this act or a rule or regulation adopted pursuant to these Rules and Regulations.

- B. The Department may petition a court of competent jurisdiction for injunctions or other appropriate relief to enforce the provisions of these Rules and Regulations. The attorney of the appropriate jurisdiction shall represent the Department when requested to do so.
- C. Any person who willfully violates any of the provisions of these Rules and Regulations is guilty of a misdemeanor.
- D. Any well owner who knowingly causes or permits a hazardous or potentially hazardous condition to exist due to well construction or any other reasons as outlined in these Rules and Regulations which could cause deterioration of groundwater aquifers in the system shall forfeit his right to an approved, certified permit. He shall also be liable to enforcement action.

18.02 -- Penalties

The well driller or any other person who fails to comply with these Rules and Regulations or the rules and regulations promulgated hereunder shall be guilty of a misdemeanor, and upon conviction be fined a minimum of twenty-five dollars (\$25) per day or a maximum of five hundred dollars (\$500) per day and each day such violation of these Rules and Regulations occur shall constitute a separate offense.

APPENDIX B

WELL DATA

**Monitoring Wells
Leak Detection Wells
and
Production Wells**

Site/Tank #	Well #	Type	Located	Surface Protector	Cement Pad/	No. Guard	Well Cap	Type	Reported							Observed			COMMENTS	
									Date Install	TOC Elev.	Total Depth	Well Material	Screen Dia	Slot Length	Well Depth	Water Depth	Diff TOC			
									MMDDYYR	MSL	Feet	Inch	FEET	Inch	Feet	Feet	Feet			
SITE 2 SOUTH LANDFILL	GM-1	MW	Y	AG	2	N	N	Y	S	120784	268.96	49.00	PVC	2	5.0	0.01	49.39	3.58	1.83	
	GM-2	MW	Y	AG	2	N	N	Y	S	061785	266.71	44.00	PVC	2	5.0	0.01	45.48	7.29	1.85	
	GM-3	MW	Y	AG	2	N	N	Y	S	121484	269.51	45.00	PVC	2	5.0	0.01	46.66	11.41	1.70	
	GM-4	MW	Y	AG	4	N	N	N	N	121584	269.45	22.00	PVC	2	5.0	0.01	24.11	5.01	1.72	
	GM-5	MW	Y	AG	2	N	N	Y	S	121584	267.38	57.00	PVC	2	5.0	0.01	58.55	9.87	1.80	
SITE 3 N-121	GM-6	MW	Y	AG	4	N	N	Y	S	120784	288.75	50.00	PVC	2	5.0	0.01	51.30	26.76	2.19	
	GM-7	MW	Y	AG	2	N	N	Y	S	121184	286.26	60.00	PVC	2	5.0	0.01	61.53	24.25	2.48	
	GM-8	MW	Y	AG	2	N	N	Y	S	121384	286.88	20.00	PVC	2	5.0	0.01	23.30	9.24	1.87	
SITE 7 - N-126	GM-9	MW	Y	AG	2	N	N	Y	S	061085	283.86	54.00	PVC	2	5.0	0.01	52.08	23.82	-0.23	
SITE 8 CEMETERY DISPOSAL	GM-10	MW	Y	AG	3	N	N	Y	S	061385	329.16	30.00	PVC	2	5.0	0.01	26.48	20.92	1.79	
	GM-11	MW	Y	AG	3	N	N	Y	S	061485	321.74	30.00	PVC	2	5.0	0.01	32.86	14.34	2.10	
	GM-12	MW	Y	AG	4	N	N	N	S	061385	324.04	25.00	PVC	2	5.0	0.01	23.98	19.37	1.95	
FLYING CLUB	FCMW-1	MW	Y	AG	1	1	4	Y	H	051193	300.06	17.57	PVC	2	10.0	0.01	17.41	9.30	2.08	
	FCMW-2	MW	Y	AG	1	1	4	Y	H	051293	297.53	22.60	PVC	2	15.0	0.01	22.59	7.25	2.22	
	FCMW-3	MW	Y	AG	1	1	4	Y	H	051293	297.53	22.60	PVC	2	15.0	0.01	22.63	8.89	2.21	
	FCMW-4	MW	Y	AG	1	1	4	Y	H	051293	297.89	22.95	PVC	2	15.0	0.01	22.55	8.65	2.24	
	FCMW-5	MW	Y	AG	1	1	4	Y	H	051193	298.23	22.55	PVC	2	15.0	0.01	22.55	7.31	2.29	
	FCMW-6	MW	Y	AG	1	1	4	Y	H	071593	295.65	23.10	PVC	2	15.0	0.01	23.50	11.30	2.16	
T1205N	T1205N-1	LD	N	--	--	--	--	--	--	010490	296.79	15.00	PVC	2	12.5	0.01	--	--	--	Removed with tank.
	T1205N-2	LD	N	--	--	--	--	--	--	010490	297.2	15.00	PVC	2	12.5	0.01	--	--	--	Removed with tank.
T1205S	T1205S-1	LD	Y	F	N	N	0	N	E	010490	296.13	15.00	PVC	2	12.5	0.01	13.79	5.45	0.00	Closure recommended.
	T1205S-2	LD	Y	F	N	N	0	N	E	010490	296.86	15.00	PVC	2	12.5	0.01	13.92	4.19	0.00	Closure recommended.
N-126 NORTH FUEL FARM	NFMW-1	MW	Y	AG	1	1	4	Y	H	051393	285.95	22.51	PVC	2	15.0	0.01	22.38	9.21	2.27	
	NFMW-2	MW	Y	AG	1	1	4	Y	H	051493	284.76	22.55	PVC	2	15.0	0.01	22.58	9.70	2.28	
	NFMW-3	MW	Y	AG	1	1	4	Y	H	051793	285.90	22.57	PVC	2	15.0	0.01	22.54	9.69	2.13	
	NFMW-4	MW	Y	AG	1	1	4	Y	H	051493	286.53	27.30	PVC	2	20.0	0.01	27.50	7.55	2.39	
	NFMW-5	MW	Y	AG	1	1	4	Y	H	051393	285.19	27.55	PVC	2	20.0	0.01	27.59	11.28	2.08	
	NFMW-6	MW	Y	F	1	1	0	N	H	071593	281.95	20.15	PVC	2	15.0	0.01	20.10	9.13	-0.28	
	MW-1	MW	Y	AG	1	1	4	Y	H	071194	274.90	20.00	PVC	2	15.0	0.01	20.00	9.78	2.80	
	MW-2	MW	Y	AG	1	1	4	Y	H	071194	272.19	20.00	PVC	2	15.0	0.01	20.00	12.75	2.45	

Site/Tank #	Well #	Type	Located	Type	Surface Protector	Cement Pad/ Cond.	No. Guerd Post	Well Lock	Well Type	Date Install	TOC Elev. MSL	Total Depth TOC Feet	Reported			Observed			COMMENTS	
													Well	Screen	Slot	Well	Water	Diff		
													Material	Die Inch	Length FEET	Size Inch	Depth TOC Feet	Depth TOC Feet		TOC Surface Feet
T304	MW-3	MW	Y	AG	1	1	4	Y	H	071294	274.34	20.00	PVC	2	15.0	0.01	20.00	11.59	2.60	
	T304-1	LD	Y	F	1	1	0	N	H	010990	284.34	15.00	PVC	2	12.5	0.01	15.2	2.78	-0.28	
	T304-2	LD	Y	F	1	1	0	N	H	010990	283.83	15.00	PVC	2	12.5	0.01	15.25	2.33	-0.42	
T1239	T1239-1	LD	Y	F	1	1	0	N	H	010390	284.08	15.00	PVC	2	12.5	0.01	15.23	3.64	-0.23	
	T1239-2	LD	Y	F	1	1	0	N	H	010990	283.28	15.00	PVC	2	12.5	0.01	15.19	3.25	-0.35	
	T1239-3	LD	Y	F	1	1	0	N	H	010990	283.64	15.00	PVC	2	12.5	0.01	15.2	2.25	-0.72	
N-94	94MW-5	MW	Y	AG	1	1	3	Y	H	010892	285.98	20.00	PVC	4	10.0	0.01	22.67	8.78	3.32	
	94MW-6	MW	Y	AG	1	1	3	Y	H	010892	286.70	17.00	PVC	4	10.0	0.01	19.35	8.11	2.44	
	94MW-7	MW	Y	AG	1	1	3	Y	H	010892	286.32	20.00	PVC	4	10.0	0.01	20.92	7.17	2.46	
T301	T301-1	LD	Y	F	1	1	0	N	H	010590	283.88	15.00	PVC	2	12.5	0.01	15.23	2.31	-0.31	
	T301-2	LD	Y	F	1	1	0	N	H	010990	283.63	15.00	PVC	2	12.5	0.01	15.2	4.21	-0.38	
	T301-3	LD	Y	F	1	1	0	N	H	010990	283.55	15.00	PVC	2	12.5	0.01	15.18	2.23	-0.36	
T1242	T1242-1	LD	Y	F	1	1	0	N	H	010490	283.83	15.00	PVC	2	12.5	0.01	15.25	5.6	-0.38	
	T1242-2	LD	Y	F	1	1	0	N	H	010490	283.90	15.00	PVC	2	12.5	0.01	15.29	7.79	-0.26	
T1243	T1243-1	LD	Y	F	1	1	0	N	H	010590	284.43	15.00	PVC	2	12.5	0.01	15.2	3.04	-0.37	
	T1243-2	LD	Y	F	1	1	0	N	H	010990	284.26	15.00	PVC	2	12.5	0.01	15.2	2.77	-0.43	
AFFTA	FFMW-1	MW	Y	AG	1	1	4	Y	H	062292	286.77	20.30	PVC	2	10.0	0.01	20.24	4.63	1.58	
	FFMW-2	MW	Y	AG	1	1	4	Y	H	062292	267.91	20.28	PVC	2	10.0	0.01	20.18	7.60	1.35	
	FFMW-3	MW	Y	AG	1	1	4	Y	H	062392	268.15	21.29	PVC	2	10.0	0.01	21.24	5.48	1.31	
	FFMW-4	MW	Y	AG	1	1	4	Y	H	062392	267.54	18.30	PVC	2	10.0	0.01	18.27	4.87	1.58	
	FFMW-5	MW	Y	AG	1	1	4	Y	H	062492	268.83	18.06	PVC	2	10.0	0.01	18.00	3.00	1.61	
	FFMW-6	MW	Y	AG	1	1	4	Y	H	062492	270.32	22.88	PVC	2	10.0	0.01	22.82	4.48	1.52	
	FFMW-7	MW	Y	AG	1	1	4	Y	H	062592	267.94	17.92	PVC	2	10.0	0.01	14.87	4.10	1.44	
	FFMW-8	MW	Y	AG	1	1	4	Y	H	062592	268.12	18.02	PVC	2	10.0	0.01	17.96	4.11	1.59	
	FFMW-9	MW	Y	AG	1	1	4	Y	H	062692	267.81	18.14	PVC	2	10.0	0.01	18.60	4.07	1.65	
	FFMW-10	MW	Y	AG	1	1	4	Y	H	062692	268.26	19.33	PVC	2	10.0	0.01	19.25	4.22	1.63	
	FFMW-11	MW	Y	AG	1	1	4	Y	H	062692	270.16	18.23	PVC	2	10.0	0.01	18.16	5.09	1.57	

Site/Tank #	Well #	Type	Located	Type	Surface Protector	Cement Pad/ Cond.	No. Guerd Post	Well Look	Well Cap	Date Install	TOC Elev.	Total Depth Feet	Reported			Observed			COMMENTS	
													Well	Screen	Slot	Well	Water	Diff		
													Material	Dia Inch	Length FEET	Size Inch	Depth Feet	Depth Feet		TOC Surface Feet
T1489	T1489-1	LD	Y	F	1	1		N	H	122889	268.13	15.00	PVC	2	12.5	0.01	14.75	5.54	-0.32	Well removed with UST.
	T1489-2	LD	N	--	--	--	--	--	--	122889	268.22	15.00	PVC	2	12.5	0.01	--	--	--	
	T1489-3	LD	Y	F	1	1	0	N	H	122889	267.51	15.00	PVC	2	12.5	0.01	14.84	4.68	-0.57	
	T1489-4	LD	Y	F	1	1	0	N	H	122889	267.75	15.00	PVC	2	12.5	0.01	14.81	2.29	-0.76	
T1508	T1508-1	LD	Y	F	1	1	0	N	H	122989	268.07	15.00	PVC	2	12.5	0.01	14.81	4.1	-0.33	Well removed with UST.
	T1508-2	LD	N	--	--	--	--	--	--	122989	267.74	15.00	PVC	2	12.5	0.01	--	--	--	
	T1508-3	LD	N	--	--	--	--	--	--	122989	266.67	15.00	PVC	2	12.5	0.01	--	--	--	
NAVY HOSPITAL	NHMW-1	MW	Y	F	1	1	0	N	H	051892	289.47	27.40	PVC	2	10.0	0.01	27.48	11.15	-0.22	
	NHMW-2	MW	Y	F	1	1	0	N	H	051992	286.13	21.60	PVC	2	10.0	0.01	21.65	8.21	-0.47	
	NHMW-3	MW	Y	F	1	2	0	N	H	052092	278.46	22.80	PVC	2	10.0	0.01	22.88	1.50	-0.47	
	NHMW-4	MW	Y	F	1	2	0	N	H	060292	278.51	15.60	PVC	2	10.0	0.01	15.81	2.12	-0.23	
NAVY EXCHANGE	757-1	MW	Y	F	2	2	0	N	H	010787	269.49	20.70	PVC	4	14.8	0.02	19.61	4.50	-0.43	Well pipe broken at top.
	757-2	MW	Y	F	2	2	0	N	H	010887	270.88	19.60	PVC	4	14.8	0.02	19.03	5.20	-0.33	
	757-3	MW	Y	F	2	2	0	N	H	010887	270.26	19.90	PVC	4	14.8	0.02	19.37	3.66	-0.52	
	757-4	MW	Y	F	1	2	0	N	H	010987	268.74	18.70	PVC	4	14.8	0.02	19.20	4.34	-0.63	
	757-5	MW	Y	F	2	3	0	N	H	010987	271.14	19.70	PVC	4	14.8	0.02	19.54	4.74	-0.30	
	757-6	MW	Y	F	2	3	0	N	H	010987	271.82	19.70	PVC	4	14.8	0.02	17.56	3.91	-0.32	
	757-7	MW	Y	F	2	2	0	N	H	110387	270.08	25.50	PVC	4	20.0	0.02	25.68	3.57	-0.50	
	757-8	MW	Y	F	2	2	0	N	H	110387	270.98	25.50	PVC	4	20.0	0.02	25.00	5.23	-0.30	
	757-9	MW	Y	F	2	2	0	N	H	110487	271.06	25.50	PVC	4	20.0	0.02	25.50	3.89	-0.34	
	757-10	MW	Y	F	2	2	0	N	H	110487	271.16	25.50	PVC	4	20.0	0.02	24.89	5.70	-0.69	
	757-11	MW	Y	F	4	4	0	N	H	110587	271.22	25.50	PVC	4	20.0	0.02	25.76	4.20	-0.27	
	757-12	MW	Y	F	2	3	0	N	H	--	--	--	PVC	5	--	0.02	28.53	4.65	-0.43	
	757-13	MW	Y	F	2	2	0	N	H	--	--	--	PVC	4	--	0.02	29.74	4.83	-0.28	
	757-14	MW	Y	F	2	2	0	N	H	--	--	--	PVC	4	--	0.02	28.82	4.87	-0.42	
	757-15	MW	Y	F	2	3	0	N	H	--	--	--	PVC	4	--	0.02	13.69	3.16	-0.39	
	757-16	MW	Y	F	2	2	0	N	H	--	--	--	PVC	4	--	0.02	14.28	4.09	-0.39	
	757-17	MW	Y	F	2	2	0	N	H	--	--	--	PVC	4	--	0.02	13.92	3.61	-0.32	

Site/Tank #	Well #	Type	Located	Type	Surface /Cond.	Cement Pad/ Cond.	No. Guerd Post	Well Look	Well Type	Date Install	TOC Elev. MSL	Reported					Observed			COMMENTS
												Total Depth	Well Die	Screen Length	Slot Size	Well Depth	Water Depth	Diff		
																			TOC Feet	
	757-18	MW	Y	F	1	1	0	N	H	--	--	--	PVC	4	--	0.02	13.70	2.65	-0.52	
	757-141	C	Y	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	Closed (borings?)
	757-142	C	Y	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	Closed (borings?)
Leak Detection	757-1	LD	Y	AG	0	2	0	N	H	02--86	--	--	PVC	4	--	--	14.80	3.87	0.84	
	757-2	LD	Y	AG	0	2	0	N	H	02--86	--	--	PVC	4	--	--	15.60	3.73	0.60	
	757-3	LD	Y	AG	0	3	0	N	H	02--86	--	--	PVC	4	--	--	14.86	4.71	0.40	
	757-4	LD	Y	AG	0	2	0	N	H	02--86	--	--	PVC	4	--	--	14.29	5.18	0.28	
S-50	S50-1	MW	Y	F	1	2	0	N	H	081593	266.35	21.80	PVC	2	15.0	0.01	20.93	6.62	-0.29	Closed 081594
	S50-2	MW	Y	F	1	2	0	N	H	081593	265.82	21.30	PVC	2	15.0	0.01	20.88	6.75	-0.30	Closed 081594
	S50-3	MW	Y	F	1	2	0	N	H	081693	266.58	21.40	PVC	2	15.0	0.01	20.68	4.78	-0.44	Closed 081594
	S50-4	MW	Y	F	1	2	0	N	H	081793	266.24	21.10	PVC	2	15.0	0.01	20.93	4.89	-0.31	Closed 081594
	S50-5	MW	Y	F	1	2	0	N	H	081893	266.55	21.10	PVC	2	15.0	0.01	21.08	7.04	-0.18	Closed 081594
S-376	S376-1	MW	Y	F	1	2	0	N	H	073092	264.17	14.80	PVC	2	10.0	0.01	14.94	5.32	-0.24	
	S376-2	MW	Y	F	1	2	0	N	H	073092	263.75	13.50	PVC	2	10.0	0.01	13.55	7.23	-0.19	
	S376-3	MW	Y	F	1	2	0	N	H	073192	264.02	16.00	PVC	2	10.0	0.01	16.82	9.59	-0.22	
	S376-4	MW	Y	F	1	2	0	N	H	073192	264.29	16.50	PVC	2	10.0	0.01	16.58	7.70	-0.25	
T1249	T1249-1	LD	Y	F	2	2	0	N	H	010690	264.04	15.00	PVC	2	12.5	0.01	14.88	5.10	-0.32	
	T1249-2	LD	Y	F	2	2	0	N	H	010690	264.06	15.00	PVC	2	12.5	0.01	14.88	4.23	-0.23	
T1482	T1482-1	LD	Y	F	2	2	0	N	H	010690	264.62	15.00	PVC	2	12.5	0.01	14.69	5.95	-0.20	
	T1484-2	LD	N	--	--	--	--	--	--	--	--	--	--	--	--	0.01	--	--	--	Well reportedly was removed with UST.
	T1482-3	LD	Y	F	2	2	0	N	H	010690	263.75	15.00	PVC	2	12.5	0.01	14.71	4.94	-0.23	
S-237	S237-1	MW	Y	AG	1	1	0	Y	H	092392	NR	16.00	PVC	2	10.0	0.01	17.34	6.53	2.41	
	S237-2	MW	Y	F	1	2	0	N	H	092292	NR	15.00	PVC	2	10.0	0.01	14.61	3.25	-0.33	
	S237-3	MW	Y	F	1	2	0	N	H	092292	NR	15.00	PVC	2	10.0	0.01	14.95	3.31	-0.29	
	S237-4	MW	Y	F	1	2	0	N	H	092392	NR	10.00	PVC	2	10.0	0.01	9.67	5.24	-0.21	
	S237-5	MW	Y	AG	1	1	0	Y	H	101392	NR	15.00	PVC	2	10.0	0.01	16.82	7.86	2.38	
	S237-6	MW	Y	AG	1	1	0	Y	H	101392	NR	15.00	PVC	2	10.0	0.01	17.50	8.85	2.47	
T337	T337-1	LD	Y	F	2	1	0	N	H	010390	271.37	15.00	PVC	2	12.5	0.01	15.18	2.46	-0.31	
JP-6 FUEL FARM	T337-2	LD	Y	F	2	1	0	N	H	010390	270.86	15.00	PVC	2	12.5	0.01	15.17	2.71	-0.31	
	T337-3	LD	Y	F	2	1	0	N	H	010390	271.17	15.00	PVC	2	12.5	0.01	15.23	2.51	-0.36	

Site/Tank #	Well #	Type	Located	Type	Surface Protector /Cond.	Cement Pad/ Cond.	No. Guard Post	Well Look	Well Type	Data Install	TOC Elev.	Total Depth TOC Feet	Reported			Observed			COMMENTS	
													Well	Screen	Slot	Well	Water	Diff		
													Material	Die Inch	Length FEET	Size Inch	Depth TOC Feet	Depth TOC Feet		TOC Surface Feet
T336	T336-1	LD	Y	F	2	1	0	N	H	010390	271.01	15.00	PVC	2	12.5	0.01	15.20	2.88	-0.15	
JP-6 FUEL	T336-2	LD	Y	F	2	1	0	N	H	010390	271.56	15.00	PVC	2	12.5	0.01	15.24	2.48	-0.39	
FARM	T336-3	LD	Y	F	2	1	0	N	H	010390	271.29	15.00	PVC	2	12.5	0.01	15.24	5.32	-0.24	
T1637	T1637-1	LD	Y	F	2	3	0	N	H	010590	288.67	15.00	PVC	2	12.5	0.01	14.89	10.88	-0.37	Approximately 3-feet of sediment at bottom.
	T1637-2	LD	Y	F	2	1	0	N	H	010590	288.49	15.00	PVC	2	12.5	0.01	12.52	8.99	-0.36	
	T1637-3	LD	Y	F	2	1	0	N	H	010590	288.59	15.00	PVC	2	12.5	0.01	14.93	9.14	-0.26	
TEST WELL	TW-1	TW	Y	AG	2	N	0	N	W	--	271.02	--	Steel	8	--	--	NM	NM	NM	
LAKEHOUSE	N-761	NP	Y	F	2	3	0	Y	E	07/84	323.57	215.00	PVC	4	--	--	215.00	80.98	0.01	
S172	S172-1	NP	Y	AG	4	N	0	Y	E	--	332.88	143.00	Galvan	2	--	--	145.00	88.89		
RWY-9	RWY-9	NP	Y	F	3	N	0	Y	E	--	--	79.00	PVC	4	--	--	80.50	46.26	0.10	
O-CLUB	CP-1	NP	Y	AG	4	4	0	N	P	--	295.40	--	Steel	--	--	--	NM	NM	NM	
GOLF COURSE	GC-1	NP	Y	AG	2	1	0	N	P	05/87	300.93	--	Steel	--	--	--	NM	NM	NM	
PRODUCTION	PW-N1	PW	Y	AG	1	1	0	Y	P	1982	284.58	523.00	Steel	--	--	--	NM	NM	NM	
WELLS	PW-N2	PW	Y	AG	1	1	0	Y	P	01/81	287.23	488.00	Steel	--	--	--	NM	NM	NM	
	PW-S3	PW	Y	AG	1	1	0	Y	P	10/86	294.77	1450.00	Steel	--	--	--	NM	NM	NM	
	PW-S4	PW	Y	AG	1	1	0	Y	P	10/86	269.71	1450.00	Steel	--	--	--	NM	NM	NM	
	PW-S5	PW	Y	AG	1	1	0	Y	P	10/86	267.00	1435.00	Steel	--	--	--	NM	NM	NM	

Key:

Well Type	Well Mount	Condition Rating	Well Cap Type	General
MW = Monitoring Well	F = Flush	1 = Good	S = Slip Cap	-- = No Data
LD = Leak Detection	AG = Above G	2 = Acceptable	H = Hex Keyed Type	NM = Not Measured
C = Closed		3 = Minor damage/disrepair	E = Expandable	TOC = Top of Casing
TW = Test Well		4 = Moderate damage/disrepair	W = Welded	
PW = Production Well		5 = Severe damage/disrepair	P = Pump	
NP = Nonpotable				

DATA IS INCORRECT 

LOCATION OF MONITORING AND PRODUCTION WELLS, NAS MEMPHIS, TN.

WELL ID.	LATITUDE	LONGITUDE	EASTING	NORTHING	ELEV-MSL
757-18	35 19 58.68606567	89 52 47.07611	811533.1380	389569.1187	266.8895
757 4	35 19 57.38661194	89 52 45.89991	811625.3107	389433.9758	268.9636
757-1	35 19 59.86280441	89 52 45.68509	811653.0193	389683.4337	270.6325
757-10	35 19 59.05101776	89 52 45.37192	811675.6944	389600.3927	271.2155
757-11	35 19 59.77738571	89 52 44.77401	811728.1068	389671.8126	271.3953
757-12	35 20 0.02270700	89 52 45.46873	811671.5731	389698.8778	270.8254
757-13	35 19 59.93320084	89 52 45.52699	811666.3905	389690.0266	270.7949
757-14	35 20 0.01840200	89 52 45.40759	811676.6173	389698.2422	270.3652
757-14b	35 19 59.98109055	89 52 45.43210	811674.4383	389694.5532	899.9497
757-15	35 20 1.19847202	89 52 43.47406	811841.4262	389811.1132	272.2877
757-16	35 20 0.00098300	89 52 42.14542	811946.6290	389685.7721	273.8543
757-17	35 20 0.22005200	89 52 49.10317	811371.4615	389730.7505	268.7064
757-2	35 20 0.31750399	89 52 45.11276	811702.2254	389727.4916	270.8090
757-3	35 19 59.89617157	89 52 46.08334	811620.1811	389688.1124	270.4127
757-5	35 20 1.10566401	89 52 44.15496	811784.6815	389803.9726	271.4196
757-6	35 20 0.40604100	89 52 44.03856	811791.5154	389732.9093	270.9360
757-7	35 19 59.92679214	89 52 46.56544	811580.3894	389692.7891	270.0787
757-7b	35 19 59.89873123	89 52 46.56774	811580.0871	389689.9617	899.5986
757-8	35 19 59.81931686	89 52 45.22710	811690.7628	389677.5365	271.2569
757-9	35 19 59.10069656	89 52 45.91920	811630.5831	389607.2087	271.3842
757-B1	35 20 0.54263198	89 52 42.74247	811899.3682	389742.4536	275.0967
757-B2	35 20 0.66082901	89 52 43.15634	811865.5769	389755.7534	274.6591
757-B3	35 19 59.83841705	89 52 42.89618	811883.8206	389671.8132	274.6282
757-B4	35 19 59.78185654	89 52 43.54692	811829.7184	389668.2354	273.6863
94MW-5	35 20 20.84801674	89 52 29.65358	813064.2967	391750.9086	285.9831
94MW-6	35 20 19.79784393	89 52 29.85273	813043.6064	391645.4653	286.7075
94MW-7	35 20 19.69999886	89 52 29.06224	813108.6562	391632.9878	286.3190
FCMW-1	35 20 17.50763321	89 52 1.11865	815413.2528	391319.9489	300.2628
FCMW-2	35 20 15.93851662	89 52 0.45727	815461.7393	391159.2597	297.6237
FCMW-3	35 20 16.00032425	89 52 1.12174	815406.9760	391167.6787	297.6427
FCMW-4	35 20 16.42030144	89 52 1.60066	815369.0051	391211.6757	297.9734
FCMW-5	35 20 16.53119278	89 52 0.80749	815435.1122	391220.2828	298.2851
FCMW-6	35 20 15.28576660	89 52 1.40640	815380.5549	391096.4201	295.7179

LOCATION OF MONITORING AND PRODUCTION WELLS, NAS MEMPHIS, TN.

WELL ID.	LATITUDE		LONGITUDE		EASTING	NORTHING	ELEV-MSL	
FFMW-1	35	20	3.89621210	89 52	55.64045	810844.9701	390123.6192	269.0659
FFMW-10	35	20	5.13838720	89 52	48.52745	811438.8392	390225.7463	268.5207
FFMW-11	35	20	4.44512987	89 52	48.84099	811410.1026	390156.7380	270.4521
FFMW-2	35	20	4.33539915	89 52	55.76239	810836.6364	390168.3898	268.1542
FFMW-3	35	20	4.67779112	89 52	55.49752	810859.9374	390202.1104	268.3724
FFMW-4	35	20	4.73808718	89 52	55.82220	810833.2988	390209.2688	267.7989
FFMW-5	35	20	2.92347097	89 52	48.25502	811452.5168	390001.0843	269.1250
FFMW-6	35	20	4.47005987	89 52	47.54600	811517.4159	390155.0037	270.6607
FFMW-7	35	20	5.31572294	89 52	48.95658	811404.0224	390245.0714	268.2572
FFMW-8	35	20	5.57481384	89 52	50.07904	811312.1322	390274.9333	268.3776
FFMW-9	35	20	5.73687983	89 52	48.51277	811442.4533	390286.1622	268.0748
FFMW01	35	20	3.89652801	89 52	55.63957	810845.0443	390123.6483	269.0085
GM-1	35	19	2.54828095	89 51	35.31867	817250.2970	383662.5758	269.9098
GM-10	35	21	22.57406044	89 51	56.73439	816036.0382	397879.1331	328.9169
GM-11	35	21	24.37965775	89 51	56.57789	816056.2014	398061.0371	327.9071
GM-12	35	21	24.63342094	89 51	54.67993	816214.3054	398080.4663	324.2415
GM-2	35	18	51.31866074	89 51	45.98019	816322.6202	382562.9210	268.4032
GM-3	35	18	52.40207672	89 51	53.67497	815689.7245	382697.5480	270.7723
GM-4	35	18	52.40239716	89 51	53.72691	815685.4245	382697.7503	272.1007
GM-5	35	18	55.98691177	89 52	6.58940	814634.5843	383101.9937	270.5351
GM-6	35	20	12.87066174	89 52	9.07411	814736.1089	390877.5308	288.6569
GM-7	35	20	11.45995331	89 52	8.91249	814743.8514	390734.4807	286.4152
GM-8	35	20	11.50206757	89 52	9.33373	814709.1450	390740.1150	287.0044
GM-9	35	20	23.84733963	89 52	23.12473	813616.7945	392032.5162	283.9080
NFMW-1	35	20	21.12790489	89 52	22.80593	813632.3068	391756.7330	285.9726
NFMW-2	35	20	21.19779968	89 52	26.95414	813289.1727	391777.3941	284.7987
NFMW-3	35	20	20.52186584	89 52	26.62729	813313.5262	391708.0344	285.9827
NFMW-4	35	20	20.06567192	89 52	25.97410	813365.7757	391659.8045	286.6041
NFMW-5	35	20	20.71922684	89 52	26.23863	813346.4918	391726.6989	285.2456
NFMW-6	35	20	21.67104912	89 52	26.14717	813357.8721	391822.5594	282.0258
NHMW-1	35	19	55.32700729	89 50	44.96325	821629.8644	388830.4966	288.0054
NHMW-2	35	19	54.47776794	89 50	44.79511	821640.4114	388744.1516	286.2990
NHMW-3	35	19	54.09485626	89 50	45.59672	821572.5213	388708.0761	279.4766
NHMW-4	35	19	54.73130035	89 50	45.11772	821614.7087	388770.8159	271.1578

LOCATION OF MONITORING AND PRODUCTION WELLS, NAS MEMPHIS, TN.

WELL ID.	LATITUDE	LONGITUDE	EASTING	NORTHING	ELEV-MSL
S237-1	35 19 50.18725204	89 52 10.46401	814530.3718	388590.4272	269.7254
S237-2	35 19 50.18704224	89 52 10.46689	814530.1325	388590.4155	272.1224
S237-3	35 19 48.88357544	89 52 11.97232	814400.2802	388463.6603	267.5555
S237-4	35 19 49.54533768	89 52 10.97263	814485.6952	388527.2420	269.6887
S237-5	35 19 49.36593246	89 52 10.58812	814516.8133	388507.8576	273.3038
S237-6	35 19 49.39953995	89 52 12.04253	814396.5294	388516.0171	272.3694
S376-1	35 19 27.69792747	89 52 50.92937	811089.8945	386451.1246	264.9269
S376-2	35 19 28.05639839	89 52 51.61933	811034.2018	386489.6067	265.0135
S376-3	35 19 27.79087830	89 52 52.08642	810994.4620	386464.3165	264.7881
S376-4	35 19 27.48744774	89 52 52.14826	810988.1251	386433.8649	264.4787
S50-1	35 19 37.71200180	89 52 10.84364	814449.0738	387331.3234	267.1388
S50-2	35 19 37.28761673	89 52 11.63439	814381.9043	387291.0391	266.9584
S50-3	35 19 38.34915543	89 52 11.56041	814392.2732	387398.0416	267.2464
S50-4	35 19 37.72502518	89 52 12.68209	814296.9048	387338.6617	266.5732
S50-5	35 19 37.75728989	89 52 11.42866	814400.8160	387337.8152	271.0800
T1205S-1	35 20 16.49028206	89 52 0.70707	815443.2626	391215.8210	295.7654
T1205S-2	35 20 16.57253838	89 52 0.57037	815454.9086	391223.6838	296.0827
T1239-1	35 20 20.63321304	89 52 25.04417	813445.0321	391714.0929	283.9165
T1239-2	35 20 20.94488144	89 52 25.16238	813436.4932	391745.9676	282.9490
T1239-3	35 20 20.86263847	89 52 24.35304	813503.1660	391735.0054	283.3430
T1242-1	35 20 20.82263756	89 52 30.63037	812983.3305	391751.5482	283.5717
T1242-2	35 20 20.92442703	89 52 30.45423	812998.3199	391761.2540	283.7151
T1243-1	35 20 20.54317284	89 52 30.42617	812999.1171	391722.6448	284.0887
T1243-2	35 20 20.62561226	89 52 30.24043	813014.8233	391730.3643	283.8177
T1249-1	35 19 27.60161018	89 52 51.31266	811057.7719	386442.6531	264.8219
T1249-2	35 19 27.72768593	89 52 51.23092	811065.0450	386455.1217	265.0132
T1482-1	35 19 28.18220520	89 52 51.39523	811053.2623	386501.5804	265.4518
T1482-3	35 19 27.58801079	89 52 51.70079	811025.5795	386442.5543	264.5463
T1489-1	35 20 4.46018314	89 52 48.66049	811425.1067	390157.6660	267.7878
T1489-3	35 20 4.08816624	89 52 48.98170	811397.0225	390121.1371	267.8340

LOCATION OF MONITORING AND PRODUCTION WELLS, NAS MEMPHIS, TN.

WELL ID.	LATITUDE		LONGITUDE		EASTING	NORTHING	ELEV-MSL	
T1489-4	35	20	4.15164900	89 52	48.62520	811426.7917	390126.3797	267.2868
T1508-1	35	20	4.33962107	89 52	55.52730	810856.1161	390168.0439	267.9921
T1637-1	35	20	24.52538109	89 52	15.05167	814287.8368	392074.5611	288.4689
T1637-2	35	20	24.47206879	89 52	15.21187	814274.3616	392069.6999	288.1300
T1637-3	35	20	24.57898140	89 52	15.36433	814262.1674	392081.0006	288.4466
T301-1	35	20	20.24966240	89 52	29.57338	813068.5415	391690.1952	283.5891
T301-2	35	20	20.18387985	89 52	29.43826	813079.4638	391683.1063	283.2794
T301-3	35	20	20.26098442	89 52	29.29870	813091.3258	391690.4383	283.1980
T304-1	35	20	20.52660942	89 52	23.97612	813533.0255	391699.8215	284.1301
T304-2	35	20	20.92331886	89 52	23.76946	813551.7218	391739.2227	283.4205
T336-1	35	20	28.04274940	89 53	5.33037	810139.6320	392594.9276	270.9984
T336-2	35	20	28.59641838	89 53	5.87794	810096.5239	392652.6637	270.6332
T336-3	35	20	28.61895943	89 53	4.85581	810181.2304	392651.5802	270.7250
T337-1	35	20	26.38620949	89 53	2.37696	810377.4804	392417.8625	270.5991
T337-2	35	20	26.79694176	89 53	3.32506	810300.6404	392462.4743	271.2539
T337-3	35	20	27.14305115	89 53	2.34430	810383.2209	392494.2167	270.9583
ABND 1	35	20	59.421531	89 52	20.38198	813986.1503	395617.5061	293.7054
ABND N2	35	20	17.628082	89 52	23.11711	813592.5435	391404.1740	283.1606
ABND S-1	35	19	44.847216	89 52	56.60437	810688.7729	388202.3181	264.6680
ABND S-2B	35	19	38.129575	89 52	54.97898	810796.4125	387518.3116	264.3268
ABND S-3	35	19	31.053981	89 52	55.55591	810720.2699	386805.3793	262.5618
GOLF COURS	35	19	59.660091	89 51	26.09943	818241.2933	389402.3699	300.9278
S172-1	35	21	33.118184	89 51	16.62276	819398.0177	398813.3670	332.8795
LAKEHOUSE	35	21	33.927835	89 51	18.47412	819248.0123	398901.2036	323.5623
Officers Club	35	19	43.422929	89 51	37.39539	817241.3210	387798.8540	295.3963
PW-N1	35	20	20.771670	89 52	27.74704	813221.8262	391736.9432	284.5720
PW-N2	35	20	16.997968	89 52	18.59021	813964.7921	391325.6778	287.2294
PW-N3	35	20	0.305414	89 52	31.99537	812788.1906	389683.2198	294.7694
PW-S4	35	19	56.937496	89 52	55.72897	810809.7360	389420.8898	269.7077
PW-S5	35	19	42.652801	89 52	52.38170	811029.5963	387966.7471	266.9987

LOCATION OF MONITORING AND PRODUCTION WELLS, NAS MEMPHIS, TN.

WELL ID.	LATITUDE	LONGITUDE	EASTING	NORTHING	ELEV-MSL
TH-4	35 20 14.808444	89 52 29.13859	813082.7577	391139.0560	279.8529
TW-1	35 19 57.269231	89 52 56.90181	810713.9640	389458.2582	271.0154

BASE GRID COORDINATES

MON 11	35 19 7.80917120	89 52 9.47508	814442.8712	384305.8228	273.2546
MON 29	35 19 41.08005524	89 52 32.02808	812708.5168	387741.0358	263.3885
MON 33	35 19 40.08539963	89 52 20.94237	813622.4072	387604.1945	265.0256
MON 8	35 19 29.09601593	89 52 6.681106	814759.2964	386447.2357	275.3054
MON 9	35 19 24.01716423	89 52 7.12907	814701.9079	385935.5973	261.2593
MON05	35 20 15.32281494	89 52 0.40104	815463.9351	391096.8726	292.5798
mon19	35 19 42.51343536	89 52 48.00454	811391.4529	387938.2890	264.8304
mon20	35 19 51.06523132	89 52 46.86220	811520.3066	388798.5031	267.9912
mon51	35 19 40.08524323	89 52 20.94130	813622.4952	387604.1752	265.1159
control11	35 20 14.91285992	89 52 31.77775	812864.6847	391158.2610	276.4422

NOTES: Northing and Easting are Tennessee State Plan coordinates.
Elevations are in feet mean sea level.