Final Report

WATER CONSERVATION STUDY

FT. DRUM, NEW YORK
WATERTOWN, NEW YORK

Prepared for

U.S. Army Engineer District, Norfolk
803 Front Street
Norfolk, VA 23510-1096

Under

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PAGE 6 IS MISSING BECAUSE THE PAGES

IN APPENDIX B WAS MISNUMBERED.

PAGES 15, 13, 7 & 6 IN THE ENERGY PRICE

INDICES AND DISCOUNT FACTORS FOR LIFE-CYCLE

COST ANALYSIS 1996 IS CORRECT THE WAY THEY

ARE. THEY ARE FROM VARIOUS SOURCES

PER: ANDREW LALBO

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EMC ENGINEERS, INC.

ALTANTA, GA.

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LIST OF ABBREVIATIONS

AC	-	asbestos cement
AWWA	-	American Water Works Association
COE	-	Corps of Engineers
CY	-	cubic yards
DANC	-	Development Authority of the North Country
ECIP	-	Energy Conservation Investment Program
ECO	-	Energy Conservation Opportunity
EMC	-	E M C Engineers, Inc.
F	-	Fahrenheit
FEMP	-	Federal Energy Management Program
ft	-	foot, feet
gal	-	gallons
gpd	-	gallons per day
gpm	-	gallons per minute
hp	-	horsepower
hr	-	hour
HVAC	-	heating, ventilating, and air-conditioning
hz	-	hertz
in	-	inch
kgal	-	kilo-gallon, one thousand gallons
kW	-	kilowatt, one thousand watts
kWh	-	kilowatt-hours, one thousand watt-hours
LCCA	-	Life Cycle Cost Analysis
LF	-	linear foot (feet), load fraction
MES	-	M.E. Simpson Co., Inc.
mgd	-	million gallons per day
mi	-	mile(s)
O&M	-	operation and maintenance manual
ppm	-	parts per million
PVC	-	polyvinyl chloride
RTU	-	remote terminal unit
SIOH	-	supervision, inspection and overhead
SIR	-	Savings-to-Investment Ratio
SOW	-	scope of work
SPB	-	simple payback
UPS	-	uninterruptible power system
UPW	-	Uniform Present Worth factor
yr	-	year(s)

EXECUTIVE SUMMARY

AUTHORIZATION FOR STUDY

This study was conducted and this report prepared under Contract No. DACA01-94-D-0033, Delivery Order No. 0012. The contract was issued by the U.S. Army Engineer District, Mobile, Alabama, to E M C Engineers, Inc. (EMC) on 15 August 1994. The Norfolk District of the Corps of Engineers (COE) has responsibility for this study.

PURPOSE OF STUDY

The purpose of this water conservation study is to conduct a limited site survey and evaluate energy use and savings, estimate construction costs and water savings and provide a cost-to-savings ratio associated with repairing the leaks in the domestic water distribution system at Ft. Drum, New York.

METHOD OF ANALYSIS

Specific work required includes:

1. Perform a limited site survey of the domestic water system to collect data required to identify and evaluate specific energy conservation opportunities (ECOs).

2. Conduct a thorough survey of the potable water system using state-of-the-art underground leak detection equipment on all piping designated by Ft. Drum personnel.

3. Evaluate specific ECOs to determine energy savings potential and economic feasibility.

4. Provide programming documentation for recommended ECOs.

5. Prepare a report to document work performed, and to describe the results and recommendations of the site energy audit and the leak detection study.

LEAK DETECTION SURVEY

A leak detection survey was performed on all water distribution piping designated by Ft. Drum personnel. The leak detection analysis was performed using a combination of listening devices and preamplified-transducer systems to identify the majority of leak locations. When the location of the leak could not be readily identified using these methods, a leak correlator was used. The leak correlator determines leak location based on the time it takes for sound to travel from the leak to a waterline connection point.

Eighteen leaks were identified by the survey on the water mains within the project scope area. The estimated leakage of 169,000 gallons per day (gpd) was categorized into the following types of leaks:

- One main line leak at 125,000 gpd.
- Two service line leaks at 29,000 gpd.
- One valve leaks at 2,000 gpd.
- Thirteen fire hydrant leaks at 13,000 gpd.

An additional 18,000 gpd of leakage was identified by the leak detection survey in 13 fire hydrants and one additional valve. However, the leak detection crew was able to tighten these appurtenances and eliminate the leaks.

ENERGY CONSERVATION OPPORTUNITIES

Approximately 8.7% of the water usage in the Ft. Drum water distribution system can be attributed to leakage. ECOs were evaluated that would serve to reduce leakage, thereby reducing water production, maintenance, and energy costs.

Description of ECOs

The following ECOs were evaluated for the water distribution system at Ft. Drum:

- **ECO 1.** Repair the main line and service line water leaks identified in the leak detection survey. One main line leak was located near Building T-2473 on a 12" line. Two service leaks were also identified. All three leaks should be repaired.

- **ECO 2.** Repair the water valve leak identified in the leak detection survey. One leaking water stub valve was identified and should be replaced.

- **ECO 3.** Repair fire hydrants which were found to be leaking during the leak detection survey. Thirteen fire hydrants were found to be leaking and should be replaced.

- **ECO 4.** Repair the main line, valve and fire hydrant leaks. This ECO is a combination of ECOs 1 through 3.

- **ECO 5.** Implement an annual water audit and leak detection program.

- **ECO 6.** Connect valve pit actuators to telemetry system to improve circulation. Connection of these valve actuators will allow system operators to automatically open and close valves, providing a low cost solution to stagnation problems in the western end of the old Post.

- **ECO 7.** Reconnect isolated main line near Oswego Avenue. Approximately 1,200 LF of 12" main line is currently isolated from the system. Reconnection of this segment of piping may serve to improve stagnation problems in the eastern end of old Post.

- **ECO 8.** Implement policy to optimize the percentage of water produced by Ft. Drum and by the DANC. Optimal quantities of water will be based on cost, water quality, reliability, and O&M requirements.

Economic Analysis

The economic analysis of the ECOs is summarized in Table ES-1 below.

Table ES-1. Summary of ECOs

ECO No.	Description	Investment Cost ($)	Annual Water Savings*	Total Discounted Savings ($)	SIR	Payback (yrs)	First Year $ Savings
1	Repair Main Line Leaks	2,612	56,210	623,681	238.82	0.06	46,261
2	Repair Valve Leaks	927	730	8,100	8.74	1.54	601
3	Repair Fire Hydrant Leaks	35,908	4,745	52,648	1.47	9.20	3,905
4	Repair All Leaks	39,447	61,685	684,430	17.35	0.78	50,767
5	Implement Leak Detection	29,120	62,621	302,564	10.39	1.30	22,417
6	Connect Valve Pit Actuators	3,247	396	4,394	1.35	9.96	326
7	Reconnect Isolated Main	11,333	132	1,465	0.13	104.32	—
8	Optimize Ft. Drum vs. DANC	-	-	-	-	-	—

*Annual Water Savings are in units of thousands of gallons saved per year

$\sum_{1}^{6}$ 186,387 124,277

All ECOs, except for ECO 7, display favorable economic payback. That is, they all have SIRs greater than 1.25 and a simple payback of 10 years or less. Based on the qualifications listed by the Scope of Work, these ECOs qualify for government energy conservation funding programs.

RECOMMENDATIONS

The ECOs listed in Table ES-2 are recommended for implementation.

Table ES-2. Recommended ECOs

ECO No.	Description	Investment Cost ($)	Annual Water Savings*	Total Discounted Savings ($)	SIR	Payback (yrs)
4	Repair All Leaks	39,447	61,685	684,430	17.35	0.78
5	Implement Leak Detection	29,120	62,621	302,564	10.39	1.30
6	Connect Valve Pit Actuators	3,247	396	4,394	1.35	9.96
8	Optimize Ft. Drum vs. DANC	-	-	-	-	-

*Annual Water Savings are in units of thousands of gallons saved per year

- **ECO 4.** Replace the main line, valves, and fire hydrants identified as having leaks by the leak detection survey. ECO 4 is a combination of ECOs 1 through 3. Although each of those ECOs are economically feasible based upon their own merits, combining them would simplify the programming documentation and produce a better project.

  Note that some of the leaks may have been repaired by maintenance personnel at the time they were discovered by the leak detection survey. Coordination with maintenance personnel will be required to determine which leaks are still in need of repair.

- **ECO 5.** Implement a leak detection program, including a water audit, every year as recommended by the American Water Works Association (AWWA) Manual 36, *Water Audits and Leak Detection.* Implement a policy to immediately excavate and repair all leaks discovered by the leak detection survey.

- **ECO 6.** Connect the water valve actuators in Valve Pit #4 to the telemetry system. Providing automatic control to the valves will allow flow to be alternated between the 16" and 20" main lines that join the old and new Posts. Increased flow through Valve Vault #4 (16" line) should improve water circulation on the western side of the old Post.

- **ECO 8.** Water consumed at Ft. Drum comes from two sources. Water provided by the DANC makes up approximately 75% of the total, while wells at Ft. Drum supply the remaining 25%. Ft. Drum currently pays $0.82 per thousand gallons of water, which accounts for water produced from the wells at Ft. Drum and also the variable costs of water produced by the DANC. Under an agreement, DANC provides a minimum of 1.5 mgd at a fixed cost according to a schedule provided by Ft. Drum personnel. (The cost in 1995 was $6.25/kgal. In 1997, after capital costs are paid in full, the cost is estimated to be $1.49/kgal.)

  The total cost of water from both sources was based on a combination of electrical costs, O&M costs, chemical treatment costs, and water storage costs. Calculations show that the total cost of the water produced by both sources decreases as more well water is produced and less DANC water is used. The cost of water if Ft. Drum supplies 75% of the total water consumed was calculated to be $0.41 per kgal. The cost of water if Ft. Drum supplies 95% of the total was calculated to be about $0.24 per kgal.

It is reasonable to maintain an equitable balance between Ft. Drum well water and water supplied by the DANC. If Ft. Drum is able to negotiate a lower guaranteed water production rate from the DANC, it would produce lower annual costs.

In accordance with the SOW, Ft. Drum personnel provided direction regarding the combination of ECOs into projects. They requested that all appropriate ECOs be combined into one project. To be considered appropriate, the synergistic effects of the bundled ECOs must meet government funding criteria with an SIR of 1.25 and a simple payback of 10 years or less. Programming documentation has been prepared for ECOs 4, 5, 6, and 7. The results of the economic analysis for the bundled project are listed in Table ES-3 below.

Table ES-3. Economic Analysis for Bundled Project

Total Investment	$83,148
Annual Water Savings (kgal/year)	124,834
Annual Cost Savings	$73,618
Total Discounted Cost Savings	$992,857
Simple Payback (years)	1.13
Savings-to-Investment Ratio	11.94

1. INTRODUCTION

1.1 AUTHORITY FOR STUDY

This study was conducted and this report prepared under Contract No. DACA01-94-D-0033, Delivery Order No. 0012. The contract was issued by the U.S. Army Engineer District, Mobile, Alabama, to E M C Engineers, Inc. (EMC). The Norfolk District of the Corps of Engineers (COE) has responsibility for this study.

1.2 PURPOSE OF STUDY

This project consists of a potable water conservation study for Fort Drum, New York. The tasks required for this include:

- Conduct a limited site survey.
- Conduct a leak detection survey.
- Evaluate water production and consumption at Ft. Drum.
- Evaluate projects which would produce energy and cost savings.
- Estimate construction costs and water savings.
- Provide a cost to savings ratio associated with repairing leaks and water stagnation problems in the domestic water distribution system at Ft. Drum.

This study presents information obtained during an audit and leak detection study of the water distribution system. This study also makes recommendations for corrective actions that could result in energy, operational and maintenance savings. Recommended ECOs presented by this study are based strictly on economic feasibility and life cycle cost analysis.

1.3 BACKGROUND

Ft. Drum is located 10 miles northeast of Watertown, New York, between Lake Ontario and the Adirondack Mountains. Ft. Drum was originally constructed in 1941 and became the home of the 10th Mountain Division in 1984. From 1984 to 1986 Ft. Drum was expanded, creating the "new" Post to the north of Main St. and Oneida Ave. The original Post area is designated as the "old" Post.

In addition to garrisoning the 10th Mountain Division, Ft. Drum is also a major training site for Reserve Components and host to 26 Tenant organizations. The mission statement for Ft. Drum is provided below.

Command, operate, manage, and administer the use of resources to accomplish all assigned missions. Additionally, the garrison provides administrative, logistical, and management support to assigned or attached tenant units and activities to include both on-post and off-post units or activities in the assigned geographic areas.

The mission statement is contained in the Total Army Quality Self Assessment which is included in Appendix A.

Ft. Drum is served by a multi-looped water distribution system. Potable water is distributed throughout the base by approximately 130 miles of piping. The distribution system consists mainly of polyvinyl chloride (PVC) and ductile iron piping. Service and lateral lines are generally constructed of PVC and steel pipe.

The original piping for the old Post was constructed of transite (asbestos cement) piping. A project was performed approximately four years ago to replace the majority of transite piping with ductile iron pipe. In most cases, the transite piping was abandoned in place.

Ft. Drum collects water from a series of 11 wells and stores the water in two elevated water tanks and one below ground reservoir. The Post decommissioned a third elevated water tank. The wells and tanks are connected to a telemetry system where the operation of each segment is optimized.

The Post also receives water from the Development Authority of the North Country (DANC). In an agreement reached between Ft. Drum and the DANC, Ft. Drum purchases a minimum average 1.5 million gallons of water per day (mgd) from the DANC. The DANC operates a pumping station on Ft. Drum which contains a water storage tank, pumps and controls. The controls integrate the DANC system with Ft. Drum's telemetry system.

1.4 SCOPE OF WORK

The Scope of Work (SOW) for this project is included in Appendix A. The major technical criteria identified by the SOW are summarized below:

- Perform a limited site survey on Ft. Drum's water distribution system. Sufficient information should be collected to allow for an adequate understanding of the water system and to identify possible energy conservation opportunities (ECOs) as they are associated with the domestic water distribution system. This information would include as-built drawings, historical usage data, and interviews of on-site personnel.

- Perform an underground leak detection survey on all piping designated by Ft. Drum personnel. The survey should identify the location, type and quantity of all discovered leaks.

- Evaluate identified ECOs to determine their energy savings potential and economic feasibility.

- Provide programming documentation for recommended ECOs.

- Prepare a report to document work performed and to describe the results and recommendations of the site and energy audit and the leak detection study.

1.5 APPROACH

The approach taken in this study is as follows:

1. **Field Survey.** The water distribution system at Ft. Drum was examined to gain an understanding of system operation and maintenance and to determine the condition of the system. Information such as pump nameplate data, as-built drawings, and historical meter data was obtained. On-site personnel were interviewed to ascertain system operation and to define unacceptable conditions, past problems, and future requirements.

2. **Leak Detection Survey.** A survey of all water distribution piping designated by Ft. Drum personnel was performed to determine the location, type, and quantity of leaks. The survey was performed by M.E. Simpson Co., Inc. (MES).

3. **Analysis of Leak Detection Survey.** Data from the leak detection survey was summarized. The location of each leak was documented on individual drawings and the quantities of the leaks were tabulated in a separate table.

4. **ECO Analysis.** Appropriate ECOs were identified and analyzed to determine their economic feasibility. Economic feasibility was judged as a comparison between the investment cost of implementing the ECO and the savings that would result. Cost savings were calculated as the sum of reduced pumping, water treatment, and maintenance costs as a result of reduced water consumption. Criteria outlined by the Energy Conservation Investment Program (ECIP) was used to define economic feasibility. A recommended ECO must have a savings-to-investment ratio (SIR) of 1.25 or better and a simple payback (SPB) of 10 years or less to be considered for government funding.

5. **Interim Report and Review.** The results of the field and leak detection survey, as well as the identification and analysis of ECOs, are to be presented in an Interim Report. The ECOs are to be organized as possible ECIP or Federal Energy Management Program (FEMP) projects.

6. **Final Report.** The incorporation of programming documentation, and the Interim Report constitute the Final Report. Additionally, the results of the government

review will be incorporated into the Final Report. The programming documentation shall be prepared according to the direction given by the client, based on recommendations outlined by the interim report.

2. DESCRIPTION OF EXISTING CONDITIONS

2.1 GENERAL

During the week of 23 October 1995, a field survey was performed by EMC to obtain the necessary information to identify and evaluate possible energy conservation opportunities (ECOs) for the potable water distribution system at Ft. Drum. MES performed a leak detection study of the water distribution system from 24 October to 7 November.

EMC compared the average daily water usage for August 1993 through July 1995 to the leakage rate determined by MES. The calculation determined that approximately 8.7% (169,000 gpd/2.0 mgd) of the water consumption is due to leaks in distribution piping, valves, and fire hydrants. Therefore, the initial focus of the ECOs will seek to reduce water usage by reducing the amount of leakage. Other ECOs are produced as appropriate.

2.1.1 Description of Water Distribution System

Ft. Drum collects high quality, slightly basic, groundwater from a series of 11 wells (reference Table 2-1). The water requires minimal treatment beyond chlorination. The Post stores the water in three reservoirs:

- a 250,000 gallon elevated water tank (old Post);
- a 1 MG elevated water tank (new Post); and,
- a 750,000 gallon below ground reservoir (old Post).

Ft. Drum decommissioned a third elevated water tank in the old Post area. The wells and tanks are connected by a telemetry system whereby the operation of each segment is optimized through criteria developed by Ft. Drum personnel.

The Post also receives water from the DANC. In an agreement reached between Ft. Drum and the DANC, Ft. Drum purchases a minimum average 1.5 million gallons of water per day from the DANC. The 1.5 mgd is an amount that is totalized at the end of the month, therefore, actual daily usage is flexible and optimized using the telemetry system and criteria set forth by Ft. Drum personnel.

The DANC provides treated, slightly acidic, surface water (derived from the Black River) to Ft. Drum from the southwest (Watertown) which travels to a DANC pumping station located at Fourth St. and St. Lawrence Ave. The DANC's pump station contains a water storage tank, pumps and controls. The controls integrate the DANC pump station operation with Ft. Drum's telemetry system. The DANC's water is also stored in Ft. Drum's elevated water tanks and below ground reservoir.

Ft. Drum is served by a multi-looped water distribution system. Potable water is distributed throughout the base by approximately 130 miles of piping. The distribution system, which is approximately 8-40 years old on the old Post and 6-8 years old on the new Post, consists mainly of polyvinyl chloride (PVC) and ductile iron piping. Specifically, the distribution mains (sizes 12"-20") are ductile iron piping. Service and lateral lines are generally constructed of PVC and steel pipe.

At one time, the old Post's water system was constructed of almost entirely asbestos cement (AC) piping. Over the years the AC pipe has been replaced but there are still small stretches of AC piping on Post. There was no information found regarding the location of the AC piping except that it may be located in the 2000 and 2800 areas. The survey did not identify specific AC pipe locations.

Table 2-1. Existing Pump Schedule

Pump Identification	Motor Manufacturer	Motor Size (hp)	Capacity of Pump (gpm)	*Annual Operating Hours
Pump 2	Sumo	40	440	1,098
Pump 3	Franklin	20	140	2,070
Pump 4	Franklin	15	80	1,585
Pump 5	Franklin	40	445	1,050
Pump 6	Franklin	15	130	1,954
Pump 7	Franklin	15	160	1,315
Pump 8	Franklin	15	80	2,146
Pump 9	Franklin	20	200	1,331
Pump 10	Franklin	25	230	1,676
Pump 11	Franklin	40	300	1,007
Pump 12	Franklin	30	200	1,283
750,000 gallon reservoir service pump	Westinghouse	40	450	2,614
750,000 gallon reservoir fire pump	Louis Allis	75	N/A	0

*Note: The annual operating hours for the well pumps were taken from telemetry system data. The hours shown are the average value for the last two years (August 1993 to July 1995). All pumps provide domestic water service.

2.1.2 Description of Water Distribution System Operation

The Ft. Drum water distribution system telemetry system affords the Ft. Drum personnel a high degree of operational freedom. The personnel are able to:

- Remotely turn on/off any of the 11 pumps.
- Set priority of operation for the pumps.
- Monitor well function, operating hours.
- Monitor tank water elevation.
- Monitor the DANC facility.
- Track water use.
- Prepare a water use data base to spot trends or histories.

The telemetry system items listed above are further explained as follows. The Ft. Drum personnel have set a protocol for the system to determine which pumps should be turned on to meet system demands. As the water level in the water tanks decrease to certain set point elevations, the telemetry system identifies the pump with the fewest hours of operation and turns it on. As the demands of the distribution system increase, the telemetry system identifies each additional pump with the fewest operational hours and turns them on. This continues until the flow rate from the wells is sufficient to meet the water system demand and maintain or increase the water volume in the tanks.

As the water system demand decreases, the telemetry system turns off pumps according to which pump has the highest operational hours. Removal of pumps from the distribution system continues until only one pump is left on to maintain operation of the chlorination system. This type of operation allows the Post to maintain balanced pump operational hours.

All system functions are monitored from the system telemetry office which houses the remote terminal units (RTU), a 20 hour uninterruptible power system (UPS), a CPU, monitor and printer. From the system telemetry office, the Post personnel can "view" the DANC system operation to optimize their water purchases from the DANC.

Since Ft. Drum is required to purchase 1.5 mgd and, if, near the end of the month they lag behind the average daily use rate, they can extend the operation of the DANC pumps (up to 3 mgd, maximum) and increase the daily water intake. By monitoring the system in this manner, the Post won't have to pay for water they don't use. The converse is also true. If they are running ahead of the water use schedule, they may opt to reduce the amount of the DANC water used each day such that they don't have to pay for additional water at the end of the month.

The telemetry system also assists in flow modulating between the old and new Posts. The new Post and old Post water systems are connected at two control valve vaults. The vaults are located on Conway Road and Fourth Street East. The valves in the vault on Fourth Street East are connected to the telemetry system allowing Ft. Drum personnel to operate the valves, as required. The valves in the Conway Road vault are not yet connected to the telemetry system, although they have electric actuators installed. The valves are presently in the closed position, thereby forcing all the flow between the Posts to be channeled through the Fourth Street West valve vault.

There is another pressure reducing valve (PRV) on Lewis Avenue which does not have actuators installed. The PRV is located in the 8300 area.

The final item of note about the existing water system is the closure of a section of pipe on Oswego Avenue. The 1,200 linear foot stretch of line (from Leroysville Road west) is out of commission as a result of repair work done a few years ago. The repair work was conducted, but the line could not be properly chlorinated to allow its reinstatement into the water distribution system.

Ft. Drum personnel have reported low chlorine levels (less than 0.5 ppm) in the water system in the following areas: 0; 100; 1100; 4000; 6000. The Post thinks the problem occurs because the use in these areas has dropped off substantially since the new Post has opened. To relieve the problem, field maintenance personnel have manually opened local fire hydrants which in turn increased the circulation in the area, bringing in more chlorinated water and raising the chlorine level. In other areas this practice is generally used on long dead-end lines, but has proven effective for use in this case.

Historical water usage was taken from operating logs from the telemetry system. Table 2-2 summarizes the total water usage for Ft. Drum from August 1993 to July 1995.

Table 2-2. Average Annual Water Production (August 1993-July 1995)

	Water Quantity	Percentage of Total
Annual Well Operation (hours)	16,515	-
Annual Well Production (gal)	180,282,960	25.4
Annual DANC Production - Actual (gal)	529,017,693	74.6
Annual DANC Production - Contractual (gal)	547,500,000	-
*Total Water Production - Ft. Drum	709,300,653	100.0

*Note: Total Ft. Drum water usage was based on actual production amount from DANC, not contractual. Taken from Telemetry System (Datalog No. 3)

A detailed summary of monthly water usage as well as usage data supplied by Ft. Drum can be found in Appendix B.

2.2 LEAK DETECTION SURVEY

EMC contracted MES of Valparaiso, Indiana to perform the leak detection survey on 129 miles of water distribution piping. The survey determined the location, type, and quantity of leaks by examining all fire hydrants, all accessible mainline valves and 30 services.

2.2.1 Method of Analysis

When water escapes from an orifice, it causes a vibration in the 500-800 Hz range. This sound travels along the pipe wall and can be heard a considerable distance away by an observer with the proper equipment. Other sounds (in the 25-250 Hz range) are caused by water striking the soil and swirling around in the cavity it creates. This sound does not travel well along the pipe, and is therefore useful in pinpointing the leak. (Walski, 1984)

Leak detection by listening is qualitative, as there is virtually no correlation between size of leak and intensity of sound. The sound is influenced by such factors as pipe material (metal pipes conduct sound better), soil type, and leak configuration. (Walski, 1984)

MES used a combination of listening devices and preamplified-transducer systems to identify the majority of leak locations during the leak detection survey. When identification of the leaks proved difficult by these means, they used a device called a leak correlator to identify the leak location.

The correlator is used when the leak location(s) are not readily identified by the above methods. The correlator is connected to the waterline at two points. The microprocessor units measure the time it takes for the sound to travel from the leak to the waterline connection point. Since the correlators are connected to the waterline at two points, the precise leak location can be identified.

Using the listening devices and transducers set up on fire hydrants and valve boxes when appropriate, MES "listened" for leaks in the system. The audible noises created when water escapes from a pipe, valve, or hydrant can be deciphered as the source of the leak.

Water flowing through the pipe at the point of use creates similar sounds to water leakage. MES eliminated these water usage sounds from consideration by investigating the general area to locate any normal water usage. If usage was found in the general area, the water supply would have been turned off and the water line retested. If no usage was found in the general area, the sounds would have been attributed to leakage. MES did not have to turn off any water supplies during this survey at Ft. Drum.

When MES located the source of a leak noise, they initially called in an excavating crew to excavate the leak. Once uncovered, the leak rate was estimated by the "bucket and stopwatch method" or by using the experience of the technician. As the leak detection survey progressed through the Post, an excavating crew was not called in for every leak found. The location and size of the leaks were located and noted on a map (enclosed in the pocket). In addition to the "bucket and stopwatch method", the Greeley formula and the "hose and meter" method could also be used. These and other methods used are described in the AWWA Manual 36, *Water Audits and Leak Detection.*

2.2.2 Summary of Results

The water mains within the project scope area were surveyed and seventeen leaks were located. The total leakage quantity was estimated to be 169,000 gallons per day (61,685,000 gallons per year). This translates to approximately 8.7% of the total water usage at Ft. Drum (see Table 2-2). The leakage quantity is summarized in Table 2-3 below.

Table 2-3. Leak Detection Summary

Type of Leak	No. of Leaks	Size (gpd)	Size (kgal/year)
Main Line	1	125,000	45,625
Service Line	2	29,000	10,585
Valve	1	2,000	730
Fire Hydrant	13	13,000	4,745
Total	17	169,000	61,685

An additional leakage quantity of 18,000 gpd was identified by the leak detection survey. This leakage was found in 13 additional fire hydrants and one additional valve. However, the leak detection crew was able to tighten these appurtenances and eliminate the leaks.

A breakdown of the leakage results and locations of the leaks is contained in Appendix C.

3. WATER SYSTEM ENERGY AUDIT

Ft. Drum receives water from two different sources. Water is provided from the DANC and from wells located at Ft. Drum. Therefore, the cost of water at Ft. Drum is a function of the combined production, maintenance, and capital costs incurred from both sources. Reducing the amount of water lost to leakage can result in energy and cost savings.

The purpose of this energy audit is to investigate possible energy conservation opportunities (ECOs) that would serve to reduce leakage in the distribution system. The energy audit is based on information from two sources, a leak detection survey and a water audit. The leak detection survey was conducted to assess the current quantity of water lost to leakage in main lines, valves, and hydrants. Energy and cost savings will be produced by reducing the amount of leakage. These savings are described in ECOs 1 through 4. The water audit performed in this study estimates potential usage in the distribution system and is the basis for the calculation of ECOs 5 through 8.

3.1 COST CALCULATIONS

The total cost of water at Ft. Drum can be separated into the following categories:

- **Ft. Drum Electrical Charges.** Ft. Drum utilizes eleven wells with electrical motors ranging in size from 15 hp to 40 hp. These wells operate for an average of 16,515 hours per year.

- **Ft. Drum Operation & Maintenance Costs.** These costs include the labor costs associated with operating and maintaining the water treatment plant and water distribution system at Ft. Drum, and includes chemical treatment costs for water produced by the wells.

- **Ground Reservoir Pump Electrical Costs.** There are two pumps which serve the 750,000 gallon ground reservoir. One pump (40 hp) is used to circulate water through the reservoir. The other pump (75 hp) is necessary to maintain water volume in the reservoir in case of excessive demand. This pump has not been used for several years. The electrical costs (per thousand gallons, or kGal, of water) for these reservoir pumps are calculated separately from the well pumps because they serve water produced from both the wells and from the DANC.

- **DANC Costs.** Ft. Drum contractually pays for a minimum 1.5 mgd of the DANC water. The cost of the water is comprised of fixed and variable costs incurred by the DANC and by the City of Watertown. For this report, the DANC and the City of Watertown fixed costs are the capital costs incurred to build the capital improvements to the system. The variable costs are those costs which vary according to the amount of water produced, such as the operation, maintenance, and overhead charges.

Projects that are analyzed using the Energy Conservation Investment Program (ECIP) criteria must differentiate between energy and non-energy savings because different discount rates apply to each over the economic life of the ECO. Therefore, electrical, operation and maintenance, and water production cost savings for water produced at Ft. Drum and the DANC were calculated separately in units of cost per gallons. In calculating water costs in terms of dollars per gallon, a cost savings can be calculated based on the amount of water saved by an ECO.

3.1.1 Ft. Drum Electrical Costs

The electrical rates paid by Ft. Drum were provided by the utility office at Ft. Drum. The electrical rates were broken into the following charges:

- Monthly customer charge: $3,172/month (minimum charge)
- Demand charge: $7.02/kW
- On peak electrical consumption charge: $0.06196/kWh
- Off peak electrical consumption charge: $0.05197/kWh
- Bundled electrical charge: $0.072/kWh.

EMC was directed by the utility office to use the bundled electrical charge when performing energy and cost savings calculations for potential ECIP/FEMP projects. This bundled charge takes into account all demand, consumption, and customer charges incurred by Ft. Drum. EMC was directed by the utility office not to use the other electrical charges (such as off-peak electrical consumption) for energy and cost savings calculations. Because of this direction, ECOs regarding pumping during non-peak hours were not included in this energy audit.

There are eleven wells currently in operation at Ft. Drum. The electrical operating cost for the well pumps was calculated using the following equation:

$$Cost = \sum_{AllWells} \frac{(hp)(0.746)(LF)(Hours)(\$0.072 / kWh)}{EFFM}$$

where:

hp	=	nameplate horsepower,
0.746	=	conversion factor relating kilowatts to horsepower,
LF	=	load factor (assume 75% average),
Hours	=	annual operating hours, taken from telemetry data
$0.072	=	bundled energy cost ($/kWh), and
EFFM	=	motor efficiency (standard efficiency).

Based on the telemetry data from August 1993 to July 1995, the wells operated an average of 16,515 hours per year, which translates into an electrical consumption of 241,671 kWh. At the bundled electrical cost of $0.072/kWh, the annual electrical cost for operating all eleven wells was $17,400. Based on a total water production of 180,282,960 gallons (see Table 2-2), the total electrical cost of the water produced from the wells at Ft. Drum is **$0.097 per kgal.**

3.1.2 Ft. Drum Operation and Maintenance Costs

The total operation and maintenance (O&M) costs were provided by Ft. Drum personnel. These costs include labor and equipment costs for upgrading and maintaining the water treatment plant and distribution system. Also included is the cost for chemical treatment of the water produced by the wells at Ft. Drum.

The total O&M costs reported by Ft. Drum follows:

- Fiscal Year 1994: $22,127
- Fiscal Year 1995: $25,655
- Chemical Treatment (1995): $5,550 (included in FY-95 costs)

Operation and maintenance costs were applied to water produced from the wells at Ft. Drum and from the DANC. Chemical treatment costs were only applied to water produced from the wells. Based on a total water production of 709,300,653 gallons (see Table 2-2) and FY-1995 costs ($20,105, without chemical treatment costs), the cost for O&M of the water distribution system at Ft. Drum was calculated to be **$0.028 per kgal.** The cost for chemical treatment of only the 180,282,960 gallons of water per year produced by the Ft. Drum wells was found to be **$0.031 per kgal.**

3.1.3 Ground Reservoir Pump Electrical Costs

There are two pumps which serve the 750,000 gallon ground reservoir at Ft. Drum. One pump (40 hp) is used to circulate water through the reservoir. The other pump (75 hp) is necessary to maintain water volume in the reservoir in case of excessive demand. This pump has not been used for several years.

The equations used to calculate energy costs are identical to those used to calculate energy costs for the well pumps in Section 3.1.1. Based on telemetry data from August 1993 to July 1995, the 40 hp pump operates for an average of 2,614 hours per year, which translates into an electric consumption of 65,365 kWh. Based on the number of annual operating hours and an average flow rate of 450 gpm, the pump was assumed to circulate 70,578,000 gallons of water per year. Based on the bundled electrical cost of $0.072/kWh, the total annual electrical cost is $4,706.

The only difference between the electrical cost calculations for the reservoir pump and the well pumps is that the reservoir pump serves water produced from both the well pumps and from the DANC. Therefore, the total electrical cost for the reservoir pump (based on the total production of 70,578,000 gallons per year) was **$0.067 per kgal.**

3.1.4 DANC Water Costs

The DANC built and maintains booster pumping stations at Ft. Drum and near the City of Watertown, as well as a pipeline which connects the two stations. The booster station at Ft. Drum consists of an above-ground storage tank and a building which houses three booster pumps, controls and chemical treatment equipment. Under a contractual agreement, Ft. Drum is obligated to pay a fee (per kgal of water produced) for a minimum of 1.5 mgd from the DANC (reference DANC Schedule "A", located in Appendix B). The fee charged for the water is comprised of several costs incurred by the DANC and City of Watertown. The total cost includes fixed and variable costs. The costs are described in detail below.

- **DANC Electrical Costs.** Includes electrical costs for operating three booster pumps at the DANC booster pumping station at Ft. Drum and at the booster station off-Post. For the purposes of this study, the electrical costs are considered variable. That is, the cost depends upon the amount of electricity consumed, which is dependent upon the amount of water produced.

- **DANC O&M Costs.** Includes operation and maintenance costs for the booster pumping stations and the pipeline which connects them. For the purposes of this study, the O&M costs are considered variable costs.

- **Overhead Costs.** Includes the DANC assigned overhead costs. For the purposes of this study, the overhead costs were assumed to be variable.

- **DANC Capital Costs.** Includes capital costs incurred by the DANC for construction of their water distribution system. For the purposes of this study, the DANC capital costs were assumed to be fixed.

- **City of Watertown Capital Costs.** Includes capital costs incurred by the City of Watertown for construction of the DANC's water distribution system. For purposes of this study, the city's capital costs are also assumed to be fixed.

The assumption was made for this study that the fixed (capital) costs were incurred upon construction of the booster stations and the pipeline. Because these costs have already been incurred, it was assumed that Ft. Drum is obligated to pay them in full according to the schedule provided by the DANC. It is unlikely that either the amount or the schedule of payment of the incurred fixed costs are negotiable. Because these fixed costs must be paid regardless of the amount of water consumed, it was assumed that any water savings resulting from implementation of the ECOs in this study would not include DANC's fixed costs as savings.

A schedule of the current and anticipated fees paid to the DANC was provided by Ft. Drum personnel. The costs that comprise the total fee for water provided by the DANC for the period 1 April 1995 to 31 March 1996 are listed in Table 3-1.

Table 3-1. Total Cost of Water Provided by the DANC (April 1995 - March 1996)

Description	Type of Cost	Total Cost ($)	Total Cost ($/kgal)
DANC Capital Costs	Fixed	2,632,305	4.81
City of Watertown Capital Costs	Fixed	314,049	0.57
Total Fixed Cost	-	2,946,354	5.38
DANC Overhead Costs	Variable	86,203	0.157
DANC O&M Costs	Variable	167,451	0.306
City of Watertown O&M Costs	Variable	222,873	0.407
Total Variable Cost	-	476,527	0.87
Total Cost	-	**$3,422,886**	**$6.25**

Costs taken from Schedule 'A', provided by Ft. Drum personnel. Costs ($/kGal) were based on water production of 547,500 kGal per year.

It is assumed that any water savings resulting from implementation of the ECOs would result in variable cost savings for the water produced from the DANC. Therefore, for a variable cost of $476,527 and an actual water production of 529,017,693 gallons per year (see Table 2-2), the cost of DANC water is **$0.90 per kgal**.

All of the ECOs are based upon the total cost of water consumed at Ft. Drum, which is a combination of Ft. Drum well water and water provided by the DANC. Since Ft. Drum is currently obligated to pay for an minimum of 1.5 mgd, it should be noted that the ECOs may produce a more favorable economic payback if the DANC contract is renegotiated to exclude the minimum quantity restrictions.

3.1.5 Total Water Costs

Water savings produced by recommended ECOs will be applied to the total amount of water at Ft. Drum, regardless of the source. It is unrealistic to separate water savings and apply it to separate cost categories. Therefore, the total cost of water consumed at Ft. Drum must be prorated to accurately represent actual water production.

It is reasonable to assume that the capital (fixed) costs charged by the DANC will remain unchanged because they are being applied to costs previously incurred for construction. **Therefore, fixed costs charged by the DANC and by the City of Watertown are not included in the cost of water calculation.** The total cost of the water consumed at Ft. Drum was based on the costs attributed to water produced at Ft. Drum and the variable costs charged by the DANC. Table 3-2 illustrates the total water cost calculation.

Table 3-2. Total Cost of Water - Ft. Drum

Cost Category	Cost ($/kgal)	Actual Water Production (gal)	Percentage of Total Production	Prorated Cost ($/kgal)
Drum Electrical	0.097	180,282,960	25.4	$0.025
Drum O&M	0.028	709,300,653	100.0	$0.028
Ft. Drum Chemical Treatment	0.031	180,282,960	-	$0.031
Reservoir Pump	0.067	70,578,000	-	$0.067
DANC (variable)	0.90	529,017,693	74.6	$0.672
Total	-	-	-	**$0.82**

The total water cost at Ft. Drum was calculated to be **$0.82 per kgal.**

A copy of the cost calculations and cost backup data provided by Ft. Drum and the DANC can be found in Appendix D of this report.

3.2 LIFE CYCLE COST ANALYSIS METHODOLOGY

Economic analysis was performed in accordance to the January 1994 ECIP guide. Uniform present worth factors are based on a 4.1% discount factor and were taken from Table 2, Census Region 1 (New York), of the NISTIR 85-3273-10, *Energy Price Indices and Discount Factors for Life-Cycle Cost Analysis 1996 (Oct. 1995).* Uniform present worth (UPW) factors for non-energy costs were taken from Table A-2. The economic life of equipment was taken from Appendix B of the ECIP guide. A copy of the life cycle discount factors and calculations can be found in Appendix D.

ECO construction costs were prepared using Means Mechanical Cost Data 1996. Location factors for Watertown, New York, were applied to all material and labor costs. Additional markups used for the LCCA include:

- 20% for overhead and bond
- 10% for profit
- 10% for contingency
- 6% for Supervision, Inspection, and Overhead (SIOH)
- 6% for design costs

3.3 ENERGY CONSERVATION OPPORTUNITIES

The following ECOs were evaluated for the water distribution system at Ft. Drum:

- **ECO 1.** Repair the main line and service line water leaks identified in the leak detection survey. One main line leak was located near Building T-2473 on a 12" line. Two service leaks were also identified. All three leaks should be repaired.

- **ECO 2.** Repair the water valve leak identified in the leak detection survey. One leaking water stub valve was identified and should be replaced.

- **ECO 3.** Repair fire hydrants which were found to be leaking during the leak detection survey. Thirteen fire hydrants were found to be leaking and should be replaced.

- **ECO 4.** Repair the main line, valve and fire hydrant leaks.

- **ECO 5.** Implement an annual water audit and leak detection program.

- **ECO 6.** Connect valve pit actuators to telemetry system to improve circulation. Connection of these valve actuators will allow system operators to automatically open and close valves, providing a low cost solution to stagnation problems in the 8500 Area of the old Post.

- **ECO 7.** Reconnect isolated main line near Oswego Avenue. Approximately 1,200 LF of 12" main line is currently isolated from the system. Reconnection of this segment of piping may serve to alleviate stagnation problems in the old Post.

- **ECO 8.** This is a no cost ECO. Implement a policy to optimize the proportion of water produced by Ft. Drum and by the DANC. Optimal quantities of water will be based on water quality, reliability, and cost.

3.4 RECOMMENDED ECOs

ECOs 1 through 6 and ECO 8 were found to be economically feasible based on ECIP criteria, and are recommended for implementation.

3.4.1 ECO 1: Repair Main and Service Line Leaks

Proposed Modifications: Repair main line and service line water leaks identified in leak detection survey.

Existing Conditions: The leak detection survey located one main line and two service line leaks in the water distribution system. The total leakage quantity attributed to the main line leak was estimated at 125,000 gpd, while the service line leaks were estimated at 29,000 gpd. The complete leak detection report can be found in Appendix C.

Method of Analysis: Analysis proceeded as follows:

- The total quantity of the main line and service line leaks located by the leak detection survey was summarized and located on a site location map.

- Cost estimates were performed to determine the cost of repairing these pipes. Costs for site work were included with the costs for patching the leaks.

- A Life Cycle Cost Analysis (LCCA) was performed to determine the life cycle cost of repairing the leaks located by the leak detection survey. **Note: The leak detection survey was performed in November 1995. It is possible that new leaks have occurred in the interim while some of the old leaks may have been repaired. The economic analysis is strictly based on the leakage quantities identified by the leak detection survey.**

Results: Table 3-3 below summarizes the economic analysis. The LCCA, cost estimate, and calculation of total leakage savings can be found in Appendix D.

Table 3-3. ECO 1 Economic Analysis

Total Investment	$2,612
Annual Water Savings (kgal/year)	56,210
Annual Cost Savings	$46,261
Total Discounted Cost Savings	$623,681
Simple Payback (years)	0.06
Savings-to Investment Ratio	238.82

ECIP/FEMP funding qualifications require an ECO candidate to have a simple payback of 10 years or less and an SIR of 1.25 or better. This ECO meets government funding criteria.

It is important to note that some of the main line leaks may have been repaired by maintenance personnel at the time they were discovered by the leak detection survey. Coordination with maintenance personnel will be necessary to determine which leaks are still in need of repair.

3.4.2 ECO 2: Repair Water Valve Leaks

Proposed Modifications: Repair water valve leaks identified in leak detection survey.

Existing Conditions: The leak detection survey identified one water valve leak. The total leakage quantity was estimated at 2,000 gpd. The complete leak detection report can be found in Appendix C.

Method of Analysis: Analysis proceeded as follows:

- The water valve leak located by the leak detection survey was identified and located on site location maps.

- A cost estimates was performed to determine the cost of replacing the valve. Costs for site work were included with the cost for replacing the valve.

- A Life Cycle Cost Analysis (LCCA) was performed to determine the life cycle cost of repairing the leaks located by the leak detection survey. **Note: The leak detection survey was performed in November 1995. It is possible that new leaks have occurred in the interim while some of the old leaks may have been repaired. The economic analysis is be strictly based on the leakage quantities identified by the leak detection survey.**

Results: Table 3-4 below summarizes the economic analysis. The LCCA, cost estimate, and calculation of total leakage savings can be found in Appendix D.

Table 3-4. ECO 2 Economic Analysis

Total Investment	$927
Annual Water Savings (kgal/year)	730
Annual Cost Savings	$601
Total Discounted Cost Savings	$8,100
Simple Payback (years)	1.54
Savings-to Investment Ratio	8.74

ECIP/FEMP funding qualifications require an ECO candidate to have a simple payback of 10 years or less and an SIR of 1.25 or better. This ECO meets government funding criteria.

It is important to note that the valve leak may have been repaired by maintenance personnel at the time it was discovered by the leak detection survey. Coordination with maintenance personnel will be necessary to determine which leaks are still in need of repair.

3.4.3 ECO 3: Repair Fire Hydrant Leaks

Proposed Modifications: Repair fire hydrant leaks identified in leak detection survey.

Existing Conditions: The leak detection survey located thirteen fire hydrant leaks. The total leakage quantity was estimated at 13,000 gpd. The complete leak detection report can be found in Appendix C.

Method of Analysis: Analysis proceeded as follows:

- The total quantity of all fire hydrant leaks located by the leak detection survey was summarized and located on site location maps.

- Cost estimates were performed to determine the cost of replacing the leaking fire hydrants. Costs for site work were included with the costs for replacing the hydrants.

- A Life Cycle Cost Analysis (LCCA) was performed to determine the life cycle cost of repairing the leaks located by the leak detection survey. **Note: The leak detection survey was performed in November 1995. It is possible that new leaks have occurred in the interim while some of the old leaks may have been repaired. The economic analysis is strictly based on the leakage quantities identified by the leak detection survey.**

Results: Table 3-5 summarizes the economic analysis. The LCCA, cost estimate, and calculation of total leakage savings can be found in Appendix D.

Table 3-5. ECO 3 Economic Analysis

Total Investment	$35,908
Annual Water Savings (kgal/year)	4,745
Annual Cost Savings	$3,905
Total Discounted Cost Savings	$52,648
Simple Payback (years)	9.20
Savings-to Investment Ratio	1.47

ECIP/FEMP funding qualifications require an ECO candidate to have a simple payback of 10 years or less and an SIR of 1.25 or better. This ECO meets government funding criteria.

3.4.4 ECO 4: Repair Main Line, Service Line, Valve, and Fire Hydrant Leaks

Proposed Modifications: Repair all leaks identified in leak detection survey.

Existing Conditions: The leak detection survey located one main line leak, two service line leaks, one valve leak, and thirteen fire hydrant leaks. The total leakage quantity was estimated at 169,000 gpd. The complete leak detection report can be found in Appendix C.

An additional number of valves and fire hydrants were discovered to be leaking. However, the leaks stopped once these appurtenances were tightened. The estimated leakage total of 18,000 gpd for these particular valves and fire hydrants were not included in the economic analysis.

<u>Method of Analysis:</u> Analysis proceeded as follows:

- The total quantity of all leaks located by the leak detection survey was summarized and located on site location maps.
- Cost estimates were performed to determine the cost of repairing the leaks. Costs for site work were included with the repair costs.
- A Life Cycle Cost Analysis (LCCA) was performed to determine the life cycle cost of repairing the leaks located by the leak detection survey. **Note: The leak detection survey was performed in November 1995. It is possible that new leaks have occurred in the interim while some of the old leaks may have been repaired. The economic analysis is strictly based on the leakage quantities identified by the leak detection survey.**

<u>Results:</u> Table 3-6 below summarizes the economic analysis. The LCCA, cost estimate, and calculation of total leakage savings can be found in Appendix D.

Table 3-6. ECO 4 Economic Analysis

Total Investment	$39,447
Annual Water Savings (kgal/year)	61,685
Annual Cost Savings	$50,767
Total Discounted Cost Savings	$684,430
Simple Payback (years)	0.78
Savings-to Investment Ratio	17.35

ECIP/FEMP funding qualifications require an ECO candidate to have a simple payback of 10 years or less and an SIR of 1.25 or better. This ECO meets government funding criteria.

3.4.5 ECO 5: Implement Leak Detection Program

<u>Proposed Modifications:</u> Implement a water audit followed by a leak detection program on an annual basis. This audit is based upon actual and theoretical water consumption values and is used to establish a baseline (minimum value) of expected water leakage rate. When the actual values of water consumption are well known, thereby reducing the number of theoretical values, the amount of recoverable water distribution system leakage can be readily and accurately identified.

Existing Conditions: A water audit was performed on the potable water system according to guidelines set by the American Water Works Association (AWWA) Manual 36, "Water Audits and Leak Detection." The audit was based on information supplied by Ft. Drum personnel. Water usage in the potable water system can be separated into the following categories:

- **Domestic Water Consumption.** The amount of water consumed by all military and civilian occupants of Ft. Drum was estimated. Demographic data, obtained from Ft. Drum, provided the number of people who occupy the base. These demographics, taken from the Total Army Quality Self-Assessment (1995), were separated into active duty military and civilian personnel, family members, military retirees, and reserve component personnel. Assumptions were made to determine the number of residents and non-residents and are listed in Appendix D.

  According to guidelines in Army Technical Manual TM 5-813-1, "Water Supply Sources and General Considerations," the design allowances for water consumption are 150 gpd per person for residents and 50 gpd per person for non-residents. Multiplying these design allowances by the number of residents and non-residents produced an estimate of the amount of water consumed for domestic use.

- **Metered Water Usage.** Water usage for specific buildings on Post is metered. Examples of these buildings would be the PX, Mini Mall, Commissary, The Inn at Ft. Drum, and the central plant. Ft. Drum personnel provided meter data for 15 buildings over the last two years. The average water usage over the last two years was used for this water audit. For purposes of this study, the Metered Water Usage is in addition to Domestic Water Consumption.

- **Fire Hydrants.** According to Ft. Drum fire station personnel, there is no annual program for exercising fire hydrants. Water was assumed to be consumed through the fire hydrants for two purposes at Ft. Drum:

  ◊ Fire Protection. Hydrants are opened by the fire department as requested or as necessary to provide fire protection to the Post. Because no records of hydrant use was found, it was assumed that the hydrants are used 8 hours per year for the purpose of fire protection. It was assumed that the hydrants have a flow rate of approximately 1,200 gpm, based on hydrant test data provided by fire station personnel. The product of the hydrant flow rate and amount of time required was calculated to be the total water usage per year.

  ◊ Maintenance. Maintenance personnel also open the hydrants for maintenance reasons or to improve water circulation within a specific area, thus improving chlorine residuals. It was assumed that each hydrant was opened approximately twice a week during the summer months, which was assumed to be May through September (22 weeks). It was also assumed that a hydrant is opened for approximately ten minutes at a time. Based on the hydrant flow rate of approximately 1,200 gpm, the total water usage per year attributed to hydrant maintenance was calculated.

- **Once-through Cooling Units.** Domestic water is used for cooling in the condenser units of six HVAC and refrigeration units throughout the Post. The size of these units, annual operating hours, and domestic water requirements for each unit is summarized in Table 3-7. This information was provided by personnel in the HVAC Shop at Ft. Drum.

Table 3-7. Once-through Cooling Units

Type/Size of Unit	Water Usage (gpm)	Annual Hours	Annual Water Usage (gal)
3 ton HVAC	7.5	1,000	450,000
10 ton HVAC	25	1,000	1,500,000
(4) Walk-in Coolers	30 (total)	2,500	4,500,000

- **Landscaping/Irrigation Water.** From mid-May through September, water from the distribution system is used to irrigate lawns at the headquarters buildings, parade fields and athletic fields at Ft. Drum. Assumptions were made for the number of sprinkler heads that serve each area, the flow produced by each sprinkler head, and the amount of time required for each sprinkler cycle. The product of these assumptions produced a total water usage estimate.

- **Discovered leaks.** According to Ft. Drum personnel, no documented water main breaks have occurred in the water distribution system over the past two years. Therefore, water loss attributed to discovered water main breaks was assumed to be negligible.

Table 3-8 summarizes the results of the water audit of the domestic water system.

Table 3-8. Water Audit Results

Potable Water Uses	Gallons Per Year
Total Water Produced*	**709,300,653**
Domestic Water Consumption	596,420,000
Metered Water Uses	17,308,500
Fire Hydrants (Fire Protection)	576,000
Fire Hydrants (Maintenance)	528,000
Once-through Cooling Units	6,450,000
Landscaping/Irrigation	4,524,000
Total Identified Water Consumed	**625,806,500**
Potential Water System Losses	**83,494,153**

Recoverable Leakage	**62,620,615**

*Total Water Produced: Quantity taken from telemetry data (Datalog No. 3)

Method of Analysis: Analysis proceeded as follows:

- A water audit was performed on the potable water system according to AWWA Manual 36. All water usage in the audit was based on information obtained from Ft. Drum personnel.

- The amount of recoverable leakage was estimated. According to AWWA Manual 36, recoverable leakage is defined as approximately 75% of all potential losses in the system. For this audit, it was assumed that all potential losses, which are equal to the total water produced minus the total identified water consumed, outlined in Table 3-6, can be fully attributed to potential leakage.

- The total beneficial cost of repairing recoverable leakage was calculated. The cost of water was assumed to be the costs that vary with the amount of water delivered to the potable water system. These include operation, maintenance, and energy costs. The cost of leak repair, however, is not included. Because leaks are continually discovered and repaired in the normal course of operations, the leaks found in the leak detection program would eventually be repaired (AWWA Manual 36). If the leaks are repaired as part of a leak detection program, the expense of repairing leaks as they are accidentally discovered is avoided. Although some cost savings would be realized in fixing the leaks when they are discovered by a leak detection program, as opposed to discovering them accidentally, AWWA Manual 36 allows the auditor to assume that the savings is negligible.

- The total payback of the leak detection program was calculated by dividing the total cost of the leak detection program by the cost savings of recovered leakage. The total cost of the leak detection survey was taken from cost information provided by AWWA and from the average cost of the contractor's bids for the leak detection survey performed at Ft. Drum. The cost of a leak detection survey was calculated to be $200 per mile of pipe surveyed.

Results: The water audit estimated that 11.8% of the Ft. Drum water production is attributable to water lost due to leakage, and 8.8% is recoverable. Table 3-9 below summarizes the results of the economic analysis. The LCCA and water audit worksheets can be found in Appendix D.

Table 3-9. ECO 5 Economic Analysis

Amount of Recoverable Leakage (gal/yr)	62,620,615
Cost of Domestic Water ($ / kgal)	$0.82
Total Cost of Leak Detection Program	$29,120
Annual Cost Savings	$22,417
Total Discounted Cost Savings	$302,564
Simple Payback (years)	1.30
Savings-to-Investment Ratio	10.39

ECIP/FEMP funding qualifications require an ECO candidate to have a simple payback of 10 years or less and a savings-to-investment ratio (SIR) of 1.25 or better. Therefore, this ECO meets government funding criteria.

3.4.6 ECO 6: Connect Valve Pit Actuators to Telemetry System

Proposed Modifications: Provide sufficient labor hours to allow Ft. Drum personnel to connect existing valve actuators to the telemetry system. Automatic control of valves connecting the old and new Posts will allow for improved circulation, thus alleviating stagnation problems that are occurring in certain areas of the old Post.

Existing Conditions: Ft. Drum is currently experiencing problems with stagnating water and low chlorine residuals in certain areas of the old Post, especially on the western portion of the old Post (which includes Areas 0, 100, 1100, 4000 and 6000). Improvements in water quality in these areas will most likely improve the water quality in Areas 8300-8500, which have also had some stagnation problems.

There are three main lines that connect the water distribution systems of the old and new Posts:

- Valve Vault #3. This is a 20″ main line connection that runs through Area 4400, near Fourth Street East. Within the valve vault, the 20″ line enters, separates and connects to two 16″ control valves, and then is recombined into a 20″ main line, which exits the vault. The electric actuators on the control valves have been installed and connected to the telemetry system, allowing for automatic control.

- Valve Vault #4. This is a 16″ main line connection that runs through Area 4300, near Conway Road. Within this valve vault, the 16″ line enters, separates and connects to two 12″ control valves, and then is recombined into the 16″ main line, which exits the vault. There are also two 3″ lines which bypass the 12″ control valves, and are used in periods of low flow. The electric actuators on the control valves have been installed but are not connected to the telemetry system. Currently the 12″ control valves are closed, which forces most of the water flow to the new Post through Valve Vault #3. The 12" control valves must be manually opened by maintenance personnel.

- Valve Vault. This is an 8" main line connection that runs through Areas 8300 - 8500, near Lewis Avenue.

The stagnation problem is thought to arise from two conditions. The first condition is the decreased flow of water through the old Post. The low water demand has been created from the shift of activity at Ft. Drum to the new Post. The lower the demand, the slower the turnover rate of the water in the area's lines, creating stagnated water. Secondly, the entire flow between Posts occurs through Valve Vault #3. Since the actuators in Valve Vault #4 are not connected to the SCADA system, flow cannot be regulated between Valve Vault #3 and #4. The valves in Valve Vault #4 are usually closed thereby creating a short circuit condition in the flow of water between the Posts.

The plumbing shop personnel want to automatically alternate or combine water flow through Valve Vaults #3 and #4. Water flow through Valve Vault #4 would enhance water circulation and mixing towards the west end of the old Post, thus alleviating some of the stagnation problems. Connecting the actuators in Valve Vault #4 to the SCADA system will allow the automatic actuation of the valves required to enhance water mixing and flow though the old Post.

The FM and hardware connections required to connect the actuators in Valve Vault #4 to the telemetry system have already been procured. Only labor is required to complete the connection.

<u>Method of Analysis</u>: Analysis proceeded as follows:

- The amount of water lost annually for the purpose of alleviating stagnation in the water distribution system at Ft. Drum was estimated. According to the water audit performed in Section 3.3.1.5 of this report, approximately 528,000 gallons of water was lost through hydrants for the purpose of alleviating stagnation in water distribution piping or for maintenance reasons. Specific data on the number of times that the hydrants were opened was not available. Therefore, it was assumed that 75% of the total hydrant exercises occurred specifically for the purpose of improving water circulation in the western area of the old Post. Based on the assumption that 528,000 gallons of water per year was used for hydrant exercising, it was determined that approximately 396,000 gallons of water could be saved by implementing this ECO.

- A cost estimate was performed to calculate the cost of implementing this ECO. According to conversations with plumbing shop personnel, it is estimated that three to four people would be required for about two weeks to properly connect the wiring and fine-tune the telemetry system data. Labor costs were based upon the rate listed for an electrician in Means Mechanical Cost Data (1996).

Because this is anticipated to be an internal project at Ft. Drum, subcontractor's markups such as overhead, profit and contingency were not added to this particular cost estimate.

- A Life Cycle Cost Analysis (LCCA) was performed to determine the economic feasibility of implementing this ECO. Cost savings was based upon the estimated quantity of water saved from hydrant exercising each year.

Results: Table 3-10 below summarizes the economic analysis. The LCCA, cost estimate, and calculation of total water savings can be found in Appendix D.

Table 3-10. ECO 6 Economic Analysis

Total Investment	$3,247
Annual Water Savings (kgal/year)	396
Annual Cost Savings	$326
Total Discounted Cost Savings	$4,394
Simple Payback (years)	9.96
Savings-to Investment Ratio	1.35

FEMP funding qualifications require an ECO candidate to have a simple payback of 10 years or less and an SIR of 1.25 or better. Based on the assumed labor rate taken from Means Mechanical (1996), it was determined that a maximum of approximately 90 total man-hours could be used before the project would become economically unfeasible (that is, before the project would display an SIR of less than 1.25).

3.4.7 ECO 8: Optimizing Ft. Drum and DANC Water Production

Proposed Modifications: Determine the most equitable proportion of water produced by Ft. Drum and by the DANC. Optimal quantities of water will be based on water quality, reliability, and costs.

Existing Conditions: Ft. Drum is currently under contract to pay a fixed fee to the DANC for the water it provides. This fee is based on a number of costs incurred by the DANC, including:

- DANC Electrical Costs
- DANC O&M Costs
- DANC Overhead Costs
- DANC Capital Costs
- City of Watertown Capital Costs

The cost of water provided by the DANC was taken from the Water Line Schedule "A", which is included in Appendix D. The overall cost varies as the capital, overhead, and O&M charges are applied at different rates and over different periods of time. The overall cost will decrease significantly in 1997 when the balance of the DANC's capital costs are paid in full. However, as stated in Section 3.1.4 of this report, capital costs charged by the DANC are considered fixed costs and must be paid regardless of the amount of water produced. Therefore, only the variable costs were considered in the calculation of the cost of water at Ft. Drum. The cost of water provided by the DANC for the next five years is listed in Table 3-11. A complete listing of the anticipated DANC water costs for the next 20 years can be found in Appendix D.

Table 3-11. DANC Water Costs (1995 - 2000)

Date	City Capital Cost	DANC Capital Cost ($)	DANC Overhead Cost ($)	City O&M Cost ($)	DANC O&M Cost ($)	Total Variable Cost (per kgal)	Total Cost ($/kgal)
4/95 - 3/96	314,049	2,632,305	86,203	222,873	167,451	0.87	6.25
4/96 - 3/97	314,049	1,535,136	88,359	228,384	171,637	0.89	4.27
4/97 - 3/98	314,049	0	90,567	234,093	175,928	0.91	1.49
4/98 - 3/99	314,049	0	92,831	239,946	180,326	0.94	1.51
4/99 - 3/00	314,049	0	95,152	243,944	184,835	0.96	1.53

Ft. Drum is currently paying for a minimum of 1.5 mgd (547,500,000 gallons per year). If Ft. Drum uses less than that amount over the period of a month, then it is charged for 1.5 mgd. If it uses more than the minimum amount, then it is charged for actual usage. Because of its telemetry system, Ft. Drum is able to closely monitor its water usage every month so it uses close to the minimum amount of the DANC water as possible. Ft. Drum currently is consuming approximately 1.94 mgd (709,300,653 gallons per year). According to telemetry system data, the DANC provides 74.6% of the water consumed at Ft. Drum. The remaining 25.4% is provided by Ft. Drum wells.

Ft. Drum personnel have requested that the water sources be analyzed to determine the optimum balance of water based on water quality, reliability, and cost.

<u>Method of Analysis:</u> Analysis proceeded as follows:

<u>Water Quality</u>: According to information from Ft. Drum personnel, the quality of the water provided from the wells at Ft. Drum is very good. The water is slightly basic and requires little chlorine treatment. Because the water is slightly basic, the chlorine may last longer in the distribution system.

The water provided by the DANC is surface water from the Black River. This water, which is more acidic, is not the quality of the well water. This water requires more chemical treatment than the well water. However, because the water is slightly acidic, the chlorine may have better disinfectant capabilities. If the pH of the water is within 0.5 point either way of neutral (7.0), the effect on chlorine usage is probably minimal.

<u>Reliability</u>: The DANC is a highly reliable source of water for Ft. Drum. Even though the DANC currently provides 1.5 mgd, it is capable of providing up to 3.0 mgd.

The eleven wells at Ft. Drum are currently capable of providing approximately 2,200 gpm. In order to supplement water produced from the DANC, each well is currently operated for an average of 1,500 hours each per year. The wells are also a reliable source of water, as two of the wells are equipped with supplemental diesel engines. These engines can be used in the case of an electrical power outage.

In addition to the eleven wells currently in use, Ft. Drum has another well in reserve. The additional well has been drilled, but is not connected to the distribution system. The reserve well would require piping and electrical connections. However, well tests have indicated that this well is capable of producing up to 800 gpm.

<u>Cost</u>: Because the water quality and reliability of both sources is fairly equal, the most important issue in determining the optimum balance of water is cost. In order to objectively determine the optimum balance of water, the cost of Ft. Drum well water and the DANC water was analyzed at different proportions. As mentioned in Section 3.1 of this report, the cost of water at Ft. Drum is comprised of several different components:

- **Ft. Drum Electrical Costs.** Ft. Drum must pay for the electrical costs associated with operating eleven wells.

- **O&M Costs.** Maintenance charges apply to the distribution system, and are therefore assessed proportionally to both water sources. However, chemical treatment costs are applied only to the well water. The cost of treating water provided by the DANC is included in DANC's overall cost.

- **Ground Reservoir Pump Electrical Costs.** As with the O&M costs, the electrical cost incurred by the 40 hp pump which circulates water at the ground reservoir is applied proportionally to both water sources.

- **DANC Water Costs.** Ft. Drum pays a fixed fee, which includes all operational, maintenance, capital, and overhead charges incurred by the DANC and by the City of Watertown to provide water. For reasons mentioned in section 3.1.4, the capital costs are not part of the cost calculation.

The total cost of water was calculated and compared at varying proportions of water production. At one extreme, the costs were calculated based on the existing conditions, with the DANC providing 75% of the total water consumed and Ft. Drum providing the remaining 25%. At the other extreme, the cost of water was calculated with Ft.

Drum providing approximately 95% of the water demand and the DANC providing 5%. The cost analysis was based on the following assumptions:

- The total water demand for Ft. Drum was assumed to be 709,300,653 gallons per year, which is equal to the average annual demand between August 1993 and July 1995.

- It was assumed that all of the wells were operated for approximately the same number of hours each year. The independent variable in the cost analysis was the annual operating hours of each well. The costs were generally analyzed with well operating hours in 200 gpm increments (for a total of 2,200 gpm for eleven wells).

- The cost of water was analyzed based on 1995 values. The following costs were used in the analysis:

  ◊ DANC Cost ($0.90/kGal). The sum of the variable costs incurred by the DANC. The cost were taken from Schedule "A", provided by Ft. Drum personnel.

  ◊ Ft. Drum Electrical Cost ($0.072/kWh). The bundled cost of electricity, provided by the utility office at Ft. Drum.

  ◊ Ft. Drum O&M Cost ($20,105 per year). Ft. Drum O&M costs were provided for 1994 and 1995. This cost is based on the total costs incurred for 1995 and does not include chemical treatment costs.

  ◊ Chemical Treatment Cost ($5,550 per year). The chemical treatment cost for 1995 was provided by Ft. Drum personnel. It was assumed that chemical treatment costs would increase linearly as the amount of water provided by the wells increased.

  ◊ Ground Reservoir Pump Electrical Cost ($0.067/kGal). The cost incurred by the ground reservoir pump was based on the electrical cost necessary to circulate water through the reservoir. It was assumed that the annual operating hours required by the pump would not change because total water demand at Ft. Drum was assumed to remain constant.

- It was assumed that costs applied to both water sources would be proportioned based on the percentage of water volume supplied by each source. For example, O&M and reservoir costs are applied to both water sources. Because the total water demand does not change, the total O&M and reservoir costs will not change. However, they were proportionally charged to each water source based upon the percentage of water volume that each source provided. If the wells were analyzed at 40% of the total water volume supplied to Ft. Drum, it incurred 40% of the total O&M and reservoir costs.

Results: Table 3-12 contains a sample of the calculations performed in the water cost analysis. The entire cost analysis is contained in Appendix D.

Table 3-12. Optimum Cost of Water

Usage Per Well (hrs)	% of Total Flow DANC	% of Total Flow Ft. Drum Wells	Total Cost DANC ($)	Total Cost Ft. Drum Wells ($)	Total Cost ($)
1,500	75.1	24.9	0.742	0.081	0.823
2,000	62.8	37.2	0.616	0.103	0.719
3,000	44.1	55.9	0.427	0.138	0.565
4,000	25.5	74.5	0.238	0.174	0.412
5,000	6.9	93.1	0.048	0.210	0.258
5,200	3.1	96.8	0.010	0.217	0.227

Based on the results of the water cost analysis, it appears that the total cost of water consumed at Ft. Drum decreases as the amount of water produced by the wells increases. Each of the wells at Ft. Drum would be required to operate approximately 5,200 hours per year to produce the amount of water required.

To illustrate the significant cost savings that Ft. Drum could expect to see, Table 3-13 gives an annual cost of water based on a demand of 709,300,693 gallons per year. The cost savings are compared to the annual cost of $583,755.

Table 3-13. Potential Cost Savings - Ft. Drum Water

Well Usage (hrs)	Cost ($/kgal)	% DANC Water	% Ft. Drum Water	Annual Cost ($)	Annual Cost Savings ($)
1,500	0.823	75.1	24.9	583,755	-
2,000	0.719	62.8	37.2	509,987	73,768
3,000	0.565	44.1	55.9	400,755	183,000
4,000	0.412	25.5	74.5	292,232	291,523
5,000	0.258	6.9	93.1	183,000	400,755
5,200	0.227	3.1	96.8	161,011	422,744

It is probably not realistic to use Ft. Drum well water exclusively. The increased operating hours for the well pumps will increase their wear, which will produce increased operation and maintenance costs. In addition, the wells will have to be replaced sooner because of the increased operating hours. It is wise to continue to use some portion of the DANC water as a reliable back-up source and as a source to shave the peak usage of water at the Post.

It should be noted under the current contract with the DANC, Ft. Drum is being charged for capital, O&M and overhead costs, depending upon the amount of water produced. If Ft. Drum uses more than the guaranteed 1.5 mgd in a given month, they are charged the same rate. This could infer that Ft. Drum is paying twice for capital costs once the Post's usage exceeds an average 1.5 mgd in any given month. In future contract negotiations, if possible, Ft. Drum should negotiate a lower rate for water consumption over 1.5 mgd. This rate should not include capital (fixed) costs.

If Ft. Drum is also able to negotiate a lower guaranteed water production rate from the DANC, it would produce lower annual costs.

3.5 ECO NOT RECOMMENDED

ECO 7 was not found to be economically feasible based on ECIP criteria. It is not recommended for implementation.

3.5.1 ECO 7: Reconnect Isolated Main Line

Proposed Modifications: Approximately 1,200 LF of a 12" main line located in Area 1000 near Oswego Avenue is isolated from the water distribution system. Reinstatement of this main line will allow for improved water circulation in this area.

Existing Conditions: The 1,200 LF section of 12" piping along Oswego Avenue from Leroysville Road to Tenth Street is out of commission as a result of repair work performed a few years ago. The repair work was conducted, but the line could not be properly chlorinated to allow its reinstatement into the water distribution system. This section of piping is one of six main lines that transport water from the water treatment plant to the old Post. Hydraulic and stagnation problems exist because water is forced into the other mains, thus bypassing the area directly served by the 12" main line.

Method of Analysis: Analysis proceeded as follows:

- The amount of water lost annually for the purpose of alleviating stagnation in this particular area of the water distribution system at Ft. Drum was estimated. According to the water audit performed in Section 3.3.1.5 of this report, approximately 528,000 gallons of water was lost through hydrants for the purpose of alleviating stagnation in water distribution piping or for maintenance reasons. Specific data on the number of times that the hydrants were opened in this specific area was not available. Therefore, it was assumed that 25% of the total hydrant exercises occurred specifically for the purpose of improving water circulation in the eastern area of the old Post. Based on the assumption that 528,000 gallons of water per year was used for hydrant exercising, it was determined that approximately 132,000 gallons of water could be saved by implementing this ECO.

- A cost estimate was performed to calculate the cost of implementing this ECO. In order to properly chlorinate this line, the following construction sequence was assumed:

  ◊ It is assumed that each end of the isolated main line is capped off. The active main line on each end would be valved off to allow the existing caps to be removed and new segments of pipe to be installed. New 12" x 6" tees would also be installed in the main line to allow for a new fire hydrant installation on each end of the isolated line.

  ◊ A new fire hydrant would be installed on each end of the isolated main line and connected to the main line tees.

  ◊ Once the new lines are reconnected and the new hydrants are installed, open the hydrant on both ends of the main line to flush the previously isolated main line clean.

  ◊ Once the main line has been flushed and proper chlorine levels have been reached, open the gate valves on the both ends of the main line. The hydrants on the both ends of the main line should be closed, thus reinstating the isolated main line back into the distribution system.

  The estimate included site work and mechanical costs required to connect both ends of the isolated pipe, as well the cost to connect a fire hydrant on each end.

- A Life Cycle Cost Analysis (LCCA) was performed to determine the economic feasibility of implementing this ECO. Cost savings was based upon the estimated quantity of water saved from hydrant exercising in order to alleviate stagnation problems in this particular area.

Results: Table 3-14 below summarizes the economic analysis. The LCCA, cost estimate, and calculation of total leakage savings can be found in Appendix D.

Table 3-14. ECO 7 Economic Analysis

Total Investment	$11,333
Annual Water Savings (kgal/year)	132
Annual Cost Savings	$109
Total Discounted Cost Savings	$1,465
Simple Payback (years)	104.32
Savings-to Investment Ratio	0.13

FEMP funding qualifications require an ECO candidate to have a simple payback of 10 years or less and an SIR of 1.25 or better. This particular project does not qualify for government funding.

4. SUMMARY AND RECOMMENDATIONS

4.1 SUMMARY OF THE WATER DISTRIBUTION SYSTEM

According to the data accumulated from the field survey and the leak detection survey, the following were noted:

- The domestic water system at Ft. Drum uses an average of 709,300,653 gallons of water per year, which translates to a daily rate of approximately 1.94 million gallons.

- The estimated leakage discovered by the leak detection survey was 187,000 gpd (68,255,000 gallons per year or 9.6% of the total water produced). However, leakage amounting to 18,000 gpd was eliminated once thirteen fire hydrants and one valve were completely sealed by the leak detection crew. Therefore, a total of 169,000 gpd (61,685,000 gallons per year) was identified as leakage, which translates into approximately 8.7% of the total usage.

- The estimated audit value for annual recoverable leakage was calculated to be 62,620,615 gallons per year, or nearly 8.8% of the total usage.

The estimated audit value is a baseline or "minimum expected" leakage rate. The estimated leakage discovered is the actual estimated leakage rate. Given this information, it should be noted that the results of ECO 5 show a favorable economic payback while using the slightly higher leakage amount estimated by the water audit.

4.2 SUMMARY OF ENERGY AUDIT

According to the Scope of Work, ECIP criteria is to be used to categorize ECOs. In order to qualify for government funding programs, the ECOs must have a simple payback of 10 years or less and a SIR of 1.25 or greater. For this study, eight ECOs were investigated. Table 4-1 on the following page summarizes the ECOs investigated in this study.

Table 4-1. Summary of ECOs

ECO No.	Description	Investment Cost ($)	Annual Water Savings*	Total Discounted Savings ($)	SIR	Payback (yrs)
1	Repair Main Line Leaks	2,612	56,210	623,681	238.82	0.06
2	Repair Valve Leaks	927	730	8,100	8.74	1.54
3	Repair Fire Hydrant Leaks	35,908	4,745	52,648	1.47	9.20
4	Repair All Leaks	39,447	61,685	684,430	17.35	0.78
5	Implement Leak Detection	29,120	62,621	302,564	10.39	1.30
6	Connect Valve Pit Actuators	3,247	396	4,394	1.35	9.96
7	Reconnect Isolated Main	11,333	132	1,465	0.13	104.32
8	Optimize Ft. Drum vs. DANC	-	-	-	-	-

*Annual Water Savings are in units of thousands of gallons saved per year

4.3 RECOMMENDATIONS

It is recommended that the qualifying ECOs for government funding programs be implemented. A summary of the recommended ECOs is listed in Table 4-2 below.

Table 4-2. Recommended ECOs

ECO No.	Description	Investment Cost ($)	Annual Water Savings*	Total Discounted Savings ($)	SIR	Payback (yrs)
4	Repair All Leaks	39,447	61,685	684,430	17.35	0.78
5	Implement Leak Detection	29,120	62,621	302,564	10.39	1.30
6	Connect Valve Pit Actuators	3,247	396	4,394	1.35	9.96
8	Optimize Ft. Drum vs. DANC	-	-	-	-	-

*Annual Water Savings are in units of thousands of gallons saved per year

- ECO 4. Replace the main line, valves, and fire hydrants identified as having leaks by the leak detection survey. ECO 4 is a combination of ECOs 1 through 3. Although each of those ECOs are economically feasible based upon their own merits, combining them would simplify the programming documentation and produce a better project.

  Note that some of the leaks may have been repaired by maintenance personnel at the time they were discovered by the leak detection survey. Coordination with maintenance personnel will be required to determine which leaks are still in need of repair.

- ECO 5. According to the guidelines set by AWWA Manual 36, a leak detection survey should be performed annually. An aggressive leak detection program should produce a decrease in the amount of leakage. The water audit showed that the benefits of performing a leak detection survey and repairing the leaks that are discovered will outweigh the costs of the survey.

- **ECO 6.** Connect the water valve actuators in Valve Pit #4 to the telemetry system. Providing automatic control to the valves will allow flow to be alternated between the 16" and 20" main lines that join the old and new Posts. Increased flow through Valve Vault #4 (16" line) should improve water circulation on the western side of the old Post.

- **ECO 8.** Water consumed at Ft. Drum comes from two sources. Water provided by the DANC makes up approximately 75% of the total, while wells at Ft. Drum supply the remaining 25%. Ft. Drum currently pays $0.82 per thousand gallons of water, which accounts for water produced from both sources (except for fixed costs charged by the DANC). Under an agreement, DANC provides a minimum of 1.5 mgd at a fixed cost according to a schedule provided by Ft. Drum personnel (In 1995, the cost was $6.25/kgal. In 1997, after DANC capital costs are paid in full, the cost is estimated to be $1.49/kgal.).

  The total cost of water from both sources was based on a combination of electrical costs, O&M costs, chemical treatment costs, and water storage costs. Calculations show that the total cost of the water produced by both sources decreases as more well water is produced and less DANC water is used. The cost of water if Ft. Drum supplies 75% of the total water consumed was calculated to be $0.41 per kGal. The cost of water if Ft. Drum supplies 95% of the total was calculated to be about $0.24 per kGal.

  It is reasonable to maintain an equitable balance between Ft. Drum well water and water supplied by the DANC. If Ft. Drum is able to negotiate a lower guaranteed water production rate from the DANC, it would produce lower annual costs.

In accordance with the SOW, Ft. Drum personnel provided direction regarding the combination of ECOs into projects. They requested that all appropriate ECOs be combined into one project. To be considered appropriate, the synergistic effects of the bundled ECOs must meet government funding criteria with an SIR of 1.25 and a simple payback of 10 years or less. Programming documentation has been prepared for ECOs 4, 5, 6, and 7. The results of the economic analysis for the bundled project are listed in Table 4-3 below.

Table 4-3. Economic Analsysis for Bundled Project

Total Investment	$83,148
Annual Water Savings (kgal/year)	124,834
Annual Cost Savings	$73,618
Total Discounted Cost Savings	$992,857
Simple Payback (years)	1.13
Savings-to-Investment Ratio	11.94

The programming documentation and backup calculations can be found in Appendix E.

5. REFERENCES

AWWA Manual 36, Water Audits and Leak Detection, American Water Works Association, Denver, CO, 1990.

AWWA Research Foundation, Assessment of Existing and Development of Water Main Rehabilitation Practices, American Water Works Association, Denver, CO, 1990.

AWWA Research Foundation, Water Main Evaluation for Rehabilitation/Replacement, American Water Works Association, Denver, CO, 1986.

Walski, Thomas M., Ph.D., P.E., Analysis of Water Distribution Systems, Van Nostrand Reinhold Company Inc., 1984.

APPENDIX A

SCOPE OF WORK AND CONFIRMATION NOTICES

Scope of Work
Confirmation Notices
Mission Statement

SCOPE OF WORK
FY 95 POTABLE WATER CONSERVATION STUDY
FOR
FORT DRUM, NEW YORK

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1. **BRIEF DESCRIPTION OF WORK**: The Architect Engineer (AE) shall:

1.1 Perform a site survey of specific buildings or areas to collect all data required to evaluate the specific ECOs included in this study.

1.2 Evaluate specific ECOs to determine their energy savings potential and economic feasibility.

1.3 Provide project documentation for recommended ECOs as detailed herein.

1.4 Prepare a comprehensive report to document all work performed, the results and all recommendations.

2. **GENERAL**

2.1 This Study is limited to the evaluation of the specific buildings, systems, or ECOs listed in APPENDIX A, DETAILED SCOPE OF WORK.

2.2 The information and analysis outlined herein are considered to be minimum requirements for adequate performance of this study.

2.3 For the buildings, systems or ECOs listed in APPENDIX A, DETAILED SCOPE OF WORK,, all methods of energy conservation which are reasonable and practical shall be considered, including improvements of operational methods and procedures as well as the physical facilities. All energy conservation opportunities which produce energy or dollar savings shall be documented in this report. Any energy conservation opportunity considered unfeasible shall also be documented in the report with reasons for elimination.

2.4 The "Energy Conservation Investment Program (ECIP) Guidance", described in letter from DAIM-FDF-U, dated 10 Jan 1994 establishes criteria for ECIP projects and shall be used for performing the economic analyses of all ECOs and projects. The Program Life Cycle Cost In Design (LCCID), has been developed for performing life cycle cost calculations in accordance with ECIP guidelines and is referenced in the ECIP Guidance. If any program other than LCCID is proposed for life cycle cost analysis, it must use the mode of calculation specified in the ECIP Guidance. The output must be in the format of the ECIP LCCA summary sheet, and it must be submitted for approval to the Contracting Officer.

2.5 Energy conservation opportunities determined to be technically and economically feasible shall be developed into projects acceptable to installation personnel. This may involve combining similar ECOs into larger packages which will qualify for ECIP, or O&M funding, and determining in coordination with installation personnel the appropriate packaging and implementation approach for all feasible ECOs.

2.5.1 Projects which qualify for ECIP funding shall be identified, separately listed, and prioritized by the Savings to Investment Ratio (SIR).

2.5.2 All feasible Non-ECIP projects shall be ranked in order of highest to lowest SIR.

2.5.3 At some installations Energy Conservation and Management (ECAM) funding will be used instead of ECIP funding. The criteria for each program is the same. The Director of Public Works will indicate which program is used at this installation. This Scope of Work mentions only ECIP, however, ECAM is also meant.

3. PROJECT MANAGEMENT

3.1 Project Managers. The AE shall designate a project manager to serve as a point of contact and liaison for work require under this contract. Upon award of this contract, the individual shall immediately be designated in writing. The AE's designated project manager shall be approved by the Contracting Officer prior to commencement of work. This designated individual shall be responsible for coordination of work required under this contract. The Contracting Officer will designate a project manager to serve as the Government's point of contact and liaison for all work required under this contract. This individual will be the Government's representative

3.2 Installation Assistance. The Commanding Officer or authorized representative at the installation will designate an individual to assist the AE in obtaining information and establishing contacts necessary to accomplish the work required under this contract. This individual will be the installation representative

3.3 Public Disclosures. The AE shall make no public announcements or disclosures relative to information contained or developed in this contract, except as authorized by the Contracting Officer

3.4 Meetings. Meetings will be scheduled whenever requested by the AE or the Contracting Officer for the resolution of questions or problems encountered in the performance of the work. The AE's project manager and the Government's representative shall be required to attend and participate in all meetings pertinent to the work required under this contract as directed by the Contracting Officer. These meetings, if necessary, are in addition to the presentation and review conferences.

3.5 Site Visits. Inspections, and Investigations. The AE shall visit and inspect/investigate the site of the project as necessary and required during the preparation and accomplishment of the work

3.6 Records

3.6.1 The AE shall provide a record of all significant conferences, meetings, discussions, verbal directions, telephone conversations, etc., with Government representative(s) relative to this contract in which the AE and/or designated representative(s) thereof participated. These records shall be dated and shall identify the contract number, and modification number if applicable, participating personnel, subject discussed and conclusions reached. The AE shall forward to the Contracting Officer within ten calendar days, a reproducible copy of the records.

3.6.2 The AE shall provide a record of requests for and/or receipt of Government furnished material, data, documents, information, etc., which if not furnished in a timely manner, would significantly impair the normal progression of the work under this contract. The records shall be dated and shall identify the contract number and modification number, if applicable. The AE shall forward to the Contracting Officer within ten calendar days, a reproducible copy of the record of request or receipt of material

3.7 Interviews. The AE and the Government's representative shall conduct entry and exit interviews with the Director of Public Works before starting work at the installation and after completion of the field work. The Government's representative shall schedule the interviews at least one week in advance

3.7.1 Entry. The entry interview shall describe the intended procedures for the survey and shall be conducted prior to commencing work at the facility. As a minimum, the interview shall cover the following points:

- Schedules
- Names of energy analysts who will be conducting the site survey
- Proposed working hours
- Support requirements from the Director of Public Works

3.7.2 Exit. The exit interview shall briefly describe the items surveyed and probable areas of energy conservation. The interview shall also solicit input and advice from the Director of Public Works.

4. **SERVICES AND MATERIALS.** All services, materials (except those specifically enumerated to be furnished by the Government), labor, supervision and travel necessary to perform the work and render the data required under this contract are included in the lump sum price of the contract.

5. **PROJECT DOCUMENTATION.** All energy conservation opportunities which the AE has considered shall be included in one of the following categories and presented in the report as such.

5.1 ECIP Projects. To qualify as an ECIP project, an ECO, or several ECOs which have been combined, must have a construction cost estimate greater than $300,000, a Savings to Investment Ratio greater than 1.25 and a simple playback period of less than ten years. For ECAM projects, the $300,000 limitation may not apply in such cases, the AE shall check with the installation for guidance. The overall project and each discrete part of the project shall have an SIR greater than 1.25. All projects meeting the above criteria shall be arranged as specified in paragraph 2.6.1 and shall be provided with programming documentation. Programming documentation shall consist of a DD Form 1391, life cycle cost analysis (LCCA) summary sheet(s) (with necessary backup data to verify the numbers presented), and a Project Development Brochure(PDB). A life cycle cost analysis summary sheet shall be developed for each ECO and for the overall project when more than one ECO are combined. The energy savings for projects consisting of multiple ECOs must take into account the synergistic effects of the individual ECOs

5.2 Non-ECIP Projects. Projects which do not meet ECIP criteria with regard to cost estimate or play back period, but which have a SIR greater than 1.25 shall be documented. Projects or ECOs in this category shall be arranged as specified in paragraph 2.5.2 and shall be provided with the following documentation: the life cycle cost analysis (LCCA) summary sheet completely filled out, a description of the work to be accomplished, backup data for the LCCA, i.e., energy savings calculations and cost estimate(s), and the simple play back period. The energy savings for projects consisting of multiple ECOs must take into account the synergistic effects of the individual ECOs. In addition these projects shall have the necessary documentation prepared, as required by the Government's representative, for one of the following categories:

5.2.1. 0 & M Energy Projects: An O&M Energy project is one that results in needed maintenance or repair to an existing facility, or replaces a failed or failing existing facility, and also results in energy savings. The criteria are similar to the criteria for ECIP projects, i.e., $300,000 construction cost, SIR $\geq$ 1.25, and simple play back period of less than ten years. In addition, if the project would replace a system or equipment that is considered failed or failing' due solely to obsolete technology or inefficiency, the equipment to be replaced must have been in use for at least three years; and the simple play back period must be three years or less.

5.2.2. Low Cost/No Cost Projects. These are projects which the Director of Public Works (DPW) can perform using his resources. Documentation shall be as required by the DPW.

5.3 Non-feasible ECOs. All ECOs which the AE has considered but which are not feasible, shall be documented in the report with reasons and justifications showing why they were rejected.

6. **DETAILED SCOPE OF WORK**. The Detailed Scope of Work is contained in APPENDIX A, DETAILED SCOPE OF WORK,.

7. **WORK TO BE ACCOMPLISHED**.

7.1 Perform A Site survey. The AE shall obtain all necessary data to evaluate the ECOs or projects by conducting a site survey. The AE shall document his site survey on forms developed for the survey, or standard forms, and submit these completed forms as part of the report.

7.2 Evaluate Selected ECOs. The AE shall analyze the ECOs listed in APPENDIX A, DETAILED SCOPE OF WORK,. These ECOs shall be analyzed in detail to determine their feasibility. Savings to Investment Ratios (SIRS) shall be determined using current ECIP guidance. The AE shall provide all data and calculations needed to support the recommended ECO. All assumptions and engineering equations shall be clearly stated. Calculations shall be prepared showing how all numbers in the CEO were figured. Calculations shall be an orderly step by step progression from the first assumption to the final number. Descriptions of the products, manufacturers catalog cuts, pertinent drawings and sketches shall also be included. Construction cost estimates shall be provided and shall break out the costs associated with rehab work (architectural, electrical, mechanical) where applicable. A life cycle cost analysis summary sheet shall be prepared for each ECO and included as part of the supporting data.

7.3 Combine ECOs Into Recommended Projects. During the Interim Review Conference, as outlined in paragraph 7.4.1, the AE will be advised of the DPW's preferred packaging of recommended ECOs into projects for implementation. Some projects may be a combination of several ECOs, and others may contain only one. These projects will be evaluated and arranged as outlined in paragraphs 5.1, 5.2, and 5.3. Energy savings calculations shall take into account the synergistic effects of multiple ECOs within a project and the effects of one project upon another. The results of this effort will be reported in the Final Submittal per par 7.4.2.

7.4 Submittals, Presentations and Reviews. The work accomplished shall be fully documented by a comprehensive report. The report shall have a table of contents and shall be indexed Tabs and dividers shall clearly and distinctly divide sections, subsections, and appendices. All pages shall be numbered. Names of the persons primarily responsible for the project shall be included. The AE shall give a formal presentation of the interim submittal to installation, command, and other Government personnel. Slides or view graphs showing the results of the study to date shall be used during the presentation. During the presentation, the personnel in attendance shall be given ample opportunity to ask questions and discuss any changes deemed necessary to the study. A review conference will be conducted the same day, following the presentation. Each comment presented at the review conference will be discussed and resolved or action items assigned. It is anticipated that the presentation and review conference will require approximately one working day. The presentation and review conference will be at the installation on the date agreeable to the Director of Public Works, the AE and the Government's representative. The Contracting Officer may require a re-submittal of any document(s), if such document(s)are not approved because they are determined by the Contracting Officer to be inadequate for the intended purpose.

7.4.1 Interim Submittal. An interim report shall be submitted for review after the field survey has been completed and an analysis has been performed on all of the ECOs. The report shall indicate the work which has been accomplished to date, illustrate the methods and justifications of the approaches taken and contain a plan of the work remaining to complete the study. Calculations showing energy and dollar savings, SIR, and simple play back period of all the ECOs shall be included. The results of the ECO analyses shall be summarized by lists as follows:

7.4.1.a. All ECOs eliminated from consideration shall be grouped into one listing with reasons for their elimination as discussed in par 5.3.

7.4.1.b. All ECOs which were analyzed shall be grouped into two listings, recommended and non-recommended, each arranged in order of descending SIR. These lists may be subdivided by building or areas appropriate for the study. The AE shall submit the Scope of Work and any modifications to the Scope of Work as an appendix to the report. A narrative summary describing the work and results to date shall be a part of this submittal. At the Interim Submittal and Review Conference, the Government's and AE's representatives shall coordinate with the Director of Public Works to provide the AE with direction for packaging or combining ECOs for programming purposes and also indicate the fiscal year for which the programming or implementation documentation shall be prepared. The survey forms completed during this Study shall be submitted with this report. The survey forms only may be submitted in final form with this submittal. They should be clearly marked at the time of submission that they are to be retained. They shall be bound in a standard three ring binder which will allow repeated disassembly and re-assembly of the material contained within.

7.4.2 Final Submittal. The AE shall prepare and submit the final report when all sections of the report are 100% complete and all comments from the interim submittal have been resolved. The AE shall submit the Scope of Work for the study and any modifications to the Scope of Work as an appendix to the submittal. The report shall contain a narrative summary of conclusions and recommendations, together with all raw and supporting data, methods used, and sources of information. The report shall integrate all aspects of the study. The recommended projects, as determined in accordance with paragraph 5, shall be presented in order of priority by SIR. The lists of ECOs specified in paragraph 7.4.1 shall be included for continuity. The final report and all appendices shall be bound in standard three ring binders which will allow repeated disassembly and re-assembly. The final report shall be arranged to include:

7.4.2.a. An Executive Summary to give a brief overview of what was accomplished and the results of this study using graphs, tables and charts as much as possible (See APPENDIX B, EXECUTIVE SUMMARY GUIDELINE, for minimum requirements).

7.4.2.b. The narrative report describing the problem to be studied, the approach to be used, and the results of this study.

7.4.2.c. Documentation for the recommended projects.

1) Backup information as specified in par 5.1.

7.4.2.d. Appendices to include as a minimum:

1) Energy cost development and backup data

2) Detailed calculations

3) Cost estimates

4) Computer printouts (where applicable)

5) Scope of Work

APPENDIX A
DETAILED SCOPE OF WORK,
FY95 POTABLE WATER CONSERVATION STUDY
FORT DRUM, NEW YORK

1. All facilities to be investigated in this Study are located at Fort Drum, New York

2. The General Scope of Work outlines requirements for the Study and the Report; and the detailed scope of work lists the specific areas to be studied. If any conflicts arise between the General and the Detailed scopes of work, the Detailed Scope of Work shall govern.

3. The work consists of identifying and evaluating energy conservation opportunities (ECOs) for post wide Potable Water System. A list of suggested ECOs is provided in APPENDIX D, POTABLE WATER SYSTEM ECOS. The ECOS in APPENDIX D, are to be evaluated as applicable for the area or facilities listed in APPENDIX D, LIST OF AREAS/FACILITIES TO BE STUDIED.

4. Completion and Payment Schedule: The following schedule shall be used as a guide in approving payments on this contract. The Contracting Officer's Representative (COR) will be Mr. Bryant Wilkins at the Norfolk District, COE

Interm Submittal	135 Calendar Days after Notice to Proceed
Pre-Final Submittal	150 Calendar Days after Notice to Proceed
Final Submittal	180 Calendar Days after Notice to Proceed

MILESTONE	PERCENT OF CONTRACT AMOUNT AUTHORIZED FOR PAYMENT
Entry Interview	10
Completion of Field Work	50
Receipt of Interim Submittal	75
Completion of Interim Presentation & Review	85
Receipt of Final Submittal	100

5. The installation representative for this contract will be Mr. Joe Ogiba Utilities Branch, Directorate of Public Works , FORT DRUM, New York. (315) 772-3322 FAX (315) 772-9613.

6. Government Furnished Information: The following documents are available for the use of the AE.

- As built drawings (as available) of buildings/systems

- Architectural and Engineering Instructions, Design Criteria, dated 9 December 1991, Revised 8 July 1992.

- TM5-785 Engineering Weather Data.

- AR5-4, Change No.1, dated 1 August 1982, Department of the Army Productivity Improvement Program.
- Energy Conservation Investment Program (ECIP) Guidance, dated 10 January 1994.
- AR415-15, dated 1 January 1994, Military Construction, Army (MCA) Program Development.
- Tri-Service Military Construction Program (MCP) Index, dated February 1991 for Cost Estimating

7. Direct Distribution of Submittals: The AE shall make direct distribution of correspondence, minutes, report submittals, and responses to comments as indicated by the following schedule:

AGENCY	CORRESPONDENCE	EXECUTIVE SUMMARIES	REPORTS	FIELD NOTES
Commander 10th Mountain Division (LI) and Ft. Drum 85 First Street West Fort Drum, NY 13603-5097 Attn: AFZS-EH-OM, Mr. Joe Ogiba	1	3	3	1*
Commander U. S. Army Engineer District, Norfolk ATTN: CENAO-EN-MP (Mr Mlecik) 803 Front Street Norfolk, VA 23510	1	3	3	1*
Commander USAED, North Atlantic ATTN: CENAD-EN-MM (Mr Wong) 90 Church Street New York, NY 10007	-	1	1	-

Commander USAED, Mobile ATTN: CESAM-EN-DM (Battaglia) PO Box 2288; Mobile, AL 36628-0001	1	1	1	-
Commander US Army Corps of Engineers ATTN: CEMP-ET (Mr Gentil) 20 Massachusetts Avenue NW Washington, DC, 20314 - 1000	-	1 (Final Only)	-	-
Headquarters, Forces Command Attn: FCEN-RDF, Mr. Naresh Kapur Energy Office, Building 200 Ft. McPherson, GA 30330-6000	-	1 (Final Only)	-	-

* Field Notes submitted in final form at interim submittal.

Progress reports will be prepared on a monthly basis to highlight the significant events of the prior month. This is especially true of actions completed, problems discovered, schedule changes and ECO developments. The progress reports will accompany monthly billings and will form the basis for progress meetings.

8. A computer program titled Life Cycle Costing in Design (LCCID) is available from the BLAST Support Office in Urbana, Illinois for a nominal fee. This computer program can be used for performing the economic calculations for ECIP and non-ECIP ECOs. The AE is encouraged to obtain and use this computer program. The BLAST Support Office can be contacted at 144 Mechanical Engineering Building, 1206 West Green Street, Urbana, Illinois 61801. The telephone number is (217) 333-3977 or (800) 842-5278.

9. METHOD

9.1 INVESTIGATION OF EXISTING CONDITIONS

The Contractor will collect information on the existing Potable Water system (approximately 129 miles of pipe) and operations so as to have a reasonable understanding of operations, costs, energy use, problems, limitations, future needs, etc. This will be accomplished in the following steps.

Data Gathering. The Contractor will collect available data that will assist in energy use evaluations and recommendations. A partial list of data that will be sought are:

Energy bills and summaries

Prior studies and energy reports (if any)
Schedules
Piping drawings
Site plans
Maintenance records
Copies of other drawings needed
Proposals from vendors or contractore
Potable Water plant operator logs

Site Visits, Inspections. The AE shall perform a site survey of the existing Potable Water System and perform a through survey using state of the art underground leak detection equipment such as infrared and tracer gas on all water mains and branches but not including service lines to individual buildings to determine existing conditions and areas of containment system degradation.. The AE shall also obtain a copy of any prior infrared surveys. Refer to Appendix E for detailed requirements of the leak detection survey.

The AE shall confer with DPW personnel to determine operating conditions and planned projects which affect the system.

Nameplate data will be collected as well as observations of arrangements, physical condition and effectivness. The following measurements will be normally collected:

Electrical loads, voltage, amperage, kVA, and P.F.
Potable Water flow rates
Schedules (where possible)
Dimensions

Photographs will be taken of key areas for later reference.

ANALYSIS OF SYSTEMS

The Contractor will utilize standard methods of engineering calculations to understand current energy consumption in such detail as to permit identification of further improvement options.

POTABLE WATER SURVEY

Process water system maps for Fort Drum shall be developed showing the location and estimated flow of the leaks. The resulting maps shall be compared with Fort Drum's current mission, and a decision shall be made by Fort Drum DPW whether to repair, replace or isolate faulty piping sections. The Contractor shall confer with Fort Drum DPW and agree upon projects to develop for the water piping upgrades. The energy savings resulting from these projects will include reduced pumping costs, water treatment costs, annual repair costs where piping is replaced or isolated, and any other savings resulting from reduced water consumption.

The AE shall review information collected during the field survey to evaluate modifications currently being made to the cathodic protection system to determine if the modifications will eliminate the Potable Water containment system deterioration. The AE shall also evaluate potential modifications which will correct existing Potable Water containment system deficiencies.

The AE shall estimate the cost of modifications to correct the continuing deterioration of the Potable Water containment system and the cost to repair existing deficiencies. The AE shall estimate energy savings and perform an LCCA for each modification considered.

The analysis will also consider Potable Water loads that are expected to increase or reduce in the future due to changes in facility use, change of mission, new additions, etc.

Other Miscellaneous Uses and Losses. The study will also consider costs and energy usage related to other Potable Water usage not discussed above. Each miscellaneous use may include cost of water, pumping costs, chemical treatment. etc.

Utility Rate Analysis. A separate calculation will be performed for each type of energy conserved - gas, oil, and electric. The incremental cost of fuel will be used for all energy savings options.

ENERGY CONSERVATION OPPORTUNITY INVESTIGATIONS

The Contractor will investigate all reasonable options of saving energy and energy-related costs in the operation of the Potable Water production and distribution systems. The approach used to identify each option is briefly described below.

Existing Conditions. This section describes the nature of the existing operating system, its energy use, costs, advantages and disadvantages. Data is usually transferred to this section from the calculations.

Energy Conservation Opportunities. This section describes improvement ideas that are different from the existing conditions. They may describe a capital projects, modifications, or O&M procedures. The resulting improvements are described, energy costs, quantities and arrangements are briefly noted. Sufficient conceptual studies will be executed to determine feasibility, generate anticipated operational data and estimating values.

Construction Cost Estimate. A feasibility cost estimate in the format prescribed will be performed. The estimate breakdown will be included in the report showing known quantities and costs. Allowances for indirect costs and contingencies are included.

Annual Savings. The report will show the annual savings in energy, quantities, demand, costs, and BTU's. As the report is written, these savings are merely the difference between existing and proposed.

Discussion. This section of the report describes a number of relevant factors including payback period, impact on labor or non-energy costs, O&M concerns, appearances, comfort, life extension, etc. The intent of this section is to address normal impacts or uncertainties of various improvement ideas.

REPORT PREPARATION PHASE

The Contractor will prepare an Energy Analysis report which will fully document the steps previously described. The report will be prepared as follows.

Executive Summary - Section 1. The outline of the executive section is shown on Appendix B.

Methodology - Section 2. This part of the report describes the approach, sequence, assumptions, calculations methods, computer programs, sample outputs, etc. that were used for the study.

Facility Description - Section 3. The report will briefly discuss the buildings and systems covered by the study. It will show floor plans, layout flow diagrams, facility age and condition, major equipment characteristics by system, hours of operation, and concerns expressed by occupants and managers.

Energy Use and Costs - Section 4. The report will describe individual and combined energy consumption for the past two years. The report will describe rate structures, incremental cost calculations, trends, and analysis of use by source. This section critically establishes baseline use of energy for later improvement possibilities.

ECOs Recommended - Section 5. This section describes in detail each of the Energy Conservation Opportunities (ECOs) that are recommended for adoption and funding. The approach to each ECO write-up is described in Section 5, Project Documentation

ECOs Not Recommended - Section 6. The report will also show ECOs that were investigated but not recommended for adoption due to economics, conflicts, with other ECOs or concerns of operations.

Discussion - Section 7. This part of the report will cover interesting findings of the study not related to other sections of the report. It may include recommendations for non-energy problems, further studies, O&M procedures, training, etc.

Attachments. As part of the report, there will be enclosures for photos, backup calculations, referenced materials such as rate tariffs, codes, etc.

Applications and Funding Requests. As part of this study, applications for project funding will be made in accordance with Section 5, Project Documentation and directions from local authorized persons. The exact level of funding and funding program (expected to be ECIP), will be at the direction of the facility manager.

Suggested Implementation Schedules. The report will also contain a suggested timetable for implementing various projects or programs. This recommendation will be made in consultation with various facility managers.

Operation and Maintenance Instructions. Where appropriate, the study will recommend the formation of procedures or changes to processes that relate to improved energy usage and costs through Operation and Maintenance.

APPENDIX B
EXECUTIVE SUMMARY GUIDELINE,

1. Introduction.

2. Building Data (types, number of similar buildings, sizes etc.)

3. Present Energy Consumption of Buildings or Systems Studied.

- Total Annual Energy Used.
- Source Energy Consumption.
  Electricity KWH, Dollars, BTU
  Fuel Oil GALS, Dollars, BTU
  Natural Gas THERMS, Dollars, BTU
  Propane GALS, Dollars, BTU
  Other QTY, Dollars, BTU

4. Reevaluated Projects Results.

5. Energy Conservation Analysis.

- ECOs Investigated.
- ECOs Recommended.
- ECOs Rejected. (Provide economics or reasons)
- ECIP Projects Developed. (Provide list)*
- Non-ECIP Projects Developed. (Provide list)*
- Operational or Policy Change Recommendations.

* Include the following data from the life cycle cost analysis summary sheet; the cost (construction plus SIOH), the annual energy savings (type and amount), the annual dollar savings, the SIR, the simple pay back period and the analysis date.

6. Energy and Cost Savings.

- Total Potential Energy and Cost Savings.
- Percentage of Energy Conserved.
- Energy Use and Cost Before and After the Energy Conservation opportunities are Implemented.

APPENDIX C,
REQUIRED FORM DD1391 DATA,

To facilitate ECIP project approval, the following supplemental data shall be provided:

1. In title block clearly identify projects as "ECIP."

2. Complete description of each item of work to be accomplished including quantity, square footage, etc.

3. A comprehensive list of buildings, zones, or areas including building numbers, square foot floor area, designated temporary or permanent, and usage (administration, patient treatment, etc.).

4. List references, and assumptions, and provide calculations to support dollar and energy savings, and indicate any added costs.

4.1. If a specific building, zone, or area is used for sample calculations, identify building, zone or area, category, orientation, square footage, floor area, window and wall area for each exposure.

4.2. Identify weather data source.

4.3. Identify infiltration assumptions before and after improvements

4.4. Include source of expertise and demonstrate savings claimed. Identify any special or critical environmental conditions such as pressure relationships, exhaust or outside air quantities, temperatures, humidity, etc.

5. Lighting retrofit projects must identify number and type of fixtures, and wattage of each fixture being deleted and installed. New lighting shall be only of the level to meet current criteria. Lamp changes in existing fixtures is not considered an ECIP type project.

6. An ECIP life cycle cost analysis summary sheet as shown in the ECIP Guidance shall be provided for the complete project and for each discrete part included in the project. The SIR is applicable to all segments of the project. Supporting documentation consisting of basic engineering and economic calculations showing how savings were determined shall be included.

7. The DD Form 1391 face sheet shall include, for the complete project, the annual dollar and MBTU savings, SIR, simple amortization period and a statement attesting that all buildings and retrofit actions will be in active use throughout the amortization period

8. The calendar year in which the cost was calculated shall be clearly shown on the DD Form 1391.

9. For each temporary building included in a project, separate documentation is required showing (1) a minimum 10 year continuing need, based on the installation's annual real property utilization survey, for active building retention after retrofit,(2) the specific retrofit action applicable and (3) an economic analysis supporting the specific retrofit.

10. Non-appropriated funded facilities will not be included in an ECIP project without an accompanying statement certifying that utility costs are not reimbursable.

11. Any requirements required by ECIP guidance dated 10 Jan 1994 and any revisions thereto. Note that non-escalated costs and savings are to be used in the economic analyses.

12. The five digit category number for all ECIP projects except for Family Housing is 80000. The category code number for Family Housing projects is 71100.

APPENDIX D
POTABLE WATER ECOS

Energy Savings Opportunities include but are not necessarily limited to:

Replacement of failed elements of POTABLE WATER distribution system
Isolation of branches of the POTABLE WATER system
Prevention of further degradation of the POTABLE WATER distribution system.
Examination of ongoing cathodic protection program
Reduction of flushing costs due to stagnant lines.

LIST OF AREAS/FACILITIES TO BE STUDIED,

This study will include a thorough understanding of recommended improvements to the following:

Potable Water Distribution system from the central plant to other buildings served by the system including piping, insulation, valves, controls, and associated structures.

Facilities which currently or will potentially utilize the Potable Water

ENGINEERS, INC.

2750 South Wadsworth Blvd. • Suite C-200
Denver, Colorado 80227-3400
303/988-2951 • Fax: 303/985-2527

CONFIRMATION NOTICE

Confirmation Notice No. 1 EMC #1406-012

DATE:	3 November 1995
PROJECT:	Ft. Drum Water Conservation Study
CONTRACT NO.:	DACA01-94-D-0033, D.O. No. 12
NOTES PREPARED BY:	Michael Scholz and Tom Poeling E M C Engineers, Inc.
DATE OF MEETING:	24 October 1995
PLACE OF MEETING:	Building 4000, Ft. Drum Watertown, NY
SUBJECT:	Kick-off Meeting Notes
ATTENDEES:	Steve Rowley, Energy Manager, Ft. Drum Joe Ogiba, Telemetry System Manager, Ft. Drum Gregory Engel, M.E. Simpson, Inc. Mike Simpson, M.E. Simpson, Inc Bill Center, EMC Engineers, Inc. Michael Scholz, EMC Engineers, Inc. Thomas Poeling, EMC Engineers, Inc.

The following is a summary of the items discussed, the comments made, and the decisions made during the kick-off meeting conference.

The meeting began with an overview of the work to be performed for the water study. The study will consist of the following main elements:

- **Leak Detection Survey and Site Audit.** A leak detection survey will be performed by M.E. Simpson, Co.. M.E. Simpson will use a combination of listening devices and preamplified-transducer systems to identify leak locations. When the location of the leak can not be readily identified using these methods, a leak correlator will be used.

  E M C Engineers, Inc. will perform a site audit on the existing potable water distribution system. The audit will include tasks such as interviewing post personnel to gain an understanding of the current system operation and past history, gathering data relevant to water consumption and electrical usage, and identifying possible energy conservation projects in the water system.

- **Economic Analysis.** Specific energy conservation opportunities (ECOs) will be evaluated to determine their economic feasibility. ECOs will be evaluated based on current Energy Conservation Investment Program (ECIP) criteria, according to the scope of work. Analysis will include cost estimates and a Life Cycle Cost Analysis (LCCA) for each ECO.

- **Interim Submittal.** Results of the leak detection survey and the economic analysis will be submitted in the form of an interim submittal report.

- **Final Submittal.** Comments from government agencies on the interim submittal will be incorporated into a final report. Programming documentation for economically feasible projects will also be included.

Mr. Simpson presented a brief overview of the leak detection survey, as described above. Mr. Simpson anticipates that his crew will be on site until approximately 10 November. Mr. Rowley states that there are no restricted areas on post accept for those areas within fences. The M.E. Simpson crew should contact Post personnel for access. Mr. Rowley will notify the provost by letter regarding the water study; Building T-213 will be made available for M.E. Simpson's use, if required.

The water distribution system at Ft. Drum is close in many locations to High Temperature Hot Water (HTHW) piping. Mr. Simpson was asked whether pipes buried within close proximity to the water distribution system could produce incorrect leak sounds in the detection equipment. Mr. Simpson replied that he personally has only experienced an incorrect leak sound once, and the pipe was physically touching the water distribution pipe.

Mr. Simpson was asked to explain his method for estimating the quantity of leakage. He replied that the best way to estimate leakage is to excavate the leak for visual inspection. The quantity of leakage is based on several factors, including the type and size of pipe, water pressure, and physical size of the leak. When the leak is not excavated, experience is the best tool to estimate leakage rate.

Mr. Center discusses the fact of cathodic protection evaluation being written as part of the scope was included in error and is not a part of the scope of work for this project. Mr. Rowley concurs.

The scope of work involves the investigation of an estimated 129 miles of water distribution piping. The investigation will include both the old and new Post. The new Post is 6-8 years old, the old Post was constructed between 1941-1942. The water distribution system is constructed primarily of ductile iron main lines, with branch lines made of ductile iron and PVC (especially in the housing areas). Original piping for the old Post was constructed of transite (asbestos cement) piping. A project was performed several years ago to replace the majority of transite piping with ductile iron. In most cases, the transite piping was abandoned in place.

Water is provided to Ft. Drum from two major sources:

- Eleven active water wells, located mainly east of the old Post, which are capable of providing 2,200 gpm. The quality of the water from the wells is very good. Well No. 1 is a twelfth well presently not operating and has not been utilized for a few years.

- DANC (Development Authority of North Country) provides Ft. Drum with water to supplement their system. By contract, Ft. Drum purchases 1.5 MGD. This is a negotiated quantity and has been reduced from previous levels. The flow rate is an average of 2400 gpm to 4800 gpm. The DANC facility is about 4 years old. The water from DANC originates as surface water from the Black River, is treated and pumped to an above ground storage tank at Ft. Drum.

The water system has more than adequate storage and capacity for Ft. Drum's water demand. The system is comprised of the following components:

- Three elevated tanks, No. 1, 2 and 3. Tank No. 1 (250,000 gallons) supplies water to the old Post. Tank No. 2 (250,000 gallons) is currently not being used due to low demand for water in the old Post. Tank No. 3 (1 MG) supplies water to the new Post.

- A 750,000 gallon ground water storage facility. This reservoir is served by two pumps. A 40 hp pump is used to maintain reservoir volume and a 75 hp pump is used only for emergency fire demand.

- Chlorine is injected at the water treatment plant. The water has 1.5 ppm free chlorine at water plant. At the sewage treatment plant, the site furthest from the water plant, the chlorine level is normally measured at 0.2 to 0.4 ppm.

- The maximum pressure in the old Post is 90 psi, and 130 psi in new post. Minimum pressure expected in the new Post is approximately 30 psi.

The water distribution system is monitored and controlled by a Bristol-Babcock telemetry system, which was installed approximately three years ago. Nine remote units and a master unit provide an electronic interface with various components within the water system.

The system has the capability to:

- Monitor and control water tank levels.

- Provide manual or automatic control for all eleven operating wells. The telemetry system automatically operates and sequences each well based on elevated tank water elevation and the operating hours for each well. One well is operated continuously to allow chlorine to be injected into the water system at all times. Wells with the fewest operating hours are turned on first. Wells with the most operating hours are the first to be turned off.

- Monitor and control chlorine injection into the system.

- Operate during power outages. The control units located in the plumbing shop and the water treatment plant are each equipped with a 20 hour UPS.

- Provide over three years of historical data regarding equipment and operations in the water distribution system. Appropriate information regarding historical water usage from specific meters will be provided to EMC.

This water study will propose projects that will improve Ft. Drum's water system. Justification for the projects will be based on energy savings and economic payback according to the ECIP guidelines. Mr. Rowley related that it was his intention to request funding from the Federal Energy Management Program (FEMP) program. FEMP has a separate category for water conservation studies that does not offer as stringent requirements for acceptance as typical energy projects.

Several energy conservation programs were identified, including:

- Location and remediation of leaks throughout the distribution system, including main line, valve, and hydrant leaks.

- Remediation of water stagnation problems, which is evidenced by low chlorine residual measurements. Low chlorine is not only relegated to dead end lines. There are areas in the old Post which are subject to low water usage and have low chlorine content. The installation of recirculation pumps or additional looped water lines to improve water flow circulation was suggested as possible solutions.

- Isolation of branches of the potable water system. Areas of low water demand which exhibit high leakage levels may be isolated from the system. Isolation of specific areas would have to be approved by the appropriate fire safety authorities.

- Upgrade of telemetering system. Additional remote monitoring units may assist Ft. Drum personnel in determining the source of recoverable leakage by decreasing the amount of unknown water users on Post.

- Water audit and leak detection program. The water audit will include identification of all known water users on Post and an estimation of the amount of water used. The amount of known water used subtracted from the total amount of water pumped would result in unknown water usage. AWWA allows auditors to assume that 75% of the unknown water is leakage that can be recovered.

The submittal schedule for this project will be as proposed below with a slight change from Scope of Work to include an interim submittal review conference and revised final submittal date.

- Notice to Proceed: 16 October 1995
- Interim Submittal: 28 February 1996
- Interim Submittal Review Conference: 30 March 1996
- Final Submittal: 30 April 1996 (or 30 days after Interim Submittal Review Conference)

This meeting was adjourned.

Respectfully submitted,

Michael J. Scholz

Michael J. Scholz, Project Engineer

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cc: Attendees
Tony Battaglia, COE Mobile
Doug Gray, EMC
Dennis Jones, EMC

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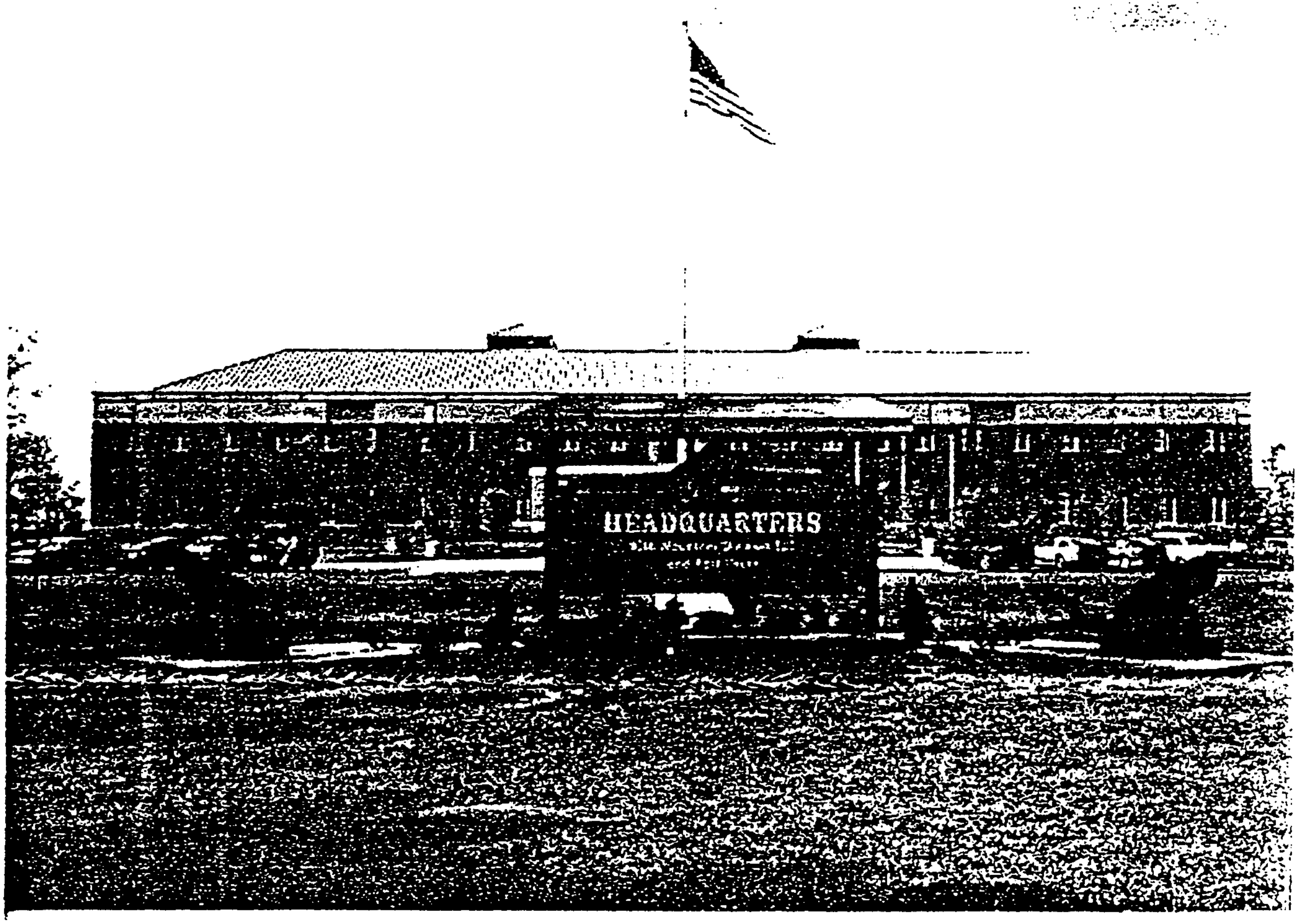
10th Mountain Division (LI)
and
Fort Drum



Total Army Quality Self Assessment

1995

OVERVIEW

INTRODUCTION AND HISTORY

Fort Drum is a FORSCOM Army installation located in northern New York. As a major training and mobilization center for all branches of the Total Army, it is the largest Army Installation in the Northeast, and the only all-weather training base in the continental United States. In 1908, National Guard soldiers from the New England states began training on 10,000 acres of land leased from the Greater Watertown Chamber of Commerce.

The War Department purchased the land the following year and named it Pine Plains after the abundance of pine trees which covered the area. Major expansion took place just prior to World War II. Pine Plains, renamed Pine Camp, was designated as a training post to develop armored divisions. Three divisions trained here: the 4th Armored Division, the 5th Armored Division, and the 45th Infantry Division. The wooden cantonment area, basically completed in 1941, was large enough to house one division. In 1951, Pine Camp was designated Camp Drum, in memory of Lieutenant General Hugh A. Drum, a First Army Commander during World War II.

As an indicator of the importance Camp Drum plays in the Total Army, it was designated Fort Drum in 1974. In September 1984, the Department of Army announced that Fort Drum would be the home of the reactivated 10th Mountain Division (Light Infantry). In addition to the Division, Fort Drum is also a major training site for Reserve Components and host to 26 Tenant organizations.

MISSION

The mission of the Fort Drum Garrison is to:

Command, operate, manage and administer the use of resources to accomplish all assigned missions. Additionally, the garrison provides administrative, logistical and management support to assigned or attached tenant units and activities to include both on-post and off-post units or activities in the assigned geographic area.

VISION

Fort Drum has fully embraced the Total Army Quality concepts over the past 4 years and the recently developed Total Army Quality Performance Improvement Criteria. Fort Drum's Garrison Commander, Colonel Joel E. Williamson, has taken a personal interest in this program and has worked with his staff and many others at the installation to develop the Garrison Quality Vision Statement which follows:

Provide a highly effective, efficient, customer-focused, service oriented installation where all soldiers, civilian employees and families live, work, and train with the full support of the North Country Community. Continuously look for ways to improve processes and procedures that will result in improved readiness, service, support, and quality of life, enabling Fort Drum to remain viable into the 21st Century.

PRODUCTS AND SERVICES

The support services provided by the Fort Drum Garrison can be divided into three major areas. The first area consist of those services which directly support the development of Combat Ready Soldiers who must be able to mobilize and deploy within 18 hours of notification.

Fort Drum's civilian workforce performs deployment and re-deployment functions in lieu of soldiers.

In addition, the garrison provides numerous other support to Combat Ready Soldiers ranging from Quality of Life Programs to operation and maintenance of training ranges.

The second major service area consist of those services tailored to supporting other permanent, satellite and transient organizations.

The third support area consist of those services necessary to maintain a safe and healthy environment for all soldiers, civilian workers, family members, and the residents of the North Country communities.

ENGINEERS, INC.

2750 South Wadsworth Blvd. • Suite C-200
Denver, Colorado 80227-3400
303/988-2951 • Fax: 303/985-2527

CONFIRMATION NOTICE

Confirmation Notice No. 2 EMC #1406-012

DATE:	11 April 1996
PROJECT:	Ft. Drum Water Conservation Study
CONTRACT NO.:	DACA01-94-D-0033, D.O. No. 12
NOTES PREPARED BY:	Michael Scholz E M C Engineers, Inc.
DATE OF MEETING:	1 April 1996
PLACE OF MEETING:	Building 4000, Ft. Drum Ft. Drum, NY
SUBJECT:	Interim Report Review Meeting Notes
ATTENDEES:	Steve Rowley, Energy Manager, Ft. Drum Joe Ogiba, Telemetry System Manager, Ft. Drum Michael Scholz, EMC Engineers, Inc.

The following is a summary of the items discussed, the comments made, and the decisions made during the kick-off meeting conference.

The meeting began with an overview of the work performed for the water study. The study consisted of the following main elements:

- **Leak Detection Survey and Site Audit.** A leak detection survey was performed by M.E. Simpson, Co.. M.E. Simpson used a combination of listening devices and preamplified-transducer systems to identify leak locations. M.E. Simpson surveyed the 130 miles of water distribution lines at Ft. Drum plus the piping in the water well field. The survey of the well field was confirmed by a phone conversation between Michael Scholz and Michael Simpson on 10 April. M.E. Simpson did not find any leaks in the well field piping.

  E M C Engineers, Inc. performed a site audit on the existing potable water distribution system. The audit included tasks such as interviewing post personnel to gain an understanding of the current system operation and past history, gathering data relevant to water consumption and electrical usage, and identifying possible energy conservation projects in the water system.

- **Economic Analysis.** Specific energy conservation opportunities (ECOs) were evaluated to determine their economic feasibility. ECOs were evaluated based on current Federal Energy Management Program (FEMP) criteria, according to the scope of work. Analysis included cost estimates and a Life Cycle Cost Analysis (LCCA) for each ECO.

The water study proposed projects that will improve Ft. Drum's water system. Justification for the projects was based on energy savings and economic payback according to the ECIP guidelines.

Mr Rowley and Mr. Ogiba were satisfied with the report stating that the report met their expectations. They did not have any editorial or technical comments to incorporate into the report.

Mr. Rowley requested EMC bundle ECO 4, 5, 6 and 7 together and prepare one DD1391 for the final report. EMC will wait until 15 April for any additional comments. After this date, final document preparation must commence to produce the final report on schedule.

This meeting was adjourned.

Respectfully submitted,

Michael J. Scholz, Project Engineer

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cc: Attendees
Tony Battaglia, COE Mobile
Doug Gray, EMC
Dennis Jones, EMC

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EMC
ENGINEERS, INC.

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Denver, Colorado 80227-3400
303/988-2951 • Fax: 303/985-2527

CONFIRMATION NOTICE

Confirmation Notice No. 3 EMC #1406-012

DATE:	14 May 1996
PLACED TO:	Mr. Tony Battaglia
REPRESENTING:	COE, Mobile
PHONE::	334-690-2618
PROJECT:	Ft. Drum Water Conservation Study
CONTRACT NO.:	DACA01-94-D-0033, D.O. No. 12
NOTES PREPARED BY:	Michael Scholz E M C Engineers, Inc.
DATE OF CONVERSATION:	9 and 13 May 1996
SUBJECT:	Review of Interim Report comments

The following is a summary of the items discussed, the comments made, and the decisions made during the phone conversations.

9 May

- We discussed the Interim Report comments received on 8 May from Mr. Battaglia via Norfolk COE (attached). We discussed the comments were sent by Mr. Battaglia on 9 April and must have been diverted. We asked Mr. Battaglia how we should proceed since the final version of the report had been sent on 3 May.

Mr. Battaglia called EMC after he had spoken with Norfolk COE and mentioned he would like the comments addressed if at all possible. We responded by saying will comply with the request.

- Below are the EMC response to the comments received on 8 May. The comments are not repeated here, as they are attached.
  1. Concur.
  2. Item was added from in-house review.
  3. Will identify.

4. Will highlight sentence.
5. Will change calculations based upon phone discussions with Mr. Battaglia on **13 May**. Discussions were about the merits of performing various different calculations for the annual cost of leak detection of the potable water system. The end result will be presented as Mr. Battaglia suggested in the comment.
6. Will clarify.
7. All personnel have been included according to Ft. Drum data.
8. Will change.
9. Will change.
10. Will change.
11. Will change.
12. Will modify LCCA summary sheet to list variables in cost savings calculations.

- Mr. K. Butler comment response:
  1. Will change from 18 to 17.

Respectfully submitted,

Michael J. Scholz

Michael J. Scholz, Project Engineer

mjs/MS
v:\1406.012\admin\ot-crspd\conf3.doc

cc: Joe Ogiba/Ft. Drum
Steve Mlecik/COE, Norfolk
Tony Battaglia, COE Mobile
Doug Gray, EMC
Dennis Jones, EMC
Tom Poeling, EMC

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U.S. Army Corps of Engineers
Norfolk District
803 Front Street
Norfolk, VA 23510-1096
voice (804) 441-7694
fax (804) 441-7831

fax transmittal

To: Bill Center
Fax #: 770-552-6759
From: Keith R. Butler
Date: 8 May 1996
Re: Water Conservation Study, Fore Drum, NY
Pages: 2

Notes:

I am reviewing the Water Conservation Study for Steve Mlecik. I'm forwarding some additional comments from Mr. Anthony Battaglia and myself. Please revise the study accordingly and provide us with the necessary sheets.

Coment:

Table 2-3, page 2-6:
-The total number of leaks should equal 17 not 18.

Mike Scholz - Call me when you receive this.
Bill,

MOBILE DISTRICT PROJECT REVIEW COMMENTS:		DATE: 9 April 1996	Page 1 of 1
TO: Steve Mlecik US Army Engineer District, Norfolk		FROM: Anthony W. Battaglia, CESAM-EN-DM Phone: (334) 690-2618 FAX: (334) 690-2424	
PROJECT/FY: FY95 REAP Water Conservation Study			
LOCATION: Fort Drum, New York			
TYPE REVIEW: Interim Submittal			

NO.	Page/Par	COMMENT	Response to Comment
1.	Pgs ES-1 & 1-1	Authorization for Study: The Norfolk District of the Corps of Engineers has responsibility for the study and should be mentioned in the authorization.	
2.	Pg 2-1	Par 2.1: Add "percent" after "8.7".	
3.	Pg 2-2	Table 2-1: Identify type of service for each motor.	
4.	Pg 3-5	Par 3.1.5: Suggest highlighting or typing in bold letters the following sentence: "Therefore, fixed costs charged by the DANC and by the City of Watertown are not included in the cost of water calculation." This is a very important step in the development of the costs, and it deserves emphasis.	
5.	Pg 3-11, Pg 3-14, & App D	ECO 5: If the leak detection is to be performed annually, there has to be an annual cost. This annual cost should be treated as an annual recurring non-energy cost. The cost for the leak detection survey for the first year can still be used as the construction cost as shown in Appendix D. Based upon a preliminary try, the ECO should still be cost effective.	
6.	Pg 3-12	ECO 5: When first reading this discussion, I thought that the metered usage was probably included in the domestic water consumption; but after reading through all of the backup data, I decided that this was not the case. To dispel any notions that this might be double-counting, suggest saying something about the use of the PX, Commissary, and Min-Mall by the off-post dependents and retired personnel.	
7.	App D	ECO 5: In the development of the post population numbers, the unaccompanied active duty personnel have not been mentioned. Certainly there are people living in barracks and BOQs. Please investigate and make corrections as necessary.	
8.	Pg 3-16	ECO 6: Several places in the discussion of ECO 6 the phrase "improving stagnation" is used. Suggest changing this to "alleviating stagnation".	
9.	Pg 3-16	Last line: Change "leakage savings" to "water savings".	
10.	Pg 4-2	Par 4.3: In the last sentence before Table 4-2, change "recommended" to "recommendations" or to "recommended ECOs".	
11.	App D	Type a title on the separator sheet for each sub-section of Appendix D.	
12.	App D	On several of the ECOs in Appendix D there is only a LCCA Summary Sheet and an estimate. Please add a sheet showing the cost savings calculations. For example, on ECO #1, O&M Reservoir Savings = (.028 + .031 + .067) X 56,120.	
		END OF COMMENTS	

APPENDIX B

FIELD SURVEY NOTES

Field Survey Notes
Data Supplied by Ft. Drum
Telemetry System Data (August 1993 - July 1995)

Field Survey Notes - Ft. Drum Water Study MJS ①

- Mike anticipates being on site until 10 November.
- Rules and regs on Post? - don't go into locked area.
- photos are sensitive. No photos of bldgs.
- Bristol Babcocks telemetry. by Joe Ogiba.
- Steve Rowley will write a letter to provost

bldg T 213 will be provided for our use. ..

Lewis St.

- Bill Center discusses the evaluation of cathodic protection. It is not a part of scope for potable water.

- New Post is 6-8 years old

Frank Colburn
John Kerr.

- Water telemetry system which controls water system

4 yrs old - chlorine system.

- 11 wells. shallow pipeline?

- 1.5 gallons/day charged > 2400 gpm to 4800 gpm. from Watertown.

- 2,200 gpm wells

- water use is evenly.

NC development authority & other concern - historical background on precip information.

- Sewage goes to Watertown direct.

~~show~~

- 3 tanks 1 550,000 gals for 1 & 2 old area in well field tank 2 not used Tank 3 1 mg in new area.

MJS

- Tank 1 is highest, Tank 3 is on another elevation

✓ - 750,000 gal reservoir - below ground. - 225,000 gal/day turnover.

✓ - 1.5 ppm free Cl injected @ water plant. Site furthest away has .1 or 0.2 ppm.

- ~~Not~~ Low chlorine is not relegated to dead ends - also on Post.

✓ - I mentioned need for Mission Statement or/and future use to Joe.

✓ - 20,000 people on post

- [redacted].

- experiance a couple of breaks in spring/year. ~24 per year

✓ - pressure is - 90 psi in - old area.
130 psi in new area tank #3

- FEMP is energy and water. Water is not as strict. Steve wants to summary of water saving. More Water money than projects.

~~call Labor to~~

- Tanks over running. - meter? - not anymore - Ogiba

- Ft. Drum Water Conservation Study will be context of Steve's submittal to gov'mt.

ADS
(3)

- Joe estimates constant low flow of 450 gpm. - on computer its ~600 gpm
- Bill Center mentions ~~see~~ a couple of A/C's use water on once through.
- hard copy redline map is acceptable to Joe Ogiba.
- John Kerr makes reports for state.

- 13 pH analyzers. 4 installed now, 9 w/in year.

- Telemetering is twofold - • be informed of trend towards problem.
  • proactive approach to maint

9:30 @ Telemetry bldg

- 4th St. East / St Lawrence - 750,000 gal. tank (DANC)

- 45th Division Drive. tank # 3.

- North entry point is farthest point

Saw
- 750,000 gal reservoir on 6th St. north of Railroad.

- They shut down wells over the weekend.

- 2.2 mgd average, Saturday more, Sunday more than ~~Sat~~ Sat
- DANC says 3 mg/day max - not an avg of 3 mg/day or "rate" of 3 mg/day

DANC's Ex. Dir
- They have a 20 hr UPS @ tele station and @ water station

- Wells are turned on based on well w/ lowest number of operating hours.

MJS
(4)

2.2 - 2.4 MGD Summer } rates
1.6 - 1.8 MGD winter.

– M.E. Simpson says their maps only cover old Ft. Drum. We need 3 sets for New Ft Drum.

12:30 John Ken & M.E. Simp. & Crew, Bill Center
– AMC housing area is PVC in new area.
– ~~Main~~ old post is ~~Cast iron~~ ductile iron. Not much transite pipe left.
– some of the ductile iron was capped a few years ago.

{ distribution main – 12"-20" – ductile iron
new post <12" is PVC
1986 – finished 1989.

Old post 1942-1945 age. – A.C. replaced
In the 2000 area and 2800 area maybe as old as 1930. Some transite in that area.

– Air port has fire system & fire suppress sys deluge.
2 diesel pumps
1 electric.

MJS

(5)

Piping Shop — 25589
25574

- Fire department might test flows. Chief Harrell 77 24131.

- New fort has PRV's

- 2 hydraulic valves also at New Fort

- Tank #3 is ~90' high.

- Generally, the Old Fort has low < 0.5 ppm chlorine.

2200
2400
2308
2100

100
0
1100
4000
6000

These areas

- All water into new fort goes through 4th St. East 20" pipeline.

- Valve vault @ Conway, valve vault on Lewis Ave.
  - pictures of valve vault - confined space.

- on Lewis St. they aren't elec. actuated.
  - if line in ~~St. Lawrence~~ Oswego Ave. line is connected, or reopened, then all 12" lines in Old Drum would operate ~1200 LF. from Leraysville ~~Ave~~ Road west.

- 9100 low chlorine also. Pos. E. Coli. this year.

- no areas of known low pressure.

- Fire Dept @ 10710 area. - Conway, memorial to L South
  Riva Ridge Loop.

MJS

(1)

10/25/95 8:05 @ Joe Ogiba's office. 315-772-3322

requested of Joe:

- water drawings in New FORT. - re delegates to Rick
- utility rates of DANC facility since Ft. Drum pays for utility.
- escort to wells.
- utility (water use) of power facility.

8:25 - @ DANC

Video interior, Tom takes Nameplate

Joe wants to have us meet Tom Ferguson. for HTHW.

Joe wants to have cathodic protection monitoring as part of SCADA system.

requests of John Kerr

- Video tape vault to reconnect to SCADA for Cl_2 enhancement
- keys & (escort) to wells or - } EPS's asked for info.
  nameplate data of pumps & motor.
- brief overview water system again

requests of Tom Ferguson

- Emergency response plan
- Total Army Quality Self Assessment. ✓ received
- Ft. Drum water is basic, Watertown water is slightly acidic - how does it effect Cl_2 amount?

105

(8)

- They have a well drilled which would produce 700-800 gpm. Needs power and waterline const. what is estimated l.f. ~~of~~ from well to waternetwork.

- Shallow pipeline - no shallow depth. ~ burial is about 4'-5'.

- HTHW parallels cold water - operates @ 360° during ~~water~~ winter could be a temperature problem between the two pipes.

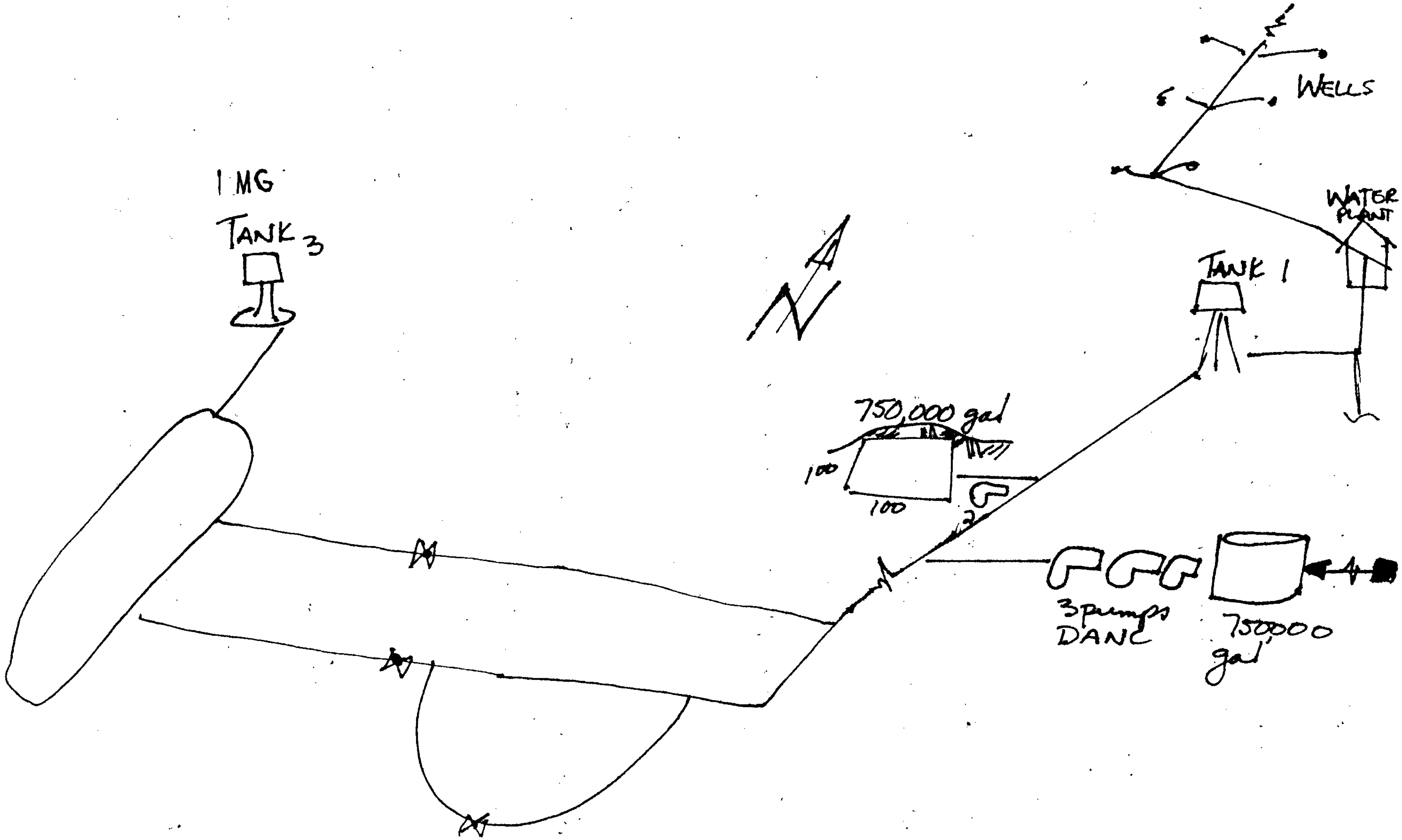
supply & return riewil system. 12" ϕ.

10/25/95 10:30 Wayne Davis helps. w/ nameplate data on wells. in files

8" water map of new fort: File No. 7549-00-13950

10/26/95

verify:
- pump in ground storage
- pump(s) @ water treatment
- water vault photos.
- wells - submers or vert. turbine
- ~~ϕ~~ computer tape
- water map? on site map.
- Copy of screens of Joe's program.
- need John's map(s)



1 MG
TANK 3
WELLS
WATER PLANT
TANK 1
N
750,000 gal
100
100
2
3 pumps
DANC
750000 gal

MJS
(10)

10/26/95 Joe Ogiba 8:00.

- DANC facility is the primary source to fill Tank 1 & Tank
- Ft. Drum facility doesn't have any pumps except at wells.
- Ft. Drums pumps were on all the time before DANC
- Before DANC, not all troops here. The troop ~~foot~~ numbers grew over years.
- Sequencing of wells is based on setpoint which is variable, day to day - this is automatic.

★ - John has operating hours of wells - monthly.
- There are 2 pumps @ 750,000 gal reservoir. 75hp. is a volume pump that hasn't run. 35hp is workhorse
- reservoir is a balancing tool for chlorine and emergency storage.
Joe will get an average week pumping - summer
" " " - winter
for 35 hp motor.
- Headquarters & parade fields are only irrigated areas. People are using sprinklers @ family housing June-Sep
- No prior water studies that Joe has found.

M.S

(11)

10/26/95 before mtg w/ John Kerr 10:15

✓ - Verify wells. - submersible pumps - vert turbines were orig. control valve.

✓ - get into reservoir for nameplate data; & Vault

✓ - get info for operating of hours for wells.

- estimated hrs. sprinkling ath fields. - Frank may know

- Stop by fire dept to get fire flow info.

- how often xr size fire hyd's? - 3yrs for old post all hydrants

✓ - Chlorine usage figures? DANC vs. Drum.

- air conditioners use water once through. - HVAC shop

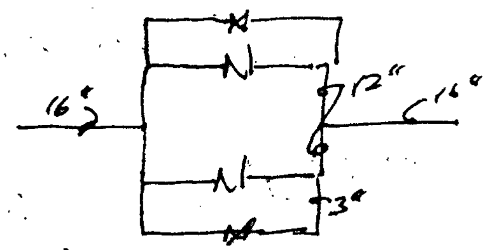
Ed Roar is supervisor

- get elec. file of map.

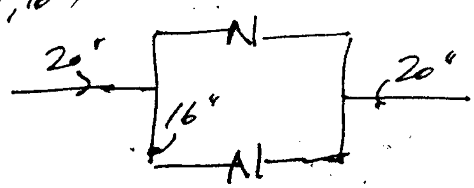
✓ - ask John about maps.

10/26/95 John Kerr 3pm

Control valve vaults:



16" vault - 3" bypass lines are there for low flow. When higher flow, control valves (12", 16") open.



10/26 w/ Bob Bellinger

LZA did master plan work. He has gas & water drawings. Lev Zetlin, New York New York. 641 Ave of Americas

10/27/95 Joe Ogiba.

3.5772 9613 (fax)

Field Survey Notes - Ft. Drum Water Study ①

Joe Ozyiba (315) 772-3322

Ft. Drum Water Conservation Study

Items needed:

- Cost of water, electricity, utilities (2 yrs)
- Amount of water consumed (meter data)
- Identification of potable water system.
- " of " " usage:
  - Population data
  - Fire hydrant usage
  - Industrial uses
  - Irrigation, landscaping

- Pump nameplate data, operating hours
- Prior studies
- Future plans, mission statement

- Hold to report prep. described in SOW?

Kickoff Meeting 10-24-95

- Scholz - Explains SOW. Leak detection survey, methods of energy conservation regarding water system, LCCA, cost estimates. Provide interim submittal, review, final submittal, programming documentation. (Basis of fee)

- Simpson - Explains leak detection. Uses leak correlator. Listens to pipe - times sound that travels from point to point. Listen to all valves, hydrants in all distribution system.

TCP

(2)

Verify noise areas twice. Use microprocessor to check pipe type, size, material, define precise location of leak. Go in and estimate amount of leakage. Ever find leakage from other pipes? Very seldom. Usually must be touching.

How to estimate water leakage? Best way is to excavate. Look at design pumping vs. actual. Look at pipe pressure, type to estimate leakage rate.

How to estimate water usage - End usage; water audit.

5

- Simpson - Will work now until November 8-10. Except Sundays. Rules, regs to follow while on post? Any off limits parts of post. Need regular on-post personnel POC? Joe Ogibe - POC.

- Very sensitive of photos. Hydrants, excavations leaks.

- Bldg. T-213 - Used to store equipment, can use as base.

TCL.
(3)

Kickoff Meeting 10/24 (cont)

- Center - Would like to remove SOW regarding on cathodic protection for this water project.

- Review basis of fee for Joe Ogston
Look for problems - stagnation lines.

- SOW reviews entire post. Problems w/ stagnation have been in new post.

- New post was built 6-~~8~~ yrs. ago. New lines - Frank Coburn, John Kle~~...~~.
Plumbing shop POC.

- Tele-monitoring system - Have 3½ yrs. of data available - Lotus compatible.
Every thing is controlled - 9 sites - master unit. Have 11 wells. + commerical source (charged for 1.5 mgd) - Avg. monthly.
Subsidizing w/ 2200 gpm with well.
Can pull up to 4800 gpm - commercial.
Electronic interface with well pumps.
Interface w/ commercial source - above ground tank. Can provide electronic copy of data.

- Stagnation line - Keep water moving. Recirculating water back to plant. Getting bacteria in places w/ high chlorine. Sporatic in places.
Did take samples on bacteria this summer - no results - think results are inconclusive

TCP
(4)

Circ. lines ECOs

- Financial justification for stagnation - Amount to flush + disinfect lines - they have data. Do have problems in housing area.

- Summer drought - 1/50 of avg. rainfall this year.

(From Black Watrives) DANC. Development Authority of North Country

- City water - bacteria free? Buying water from Watertown. Sewage goes straight to Watertown. Water from Watertown - surface water. Runs through pipe - 1 day turnover. Do have problems w/ surface water - particulates.

5

- There are 3 tanks (1-2 old area - 250,000 gal)
Tank 3 - 1 million gal. - new area.
Tank 1 turns over quickly 92-82 ft.)
Tank 2 is not being used.
Have 750,000 gal. below ground reservoir.
Used as well - pump into that reservoir
high turnover. 250,000 gal/day.

1.5 ppm chlorine (free)

- Site furthest away - Sewage pumping station (no use) - 0.2 - 0.4 ppm chlorine.

- Old piping in old area. Not as much usage to circulate enough water to keep residuals down.

TCP
(5)

- Request future mission statement. Approx. 20,000 people on-post (avg.) Will get last year's population data. [redacted]

- Many water main breaks - Couple during the spring (mainly) - Problems with old pipe, new pipe on rocks.

- Working pressure - 90 psi - Tank #1
125 psi - Tank 3 (new area).

- FEMP has separate category for water conservation. Not as stringent. Not as high competition for water projects. Do not have to compete w/ energy conservation programs for funding.

ECOs
- Fix nuisance leaks as ECO - 24 to 50 ~~gpd~~ leaks.
- " stagnation problems - circ pumps, lines
- Upgrade tele-metering. (Tanks overflowing)

- Telemetering - May have leaks in well field. Joe is trying to reduce un-accounted for water. (Avg. 450 gpm)

X
- Do have some domestic water for once-through cooling - condensers. Need to look.

TCP ⑥

- Prefer red-line mark ups of water line system maps.

- Steve thinks this is one-time study. Water audit should be put in report.

- ECO - improve meter system to determine unrecovered leakage. System (radio) prints report once a day.

- Chlorine injection now based on flow (23 chlorine/PH analyzers - 2-3 installed) ① will automate water system.

② Don't want to wait for problems. System allows for proactive maintenance

- System (water) - 3 yrs old. In process of putting on gas, electric, other systems.

Old Area - bldgs. are deactivated for winter. Have stagnation problems.

Overflow tanks put 2-3 hrs/yr. to skim top surface of tanks.

Off peak pumping?

Shut well field down on weekend, saves operating time. Turns off on Sat. 8 am - Mon 8 am. Use DANC water during weekend. Weekend is highest use - Sunday.

TCP

(7)

- Wells turn on based on feet. (of tank height) Wells are rotated by operating hours. Longest operating hours are turned off first. Are some wells that are turned on all the time (except weekends).

- Pay for 1.5 mgd - avg. over month (Demand type rate) Can pump up to 3 mgd from DANC. DANC pumping station - 4 yrs old.

- Telemetry system - Bristol Babcock - very reliable UPS system - 20 hrs. for power outage.

- At 8 am. they can change well setpoints based on tank height and water daily usage.

- Use one well continuously for chlorine, but switch well use around (about weekly).

- Telemetry system = $6500 - 7500 per unit. Payback about 4 years.

- Troop movements - don't change water usage. Wives still here.
  Summer - 2.2 - 2.4 mgd (avg.)
  Winter - 1.6 - 1.8 mgd "

- Don't use 1.5 mgd always from DANC because they keep well on for chlorination. They pay for 1.5 mgd regardless.

TCP
(3)

- Two chlorine injection pump. Pump 1 is on even numbered months; pump 2 on odd-numbered pump.

- Only manual operation - change chlorine filter cylinder (about once a week).

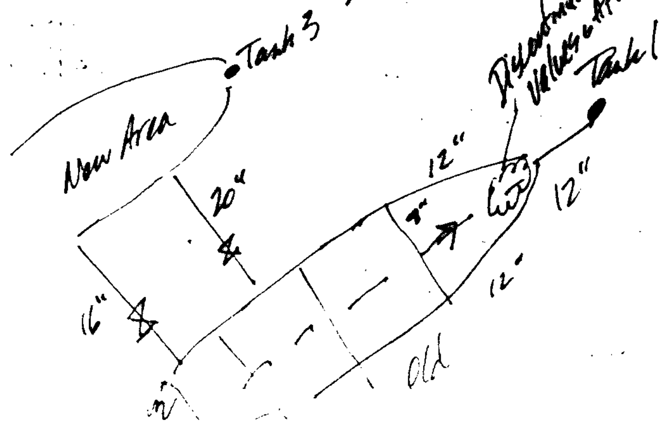
- Very good water quality outside of wells. DANC water is surface water - not good as quality.

5

John ~~[illegible]~~ Kerr -
Water lines - Ductile iron, PVC (Housing) New
" " - ~~cast~~ iron, isolated transite, cement piping. (Old section).

Took transite out of service - left them abandoned.
Some bldgs. removed (old) - capped lines.
Dwgs. File 92-118 "Replacement of Transite Water Pipe"
Areas 300, 400, 500, 600, 2200.

Airfield has separate fire protection system.
So also have potable water system.



TCP
(9)

ECD

- Would like to create two small projects to finish valve connection to 16" line and valve to 8500 Area. Everything is ready to go but needs to be fine-tuned (manually).

- Fine-tuning - with one man at Tank 3, one or two at valve 16" and one or two at 8500 PRV, one other person to see pressure. (Would take three guys about two weeks. to do one valve at time.)

- Could add RTU (remote sensing unit) to 8500 unit - all set up to do it.

ECD

- look at replacing discontinuity near Tank 1. All 3-12" flowing to meet demand in 16"-20". But is feeding a 12" manifold - could make 12" manifold larger to feed all 12". However, it might fix hydraulic problem to new area, but wouldn't fix chlorine stag. - problem to 8500 Area. (that is priority)

- Lines shut down - Oswego from Lerangeville Road - about 1200 LF. All mains should be ~~shut down~~ pressurized.

- Have (low chlorine residuals) bacteria growth in 9600 Area. Couldn't verify any cross connection. Housing will not have any backflow preventers, unless their heater.

TCP (10)

- Never have problems with low pressure in distribution systems.

Fire Station 10-24-95
- Fire hydrants are exercised as requested. Use hydrants for usage, not for mission.

- Maintenance shops will open hydrants for maintenance

5

For 10/24:
- Question: DANC facility - Does Ft. Drum pay for electrical pump usage on top of 1.5 mgd. water charge.

- Need drawings of new Ft. Drum.
- Nameplate data - 11 wells, water treatment plants, DANC facility
- Video of control valves (16")

10/25 Tom Ferguson
- High capacity, low demand in system
- Change in quality of water since gone to DANC (surface water worse than well water). PH changes probably corrosion problems with pipe reactions.

Projects: ① Non-peak pumping, ② lower usage from DANC to 1.5 mgd usage.
③ Optimize PH with optimum chlorine levels.

TYP

(9)

* Does SOW include raw water transmission lines from well fields? Will check with M.G. Simpson.

- 3-4 yrs. ago removed transite piping. (poor condition (50 yrs)) Replaced with cement lined ductile iron. Had some asbestos traces in water. Also abandoned in place some of transite pipe. Use PVC on residual areas, smaller diameter.

- Non-peak pumping - lower tanks, use wells during peak times. High storage capacity in system.

- Unrecoverable ~~data~~ water - Approx. 400-600 gpd assumed (Joe)

* Emergency Response Plan written, Total Army Quality Self Assessment - Information regarding mission statement.

- Have had trouble with biofilm contamination (slime covered pipe) throughout base. with State health Bacteria had resistance to chlorine.

- Water from Watertown - Acidic
  " " wells - Basic (High chlorine)

* Low chlorine demand for well water, good quality. Use more well water in summer than in winter.

TCA
(12)

- low usage in winter (1.8 mgd) use mostly DANC water.

- At 1.5 mgd level for DANC the optimum level to be at for Ft. Drum.

- May have more flexibility in future. Capital expenditures are getting paid off. O+M Expenditures would be less.

- Can pump more water (Have new well that could pump 700-800 gpm with no problem but would need to connect piping and electrical to it (only well is drilled) without having to use more water from DANC.

- Base recommendations for water use/DANC on what is good for Army, let them worry about political issues w/ using DANC water.

- Piping is buried 3-5' in ground. Have HTHW 350°F, 500 psi, 2" mineral wool. that runs parallel to domestic water. May warm DW. May be some physical connection. Heat may be promoting bacteria growth combined with low flow in system.

- low flow rates - moderate temps. HTHW Buried in Ricwil system, supply + return buried in same 12" conduit.

F/G - Franklin Motor/Gould Pumps

TCI

(13)

Well Nameplate Data - Plumbing Shop

Well #1: US Motor SN 234474
20 HP, Layne Pump Type DRHC
Not operating 12/10/87, pump worn out

(F/G) Well #2: 40 HP submersible (Dwg) - 2/82 (Sumo pump) 8JL? -6"

Well #3: 20 HP Franklin submersible with (7/78)
Goulds pump 5-stage. and 75 KW Generator
Cummings - Mohawk. (Model 2361059006 motor)

Well 4,5 - Sumo Submersible 40 HP w/Goulds (7/78)
pump, 3 stages, 100 KW Generator - Cummings/
Mohawk

Well 15 HP 10/83 dwg.

(F/G) Well 6 - 15 HP submersible pump (2/82) (Base bid)
SN 150H156632

(F/G) Well 7 - " " " (2/82) "
SN 150H156632

Well 8 - " " " (10/83) "

(F/G) Well 9 - 20 HP " " (2/82) "
SN 225H206632

(F/G) Well 10 - 25 HP " " (2/82) "
SN 225H256632

Well 11 - 40 HP Franklin submersible with Goulds
pump, 3 stages (Motor Model 2391006102)
Well 12 - 30 HP Franklin submersible with Goulds
pump, 3 stages. (Motor Model 2361179006)

TCP.
(14)

Joe Ojiba - 10/26

8 am Operating sequence:

Major sources of water: ① DANC facility
② Well pumps

Well pumps are turned on one at a time based on height of tank. Wells (additional) are brought on line as more water (feet) are lost out of tank. Which well comes on depends on operating hours of well pumps. Lowest operating hours well comes on first and goes off last.

They change setpoints of tank levels all the time to balance usage with DANC water. (Setpoint higher turns on wells faster to use more well water, lower uses less.)

* Get operating hours of wells from John Kerr.

→ Consumption also dependent upon heads - changes dependent upon season.

Reservoir Pumps

2 pumps - 35 HP, 75 HP (never used) 75HP is volume pump but has never been used.

C.V. automatically controlled to open/closed

One for low pressure, one for system pressure (but not used)

TH

(15)

- 35 HP pump turns on when first well comes on to exchange 150,000-200,000 gal. out of ~~tank~~ reservoir. Helps to improve chlorine residual. Pumps into the system. Tank is for emergency use.

- Reservoir - Can not go below 6' level (10' full) for contingency for system.

* RCT
- Operating hours are available in database. Requested from Joe to look at operating hours of 35 HP - look at one week in summer, one in winter - extrapolate total energy usage.

- Irrigation: Headquarters, parade fields, football fields. Water - end of June, to mid-Sept. Headquarters - 16-20 hrs/day.

*
- Ask about irrigation uses in parade grounds. (John)

- Electric charges: $3,172 customer charge (min payment)
  Demand KW: $7.02
  On Peak KWH: $0.06196
  Off Peak KWH: $0.05197
  Reactive Kilovolt Ampere (RKVA)

[illegible] Greer
Utility Specialist
772-4151

Bundled prices: $0.072 / $0.075/KWH includes all KW, KWH prices - what Ft. Drum pays.

TCP
(16)

John Kerr 11am

Submersible pumps were replaced from 1980 on. All vertical turbines have been removed.

John Kerr 3pm

Control Valves - 16"

- Has two main 12" lines and two 3" bypass lines. 3" bypass used when low flow.
- John would like to alternate 16" - 20" line every month. Would like to alternate two lines upon same pit every 2 weeks.
- 20" vault: 2- 16" lines, no bypass.

- Have procured the FM and hardwire connection to vault. Material cost has already been taken care of. Would only require labor manhours to connect it to T-4000 (master)

- Plumbing shop in monitoring station is slave to T-4000 master station.

Fire Dept. 2:30pm 4131 Supervision

- Water treatment plant - May have info. on fire hydrant testing. 24515

- Hydrants in older area - 65-75psi
  " " newer - 45-50psi

TCP

(17)

Ed Rohr - HVAC Shop

- Once-through cooling units: 2-3 ton units are water cooled. Also 10 ton unit. Also some refrigeration units.

- Estimates operates 4 months/year. Use about 100 gpd (10 ton unit). 3 ton unit uses 50-60 gpd. Walk-in coolers (4) - 1 ton units total of 100 gpd.

- Use of water cooled - don't have space to install air cooled condenser. Don't recommend changing.

- Also have unit at refrig. plant - Evaporative cooling condenser (summer - water cooled, winter - air cooled) Unit probably uses 100-200 gpd.

- Very little maintenance problems with water cooled system.

* - Water usage for make-up water for heating steam boilers. Several hundreds of boilers - closed systems - use little water, but several units.

TCP
(18)

10/27
10am

Central Wash Facility

- There are two facilities that use recycled water from ponds. Once water in wash bay depletes levels in ponds or becomes poor quality, they will replenish or replace the water in ponds. No meters on usage - depends greatly on number of factors (troops needs, weather, etc). Joe will investigate usage.

w/potable water →

→ Joe Ogilvie - Fax (315) 772-9613

10/28 Additional Questions:

- Location of previous water main breaks? Bad sections
- Schedule - Notice to Proceed?

10/

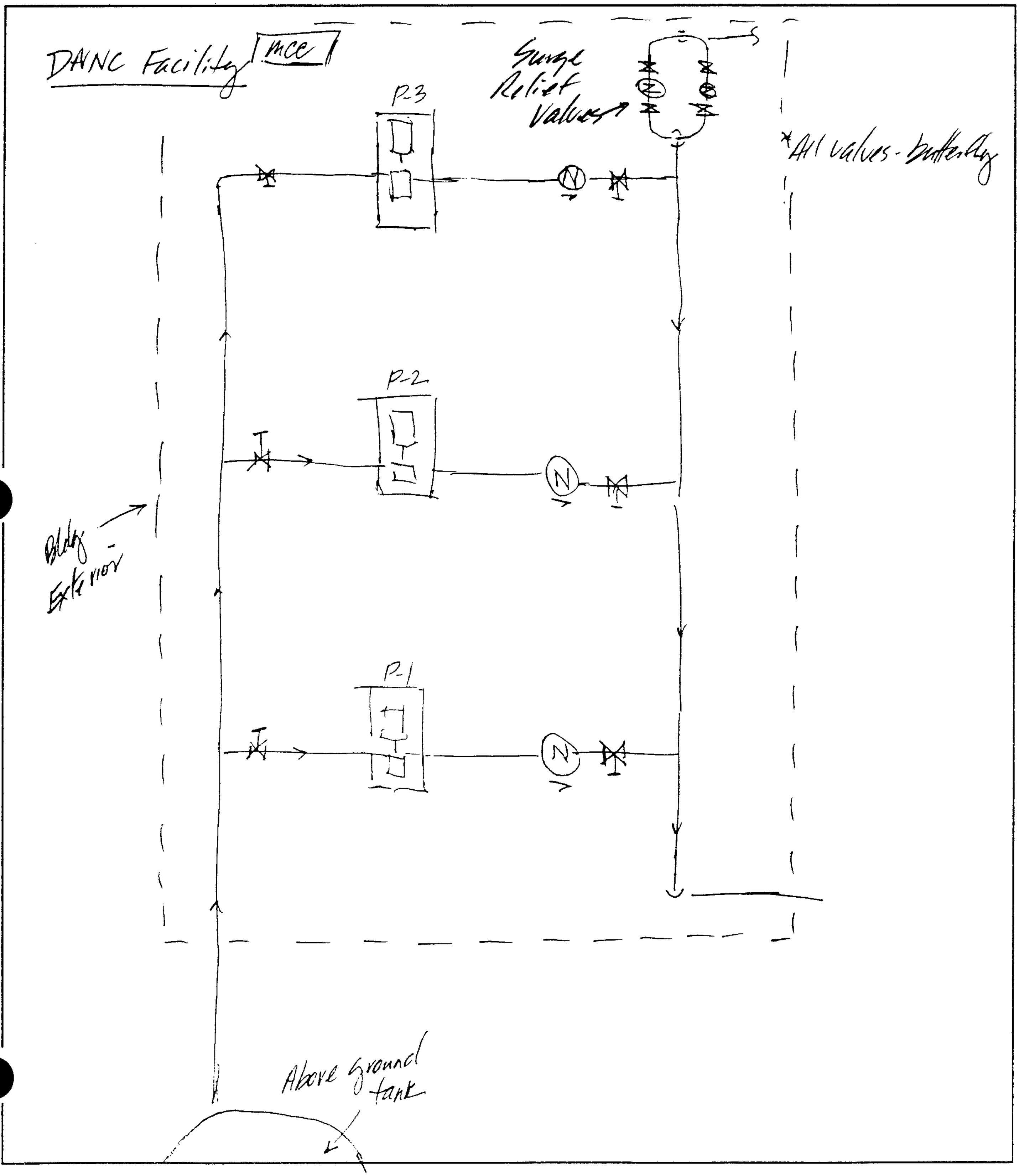
10/
1

11
3

10
5

E M C ENGINEERS, INC.
2750 S. Wadsworth Blvd.
Suite C-200
Denver, CO 80227
(303) 988-2951
9755 Dogwood Rd.
Suite 220
Roswell, GA 30075
(404) 642-1864

JOB Ft. Drum Water Study 1406-012
SHEET NO. 1 OF 5
CALCULATED BY TCP DATE 10-25-95
CHECKED BY ________ DATE ________
SCALE Field Survey



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9755 Dogwood Rd. Suite 220 Roswell, GA 30075 (404) 642-1864

JOB Ft. Drum Water Study
SHEET NO. 2 OF 5
CALCULATED BY TGP DATE 10-25-95
CHECKED BY DATE
SCALE Field Survey

DANC Facility Booster Pump Station #2

Motor #1: US Electrical Motor
ID# 640881/T11T2180197R-1
150 HP, 460V, 169A, 3ϕ/60 hz
Frame: 447T, Type: TE, 1780 rpm
Design B, Code F, SF 1.15, Ins. F.
Nom. Eff. 96.2, F.L. P.F = 86.7, Max KVAR = 22.3
Lower Shaft Brg: 6220-J/C3, Upper: 6313-J/C3

Pump #1: ITT A-C Pump
Size: 10 x 8 x 175
SN: 1-11657-02-1, Type: 8000
2100 gpm, 195' HD, 1785 rpm
Model #150, Imp. = 15", 175 psi
Frame: F-20-E2, Inb. Brg: 6309
Out. Brg = 5308
Installed: 1990

Motor/Pump Typical of (3)

Motor #2: US Motor
ID# 640881/T11T2180197R-2

Pump #2: ITT A-C Pump
SN 1-11657-02-2

Motor #3: US Motor
ID# 64088/T11T2180197R-3
Operating at 90 psi

Pump #3: ITT A-C Pump
SN 1-11657-02-3

Pump has altitude (check) valve on discharge piping which senses differential pressure between suction side and discharge. Pump pushes against same pressure regardless of tank height. Pump independently of distribution pressures.

BPS #1 is off-post, operated by DANC, to fill tank.

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(404) 642-1864

JOB Ft. Drum Water Study
SHEET NO 3 OF 5
CALCULATED BY TCP DATE 10-25-95
CHECKED BY ______ DATE ______
SCALE Field Survey

DANC Facility BPS #2 - System Parameters

Suction/Pressure Chart

- Discharge Pressure - 90 psi (±2 psi) Pump running
  0 psi " off
- Suction Pressure - 7-15 psi (depending on tank level)

Flow Chart

- 2.0 - 4.1 MGD w/one pump running
- 4.0 - 6.0 MGD w/two " "

Tank Level Chart

- 16'-31' - normal operation
- 32.5' - overflow level + alarm
- 31' - BPS #1 pumps off
- 16' - " " on
- 15' - low tank level + alarm
- 14' - BPS #1 both pumps run

Chlorine Analyzer

- 0.85 ppm - low chlorine residual alarm
- 0.8 ppm - turns chlorine system on
- 2.0 ppm - " " " off
- 4.0 ppm - high chlorine residual alarm

These are current figures.

BPS #2 - 3 pumps

BPS #2 [illegible] [illegible]

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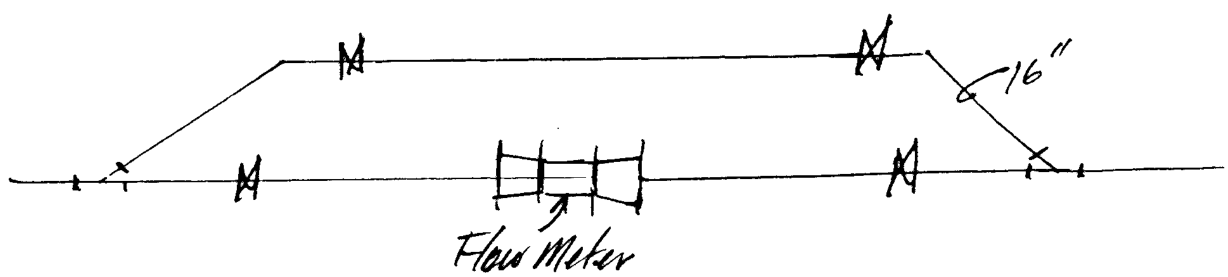
JOB Ft. Drum Water Study
SHEET NO. 4 OF 5
CALCULATED BY TCP DATE 10-25-95
CHECKED BY DATE
SCALE Field Survey

Water Treatment Plant

- Pump #1: General Electric Model # 5K184AL 217D
  5HP, 230/460V, 14/7 A, 1725 rpm, 3ϕ/60hz
  Frame: 184T, B Ins., Design B, SF 1.15
  Brg. 30BC02XP, Inner: 25BC02XP
  Typical of 2 pumps (100psi)
- Brooks-Mag Magnetic Flow Meter
  Model # 7508C1A2C1 AAAA, SN 9401-34973-1-1
  K-Factor: 108.157 ppg, 285 psi, 1.965 MPa Max Press.
  185°F Max temp.

Elevation



Plan:

E M C ENGINEERS, INC.
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JOB Ft. Drum Water Study
SHEET NO. 5 OF 5
CALCULATED BY TCP DATE 10-26-95
CHECKED BY DATE
SCALE Field Survey

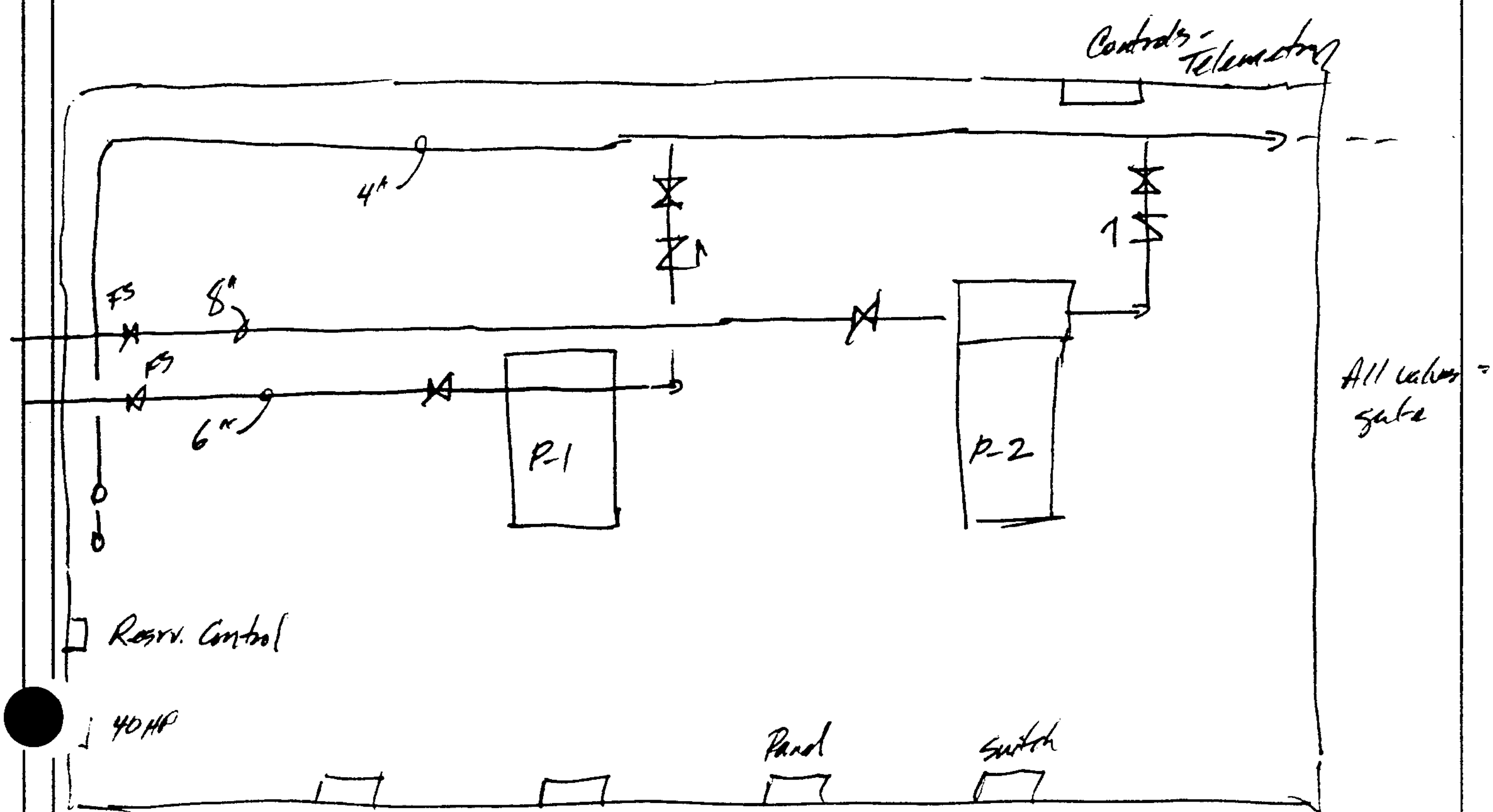
Reservoir Pumps

Pump #1: Westinghouse Electric Style 1077328
SN 542

40 HP, 220/440 V, 97.3/48.6 A, 1760 rpm, 3ϕ/60hz
Dayton-Dowd pump

Pump #2: Louis Allis Co. # 564460

75 HP, 220/440 V, 190/95A, 1770 rpm, 3ϕ/60hz
Frame: 505S, Type FX, Class 2A



THE PUMP IN THIS WELL IS POWERED
BY A FRANKLIN SUBMERSIBLE MOTOR

MODEL 2361176010 HP 30 PH 3
VOLTS 460/380 RPM 3450/2875 HZ 60/50
MAX AMPS 46.0/50.3 CONTINUOUS DUTY
SF 1.15/1.00 KVA CODE J/G
MIN FLOW FT/SEC 0.5

Franklin Electric
Bluffton, Indiana 46714

THE PUMP IN THIS WELL IS POWERED
BY A FRANKLIN SUBMERSIBLE MOTOR

MODEL 2361056010 HP 20 PH 3
VOLTS 230 RPM 3450 HZ 60
MAX AMPS 61.0 CONTINUOUS DUTY
SF 1.15 KVA CODE J
MIN FLOW FT/SEC 0.5

Franklin Electric
Bluffton, Indiana 46714

THE PUMP IN THIS WELL IS POWERED
BY A FRANKLIN SUBMERSIBLE MOTOR

MODEL 2361186010 HP 40 PH 3
VOLTS 460/380 RPM 3450/2875 HZ 60/50
MAX AMPS 60.0/64.1 CONTINUOUS DUTY
SF 1.15/1.00 KVA CODE J/H
MIN FLOW FT/SEC 0.5

Franklin Electric
Bluffton, Indiana 46714

	Well No. 2	Well No. 4	Well No. 6	Well No. 7	Well No. 8	Well No. 9	Well No. 10
Existing Pump Motor Horsepower	40	15	15	25 15	15	20	25
Pump capacity, g.p.m. at total head	440	80	130	255 160	80	200	230
Discharge Pressure at top of well, lbs.	95	65	75	75	90	80	125
Well casing I.D., in.	18x8	18x10	18x10	12	18x10	18x10x8	18x10
Datum elevation (floor)	612.99	684.50	684.26	672.60	670.22	649.67	593.11
Static Water Elevation, ft.	$602^{\pm}$	$642^{\pm}$	$642^{\pm}$	--	$633^{\pm}$	$590^{\pm}$	--
Existing Pump Setting, ft.	$44^{\pm}$	$80^{\pm}$	$85^{\pm}$	$85^{\pm}$	$65^{\pm}$	$105^{\pm}$	$40^{\pm}$
Total Depth of Well, ft.	108	90	92	90	76	190	100

Well Pump Motor - Ft. Drum

Well #

2 - 8 JLC 40HP Sumo 6"

6 - 150H156632 15HP Franklin 4"

7 - Same as 6 4"

9 - 225H206632 20HP Franklin 4"

10 - 225H256632 25HP Franklin 4"

All Pumps are Gould

Well Pump Motor – Ft. Drum

	model num	Hp	volts	Date Cod.
#3 –	2361059006 –	20 –	230	Dec M79
	Subtrol –	40 –	460/380	Jan J80
#11 –	2391006102 none –	30 –	460/380	Nov L.79
#12 –	2361179006 –			

FIRMS HYDRANT CARD

FT DRUM FIRE DEPARTMENT

October 26, 1995

Hydrant number : 8506
District : 00
Location : JACKSON LOOP 8548
Make : WATEROUS
Thread type : S
Available water : 0 as of / /
Class : RED

Inspection month : 05
Aux pumps : NO
Out of service : NO
Date out : / /
Corr factor : 0.90
Add Corr factor : 1.00
Card marked :

DATE	TIME	TESTED BY	PORT SIZE	STAT PRES	RES PRES	GPM	REMARK CODES
5/20/93	15:12	ASHLINE	2.50	60	40	1061	
/ /	:		0.00	0	0	0	
/ /	:		0.00	0	0	0	
/ /	:		0.00	0	0	0	
/ /	:		0.00	0	0	0	
/ /	:		0.00	0	0	0	
/ /	:		0.00	0	0	0	
/ /	:		0.00	0	0	0	
/ /	:		0.00	0	0	0	
/ /	:		0.00	0	0	0	

FIRMS HYDRANT CARD

FT DRUM FIRE DEPARTMENT

October 26, 1995

Hydrant number : 8004
District : 00
Location : GEN GRANT DR. 8005
Make : WATEROUS
Thread type : S
Available water : 0 as of / /
Class : RED

Inspection month : 05
Aux pumps : NO
Out of service : NO
Date out : / /
Corr factor : 0.90
Add Corr factor : 1.00
Card marked :

DATE	TIME	TESTED BY	PORT SIZE	STAT PRES	RES PRES	GPM	REMARK CODES
5/20/93	13:28	ASHLINE	2.50	84	48	1163	
/ /	:		0.00	0	0	0	
/ /	:		0.00	0	0	0	
/ /	:		0.00	0	0	0	
/ /	:		0.00	0	0	0	
/ /	:		0.00	0	0	0	
/ /	:		0.00	0	0	0	
/ /	:		0.00	0	0	0	
/ /	:		0.00	0	0	0	
/ /	:		0.00	0	0	0	

FORT DRUM'S WATER USAGE

	DANC WATER	WELL WATER	TOTAL WATER GALLONS	GALS PER DAY	% OF WATER PURCHASED	% OF WELL WATER
OCT 93	43,488,630	15,313,635	58,802,265	1,896,847	73.96%	26.04%
NOV 93	42,813,663	9,806,692	52,620,355	1,754,012	81.36%	18.64%
DEC 93	46,743,913	11,572,348	58,316,261	1,881,170	80.16%	19.84%
JAN 94	46,503,684	15,353,848	61,857,532	1,995,404	75.18%	24.82%
FEB 94	41,222,663	10,786,765	52,009,428	1,857,480	79.26%	20.74%
MAR 94	46,726,426	15,474,860	62,201,286	2,006,493	75.12%	24.88%
APR 94	41,829,710	7,526,368	49,356,078	1,645,203	84.75%	15.25%
MAY 94	45,029,906	11,867,234	56,897,140	1,835,392	79.14%	20.86%
JUN 94	44,536,151	21,973,407	66,509,558	2,216,985	66.96%	33.04%
JUL 94	46,427,149	24,059,671	70,486,820	2,273,768	65.87%	34.13%
AUG 94	46,500,721	17,838,670	64,339,391	2,075,464	72.27%	27.73%
SEP 94	40,857,108	11,493,547	52,350,655	1,745,022	78.05%	21.95%
FY 94	532,679,724	173,067,045	705,746,769	1,933.553	75.48%	24.52%
OCT 94	38,856,675	7,094,404	45,951,079	1,482,293	84.56%	15.44%
NOV 94	36,107,144	6,330,919	42,438,063	1,414,602	85.08%	14.92%
DEC 94	46,306,777	7,823,514	54,130,291	1,746,138	85.55%	14.45%
JAN 95	46,471,194	14,400,370	60,871,564	1,963,599	76.34%	23.66%
FEB 95	41,133,980	10,328,010	51,461,990	1,837,928	79.93%	20.07%
MAR 95	46,226,124	9,866,787	56,092,911	1,809,449	82.41%	17.59%
APR 95	46,010,361	7,600,496	53,610,857	1,787,029	85.82%	14.18%
Y 95	47,105,160	17,641,697	64,746,857	2,088,608	72.75%	27.25%
JUN 95	51,915,343	33,108,355	85,023,698	2,834,123	61.06%	38.94%
JUL 95	45,275,548	36,901,399	82,176,947	2,650,869	55.10%	44.90%
AUG 95	45,425,295	32,655,708	78,081,003	2,518,742	58.18%	41.82%
SEP 95	44,865,012	22,623,044	67,488,056	2,249,602	66.48%	33.52%
FY 95	535,698,613	206,374,703	742,073,316	2,033,078	72.19%	27.81%

FORT DRUM

METERED WATER USERS

		FY 94 K GALS	FY 95 METERED
P-10730B	PX	1,623	1,703
P-10720	BURGER KING	389	376
P-10502	SPINNERS	538	557
P-2300	OLD PX	558	599
P-4320	MINI MALL	3,511	3,149
P-11005	N ENTRY MINI MALL	93	80
P-10207	PENNANTS	559	445
P-11110	GAS STATION	55	53
-10730A	COMMISSARY	790	815
4205	INN @ FT DRUM	5,252	5,213
-6000	NJNG	358	307
P-6001	NJNG	345	592
	CREDIT UNION	71	151
P-4515	J.A. JONES	2,366	3.939
P-10762	KEY BANK	95	35

FAX TRANSMISSION

EMC ENGINEERS, INC.
2750 S. Wadsworth Blvd.,
Suite C-200
Denver, CO 80227
303/988-2951 Fax 985-2527

Date: 12 January 1996
Number of pages including cover sheet: 5

Deliver To: Mr. Joe Ogiba
Telemetry Systems Administrator

Fax No: 1 315 772 9613

From: Michael Scholz

EMC No. 1406-012

REMARKS:	☐ Per your request	☒ For your review	☐ FAX only, original will not follow	☒ Please reply

Joe:

[redacted]

We have some questions for your resolution or direction for the evaluation and report we are preparing.

1. When we were at the Post, we inquired about the water usage at the Central Wash Facility (Potable water used to replenish the water cycle). Have you been able to identify the water usage rate for the facility?

2. We would like to know about the water main breaks that have been discovered and fixed under the course of normal maintenance activities in the past two years. Would it be possible to obtain the number of discovered breaks, the size of water main, and, if possible, the location of the water main break?

3. DANC and Ft. Drum Water Rates. In order to calculate the cost of water at Ft. Drum, we are combining a number of factors. Please verify that the attached schedule of rates are correct and if it is appropriate to include with the cost of Ft. Drum's water.

- **Ft. Drum Electrical Charges.** Mr. Gordon Greene in the Utilities Department supplied us with the following charges (attached):

  - Monthly customer charge: $3,172
  - Demand: $7.02/kW
  - On Peak consumption: $0.06196/kWh
  - Off Peak consumption: $0.05197/kWh
  - Reactive Kilovolt-Ampere (RKVA): $1.02
  - Bundled charge: $0.072/kWh (Includes all charges that Ft. Drum pays)

  We were directed to use the bundled charge when calculating electrical consumption.

- **Ft. Drum O&M, Chemical Treatment Charges.** Our records do not include maintenance and chlorine charges incurred by Ft. Drum. Could you please verify those charges for us for the past two years?

- **DANC Water Charges.** According to the schedule you provided (attached), Ft. Drum appears to pay $5.35/kGal for a contracted amount of 1.5 MGD for the period of 4/1/95 to 3/31/96. This charge includes capital, overhead, and O&M charges for both the City of Watertown and DANC. Does Ft. Drum pay for all of these charges or some of them?
- **DANC Electrical Charges.** We were also given a schedule (attached) that gives a estimated cost ($21,500 in FY94) for pumping water from the DANC facility. Does DANC or Ft. Drum pay this cost? Has this cost been updated for FY1995?
- What items make up the DANC O&M charges?
- What items make up the City O&M charges?
- Does Ft. Drum have chlorine costs associated with the DANC water or the DANC facility? Is that included with the DANC O&M charges?

Any help you can provide is appreciated. I hope to talk to you about this next week, or if more convenient, fax back the answers, if possible, before 19 January. (fax 303-985-2527)

Thank you for your help.

Michael J. Scholz

Sincerely,

Sep-95

THE ATTACHED SCHEDULE HAS BEEN PROVIDED BY THE
DEVELOPMENT AUTHORITY OF THE NORTH COUNTRY

SCHEDULE SHOWS THE APPROXIMATE COST OF FORT DRUM'S
.TRACTED WATER.

THIS SCHEDULE WAS DEVELOPED BASED ON FORT DRUM USING 1.5 MGD.

FOR FURTHER INFORMATION REGARDING THIS SCHEDULE, PLEASE CONTACT
GORDON GREENE OR JEAN HUGHES AT 315-772-4951 (FORT DRUM UTILITIES)

****

IN FY 94 AN ESTIMATED 265,000 KWH WAS USED TO PUMP WATER;
ESTIMATED COSTS $21,500.

THIS FIGURE WILL BE REVIEWED AND UPDATED FOR FY 95.

Who pays this cost? Does DANC, Ft. Drum, or is it included in the contracted price for the 1.5 MGD? . . .

Rates effective 15 Sep 93		EFFECTIVE 27 APR 95	
Rate 3A	Customer Charge:	$3,172.00	
	Demand KW:	$7.02	
	On Peak KWH:	$0.06196	
	Off Peak KWH:	$0.05197	
	Refund Credit	0	
	RKVA	$1.02	

Mr. Gordon Crane (Ft. Drum utility office) directed us to use the bundled price of $0.072/KWH, which combines all KW and KWH costs that Ft. Drum pays to the utility.

* Previous schedule, received 10/25/95 from E.T. Dunn

THIS SCHEDULE IS FOR INFORMATIONAL PURPOSES ONLY

Development Authority of the North Country
Water Line - Projected to Completion of Capital Payments
Schedule "A"

Year	City Capital	DANC Capital	DANC Overhead	Combined Capital and Overhead	City O&M	DANC O&M	O&M $/KGal.	Guar. MGD	Total $/KGal.
4/1/91 - 3/31/92	310,694	2,532,806	75,000	2,918,500	159,617	184,880	0.63	1.50	5.98
4/1/92 - 3/31/93	326,817	2,799,108	71,000	3,196,925	176,126	307,211	0.88	1.50	6.72
4/1/93 - 3/31/94	314,049	2,568,159	38,000	2,920,208	217,379	307,685	0.96	1.50	6.29
4/1/94 - 3/31/95	303,960	2,295,832	84,100	2,683,892	200,232	252,007	0.83	1.50	5.73
4/1/95 - 3/31/96	294,727	2,179,970	88,305	2,563,002	210,244	154,960	0.67	1.50	5.35
4/1/96 - 3/31/97	285,030	2,043,125	92,720	2,420,875	220,756	162,708	0.70	1.50	5.12
4/1/97 - 3/31/98	282,610	0	97,356	379,966	231,794	170,843	0.74	1.50	1.43
4/1/98 - 3/31/99	271,576	0	102,224	373,800	243,383	179,386	0.77	1.50	1.45
4/1/99 - 3/31/00	256,182	0	107,335	363,517	255,552	188,355	0.81	1.50	1.47
4/1/00 - 3/31/01	247,212	0	112,702	359,914	268,330	197,773	0.85	1.50	1.51
4/1/01 - 3/31/02	237,709	0	118,337	356,046	281,747	207,661	0.89	1.50	1.54
4/1/02 - 3/31/03	233,057	0	124,254	357,311	295,834	218,044	0.94	1.50	1.59
4/1/03 - 3/31/04	220,004	0	130,467	350,471	310,626	228,947	0.99	1.50	1.63
4/1/04 - 3/31/05	209,687	0	136,990	346,677	326,157	240,394	1.03	1.50	1.67
4/1/05 - 3/31/06	199,776	0	143,840	343,616	342,465	252,414	1.09	1.50	1.71
4/1/06 - 3/31/07	189,519	0	151,032	340,551	359,588	265,034	1.14	1.50	1.76
4/1/07 - 3/31/08	159,063	0	158,583	317,646	377,567	278,286	1.20	1.50	1.78
4/1/08 - 3/31/09	150,285	0	166,512	316,797	396,446	292,200	1.26	1.50	1.84
4/1/09 - 3/31/10	91,496	0	174,838	266,334	416,268	306,810	1.32	1.50	1.81
4/1/10 - 3/31/11	68,386	0	183,580	251,966	437,081	322,151	1.39	1.50	1.85
4/1/11 - 3/31/12	35,921	0	192,759	228,680	458,935	338,258	1.46	1.50	1.87
4/1/12 - 3/31/13	0	0	202,397	202,397	481,882	355,171	1.53	1.50	1.90

DANC Capital and City of Watertown Capital are stated at actual based on amortization schedules as of April 1, 1994.
City O&M, DANC O&M and DANC Overhead each reflect a 5% increase per year beginning in FYE 3/31/96.

THIS SCHEDULE IS FOR INFORMATIONAL PURPOSES ONLY c: Tom Poeling

FAX PW PUBLIC WORKS FORT DRUM, NEW YORK HEADER SHEET

DATE: 16 JAN 96

FROM: OPERATIONS & MAINTENANCE DIVISION
PUBLIC WORKS
85 FIRST STREET WEST
FORT DRUM NY 13602-5097

Joseph Ogiba

TELEPHONE NO.: (315) 772- 3322
FACSIMILE NO.: (315) 772-9613
DSN: 341-

TO: Michael Scholz

TELEPHONE #: (303) 988-2951
FAX #: (303) 985-2527
NUMBER OF PAGES(INCL.HEADER SHEET) 2

MESSAGE: Mike, A more accurate "Sched. A" is attached. 1 MAY 96 we will have an update. Other info is forth coming.

Joe

SENT: DATE ____ TIME ____ INITIALS ____

Development Authority of the North Country
Water Line
Schedule "A"

Year	City Capital	DANC Capital	DANC Overhead	Combined Capital and Overhead	City O&M	DANC O&M	O&M /KGal.	Guar. MOD	Total /KGal.
4/1/91 - 3/31/92	316,496	2,532,005	75,000	2,918,500	159,317	184,020	0.63	1.50	3.96
4/1/92 - 3/31/93	328,817	2,799,105	71,000	3,198,923	176,126	307,211	0.68	1.50	6.72
4/1/93 - 3/31/94	314,049	2,568,159	38,000	2,920,208	217,379	307,685	0.56	1.50	6.29
4/1/94 - 3/31/95	314,049	2,295,832	81,100	2,693,981	217,379	252,007	0.86	1.50	5.78
4/1/95 - 3/31/96	314,049	2,632,303	86,205	3,032,557	322,073	167,451	0.71	1.50	6.25
4/1/96 - 3/31/97	314,049	1,535,136	88,350	1,937,563	228,364	171,637	0.73	1.50	6.27
4/1/97 - 3/31/98	314,049	0	90,567	404,616	234,093	175,028	0.75	1.50	1.49
4/1/98 - 3/31/99	314,049	0	92,831	406,880	239,946	180,326	0.77	1.50	1.51
4/1/99 - 3/31/00	314,049	0	95,151	409,201	245,944	184,835	0.79	1.50	1.53
4/1/00 - 3/31/01	314,049	0	97,530	411,579	252,093	189,455	0.81	1.50	1.56
4/1/01 - 3/31/02	314,049	0	99,968	414,015	258,395	194,192	0.83	1.50	1.58
4/1/02 - 3/31/03	314,049	0	102,468	416,517	264,855	199,047	0.85	1.50	1.61
4/1/03 - 3/31/04	314,049	0	105,029	419,079	271,477	204,023	0.87	1.50	1.63
4/1/04 - 3/31/05	314,049	0	107,655	421,704	278,263	209,123	0.89	1.50	1.66
4/1/05 - 3/31/06	314,049	0	110,346	424,395	285,220	214,351	0.91	1.50	1.69
4/1/06 - 3/31/07	314,049	0	113,105	427,156	292,351	219,710	0.94	1.50	1.72
4/1/07 - 3/31/08	314,049	0	115,933	429,982	299,659	225,203	0.96	1.50	1.74
4/1/08 - 3/31/09	266,661	0	118,831	385,492	307,151	230,833	0.98	1.50	1.67
4/1/09 - 3/31/10	180,434	0	121,802	302,238	314,833	236,604	1.01	1.50	1.56
4/1/10 - 3/31/11	145,235	0	124,847	270,082	322,700	242,519	1.03	1.50	1.53
4/1/11 - 3/31/12	26,076	0	127,968	154,044	330,768	248,582	1.06	1.50	1.36
4/1/12 - 3/31/13	0	0	131,167	131,167	339,037	254,796	1.08	1.50	1.32
4/1/13 - 3/31/14	0	0	134,446	134,446	347,513	261,165	1.11	1.50	1.36

I have estimated the
City Capital Pmts. based
on the issue date of the debt
and current payments.

I have also estimated an
annual increase of 2.5%
on O&M and
DANC Overhead.

THIS SCHEDULE HAS BEEN PREPARED
BY SPECIAL REQUEST. IT MAY BE IN VARIANCE WITH
CURRENT OR FUTURE SCHEDULE A's

FAX HEADER SHEET

PW PUBLIC WORKS
FORT DRUM, NEW YORK

DATE: 26 JAN 95

FROM: OPERATIONS & MAINTENANCE DIVISION
PUBLIC WORKS Joseph Ogiba
85 FIRST STRFET WEST
FORT DRUM NY 13602-5097

TELEPHONE NO.: (315) 772-3322
FACSIMILE NO.: (315) 772-9613
DSN: 341-

TO: Mike Schulz

TELEPHONE #: (303) 988-2951
FAX #: (303) 985-2527
NUMBER OF PAGES(INCL.HEADER SHEET) 6

MESSAGE:

SENT: DATE ____ TIME ____ INITIALS ____

We have some questions for your resolution or direction for the evaluation and report we are preparing.

1. When we were at the Post, we inquired about the water usage at the Central Wash Facility (Potable water used to replenish the water cycle). Have you been able to identify the water usage rate for the facility? Enclosed

No water MAIN breakes.

2. We would like to know about the water main breaks that have been discovered and fixed under the course of normal maintenance activities in the past two years. Would it be possible to obtain the number of discovered breaks, the size of water main, and, if possible, the location of the water main break?

3. **DANC and Ft. Drum Water Rates.** In order to calculate the cost of water at Ft. Drum, we are combining a number of factors. Please verify that the attached schedule of rates are correct and if it is appropriate to include with the cost of Ft. Drum's water.

- Ft. Drum Electrical Charges. Mr. Gordon Greene in the Utilities Department supplied us with the following charges (attached):

  - Monthly customer charge: $3.172
  - Demand: $7.02/kW
  - On Peak consumption: $0.06196/kWh
  - Off Peak consumption: $0.05197/kWh
  - Reactive Kilovolt-Ampere (RKVA): $1.02
  - Bundled charge: $0.072/kWh (Includes all charges that Ft. Drum pays)

  OK

  We were directed to use the bundled charge when calculating electrical consumption.

- Ft. Drum O&M, Chemical Treatment Charges. Our records do not include maintenance and chlorine charges incurred by Ft. Drum. Could you please verify those charges for us for the past two years?

Info will be AVAilable Mon. 29 JAN 96

- DANC Water Charges. According to the schedule you provided (attached), Ft. Drum appears to pay $5.35/kGal for a contracted amount of 1.5 MGD for the period of 4/1/95 to 3/31/96. This charge includes capital, overhead, and O&M charges for both the City of Watertown and DANC. [redacted] Ft. Drum pay for all of these charges [redacted]
- DANC Electrical Charges. We were also given a schedule (attached) that gives a estimated cost ($21,500 in FY94) for pumping water from the DANC facility. Does DANC or Ft. Drum pay this cost? Has this cost been updated for FY1995? Not yet Available.
- What items make up the DANC O&M charges? All O+M incurred in providing Ft. Drum
- What items make up the City O&M charges?
- Does Ft. Drum have chlorine costs associated with the DANC water or the DANC facility? [redacted] included with the DANC O&M charges

Any help you can provide is appreciated. I hope to talk to you about this next week, or if more convenient, fax back the answers, if possible, before 19 January. (fax 303-985-2527)

Thank you for your help,

Michael J. Scholz

Sincerely,

1/31/96 Joe Ozyba 7:40 called him for O&M info. Joe says Ft. Drum O&M is comprized of 3 items. Labor, Equip Rental & Supplies #22,127 FY 1994
#25,655 FY 1995

Just Chlorine # 5,550 and is included in 1995

FAX TRANSMISSION

ENGINEERS, INC.
2750 S. Wadsworth Blvd.,
Suite C-200
Denver, CO 80227
303/988-2951 Fax 985-2527

Date: 31 January 1996

Number of pages including cover sheet: 1

Deliver To:	Mr. Joe Ogiba	From:	Michael Scholz
	Telemetry Systems Administrator		
	Ft. Drum, NY	EMC No.	1406.012
Fax No:	(315) 772-9613		

REMARKS: ☐ Per your request ☐ For your review ☐ FAX only, original will not follow ☒ Please reply

Joe:

I appreciate your response to our inquiry regarding the operation and maintenance costs for the water system at Ft. Drum. I have a few additional questions:

1. We have determined the operating hours for the 40-hp ground reservoir draining pump from the telemetry data. However, I do not have a record of the flow rate of that pump. Do you happen to know the GPMs of the two ground reservoir pumps (40 hp and 75 hp)?
2. The telemetry system tracks the average flow of water consumed on post (included in Datalog #1 as the variable "FLOW" and "FLW2"). I was curious as to how this value is determined and what elements of the post it represents. For example, are the values for the Central Wash Facility that you just sent to us included in these figures? How about the metered water users such as the PX, Burger King, central plant, etc.?

If you can take a few moments to clarify these questions, I would greatly appreciate it. Thanks for all your help.

Sincerely,

MS

Sep-95

Joe:

I appreciate your response to our inquiry regarding the operation and maintenance costs for the water system at Ft. Drum. I have a few additional questions:

1. We have determined the operating hours for the 40-hp ground reservoir draining pump from the telemetry data. However, I do not have a record of the flow rate of that pump. Do you happen to know the GPMs of the two ground reservoir pumps (40 hp and 75 hp)? 450 GPM
2. The telemetry system tracks the average flow of water consumed on post (included in Datalog #1 as the variable "FLOW" and "FLW2"). I was curious as to how this value is determined and what elements of the post it represents. For example, are the values for the Central Wash Facility that you just sent to us included in these figures? How about the metered water users such as the PX, Burger King, central plant, etc.?

If you can take a few moments to clarify these questions, I would greatly appreciate it. Thanks for all your help.

Sincerely,

Flow = All wells + Tank incoming flows minus ~~All~~ Tank + storage mediums increases in gals averaged for the last 15 Min.

Sep-96

Flow 2 = same, only avged for 1 hrs.

LEGEND FOR TELEMETRY DATA VARIABLES

The files on these disks are the past two and one half years of data collectedby Fort Drum's Telemetry system which at this time is monitoring and controlling, mainly, the water system on the post. They are "zipped" using PKZIP and accomodations for hard disk space of 60 MB free space is necessary for all the data.

The remainder of this file attempts to explain the signals in the different data bases that the telemetering system records on the hard drive every five minutes. If there are any questions about this data, call Mr. Joseph Ogiba at (315) 772-3322.

DATALOG 1

"Var" is the variable:

T1LV = Tank 1 level. Located at the water treatment plant.

T2LV = Tank 2 level. Located in the old area on the southern area of the post. No longer in service.

T3LV = Tank 3 level. Located in the new area on the northern area of the post.

WTPF = Water Treatment Plant Flow. GPM output of the water treatment plant

V3V1 = Vault 3 Valve 1. An altitude valve (No. 1) controlled by the telemetering system that fills Tank 3.

DCL2 = Danc Chlorine residual. Chlorine level in ppm of the water as it enters our system from DANC.

DSLS = Danc Start Lead System. The first of two pumps we are able to activate at the Danc pumping station.

DTNK = Danc Tank. Water level at the Danc pumping station.

DFGM = Danc Flow Gallons per Minute. Output flow of water from the Danc pumping station.

DSGS = Danc Start Lag System. The second of two pumps we are able to activate at the Danc pumping station.

RLVL = Reservoir Level. Level of water at the 750,000 gallon emergency reservoir.

RDRN = Reservoir Draining.

RFIL = Reservoir Filling.

V3V2 = Vault 3 Valve 2. An altitude valve (No. 2) controlled by the telemetering system that fills Tank 3.

FPFJ = Fire Pump Facility Jockey pump cycles. Fire Pump Facility Jocky pump cycles (accumulated cycles since 0800 today) with a minimum of 0.00 psi and a maximum of 300.00 psi. The site provides one million gallons of water under "higher than normal" pressure to the sprinkler systems and water cannons in facilities at the new runway area. The Jockey pump is a small pump that keeps the pressure in the system at an acceptable safe level.

FLOW = The average flow of water for the past 15 minutes that has been consumed on post.

FLW2 = The average flow of water for the past 1 hour that has been consumed on post.

DATALOG 2

"Var" is the variable:

ST02 through ST12 are the 11 wells on post that suppliment the water from DANC. This data shows when each pump came on and went off.

ARM1 and ARM2 are alarm signals indicating enterance to the computer room and movement therin.

DATALOG 3

The "Var" is the variable:

DFTL = DANC flow total (for the preceeding day 0800-0800) with a minimum of 0.00 gal. and a max of 3000000 gal.. This is the flow from a commercial source in Watertown.

WTPT = Water treatment plant total (for the preceeding day 0800-0800) with a minimum of 0.00 gal. and a max of 2500000 gal.. This is flow from our wells.

FPFJ = Fire Pump Facility Jocky pump cycles per day (for the preceeding day 0800-0800) with a minimum of 0.00 psi and a maximum of 300.00 psi. The site provides one million gallons of water under "higher than normal" pressure to the sprinkler systems and water cannons in facilities at the new runway area. The Jocky pump is a small pump that keeps the pressure in the system at an acceptable level.

E M C Engineers, Inc.
Water Conservation Study
Ft. Drum, NY

Prepared by: TCP
1/31/96
EMC #1406.012

SUMMARY - DATALOG #1 VALUES

	Date	Reservoir Draining	Reservoir Filling	DANC First Pump Operation	DANC Second Pump Operation	Vault 3, Valve 1 Operation	Vault 3, Valve 2 Operation	Avg. Flow On Post (gal)	
	Aug-93	11,250	8,515	13,760	75	20,955	0	68,157,844	
	Sep-93	13,465	10,325	18,685	0	16,980	0	61,290,794	
	Oct-93	9,975	7,635	17,690	0	8,255	0	59,574,456	
	Nov-93	14,460	10,540	18,720	0	8,250	5	53,432,542	
*	Dec-93	13,136	10,003	18,019	40	6,792	0	50,798,037	
	Jan-94	15,050	10,835	20,870	60	7,900	0	63,543,661	
	Feb-94	13,170	10,050	16,425	150	6,260	15	49,460,309	
	Mar-94	13,705	12,210	21,145	40	7,150	10	63,570,191	
	Apr-94	15,895	14,055	18,300	0	5,900	0	53,618,772	
	May-94	18,545	16,650	20,595	25	17,735	35	56,948,910	
	Jun-94	15,565	13,635	21,150	40	9,405	5	67,565,334	
	Jul-94	15,385	13,400	21,025	20	9,450	15	66,056,844	
	Total (Min.)	169,601	137,853	226,384	450	125,032	85	714,017,694	(gal)
	Total (Hours	2,827	2,298	3,773	8	2,084	1	714,018	(kgal/yr)
	Aug-94	15,700	14,505	22,545	275	9,615	0	65,157,060	
	Sep-94	16,895	14,875	21,410	0	7,285	0	54,783,694	
	Oct-94	18,395	16,250	18,155	50	5,110	0	48,043,852	
**	Nov-94	18,533	16,174	16,464	0	5,297	5	44,843,294	
	Dec-94	15,850	14,370	21,200	125	6,025	0	57,702,973	
	Jan-95	0	300	21,360	110	7,065	0	64,111,233	
	Feb-95	8,375	12,950	18,695	0	6,260	160	55,129,641	
	Mar-95	8,595	14,095	21,125	20	7,235	0	59,888,010	
***	Apr-95	15,895	14,055	18,300	0	5,900	0	53,618,772	
	May-95	9,970	15,945	20,830	100	8,190	0	67,528,936	
	Jun-94	8,200	11,300	21,890	9,675	13,575	0	83,657,862	
	Jul-95	7,690	4,795	19,140	930	16,440	3,135	80,539,244	
	Total (Min.)	144,098	149,614	241,114	11,285	97,997	3,300	735,004,571	(gal)
	Total (Hours	2,402	2,494	4,019	188	1,633	55	735,005	(kgal/yr)
	Avg. (Min.)	156,850	143,734	233,749	5,868	111,515	1,693	724,511,133	(gal)
	Avg. (Hours)	2,614	2,396	3,896	98	1,859	28	724,511	(kgal/yr)

Annual operating hours as recorded by telemetry system.

*Note: Telemetry data was incomplete, covering from December 1 to December 28 (06:28) only. Value was extrapolated.

**Note: Telemetry data was incomplete, covering from November 1 to November 23 (09:48) only. Value was extrapolated.

***Note: Telemetry data received or April 1995 was in unreadable format. Data for April 1994 was substituted.

Water Conservation Study
Ft. Drum, NY

TELEMETERING SYSTEM DATALOG #1 - AUGUST 1993

Time/ Date	Avg. Flow On Post (gpm)	Vault 3 Valve 1 (Tank 3)	Vault 3 Valve 2 (Tank 3)	DANC First Pump Operation	DANC 2nd Pump Operation	Reservoir Draining	Reservoir Filling	DANC Chlorine Residual	
20:58:41	1418.59	1	0	0	0	1	0	5	
21:03:41	1046.75	1	0	0	0	1	0	5	
21:08:41	1046.75	1	0	0	0	1	0	5	
21:13:41	1046.75	1	0	0	0	1	0	5	
21:18:41	1362.25	1	0	0	0	1	0	5	
21:23:41	1362.25	1	0	0	0	1	0	5	
21:28:41	1362.25	1	0	0	0	1	0	5	
21:33:41	895.581	1	0	0	0	1	0	5	
21:38:41	895.581	1	0	0	0	1	0	5	
21:43:41	895.581	1	0	0	0	1	0	5	
21:48:41	1544.42	1	0	0	0	1	0	5	
21:53:41	1544.42	1	0	0	0	1	0	5	
21:58:41	1544.42	1	0	0	0	1	0	5	
22:03:41	1365.36	0	0	0	0	1	0	5	
22:08:41	1365.36	0	0	0	0	1	0	5	
22:13:41	1365.36	0	0	0	0	1	0	5	
22:18:41	1071.93	0	0	0	0	1	0	5	
22:23:41	1071.93	0	0	0	0	1	0	4.984	
22:28:41	1071.93	0	0	0	0	1	0	4.695	
22:33:41	1391.69	0	0	0	0	0	0	4.581	
22:38:41	1391.69	0	0	0	0	0	0	4.329	
22:43:41	1391.69	0	0	0	0	0	0	4.174	
22:48:41	1207.51	0	0	0	0	0	0	4.141	
22:53:41	1207.51	0	0	0	0	0	0	4.02	
22:58:41	1207.51	0	0	0	0	0	0	3.957	
23:03:41	1418.15	0	0	0	0	0	0	3.945	
23:08:41	1418.15	0	0	0	0	0	0	3.986	
23:13:41	1418.15	0	0	0	0	0	0	4.044	
23:18:41	897.191	0	0	0	0	0	0	4.08	
23:23:41	897.191	0	0	0	0	0	0	4.154	
23:28:41	897.191	0	0	0	0	0	1	4.157	
23:33:41	1011.69	0	0	0	0	0	1	4.204	
23:38:41	1011.69	0	0	0	0	0	0	4.29	
23:43:41	1011.69	0	0	0	0	0	0	4.219	
23:48:41	1116.73	0	0	0	0	0	0	4.333	
23:53:41	1116.73	0	0	0	0	0	0	4.386	
23:58:41	1116.73	0	0	0	0	0	0	4.413	
Segments	13,631,569	4,191	0	3,952	15	2,250	1,703	0.744	Min.
Sum (gpm)	4,543,856	-	-	-	-	-	-	5	Max.
(gal) (15x)	68,157,844	-	-	-	-	-	-	2.689	Avg.
Minutes (5x)		20,955	0	19,760	75	11,250	8,515		
Hours		349	0	329	1	188	142		

Water Conservation Study
Ft. Drum, NY

TELEMETERING SYSTEM DATALOG #1 - SEPTEMBER 1993

Time/ Date	Avg. Flow On Post (gpm)	Vault 3 Valve 1 (Tank 3)	Vault 3 Valve 2 (Tank 3)	DANC First Pump Operation	DANC 2nd Pump Operation	Reservoir Draining	Reservoir Filling	DANC Chlorine Residual	
21:33:33	1343.92	0	0	0	0	1	0	4.42	
21:38:33	1343.92	0	0	0	0	1	0	4.353	
21:43:33	1343.92	0	0	0	0	1	0	4.385	
21:48:33	1336.27	0	0	0	0	1	0	4.264	
21:53:33	1336.27	0	0	0	0	1	0	4.322	
21:58:33	1336.27	0	0	0	0	1	0	4.326	
22:03:33	1254.78	0	0	0	0	1	0	4.193	
22:08:33	1254.78	0	0	0	0	1	0	4.188	
22:13:33	1254.78	0	0	0	0	1	0	4.189	
22:18:33	1253.71	0	0	0	0	1	0	4.282	
22:23:33	1253.71	0	0	0	0	1	0	4.295	
22:28:33	1253.71	0	0	0	0	1	0	4.335	
22:33:33	950.279	0	0	0	0	1	0	4.318	
22:38:33	950.279	0	0	0	0	1	0	4.313	
22:43:33	950.279	0	0	0	0	1	0	4.335	
22:48:33	909.43	0	0	0	0	0	0	4.388	
22:53:33	909.43	0	0	0	0	1	0	4.423	
22:58:33	909.43	0	0	0	0	1	0	4.382	
23:03:33	1251.98	0	0	0	0	1	0	4.382	
23:08:33	1251.98	0	0	0	0	1	0	4.513	
23:13:33	1251.98	0	0	0	0	1	0	4.48	
23:18:33	719.998	0	0	0	0	0	0	4.663	
23:23:33	719.998	0	0	0	0	0	0	4.768	
23:28:33	719.998	0	0	0	0	1	0	4.76	
23:33:33	845.92	0	0	0	0	1	0	4.804	
23:38:33	845.92	0	0	0	0	1	0	4.882	
23:43:33	845.92	0	0	0	0	1	0	4.894	
23:48:33	605.073	0	0	0	0	1	0	4.937	
23:53:33	605.073	0	0	0	0	1	0	4.992	
23:58:33	605.073	0	0	0	0	1	0	4.989	
Segments	12,258,159	3,396	0	3,737	0	2,693	2,065	0.000	Min.
Sum (gpm)	4,086,053	-	-	-	-	-	-	5	Max.
(gal) (15x)	61,290,794	-	-	-	-	-	-	3.898	Avg.
Minutes (5x)		16,980	0	18,685	0	13,465	10,325		
Hours		283	0	311	0	224	172		

Water Conservation Study
Ft. Drum, NY

TELEMETERING SYSTEM DATALOG #1 - OCTOBER 1993

Time/ Date	Avg. Flow On Post (gpm)	Vault 3 Valve 1 (Tank 3)	Vault 3 Valve 2 (Tank 3)	DANC First Pump Operation	DANC 2nd Pump Operation	Reservoir Draining	Reservoir Filling	DANC Chlorine Residual	
23:24:00	1704.93	0	0	0	0	0	0	2.752	
23:29:00	1704.93	0	0	0	0	0	0	2.727	
23:34:00	1281.23	0	0	0	0	0	0	2.732	
23:39:00	1281.23	0	0	0	0	0	0	2.726	
23:44:00	1281.23	0	0	0	0	0	0	2.696	
23:49:00	920.991	0	0	0	0	0	0	2.707	
23:54:00	920.991	0	0	0	0	0	0	2.672	
23:59:00	920.991	0	0	0	0	0	0	2.672	
Segments	11,914,891	1,651	0	3,538	0	1,995	1,527	0.000	Min.
Sum (gpm)	3,971,630	-	-	-	-	-	-	5	Max.
(gal) (15x)	59,574,456	-	-	-	-	-	-	2.328	Avg.
Minutes (5x)		8,255	0	17,690	0	9,975	7,635		
Hours		138	0	295	0	166	127		

Water Conservation Study
Ft. Drum, NY

TELEMETERING SYSTEM DATALOG #1 - NOVEMBER 1993

Time/ Date	Avg. Flow On Post (gpm)	Vault 3 Valve 1 (Tank 3)	Vault 3 Valve 2 (Tank 3)	DANC First Pump Operation	DANC 2nd Pump Operation	Reservoir Draining	Reservoir Filling	DANC Chlorine Residual	
22:41:31	1696.69	0	0	0	0	0	0	1.908	
22:46:31	1004.98	0	0	0	0	0	0	2.014	
22:51:31	1004.98	0	0	0	0	0	0	2.041	
22:56:31	1004.98	0	0	0	0	0	0	2.06	
23:01:31	1136.07	0	0	0	0	0	0	2.081	
23:06:31	1136.07	0	0	0	0	0	0	1.823	
23:11:31	1136.07	0	0	0	0	0	0	1.877	
23:16:31	1278.65	0	0	0	0	0	0	1.97	
23:21:31	1278.65	0	0	0	0	0	0	2.035	
23:26:31	1278.65	0	0	0	0	0	0	2.073	
23:31:31	678.023	0	0	1	0	0	0	2.105	
23:36:31	678.023	0	0	1	0	0	1	1.935	
23:41:31	678.023	0	0	1	0	0	1	2.049	
23:46:31	1788.02	0	0	1	0	0	1	2.086	
23:51:31	1788.02	0	0	1	0	0	1	2.066	
23:56:31	1788.02	0	0	1	0	0	1	2.096	
Segments	10,686,508	1,650	1	3,744	0	2,892	2,108	0.000	Min.
Sum (gpm)	3,562,169	-	-	-	-	-	-	3.181	Max.
(gal) (15x)	53,432,542	-	-	-	-	-	-	1.918	Avg.
Minutes (5x)		8,250	5	18,720	0	14,460	10,540		
Hours		138	0	312	0	241	176		

Water Conservation Study
Ft. Drum, NY

TELEMETERING SYSTEM DATALOG #1 - DECEMBER 1993

Time/ Date	Avg. Flow On Post (gpm)	Vault 3 Valve 1 (Tank 3)	Vault 3 Valve 2 (Tank 3)	DANC First Pump Operation	DANC 2nd Pump Operation	Reservoir Draining	Reservoir Filling	DANC Chlorine Residual	
3:22:55	1594.69	0	0	1	0	0	0	1.896	
3:27:55	1594.69	0	0	1	0	0	0	1.896	
3:32:55	1365.94	0	0	1	0	0	1	1.893	
3:37:55	1365.94	0	0	1	0	0	1	1.921	
3:42:55	1365.94	0	0	1	0	0	1	1.915	
3:47:55	1190.35	0	0	1	0	0	1	1.898	
3:52:55	1190.35	0	0	1	0	0	1	1.916	
3:57:55	1190.35	0	0	1	0	0	1	1.905	
4:02:55	1536.81	0	0	1	0	0	1	1.931	
4:07:55	1536.81	0	0	1	0	0	1	1.952	
4:12:55	1536.81	0	0	0	0	0	1	1.925	
4:17:55	1338.9	0	0	0	0	0	1	1.877	
4:22:55	1338.9	0	0	0	0	0	1	1.931	
4:27:55	1338.9	0	0	0	0	0	1	1.941	
4:32:55	985.962	0	0	0	0	0	0	1.955	
4:37:55	985.962	0	0	0	0	0	0	1.971	
4:42:55	985.962	0	0	0	0	0	0	1.923	
4:47:55	1533.08	0	0	0	0	0	0	1.936	
4:52:55	1533.08	0	0	0	0	0	0	1.943	
4:57:55	1533.08	0	0	0	0	1	0	1.943	
5:02:55	1126.14	0	0	0	0	1	0	1.92	
5:07:55	1126.14	0	0	0	0	1	0	1.931	
5:12:55	1126.14	0	0	0	0	1	0	1.937	
5:17:55	1196.72	0	0	0	0	1	0	1.913	
5:22:55	1196.72	0	0	0	0	1	0	1.931	
5:27:55	1196.72	0	0	0	0	1	0	1.877	
5:32:55	1225.53	0	0	0	0	1	0	1.901	
5:37:55	1225.53	0	0	0	0	1	0	1.858	
5:42:55	1225.53	0	0	0	0	1	0	1.911	
5:47:55	1393.34	0	0	0	0	1	0	1.886	
5:52:55	1393.34	0	0	0	0	1	0	1.877	
5:57:55	1393.34	0	0	0	0	1	0	1.908	
6:02:55	1409.98	0	0	0	0	1	0	1.911	
6:07:55	1409.98	0	0	0	0	1	0	1.903	
6:12:55	1409.98	0	0	0	0	1	0	1.861	
6:17:55	1874.16	0	0	0	0	0	0	1.931	
6:22:55	1874.16	0	0	0	0	0	0	1.905	
6:27:55	1874.16	0	0	0	0	0	0	1.909	
Segments	9,176,420	1,227	0	3,255	7	2,373	1,807	0.000	Min.
Sum (gpm)	3,058,807	-	-	-	-	-	-	3.358	Max.
(gal) (15x)	45,882,098	-	-	-	-	-	-	1.818	Avg.
Minutes (5x)		6,135	0	16,275	35	11,865	9,035		
Hours		102	0	271	1	198	151		

*Note: Telemetry data is incomplete and only covers from December 1 to December 28 (06:28)

Assume data is extrapolated to 31 days:

50,798,037	6,792	0	18,019	39	13,136	10,003
(gal)	(min.)	(min.)	(min.)	(min.)	(min.)	(min.)

TELEMETERING SYSTEM DATALOG #1 - JANUARY 1994

Time/ Date	Avg. Flow On Post (gpm)	Vault 3 Valve 1 (Tank 3)	Vault 3 Valve 2 (Tank 3)	DANC First Pump Operation	DANC 2nd Pump Operation	Reservoir Draining	Reservoir Filling	DANC Chlorine Residual	
22:16:25	1751.32	0	0	0	0	0	0	1.183	
22:21:25	1751.32	0	0	0	0	0	0	1.165	
22:26:25	1751.32	0	0	0	0	0	0	1.176	
22:31:25	1405.32	0	0	0	0	0	0	1.161	
22:36:25	1405.32	0	0	0	0	0	0	1.16	
22:41:25	1405.32	1	0	0	0	0	0	1.184	
22:46:25	0	1	0	0	0	0	0	1.113	
22:51:25	0	1	0	0	0	0	0	1.156	
22:56:25	0	1	0	0	0	0	0	1.145	
23:01:25	527.356	1	0	0	0	1	0	1.175	
23:06:25	527.356	1	0	0	0	1	0	1.121	
23:11:25	527.356	1	0	0	0	1	0	1.159	
23:16:25	668.138	1	0	0	0	1	0	1.168	
23:21:25	668.138	1	0	0	0	1	0	1.151	
23:26:25	668.138	0	0	0	0	1	0	1.131	
23:31:25	2728.86	0	0	0	0	1	0	1.132	
23:36:25	2728.86	0	0	0	0	1	0	1.125	
23:41:25	2728.86	0	0	0	0	1	0	1.121	
23:46:25	1612.48	0	0	0	0	1	0	1.118	
23:51:25	1612.48	0	0	0	0	1	0	1.137	
23:56:25	1612.48	0	0	0	0	0	0	1.129	
Segments	12,708,732	1,580	0	4,174	12	3,010	2,167	0.720	Min.
Sum (gpm)	4,236,244	-	-	-	-	-	-	2.495	Max.
(gal) (15x)	63,543,661	-	-	-	-	-	-	1.689	Avg.
Minutes (5x)		7,900	0	20,870	60	15,050	10,835		
Hours		132	0	348	1	251	181		

Water Conservation Study
Ft. Drum, NY

TELEMETERING SYSTEM DATALOG #1 - FEBRUARY 1994

Time/ Date	Avg. Flow On Post (gpm)	Vault 3 Valve 1 (Tank 3)	Vault 3 Valve 2 (Tank 3)	DANC First Pump Operation	DANC 2nd Pump Operation	Reservoir Draining	Reservoir Filling	DANC Chlorine Residual	
20:34:20	1420.91	0	0	0	0	1	0	1.592	
20:39:20	1420.91	0	0	0	0	1	0	1.602	
20:44:20	1420.91	0	0	0	0	1	0	1.587	
20:49:20	1300.8	0	0	0	0	1	0	1.564	
20:54:20	1300.8	0	0	0	0	1	0	1.583	
20:59:20	1300.8	1	0	1	0	1	0	1.536	
21:04:20	0	1	0	1	0	1	0	1.579	
21:09:20	0	1	0	1	0	1	0	1.6	
21:14:20	0	1	0	1	0	1	0	1.571	
21:19:20	635.934	1	0	1	0	1	0	1.583	
21:24:20	635.934	1	0	1	0	1	0	1.614	
21:29:20	635.934	1	0	1	0	1	0	1.59	
21:34:20	949.127	1	0	1	0	1	0	1.576	
21:39:20	949.127	1	0	1	0	1	0	1.561	
21:44:20	949.127	0	0	1	0	1	0	1.559	
21:49:20	3754.75	0	0	1	0	1	0	1.623	
21:54:20	3754.75	0	0	1	0	1	0	1.634	
21:59:20	3754.75	0	0	1	0	1	0	1.639	
22:04:20	1334.96	0	0	1	0	1	0	1.649	
22:09:20	1334.96	0	0	1	0	1	0	1.665	
22:14:20	1334.96	0	0	1	0	1	0	1.696	
22:19:20	1543.66	0	0	1	0	1	0	1.685	
22:24:20	1543.66	0	0	1	0	1	0	1.684	
22:29:20	1543.66	0	0	1	0	1	0	1.684	
22:34:20	1382.46	0	0	1	0	1	0	1.697	
22:39:20	1382.46	0	0	0	0	0	1	1.668	
22:44:20	1382.46	0	0	0	0	0	1	1.661	
22:49:20	1152.51	0	0	0	0	0	1	1.665	
22:54:20	1152.51	0	0	0	0	0	1	1.66	
22:59:20	1152.51	0	0	0	0	0	0	1.602	
23:04:20	873.049	0	0	0	0	0	0	1.647	
23:09:20	873.049	0	0	0	0	0	0	1.622	
23:14:20	873.049	0	0	0	0	0	0	1.614	
23:19:20	1319.93	0	0	0	0	0	0	1.621	
23:24:20	1319.93	0	0	0	0	0	0	1.629	
23:29:20	1319.93	0	0	0	0	0	0	1.651	
23:34:20	1009.82	0	0	0	0	0	0	1.629	
23:39:20	1009.82	0	0	0	0	0	0	1.598	
23:44:20	1009.82	0	0	0	0	0	0	1.622	
23:49:20	913.785	0	0	0	0	0	0	1.619	
23:54:20	913.785	0	0	1	0	0	0	1.595	
23:59:20	913.785	0	0	1	0	0	1	1.717	
Segments	9,892,062	1,252	3	3,285	30	2,634	2,010	0.000	Min.
Sum (gpm)	3,297,354	-	-	-	-	-	-	2.108	Max.
(gal) (15x)	49,460,309	-	-	-	-	-	-	1.503	Avg.
Minutes (5x)		6,260	15	16,425	150	13,170	10,050		
Hours		104	0	274	3	220	168		

Water Conservation Study
Ft. Drum, NY

TELEMETERING SYSTEM DATALOG #1 - MARCH 1994

Time/ Date	Avg. Flow On Post (gpm)	Vault 3 Valve 1 (Tank 3)	Vault 3 Valve 2 (Tank 3)	DANC First Pump Operation	DANC 2nd Pump Operation	Reservoir Draining	Reservoir Filling	DANC Chlorine Residual	
22:05:28	1221.79	0	0	0	0	1	0	1.647	
22:10:28	1221.79	0	0	0	0	1	0	1.63	
22:15:28	1576.26	0	0	0	0	1	0	1.637	
22:20:28	1576.26		0	0	0	1	0	1.627	
22:25:28	1576.26	0	0	0	0	1	0	1.649	
22:30:28	1225.53	0	0	0	0	0	0	1.645	
22:35:28	1225.53	0	0	0	0	0	0	1.634	
22:40:28	1225.53	0	0	0	0	0	0	1.635	
22:45:28	1228.01	0	0	0	0	0	0	1.665	
22:50:28	1228.01	0	0	0	0	0	0	1.642	
22:55:28	1228.01	1	0	1	0	0	0	1.654	
23:00:28	0	1	0	1	0	0	1	1.685	
23:05:28	0	1	0	1	0	0	1	1.655	
23:10:28	0	1	0	1	0	0	1	1.655	
23:15:28	72.962	1	0	1	0	1	0	1.668	
23:20:28	72.962	1	0	1	0	1	0	1.664	
23:25:28	72.962	1	0	1	0	1	0	1.664	
23:30:28	4000	1	0	1	0	1	0	1.693	
23:35:28	4000	1	0	0	0	0	0	1.658	
23:40:28	4000	0	0	0	0	0	0	1.668	
23:45:28	1321.62	0	0	0	0	0	0	1.649	
23:50:28	1321.62	0	0	0	0	0	0	1.63	
23:55:28	1321.62	0	0	0	0	0	0	1.657	
Segments	12,714,038	1,430	2	4,229	8	2,741	2,442	0.000	Min.
Sum (gpm)	4,238,013	-	-	-	-	-	-	2.107	Max.
(gal) (15x)	63,570,191	-	-	-	-	-	-	1.497	Avg.
Minutes (5x)		7,150	10	21,145	40	13,705	12,210		
Hours		119	0	352	1	228	204		

Water Conservation Study
Ft. Drum, NY

TELEMETERING SYSTEM DATALOG #1 - APRIL 1994

Time/ Date	Avg. Flow On Post (gpm)	Vault 3 Valve 1 (Tank 3)	Vault 3 Valve 2 (Tank 3)	DANC First Pump Operation	DANC 2nd Pump Operation	Reservoir Draining	Reservoir Filling	DANC Chlorine Residual	
21:41:07	3248.91	0	0	1	0	1	0	1.713	
21:46:07	1008.42	0	0	1	0	1	0	1.7	
21:51:07	1008.42	0	0	1	0	1	0	1.688	
21:56:07	1008.42	0	0	1	0	1	0	1.678	
22:01:07	1814.95	0	0	0	0	1	0	1.692	
22:06:07	1814.95	0	0	0	0	0	1	1.674	
22:11:07	1814.95	0	0	0	0	0	1	1.678	
22:16:07	983.475	0	0	0	0	0	1	1.669	
22:21:07	983.475	0	0	0	0	0	1	1.658	
22:26:07	983.475	0	0	0	0	0	1	1.686	
22:31:07	1258.3	0	0	0	0	0	1	1.664	
22:36:07	1258.3	0	0	0	0	0	1	1.654	
22:41:07	1258.3	0	0	0	0	1	0	1.662	
22:46:07	982.199	0	0	0	0	1	0	1.669	
22:51:07	982.199	0	0	0	0	1	0	1.653	
22:56:07	982.199	0	0	0	0	1	0	1.666	
23:01:07	856.315	0	0	0	0	1	0	1.662	
23:06:07	856.315	0	0	0	0	1	0	1.676	
23:11:07	856.315	0	0	0	0	1	0	1.676	
23:16:07	950.665	0	0	0	0	1	0	1.658	
23:21:07	950.665	0	0	0	0	0	0	1.661	
23:26:07	950.665	1	0	1	0	0	1	1.672	
23:31:07	0	1	0	1	0	0	0	1.643	
23:36:07	0	1	0	1	0	0	0	1.65	
23:41:07	0	1	0	1	0	0	0	1.66	
23:46:07	2263.82	1	0	1	0	1	0	1.649	
23:51:07	2263.82	0	0	1	0	1	0	1.649	
23:56:07	2263.82	0	0	1	0	1	0	1.642	
Segments	10,723,754	1,180	0	3,660	0	3,179	2,811	0.000	Min.
Sum (gpm)	3,574,585	-	-	-	-	-	-	2.066	Max.
(gal) (15x)	53,618,772	-	-	-	-	-	-	1.317	Avg.
Minutes (5x)		5,900	0	18,300	0	15,895	14,055		
Hours		98	0	305	0	265	234		

Water Conservation Study
Ft. Drum, NY

TELEMETERING SYSTEM DATALOG #1 - MAY 1994

Time/ Date	Avg. Flow On Post (gpm)	Vault 3 Valve 1 (Tank 3)	Vault 3 Valve 2 (Tank 3)	DANC First Pump Operation	DANC 2nd Pump Operation	Reservoir Draining	Reservoir Filling	DANC Chlorine Residual	
23:32:07	1012.48	0	0	0	0	1	0	4.325	
23:37:07	1012.48	0	0	0	0	1	0	4.233	
23:42:07	1012.48	0	0	0	0	1	0	4.189	
23:47:07	977.827	0	0	0	0	1	0	4.229	
23:52:07	977.827	0	0	0	0	1	0	4.236	
23:57:07	977.827	0	0	0	0	0	1	4.211	
Segments	11,389,782	3,546	6	4,118	4	3,708	3,329	0.726	Min.
Sum (gpm)	3,796,594	-	-	-	-	-	-	5	Max.
(gal) (15x)	56,948,910	-	-	-	-	-	-	2.097	Avg.
Minutes (5x)		17,730	30	20,590	20	18,540	16,645		
Hours		296	1	343	0	309	277		

TELEMETERING SYSTEM DATALOG #1 - JUNE 1994

Time/ Date	Avg. Flow On Post (gpm)	Vault 3 Valve 1 (Tank 3)	Vault 3 Valve 2 (Tank 3)	DANC First Pump Operation	DANC 2nd Pump Operation	Reservoir Draining	Reservoir Filling	DANC Chlorine Residual	
23:31:24	1225.93	0	0	1	0	0	0	1.069	
23:36:24	1225.93	0	0	1	0	0	0	1.088	
23:41:24	1225.93	0	0	0	0	0	0	1.106	
23:46:24	1465.03	0	0	0	0	0	0	1.102	
23:51:24	1465.03	0	0	0	0	0	0	1.096	
23:56:24	1465.03	0	0	0	0	0	0	1.109	
Segments	13,513,067	1,881	1	4,230	8	3,113	2,727	0.000	Min.
Sum (gpm)	4,504,356	-	-	-	-	-	-	5	Max.
(gal) (15x)	67,565,334	-	-	-	-	-	-	2.026	Avg.
Minutes (5x)		9,405	5	21,150	40	15,565	13,635		
Hours		157	0	353	1	259	227		

TELEMETERING SYSTEM DATALOG #1 - JULY 1994

Time/ Date	Avg. Flow On Post (gpm)	Vault 3 Valve 1 (Tank 3)	Vault 3 Valve 2 (Tank 3)	DANC First Pump Operation	DANC 2nd Pump Operation	Reservoir Draining	Reservoir Filling	DANC Chlorine Residual	
21:49:26	2307.12	0	0	1	0	0	0	4.616	
21:54:26	2307.12	0	0	1	0	0	0	4.616	
21:59:26	2307.12	0	0	1	0	0	0	5	
22:04:26	2449.59	1	0	1	0	0	0	4.572	
22:09:26	2449.59	1	0	1	0	0	0	5	
22:14:26	2449.59	1	0	1	0	0	0	5	
22:19:26	1071.74	1	0	1	0	0	0	3.318	
22:24:26	1071.74	1	0	1	0	0	0	5	
22:29:26	1071.74	1	0	1	0	0	0	5	
22:34:26	2549.65	0	0	1	0	0	0	5	
22:39:26	2549.65	0	0	1	0	0	0	4.996	
22:44:26	2549.65	0	0	1	0	0	0	5	
22:49:26	2045.06	0	0	1	0	0	0	4.637	
22:54:26	2045.06	0	0	1	0	0	0	4.637	
22:59:26	2045.06	0	0	1	0	0	0	4.64	
23:04:26	1691.1	0	0	1	0	0	0	3.71	
23:09:26	1691.1	0	0	1	0	0	0	3.157	
23:14:26	1691.1	0	0	1	0	0	0	3.032	
23:19:26	2049.2	0	0	1	0	0	0	4.182	
23:24:26	2049.2	0	0	1	0	0	0	4.784	
23:29:26	2049.2	0	0	1	0	0	0	3.405	
23:34:26	1573.22	0	0	1	0	0	0	4.276	
23:39:26	1573.22	0	0	1	0	0	0	3.346	
23:44:26	1573.22	0	0	1	0	0	0	5	
23:49:26	1576.17	1	0	1	0	0	0	5	
23:54:26	1576.17	1	0	1	0	0	0	4.944	
23:59:26	1576.17	1	0	1	0	0	0	5	
Segments	13,211,369	1,890	3	4,205	4	3,077	2,680	0.000	Min.
Sum (gpm)	4,403,790	-	-	-	-	-	-	5	Max.
(gal) (15x)	66,056,844	-	-	-	-	-	-	2.656	Avg.
Minutes (5x)		9,450	15	21,025	20	15,385	13,400		
Hours		158	0	350	0	256	223		

Water Conservation Study
Ft. Drum, NY

TELEMETERING SYSTEM DATALOG #1 - AUGUST 1994

Time/ Date	Avg. Flow On Post (gpm)	Vault 3 Valve 1 (Tank 3)	Vault 3 Valve 2 (Tank 3)	DANC First Pump Operation	DANC 2nd Pump Operation	Reservoir Draining	Reservoir Filling	DANC Chlorine Residual	
20:42:39	1207.22	0	0	0	0	0	1	3.943	
20:47:39	1506.91	0	0	0	0	0	1	4.031	
20:52:39	1506.91	0	0	0	0	1	0	4.029	
20:57:39	1506.91	0	0	0	0	1	0	4.127	
21:02:39	1418.67	0	0	0	0	1	0	4.193	
21:07:39	1418.67	0	0	0	0	1	0	4.235	
21:12:39	1418.67	0	0	0	0	1	0	4.291	
21:17:39	1302.12	0	0	0	0	1	0	4.227	
21:22:39	1302.12	0	0	0	0	0	1	4.295	
21:27:39	1302.12	0	0	0	0	0	1	4.3	
21:32:39	931.212	0	0	0	0	0	1	4.299	
21:37:39	931.212	0	0	0	0	0	1	4.223	
21:42:39	931.212	0	0	0	0	1	0	4.15	
21:47:39	1636.44	0	0	0	0	1	0	4.178	
21:52:39	1636.44	0	0	0	0	1	0	4.095	
21:57:39	1636.44	0	0	0	0	1	0	4.072	
22:02:39	1327.76	0	0	0	0	1	0	3.949	
22:07:39	1327.76	0	0	0	0	0	1	3.946	
22:12:39	1327.76	1	0	0	0	0	1	3.91	
22:17:39	0	1	0	1	0	1	0	1.8	
22:22:39	0	1	0	1	0	1	0	3.071	
22:27:39	0	1	0	1	0	1	0	3.102	
22:32:39	453.063	1	0	1	0	1	0	3.147	
22:37:39	453.063	1	0	1	0	1	0	3.294	
22:42:38	453.063	1	0	1	0	1	0	3.289	
22:47:38	1385.13	1	0	1	0	1	0	3.241	
22:52:38	1385.13	1	0	1	0	1	0	3.303	
22:57:38	1385.13	1	0	1	0	1	0	3.154	
23:02:38	2756.3	0	0	1	0	1	0	3.154	
23:07:38	2756.3	0	0	1	0	1	0	3.103	
23:12:38	2756.3	0	0	0	0	0	1	3.512	
23:17:38	1211	0	0	0	0	0	1	3.467	
23:22:38	1211	0	0	0	0	0	1	3.484	
23:27:38	1211	0	0	0	0	0	1	3.535	
23:32:38	916.198	0	0	0	0	0	1	3.535	
23:37:38	916.198	0	0	0	0	0	0	3.503	
23:42:38	916.198	0	0	0	0	0	1	3.527	
23:47:38	1133.83	0	0	0	0	0	0	3.586	
23:52:38	1133.83	0	0	0	0	0	1	3.574	
23:57:38	1133.83	0	0	0	0	0	0	3.574	
Segments	13,031,412	1,923	0	4,509	55	3,140	2,901	0.000	Min.
Sum (gpm)	4,343,804	-	-	-	-	-	-	5	Max.
(gal) (15x)	65,157,060	-	-	-	-	-	-	2.899	Avg.
Minutes (5x)		9,615	0	22,545	275	15,700	14,505		
Hours		160	0	376	5	262	242		

TELEMETERING SYSTEM DATALOG #1 - SEPTEMBER 1994

Time/ Date	Avg. Flow On Post (gpm)	Vault 3 Valve 1 (Tank 3)	Vault 3 Valve 2 (Tank 3)	DANC First Pump Operation	DANC 2nd Pump Operation	Reservoir Draining	Reservoir Filling	DANC Chlorine Residual	
21:22:02	787.2	0	0	0	0	1	0	2.671	
21:27:02	787.2	0	0	0	0	1	0	2.641	
21:32:02	886.45	0	0	0	0	1	0	2.575	
21:37:02	886.45	0	0	0	0	1	0	2.57	
21:42:02	886.45	0	0	0	0	1	0	2.539	
21:47:02	681.857	0	0	0	0	1	0	2.496	
21:52:02	681.857	0	0	0	0	1	0	2.501	
21:57:02	681.857	0	0	0	0	1	0	2.501	
22:02:02	1036.69	0	0	0	0	1	0	2.422	
22:07:02	1036.69	0	0	0	0	1	0	2.441	
22:12:02	1036.69	0	0	0	0	1	0	2.397	
22:17:02	640.457	0	0	0	0	1	0	2.383	
22:22:02	640.457	0	0	0	0	0	1	2.363	
22:27:02	640.457	0	0	0	0	0	1	2.342	
22:32:02	933.843	0	0	0	0	1	0	2.293	
22:37:02	933.843	0	0	0	0	1	0	2.266	
22:42:02	933.843	0	0	0	0	0	0	2.244	
22:47:02	850.167	0	0	0	0	0	0	2.198	
22:52:02	850.167	0	0	0	0	0	0	2.211	
22:57:02	850.167	0	0	0	0	0	0	2.167	
23:02:02	727.169	0	0	0	0	0	0	2.167	
23:07:02	727.169	0	0	0	0	0	0	2.128	
23:12:02	727.169	1	0	1	0	0	0	2.096	
23:17:02	0	1	0	1	0	0	0	1.901	
23:22:02	0	1	0	1	0	0	0	1.898	
23:27:02	0	1	0	1	0	0	0	1.905	
23:32:02	633.082	1	0	1	0	0	0	1.941	
23:37:02	633.082	1	0	1	0	0	0	1.945	
23:42:02	633.082	1	0	1	0	0	0	1.95	
23:47:02	553.731	1	0	1	0	0	0	1.929	
23:52:02	553.731	0	0	1	0	0	0	1.988	
23:57:02	553.731	0	0	1	0	0	0	1.998	
Segments	10,956,739	1,457	0	4,282	0	3,379	2,975	0.000	Min.
Sum (gpm)	3,652,246	-	-	-	-	-	-	4.823	Max.
(gal) (15x)	54,783,694	-	-	-	-	-	-	2.662	Avg.
Minutes (5x)		7,285	0	21,410	0	16,895	14,875		
Hours		121	0	357	0	282	248		

TELEMETERING SYSTEM DATALOG #1 - OCTOBER 1994

Time/ Date	Avg. Flow On Post (gpm)	Vault 3 Valve 1 (Tank 3)	Vault 3 Valve 2 (Tank 3)	DANC First Pump Operation	DANC 2nd Pump Operation	Reservoir Draining	Reservoir Filling	DANC Chlorine Residual	
22:58:08	783.066	0	0	0	0	1	0	3.667	
23:03:08	619.077	0	0	0	0	1	0	3.714	
23:08:08	619.077	0	0	0	0	1	0	3.684	
23:13:08	619.077	0	0	0	0	0	1	3.62	
23:18:08	635.506	0	0	0	0	0	1	3.643	
23:23:08	635.506	0	0	0	0	0	1	3.609	
23:28:06	635.506	0	0	0	0	0	1	3.643	
23:33:06	530.363	0	0	0	0	1	0	3.636	
23:38:06	530.363	0	0	0	0	1	0	3.582	
23:43:06	530.363	0	0	0	0	1	0	3.553	
23:48:06	657.711	0	0	0	0	1	0	3.566	
23:53:06	657.711	0	0	0	0	1	0	3.543	
23:58:06	657.711	0	0	0	0	1	0	3.554	
Segments	9,608,770	1,022	0	3,631	10	3,679	3,250	0.000	Min.
Sum (gpm)	3,202,923	-	-	-	-	-	-	5	Max.
(gal) (15x)	48,043,852	-	-	-	-	-	-	2.979	Avg.
Minutes (5x)		5,110	0	18,155	50	18,395	16,250		
Hours		85	0	303	1	307	271		

TELEMETERING SYSTEM DATALOG #1 - NOVEMBER 1994

Time/ Date	Avg. Flow On Post (gpm)	Vault 3 Valve 1 (Tank 3)	Vault 3 Valve 2 (Tank 3)	DANC First Pump Operation	DANC 2nd Pump Operation	Reservoir Draining	Reservoir Filling	DANC Chlorine Residual	
9:13:23	1610.54	0	0	1	0	0	0	2.274	
9:18:23	1671.35	0	0	1	0	0	1	3.527	
9:23:23	1671.35	0	0	1	0	0	1	3.596	
9:28:23	1671.35	0	0	1	0	0	1	3.622	
9:33:23	1367.72	0	0	1	0	0	1	3.632	
9:38:23	1367.72	0	0	1	0	0	1	3.588	
9:43:23	1367.72	0	0	1	0	0	1	3.563	
9:48:23	1902.11	1	0	1	0	0	1	3.574	
Segments	6,654,166	786	1	2,443	0	2,750	2,400	1.720	Min.
Sum (gpm)	2,218,055	-	-	-	-	-	-	5	Max.
(gal) (15x)	33,270,831	-	-	-	-	-	-	3.571	Avg.
Minutes (5x)		3,930	5	12,215	0	13,750	12,000		
Hours		66	0	204	0	229	200		

*Note: Data is available from datalog from November 1 to November 23

Assume data is extrapolated to 31 days:

44,843,294	5,297	7	16,464	0	18,533	16,174
(gal)	(min.)	(min.)	(min.)	(min.)	(min.)	(min.)

Water Conservation Study
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TELEMETERING SYSTEM DATALOG #1 - DECEMBER 1994

Time/ Date	Avg. Flow On Post (gpm)	Vault 3 Valve 1 (Tank 3)	Vault 3 Valve 2 (Tank 3)	DANC First Pump Operation	DANC 2nd Pump Operation	Reservoir Draining	Reservoir Filling	DANC Chlorine Residual	
23:24:17	1545.83	0	0	1	0	0	0	1.639	
23:29:17	1545.83	0	0	1	0	0	0	1.629	
23:34:17	1253.4	0	0	1	0	0	0	1.619	
23:39:17	1253.4	0	0	1	0	0	0	1.6	
23:44:17	1253.4	0	0	1	0	0	0	1.61	
23:49:17	962.337	0	0	1	0	0	0	1.61	
23:54:17	962.337	0	0	1	0	0	0	1.635	
23:59:17	962.337	0	0	1	0	0	0	1.641	
Segments	11,540,595	1,205	0	4,240	25	3,170	2,874	0.000	Min.
Sum (gpm)	3,846,865	-	-	-	-	-	-	5	Max.
(gal) (15x)	57,702,973	-	-	-	-	-	-	2.535	Avg.
Minutes (5x)		6,025	0	21,200	125	15,850	14,370		
Hours		100	0	353	2	264	240		

Water Conservation Study
Ft. Drum, NY

TELEMETERING SYSTEM DATALOG #1 - JANUARY 1995

Time/ Date	Avg. Flow On Post (gpm)	Vault 3 Valve 1 (Tank 3)	Vault 3 Valve 2 (Tank 3)	DANC First Pump Operation	DANC 2nd Pump Operation	Reservoir Draining	Reservoir Filling	DANC Chlorine Residual	
22:15:33	928.617	1	0	1	0	0	0	1.685	
22:20:33	0	1	0	1	0	0	0	1.551	
22:25:33	0	1	0	1	0	0	0	1.575	
22:30:33	0	1	0	1	0	0	0	1.56	
22:35:33	689.344	1	0	1	0	0	0	1.56	
22:40:33	689.344	1	0	1	0	0	0	1.588	
22:45:33	689.344	1	0	1	0	0	0	1.625	
22:50:33	3556.65	0	0	1	0	0	0	1.59	
22:55:33	3556.65	0	0	1	0	0	0	1.6	
23:00:33	3556.65	0	0	1	0	0	0	1.61	
23:05:33	1725.64	0	0	1	0	0	0	1.599	
23:10:33	1725.64	0	0	1	0	0	0	1.586	
23:15:33	1725.64	0	0	1	0	0	0	1.568	
23:20:33	1354.01	0	0	1	0	0	0	1.613	
23:25:33	1354.01	0	0	1	0	0	0	1.619	
23:30:33	1354.01	0	0	1	0	0	0	1.595	
23:35:33	1371.98	0	0	1	0	0	0	1.584	
23:40:33	1371.98	0	0	1	0	0	0	1.584	
23:45:33	1371.98	0	0	0	0	0	0	1.638	
23:50:33	1060.88	0	0	0	0	0	0	1.688	
23:55:33	1060.88	0	0	0	0	0	0	1.721	
Segments	12,822,247	1,413	0	4,272	22	0	60	0.706	Min.
Sum (gpm)	4,274,082	-	-	-	-	-	-	2.045	Max.
(gal) (15x)	64,111,233	-	-	-	-	-	-	1.498	Avg.
Minutes (5x)		7,065	0	21,360	110	0	300		
Hours		118	0	356	2	0	5		

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TELEMETERING SYSTEM DATALOG #1 - FEBRUARY 1995

Time/ Date	Avg. Flow On Post (gpm)	Vault 3 Valve 1 (Tank 3)	Vault 3 Valve 2 (Tank 3)	DANC First Pump Operation	DANC 2nd Pump Operation	Reservoir Draining	Reservoir Filling	DANC Chlorine Residual	
20:52:56	1793	0	0	1	0	1	0	1.22	
20:57:56	1793	0	0	1	0	1	0	1.195	
21:02:56	949.42	0	0	1	0	1	0	1.183	
21:07:56	949.42	0	0	1	0	1	0	1.203	
21:12:56	949.42	0	0	1	0	1	0	1.188	
21:17:56	2006.82	0	0	1	0	1	0	1.173	
21:22:56	2006.82	0	0	1	0	1	0	1.187	
21:27:56	2006.82	0	0	0	0	0	1	1.211	
21:32:56	1470.82	0	0	0	0	0	1	1.163	
21:37:56	1470.82	0	0	0	0	0	1	1.198	
21:42:56	1470.82	0	0	0	0	0	1	1.172	
21:47:55	1202.08	0	0	0	0	0	1	1.176	
21:52:55	1202.08	0	0	0	0	0	1	1.183	
21:57:55	1202.08	0	0	0	0	0	1	1.182	
22:02:55	746.063	0	0	0	0	0	1	1.171	
22:07:55	746.063	0	0	0	0	0	1	1.171	
22:12:55	746.063	0	0	0	0	0	1	1.2	
22:17:55	1608.95	0	0	0	0	0	1	1.145	
22:22:55	1608.95	0	0	0	0	0	1	1.157	
22:27:55	1608.95	0	0	0	0	0	1	1.157	
22:32:55	971.397	0	0	0	0	0	1	1.176	
22:37:55	971.397	0	0	0	0	0	1	1.161	
22:42:55	971.397	0	0	0	0	0	1	1.163	
22:47:55	1240.32	0	0	0	0	0	1	1.163	
22:52:55	1240.32	0	0	0	0	0	0	1.206	
22:57:55	1240.32	0	0	0	0	0	0	1.145	
23:02:55	793.373	0	0	0	0	0	0	1.152	
23:07:55	793.373	0	0	0	0	0	0	1.161	
23:12:55	793.373	0	0	0	0	0	0	1.202	
23:17:55	1201.54	0	0	0	0	0	0	1.147	
23:22:55	1201.54	0	0	0	0	0	0	1.16	
23:27:55	1201.54	0	0	0	0	0	0	1.179	
23:32:55	616.804	1	0	1	0	1	0	1.121	
23:37:55	616.804	1	0	1	0	1	0	1.113	
23:42:55	616.804	1	0	1	0	1	0	1.101	
23:47:55	0	1	0	1	0	1	0	1.148	
23:52:55	0	1	0	1	0	1	0	1.157	
23:57:55	0	1	0	1	0	1	0	1.137	
Segments	11,025,928	1,252	32	3,739	0	1,675	2,590	0.000	Min.
Sum (gpm)	3,675,309	-	-	-	-	-	-	2.426	Max.
(gal) (15x)	55,129,641	-	-	-	-	-	-	1.388	Avg.
Minutes (5x)		6,260	160	18,695	0	8,375	12,950		
Hours		104	3	312	0	140	216		

Water Conservation Study
Ft. Drum, NY

TELEMETERING SYSTEM DATALOG #1 - MARCH 1995

Time/ Date	Avg. Flow On Post (gpm)	Vault 3 Valve 1 (Tank 3)	Vault 3 Valve 2 (Tank 3)	DANC First Pump Operation	DANC 2nd Pump Operation	Reservoir Draining	Reservoir Filling	DANC Chlorine Residual	
21:28:48	0	1	0	1	0	0	0	1.723	
21:33:48	0	1	0	1	0	0	0	1.724	
21:38:48	0	1	0	1	0	0	0	1.762	
21:43:48	171.039	1	0	1	0	1	0	1.762	
21:48:48	171.039	1	0	1	0	1	0	1.756	
21:53:48	171.039	1	0	1	0	1	0	1.756	
21:58:48	3043.09	0	0	1	0	1	0	1.756	
22:03:48	3043.09	0	0	1	0	1	0	1.739	
22:08:48	3043.09	0	0	1	0	1	0	1.774	
22:13:48	2450.98	0	0	1	0	0	0	1.733	
22:18:48	2450.98	0	0	1	0	0	0	1.706	
22:23:48	2450.98	0	0	1	0	0	0	1.678	
22:28:48	1742.47	0	0	1	0	0	0	1.68	
22:33:48	1742.47	0	0	1	0	0	0	1.698	
22:38:48	1742.47	0	0	1	0	0	0	1.655	
22:43:48	1139.96	0	0	1	0	0	0	1.637	
22:48:48	1139.96	0	0	1	0	0	1	1.645	
22:53:48	1139.96	0	0	1	0	0	1	1.654	
22:58:48	1117.89	0	0	1	0	0	1	1.617	
23:03:48	1117.89	0	0	1	0	0	1	1.643	
23:08:48	1117.89	0	0	1	0	0	1	1.643	
23:13:48	1406.78	0	0	1	0	0	1	1.631	
23:18:48	1406.78	0	0	0	0	0	1	1.602	
23:23:48	1406.78	0	0	0	0	0	1	1.595	
23:28:48	897.878	0	0	0	0	0	1	1.583	
23:33:48	897.878	0	0	0	0	0	1	1.595	
23:38:48	897.878	0	0	0	0	0	1	1.608	
23:43:48	891.219	0	0	0	0	0	1	1.643	
23:48:48	891.219	0	0	0	0	0	1	1.618	
23:53:48	891.219	0	0	0	0	0	1	1.611	
23:58:48	781.453	0	0	0	0	0	1	1.611	
Segments	11,977,602	1,447	0	4,225	4	1,719	2,819	1.081	Min.
Sum (gpm)	3,992,534	-	-	-	-	-	-	2.137	Max.
(gal) (15x)	59,888,010	-	-	-	-	-	-	1.485	Avg.
Minutes (5x)		7,235	0	21,125	20	8,595	14,095		
Hours		121	0	352	0	143	235		

Water Conservation Study
Ft. Drum, NY

TELEMETERING SYSTEM DATALOG #1 - MAY 1995

Time/ Date	Avg. Flow On Post (gpm)	Vault 3 Valve 1 (Tank 3)	Vault 3 Valve 2 (Tank 3)	DANC First Pump Operation	DANC 2nd Pump Operation	Reservoir Draining	Reservoir Filling	DANC Chlorine Residual	
22:14:08	1480.57	0	0	0	0	1	0	2.014	
22:19:08	1480.57	0	0	0	0	1	0	2.023	
22:24:08	1480.57	0	0	0	0	1	0	2.006	
22:29:08	1599.02	0	0	0	0	1	0	2.019	
22:34:08	1599.02	0	0	0	0	1	0	1.99	
22:39:06	1599.02	0	0	0	0	1	0	1.982	
22:44:06	1266.92	0	0	0	0	1	0	2.015	
22:49:06	1266.92	0	0	0	0	1	0	1.998	
22:54:06	1266.92	0	0	0	0	1	0	1.998	
22:59:06	1357.74	0	0	0	0	1	0	2.048	
23:04:06	1357.74	0	0	0	0	0	0	1.997	
23:09:06	1357.74	0	0	0	0	0	0	2.015	
23:14:06	1195.79	0	0	0	0	0	0	1.975	
23:19:06	1195.79	0	0	0	0	0	0	1.952	
23:24:06	1195.79	0	0	0	0	0	0	2.015	
23:29:06	814.897	0	0	0	0	0	0	2.01	
23:34:06	814.897	0	0	0	0	0	0	1.974	
23:39:06	814.897	0	0	0	0	0	0	1.959	
23:44:06	1061.77	0	0	0	0	0	0	1.987	
23:49:06	1061.77	0	0	0	0	0	0	1.987	
23:54:06	1061.77	0	0	0	0	0	0	1.982	
23:59:06	978.875	0	0	0	0	0	0	1.986	
Segments	13,505,787	1,638	0	4,166	20	1,994	3,189	0.000	Min.
Sum (gpm)	4,501,929	-	-	-	-	-	-	2.295	Max.
(gal) (15x)	67,528,936	-	-	-	-	-	-	1.391	Avg.
Minutes (5x)		8,190	0	20,830	100	9,970	15,945		
Hours		137	0	347	2	166	266		

*Note: Data for 5/1/95 from 00:00 to 08:00 was not available from database. Data from 5/1/94 (00:00 to 08:00) was substituted.

TELEMETERING SYSTEM DATALOG #1 - JUNE 1995

Time/ Date	Avg. Flow On Post (gpm)	Vault 3 Valve 1 (Tank 3)	Vault 3 Valve 2 (Tank 3)	DANC First Pump Operation	DANC 2nd Pump Operation	Reservoir Draining	Reservoir Filling	DANC Chlorine Residual	
21:44:21	2319.35	0	0	1	0	1	0	2.031	
21:49:21	2148.21	0	0	1	0	0	0	2.061	
21:54:21	2148.21	0	0	1	0	0	1	2.061	
21:59:21	2148.21	0	0	1	0	0	1	2.061	
22:04:21	283.098	0	0	1	0	0	1	2.092	
22:09:21	283.098	0	0	1	0	0	1	2.069	
22:14:21	283.098	1	0	1	0	0	1	2.052	
22:19:21	2725.51	1	0	1	0	0	1	2.103	
22:24:21	2725.51	1	0	1	0	0	0	2.093	
22:29:21	2725.51	1	0	1	0	0	0	2.031	
22:34:21	1473.81	1	0	1	0	0	0	2.065	
22:39:21	1473.81	1	0	1	0	0	0	2.061	
22:44:21	1473.81	0	0	1	0	0	0	2.073	
22:49:21	2587.17	0	0	1	0	0	0	2.081	
22:54:21	2587.17	0	0	1	0	0	0	2.062	
22:59:21	2587.17	0	0	1	0	0	0	2.062	
23:04:21	415.895	0	0	1	0	0	1	2.062	
23:09:21	415.895	0	0	1	0	0	1	2.097	
23:14:21	415.895	0	0	1	0	0	1	2.086	
23:19:21	3125	0	0	1	0	0	1	2.078	
23:24:21	3125	0	0	1	0	0	1	2.08	
23:29:21	3125	0	0	1	0	0	1	2.069	
23:34:21	1234.28	0	0	1	0	0	1	2.109	
23:39:21	1234.28	0	0	1	0	0	1	2.112	
23:44:21	1234.28	0	0	1	0	0	1	2.088	
23:49:21	2779.98	0	0	1	0	0	1	2.099	
23:54:21	2779.98	0	0	1	0	0	1	2.076	
23:59:21	2779.98	0	0	1	0	0	1	2.064	
Segments	16,731,572	2,715	0	4,378	1,935	1,640	2,260	1.010	Min.
Sum (gpm)	5,577,191	-	-	-	-	-	-	2.734	Max.
(gal) (15x)	83,657,862	-	-	-	-	-	-	1.644	Avg.
Minutes (5x)		13,575	0	21,890	9,675	8,200	11,300		
Hours		226	0	365	161	137	188		

Water Conservation Study
Ft. Drum, NY

TELEMETERING SYSTEM DATALOG #1 - JULY 1995

Time/ Date	Avg. Flow On Post (gpm)	Vault 3 Valve 1 (Tank 3)	Vault 3 Valve 2 (Tank 3)	DANC First Pump Operation	DANC 2nd Pump Operation	Reservoir Draining	Reservoir Filling	DANC Chlorine Residual	
23:26:21	1020.64	1	0	0	0	1	0	1.943	
23:31:21	1228.52	1	0	0	0	1	0	2.054	
23:36:21	1228.52	1	0	0	0	1	0	2.062	
23:41:21	1228.52	1	0	0	0	1	0	2.086	
23:46:21	1198.4	1	0	1	0	1	0	1.337	
23:51:21	1198.4	1	0	1	0	1	0	1.907	
23:56:21	1198.4	1	0	1	0	0	0	1.954	
Segments	16,107,849	3,288	627	3,828	186	1,538	959	0.874	Min.
Sum (gpm)	5,369,283	-	-	-	-	-	-	3.277	Max.
(gal) (15x)	80,539,244	-	-	-	-	-	-	1.562	Avg.
Minutes (5x)		16,440	3,135	19,140	930	7,690	4,795		
Hours		274	52	319	16	128	80		

E M C Engineers, Inc.
Water Conservation Study
Ft. Drum, NY

Prepared by: TCP
1/31/96
EMC #1406.012

SUMMARY - DATALOG #2: WELL OPERATING TIMES (MINUTES)

Date	Well No. 2	Well No. 3	Well No. 4	Well No. 5	Well No. 6	Well No. 7	Well No. 8	Well No. 9	Well No. 10	Well No. 11	Well No. 12	Total
Aug-93	9,660	26,170	9,930	9,795	1,905	6,775	9,680	6,560	22,200	9,310	3,295	115,280
Sep-93	6,365	7,350	5,225	6,510	12,830	12,605	12,665	4,480	13,210	6,200	11,225	98,665
* Oct-93	4,538	24,705	3,918	3,884	14,510	4,228	4,555	10,695	5,296	2,695	2,566	81,590
Nov-93	2,715	16,655	9,240	2,555	14,365	0	10,460	5,460	5,790	100	3,080	70,420
** Dec-93	4,141	11,476	8,802	4,041	8,293	0	8,569	10,075	5,264	0	7,246	67,907
Jan-94	5,255	5,020	10,135	4,800	16,015	0	15,910	13,690	2,160	3,030	9,675	85,690
Feb-94	2,255	16,365	3,620	2,495	9,185	0	9,435	7,775	15,205	4,780	3,080	74,195
Mar-94	12,495	8,505	7,065	7,520	10,420	20	12,110	9,250	5,550	7,590	13,835	94,360
Apr-94	1,230	16,885	15,495	1,570	6,840	0	6,775	5,920	4,110	1,435	2,435	62,695
May-94	3,570	3,555	3,595	3,515	11,265	8,135	7,910	11,240	6,400	3,580	2,570	65,335
Jun-94	9,320	9,525	9,470	9,280	13,090	10,225	9,655	4,940	12,035	9,250	9,480	106,270
Jul-94	10,685	10,590	12,685	10,525	10,480	12,480	10,745	9,475	8,225	10,485	2,810	109,185
Total (Min.)	72,229	156,801	99,180	66,490	129,198	54,468	118,469	99,560	105,445	58,455	71,297	1,031,592
Total (Hours)	1,204	2,613	1,653	1,108	2,153	908	1,974	1,659	1,757	974	1,188	17,193
Aug-94	7,075	7,125	7,005	6,995	7,165	10,055	9,490	7,770	5,375	8,420	7,240	83,715
Sep-94	4,310	4,275	4,320	4,305	6,875	4,120	19,665	5,925	18,515	0	7,690	80,000
Oct-94	865	6,010	7,640	885	8,585	4,885	13,550	825	7,615	855	3,000	54,715
Nov-94	265	6,675	4,790	570	7,890	1,555	6,855	5,135	5,695	275	2,465	42,170
Dec-94	1,315	5,175	950	1,315	7,365	8,535	12,930	7,060	8,530	1,305	1,765	56,245
Jan-95	5,750	6,570	6,615	5,835	6,610	11,685	15,425	4,750	8,465	5,815	1,035	78,555
Feb-95	2,970	5,590	6,380	2,970	3,530	9,540	7,005	6,520	5,135	2,920	8,090	60,650
Mar-95	2,005	7,785	9,420	1,970	6,145	7,505	7,255	2,005	5,935	1,985	7,600	59,610
Apr-95	1,075	7,350	6,365	1,070	7,285	8,160	7,260	570	1,155	1,095	7,960	49,345
May-95	6,250	8,955	8,965	6,285	7,255	10,830	8,775	6,170	7,995	6,180	8,445	86,105
*** Jun-95	9,925	9,038	15,500	10,188	19,250	9,175	13,550	0	11,025	10,088	10,013	117,752
Jul-95	17,705	17,055	13,040	17,130	17,320	17,275	17,250	13,475	10,280	23,485	17,365	181,380
Total (Min.)	59,510	91,603	90,990	59,518	105,275	103,320	139,010	60,205	95,720	62,423	82,668	950,242
Total (Hours)	992	1,527	1,517	992	1,755	1,722	2,317	1,003	1,595	1,040	1,378	15,837
Avg. (Min.)	65,870	124,202	95,085	63,004	117,237	78,894	128,740	79,883	100,583	60,439	76,983	990,917
Avg. (Hours)	1,098	2,070	1,585	1,050	1,954	1,315	2,146	1,331	1,676	1,007	1,283	16,515

Annual operating hours as recorded by telemetry system. Operation of each well was checked by system every five minutes.

*Note: Telemetry data was incomplete, data was missing from October 12 to October 25. Values were extrapolated to estimate usage for 31 days.

**Note: Telemetry data was incomplete, data was given from December 1 to December 28. Values were extrapolated to estimate usage for 31 days.

***Note: Telemetry data was incomplete, data was given from June 1 to June 12. Values were extrapolated to estimate usage for 30 days.

WELL OPERATING HOURS - AUGUST 1993

	Well No. 2	Well No. 3	Well No. 4	Well No. 5	Well No. 6	Well No. 7	Well No. 8	Well No. 9	Well No. 10	Well No. 11	Well No. 12
23:38:41	0	1	0	1	0	0	1	0	1	0	0
23:43:41	0	1	0	1	0	0	1	0	1	0	0
23:48:41	0	1	0	1	0	0	1	0	1	0	0
23:53:41	0	1	0	1	0	0	1	0	1	0	0
23:58:41	0	1	0	1	0	0	1	0	1	0	0
Segments	1,932	5,234	1,986	1,959	381	1,355	1,936	1,312	4,440	1,862	659
Minutes (5X)	9,660	26,170	9,930	9,795	1,905	6,775	9,680	6,560	22,200	9,310	3,295
Hours	161.00	436.17	165.50	163.25	31.75	112.92	161.33	109.33	370.00	155.17	54.92

WELL OPERATING HOURS - SEPTEMBER 1993

	Well No 2	Well No. 3	Well No. 4	Well No. 5	Well No. 6	Well No 7	Well No. 8	Well No. 9	Well No. 10	Well No. 11	Well No. 12
23:23:33	1	0	0	0	1	0	1	0	1	0	0
23:28:33	1	0	0	0	1	0	1	0	1	0	0
23:33:33	1	0	0	0	1	0	1	0	1	0	0
23:38:33	1	0	0	0	1	0	1	0	1	0	0
23:43:33	1	0	0	0	1	0	1	0	1	0	0
23:48:33	1	0	0	0	1	0	1	0	1	0	0
23:53:33	1	0	0	0	1	0	1	0	1	0	0
23:58:33	1	0	0	0	1	0	1	0	1	0	0
Segments	1,253	1,470	1,045	1,302	2,566	2,521	2,533	896	2,642	1,240	2,245
Minutes (5X)	6,265	7,350	5,225	6,510	12,830	12,605	12,665	4,480	13,210	6,200	11,225
Hours	104.42	122.50	87.08	108.50	213.83	210.08	211.08	74.67	220.17	103.33	187.08

WELL OPERATING HOURS - OCTOBER 1993

	Well No. 2	Well No. 3	Well No. 4	Well No. 5	Well No. 6	Well No. 7	Well No. 8	Well No. 9	Well No. 10	Well No. 11	Well No. 12
20:39:00	0	0	0	0	0	0	0	0	0	0	0
20:44:00	0	0	0	0	0	0	0	0	0	0	0
20:49:00	0	0	0	0	0	0	0	0	0	0	0
20:54:00	0	0	0	0	0	0	0	0	0	0	0
20:59:00	0	0	0	0	0	0	0	0	0	0	0
21:04:00	0	0	0	0	0	0	0	0	0	0	0
21:09:00	0	0	0	0	0	0	0	0	0	0	0
21:14:00	0	0	0	0	0	0	0	0	0	0	0
21:19:00	0	0	0	0	0	0	0	0	0	0	0
21:24:00	0	0	0	0	0	0	0	0	0	0	0
21:29:00	0	0	0	0	0	0	0	0	0	0	0
21:34:00	0	0	0	0	0	0	0	0	0	0	0
21:39:00	0	0	0	0	0	0	0	0	0	0	0
21:44:00	0	0	0	0	0	0	0	0	0	0	0
21:49:00	0	0	0	0	0	0	0	0	0	0	0
21:54:00	0	0	0	0	0	0	0	0	0	0	0
21:59:00	0	0	0	0	0	0	0	0	0	0	0
22:04:00	0	0	0	0	0	0	0	0	0	0	0
22:09:00	0	0	0	0	0	0	0	0	0	0	0
22:14:00	0	0	0	0	0	0	0	0	0	0	0
22:19:00	0	0	0	0	0	0	0	0	0	0	0
22:24:00	0	0	0	0	0	0	0	0	0	0	0
22:29:00	0	0	0	0	0	0	0	0	0	0	0
22:34:00	0	0	0	0	0	0	0	0	0	0	0
22:39:00	0	0	0	0	0	0	0	0	0	0	0
22:44:00	0	0	0	0	0	0	0	0	0	0	0
22:49:00	0	0	0	0	0	0	0	0	0	0	0
22:54:00	0	0	0	0	0	0	0	0	0	0	0
22:59:00	0	0	0	0	0	0	0	0	0	0	0
23:04:00	0	0	0	0	0	0	0	0	0	0	0
23:09:00	0	0	0	0	0	0	0	0	0	0	0
23:14:00	0	0	0	0	0	0	0	0	0	0	0
23:19:00	0	0	0	0	0	0	0	0	0	0	0
23:24:00	0	0	0	0	0	0	0	0	0	0	0
23:29:00	0	0	0	0	0	0	0	0	0	0	0
23:34:00	0	0	0	0	0	0	0	0	0	0	0
23:39:00	0	0	0	0	0	0	0	0	0	0	0
23:44:00	0	0	0	0	0	0	0	0	0	0	0
23:49:00	0	0	0	0	0	0	0	0	0	0	0
23:54:00	0	0	0	0	0	0	0	0	0	0	0
23:59:00	0	0	0	0	0	0	0	0	0	0	0
Segments	527	2,869	455	451	1,685	491	529	1,242	615	313	298
Minutes (5X)	2,635	14,345	2,275	2,255	8,425	2,455	2,645	6,210	3,075	1,565	1,490
Hours	43.92	239.08	37.92	37.58	140.42	40.92	44.08	103.50	51.25	26.08	24.83

*Note: Telemetry data is incomplete. Data is missing from October 12 to October 25.

Assume data is extrapolated to 31 days:

Minutes	4,538	24,705	3,918	3,884	14,510	4,228	4,555	10,695	5,296	2,695	2,566
Hours	75.63	411.75	65.30	64.73	241.83	70.47	75.92	178.25	88.26	44.92	42.77

WELL OPERATING HOURS - NOVEMBER 1993

	Well No. 2	Well No. 3	Well No. 4	Well No. 5	Well No. 6	Well No. 7	Well No. 8	Well No. 9	Well No. 10	Well No. 11	Well No. 12
21:46:31	0	0	0	0	0	0	1	0	0	0	1
21:51:31	0	0	0	0	0	0	1	0	0	0	1
21:56:31	0	0	0	0	0	0	1	0	0	0	1
22:01:31	0	0	0	0	0	0	1	0	0	0	1
22:06:31	0	0	0	0	0	0	1	0	0	0	1
22:11:31	0	0	0	0	0	0	1	0	0	0	1
22:16:31	0	0	0	0	0	0	1	0	0	0	1
22:21:31	0	0	0	0	0	0	1	0	0	0	1
22:26:31	0	0	0	0	0	0	1	0	0	0	1
22:31:31	0	0	0	0	0	0	1	0	0	0	1
22:36:31	0	0	0	0	0	0	1	0	0	0	1
22:41:31	0	0	0	0	0	0	1	0	0	0	1
22:46:31	0	0	0	0	0	0	1	0	0	0	1
22:51:31	0	0	0	0	0	0	1	0	0	0	1
22:56:31	0	0	0	0	0	0	1	0	0	0	1
23:01:31	0	0	0	0	0	0	1	0	0	0	1
23:06:31	0	0	0	0	0	0	1	0	0	0	1
23:11:31	0	0	0	0	0	0	1	0	0	0	1
23:16:31	0	0	0	0	0	0	1	0	0	0	1
23:21:31	0	0	0	0	0	0	1	0	0	0	1
23:26:31	0	0	0	0	0	0	1	0	0	0	1
23:31:31	0	0	0	0	0	0	1	0	0	0	1
23:36:31	0	0	0	0	0	0	1	0	0	0	1
23:41:31	0	0	0	0	0	0	1	0	0	0	1
23:46:31	0	0	0	0	0	0	1	0	0	0	1
23:51:31	0	0	0	0	0	0	1	0	0	0	1
23:56:31	0	0	0	0	0	0	1	0	0	0	1
Segments	543	3,331	1,848	511	2,873	0	2,092	1,092	1,158	20	616
Minutes (5X)	2,715	16,655	9,240	2,555	14,365	0	10,460	5,460	5,790	100	3,080
Hours	45.25	277.58	154.00	42.58	239.42	0.00	174.33	91.00	96.50	1.67	51.33

WELL OPERATING HOURS - DECEMBER 1993

	Well No. 2	Well No. 3	Well No. 4	Well No. 5	Well No. 6	Well No. 7	Well No. 8	Well No. 9	Well No. 10	Well No. 11	Well No. 12
5:57:55	0	0	1	0	0	0	0	0	0	0	1
6:02:55	0	0	1	0	0	0	0	0	0	0	1
6:07:55	0	0	1	0	0	0	0	0	0	0	1
6:12:55	0	0	1	0	0	0	0	0	0	0	1
6:17:55	0	0	1	0	0	0	0	0	0	0	1
6:22:55	0	0	1	0	0	0	0	0	0	0	1
6:27:55	0	0	1	0	0	0	0	0	0	0	1
Segments	748	2,073	1,590	730	1,498	0	1,548	1,820	951	0	1,309
Minutes (5X)	3,740	10,365	7,950	3,650	7,490	0	7,740	9,100	4,755	0	6,545
Hours	62.33	172.75	132.50	60.83	124.83	0.00	129.00	151.67	79.25	0.00	109.08

*Note: Telemetry data is incomplete and only covers from December 1 to December 28 (06:28)

Assume data is extrapolated to 31 days:

Minutes	4,141	11,476	8,802	4,041	8,293	0	8,569	10,075	5,264	0	7,246
Hours	69.01	191.26	146.70	67.35	138.21	0.00	142.82	167.92	87.74	0.00	120.77

WELL OPERATING HOURS - JANUARY 1994

	Well No. 2	Well No. 3	Well No. 4	Well No. 5	Well No. 6	Well No. 7	Well No. 8	Well No. 9	Well No. 10	Well No. 11	Well No 12
22:31:25	1	0	0	0	1	0	0	1	0	1	0
22:36:25	1	0	0	0	1	0	0	1	0	1	0
22:41:25	1	0	0	0	1	0	0	1	0	1	0
22:46:25	1	0	0	1	1	0	0	1	0	1	0
22:51:25	1	1	0	1	1	0	0	1	0	1	0
22:56:25	1	1	1	1	1	0	0	1	0	1	0
23:01:25	1	1	1	1	1	0	0	1	0	1	1
23:06:25	1	1	1	1	1	0	1	1	0	1	1
23:11:25	1	1	1	1	1	0	1	1	0	1	1
23:16:25	1	1	1	1	1	0	1	1	0	1	1
23:21:25	1	1	1	1	1	0	1	1	0	1	1
23:26:25	1	1	1	1	1	0	1	1	0	1	1
23:31:25	1	1	1	1	1	0	1	1	0	1	1
23:36:25	1	1	1	1	1	0	1	1	0	1	1
23:41:25	1	1	1	1	1	0	0	1	0	1	1
23:46:25	1	1	1	1	1	0	0	1	0	1	0
23:51:25	1	1	1	1	1	0	0	1	0	1	0
23:56:25	1	1	0	1	1	0	0	1	0	1	0
Segments	1,051	1,004	2,027	960	3,203	0	3,182	2,738	432	606	1,935
Minutes (5X)	5,255	5,020	10,135	4,800	16,015	0	15,910	13,690	2,160	3,030	9,675
Hours	87.58	83.67	168.92	80.00	266.92	0.00	265.17	228.17	36.00	50.50	161.25

Water Conservation Study
Ft. Drum, NY

WELL OPERATING HOURS - FEBRUARY 1994

	Well No. 2	Well No. 3	Well No. 4	Well No. 5	Well No. 6	Well No. 7	Well No. 8	Well No. 9	Well No. 10	Well No. 11	Well No. 12
23:39:20	0	0	0	0	0	0	1	0	0	0	1
23:44:20	0	0	0	0	0	0	1	0	0	0	1
23:49:20	0	0	0	0	0	0	1	0	0	0	1
23:54:20	0	0	0	0	0	0	1	0	0	0	1
23:59:20	0	0	0	0	0	0	1	0	0	0	1
Segments	451	3,273	724	499	1,837	0	1,887	1,555	3,041	956	616
Minutes (5X)	2,255	16,365	3,620	2,495	9,185	0	9,435	7,775	15,205	4,780	3,080
Hours	37.58	272.75	60.33	41.58	153.08	0.00	157.25	129.58	253.42	79.67	51.33

WELL OPERATING HOURS - MARCH 1994

	Well No. 2	Well No. 3	Well No. 4	Well No. 5	Well No. 6	Well No. 7	Well No. 8	Well No. 9	Well No. 10	Well No. 11	Well No. 12
22:20:28	0	1	1	0	0	0	0	0	0	0	0
22:25:28	0	1	1	0	0	0	0	0	0	0	0
22:30:28	0	1	1	0	0	0	0	0	0	0	0
22:35:28	0	1	1	0	0	0	0	0	0	0	0
22:40:28	0	1	1	1	0	0	0	0	0	0	0
22:45:28	0	1	1	1	0	0	0	0	0	0	0
22:50:28	0	1	1	1	0	0	0	0	0	0	0
22:55:28	0	1	1	1	0	0	0	0	0	1	0
23:00:28	0	1	1	1	0	0	0	0	0	1	0
23:05:28	0	1	1	1	1	0	0	0	0	1	0
23:10:28	1	1	1	1	1	0	0	0	0	1	0
23:15:28	1	1	1	1	1	0	0	0	0	1	0
23:20:28	1	1	1	1	1	0	0	0	0	1	0
23:25:28	1	1	1	1	1	0	0	0	0	1	0
23:30:28	1	1	1	1	1	0	0	0	0	1	0
23:35:28	1	1	1	1	1	0	0	0	0	1	0
23:40:28	0	1	1	1	1	0	0	0	0	1	0
23:45:28	0	1	1	1	1	0	0	0	0	1	0
23:50:28	0	1	1	1	1	0	0	0	0	1	0
23:55:28	0	1	1	1	1	0	0	0	0	1	0
Segments	2,499	1,701	1,413	1,504	2,084	4	2,422	1,850	1,110	1,518	2,767
Minutes (5X)	12,495	8,505	7,065	7,520	10,420	20	12,110	9,250	5,550	7,590	13,835
Hours	208.25	141.75	117.75	125.33	173.67	0.33	201.83	154.17	92.50	126.50	230.58

WELL OPERATING HOURS - APRIL 1994

	Well No. 2	Well No. 3	Well No. 4	Well No. 5	Well No. 6	Well No. 7	Well No. 8	Well No. 9	Well No. 10	Well No. 11	Well No. 12
21:31:07	0	0	0	0	0	0	0	0	0	0	0
21:36:07	0	0	0	0	0	0	0	0	0	0	0
21:41:07	0	0	0	0	0	0	0	0	0	0	0
21:46:07	0	0	0	0	0	0	0	0	0	0	0
21:51:07	0	0	0	0	0	0	0	0	0	0	0
21:56:07	0	0	0	0	0	0	0	0	0	0	0
22:01:07	0	0	0	0	0	0	0	0	0	0	0
22:06:07	0	0	0	0	0	0	0	0	0	0	0
22:11:07	0	0	0	0	0	0	0	0	0	0	0
22:16:07	0	0	0	0	0	0	0	0	0	0	0
22:21:07	0	0	0	0	0	0	0	0	0	0	0
22:26:07	0	0	0	0	0	0	0	0	0	0	0
22:31:07	0	0	0	0	0	0	0	0	0	0	0
22:36:07	0	0	0	0	0	0	0	0	0	0	0
22:41:07	0	0	0	0	0	0	0	0	0	0	0
22:46:07	0	0	0	0	0	0	0	0	0	0	0
22:51:07	0	0	0	0	0	0	0	0	0	0	0
22:56:07	0	0	0	0	0	0	0	0	0	0	0
23:01:07	0	0	0	0	0	0	0	0	0	0	0
23:06:07	0	0	0	0	0	0	0	0	0	0	0
23:11:07	0	0	0	0	0	0	0	0	0	0	0
23:16:07	0	0	0	0	0	0	0	0	0	0	0
23:21:07	0	0	0	0	0	0	0	0	0	0	0
23:26:07	0	0	0	0	0	0	0	0	0	0	0
23:31:07	0	0	0	0	0	0	0	0	0	0	0
23:36:07	0	0	0	0	0	0	0	0	0	0	0
23:41:07	0	0	0	0	0	0	0	0	0	0	0
23:46:07	0	0	0	0	0	0	0	0	0	0	0
23:51:07	0	0	0	0	0	0	0	0	0	0	0
23:56:07	0	0	0	0	0	0	0	0	0	0	0
Segments	246	3,377	3,099	314	1,368	0	1,355	1,184	822	287	487
Minutes (5X)	1,230	16,885	15,495	1,570	6,840	0	6,775	5,920	4,110	1,435	2,435
Hours	20.50	281.42	258.25	26.17	114.00	0.00	112.92	98.67	68.50	23.92	40.58

WELL OPERATING HOURS - MAY 1994

	Well No. 2	Well No. 3	Well No. 4	Well No. 5	Well No. 6	Well No. 7	Well No. 8	Well No. 9	Well No. 10	Well No. 11	Well No. 12
20:42:07	0	0	0	0	0	0	1	0	1	1	0
20:47:07	0	0	0	0	0	0	1	0	1	1	0
20:52:07	0	0	0	0	0	0	1	0	1	0	0
20:57:07	0	0	0	0	0	0	1	0	1	0	0
21:02:07	0	0	0	0	0	0	1	0	1	0	0
21:07:07	0	0	0	0	0	0	1	0	1	0	0
21:12:07	0	0	0	0	0	0	1	0	1	0	0
21:17:07	0	0	0	0	0	0	1	0	1	0	0
21:22:07	0	0	0	0	0	0	1	0	1	0	0
21:27:07	0	0	0	0	0	0	1	0	1	0	0
21:32:07	0	0	0	0	0	0	1	0	1	0	0
21:37:07	0	0	0	0	0	0	1	0	1	0	0
21:42:07	0	0	0	0	0	0	1	0	1	0	0
21:47:07	0	0	0	0	0	0	1	0	1	0	0
21:52:07	0	0	0	0	0	0	1	0	1	0	0
21:57:07	0	0	0	0	0	0	1	0	1	0	0
22:02:07	0	0	0	0	0	0	1	0	1	0	0
22:07:07	0	0	0	0	0	0	1	0	1	0	0
22:12:07	0	0	0	0	0	0	1	0	1	1	0
22:17:07	0	0	0	0	0	0	1	0	1	1	0
22:22:07	0	0	0	0	0	0	1	0	1	1	0
22:27:07	0	0	0	0	0	0	1	0	1	1	0
22:32:07	0	0	0	0	0	0	1	0	1	1	0
22:37:07	0	0	0	0	0	0	1	0	1	1	0
22:42:07	0	0	0	0	0	0	1	0	1	1	0
22:47:07	0	0	0	0	0	0	1	0	1	1	0
22:52:07	0	0	0	0	0	0	1	0	1	0	0
22:57:07	0	0	0	0	0	0	1	0	1	0	0
23:02:07	0	0	0	0	0	0	1	0	1	0	0
23:07:07	0	0	0	0	0	0	1	0	1	0	0
23:12:07	0	0	1	0	0	0	1	0	1	0	0
23:17:07	0	0	1	0	0	0	1	0	1	0	0
23:22:07	0	0	1	0	0	0	1	0	1	0	0
23:27:07	0	0	1	0	0	0	1	0	1	0	0
23:32:07	0	0	1	0	0	0	1	0	1	0	0
23:37:07	0	0	1	0	0	0	1	0	1	0	0
23:42:07	0	0	1	0	0	0	1	0	1	0	0
23:47:07	0	0	1	0	0	0	1	0	1	0	0
23:52:07	0	0	1	0	0	0	1	0	1	0	0
23:57:07	0	0	1	0	0	0	1	0	1	0	0
Segments	714	711	719	703	2,253	1,627	1,582	2,248	1,280	716	514
Minutes (5X)	3,570	3,555	3,595	3,515	11,265	8,135	7,910	11,240	6,400	3,580	2,570
Hours	59.50	59.25	59.92	58.58	187.75	135.58	131.83	187.33	106.67	59.67	42.83

WELL OPERATING HOURS - JUNE 1994

	Well No. 2	Well No. 3	Well No. 4	Well No. 5	Well No. 6	Well No. 7	Well No. 8	Well No. 9	Well No. 10	Well No. 11	Well No. 12
22:56:24	1	0	0	1	1	0	0	0	1	1	0
23:01:24	1	0	0	1	1	0	0	0	1	0	0
23:06:24	0	0	0	1	1	0	0	0	1	0	0
23:11:24	0	0	0	0	1	0	0	0	1	0	0
23:16:24	0	0	0	0	1	0	0	0	1	0	0
23:21:24	0	0	0	0	1	0	0	0	1	0	0
23:26:24	0	0	0	0	1	0	0	0	1	0	0
23:31:24	0	0	0	0	1	0	0	0	1	0	0
23:36:24	0	0	0	0	1	0	0	0	1	0	0
23:41:24	0	0	0	0	1	0	0	0	1	0	0
23:46:24	0	0	0	0	1	0	0	0	1	0	0
23:51:24	0	0	0	0	1	0	0	0	1	0	0
23:56:24	0	0	0	0	1	0	0	0	1	0	0
Segments	1,864	1,905	1,894	1,856	2,618	2,045	1,931	988	2,407	1,850	1,896
Minutes(5X)	9,320	9,525	9,470	9,280	13,090	10,225	9,655	4,940	12,035	9,250	9,480
Hours	155.33	158.75	157.83	154.67	218.17	170.42	160.92	82.33	200.58	154.17	158.00

WELL OPERATING HOURS - JULY 1994

	Well No. 2	Well No. 3	Well No. 4	Well No. 5	Well No. 6	Well No. 7	Well No. 8	Well No. 9	Well No. 10	Well No. 11	Well No. 12
20:54:27	0	0	0	0	0	0	0	0	0	0	0
20:59:27	0	0	0	0	0	0	0	0	0	0	0
21:04:27	0	0	0	0	0	0	0	0	0	0	0
21:09:27	0	0	0	0	0	0	0	0	0	0	0
21:14:27	0	0	0	0	0	0	0	0	0	0	0
21:19:27	0	0	0	0	0	0	0	0	0	0	0
21:24:27	0	0	0	0	0	0	0	0	0	0	0
21:29:27	0	0	0	0	0	0	0	0	0	0	0
21:34:27	0	0	0	0	0	0	0	0	0	0	0
21:39:27	0	0	0	0	0	0	0	0	0	0	0
21:44:27	0	0	0	0	0	0	0	0	0	0	0
21:49:27	0	0	0	0	0	0	0	0	0	0	0
21:54:27	0	0	0	0	0	0	0	0	0	0	0
21:59:27	0	0	0	0	0	0	0	0	0	0	0
22:04:27	0	0	0	0	0	0	0	0	0	0	0
22:09:27	0	0	0	0	0	0	0	0	0	0	0
22:14:27	0	0	0	0	0	0	0	0	0	0	0
22:19:27	0	0	0	0	0	0	0	0	0	0	0
22:24:27	0	0	0	0	0	0	0	0	0	0	0
22:29:27	0	0	0	0	0	0	0	0	0	0	0
22:34:27	0	0	0	0	0	0	0	0	0	0	0
22:39:27	0	0	0	0	0	0	0	0	0	0	0
22:44:27	0	0	0	0	0	0	0	0	0	0	0
22:49:27	0	0	0	0	0	0	0	0	0	0	0
22:54:27	0	0	0	0	0	0	0	0	0	0	0
22:59:27	0	0	0	0	0	0	0	0	0	0	0
23:04:27	0	0	0	0	0	0	0	0	0	0	0
23:09:27	0	0	0	0	0	0	0	0	0	0	0
23:14:27	0	0	0	0	0	0	0	0	0	0	0
23:19:27	0	0	0	0	0	0	0	0	0	0	0
23:24:27	0	0	0	0	0	0	0	0	0	0	0
23:29:27	0	0	0	0	0	0	0	0	0	0	0
23:34:27	0	0	0	0	0	0	0	0	0	0	0
23:39:27	0	0	0	0	0	0	0	0	0	0	0
23:44:27	0	0	0	0	0	0	0	0	0	0	0
23:49:27	0	0	0	0	0	0	0	0	0	0	0
23:54:27	0	0	0	0	0	0	0	0	0	0	0
23:59:27	0	0	0	0	0	0	0	0	0	0	0
Segments	2,137	2,118	2,537	2,105	2,096	2,496	2,149	1,895	1,645	2,097	562
Minutes (5X)	10,685	10,590	12,685	10,525	10,480	12,480	10,745	9,475	8,225	10,485	2,810
Hours	178.08	176.50	211.42	175.42	174.67	208.00	179.08	157.92	137.08	174.75	46.83

WELL OPERATING HOURS - JUNE 1995

	Well No. 2	Well No. 3	Well No. 4	Well No. 5	Well No. 6	Well No. 7	Well No. 8	Well No. 9	Well No. 10	Well No. 11	Well No. 12
3:37:34	0	0	0	0	0	0	0	0	0	0	0
3:42:34	0	0	0	0	0	0	0	0	0	0	0
3:47:34	0	0	0	0	0	0	0	0	0	0	0
3:52:34	0	0	0	0	0	0	0	0	0	0	0
3:57:34	0	0	0	0	0	0	0	0	0	0	0
4:02:34	0	0	0	0	0	0	0	0	0	0	0
4:07:34	0	0	0	0	0	0	0	0	0	0	0
4:12:34	0	0	0	0	0	0	0	0	0	0	0
4:17:34	0	0	0	0	0	0	0	0	0	0	0
4:22:34	0	0	0	0	0	0	0	0	0	0	0
4:27:34	0	0	0	0	0	0	0	0	0	0	0
4:32:34	0	0	0	0	0	0	0	0	0	0	0
4:37:34	0	0	0	0	0	0	0	0	0	0	0
4:42:34	0	0	0	0	0	0	0	0	0	0	0
4:47:34	0	0	0	0	0	0	0	0	0	0	0
4:52:34	0	0	0	0	0	0	0	0	0	0	0
4:57:34	0	0	0	0	0	0	0	0	0	0	0
5:02:34	0	0	0	0	0	0	0	0	0	0	0
5:07:34	0	0	0	0	0	0	0	0	0	0	0
5:12:34	0	0	0	0	0	0	0	0	0	0	0
5:17:34	0	0	0	0	0	0	0	0	0	0	0
5:22:34	0	0	0	0	0	0	0	0	0	0	0
5:27:34	0	0	0	0	0	0	0	0	0	0	0
5:32:34	0	0	0	0	0	0	0	0	0	0	0
5:37:34	0	0	0	0	0	0	0	0	0	0	0
5:42:34	0	0	0	0	0	0	0	0	0	0	0
5:47:34	0	0	0	0	0	0	0	0	0	0	0
5:52:34	0	0	0	0	0	0	0	0	0	0	0
5:57:34	0	0	0	0	0	0	0	0	0	0	0
6:02:34	0	0	0	0	0	0	0	0	0	0	0
6:07:34	0	0	0	0	0	0	0	0	0	0	0
6:12:34	0	0	0	0	0	0	0	0	0	0	0
Segments	794	723	1,240	815	1,540	734	1,084	0	882	807	801
Minutes (5X)	3,970	3,615	6,200	4,075	7,700	3,670	5,420	0	4,410	4,035	4,005
Hours	66.17	60.25	103.33	67.92	128.33	61.17	90.33	0.00	73.50	67.25	66.75

*Note: Telemetry data is incomplete and only covers from June 1 to June 12 (06:12)

Assume data is extrapolated to 30 days:

Minutes	9,925	9,038	15,500	10,188	19,250	9,175	13,550	0	11,025	10,088	10,013
Hours	165.42	150.63	258.33	169.79	320.83	152.92	225.83	0.00	183.75	168.13	166.88

Water Conservation Study
Ft. Drum, NY

WELL OPERATING HOURS - JULY 1995

	Well No. 2	Well No. 3	Well No. 4	Well No. 5	Well No. 6	Well No. 7	Well No. 8	Well No. 9	Well No. 10	Well No. 11	Well No. 12
23:41:22	1	1	1	1	1	1	1	1	0	1	1
23:46:22	1	1	1	1	1	1	1	1	0	1	1
23:51:22	1	1	1	1	1	1	1	1	0	1	1
23:56:22	0	1	1	1	1	1	1	1	0	1	1
Segments	3,541	3,411	2,608	3,426	3,464	3,455	3,450	2,695	2,056	4,697	3,473
Minutes (5X)	17,705	17,055	13,040	17,130	17,320	17,275	17,250	13,475	10,280	23,485	17,365
Hours	295.08	284.25	217.33	285.50	288.67	287.92	287.50	224.58	171.33	391.42	289.42

Water Conservation Study
Ft. Drum, NY

WELL OPERATING HOURS - AUGUST 1994

	Well No. 2	Well No. 3	Well No. 4	Well No. 5	Well No. 6	Well No. 7	Well No. 8	Well No. 9	Well No. 10	Well No. 11	Well No. 12
21:27:40	0	1	0	0	0	0	1	1	0	0	0
21:32:40	0	1	0	0	0	0	1	1	0	0	0
21:37:40	0	1	0	0	1	0	1	1	0	0	0
21:42:40	0	1	0	0	1	0	1	1	0	0	0
21:47:40	0	1	0	0	1	0	1	1	0	0	0
21:52:40	0	1	0	0	1	0	1	1	0	0	0
21:57:40	0	1	0	0	1	0	1	1	0	0	0
22:02:40	0	1	0	0	1	0	1	1	0	0	0
22:07:40	0	1	0	0	1	0	1	1	0	0	0
22:12:40	0	1	0	0	1	0	1	1	0	0	0
22:17:40	1	1	0	0	1	0	1	1	0	0	0
22:22:40	1	1	0	0	1	0	1	1	0	0	0
22:27:40	1	1	0	0	1	0	1	1	0	0	0
22:32:40	1	1	0	0	1	0	1	1	0	0	1
22:37:40	1	1	0	0	1	0	1	1	0	0	1
22:42:39	1	1	0	0	1	0	1	1	0	0	1
22:47:39	1	1	0	0	1	0	1	1	0	0	1
22:52:39	1	1	0	0	1	0	1	1	0	0	1
22:57:39	1	1	0	0	1	0	1	1	0	0	1
23:02:39	1	0	0	0	1	0	1	1	0	0	1
23:07:39	1	0	0	0	0	0	1	1	0	0	1
23:12:39	1	0	0	0	0	0	1	1	0	0	1
23:17:39	1	0	0	0	0	0	1	1	0	0	1
23:22:39	1	0	0	0	0	0	1	1	0	0	1
23:27:39	1	0	0	0	0	0	1	1	0	0	1
23:32:39	1	0	0	0	0	0	1	1	0	0	1
23:37:39	1	0	0	0	0	0	1	1	0	0	1
23:42:39	1	0	0	0	0	0	1	1	0	0	1
23:47:39	1	0	0	0	0	0	1	1	0	0	1
23:52:39	1	0	0	0	0	0	1	1	0	0	1
23:57:39	1	0	0	0	0	0	1	1	0	0	1
Segments	1,415	1,425	1,401	1,399	1,433	2,011	1,898	1,554	1,075	1,684	1,448
Minutes (5X)	7,075	7,125	7,005	6,995	7,165	10,055	9,490	7,770	5,375	8,420	7,240
Hours	117.92	118.75	116.75	116.58	119.42	167.58	158.17	129.50	89.58	140.33	120.67

WELL OPERATING HOURS - SEPTEMBER 1994

	Well No. 2	Well No. 3	Well No. 4	Well No. 5	Well No. 6	Well No. 7	Well No. 8	Well No. 9	Well No. 10	Well No. 11	Well No. 12
21:07:02	0	0	0	0	0	0	1	0	1	0	0
21:12:02	0	0	0	0	0	0	1	0	1	0	0
21:17:02	0	0	0	0	0	0	1	0	1	0	0
21:22:02	0	0	0	0	0	0	1	0	1	0	0
21:27:02	0	0	0	0	0	0	1	0	1	0	0
21:32:02	0	0	0	0	0	0	1	0	1	0	0
21:37:02	0	0	0	0	0	0	1	0	1	0	0
21:42:02	0	0	0	0	0	0	1	0	1	0	0
21:47:02	0	0	0	0	0	0	1	0	1	0	0
21:52:02	0	0	0	0	0	0	1	0	1	0	0
21:57:02	0	0	0	0	0	0	1	0	1	0	0
22:02:02	0	0	0	0	0	0	1	0	1	0	0
22:07:02	0	0	0	0	0	0	1	0	1	0	0
22:12:02	0	0	0	0	0	0	1	0	1	0	0
22:17:02	0	0	0	0	0	0	1	0	1	0	0
22:22:02	0	0	0	0	0	0	1	0	1	0	0
22:27:02	0	0	0	0	0	0	1	0	1	0	0
22:32:02	0	0	0	0	0	0	1	0	1	0	0
22:37:02	0	0	0	0	0	0	1	0	1	0	0
22:42:02	0	0	0	0	0	0	1	0	1	0	0
22:47:02	0	0	0	0	0	0	1	0	1	0	0
22:52:02	0	0	0	0	0	0	1	0	1	0	0
22:57:02	0	0	0	0	0	0	1	0	1	0	0
23:02:02	0	0	0	0	0	0	1	0	1	0	0
23:07:02	0	0	0	0	0	0	1	0	1	0	0
23:12:02	0	0	0	0	0	0	1	0	1	0	0
23:17:02	0	0	0	0	0	0	1	0	1	0	0
23:22:02	0	0	0	0	0	0	1	0	1	0	0
23:27:02	0	0	0	0	0	0	1	0	1	0	0
23:32:02	0	1	0	0	0	0	1	0	1	0	0
23:37:02	0	1	0	1	0	0	1	0	1	0	0
23:42:02	0	1	0	1	0	0	1	0	1	0	0
23:47:02	0	1	0	1	0	0	1	0	1	0	0
23:52:02	0	1	0	1	0	0	1	0	1	0	0
23:57:02	0	0	0	1	0	0	1	0	1	0	0
Segments	862	855	864	861	1,375	824	3,933	1,185	3,703	0	1,538
Minutes (5X)	4,310	4,275	4,320	4,305	6,875	4,120	19,665	5,925	18,515	0	7,690
Hours	71.83	71.25	72.00	71.75	114.58	68.67	327.75	98.75	308.58	0.00	128.17

Water Conservation Study
Ft. Drum, NY

WELL OPERATING HOURS - OCTOBER 1994

	Well No. 2	Well No. 3	Well No. 4	Well No. 5	Well No. 6	Well No. 7	Well No. 8	Well No. 9	Well No. 10	Well No. 11	Well No. 12
20:48:08	0	0	0	0	0	0	0	0	0	0	1
20:53:08	0	0	0	0	0	0	0	0	0	0	1
20:58:08	0	0	0	0	0	0	0	0	0	0	1
21:03:08	0	0	0	0	0	0	0	0	0	0	1
21:08:08	0	0	0	0	0	0	0	0	0	0	1
21:13:08	0	0	0	0	0	0	0	0	0	0	1
21:18:08	0	0	0	0	0	0	0	0	0	0	1
21:23:08	0	0	0	0	0	0	0	0	0	0	1
21:28:08	0	0	0	0	0	0	0	0	0	0	1
21:33:08	0	0	0	0	0	0	0	0	0	0	1
21:38:08	0	0	0	0	0	0	0	0	0	0	1
21:43:08	0	0	0	0	0	0	0	0	0	0	1
21:48:08	0	0	0	0	0	0	0	0	0	0	1
21:53:08	0	0	0	0	0	0	0	0	0	0	1
21:58:08	0	0	0	0	0	0	0	0	0	0	1
22:03:08	0	0	0	0	0	0	0	0	0	0	1
22:08:08	0	0	0	0	0	0	0	0	0	0	1
22:13:08	0	0	0	0	0	0	0	0	0	0	1
22:18:08	0	0	0	0	0	0	0	0	0	0	1
22:23:08	0	0	0	0	0	0	0	0	0	0	1
22:28:08	0	0	0	0	0	0	0	0	0	0	1
22:33:08	0	0	0	0	0	0	0	0	0	0	1
22:38:08	0	0	0	0	0	0	0	0	0	0	1
22:43:08	0	0	0	0	0	0	0	0	0	0	1
22:48:08	0	0	0	0	0	0	0	0	0	0	1
22:53:08	0	0	0	0	0	0	0	0	0	0	1
22:58:08	0	0	0	0	0	0	0	0	0	0	1
23:03:08	0	0	0	0	0	0	0	0	0	0	1
23:08:08	0	0	0	0	0	0	0	0	0	0	1
23:13:08	0	0	0	0	0	0	0	0	0	0	1
23:18:08	0	0	0	0	0	0	0	0	0	0	1
23:23:08	0	0	0	0	0	0	0	0	0	0	1
23:28:07	0	0	0	0	0	0	0	0	0	0	1
23:33:07	0	0	0	0	0	0	0	0	0	0	1
23:38:07	0	0	0	0	0	0	0	0	0	0	1
23:43:07	0	0	0	0	0	0	0	0	0	0	1
23:48:07	0	0	0	0	0	0	0	0	0	0	1
23:53:07	0	0	0	0	0	0	0	0	0	0	1
23:58:07	0	0	0	0	0	0	0	0	0	0	1
Segments	173	1,202	1,528	177	1,717	977	2,710	165	1,523	171	600
Minutes (5X)	865	6,010	7,640	885	8,585	4,885	13,550	825	7,615	855	3,000
Hours	14.42	100.17	127.33	14.75	143.08	81.42	225.83	13.75	126.92	14.25	50.00

WELL OPERATING HOURS - NOVEMBER 1994

	Well No. 2	Well No. 3	Well No. 4	Well No. 5	Well No. 6	Well No. 7	Well No. 8	Well No. 9	Well No. 10	Well No. 11	Well No. 12
5:58:23	0	0	0	0	0	0	0	0	0	0	1
6:03:23	0	0	0	0	0	0	0	0	0	0	1
6:08:23	0	0	0	0	0	0	0	0	0	0	1
6:13:23	0	0	0	0	0	0	0	0	0	0	1
6:18:23	0	0	0	0	0	0	0	0	0	0	1
6:23:23	0	0	0	0	0	0	0	0	0	0	1
6:28:23	0	0	0	0	0	0	0	0	0	0	1
6:33:23	0	0	0	0	0	0	0	0	0	0	1
6:38:23	0	0	0	0	0	0	0	0	0	0	1
6:43:23	0	0	0	0	0	0	0	0	0	0	1
6:48:23	0	0	0	0	0	0	0	0	0	0	1
6:53:23	0	0	0	0	0	0	0	0	0	0	1
6:58:23	0	0	0	0	0	0	0	0	0	0	1
7:03:23	0	0	0	0	0	0	0	0	0	0	1
7:08:23	0	0	0	0	0	0	0	0	0	0	1
7:13:23	0	0	0	0	0	0	0	0	0	0	1
7:18:23	0	0	0	0	0	0	0	0	0	0	1
7:23:23	0	0	0	0	0	0	0	0	0	0	1
7:28:23	0	0	0	0	0	0	0	0	0	0	1
7:33:23	0	0	0	0	0	0	0	0	0	0	1
7:38:23	0	0	0	0	0	0	0	0	0	0	1
7:43:23	0	0	0	0	0	0	0	0	0	0	1
7:48:23	0	0	0	0	0	0	0	0	0	0	1
7:53:23	0	0	0	0	0	0	0	0	0	0	1
7:58:23	0	0	0	0	0	0	0	0	0	0	1
8:03:23	0	0	0	0	0	0	0	0	0	0	1
Segments	53	1,335	958	114	1,578	311	1,371	1,027	1,139	55	493
Minutes (5X)	265	6,675	4,790	570	7,890	1,555	6,855	5,135	5,695	275	2,465
Hours	4.42	111.25	79.83	9.50	131.50	25.92	114.25	85.58	94.92	4.58	41.08

Water Conservation Study
Ft. Drum, NY

WELL OPERATING HOURS - DECEMBER 1994

	Well No. 2	Well No. 3	Well No. 4	Well No. 5	Well No. 6	Well No. 7	Well No. 8	Well No. 9	Well No. 10	Well No. 11	Well No. 12
23:49:18	0	0	0	0	0	0	0	0	0	0	0
23:54:18	0	0	0	0	0	0	0	0	0	0	0
23:59:18	0	0	0	0	0	0	0	0	0	0	0
Segments	263	1,035	190	263	1,473	1,707	2,586	1,412	1,706	261	353
Minutes (5X)	1,315	5,175	950	1,315	7,365	8,535	12,930	7,060	8,530	1,305	1,765
Hours	21.92	86.25	15.83	21.92	122.75	142.25	215.50	117.67	142.17	21.75	29.42

WELL OPERATING HOURS - JANUARY 1995

	Well No. 2	Well No. 3	Well No. 4	Well No. 5	Well No. 6	Well No. 7	Well No. 8	Well No. 9	Well No. 10	Well No. 11	Well No. 12
22:40:33	0	1	1	1	1	0	1	1	0	1	1
22:45:33	0	1	1	1	1	0	1	1	0	1	1
22:50:33	0	1	1	0	1	0	1	1	0	1	1
22:55:33	0	1	1	0	1	0	1	1	0	0	1
23:00:33	0	1	1	0	1	0	1	1	0	0	1
23:05:33	0	1	1	0	1	0	1	0	0	0	1
23:10:33	0	1	1	0	1	0	1	0	0	0	1
23:15:33	0	1	1	0	1	0	1	0	0	0	1
23:20:33	0	1	1	0	1	0	1	0	0	0	1
23:25:33	0	1	1	0	1	0	1	0	0	0	1
23:30:33	0	1	1	0	1	0	1	0	0	0	1
23:35:33	0	1	1	0	1	0	1	0	0	0	1
23:40:33	0	1	1	0	1	0	1	0	0	0	1
23:45:33	0	1	1	0	1	0	1	0	0	0	1
23:50:33	0	1	1	0	1	0	1	0	0	0	1
23:55:33	0	1	1	0	1	0	1	0	0	0	1
Segments	1,150	1,314	1,323	1,167	1,322	2,337	3,085	950	1,693	1,163	207
Minutes (5X)	5,750	6,570	6,615	5,835	6,610	11,685	15,425	4,750	8,465	5,815	1,035
Hours	95.83	109.50	110.25	97.25	110.17	194.75	257.08	79.17	141.08	96.92	17.25

WELL OPERATING HOURS - FEBRUARY 1995

	Well No. 2	Well No. 3	Well No. 4	Well No. 5	Well No. 6	Well No. 7	Well No. 8	Well No. 9	Well No. 10	Well No. 11	Well No. 12
22:32:56	0	1	0	0	0	0	0	0	1	0	0
22:37:56	0	1	0	0	0	0	0	0	1	0	0
22:42:56	0	1	0	0	0	0	0	0	1	0	0
22:47:56	0	1	0	0	0	0	0	0	1	0	0
22:52:56	0	1	0	0	0	0	0	0	1	0	0
22:57:56	0	1	0	0	0	0	0	0	1	0	0
23:02:56	0	1	0	0	0	0	0	0	1	0	0
23:07:56	0	1	0	0	0	0	0	0	1	0	0
23:12:56	0	1	0	0	0	0	0	0	1	0	0
23:17:56	0	1	0	0	0	0	0	0	1	0	0
23:22:56	0	1	0	0	0	0	0	0	1	0	0
23:27:56	0	1	0	0	0	0	0	0	1	0	0
23:32:56	0	1	0	0	0	0	0	0	1	0	0
23:37:56	0	1	0	0	0	0	0	0	1	0	0
23:42:56	0	1	0	0	0	0	0	0	1	0	0
23:47:56	0	1	0	0	0	0	0	0	1	0	0
23:52:56	0	1	0	0	0	0	0	0	1	0	0
23:57:56	0	1	0	0	0	0	0	0	1	0	0
Segments	594	1,118	1,276	594	706	1,908	1,401	1,304	1,027	584	1,618
Minutes (5X)	2,970	5,590	6,380	2,970	3,530	9,540	7,005	6,520	5,135	2,920	8,090
Hours	49.50	93.17	106.33	49.50	58.83	159.00	116.75	108.67	85.58	48.67	134.83

WELL OPERATING HOURS - MARCH 1995

	Well No. 2	Well No. 3	Well No. 4	Well No. 5	Well No. 6	Well No. 7	Well No. 8	Well No. 9	Well No. 10	Well No. 11	Well No. 12
11:15:51	0	1	1	0	0	0	0	0	0	0	0
11:20:51	0	1	1	0	0	0	0	0	0	0	0
11:25:51	0	1	1	0	0	0	0	0	0	0	0
11:30:51	0	1	1	0	0	0	0	0	0	0	0
11:35:51	0	1	1	0	0	0	0	0	0	0	0
11:40:51	0	1	1	0	0	0	0	0	0	0	0
11:45:51	0	1	1	0	0	0	0	0	0	0	0
11:50:51	0	1	1	0	0	0	0	0	0	0	0
11:55:51	0	1	1	0	0	0	0	0	0	0	0
12:00:51	0	1	1	0	0	0	0	0	0	0	0
12:05:51	0	1	1	0	0	0	0	0	0	0	0
12:10:51	0	1	1	0	0	0	0	0	0	0	0
12:15:51	0	1	1	0	0	0	0	0	0	0	0
12:20:51	0	1	1	0	0	0	0	0	0	0	0
12:25:51	0	1	1	0	0	0	0	0	0	0	0
12:30:51	0	1	1	0	0	0	0	0	0	0	0
12:35:51	0	1	1	0	0	0	0	0	0	0	0
12:40:51	0	1	1	0	0	0	0	0	0	0	0
12:45:51	0	1	1	0	0	0	0	0	0	0	0
12:50:51	0	1	1	0	0	0	0	0	0	0	0
12:55:51	0	1	1	0	0	0	0	0	0	0	0
13:00:51	0	1	1	0	0	0	0	0	0	0	0
13:05:51	0	1	1	0	0	0	0	0	0	0	0
13:10:51	0	1	1	0	0	0	0	0	0	0	0
13:15:51	0	1	1	0	0	0	0	0	0	0	0
13:20:51	0	1	1	0	0	0	0	0	0	0	0
13:25:51	0	1	1	0	0	0	0	0	0	0	0
13:30:51	0	1	1	0	0	0	0	0	0	0	0
13:35:51	0	1	1	0	0	0	0	1	0	0	0
13:40:51	1	1	1	0	0	0	0	1	0	0	0
13:45:51	1	1	1	0	0	0	0	1	0	0	0
13:50:51	1	1	1	0	0	0	0	1	0	1	0
13:55:50	1	1	1	0	0	0	0	1	0	1	0
14:00:50	1	1	1	0	0	0	0	1	0	1	0
14:05:50	0	1	1	0	0	0	0	1	0	1	0
14:10:50	0	1	1	0	0	0	0	0	0	1	0
14:15:50	0	1	1	0	0	0	0	0	0	0	0
Segments	401	1,557	1,884	394	1,229	1,501	1,451	401	1,187	397	1,520
Minutes (5X)	2,005	7,785	9,420	1,970	6,145	7,505	7,255	2,005	5,935	1,985	7,600
Hours	33.42	129.75	157.00	32.83	102.42	125.08	120.92	33.42	98.92	33.08	126.67

Water Conservation Study
Ft. Drum, NY

WELL OPERATING HOURS - APRIL 1995

	Well No. 2	Well No. 3	Well No. 4	Well No. 5	Well No. 6	Well No. 7	Well No. 8	Well No. 9	Well No. 10	Well No. 11	Well No. 12
20:32:29	0	0	0	0	0	0	0	0	0	0	0
20:37:29	0	0	0	0	0	0	0	0	0	0	0
20:42:29	0	0	0	0	0	0	0	0	0	0	0
20:47:29	0	0	0	0	0	0	0	0	0	0	0
20:52:29	0	0	0	0	0	0	0	0	0	0	0
20:57:29	0	0	0	0	0	0	0	0	0	0	0
21:02:29	0	0	0	0	0	0	0	0	0	0	0
21:07:29	0	0	0	0	0	0	0	0	0	0	0
21:12:29	0	0	0	0	0	0	0	0	0	0	0
21:17:29	0	0	0	0	0	0	0	0	0	0	0
21:22:29	0	0	0	0	0	0	0	0	0	0	0
21:27:29	0	0	0	0	0	0	0	0	0	0	0
21:32:29	0	0	0	0	0	0	0	0	0	0	0
21:37:29	0	0	0	0	0	0	0	0	0	0	0
21:42:29	0	0	0	0	0	0	0	0	0	0	0
21:47:29	0	0	0	0	0	0	0	0	0	0	0
21:52:29	0	0	0	0	0	0	0	0	0	0	0
21:57:29	0	0	0	0	0	0	0	0	0	0	0
22:02:29	0	0	0	0	0	0	0	0	0	0	0
22:07:29	0	0	0	0	0	0	0	0	0	0	0
22:12:28	0	0	0	0	0	0	0	0	0	0	0
22:17:28	0	0	0	0	0	0	0	0	0	0	0
22:22:28	0	0	0	0	0	0	0	0	0	0	0
22:27:28	0	0	0	0	0	0	0	0	0	0	0
22:32:28	0	0	0	0	0	0	0	0	0	0	0
22:37:28	0	0	0	0	0	0	0	0	0	0	0
22:42:28	0	0	0	0	0	0	0	0	0	0	0
22:47:28	0	0	0	0	0	0	0	0	0	0	0
22:52:28	0	0	0	0	0	0	0	0	0	0	0
22:57:28	0	0	0	0	0	0	0	0	0	0	0
23:02:28	0	0	0	0	0	0	0	0	0	0	0
23:07:28	0	0	0	0	0	0	0	0	0	0	0
23:12:28	0	0	0	0	0	0	0	0	0	0	0
23:17:28	0	0	0	0	0	0	0	0	0	0	0
23:22:28	0	0	0	0	0	0	0	0	0	0	0
23:27:28	0	0	0	0	0	0	0	0	0	0	0
23:32:28	0	0	0	0	0	0	0	0	0	0	0
23:37:28	0	0	0	0	0	0	0	0	0	0	0
23:42:28	0	0	0	0	0	0	0	0	0	0	0
23:47:28	0	0	0	0	0	0	0	0	0	0	0
23:52:28	0	0	0	0	0	0	0	0	0	0	0
23:57:28	0	0	0	0	0	0	0	0	0	0	0
Segments	215	1,470	1,273	214	1,457	1,632	1,452	114	231	219	1,592
Minutes (5X)	1,075	7,350	6,365	1,070	7,285	8,160	7,260	570	1,155	1,095	7,960
Hours	17.92	122.50	106.08	17.83	121.42	136.00	121.00	9.50	19.25	18.25	132.67

WELL OPERATING HOURS - MAY 1995

	Well No. 2	Well No. 3	Well No. 4	Well No. 5	Well No. 6	Well No. 7	Well No. 8	Well No. 9	Well No. 10	Well No. 11	Well No. 12
22:44:07	1	0	0	1	0	0	1	0	1	1	0
22:49:07	0	0	0	1	0	0	1	0	1	1	0
22:54:07	0	0	0	1	0	0	1	0	1	1	0
22:59:07	0	0	0	1	0	0	1	0	1	1	0
23:04:07	0	0	0	1	0	0	1	0	1	1	0
23:09:07	0	0	0	1	0	0	1	0	1	1	0
23:14:07	0	0	0	1	0	0	1	0	1	1	0
23:19:07	0	0	0	1	0	0	1	0	1	1	0
23:24:07	0	0	0	1	0	0	1	0	1	1	0
23:29:07	0	0	0	1	0	0	1	0	1	1	0
23:34:07	0	0	0	1	0	0	1	0	1	1	0
23:39:07	0	0	0	1	0	0	1	0	1	1	0
23:44:07	0	0	0	1	0	0	1	0	1	1	0
23:49:07	0	0	0	1	0	0	1	0	1	1	0
23:54:07	0	0	0	1	0	0	1	0	1	1	0
23:59:07	0	0	0	1	0	0	1	0	1	1	0
Segments	1,250	1,791	1,793	1,257	1,451	2,166	1,755	1.234	1,599	1,236	1,689
Minutes (5X)	6,250	8,955	8,965	6,285	7,255	10,830	8,775	6,170	7,995	6,180	8.445
Hours	104.17	149.25	149.42	104.75	120.92	180.50	146.25	102.83	133.25	103.00	140.75

E M C Engineers, Inc.
Water Conservation Study
Ft. Drum, NY

Prepared by: TCP
2/21/96
EMC #1406.012

DATALOG #3: MONTHLY WATER PRODUCTION

Date	DANC Water (kGal)	Well Water (kGal)	Total Consumed (kGal)	Percentage of Water Purchased	Percentage of Well Water
Jan-93	51,616,589	11,074,049	62,690,638	82.34%	17.66%
Feb-93	48,525,871	9,554,357	58,080,228	83.55%	16.45%
Mar-93	54,756,724	9,717,674	64,474,398	84.93%	15.07%
Apr-93	34,312,524	21,369,480	55,682,004	61.62%	38.38%
May-93	39,371,133	14,650,554	54,021,687	72.88%	27.12%
Jun-93	44,752,142	14,612,138	59,364,280	75.39%	24.61%
Jul-93	46,983,562	22,891,369	69,874,931	67.24%	32.76%
Aug-93	49,012,266	21,012,469	70,024,735	69.99%	30.01%
Sep-93	43,348,871	17,874,997	61,223,868	70.80%	29.20%
Oct-93	42,437,705	16,372,653	58,810,358	72.16%	27.84%
Nov-93	36,935,479	9,506,089	46,441,568	79.53%	20.47%
Dec-93	46,136,198	11,868,428	58,004,626	79.54%	20.46%
Jan-94	48,199,330	13,741,064	61,940,394	77.82%	22.18%
Feb-94	40,084,913	12,090,284	52,175,197	76.83%	23.17%
Mar-94	47,327,854	14,702,874	62,030,728	76.30%	23.70%
Apr-94	41,173,157	8,610,372	49,783,529	82.70%	17.30%
May-94	44,739,281	11,046,712	55,785,993	80.20%	19.80%
Jun-94	44,332,395	21,861,312	66,193,707	66.97%	33.03%
Jul-94	44,844,363	24,990,738	69,835,101	64.21%	35.79%
Aug-94	48,470,775	16,821,081	65,291,856	74.24%	25.76%
Sep-94	37,238,629	12,293,227	49,531,856	75.18%	24.82%
FY-94	521,920,079	173,904,834	695,824,913	75.01%	24.99%
Oct-94	37,598,335	7,061,956	44,660,291	84.19%	15.81%
Nov-94	36,025,164	6,276,778	42,301,942	85.16%	14.84%
Dec-94	45,834,444	8,138,277	53,972,721	84.92%	15.08%
Jan-95	46,724,846	13,963,662	60,688,508	76.99%	23.01%
Feb-95	41,439,819	10,331,624	51,771,443	80.04%	19.96%
Mar-95	46,081,841	9,951,516	56,033,357	82.24%	17.76%
Apr-95	45,236,781	7,948,643	53,185,424	85.05%	14.95%
May-95	48,093,488	16,479,461	64,572,949	74.48%	25.52%
Jun-95	49,966,108	33,718,660	83,684,768	59.71%	40.29%
Jul-95	46,753,343	33,903,043	80,656,386	57.97%	42.03%
*Aug-95	45,425,295	32,655,708	78,081,003	58.18%	41.82%
*Sep-95	44,865,012	22,623,044	67,488,056	66.48%	33.52%
FY-95	534,044,476	203,052,372	737,096,848	72.45%	27.55%
2 Yr. Avg.	527,982,278	188,478,603	716,460,881	73.69%	26.31%

	DANC	Ft. Drum
Aug-93 to Jul-94	528,571,812	183,677,992
Aug-94 to Jul-95	529,463,573	176,887,928
Average	**529,017,693**	**180,282,960**

*Note: Incomplete telemetry data available for this month. Value taken from DANC usage figures.

E M C Engineers, Inc.
Water Conservation Study
Ft. Drum, NY

Prepared by: TCP
1/31/96
EMC #1406.012

DATALOG #3: DAILY WATER USAGE (TELEMETRY SYSTEM DATA)

Date	DANC Total Flow (gal)	WTP Total Flow (gal)	Fire Jockey Pump (cycles)	Monthly Water Totals (gal)
Low	0	0	0	
High	3,000,000	2,500,000	300	
1-Jan-93	2,464,689	71,873	187	
2-Jan-93	2,646,006	5,322	187	
3-Jan-93	3,000,000	7,079	184	
4-Jan-93	3,000,000	7,136	197	
5-Jan-93	2,139,894	401,727	185	
6-Jan-93	1,501,854	325,119	184	
7-Jan-93	1,500,468	460,767	130	
8-Jan-93	1,501,085	390,155	130	
9-Jan-93	1,787,552	68,120	131	
10-Jan-93	1,777,902	7,238	131	
11-Jan-93	1,848,008	26,053	130	
12-Jan-93	1,317,172	294,257	128	
13-Jan-93	1,299,831	314,103	131	
14-Jan-93	1,281,773	376,324	129	
15-Jan-93	1,200,743	516,336	133	
16-Jan-93	626,165	936,186	137	
17-Jan-93	9	1,479,099	142	
18-Jan-93	1,578,597	131,850	142	
19-Jan-93	2,351,767	26,631	141	
20-Jan-93	1,019,282	608,537	142	
21-Jan-93	1,387,055	611,708	142	
22-Jan-93	1,163,375	545,611	141	
23-Jan-93	1,501,535	506,566	142	
24-Jan-93	2,179,896	89,227	140	
25-Jan-93	2,216,224	4,417	140	
26-Jan-93	1,500,885	436,870	139	
27-Jan-93	1,500,748	732,469	140	
28-Jan-93	1,502,838	654,690	141	
29-Jan-93	1,502,517	499,572	141	
30-Jan-93	1,577,726	417,588	143	
31-Jan-93	1,740,993	121,419	128	
Monthly Total	51,616,589	11,074,049	4,538	62,690,637
1-Feb-93	2,334,464	119,591	128	
2-Feb-93	1,945,400	508,342	122	
3-Feb-93	1,791,460	489,806	122	
4-Feb-93	1,342,397	343,682	122	
5-Feb-93	1,505,788	338,436	121	
6-Feb-93	2,181,037	103,386	122	
7-Feb-93	1,988,380	8,645	120	
8-Feb-93	2,609,532	8,862	115	
9-Feb-93	1,510,185	798,927	120	
10-Feb-93	1,511,729	822,321	122	
11-Feb-93	1,592,068	652,939	122	
12-Feb-93	1,510,411	529,983	122	
13-Feb-93	2,041,241	79,621	128	
14-Feb-93	1,944,435	5,929	133	
15-Feb-93	1,910,808	6,058	134	
16-Feb-93	2,089,144	0	132	

DATALOG #3: DAILY WATER USAGE (TELEMETRY SYSTEM DATA)

Date	DANC Total Flow (gal)	WTP Total Flow (gal)	Fire Jockey Pump (cycles)	Monthly Water Totals (gal)
17-Feb-93	1,489,606	375,314	129	
18-Feb-93	1,521,609	526,149	129	
19-Feb-93	1,402,857	492,297	128	
20-Feb-93	1,979,598	80,464	127	
21-Feb-93	2,041,523	3,809	125	
22-Feb-93	2,132,905	4,625	151	
23-Feb-93	1,253,095	635,898	126	
24-Feb-93	946,352	914,810	126	
25-Feb-93	941,176	960,673	128	
26-Feb-93	1,249,475	718,661	127	
27-Feb-93	1,811,340	20,504	128	
28-Feb-93	1,947,856	4,624	126	
Monthly Total	48,525,871	9,554,357	3,535	58,080,228
1-Mar-93	2,184,307	4,984	126	
2-Mar-93	1,501,177	381,876	130	
4-Mar-93	1,509,401	555,575	133	
5-Mar-93	1,501,070	531,703	133	
6-Mar-93	2,534,292	50,105	134	
7-Mar-93	2,544,535	1,360	133	
8-Mar-93	2,592,456	1,547	133	
9-Mar-93	1,500,443	355,475	133	
10-Mar-93	1,500,394	702,649	134	
11-Mar-93	1,501,758	687,380	135	
12-Mar-93	1,501,581	608,685	136	
13-Mar-93	2,125,132	99,159	138	
14-Mar-93	1,996,070	2,506	141	
15-Mar-93	2,579,889	4,309	139	
16-Mar-93	1,502,182	291,938	140	
17-Mar-93	1,563,608	709,725	143	
18-Mar-93	1,726,787	654,017	141	
19-Mar-93	1,700,403	343,587	139	
20-Mar-93	1,975,275	76,839	142	
21-Mar-93	1,846,842	3,999	143	
22-Mar-93	2,065,003	0	145	
23-Mar-93	1,501,536	373,463	143	
24-Mar-93	1,500,662	394,425	146	
25-Mar-93	1,500,745	651,499	146	
26-Mar-93	1,535,150	565,280	146	
27-Mar-93	2,010,744	105,794	146	
28-Mar-93	2,335,720	970	146	
29-Mar-93	2,318,396	0	146	
30-Mar-93	1,501,830	722,211	145	
31-Mar-93	1,099,336	836,614	156	
Monthly Total	54,756,724	9,717,674	4,191	64,474,398
1-Apr-93	1,064,618	731,100	175	
2-Apr-93	1,496,589	445,972	164	
3-Apr-93	1,267,605	638,925	155	
4-Apr-93	1,944,367	3	154	
5-Apr-93	2,084,071	278	147	
6-Apr-93	1,155,357	958,027	152	

E M C Engineers, Inc.
Water Conservation Study
Ft. Drum, NY

Prepared by: TCP
1/31/96
EMC #1406.012

DATALOG #3: DAILY WATER USAGE (TELEMETRY SYSTEM DATA)

Date	DANC Total Flow (gal)	WTP Total Flow (gal)	Fire Jockey Pump (cycles)	Monthly Water Totals (gal)
7-Apr-93	1,099,776	488,614	114	
8-Apr-93	998,402	716,813	153	
9-Apr-93	1,259,944	613,839	153	
10-Apr-93	1,107,054	673,935	159	
11-Apr-93	1,993,171	370	161	
12-Apr-93	2,090,336	0	157	
13-Apr-93	1,175,638	668,192	157	
14-Apr-93	1,175,203	709,384	156	
15-Apr-93	1,148,637	809,192	157	
16-Apr-93	501,667	1,231,067	160	
17-Apr-93	601,653	1,104,827	157	
18-Apr-93	1,738,532	119	153	
19-Apr-93	2,121,165	0	152	
20-Apr-93	500,489	1,097,285	156	
21-Apr-93	501,892	1,130,635	153	
22-Apr-93	500,513	1,304,898	158	
23-Apr-93	501,855	1,322,979	147	
24-Apr-93	547,942	1,235,820	145	
25-Apr-93	2,023,485	0	143	
26-Apr-93	1,873,847	0	149	
27-Apr-93	500,665	1,324,849	149	
28-Apr-93	501,050	1,342,792	145	
29-Apr-93	500,658	1,397,587	144	
30-Apr-93	336,343	1,421,977	150	
Monthly Total	34,312,524	21,369,480	4,575	55,682,004
1-May-93	500,866	1,105,068	149	
2-May-93	1,846,626	1,285	148	
3-May-93	1,994,750	545	146	
4-May-93	500,882	1,267,056	145	
5-May-93	501,916	1,562,402	145	
6-May-93	1,400,673	748,718	146	
7-May-93	1,409,133	498,755	145	
8-May-93	1,535,244	426,841	130	
9-May-93	1,911,199	3,388	123	
10-May-93	2,002,557	2,704	121	
11-May-93	1,294,427	621,844	119	
12-May-93	1,303,092	531,270	118	
13-May-93	1,345,622	656,893	117	
14-May-93	1,281,494	877,797	114	
15-May-93	1,279,678	740,557	113	
16-May-93	1,772,883	51,521	112	
17-May-93	1,953,386	4,638	109	
18-May-93	1,092,924	565,151	110	
19-May-93	1,092,281	844,924	114	
20-May-93	1,091,891	764,263	116	
21-May-93	1,093,288	887,405	113	
22-May-93	1,212,138	843,900	112	
23-May-93	1,955,562	773	115	
24-May-93	2,278,001	0	114	
25-May-93	1,199,788	734,046	114	

E M C Engineers, Inc.
Water Conservation Study
Ft. Drum, NY

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1/31/96
EMC #1406.012

DATALOG #3: DAILY WATER USAGE (TELEMETRY SYSTEM DATA)

Date	DANC Total Flow (gal)	WTP Total Flow (gal)	Fire Jockey Pump (cycles)	Monthly Water Totals (gal)
29-May-93	809,388	908,811	116	
30-May-93	1,809,821	0	115	
31-May-93	1,901,623	0	113	
Monthly Total	39,371,133	14,650,554	3,452	54,021,687
1-Jun-93	2,121,449	0	114	
2-Jun-93	400,792	1,361,914	115	
3-Jun-93	1,427,249	806,590	118	
4-Jun-93	1,423,590	842,030	115	
5-Jun-93	1,129,698	593,032	113	
6-Jun-93	1,542,591	4,303	113	
7-Jun-93	1,912,030	461	115	
8-Jun-93	1,469,747	310,566	114	
9-Jun-93	1,315,101	441,627	115	
10-Jun-93	1,337,840	425,000	115	
11-Jun-93	1,400,000	420,000	115	
12-Jun-93	1,894,467	508,712	107	
13-Jun-93	2,879,290	0	110	
14-Jun-93	2,796,047	0	111	
15-Jun-93	871,702	1,089,278	108	
16-Jun-93	870,023	942,724	109	
17-Jun-93	870,110	964,262	107	
18-Jun-93	869,901	1,061,125	105	
19-Jun-93	868,703	843,740	99	
20-Jun-93	1,775,450	120	104	
21-Jun-93	1,907,885	0	105	
22-Jun-93	1,428,370	344,477	106	
23-Jun-93	1,438,833	297,850	105	
24-Jun-93	1,477,630	548,509	104	
25-Jun-93	1,478,148	513,759	103	
26-Jun-93	1,672,912	574,463	103	
27-Jun-93	1,828,374	528	105	
28-Jun-93	1,905,485	0	105	
29-Jun-93	1,220,116	625,087	106	
30-Jun-93	1,218,609	1,091,981	102	
Monthly Total	44,752,142	14,612,138	3,266	59,364,280
1-Jul-93	1,218,911	1,011,344	101	
2-Jul-93	1,218,410	999,237	102	
3-Jul-93	1,391,336	482,040	99	
4-Jul-93	1,926,642	0	98	
5-Jul-93	1,939,423	0	99	
6-Jul-93	2,235,181	0	98	
7-Jul-93	1,219,668	813,493	99	
8-Jul-93	1,218,768	849,883	98	
9-Jul-93	1,219,823	986,647	99	
10-Jul-93	1,356,600	796,762	97	
11-Jul-93	2,214,023	3,848	89	
12-Jul-93	2,601,163	0	88	
13-Jul-93	1,219,814	693,959	90	
14-Jul-93	1,219,664	811,126	88	
15-Jul-93	1,019,857	902,785	90	

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DATALOG #3: DAILY WATER USAGE (TELEMETRY SYSTEM DATA)

Date	DANC Total Flow (gal)	WTP Total Flow (gal)	Fire Jockey Pump (cycles)	Monthly Water Totals (gal)
16-Jul-93	808,180	1,275,951	91	
17-Jul-93	981,769	1,212,507	89	
18-Jul-93	2,083,197	1,378	88	
19-Jul-93	2,581,807	0	87	
20-Jul-93	1,023,174	1,116,360	88	
21-Jul-93	1,110,159	1,332,652	87	
22-Jul-93	1,108,178	1,172,548	84	
23-Jul-93	1,109,114	1,027,797	84	
24-Jul-93	1,369,562	647,680	85	
25-Jul-93	2,340,203	2,205	85	
26-Jul-93	2,570,189	554	86	
27-Jul-93	1,027,482	1,367,698	86	
28-Jul-93	1,330,275	1,949,791	87	
29-Jul-93	2,031,429	1,347,705	86	
30-Jul-93	1,441,071	1,077,955	89	
31-Jul-93	848,490	1,007,464	86	
Monthly Total	46,983,562	22,891,369	2,823	69,874,931
1-Aug-93	1,921,942	3,996	88	
2-Aug-93	2,181,404	0	86	
3-Aug-93	1,182,711	865,583	85	
4-Aug-93	1,311,528	901,037	85	
5-Aug-93	1,000,103	1,054,928	84	
6-Aug-93	1,175,085	959,765	85	
7-Aug-93	1,134,151	1,038,274	88	
8-Aug-93	1,941,151	3,388	87	
9-Aug-93	2,239,900	0	88	
10-Aug-93	1,198,067	899,373	86	
11-Aug-93	1,200,579	1,069,665	86	
12-Aug-93	1,002,013	1,023,247	84	
13-Aug-93	1,602,019	958,155	84	
14-Aug-93	1,500,471	1,004,203	81	
15-Aug-93	2,331,396	1,045	82	
16-Aug-93	2,384,745	0	83	
17-Aug-93	1,001,804	1,298,458	81	
18-Aug-93	2,266,025	290,462	81	
19-Aug-93	1,200,812	1,027,124	81	
20-Aug-93	1,000,804	1,100,655	84	
21-Aug-93	1,588,904	802,546	83	
22-Aug-93	1,741,397	2,642	81	
23-Aug-93	2,451,364	479	80	
24-Aug-93	1,124,910	900,194	80	
25-Aug-93	1,186,373	1,120,784	82	
26-Aug-93	802,258	1,369,860	84	
27-Aug-93	1,047,111	1,279,732	85	
28-Aug-93	1,816,744	1,214,440	82	
29-Aug-93	2,225,817	0	87	
30-Aug-93	2,630,050	0	86	
31-Aug-93	1,620,628	822,435	85	
Monthly Total	49,012,266	21,012,469	2,604	70,024,735
1-Sep-93	901,877	1,261,883	89	

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DATALOG #3: DAILY WATER USAGE (TELEMETRY SYSTEM DATA)

Date	DANC Total Flow (gal)	WTP Total Flow (gal)	Fire Jockey Pump (cycles)	Monthly Water Totals (gal)
2-Sep-93	1,356,033	867,695	90	
3-Sep-93	1,196,135	921,879	93	
4-Sep-93	1,382,528	766,813	94	
5-Sep-93	1,811,220	0	92	
6-Sep-93	1,225,493	484,379	91	
7-Sep-93	2,072,158	3,031	92	
8-Sep-93	1,430,154	931,934	91	
9-Sep-93	1,444,991	794,604	87	
10-Sep-93	904,557	1,047,826	88	
11-Sep-93	1,119,198	819,249	86	
12-Sep-93	1,752,570	0	84	
13-Sep-93	2,166,854	0	89	
14-Sep-93	1,476,266	650,460	93	
15-Sep-93	1,443,293	1,002,785	104	
16-Sep-93	1,443,130	990,458	90	
17-Sep-93	1,357,882	916,740	82	
18-Sep-93	1,329,166	829,923	78	
19-Sep-93	1,647,587	0	78	
20-Sep-93	2,086,556	375	76	
21-Sep-93	2,168,444	12,881	74	
22-Sep-93	1,153,489	908,744	84	
23-Sep-93	1,149,271	857,603	66	
24-Sep-93	1,149,118	871,759	66	
25-Sep-93	1,146,889	710,602	69	
26-Sep-93	1,711,663	5,793	66	
27-Sep-93	1,973,469	4,321	64	
28-Sep-93	1,154,000	1,025,685	66	
29-Sep-93	1,135,881	397,052	66	
30-Sep-93	1,058,999	790,523	66	
Monthly Total	43,348,871	17,874,997	2,454	61,223,868
1-Oct-93	972,772	1,059,018	66	
2-Oct-93	1,053,525	1,103,270	67	
3-Oct-93	2,704,764	0	65	
4-Oct-93	2,748,211	0	66	
5-Oct-93	1,430,209	380,925	66	
6-Oct-93	128,979	1,212,375	67	
7-Oct-93	1,710,797	432,124	66	
8-Oct-93	1,461,533	372,338	64	
9-Oct-93	733,221	840,673	67	
10-Oct-93	1,783,129	0	65	
11-Oct-93	1,739,160	0	65	
12-Oct-93	2,182,112	0	66	
13-Oct-93	1,042,465	1,042,565	64	
14-Oct-93	1,070,771	907,471	65	
15-Oct-93	812,023	951,161	66	
16-Oct-93	843,073	878,381	65	
17-Oct-93	1,716,208	0	67	
18-Oct-93	1,904,262	82	67	
19-Oct-93	868,848	904,225	65	
20-Oct-93	793,905	908,923	69	

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DATALOG #3: DAILY WATER USAGE (TELEMETRY SYSTEM DATA)

Date	DANC Total Flow (gal)	WTP Total Flow (gal)	Fire Jockey Pump (cycles)	Monthly Water Totals (gal)
21-Oct-93	860,597	946,237	69	
22-Oct-93	1,479,983	666,759	70	
23-Oct-93	1,064,481	575,092	71	
24-Oct-93	1,683,333	0	70	
25-Oct-93	2,029,200	0	73	
26-Oct-93	778,266	977,557	74	
27-Oct-93	1,479,784	499,894	75	
28-Oct-93	911,439	726,937	79	
29-Oct-93	1,487,811	522,873	80	
30-Oct-93	1,233,503	463,052	82	
31-Oct-93	1,729,341	721	86	
Monthly Total	42,437,705	16,372,653	2,147	58,810,358
1-Nov-93	2,023,697	0	91	
2-Nov-93	1,508,617	646,499	103	
3-Nov-93	1,179,945	551,825	92	
4-Nov-93	1,320,179	580,718	96	
5-Nov-93	1,346,341	561,856	96	
6-Nov-93	1,167,820	536,733	101	
7-Nov-93	1,503,100	10,733	94	
8-Nov-93	1,776,007	356	95	
9-Nov-93	848,233	907,002	95	
10-Nov-93	1,101,974	856,451	110	
11-Nov-93	732,129	946,990	98	
12-Nov-93	1,297,019	43,215	108	
13-Nov-93	1,718,960	1,988	102	
14-Nov-93	1,545,091	733	106	
15-Nov-93	1,847,006	618	99	
16-Nov-93	1,119,535	418,659	95	
17-Nov-93	1,182,585	512,539	101	
18-Nov-93	819,700	403,080	102	
19-Nov-93	959,370	372,893	105	
20-Nov-93	1,148,648	381,535	98	
21-Nov-93	1,629,701	1,955	100	
22-Nov-93	1,577,002	2,782	100	
23-Nov-93	1,438,719	610,658	101	
24-Nov-93	1,267,552	538,733	99	
25-Nov-93	1,426,500	218,472	102	
26-Nov-93	450,049	2,828	98	
27-Nov-93	0	4,115	101	
28-Nov-93	0	4,070	115	
29-Nov-93	3,000,000	1,257	101	
30-Nov-93	0	386,797	105	
Monthly Total	36,935,479	9,506,089	3,009	46,441,568
1-Dec-93	1,533,573	300,603	109	
2-Dec-93	1,451,778	283,902	105	
3-Dec-93	1,296,810	274,568	103	
4-Dec-93	1,761,085	566,894	103	
5-Dec-93	3,000,000	156,063	101	
6-Dec-93	1,977,928	2,760	101	
7-Dec-93	1,737,184	486,684	98	

DATALOG #3: DAILY WATER USAGE (TELEMETRY SYSTEM DATA)

Date	DANC Total Flow (gal)	WTP Total Flow (gal)	Fire Jockey Pump (cycles)	Monthly Water Totals (gal)
8-Dec-93	1,075,774	904,725	102	
9-Dec-93	1,200,282	783,857	101	
10-Dec-93	1,000,375	804,054	103	
11-Dec-93	694,374	961,470	105	
12-Dec-93	1,705,008	23,433	105	
13-Dec-93	1,779,247	4,629	101	
14-Dec-93	720,084	993,968	105	
15-Dec-93	583,601	967,812	106	
16-Dec-93	685,242	961,582	105	
17-Dec-93	1,267,266	365,612	108	
18-Dec-93	1,009,163	428,951	105	
19-Dec-93	1,460,147	14,978	101	
20-Dec-93	1,573,540	2,834	104	
21-Dec-93	1,299,185	363,184	103	
22-Dec-93	1,213,921	300,208	102	
23-Dec-93	1,350,908	255,209	104	
24-Dec-93	1,340,956	131,555	107	
25-Dec-93	1,588,237	4,087	101	
26-Dec-93	1,677,906	2,402	104	
27-Dec-93	2,487,111	115,758	102	
28-Dec-93	1,791,042	377,889	107	
29-Dec-93	1,996,786	505,816	109	
30-Dec-93	1,907,203	406,766	103	
31-Dec-93	1,970,482	116,175	103	
Monthly Total	46,136,198	11,868,428	3,216	58,004,626
1-Jan-94	2,141,288	4,523	103	
2-Jan-94	2,409,099	3,674	105	
3-Jan-94	2,770,191	5,043	106	
4-Jan-94	1,061,906	711,723	111	
5-Jan-94	826,173	870,852	125	
6-Jan-94	786,132	1,152,308	132	
7-Jan-94	585,325	1,045,484	124	
8-Jan-94	1,145,206	597,156	122	
9-Jan-94	1,643,197	48,732	120	
10-Jan-94	2,068,136	5,894	117	
11-Jan-94	1,431,000	328,196	118	
12-Jan-94	1,430,804	666,945	122	
13-Jan-94	1,391,421	751,182	120	
14-Jan-94	1,048,325	582,190	121	
15-Jan-94	1,209,586	421,496	121	
16-Jan-94	1,795,123	5,509	117	
17-Jan-94	1,855,467	8,524	119	
18-Jan-94	2,531,379	7,186	119	
19-Jan-94	1,217,803	468,487	119	
20-Jan-94	1,903,763	501,815	117	
21-Jan-94	1,600,426	436,107	117	
22-Jan-94	1,488,363	402,841	120	
23-Jan-94	2,001,735	4,548	120	
24-Jan-94	1,932,504	6,795	121	
25-Jan-94	1,225,798	875,603	122	

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DATALOG #3: DAILY WATER USAGE (TELEMETRY SYSTEM DATA)

Date	DANC Total Flow (gal)	WTP Total Flow (gal)	Fire Jockey Pump (cycles)	Monthly Water Totals (gal)
26-Jan-94	927,289	836,347	119	
27-Jan-94	930,122	1,000,197	114	
28-Jan-94	882,081	945,484	121	
29-Jan-94	1,302,270	1,035,277	128	
30-Jan-94	2,222,093	4,207	126	
31-Jan-94	2,435,325	6,736	123	
Monthly Total	48,199,330	13,741,064	3,689	61,940,394
1-Feb-94	445,642	1,617,307	122	
2-Feb-94	1,500,640	587,263	121	
3-Feb-94	1,314,385	648,633	122	
4-Feb-94	1,152,730	568,252	123	
5-Feb-94	1,154,348	581,776	121	
6-Feb-94	1,778,975	12,409	122	
7-Feb-94	1,917,463	4,221	120	
8-Feb-94	1,186,175	597,474	119	
9-Feb-94	1,215,372	545,305	121	
10-Feb-94	1,210,242	538,667	121	
11-Feb-94	1,243,126	519,749	121	
12-Feb-94	1,286,041	385,993	122	
13-Feb-94	1,789,666	4,613	119	
14-Feb-94	1,959,667	5,144	120	
15-Feb-94	1,349,419	455,811	119	
16-Feb-94	1,161,154	428,243	123	
17-Feb-94	1,440,070	405,527	122	
18-Feb-94	1,310,852	415,960	123	
19-Feb-94	1,160,103	474,624	121	
20-Feb-94	1,817,159	877	122	
21-Feb-94	2,209,501	3,056	120	
22-Feb-94	2,096,319	6,272	120	
23-Feb-94	1,371,821	1,431,166	121	
24-Feb-94	1,080,480	588,090	121	
25-Feb-94	1,006,867	609,921	119	
26-Feb-94	1,196,381	642,356	119	
27-Feb-94	1,850,507	4,934	120	
28-Feb-94	1,879,808	6,641	118	
Monthly Total	40,084,913	12,090,284	3,382	52,175,197
1-Mar-94	1,583,392	313,788	114	
2-Mar-94	1,509,592	290,443	115	
3-Mar-94	1,685,083	269,197	117	
4-Mar-94	1,829,905	0	117	
5-Mar-94	2,034,510	0	119	
6-Mar-94	1,999,218	0	118	
7-Mar-94	2,190,090	0	118	
8-Mar-94	1,600,971	351,450	119	
9-Mar-94	1,276,348	523,240	121	
10-Mar-94	1,147,523	787,973	120	
11-Mar-94	1,123,931	763,621	119	
12-Mar-94	967,995	952,193	124	
13-Mar-94	1,819,793	0	118	
14-Mar-94	2,232,189	0	119	

DATALOG #3: DAILY WATER USAGE (TELEMETRY SYSTEM DATA)

Date	DANC Total Flow (gal)	WTP Total Flow (gal)	Fire Jockey Pump (cycles)	Monthly Water Totals (gal)
15-Mar-94	1,091,510	767,646	117	
16-Mar-94	884,913	875,177	118	
17-Mar-94	1,059,781	791,021	118	
18-Mar-94	1,169,082	648,021	127	
19-Mar-94	1,228,166	1,133,340	126	
20-Mar-94	1,926,837	0	118	
21-Mar-94	2,175,121	4	120	
22-Mar-94	1,270,394	539,538	119	
23-Mar-94	1,239,694	580,385	121	
24-Mar-94	1,280,194	667,246	118	
25-Mar-94	1,280,016	689,818	117	
26-Mar-94	1,458,717	774,461	118	
27-Mar-94	2,306,883	75	116	
28-Mar-94	2,425,542	139	117	
29-Mar-94	1,366,629	958,768	119	
30-Mar-94	1,181,844	894,005	118	
31-Mar-94	981,991	1,131,325	117	
Monthly Total	47,327,854	14,702,874	3,682	62,030,728
1-Apr-94	981,964	1,084,672	119	
2-Apr-94	1,414,589	360,946	117	
3-Apr-94	1,934,133	65	116	
4-Apr-94	1,745,162	29	110	
5-Apr-94	1,173,951	509,063	118	
6-Apr-94	1,303,681	487,309	134	
7-Apr-94	1,185,539	415,419	119	
8-Apr-94	1,255,080	360,432	119	
9-Apr-94	1,333,867	375,629	117	
10-Apr-94	1,555,291	4,948	118	
11-Apr-94	1,821,965	3,037	116	
12-Apr-94	1,232,655	270,644	119	
13-Apr-94	1,061,466	498,299	116	
14-Apr-94	1,416,654	326,251	119	
15-Apr-94	1,441,993	325,286	119	
16-Apr-94	1,030,803	330,407	120	
17-Apr-94	1,419,993	693	129	
18-Apr-94	1,865,317	788	121	
19-Apr-94	851,659	624,749	128	
20-Apr-94	1,253,779	267,637	120	
21-Apr-94	1,256,318	276,535	119	
22-Apr-94	1,208,699	391,247	119	
23-Apr-94	1,199,323	329,504	119	
24-Apr-94	1,522,502	562	116	
25-Apr-94	1,657,181	595	116	
26-Apr-94	1,305,341	494,663	117	
27-Apr-94	1,335,865	320,862	113	
28-Apr-94	1,750,198	0	112	
29-Apr-94	1,315,368	285,868	116	
30-Apr-94	1,342,821	264,232	112	
Monthly Total	41,173,157	8,610,372	3,553	49,783,529
1-May-94	1,638,517	668	125	

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DATALOG #3: DAILY WATER USAGE (TELEMETRY SYSTEM DATA)

Date	DANC Total Flow (gal)	WTP Total Flow (gal)	Fire Jockey Pump (cycles)	Monthly Water Totals (gal)
2-May-94	1,825,696	607	142	
3-May-94	1,582,168	204,077	146	
4-May-94	1,487,261	216,196	117	
5-May-94	1,478,119	309,487	111	
6-May-94	1,658,493	329,976	122	
7-May-94	1,435,267	262,930	121	
8-May-94	1,666,587	568	119	
9-May-94	1,970,494	496	117	
10-May-94	1,644,387	290,628	120	
11-May-94	1,642,485	344,258	118	
12-May-94	1,642,503	305,401	119	
13-May-94	1,403,069	1,037,006	119	
14-May-94	1,527,452	375,249	118	
15-May-94	1,721,278	631	113	
16-May-94	1,868,512	582	112	
17-May-94	1,147,013	410,036	111	
18-May-94	1,146,919	599,522	131	
19-May-94	899,597	622,820	109	
20-May-94	1,076,178	763,245	59	
21-May-94	1,176,219	707,506	63	
22-May-94	1,673,891	987	61	
23-May-94	2,100,436	973	61	
24-May-94	1,500,702	359,806	60	
25-May-94	1,353,482	1,123,865	60	
26-May-94	36,222	1,158,690	59	
27-May-94	55,824	1,111,077	60	
28-May-94	1,104,179	506,460	59	
29-May-94	1,615,858	1,016	58	
30-May-94	1,590,167	976	58	
31-May-94	2,070,307	972	56	
Monthly Total	44,739,281	11,046,712	3,004	55,785,993
1-Jun-94	900,734	821,190	56	
2-Jun-94	862,449	1,011,122	57	
3-Jun-94	1,329,329	402,181	56	
4-Jun-94	1,680,551	392,665	55	
5-Jun-94	1,898,137	971	56	
6-Jun-94	2,115,021	954	53	
7-Jun-94	1,537,767	633,919	52	
8-Jun-94	1,403,347	437,356	52	
9-Jun-94	1,350,745	691,867	53	
10-Jun-94	1,276,684	796,394	52	
11-Jun-94	1,276,557	833,052	52	
12-Jun-94	1,921,332	7,100	51	
13-Jun-94	2,453,926	1,021	51	
14-Jun-94	2,110,888	1,015,211	51	
15-Jun-94	969,965	1,393,459	49	
16-Jun-94	1,106,991	1,618,870	49	
17-Jun-94	1,068,952	1,329,674	53	
18-Jun-94	2,159,461	299,919	49	
19-Jun-94	2,723,219	976	50	

E M C Engineers, Inc.
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DATALOG #3: DAILY WATER USAGE (TELEMETRY SYSTEM DATA)

Date	DANC Total Flow (gal)	WTP Total Flow (gal)	Fire Jockey Pump (cycles)	Monthly Water Totals (gal)
20-Jun-94	2,764,855	880	49	
21-Jun-94	1,809,310	459,183	49	
22-Jun-94	800,565	1,298,625	48	
23-Jun-94	900,717	1,427,038	47	
24-Jun-94	900,622	1,707,236	46	
25-Jun-94	508,330	1,363,671	47	
26-Jun-94	1,824,023	1,031	46	
27-Jun-94	2,492,909	965	45	
28-Jun-94	406,938	1,407,385	45	
29-Jun-94	427,473	1,606,928	44	
30-Jun-94	1,350,598	900,469	44	
Monthly Total	44,332,395	21,861,312	1,507	66,193,707
1-Jul-94	1,109,230	931,486	44	
2-Jul-94	1,127,680	695,518	42	
3-Jul-94	1,868,036	961	43	
4-Jul-94	2,082,292	945	42	
5-Jul-94	2,224,502	939	42	
6-Jul-94	1,148,623	602,368	42	
7-Jul-94	1,184,193	1,018,384	41	
8-Jul-94	1,184,011	854,909	41	
9-Jul-94	1,226,798	1,070,102	40	
10-Jul-94	1,910,451	13,029	40	
11-Jul-94	1,991,609	973	39	
12-Jul-94	1,303,327	530,897	39	
13-Jul-94	1,303,122	646,238	39	
14-Jul-94	1,302,913	1,114,072	39	
15-Jul-94	1,061,979	1,008,646	38	
16-Jul-94	1,535,528	1,150,995	37	
17-Jul-94	1,757,585	26,756	37	
18-Jul-94	2,324,625	968	37	
19-Jul-94	1,275,819	899,691	36	
20-Jul-94	1,492,152	1,076,273	36	
21-Jul-94	1,204,159	1,578,757	36	
22-Jul-94	2,319,290	1,137,170	2	
23-Jul-94	1,525,741	1,019,869	41	
24-Jul-94	2,269,714	1,103	37	
25-Jul-94	2,692,431	993	36	
26-Jul-94	1,200,530	1,087,357	36	
27-Jul-94	381,790	2,340,549	36	
28-Jul-94	339,156	2,204,897	36	
29-Jul-94	325,387	2,106,359	67	
30-Jul-94	241,496	1,856,084	80	
31-Jul-94	1,930,194	13,451	79	
Monthly Total	44,844,363	24,990,738	1,280	69,835,101
1-Aug-94	2,691,352	1,097	74	
2-Aug-94	1,547,980	944,352	69	
3-Aug-94	1,488,503	956,769	66	
4-Aug-94	1,488,385	1,170,471	62	
5-Aug-94	1,332,210	1,066,585	60	
6-Aug-94	1,109,595	836,213	54	

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DATALOG #3: DAILY WATER USAGE (TELEMETRY SYSTEM DATA)

Date	DANC Total Flow (gal)	WTP Total Flow (gal)	Fire Jockey Pump (cycles)	Monthly Water Totals (gal)
7-Aug-94	2,031,703	1,139	51	
8-Aug-94	2,350,215	1,027	48	
9-Aug-94	2,420,383	935	46	
10-Aug-94	2,247,736	963	44	
11-Aug-94	2,198,855	941	42	
12-Aug-94	2,176,119	927	42	
13-Aug-94	2,154,529	74	40	
14-Aug-94	1,897,670	0	38	
15-Aug-94	1,931,090	0	38	
16-Aug-94	1,880,374	0	37	
17-Aug-94	2,546,294	7,103	38	
18-Aug-94	2,465,520	51,843	65	
19-Aug-94	984,822	1,374,830	68	
20-Aug-94	582,815	1,453,057	56	
21-Aug-94	1,877,751	5,368	48	
22-Aug-94	1,860,447	54,603	44	
23-Aug-94	311,265	1,634,393	40	
24-Aug-94	365,908	1,355,100	36	
25-Aug-94	479,748	1,470,641	34	
26-Aug-94	520,803	1,251,730	34	
27-Aug-94	610,447	1,230,453	31	
28-Aug-94	1,604,268	202	29	
29-Aug-94	1,846,376	111	29	
30-Aug-94	750,440	975,120	29	
31-Aug-94	717,172	975,035	27	
Monthly Total	48,470,775	16,821,081	1,419	65,291,856
1-Sep-94	728,259	1,028,875	28	
2-Sep-94	1,471,370	436,757	27	
3-Sep-94	1,330,625	424,585	26	
4-Sep-94	1,775,671	342	25	
5-Sep-94	1,674,679	229	25	
6-Sep-94	2,142,172	0	24	
7-Sep-94	1,267,761	527,852	25	
8-Sep-94	1,267,378	561,737	24	
9-Sep-94	1,267,248	659,344	24	
10-Sep-94	91	580,052	24	
11-Sep-94	86	332	23	
12-Sep-94	2,128,400	0	24	
13-Sep-94	1,224,705	542,675	27	
14-Sep-94	1,224,386	548,097	23	
15-Sep-94	1,224,267	686,633	23	
16-Sep-94	1,223,965	579,170	23	
17-Sep-94	1,405,429	580,678	22	
18-Sep-94	1,733,403	263	23	
19-Sep-94	1,990,725	221	23	
20-Sep-94	1,224,832	575,959	22	
21-Sep-94	1,297,811	625,532	22	
22-Sep-94	1,342,535	440,679	22	
23-Sep-94	1,327,246	432,577	22	
24-Sep-94	376,105	838,183	22	

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DATALOG #3: DAILY WATER USAGE (TELEMETRY SYSTEM DATA)

Date	DANC Total Flow (gal)	WTP Total Flow (gal)	Fire Jockey Pump (cycles)	Monthly Water Totals (gal)
25-Sep-94	730,995	910,006	22	
26-Sep-94	1,547,334	289	21	
27-Sep-94	951,563	468,083	21	
28-Sep-94	1,196,166	273,487	22	
29-Sep-94	944,994	300,291	21	
30-Sep-94	1,218,428	270,299	22	
Monthly Total	37,238,629	12,293,227	702	49,531,856
1-Oct-94	1,064,452	229,195	21	
2-Oct-94	1,447,080	418	22	
3-Oct-94	1,423,926	406	22	
4-Oct-94	1,104,054	265,405	21	
5-Oct-94	1,002,076	442,986	21	
6-Oct-94	987,177	432,566	21	
7-Oct-94	824,615	518,238	21	
8-Oct-94	396,293	984,726	21	
9-Oct-94	1,463,938	231	21	
10-Oct-94	1,424,623	186	21	
11-Oct-94	1,659,543	0	21	
12-Oct-94	1,212,094	277,225	21	
13-Oct-94	758	296,290	21	
14-Oct-94	1,244,996	302,614	21	
15-Oct-94	1,196,591	300,571	21	
16-Oct-94	1,596,122	7,386	21	
17-Oct-94	1,560,916	120	22	
18-Oct-94	1,240,882	298,868	23	
19-Oct-94	1,118,050	308,179	23	
20-Oct-94	999,440	291,799	24	
21-Oct-94	1,107,311	364,770	23	
22-Oct-94	1,171,094	325,272	25	
23-Oct-94	1,561,718	2,029	24	
24-Oct-94	1,559,412	1,399	24	
25-Oct-94	1,153,126	276,589	25	
26-Oct-94	1,322,567	301,879	24	
27-Oct-94	1,351,473	257,373	25	
28-Oct-94	1,412,768	297,902	25	
29-Oct-94	1,152,162	276,955	25	
30-Oct-94	1,445,511	232	25	
31-Oct-94	1,393,567	147	25	
Monthly Total	37,598,335	7,061,956	700	44,660,291
1-Nov-94	1,221,140	261,047	26	
2-Nov-94	1,025,563	240,045	26	
3-Nov-94	1,182,357	239,656	27	
4-Nov-94	935,220	312,973	26	
5-Nov-94	1,091,190	257,186	27	
6-Nov-94	1,083,960	172,432	27	
7-Nov-94	1,357,902	239	27	
8-Nov-94	1,091,276	264,846	28	
9-Nov-94	1,089,403	296,041	27	
10-Nov-94	1,079,368	272,489	28	
11-Nov-94	1,014,643	256,173	29	

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DATALOG #3: DAILY WATER USAGE (TELEMETRY SYSTEM DATA)

Date	DANC Total Flow (gal)	WTP Total Flow (gal)	Fire Jockey Pump (cycles)	Monthly Water Totals (gal)
12-Nov-94	1,276,116	4,995	28	
13-Nov-94	1,455,250	256	29	
14-Nov-94	1,445,541	290	28	
15-Nov-94	703,412	413,096	29	
16-Nov-94	1,217,380	337,988	29	
17-Nov-94	902,269	487,220	30	
18-Nov-94	1,034,882	436,277	30	
19-Nov-94	1,041,559	404,792	31	
20-Nov-94	1,476,041	238	29	
21-Nov-94	1,478,707	248	30	
22-Nov-94	1,111,297	404,492	31	
23-Nov-94	1,225,778	272,168	31	
24-Nov-94	1,240,629	238,802	32	
25-Nov-94	1,301,096	23,749	31	
26-Nov-94	1,499,283	225	31	
27-Nov-94	1,476,639	230	32	
28-Nov-94	1,697,326	359	32	
29-Nov-94	1,087,210	350,937	33	
30-Nov-94	1,182,727	327,289	34	
Monthly Total	36,025,164	6,276,778	878	42,301,942
1-Dec-94	1,300,615	315,187	33	
2-Dec-94	1,033,280	307,578	35	
3-Dec-94	1,302,173	303,879	34	
4-Dec-94	1,393,387	332	35	
5-Dec-94	1,639,035	354	36	
6-Dec-94	1,327,159	286,893	36	
7-Dec-94	1,294,663	254,947	37	
8-Dec-94	1,304,857	294,578	38	
9-Dec-94	1,393,906	282,432	38	
10-Dec-94	1,281,283	277,814	38	
11-Dec-94	1,938,584	269,844	39	
12-Dec-94	1,593,271	291	38	
13-Dec-94	1,407,625	283,635	40	
14-Dec-94	1,800,074	381,514	40	
15-Dec-94	1,396,069	322,680	42	
16-Dec-94	1,269,808	308,443	41	
17-Dec-94	1,646,462	336,017	42	
18-Dec-94	2,109,441	457	42	
19-Dec-94	2,518,622	0	43	
20-Dec-94	1,500,683	402,530	44	
21-Dec-94	1,320,029	446,106	45	
22-Dec-94	1,915,356	172,109	45	
23-Dec-94	501,435	1,009,887	45	
24-Dec-94	1,614,027	344,291	46	
25-Dec-94	1,505,189	361	46	
26-Dec-94	1,587,845	416	46	
27-Dec-94	1,801,168	450	45	
28-Dec-94	1,373,830	253,467	47	
29-Dec-94	1,455,937	392,343	46	
30-Dec-94	1,130,711	489,635	47	

DATALOG #3: DAILY WATER USAGE (TELEMETRY SYSTEM DATA)

Date	DANC Total Flow (gal)	WTP Total Flow (gal)	Fire Jockey Pump (cycles)	Monthly Water Totals (gal)
31-Dec-94	1,177,920	399,807	49	
Monthly Total	45,834,444	8,138,277	1,278	53,972,721
1-Jan-95	1,772,948	424	48	
2-Jan-95	1,764,526	453	49	
3-Jan-95	2,002,521	40,872	49	
4-Jan-95	1,200,339	521,087	49	
5-Jan-95	1,250,846	646,292	50	
6-Jan-95	1,261,387	650,086	51	
7-Jan-95	1,422,702	655,451	52	
8-Jan-95	2,150,868	420	51	
9-Jan-95	2,246,592	464	52	
10-Jan-95	1,159,144	659,430	53	
11-Jan-95	1,111,582	783,234	52	
12-Jan-95	1,172,824	738,724	52	
13-Jan-95	1,224,624	771,663	54	
14-Jan-95	1,420,392	816,804	55	
15-Jan-95	2,279,677	497	55	
16-Jan-95	2,179,318	509	54	
17-Jan-95	2,300,132	492	54	
18-Jan-95	958,153	922,786	55	
19-Jan-95	850,453	968,345	55	
20-Jan-95	850,093	971,824	54	
21-Jan-95	953,313	994,647	55	
22-Jan-95	1,771,116	72,993	55	
23-Jan-95	2,053,151	0	56	
24-Jan-95	1,274,371	596,865	55	
25-Jan-95	1,315,044	582,435	55	
26-Jan-95	1,276,986	638,170	56	
27-Jan-95	1,110,194	757,125	57	
28-Jan-95	950,095	715,471	57	
29-Jan-95	1,837,304	574	57	
30-Jan-95	2,054,982	0	58	
31-Jan-95	1,549,169	455,525	57	
Monthly Total	46,724,846	13,963,662	1,662	60,688,508
1-Feb-95	1,519,296	437,132	58	
2-Feb-95	1,418,449	492,865	57	
3-Feb-95	1,500,645	335,873	58	
4-Feb-95	1,493,938	342,844	59	
5-Feb-95	1,783,395	522	58	
6-Feb-95	2,007,786	638	58	
7-Feb-95	1,253,666	622,428	60	
8-Feb-95	1,387,036	718,239	62	
9-Feb-95	1,387,086	690,759	77	
10-Feb-95	2,293,428	301,493	85	
11-Feb-95	1,871,030	676	85	
12-Feb-95	1,889,859	710	84	
13-Feb-95	1,862,598	753	84	
14-Feb-95	1,062,594	672,806	84	
15-Feb-95	697,716	1,013,785	84	
16-Feb-95	652,956	1,096,131	83	

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Date	DANC Total Flow (gal)	WTP Total Flow (gal)	Fire Jockey Pump (cycles)	Monthly Water Totals (gal)
17-Feb-95	646,533	1,052,818	83	
18-Feb-95	1,202,311	474,672	83	
19-Feb-95	1,748,662	621	81	
20-Feb-95	1,745,936	673	80	
21-Feb-95	1,803,558	726	80	
22-Feb-95	1,130,169	533,701	81	
23-Feb-95	1,348,187	439,439	81	
24-Feb-95	1,362,461	352,723	80	
25-Feb-95	1,459,450	313,110	81	
26-Feb-95	1,603,500	678	80	
27-Feb-95	1,893,256	729	81	
28-Feb-95	1,414,318	434,080	81	
Monthly Total	41,439,819	10,331,624	2,108	51,771,443
1-Mar-95	1,213,457	433,518	81	
2-Mar-95	1,467,679	459,913	81	
3-Mar-95	1,282,171	426,679	80	
4-Mar-95	1,321,940	318,458	80	
5-Mar-95	1,753,267	687	80	
6-Mar-95	1,870,081	755	80	
7-Mar-95	1,322,882	342,252	80	
8-Mar-95	1,476,154	308,066	79	
9-Mar-95	1,310,105	262,448	78	
10-Mar-95	1,559,203	285,431	78	
11-Mar-95	1,584,602	264,532	77	
12-Mar-95	1,746,781	48,314	77	
13-Mar-95	2,093,080	744	77	
14-Mar-95	1,357,078	326,330	77	
15-Mar-95	1,357,278	426,678	75	
16-Mar-95	1,382,068	411,730	75	
17-Mar-95	1,422,006	599,934	75	
18-Mar-95	1,473,939	465,874	75	
19-Mar-95	1,943,828	692	75	
20-Mar-95	1,970,931	712	74	
21-Mar-95	1,328,205	298,408	74	
22-Mar-95	1,269,867	476,732	74	
23-Mar-95	1,269,276	540,764	74	
24-Mar-95	1,269,141	641,564	75	
25-Mar-95	1,113,898	741,241	74	
26-Mar-95	1,817,288	13,099	75	
27-Mar-95	1,980,798	677	73	
28-Mar-95	1,193,830	561,800	73	
29-Mar-95	1,404,900	424,820	73	
30-Mar-95	1,277,902	429,749	73	
31-Mar-95	1,248,206	438,915	72	
Monthly Total	46,081,841	9,951,516	2,364	56,033,357
1-Apr-95	1,357,740	348,789	71	
2-Apr-95	1,712,625	680	72	
3-Apr-95	2,032,573	706	67	
4-Apr-95	1,122,240	473,117	70	
5-Apr-95	1,428,411	340,399	68	

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Date	DANC Total Flow (gal)	WTP Total Flow (gal)	Fire Jockey Pump (cycles)	Monthly Water Totals (gal)
6-Apr-95	1,384,623	319,549	70	
7-Apr-95	1,384,836	383,991	69	
8-Apr-95	1,308,419	525,496	68	
9-Apr-95	1,854,622	729	69	
10-Apr-95	1,954,377	1,070	68	
11-Apr-95	1,170,970	519,433	67	
12-Apr-95	1,291,541	446,030	65	
13-Apr-95	1,216,374	440,516	66	
14-Apr-95	1,305,332	386,446	63	
15-Apr-95	1,311,743	348,862	65	
16-Apr-95	1,736,256	740	62	
17-Apr-95	1,772,820	744	62	
18-Apr-95	1,197,815	473,572	64	
19-Apr-95	1,351,051	306,844	62	
20-Apr-95	1,324,981	476,312	61	
21-Apr-95	1,482,205	302,692	61	
22-Apr-95	1,274,893	294,149	60	
23-Apr-95	1,790,657	694	60	
24-Apr-95	2,018,317	706	59	
25-Apr-95	1,389,539	265,868	59	
26-Apr-95	1,542,858	271,748	59	
27-Apr-95	1,543,752	308,984	58	
28-Apr-95	1,541,755	335,975	57	
29-Apr-95	1,564,217	370,488	57	
30-Apr-95	1,869,239	3,312	56	
Monthly Total	45,236,781	7,948,643	1,915	53,185,424
1-May-95	2,131,318	644	56	
2-May-95	1,406,097	510,942	54	
3-May-95	1,077,143	653,043	54	
4-May-95	1,525,644	527,695	53	
5-May-95	1,486,508	468,790	53	
6-May-95	1,819,365	470,499	52	
7-May-95	2,243,763	758	52	
8-May-95	2,356,384	736	51	
9-May-95	1,383,597	614,233	51	
10-May-95	1,180,846	876,398	57	
11-May-95	1,241,460	770,826	54	
12-May-95	1,247,107	839,840	54	
13-May-95	1,091,719	1,122,459	54	
14-May-95	2,137,786	21,077	53	
15-May-95	1,973,338	31,779	53	
16-May-95	1,301,799	590,300	52	
17-May-95	1,247,209	754,694	52	
18-May-95	1,246,966	838,780	52	
19-May-95	1,246,544	1,027,092	50	
20-May-95	1,191,637	981,045	50	
21-May-95	1,964,122	31,591	49	
22-May-95	2,263,857	30,168	49	
23-May-95	1,260,666	560,950	46	
24-May-95	1,995,526	624,234	41	

E M C Engineers, Inc.
Water Conservation Study
Ft. Drum, NY

Prepared by: TCP
1/31/96
EMC #1406.012

DATALOG #3: DAILY WATER USAGE (TELEMETRY SYSTEM DATA)

Date	DANC Total Flow (gal)	WTP Total Flow (gal)	Fire Jockey Pump (cycles)	Monthly Water Totals (gal)
25-May-95	991,435	1,166,201	42	
26-May-95	923,107	1,133,751	42	
27-May-95	1,175,435	1,205,994	45	
28-May-95	2,136,015	778	40	
29-May-95	1,778,084	709	40	
30-May-95	1,998,862	0	40	
31-May-95	1,070,149	623,455	40	
Monthly Total	48,093,488	16,479,461	1,531	64,572,949
1-Jun-95	1,142,985	1,131,565	39	
2-Jun-95	1,300,498	956,789	39	
3-Jun-95	1,157,953	1,126,187	38	
4-Jun-95	1,594,775	32,516	38	
5-Jun-95	2,210,084	0	37	
6-Jun-95	1,295,935	990,229	37	
7-Jun-95	1,296,147	1,155,699	36	
8-Jun-95	1,402,308	1,493,968	37	
9-Jun-95	1,027,318	1,085,973	36	
10-Jun-95	1,272,162	981,708	35	
11-Jun-95	2,371,170	744	35	
12-Jun-95	2,568,335	698	35	
13-Jun-95	1,141,786	858,647	35	
14-Jun-95	1,183,539	1,244,034	33	
15-Jun-95	1,189,328	1,275,182	34	
16-Jun-95	1,096,498	1,534,496	33	
17-Jun-95	1,395,970	1,383,815	37	
18-Jun-95	2,485,942	375,614	32	
19-Jun-95	2,200,739	1,100,401	32	
20-Jun-95	1,951,509	1,250,620	32	
21-Jun-95	1,943,941	1,416,703	32	
22-Jun-95	1,396,955	1,837,023	31	
23-Jun-95	1,639,196	1,663,783	31	
24-Jun-95	1,733,234	1,490,030	30	
25-Jun-95	3,671,850	203	31	
26-Jun-95	3,328,160	110	30	
27-Jun-95	1,122,845	2,119,668	29	
28-Jun-95	1,092,170	2,338,113	29	
29-Jun-95	1,305,943	2,476,157	29	
30-Jun-95	1,446,833	2,397,985	23	
Monthly Total	49,966,108	33,718,660	1,005	83,684,768
1-Jul-95	3,092,220	521,269	35	
2-Jul-95	2,371,322	12,991	27	
3-Jul-95	2,298,085	24,490	28	
4-Jul-95	2,913,814	343	27	
5-Jul-95	3,000,000	191	26	
6-Jul-95	1,281,450	1,875,732	26	
7-Jul-95	984,516	2,242,960	26	
8-Jul-95	2,085,634	607,086	25	
9-Jul-95	1,979,373	287	25	
10-Jul-95	2,380,084	10,250	26	
11-Jul-95	2,625,163	748,889	25	

E M C Engineers, Inc
Water Conservation Study
Ft. Drum, NY

Prepared by: TCP
1/31/96
EMC #1406.012

DATALOG #3: DAILY WATER USAGE (TELEMETRY SYSTEM DATA)

Date	DANC Total Flow (gal)	WTP Total Flow (gal)	Fire Jockey Pump (cycles)	Monthly Water Totals (gal)
12-Jul-95	753,721	2,242,060	25	
13-Jul-95	1,022,809	2,216,236	24	
14-Jul-95	1,105,196	2,224,593	25	
15-Jul-95	1,576,642	1,943,423	25	
16-Jul-95	5,336	25	0	
17-Jul-95	1,092,837	1,190,109	24	
18-Jul-95	864,373	1,442,092	24	
19-Jul-95	1,629,777	2,283,001	24	
20-Jul-95	632,125	1,843,820	24	
21-Jul-95	1,229,218	2,330,273	24	
22-Jul-95	357,263	1,763,536	24	
23-Jul-95	2,496,070	33,568	23	
24-Jul-95	2,191,405	286	23	
25-Jul-95	590,320	1,455,512	24	
26-Jul-95	445,968	1,841,972	23	
27-Jul-95	322,885	1,893,466	23	
28-Jul-95	249,575	1,678,010	25	
29-Jul-95	570,833	1,455,644	22	
30-Jul-95	2,006,231	20,750	23	
31-Jul-95	2,599,098	179	22	
Monthly Total	46,753,343	33,903,043	747	80,656,386
1-Aug-95	523,260	1,989,260	22	
2-Aug-95	289,266	1,908,941	22	
3-Aug-95	210,125	1,841,255	22	
4-Aug-95	205,716	1,791,515	22	
5-Aug-95	437,822	1,484,408	22	
6-Aug-95	1,952,053	390	21	
7-Aug-95	2,228,114	269	21	
8-Aug-95	1,580,288	597,177	22	
9-Aug-95	1,751,925	631,271	21	
10-Aug-95	1,286,937	1,732,253	21	
11-Aug-95	754,041	1,517,269	21	
12-Aug-95	932,990	1,273,900	23	
13-Aug-95	1,835,864	385	21	
14-Aug-95	2,337,220	235	21	
15-Aug-95	738,479	1,627,000	20	
16-Aug-95	627,647	2,261,300	22	
17-Aug-95	1,242,881	1,499,204	20	
18-Aug-95	1,204,298	1,587,841	0	
19-Aug-95	878,041	1,604,734	21	
20-Aug-95	3,000,000	341	20	
21-Aug-95	3,000,000	123	20	
22-Aug-95	1,329,171	1,443,045	19	
23-Aug-95	1,001,241	1,529,771	20	
24-Aug-95	1,412,082	1,634,597	20	
25-Aug-95	841,015	1,875,945	20	
Monthly Total	31,600,476	29,832,429	504	61,432,905

APPENDIX C

LEAK DETECTION SURVEY

Leak Detection Summary
1995 Leak Detection Report

E M C Engineers, Inc.
Ft. Drum, NY
EMC #1406-012

Prepared by: T Poeling
2/2/96
Checked by: _______

LEAK DETECTION SURVEY - FT. DRUM, NY

LEAK NO.	TYPE OF LEAK	LOCATION/ DESCRIPTION	SIZE (GPD)	PIPE/VALVE SIZE ADDITIONAL COMMENTS
1-1	Service Line	Building #9224	14,000	
1-2	Fire Hydrant	Memorial Drive at South Entrance to Commissary	1,000	Leak noise quit when hydrant was tightened
2-1	Fire Hydrant	At Building #10270	1,000	Leak noise quit when hydrant was tightened
2-2	Fire Hydrant	Fourth Street East	1,000	Leak noise quit when hydrant was tightened
2-3	Valve	Fourth Street East at 4th Armored Division	2,000	
2-4	Fire Hydrant	Fourth Street East at 4th Armored Division	1,000	Leak noise quit when hydrant was tightened
2-5	Fire Hydrant	Memorial Drive	1,000	Leak noise quit when hydrant was tightened
2-6	Valve	Fourth Street East at Lake Garda Lane	5,000	Leak noise quit when valve was tightened
2-7	Fire Hydrant	Building #10050	1,000	Leak noise quit when hydrant was tightened
2-8	Fire Hydrant	Riva Ridge, North Loop	1,000	Leak noise quit when hydrant was tightened
2-9	Fire Hydrant	Memorial Drive at 45th Infantry Division Drive	1,000	Leak noise quit when hydrant was tightened
2-10	Fire Hydrant	Motor Pool Building #10173	1,000	Leak noise quit when hydrant was tightened
2-11	Fire Hydrant	Memorial Drive at 2nd Street	1,000	Leak noise quit when hydrant was tightened
3-1	Fire Hydrant	Building #4325	1,000	Leak noise quit when hydrant was tightened
3-2	Fire Hydrant	Building #4485	1,000	Leak noise quit when hydrant was tightened
4-1	Fire Hydrant	Rail Road Street at Oswego Avenue	1,000	
4-2	Fire Hydrant	Rail Road Street at Lewis Avenue	1,000	
4-3	Fire Hydrant	Building #T-145	1,000	
4-4	Fire Hydrant	First Street East at Nash Blvd.	1,000	
4-5	Fire Hydrant	Second Street at St. Lawrence Avenue	1,000	
4-6	Fire Hydrant	Second Street at Lewis Avenue	1,000	
4-7	Fire Hydrant	Pine Lane, Building #T-2256	1,000	
5-1	Fire Hydrant	George Street at Cannon Avenue	1,000	
5-2	Fire Hydrant	Cannon Avenue at Delahanty Street	1,000	
5-3	Service Line	Building #T-2315	15,000	1-1/2" service line
5-4	Fire Hydrant	Lewis Avenue, Building #T-1050	1,000	
5-5	Fire Hydrant	Nash Blvd., Building #T-1004	1,000	
5-6	Main Line	Hospital Area, Building #T-2473	125,000	12" main line connected to old 2" service
5-7	Fire Hydrant	Coyler Drive at Dunn Avenue	1,000	
6-1	Fire Hydrant	Airport Access Road, across from Bldg. #2074	1,000	
7-1	Fire Hydrant	Building #8527	1,000	Leak noise quit when hydrant was tightened

LEAK SUMMARY

Leak Type	No. of Leaks	Size (GPD)	Size (KGal/Yr)
Main Line	1	125,000	45,625
Service Line	2	29,000	10,585
Valve	1	2,000	730
Valve (Fixed)	1	5,000	1,825
Fire Hydrant	13	13,000	4,745
Hydrant (Fixed)	13	13,000	4,745
Total Leakage	17	169,000	61,685
Leakage (Fixed)	14	18,000	6,570
Total	31	187,000	68,255

M.E. SIMPSON Co., Inc.

P.O. Box 1995
Valparaiso, IN 46384

800/255-1521
Fax: 219/531-2444

Branch office:
Grayslake, IL

November 20, 1995

Mr. Michael Scholz, P.E.
Project Manager
EMC Engineers, Inc.
2750 S. Wadsworth Blvd., Suite C-200
Denver, CO 80227

Dear Mr. Scholz,

M.E. Simpson Company is a professional & technical service company that offers Leak Survey Programs, Large Meter Testing and Repair Programs, Water Main Location, and Valve Exercising, Location and Computer Mapping Programs. These **"Professional Services"** offered by M. E. Simpson Company are designed to aid a utility in reducing unaccounted for water and recovering lost revenue.

M. E. Simpson Company is pleased to submit this report of our leak detection survey for the Fort Drum Military Reservation. This survey addressed the Ft. Drum water distribution system, consisting of approximately 129 miles of water main. The report contains the results of our investigation that includes the following:

1. A LISTING OF THE MEETINGS HELD WITH FT. DRUM PERSONNEL
2. A DESCRIPTION OF THE AREA SURVEYED.
3. METHODOLOGY OF THE SURVEY
4. A LIST OF LEAKS AND TYPE OF LEAK LOCATED.
5. GENERAL RECOMMENDATIONS BASED ON OUR INVESTIGATION.

LISTING OF THE MEETINGS HELD WITH FORT DRUM PERSONNEL

M.E. Simpson Company personnel held numerous meetings with Ft. Drum personnel to keep them updated on the progress of the leak survey. The following is a listing of the meetings, who was there, and what was discussed:

10/24/95 - Project briefing - Michael Scholz, EMC
Greg Engel, M.E. Simpson Company
George Engel, M.E. Simpson Company
Michael Simpson, M.E. Simpson Company
Steve Rowley, Public Works-Ft. Drum
Joe Ogiba, Public Works-Ft. Drum
Bill Center, EMC
Tom Poeling, EMC

10/24/95 - project briefing of leak survey - John Kerr, M. Simpson, G. Engel, G. Engel.

10/25/95 - project briefing of area we were working in - J. Kerr, G. Engel, G. Engel.

10/26/95 - project briefing of area we were working in - J. Kerr, G. Engel, G. Engel.

10/27/95 - project briefing of area we were working in - J. Kerr, G. Engel. G. Engel.

10/30/95 - project briefing of area we were working in - J. Kerr, G. Engel. G. Engel.

10/31/95 - project briefing of area we were working in and to introduce John & Ray - Frank. J. Kerr G. Engel, J. Van Arsdel, G. Engel, Ray Jones.

11/01/95 - project briefing of area we were working in & listen to the well field - J. Kerr, G. Engel. J. Van Arsdel, R. Jones, G. Engel.

11/02/95 - project briefing of area we were working in - J. Kerr, J. Van Arsdel, R. Jones.

11/03/95 - project briefing of area we were working in - J. Kerr, J. Van Arsdel, R. Jones.

11/06/95 - project briefing of area we were working in and a correlator & related equipment demo - J. Ogiba, J. Kerr, J. Van Arsdel, R. Jones.

11/07/95 - project briefing, gave complete update and overview of everything that was surveyed and leaks found. Answered questions pertaining to the project. - Steve Rowley, Frank. John Van Arsdel R. Jones, J. Ogiba, J. Kerr.

DESCRIPTION OF THE AREA SURVEYED

Approximately 681.120 lineal feet was surveyed as part of the system investigation. This included all fire hydrants, all accessible mainline valves, and 30 services.

METHODOLOGY

M.E. Simpson Company used the **FLUID CONSERVATION SYSTEMS S20** listening device along with the **MP90** preamplifier-transducer system to conduct your survey. Our experienced technicians used these devices as listening equipment to survey the pipeline network. Each hydrant, and accessible valves were used as listening points to identify leaks. Service, b-boxes, (30) were used to keep the listening distances under four hundred fifty feet (450'). **"Pin-Pointing"** of the leak, as well as locating leaks that other methods failed to reveal was done with the **90/90** and or **C2000 LEAK CORRELATORS,** the latest state of the art leak computers. These electronic instruments are microprocessor units that measure the time it takes the sound of the leak to travel from the leak to the point where the leak correlator is connected to the water line. By connecting the leak correlator to the water line at two locations, it will compute the distance from the leak to each connection point thus enabling us to determine the exact leak location. The results of the leak survey, including an estimate of water loss for the leaks identified, is documented in this report.

LEAKAGE LOCATED

All water mains within the project area were surveyed and thirty one leaks were located. There was one main line leaks, two service line leak. two valve leaks, and the balance fire hydrant leaks. All of these leaks have been verbally reported to your office with their location, so many have probably been repaired already. Following are the leak locations with an estimated GPD (Gallons Per Day) leakage potential:

TYPE	LOCATION	SIZE
Sec. - 1		
Service	Building #9224 (Leak # 1-1) see enclosed diagram	14.000 GPD

TYPE	LOCATION	SIZE
Sec. - 1		
Fire Hydrant	Memorial Drive at the South entrance to the Commissary (Leak # 1-2) see enclosed diagram **fixed**	1,000 GPD
Sec. - 2		
Fire Hydrant	at Building #10270 (Leak # 2-1) see enclosed diagram **fixed**	1,000 GPD
Fire Hydrant	Forth Street East (Leak # 2-2) see enclosed diagram **fixed**	1,000 GPD
Valve	Forth Street East at 4th Armored Division (Leak # 2-3) see enclosed diagram	2,000 GPD
Fire Hydrant	Forth Street East at 4th Armored Division (Leak # 2-4) see enclosed diagram **fixed**	1,000 GPD
Fire Hydrant	Memorial Drive (Leak # 2-5) see enclosed diagram **fixed**	1,000 GPD
Valve	Forth Street East at Lake Garda Lane (Leak # 2-6) see enclosed diagram **fixed**	5,000 GPD
Fire Hydrant	Building #10050 (Leak # 2-7) see enclosed diagram **fixed**	1,000 GPD
Fire Hydrant	Riva Ridge, North loop (Leak # 2-8) see enclosed diagram **fixed**	1,000 GPD
Fire Hydrant	Memorial Drive at 45th Infantry Div. Dr. (Leak # 2-9) see enclosed diagram **fixed**	1,000 GPD
Fire Hydrant	Motor Pool, Building #10173 (Leak # 2-10) see enclosed diagram **fixed**	1,000 GPD
Fire Hydrant	Memorial Drive at 2nd Street (Leak # 2-11) see enclosed diagram **fixed**	1,000 GPD
Sec. - 3		
Fire Hydrant	Building # 4325 (Leak # 3-1) see enclosed diagram **fixed**	1,000 GPD
Fire Hydrant	Building # 4485 (Leak # 3-2) see enclosed diagram **fixed**	1,000 GPD
Sec. - 4		
Fire Hydrant	Rail Road Street at Oswego Avenue (Leak # 4-1) see enclosed diagram	1,000 GPD
Fire Hydrant	Rail Road Street at Lewis Avenue (Leak # 4-2) see enclosed diagram	1,000 GPD

TYPE	LOCATION	SIZE
Sec. - 4		
Fire Hydrant	Building # T-145 (Leak # 4-3) see enclosed diagram	1,000 GPD
Fire Hydrant	First Street East at Nash Blvd. (Leak # 4-4) see enclosed diagram	1,000 GPD
Fire Hydrant	Second Street at St. Lawrence Avenue (Leak # 4-5) see enclosed diagram	1,000 GPD
Fire Hydrant	Second Street at Lewis Avenue (Leak # 4-6) see enclosed diagram	1,000 GPD
Fire Hydrant	Pine Lane, Building # T-2256 (Leak # 4-7) see enclosed diagram	1,000 GPD
Sec. - 5		
Fire Hydrant	George Street at Cannon Avenue (Leak # 5-1) see enclosed diagram	1,000 GPD
Fire Hydrant	Cannon Avenue at Delahanty Street (Leak # 5-2) see enclosed diagram (visible)	1,000 GPD
Service Line	Building # T-2315 (Leak # 5-3) see enclosed diagram (visible)	15,000 GPD
Fire Hydrant	Lewis Avenue, Building # T-1050 (Leak # 5-4) see enclosed diagram	1,000 GPD
Fire Hydrant	Nash Blvd., Building # T-1004 (Leak # 5-5) see enclosed diagram	1,000 GPD
Main Line	Hospital Area, Building # T-2473 (Leak # 5-6) see enclosed diagram	125,000 GPD
Fire Hydrant	Coyler Drive at Dunn Avenue (Leak # 5-7) see enclosed diagram	1,000 GPD
Sec. - 6		
Fire Hydrant	Airport Access Road, across from Building # 2074 (Leak # 6-1) see enclosed diagram	1,000 GPD
Sec. - 7		
Fire Hydrant	Building # 8527 (Leak # 7-1) see enclosed diagram **fixed**	1,000 GPD
ESTIMATED LEAKAGE TOTAL		**187,000 GPD**

LEAK QUANTITIES

Quantifying leaks is difficult because there is not any accurate means of doing so. Pipe material, size of the leak, system pressure, soil material and water table will effect the noise that a leak makes. Small leaks under high system pressure will make more noise than a large leak under low system pressure. However, the above leaks are of sufficient noise levels that the above estimates should be very conservative. Using a purchase price of $5.73 per thousand gallons, these leaks were costing your utility in excess of $1,071.00 per day or $390,915.00 annually. It obvious that this Leak Survey Program has proven to be very cost effective. Naturally the main line leaks have the greatest potential for loss followed by service line, valves, and finally hydrants. Once leaks have been repaired, we would recommend that the Utility compare pumping rates before and after. This information will be more meaningful and accurate.

Please note that the per thousand cost used is what DANC is currently charging for water. If you use an estimated cost, the cost of purchasing the water in April 1997, the per day costs drops to $267.00 or an annual rate of $97,455.00. Also you need to consider the cost of running your wells in this equation.

RECOMMENDATIONS

This survey confirms that Ft. Drum's water distribution system will benefit from this project by a reduction in underground leakage. There is always a concern over the cost effectiveness of leak detection because of the uncertainty of the number of leaks located. However, with your present cost of water and the discovery of these thirty one leaks, the cost of this 1995 leak survey will pay for itself within two month. It only takes a recovery of about 56,000 gallons per day on an annual basis (56,000 gallons per day is only 38.8 gallons per minute throughout your entire water distribution system) to recover your investment. We would recommend that you conduct a Leak Survey Program every year. This recommendation becomes more critical as your cost of water increases.

We appreciate the cooperation of Mr. Ogiba, Mr. Kerr and their staff who were available to answer our questions during this project. If you have any questions with the information in this report, please do not hesitate to call.

Sincerely Yours,

Michael D. Simpson
Operations Manager

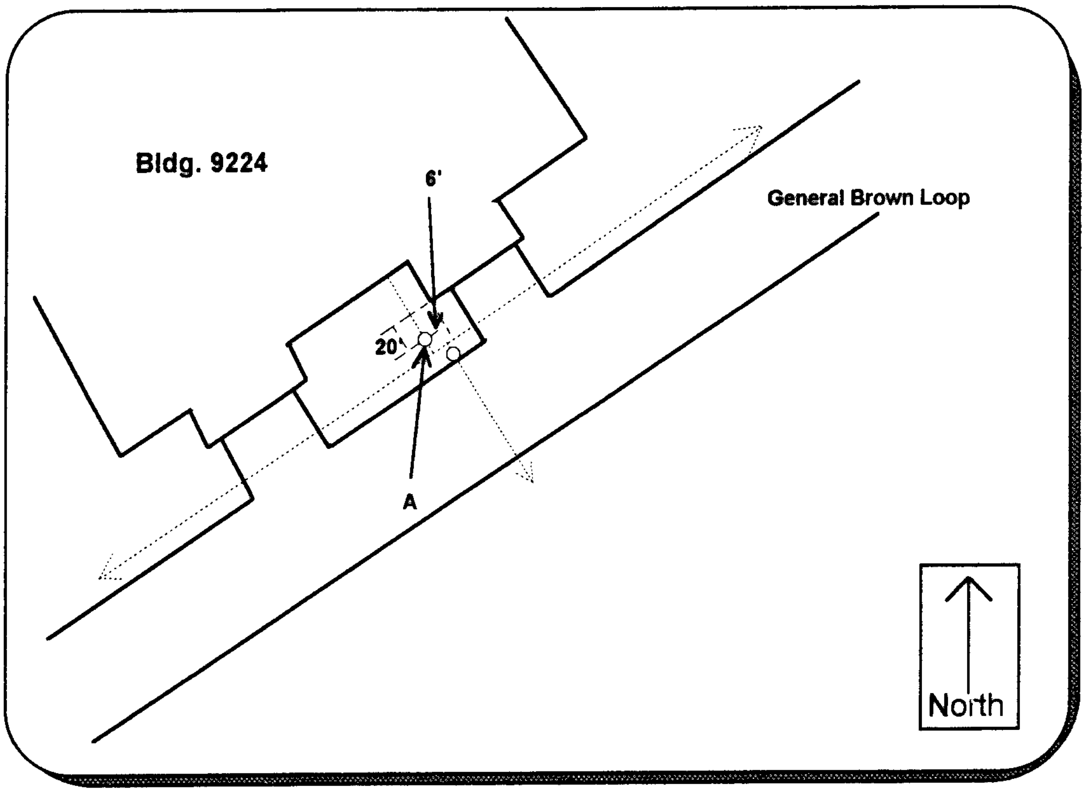
M.E. SIMPSON COMPANY, INC. - Professional Services

LEAK LOCATION REPORT

Client: Fort Drum, New York **Time:** Leak Survey

Date: Saturday, November 04, 1995 **Tech:** John and Ray

Below is a diagram of the area surveyed for a suspect leak.



Leak Number: 1-1

Distance: 0' From A

Connection point: A= Hydrant

Connection point:

Leak Location: 0' From A

Comments Service leak.

We thank you for the opportunity to work for your Utility and look forward to serving you again. If you have any questions please don't hesitate to call.

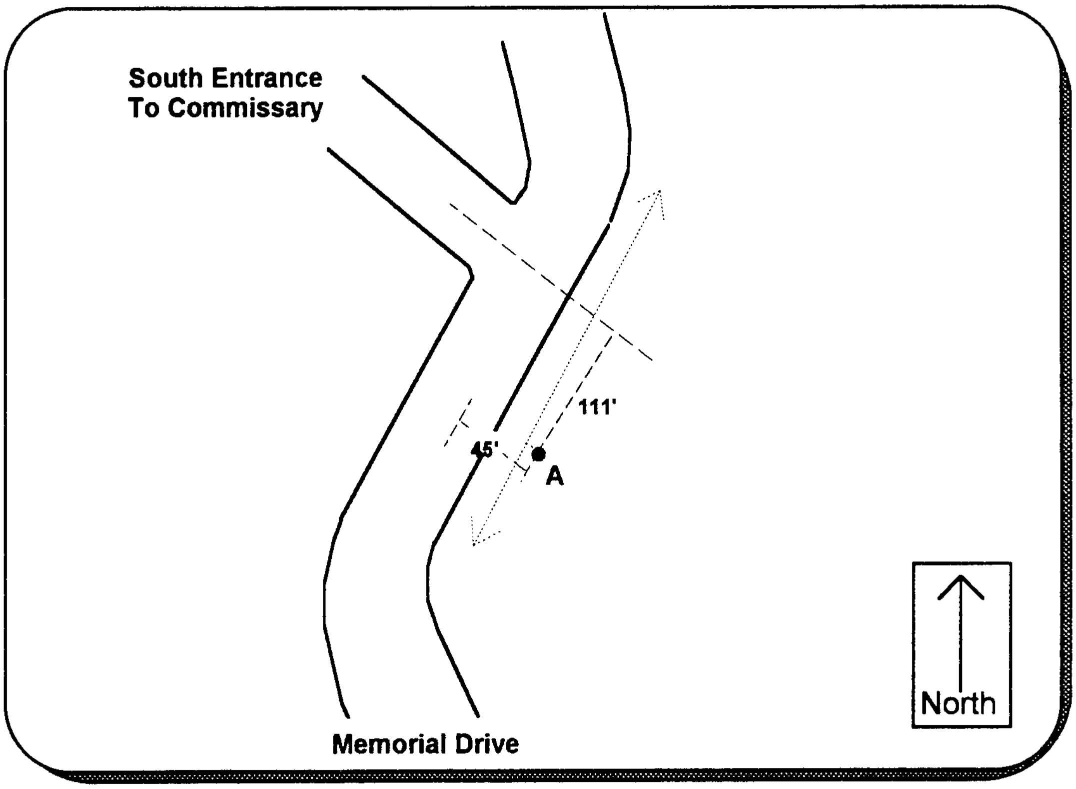
M.E. SIMPSON COMPANY, INC. - Professional Services

LEAK LOCATION REPORT

Client: Fort Drum, New York **Time:** Leak Survey

Date: Thursday, November 02, 1995 **Tech:** John and Ray

Below is a diagram of the area surveyed for a suspect leak.



Leak Number: 1-2

Distance: 0' From A

Connection point: A= Hydrant

Connection point:

Leak Location: 0' From A

Comments This was a hydrant leak. Leak noise quit when the hydrant was tightened.

We thank you for the opportunity to work for your Utility and look forward to serving you again. If you have any questions please don't hesitate to call.

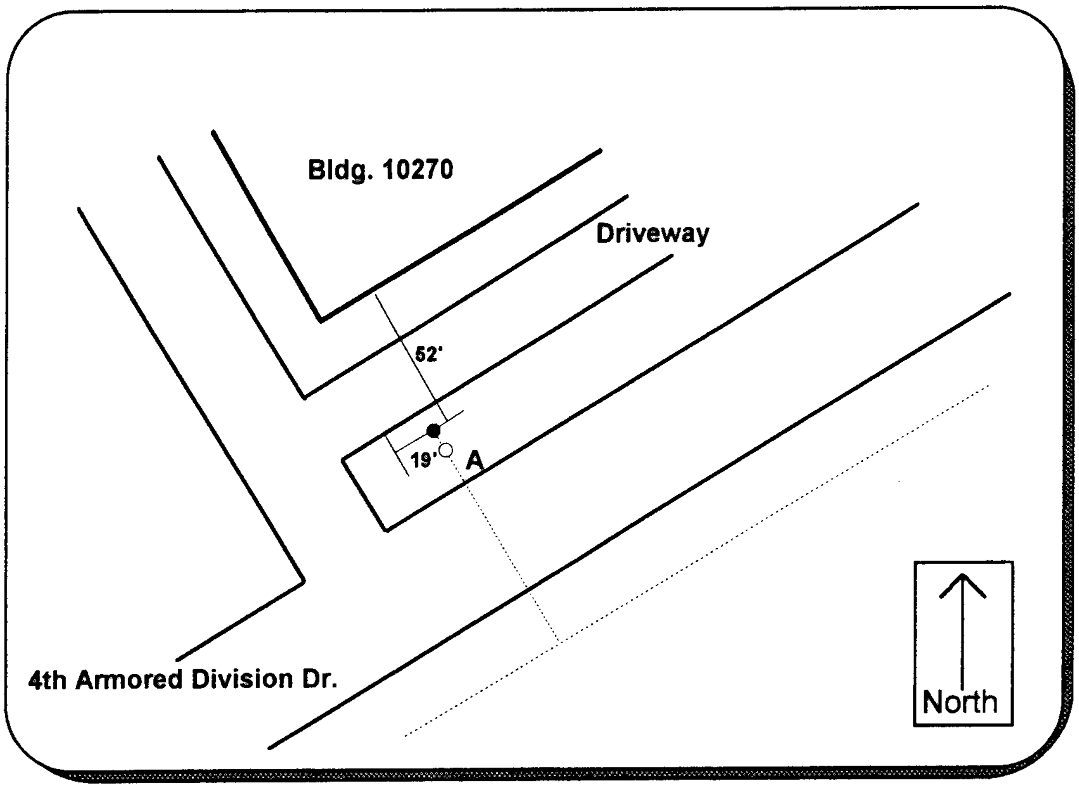
M.E. SIMPSON COMPANY, INC. - Professional Services

LEAK LOCATION REPORT

Client: Fort Drum, New York **Time:** Leak Survey

Date: Thursday, November 02, 1995 **Tech:** John and Ray

Below is a diagram of the area surveyed for a suspect leak.



Leak Number: 2-1

Distance: 0' From A

Connection point: A= Hydrant.

Connection point:

Leak Location: 0' From A

Comments This was a hydrant leak. Leak noise quit when the hydrant was tightened.

We thank you for the opportunity to work for your Utility and look forward to serving you again. If you have any questions please don't hesitate to call.

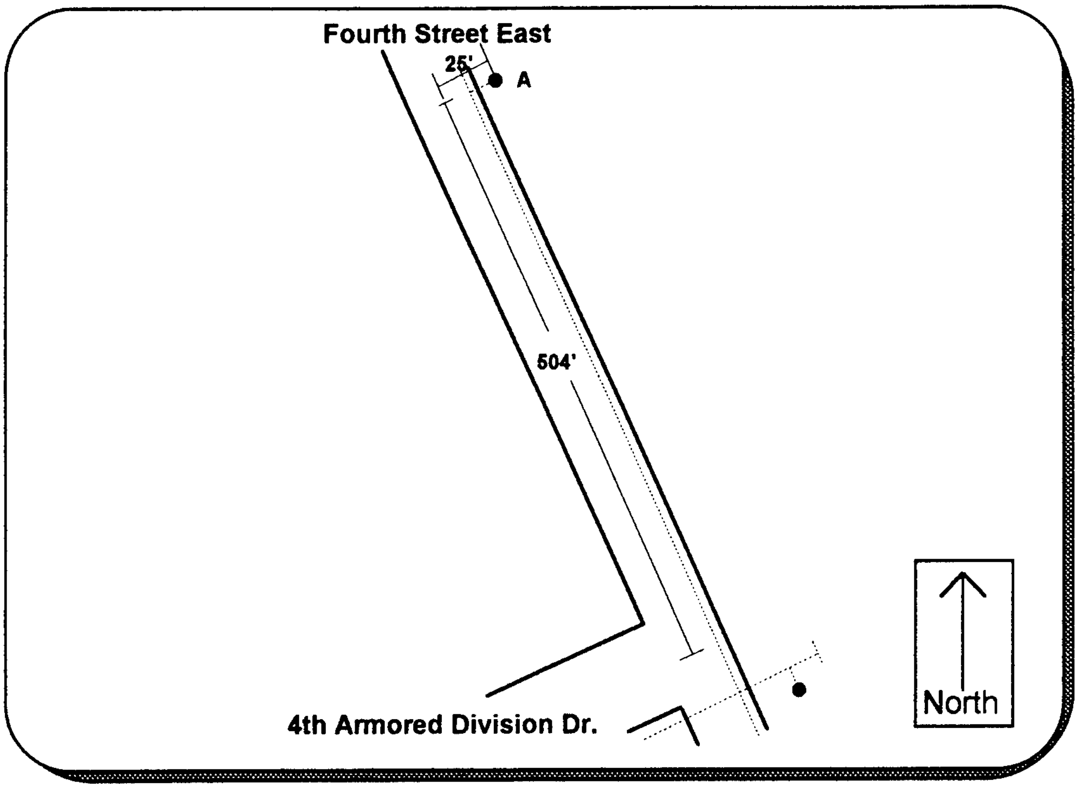
M.E. SIMPSON COMPANY, INC. - Professional Services

LEAK LOCATION REPORT

Client: Fort Drum, New York **Time:** Leak Survey

Date: Saturday, November 04, 1995 **Tech:** John and Ray

Below is a diagram of the area surveyed for a suspect leak.



Leak Number: 2-2

Distance: 0' From A

Connection point: A= Hydrant

Connection point:

Leak Location: 0' From A

Comments This was a hydrant leak. Leak noise quit when the hydrant was tightened.

We <u>thank you</u> for the opportunity to work for your Utility and look forward to serving you again. If you have any questions please don't hesitate to call.

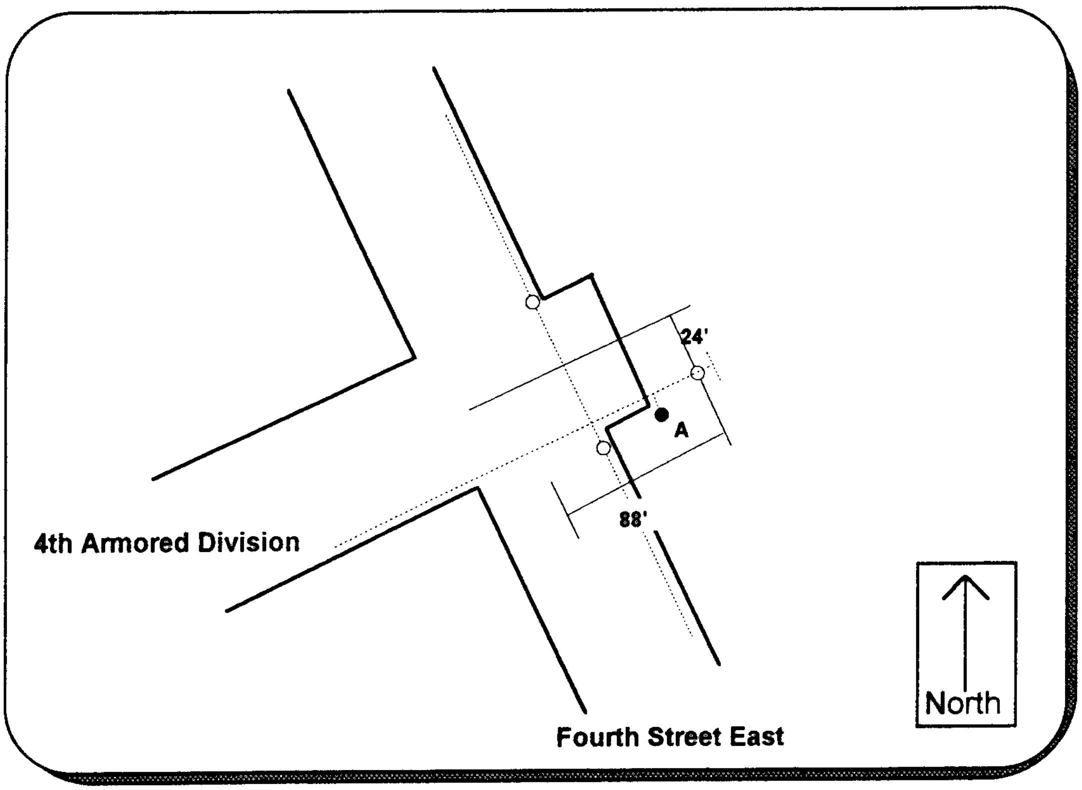
M.E. SIMPSON COMPANY, INC. - Professional Services

LEAK LOCATION REPORT

Client: Fort Drum, New York **Time:** Leak Survey

Date: Tuesday, November 07, 1995 **Tech:** John and Ray

Below is a diagram of the area surveyed for a suspect leak.



Leak Number: 2-3

Distance: 0' From A

Connection point: A= Stub valve.

Connection point:

Leak Location: 0' From A

Comments This stub valve is leaking through in closed position. Box is off to one side.

We thank you for the opportunity to work for your Utility and look forward to serving you again. If you have any questions please don't hesitate to call.

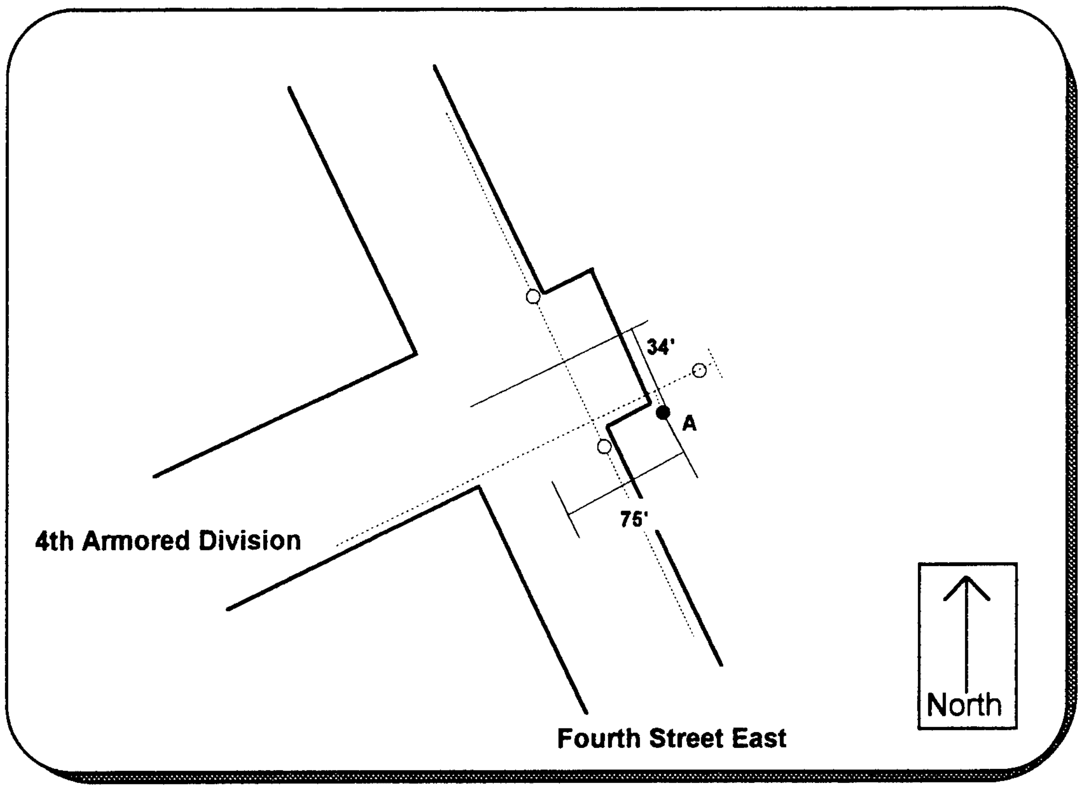
M.E. SIMPSON COMPANY, INC. - Professional Services

LEAK LOCATION REPORT

Client: Fort Drum, New York **Time:** Leak Survey

Date: Tuesday, November 07, 1995 **Tech:** John and Ray

Below is a diagram of the area surveyed for a suspect leak.



Leak Number: 2-4

Distance: 0' From A

Connection point: A= Hydrant.

Connection point:

Leak Location: 0' From A

Comments This was a hydrant leak. Leak noise quit when the hydrant was tightened.

We thank you for the opportunity to work for your Utility and look forward to serving you again. If you have any questions please don't hesitate to call.

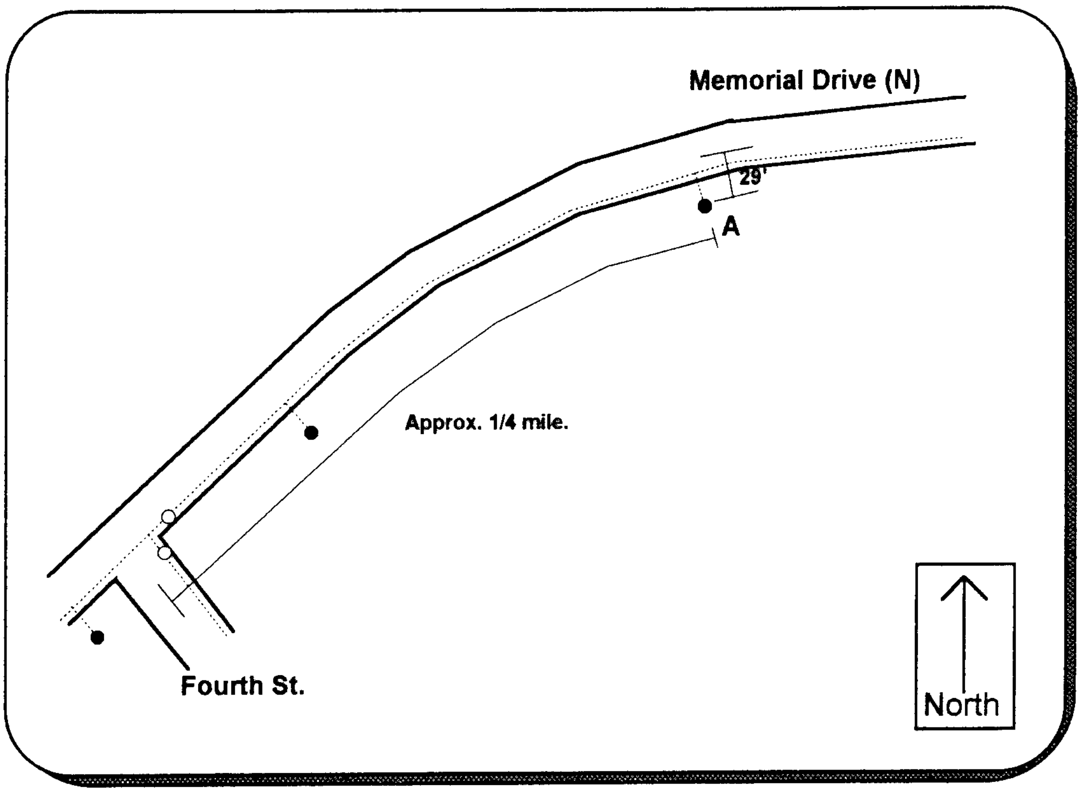
M.E. SIMPSON COMPANY, INC. - Professional Services

LEAK LOCATION REPORT

Client: Fort Drum, New York **Time:** Leak Survey

Date: Saturday, November 04, 1995 **Tech:** John and Ray

Below is a diagram of the area surveyed for a suspect leak.



Leak Number: 2-5

Distance: 0' From A

Connection point: A= Hydrant.

Connection point:

Leak Location: 0' From A

Comments This was a hydrant leak. Leak noise quit when the hydrant was tightened.

We thank you for the opportunity to work for your Utility and look forward to serving you again. If you have any questions please don't hesitate to call.

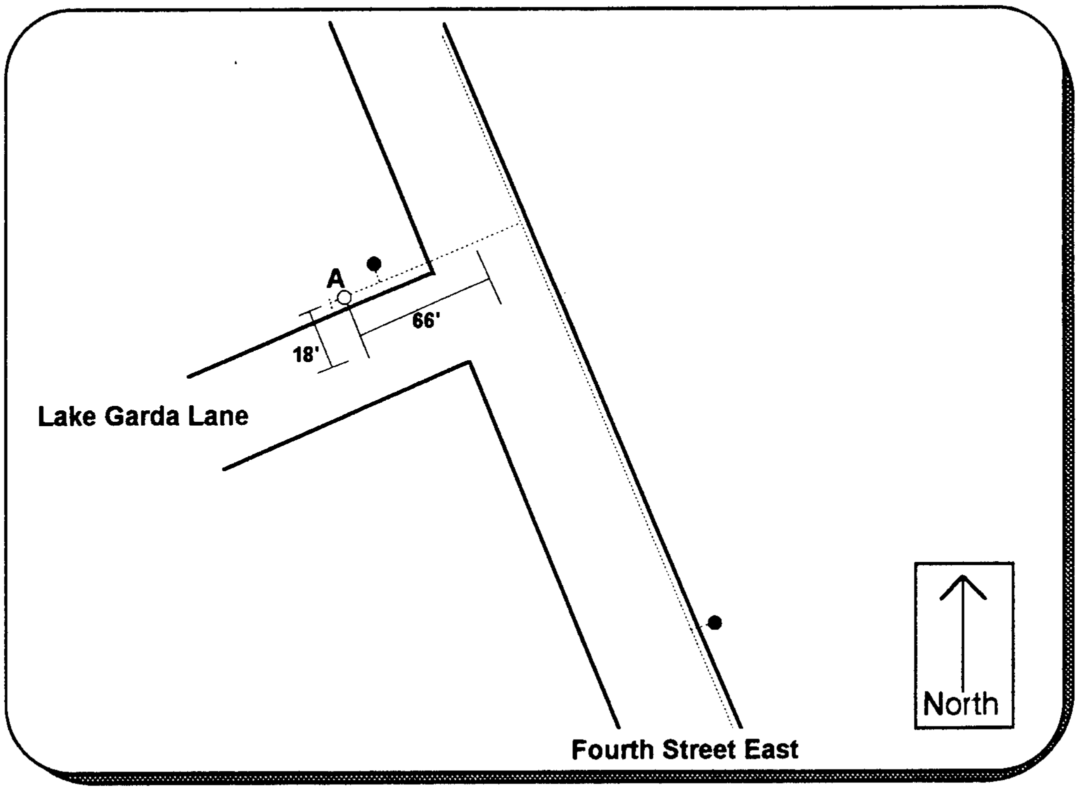
M.E. SIMPSON COMPANY, INC. - Professional Services

LEAK LOCATION REPORT

Client: Fort Drum, New York **Time:** Leak Survey

Date: Saturday, November 04, 1995 **Tech:** John and Ray

Below is a diagram of the area surveyed for a suspect leak.



Leak Number: 2-6

Distance: 0' From A

Connection point: A= Stub valve.

Connection point:

Leak Location: 0' From A

Comments This stub valve was found 1 1/2 turns open. Leak noise quit when we closed the valve fully.

We <u>thank you</u> for the opportunity to work for your Utility and look forward to serving you again. If you have any questions please don't hesitate to call.

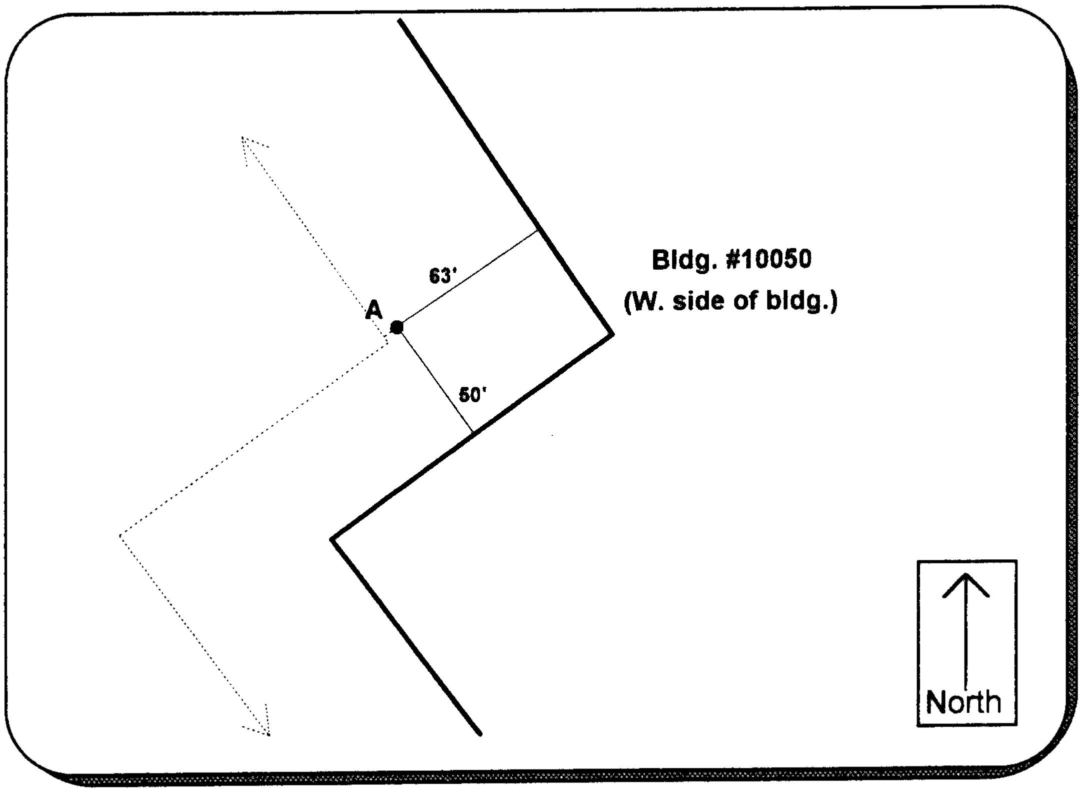
M.E. SIMPSON COMPANY, INC. - Professional Services

LEAK LOCATION REPORT

Client: Fort Drum, New York **Time:** Leak Survey

Date: Saturday, November 04, 1995 **Tech:** John and Ray

Below is a diagram of the area surveyed for a suspect leak.



Leak Number: 2-7

Distance: 0' From A

Connection point: A= Hydrant

Connection point:

Leak Location: 0' From A

Comments This was a hydrant leak. Leak noise quit when the hydrant was tightened.

We <u>thank you</u> for the opportunity to work for your Utility and look forward to serving you again. If you have any questions please don't hesitate to call.

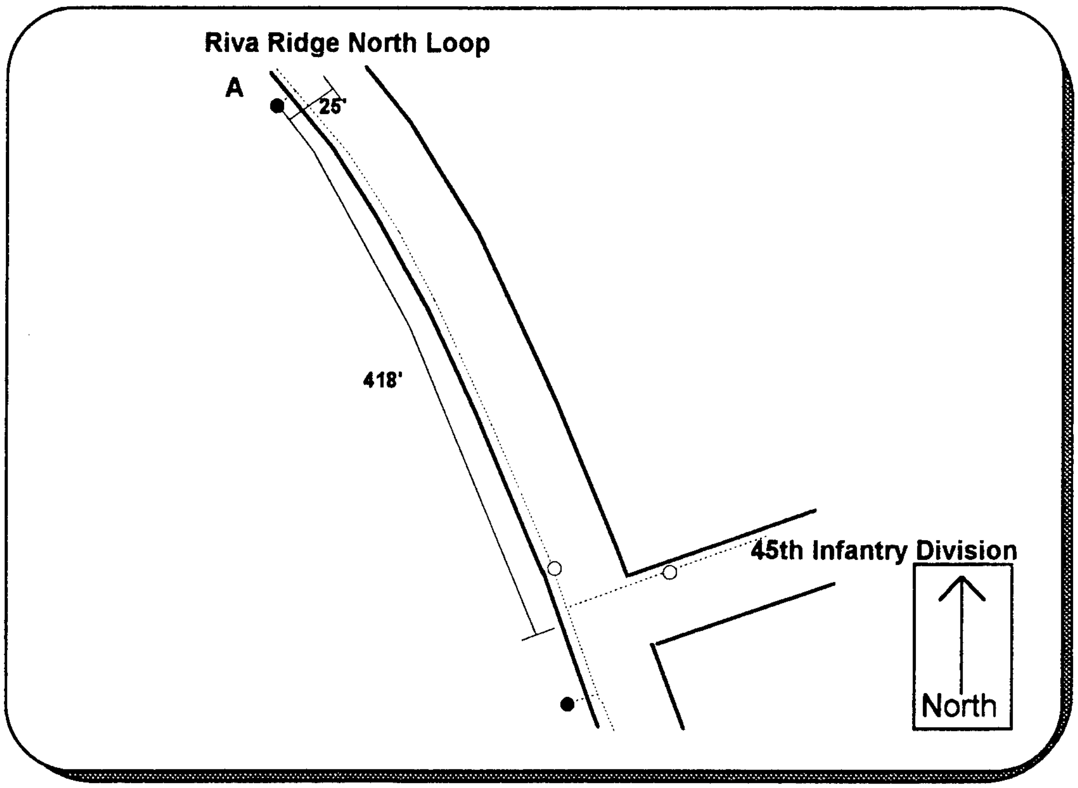
M.E. SIMPSON COMPANY, INC. - Professional Services

LEAK LOCATION REPORT

Client: Fort Drum, New York **Time:** Leak Survey

Date: Saturday, November 04, 1995 **Tech:** John and Ray

Below is a diagram of the area surveyed for a suspect leak.



Leak Number: 2-8

Distance: 0' From A

Connection point: A= Hydrant.

Connection point:

Leak Location: 0' From A

Comments This was a hydrant leak. Leak noise quit when the hydrant was tightened.

We thank you for the opportunity to work for your Utility and look forward to serving you again. If you have any questions please don't hesitate to call.

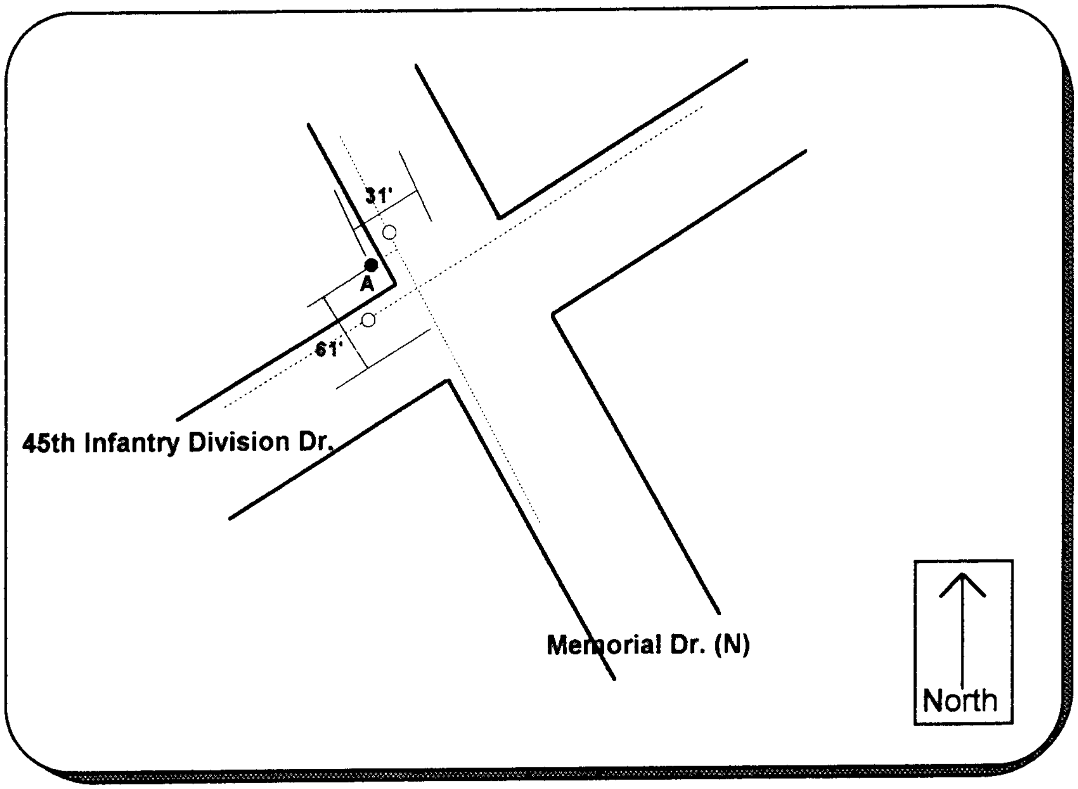
M.E. SIMPSON COMPANY, INC. - Professional Services

LEAK LOCATION REPORT

Client: Fort Drum, New York　　**Time:** Leak Survey

Date: Saturday, November 04, 1995　　**Tech:** John and Ray

Below is a diagram of the area surveyed for a suspect leak.



Leak Number: 2-9

Distance: 0' From A

Connection point: A= Hydrant.

Connection point:

Leak Location: 0' From A

Comments This was a hydrant leak. Leak noise quit when the hydrant was tightened.

We thank you for the opportunity to work for your Utility and look forward to serving you again. If you have any questions please don't hesitate to call.

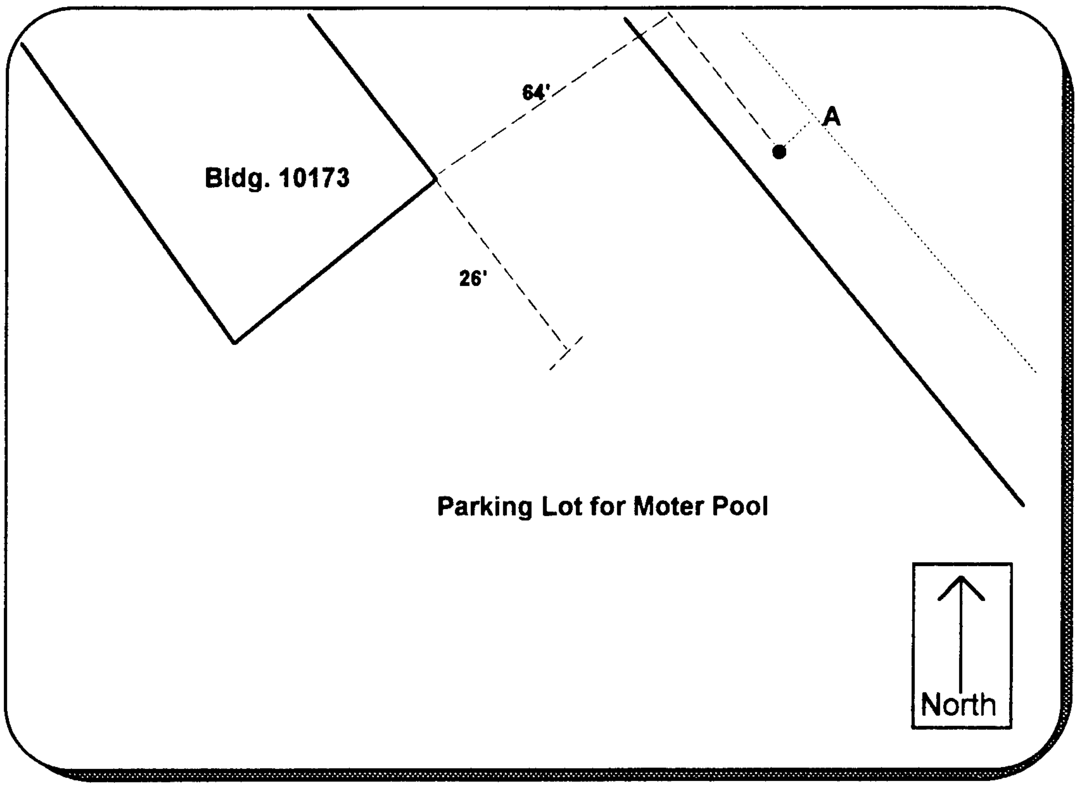
M.E. SIMPSON COMPANY, INC. - Professional Services

LEAK LOCATION REPORT

Client: Fort Drum, New York   **Time:** Leak Survey

Date: Thursday, November 02, 1995   **Tech:** John and Ray

Below is a diagram of the area surveyed for a suspect leak.



Leak Number: 2-10

Distance: 0' From A

Connection point: A= Hydrant

Connection point:

Leak Location: 0' From A

Comments This was a hydrant leak. Leak noise quit when the hydrant was tightened.

We thank you for the opportunity to work for your Utility and look forward to serving you again. If you have any questions please don't hesitate to call.

M.E. SIMPSON COMPANY, INC. - Professional Services

LEAK LOCATION REPORT

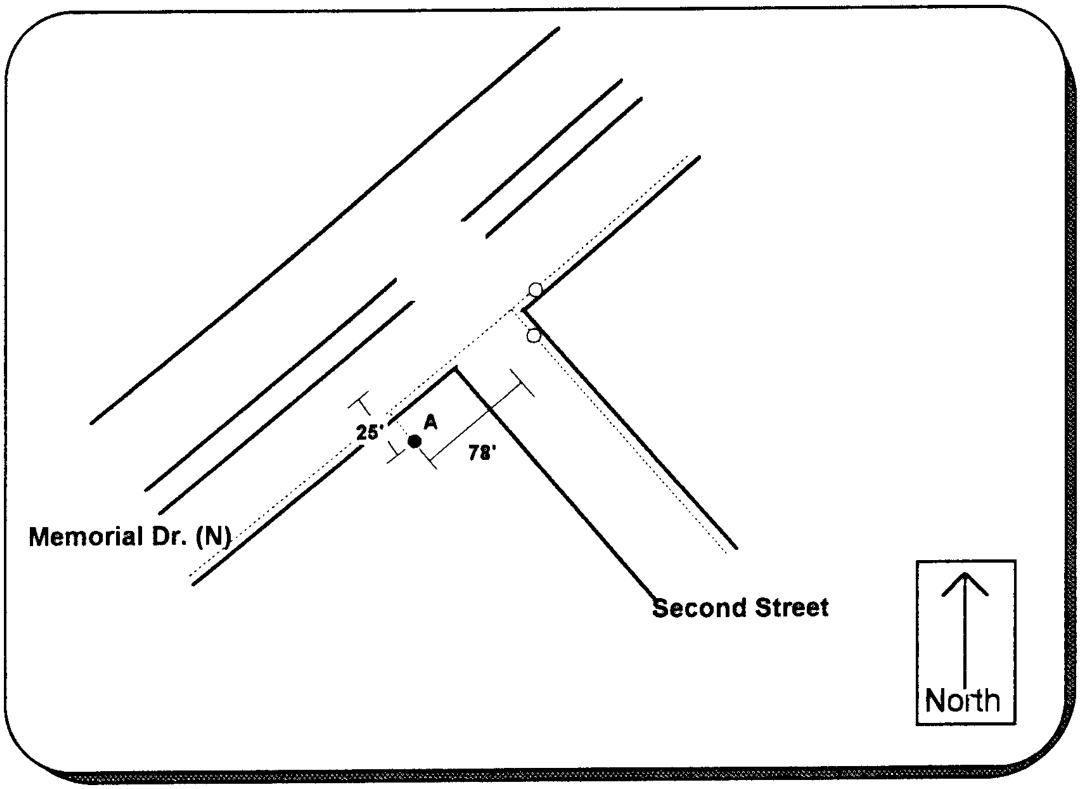
Client: Fort Drum, New York

Time: Leak Survey

Date: Saturday, November 04, 1995

Tech: John and Ray

Below is a diagram of the area surveyed for a suspect leak.



Leak Number: 2-11

Distance: 0' From A

Connection point: A= Hydrant.

Connection point:

Leak Location: 0' From A

Comments This was a hydrant leak. Leak noise quit when the hydrant was tightened.

We thank you for the opportunity to work for your Utility and look forward to serving you again. If you have any questions please don't hesitate to call.

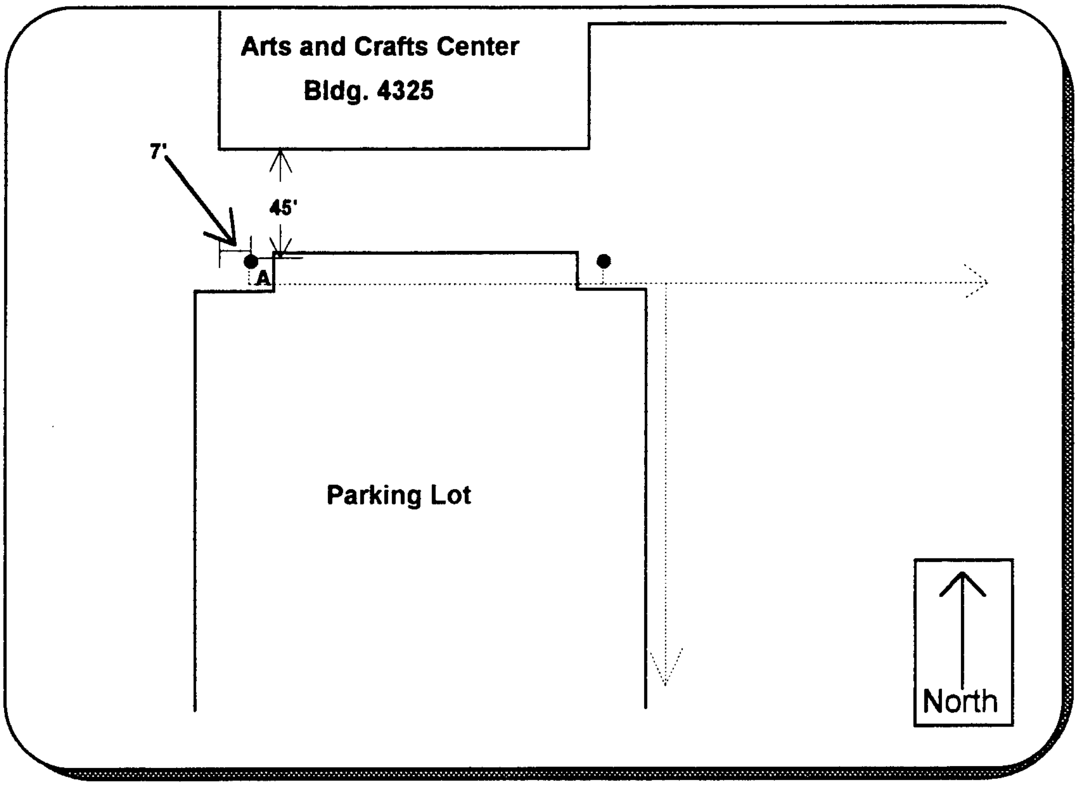
M.E. SIMPSON COMPANY, INC. - Professional Services

LEAK LOCATION REPORT

Client: Fort Drum, New York **Time:** Leak Survey

Date: Tuesday, November 07, 1995 **Tech:** John and Ray

Below is a diagram of the area surveyed for a suspect leak.



Leak Number: 3-1

Distance: 0' From A

Connection point: A= Hydrant

Connection point:

Leak Location: 0' From A

Comments This was a hydrant leak. Leak noise quit when the hydrant was tightened.

We thank you for the opportunity to work for your Utility and look forward to serving you again. If you have any questions please don't hesitate to call.

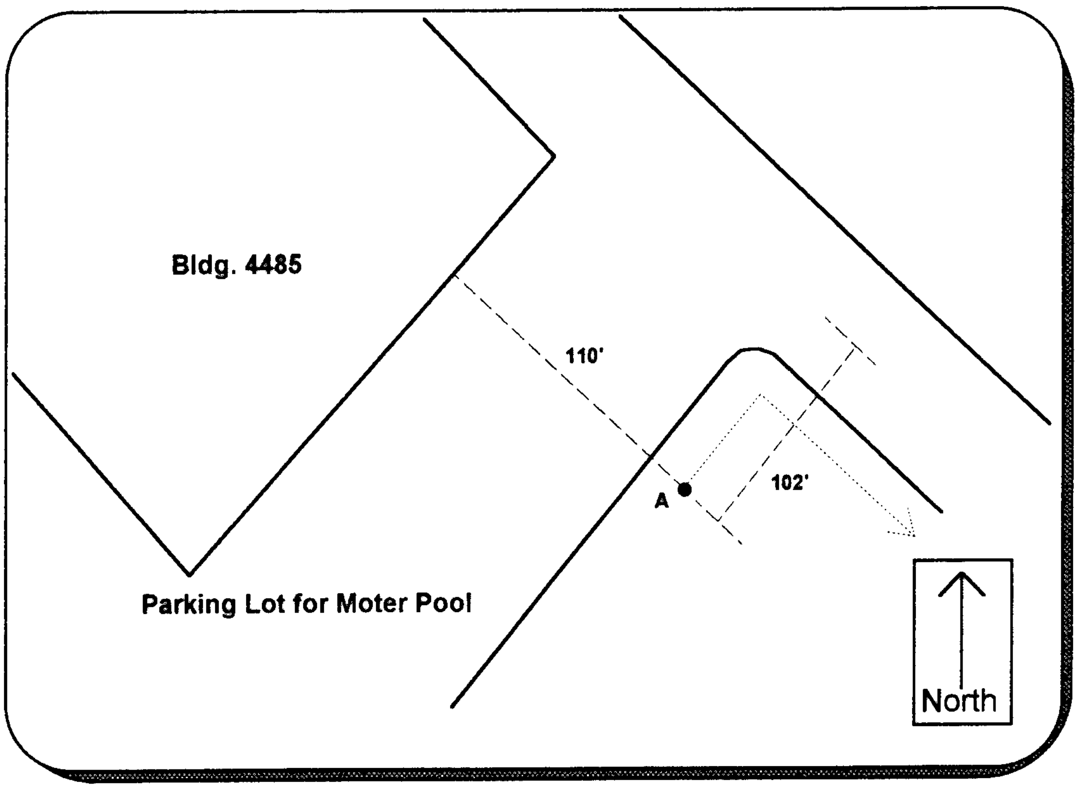
M.E. SIMPSON COMPANY, INC. - Professional Services

LEAK LOCATION REPORT

Client: Fort Drum, New York **Time:** Leak Survey

Date: Monday, November 06, 1995 **Tech:** John and Ray

Below is a diagram of the area surveyed for a suspect leak.



Leak Number: 3-2

Distance: 0' From A

Connection point: A= Hydrant

Connection point:

Leak Location: 0' From A

Comments This was a hydrant leak. Leak noise quit when the hydrant was tightened.

We thank you for the opportunity to work for your Utility and look forward to serving you again. If you have any questions please don't hesitate to call.

M.E. SIMPSON COMPANY, INC. - Professional Services

LEAK LOCATION REPORT

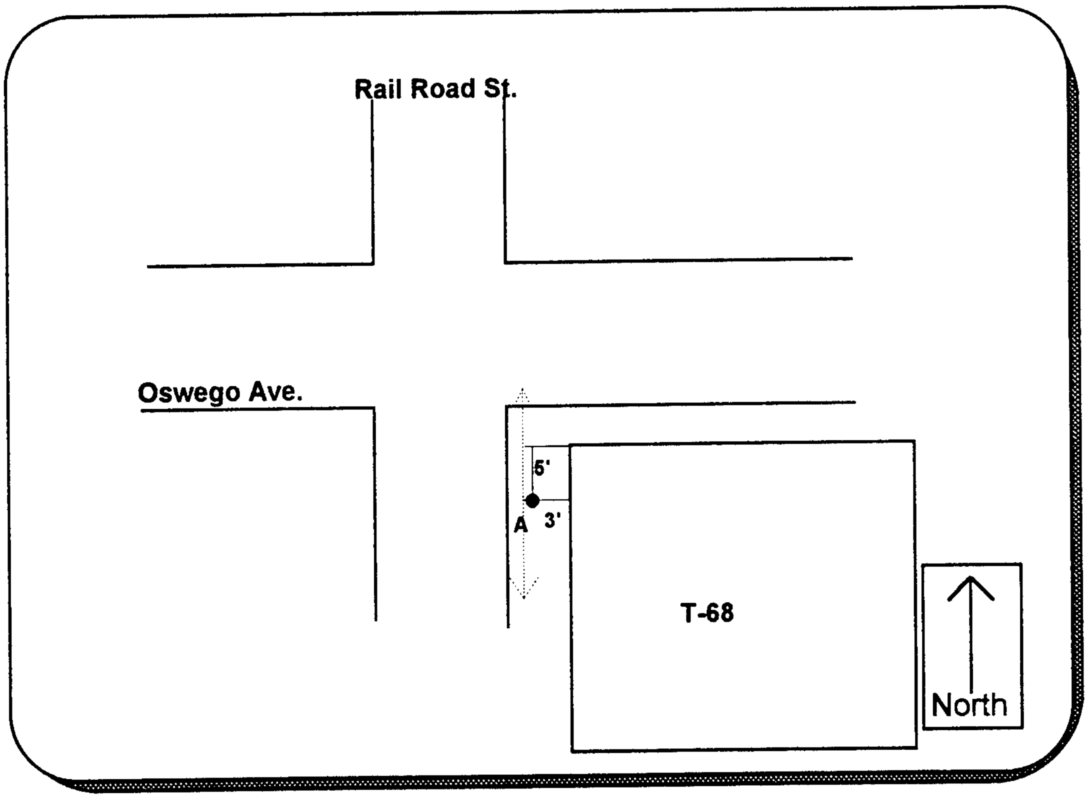
Client: Fort Drum, New York

Time: Leak Survey

Date: Monday, October 30, 1995

Tech: Greg and George

Below is a diagram of the area surveyed for a suspect leak.



Leak Number: 4-1

Distance: 0' From A.

Connection point: A=Hydrant

Connection point:

Leak Location: 0' From A.

Comments This is a hydrant leak.

We thank you for the opportunity to work for your Utility and look forward to serving you again. If you have any questions please don't hesitate to call.

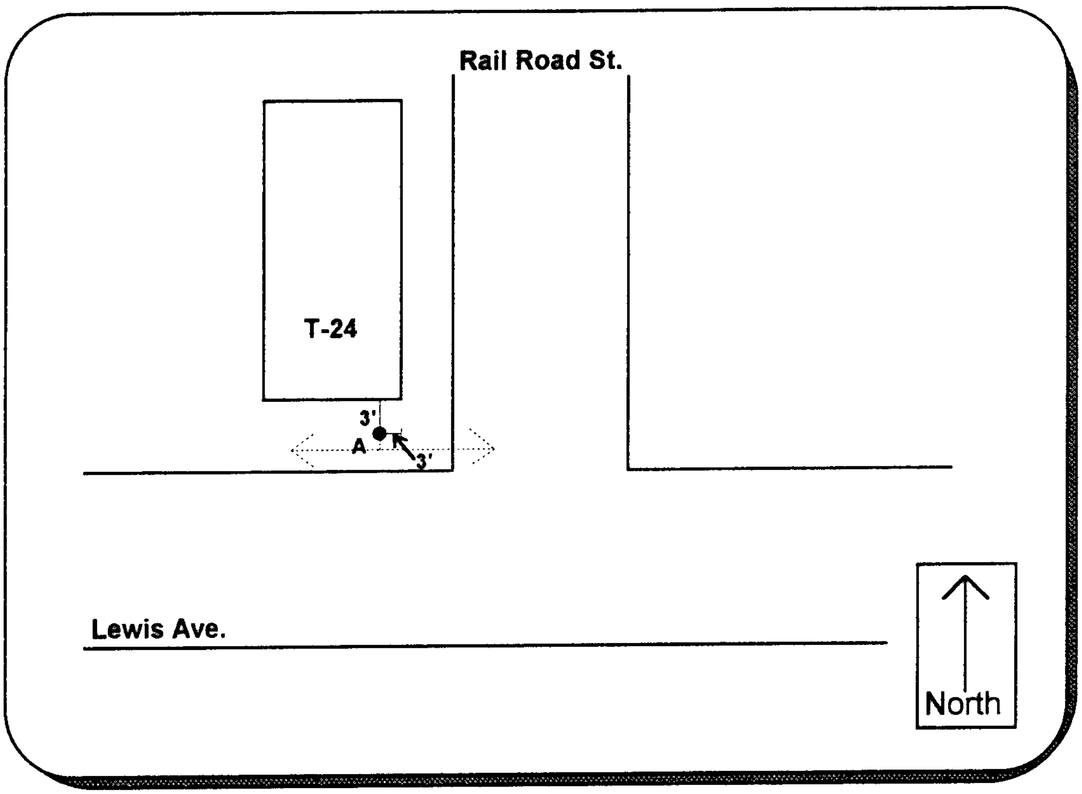
M.E. SIMPSON COMPANY, INC. - Professional Services

LEAK LOCATION REPORT

Client: Fort Drum, New York **Time:** Leak Survey

Date: Monday, October 30, 1995 **Tech:** Greg and George

Below is a diagram of the area surveyed for a suspect leak.



Leak Number: 4-2

Distance: 0' From A.

Connection point: A=Hydrant

Connection point:

Leak Location: 0' From A.

Comments This is a hydrant leak.

We thank you for the opportunity to work for your Utility and look forward to serving you again. If you have any questions please don't hesitate to call.

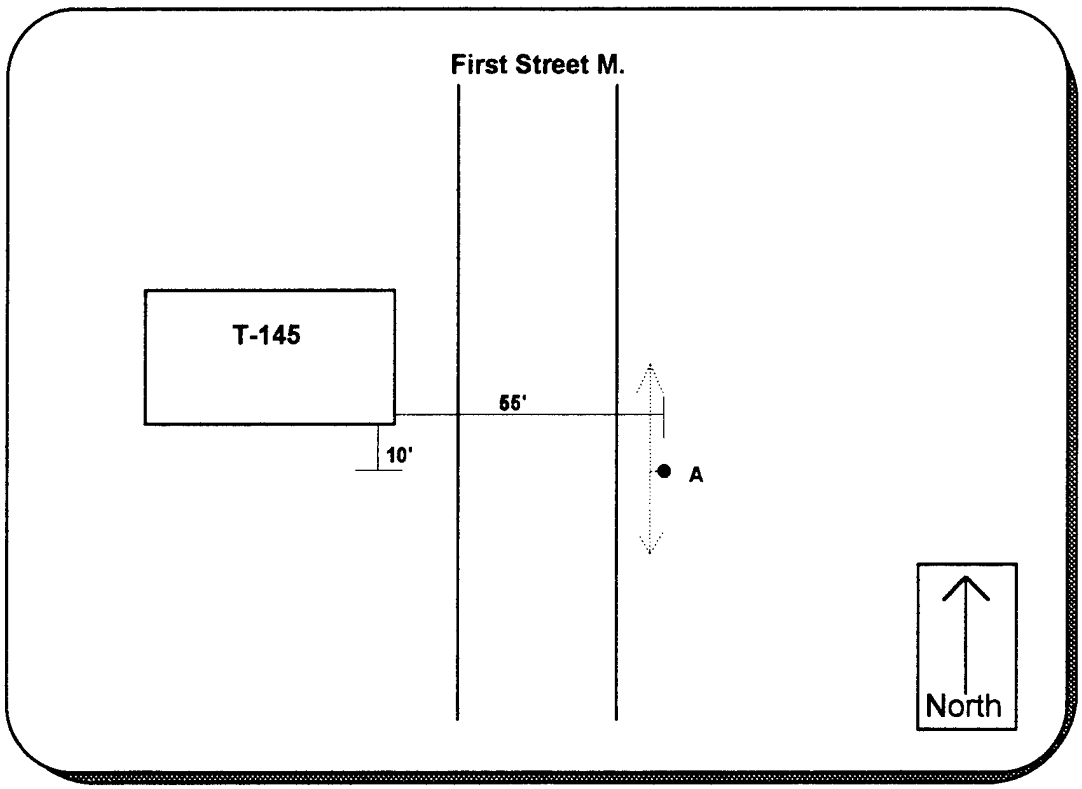
M.E. SIMPSON COMPANY, INC. - Professional Services

LEAK LOCATION REPORT

Client: Fort Drum, New York **Time:** Leak Survey

Date: Monday, October 30, 1995 **Tech:** Greg and George

Below is a diagram of the area surveyed for a suspect leak.



Leak Number: 4-3

Distance: 0' From A.

Connection point: A=Hydrant

Connection point:

Leak Location: 0' From A.

Comments This is a hydrant leak.

We thank you for the opportunity to work for your Utility and look forward to serving you again. If you have any questions please don't hesitate to call.

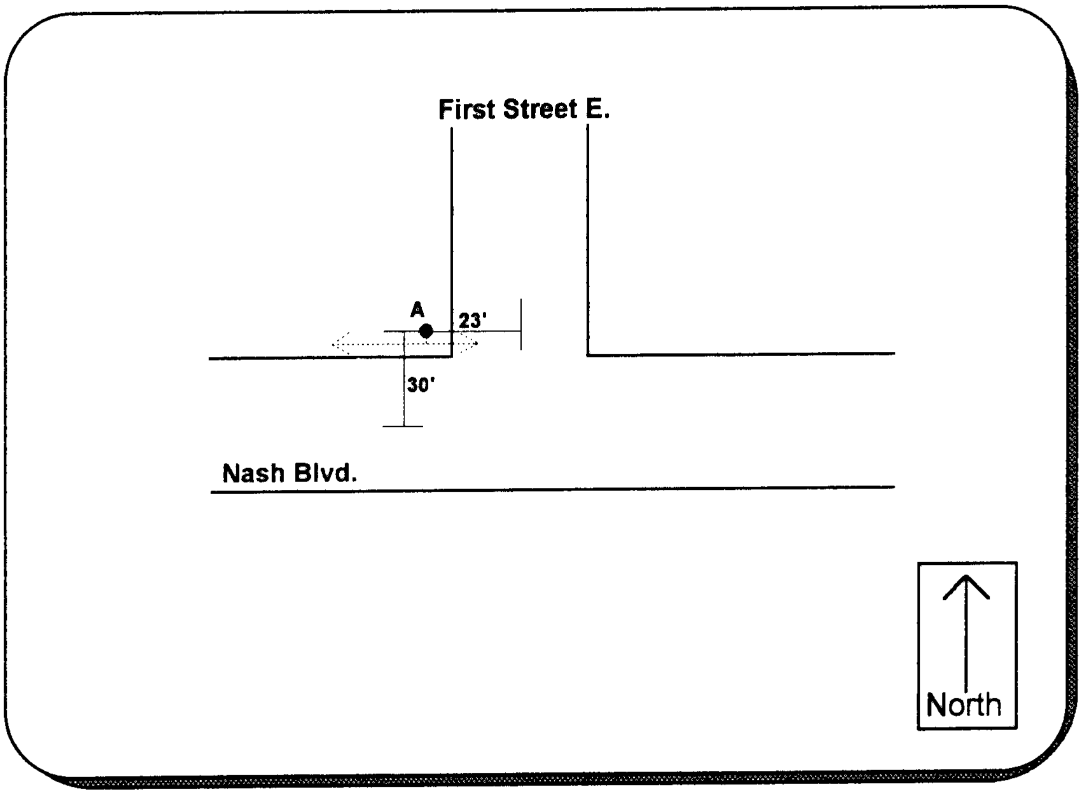
M.E. SIMPSON COMPANY, INC. - Professional Services

LEAK LOCATION REPORT

Client: Fort Drum, New York **Time:** Leak Survey

Date: Monday, October 30, 1995 **Tech:** Greg and George

Below is a diagram of the area surveyed for a suspect leak.



Leak Number: 4-4

Distance: 0' From A.

Connection point: A=Hydrant

Connection point:

Leak Location: 0' From A.

Comments This is a hydrant leak.

We thank you for the opportunity to work for your Utility and look forward to serving you again. If you have any questions please don't hesitate to call.

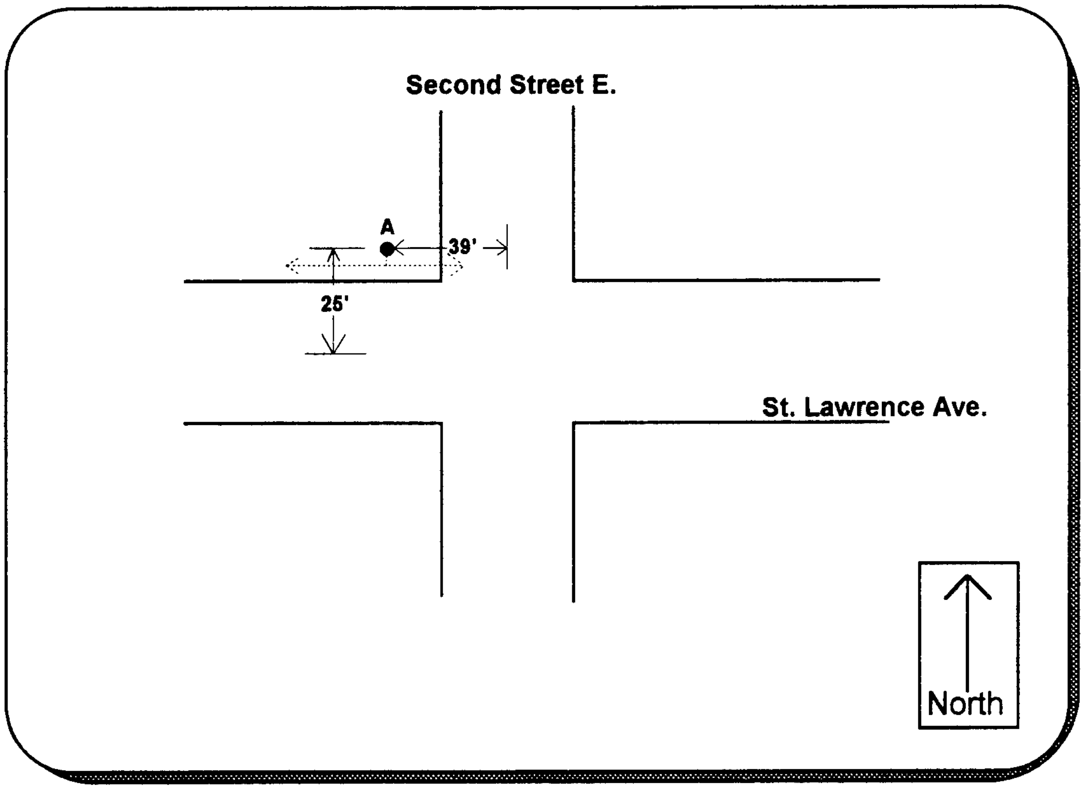
M.E. SIMPSON COMPANY, INC. - Professional Services

LEAK LOCATION REPORT

Client: Fort Drum, New York **Time:** Leak Survey

Date: Monday, October 30, 1995 **Tech:** Greg and George

Below is a diagram of the area surveyed for a suspect leak.



Leak Number: 4-5

Distance: 0' From A.

Connection point: A=Hydrant

Connection point:

Leak Location: 0' From A.

Comments This is a hydrant leak.

We thank you for the opportunity to work for your Utility and look forward to serving you again. If you have any questions please don't hesitate to call.

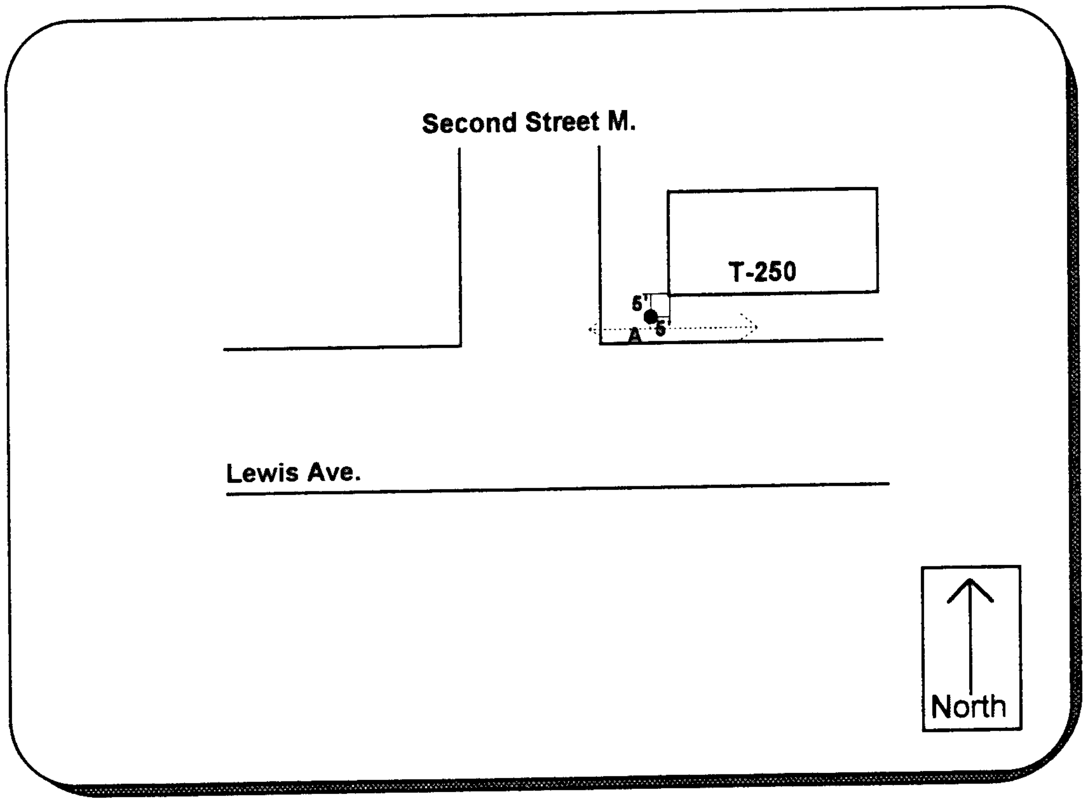
M.E. SIMPSON COMPANY, INC. - Professional Services

LEAK LOCATION REPORT

Client: Fort Drum, New York **Time:** Leak Survey

Date: Monday, October 30, 1995 **Tech:** Greg and George

Below is a diagram of the area surveyed for a suspect leak.



Leak Number: 4-6

Distance: 0' From A.

Connection point: A=Hydrant

Connection point:

Leak Location: 0' From A.

Comments This is a hydrant leak.

We thank you for the opportunity to work for your Utility and look forward to serving you again. If you have any questions please don't hesitate to call.

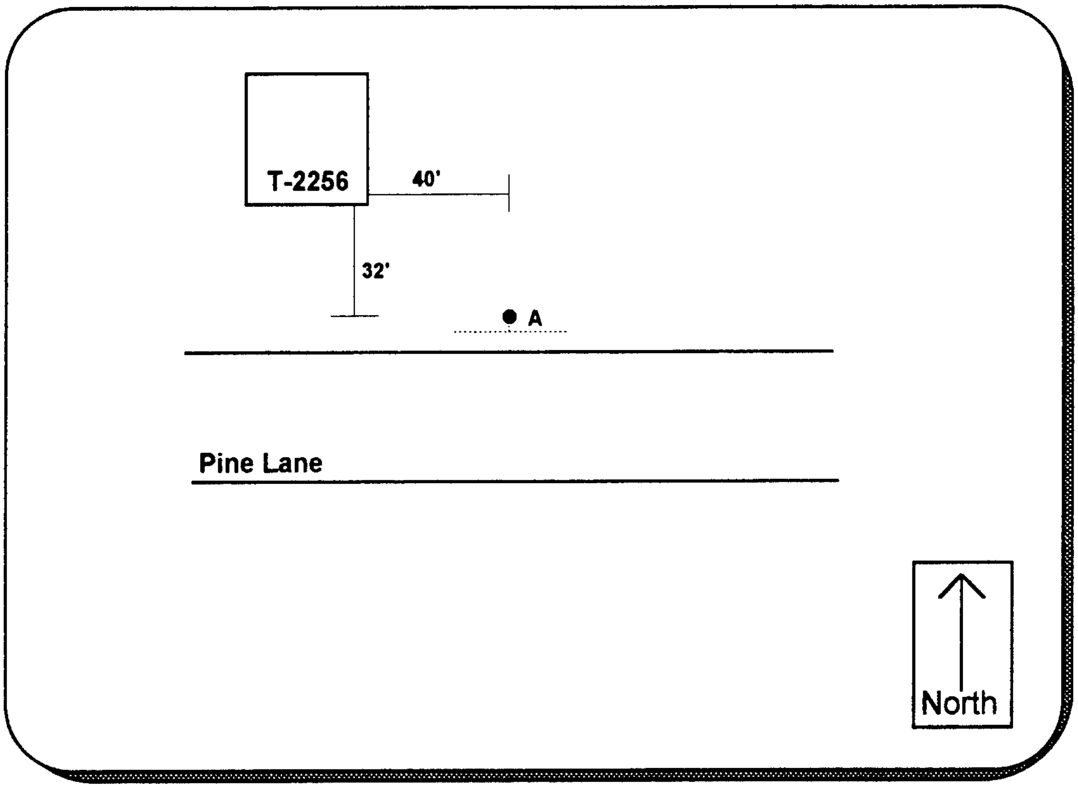
M.E. SIMPSON COMPANY, INC. - Professional Services

LEAK LOCATION REPORT

Client: Fort Drum, New York **Time:** Leak Survey

Date: Monday, October 30, 1995 **Tech:** Greg and George

Below is a diagram of the area surveyed for a suspect leak.



Leak Number: 4-7

Distance: 0' From A.

Connection point: A=Hydrant

Connection point:

Leak Location: 0' From A.

Comments This is a hydrant leak.

We thank you for the opportunity to work for your Utility and look forward to serving you again. If you have any questions please don't hesitate to call.

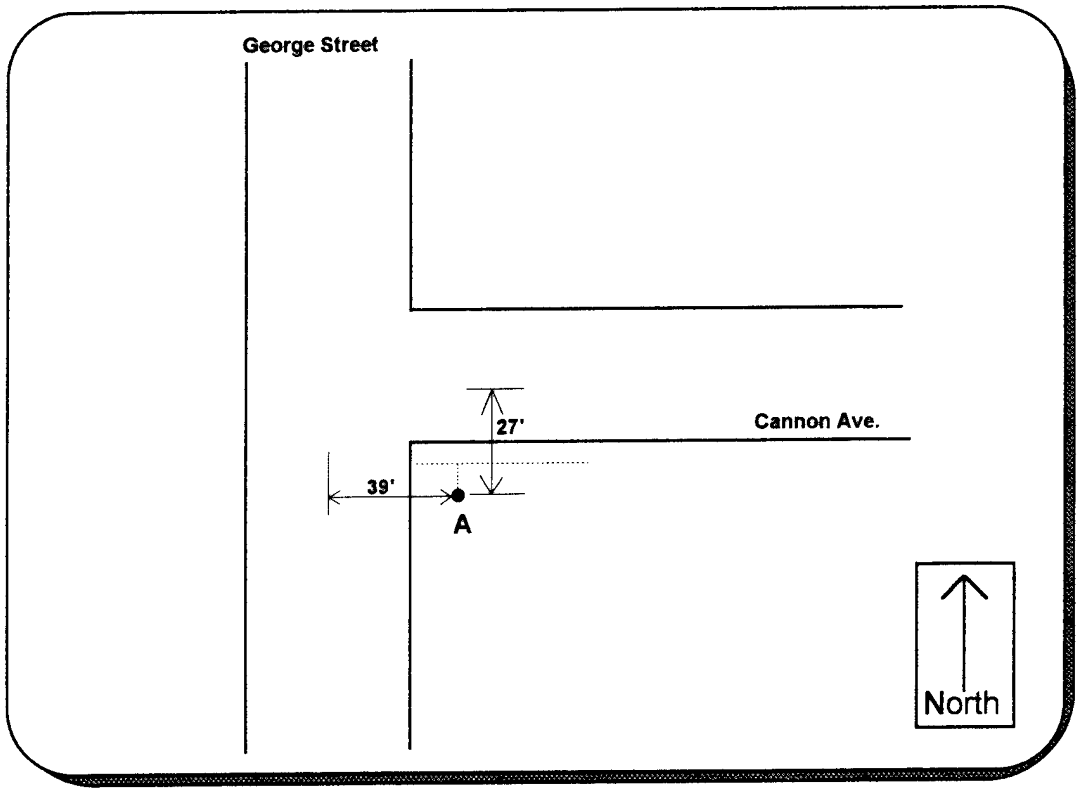
M.E. SIMPSON COMPANY, INC. - Professional Services

LEAK LOCATION REPORT

Client: Fort Drum, New York **Time:** Leak Survey

Date: Thursday, October 26, 1995 **Tech:** Greg and George

Below is a diagram of the area surveyed for a suspect leak.



Leak Number: 5-1

Distance: 0' From A.

Connection point: A=Hydrant

Connection point:

Leak Location: 0' From A.

Comments This is a hydrant leak.

We thank you for the opportunity to work for your Utility and look forward to serving you again. If you have any questions please don't hesitate to call.

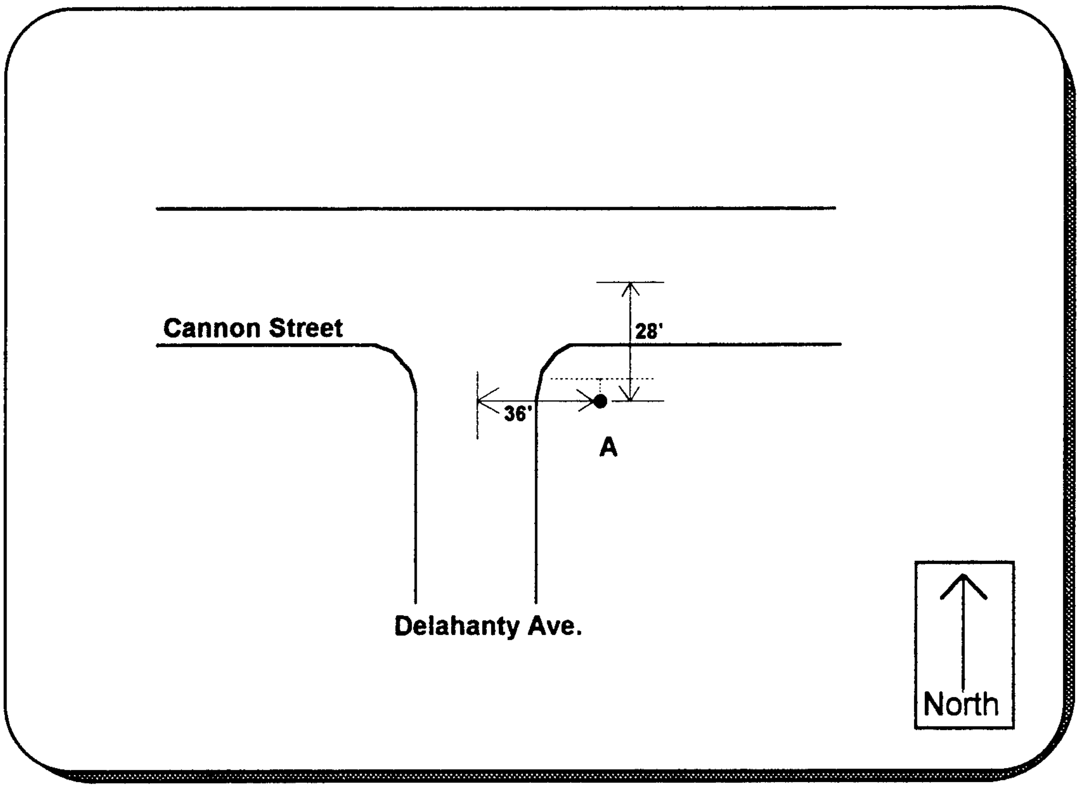
M.E. SIMPSON COMPANY, INC. - Professional Services

LEAK LOCATION REPORT

Client: Fort Drum, New York **Time:** Leak Survey

Date: Thursday, October 26, 1995 **Tech:** Greg and George

Below is a diagram of the area surveyed for a suspect leak.



Leak Number: 5-2

Distance: 0' From A.

Connection point: A=Hydrant

Connection point:

Leak Location: 0' From A.

Comments This is a hydrant leak.

We <u>thank you</u> for the opportunity to work for your Utility and look forward to serving you again. If you have any questions please don't hesitate to call.

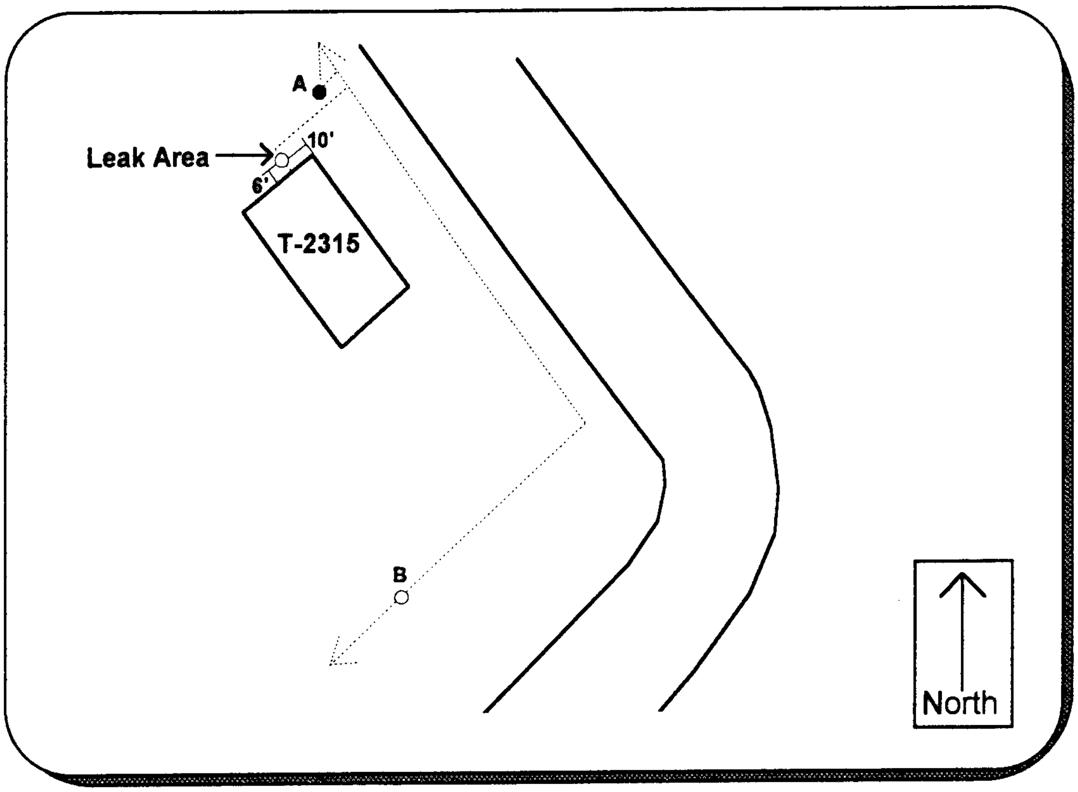
M.E. SIMPSON COMPANY, INC. - Professional Services

LEAK LOCATION REPORT

Client: Fort Drum, New York **Time:** Leak Survey

Date: Monday, October 30, 1995 **Tech:** Greg and George

Below is a diagram of the area surveyed for a suspect leak.



Leak Number: 5-3

Distance: 320' From A to B.

Connection point: A= Hydrant

Connection point: B= Main line valve

Leak Location: Service valve for T-2315

Comments This is a service leak on the 1 1/2" line going into bldg. T-2315.

We thank you for the opportunity to work for your Utility and look forward to serving you again. If you have any questions please don't hesitate to call.

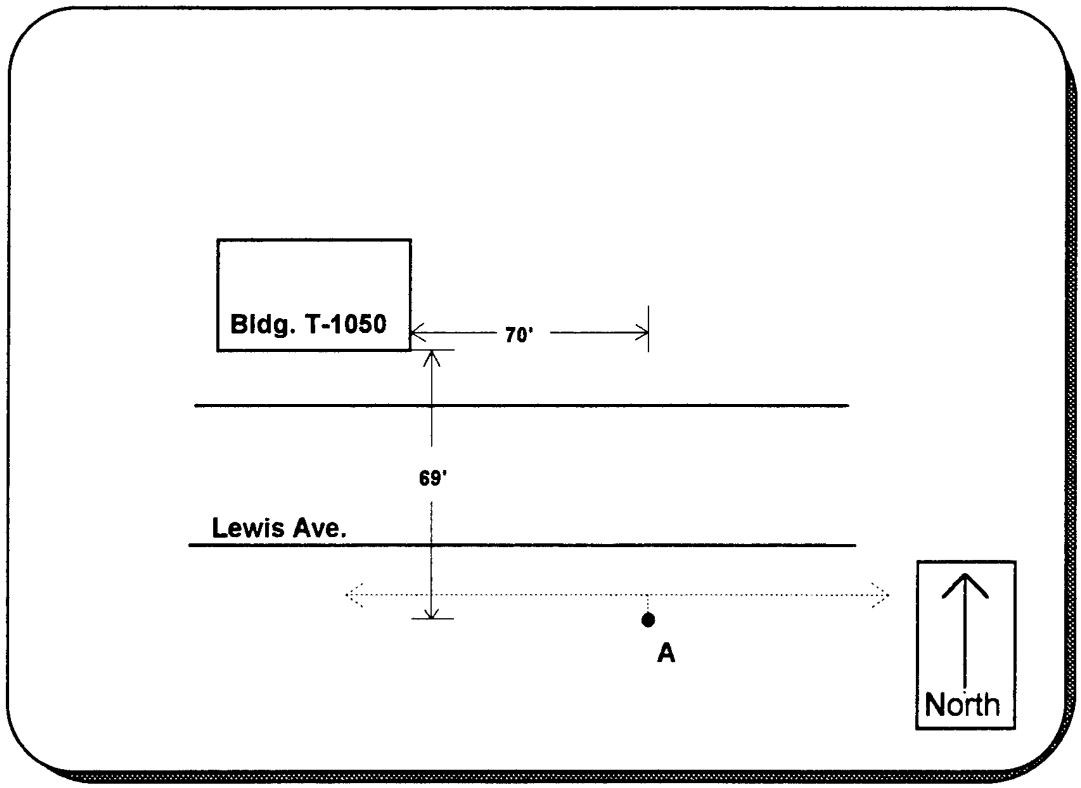
M.E. SIMPSON COMPANY, INC. - Professional Services

LEAK LOCATION REPORT

Client: Fort Drum, New York **Time:** Leak Survey

Date: Thursday, October 26, 1995 **Tech:** Greg and George

Below is a diagram of the area surveyed for a suspect leak.



Leak Number: 5-4

Distance: 0' From A.

Connection point: A=Hydrant

Connection point:

Leak Location: 0' From A.

Comments This is a hydrant leak.

We thank you for the opportunity to work for your Utility and look forward to serving you again. If you have any questions please don't hesitate to call.

M.E. SIMPSON COMPANY, INC. - Professional Services

LEAK LOCATION REPORT

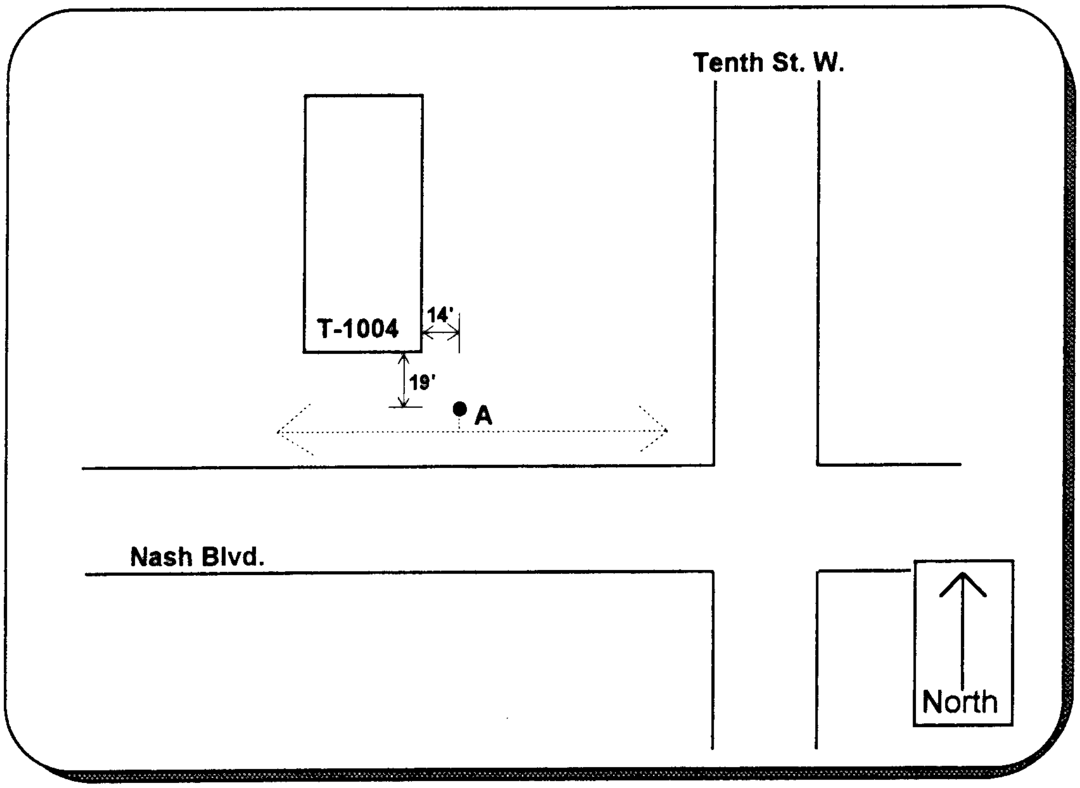
Client: Fort Drum, New York

Time: Leak Survey

Date: Thursday, October 26, 1995

Tech: Greg and George

Below is a diagram of the area surveyed for a suspect leak.



Leak Number: 5-5

Distance: 0' From A.

Connection point: A=Hydrant

Connection point:

Leak Location: 0' From A.

Comments This is a hydrant leak.

We __thank you__ for the opportunity to work for your Utility and look forward to serving you again. If you have any questions please don't hesitate to call.

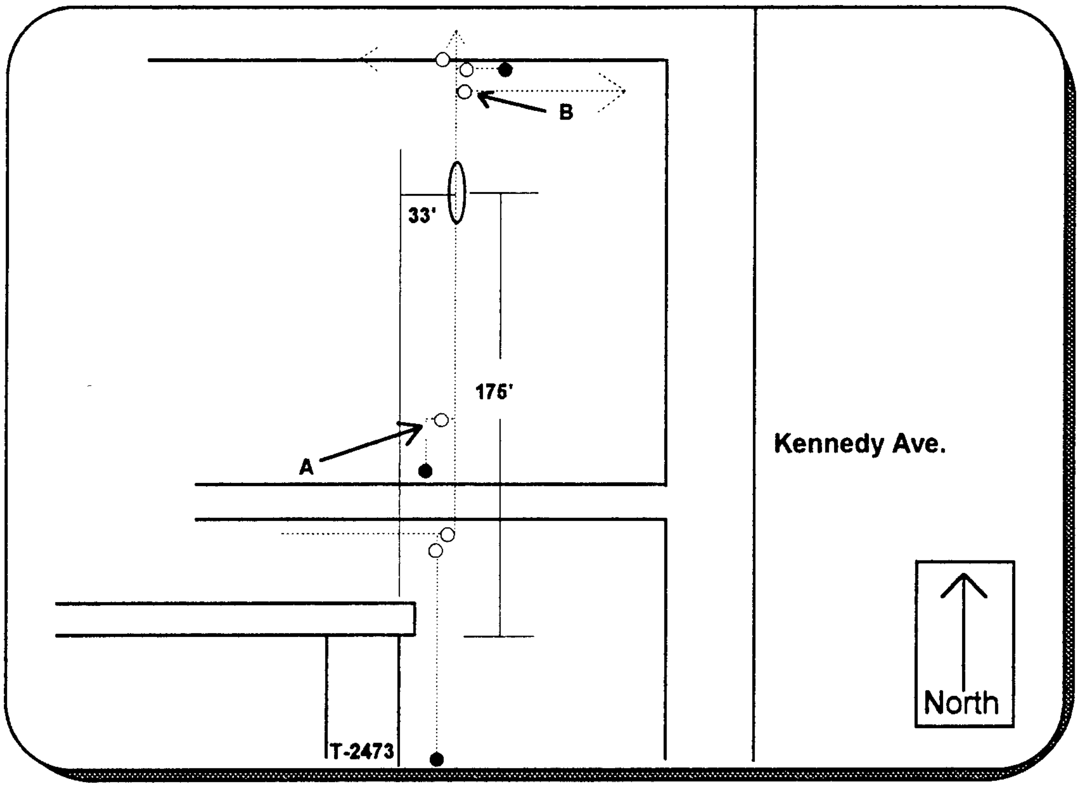
M.E. SIMPSON COMPANY, INC. - Professional Services

LEAK LOCATION REPORT

Client: Fort Drum, New York **Time:** Leak Survey

Date: Tuesday, October 31, 1995 **Tech:** Greg and George

Below is a diagram of the area surveyed for a suspect leak.



Leak Number: 5-6

Distance: 187' From A to B.

Connection point: A= 6" Aux. valve for hydrant.

Connection point: B= 8" Main line valve.

Leak Location: 105' N. of A on the 12" Main towards B.

Comments Old 2" service.

We thank you for the opportunity to work for your Utility and look forward to serving you again. If you have any questions please don't hesitate to call.

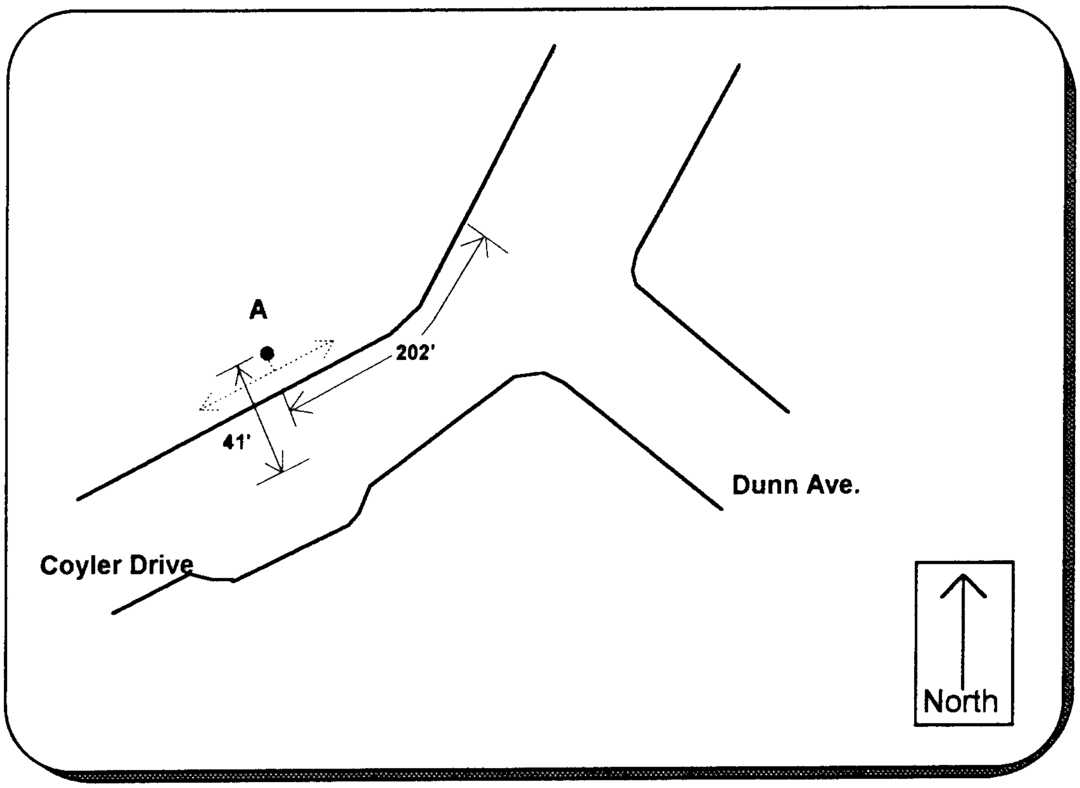
M.E. SIMPSON COMPANY, INC. - Professional Services

LEAK LOCATION REPORT

Client: Fort Drum, New York **Time:** Leak Survey

Date: Thursday, October 26, 1995 **Tech:** Greg and George

Below is a diagram of the area surveyed for a suspect leak.



Leak Number: 5-7

Distance: 0' From A.

Connection point: A=Hydrant

Connection point:

Leak Location: 0' From A.

Comments This is a hydrant leak.

We thank you for the opportunity to work for your Utility and look forward to serving you again. If you have any questions please don't hesitate to call.

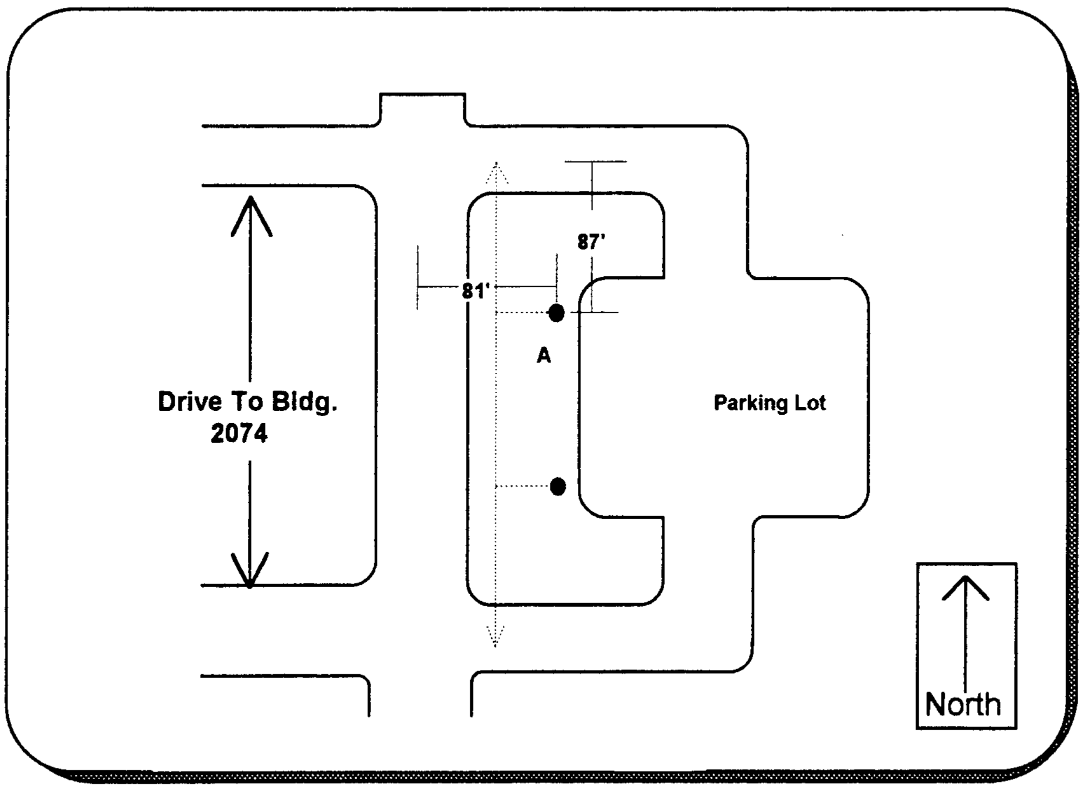
M.E. SIMPSON COMPANY, INC. - Professional Services

LEAK LOCATION REPORT

Client: Fort Drum, New York **Time:** Leak Survey

Date: Monday, November 06, 1995 **Tech:** John and Ray

Below is a diagram of the area surveyed for a suspect leak.



Leak Number: 6-1

Distance: 0' From A

Connection point: A= Hydrant

Connection point:

Leak Location: 0' From A

Comments This is a hydrant leak. This hydrant is on the high pressure fire protection system for the airport.

We thank you for the opportunity to work for your Utility and look forward to serving you again. If you have any questions please don't hesitate to call.

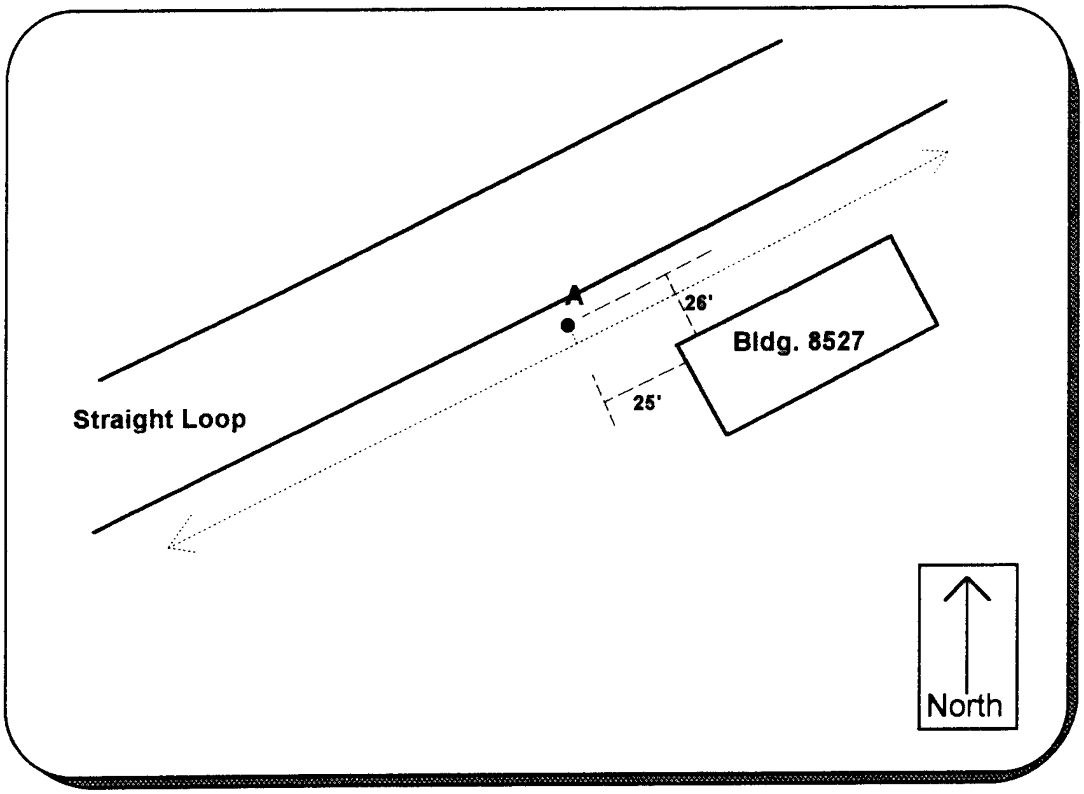
M.E. SIMPSON COMPANY, INC. - Professional Services

LEAK LOCATION REPORT

Client: Fort Drum, New York **Time:** Leak Survey

Date: Thursday, November 02, 1995 **Tech:** John and Ray

Below is a diagram of the area surveyed for a suspect leak.



Leak Number: 7-1

Distance: 0' From A

Connection point: A= Hydrant

Connection point:

Leak Location: 0' From A

Comments This was a hydrant leak. Leak noise quit when the hydrant was tightened.

We thank you for the opportunity to work for your Utility and look forward to serving you again. If you have any questions please don't hesitate to call.

APPENDIX D

ENERGY AUDIT CALCULATIONS

Energy Cost Calculations
ECO #1 LCCA
ECO #2 LCCA
ECO #3 LCCA
ECO #4 LCCA
ECO #5 LCCA
ECO #6 LCCA
ECO #7 LCCA
Cost Estimate Back-up Data
LCCA Economic Factors

Energy Cost Calculations

ELECTRICAL CONSUMPTION - FT. DRUM (WELLS, RESERVOIR PUMPS) & DANC

A full year of data taken from the telemetry system was taken from August to July.

Date	Well No. 2	Well No. 3	Well No. 4	Well No. 5	Well No. 6	Well No. 7	Well No. 8	Well No. 9	Well No. 10	Well No. 11	Well No. 12	Total	Reservoir Pump
Avg. (Hours)	1,098	2,070	1,585	1,050	1,954	1,315	2,146	1,331	1,676	1,007	1,283	16,515	2,614
Flow (gpm)	410	125	75	410	125	150	75	185	220	285	190	2,249	450
Flow (gal)	27,004,212	15,512,580	7,122,039	25,823,700	14,642,104	11,827,110	9,642,975	14,765,315	22,112,138	17,213,054	14,617,732	180,282,960	
Motor HP	40	20	15	40	15	15	15	20	25	40	30	-	40
Motor Effic.	89.5%	87.5%	86.0%	89.5%	86.0%	86.0%	86.0%	87.5%	88.0%	89.5%	88.5%	-	89.5%
Motor kW	25.0	12.8	9.8	25.0	9.8	9.8	9.8	12.8	15.9	25.0	19.0	174.49	25.0
Motor kWh	27,456.1	26,472.3	15,467.6	26,255.9	19,068.5	12,832.7	20,942.2	17,021.6	26,639.8	25,180.6	24,333.5	241,670.9	65,364.6
kWh Cost	$1,977	$1,906	$1,114	$1,890	$1,373	$924	$1,508	$1,226	$1,918	$1,813	$1,752	$17,400	$4,706

COST OF WATER - DISTRIBUTION SYSTEM - BASED ON 1995 WATER PRICES

Avg. KW: 15.86
Avg. GPM: 204.44

Total Ft. Drum O&M Cost:	$20,105	(Based on FY95 value supplied by Ft. Drum)
Total Chemical Treatment Cost:	$5,550	(=5550 * Flow Rate/180,282,960)
Total Well Operation (hrs):	16,515	
Total Well kWh Cost:	$17,400	(Based on $0.072/kWh)
Total Well Production (gal):	180,282,960	(Average value per year from Aug-93 to Jul-95)
Cost of Drum Water (per kGal)	**$0.097**	
Total Reservoir Pump Cost:	$4,706	(Based on $0.072/kWh)
Total Reservoir Pump (gal):	70,578,000	(Based on flow rate of 450 gpm)
Cost of Res. Water (per kGal):	**$0.067**	
DANC - Variable Costs:	$476,527	
DANC Production (gal):	529,017,693	(Average value per year from Aug-93 to Jul-95)
Total DANC Cost (per KGal):	**$0.90**	(Taken from Schedule A for 1997)

	DANC Water Cost / kGal			Ft. Drum Electrical Cost / kGal			Ft. Drum O & M Cost/ kGal		Ft. Drum Chem. Cost		Reservoir Pump Cost/ kGal
Total Cost:	$0.90	529,018 / 709,301	+	$0.097	180,283 / 709,301	+	$20,105 / 709,301	+	$5,550 / 180,283	+	$4,706 / 70,578
Total Cost:	$0.90	74.58%	+	$0.097	25.42%	+	$0.028	+	$0.031	+	$0.067
Total Cost:	$0.672		+	$0.025		+	$0.028	+	$0.031	+	$0.067

Total Cost: $0.82 per kGal

DANC WATER - CALCULATION OF FIXED & VARIABLE COSTS

It was assumed for the economic analysis that Ft. Drum will pay for DANC water fixed costs regardless of water consumption. Therefore, cost of water and water savings will only be based on DANC variable costs, not fixed costs.

DANC Costs:		Fixed		Fixed		Variable			Variable		Variable		Fixed		Variable			
Economic Year	Date	City Capital Cost	City Capital Cost ($/kgal)	DANC Capital Cost	DANC Capital Cost ($/kgal)	DANC Overhead Costs	DANC Overhead Cost ($/kgal)	Combined Cap. and Overhead	City O & M	City O&M Cost ($/kgal)	DANC O & M	DANC O&M Cost ($/kgal)	Total Fixed Cost	Total Fixed Cost ($/kgal)	Total Variable Cost	Total Variable Cost ($/kgal)	Total Cost	Total Cost/kGal
1	4/95 - 3/96	$314,049	$0.57	$2,632,305	$4.81	$86,203	$0.16	$3,032,562	$222,873	$0.41	$167,451	$0.31	$2,946,354	$5.38	$476,527	$0.87	$3,422,886	$6.25
2	4/96 - 3/97	$314,049	$0.57	$1,535,136	$2.80	$88,359	$0.16	$1,937,547	$228,384	$0.42	$171,637	$0.31	$1,849,185	$3.38	$488,380	$0.89	$2,337,569	$4.27
3	4/97 - 3/98	$314,049	$0.57	$0	$0.00	$90,567	$0.17	$404,617	$234,093	$0.43	$175,928	$0.32	$314,049	$0.57	$500,588	$0.91	$814,638	$1.49
4	4/98 - 3/99	$314,049	$0.57	$0	$0.00	$92,831	$0.17	$406,881	$239,946	$0.44	$180,326	$0.33	$314,049	$0.57	$513,103	$0.94	$827,153	$1.51
5	4/99 - 3/00	$314,049	$0.57	$0	$0.00	$95,152	$0.17	$409,202	$243,944	$0.45	$184,835	$0.34	$314,049	$0.57	$523,931	$0.96	$837,980	$1.53
6	4/00 - 3/01	$314,049	$0.57	$0	$0.00	$97,530	$0.18	$411,580	$252,093	$0.46	$189,455	$0.35	$314,049	$0.57	$539,078	$0.98	$853,128	$1.56
7	4/01 - 3/02	$314,049	$0.57	$0	$0.00	$99,966	$0.18	$414,016	$258,395	$0.47	$194,192	$0.35	$314,049	$0.57	$552,553	$1.01	$866,602	$1.58
8	4/02 - 3/03	$314,049	$0.57	$0	$0.00	$102,468	$0.19	$416,518	$264,855	$0.48	$199,047	$0.36	$314,049	$0.57	$566,370	$1.03	$880,419	$1.61
9	4/03 - 3/04	$314,049	$0.57	$0	$0.00	$105,029	$0.19	$419,079	$271,477	$0.50	$204,023	$0.37	$314,049	$0.57	$580,529	$1.06	$894,578	$1.63
10	4/04 - 3/05	$314,049	$0.57	$0	$0.00	$107,655	$0.20	$421,705	$278,263	$0.51	$209,123	$0.38	$314,049	$0.57	$595,041	$1.09	$909,091	$1.66
11	4/05 - 3/06	$314,049	$0.57	$0	$0.00	$110,344	$0.20	$424,394	$285,220	$0.52	$214,351	$0.39	$314,049	$0.57	$609,915	$1.11	$923,965	$1.69
12	4/06 - 3/07	$314,049	$0.57	$0	$0.00	$113,105	$0.21	$427,155	$292,351	$0.53	$219,710	$0.40	$314,049	$0.57	$625,166	$1.14	$939,216	$1.72
13	4/07 - 3/08	$314,049	$0.57	$0	$0.00	$115,933	$0.21	$429,983	$299,659	$0.55	$225,203	$0.41	$314,049	$0.57	$640,795	$1.17	$954,845	$1.74
14	4/08 - 3/09	$266,661	$0.49	$0	$0.00	$118,831	$0.22	$385,492	$307,151	$0.56	$230,833	$0.42	$266,661	$0.49	$656,815	$1.20	$923,477	$1.69
15	4/09 - 3/10	$180,436	$0.33	$0	$0.00	$121,802	$0.22	$302,238	$314,830	$0.58	$236,604	$0.43	$180,436	$0.33	$673,236	$1.23	$853,672	$1.56
16	4/10 - 3/11	$145,235	$0.27	$0	$0.00	$124,847	$0.23	$270,082	$322,700	$0.59	$242,519	$0.44	$145,235	$0.27	$690,066	$1.26	$835,301	$1.53
17	4/11 - 3/12	$26,076	$0.05	$0	$0.00	$127,968	$0.23	$154,044	$330,768	$0.60	$248,582	$0.45	$26,076	$0.05	$707,318	$1.29	$733,394	$1.34
18	4/12 - 3/13	$0	$0.00	$0	$0.00	$131,167	$0.24	$131,167	$339,037	$0.62	$254,796	$0.47	$0	$0.00	$725,000	$1.32	$725,000	$1.32
19	4/13 - 3/14	$0	$0.00	$0	$0.00	$134,446	$0.25	$134,446	$347,513	$0.63	$261,166	$0.48	$0	$0.00	$743,125	$1.36	$743,125	$1.36
20	4/14 - 3/15	$0	$0.00	$0	$0.00	$137,807	$0.25	$137,807	$356,201	$0.65	$267,696	$0.49	$0	$0.00	$761,704	$1.39	$761,704	$1.39

Costs based on guaranteed annual water production of 1.5 million gallons per day; 547,500,000 gallons per year.

Cost of Water/kgal (1995):	(Fixed)	$5.38	(Variable)	$0.87
Cost of Water/kgal (1996):	(Fixed)	$3.38	(Variable)	$0.89
Cost of Water/kgal (1997):	(Fixed)	$0.57	(Variable)	$0.91

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JOB Ft. Drum Water Study 1406-012
SHEET NO. 1 OF 4
CALCULATED BY TCP DATE 1-31-96
CHECKED BY ________ DATE ________
SCALE Utility Charges - Ft. Drum

Cost of Water - Ft. Drum

The total cost of water at Ft. Drum can be separated into the following categories:

- Ft. Drum Electrical Charges (Well Pumps)
- Ft. Drum O+M Charges (Wells, Distribution Piping, Chemicals)
- DANC Electrical Charges
- DANC O+M Charges
- DANC Capitalization and Overhead Charges
- City of Watertown Capitalization Charges

DANC + City of Watertown Costs

Ft. Drum pays a single fee ($/KGal) for a contracted amount of 1.5 MGD of water from DANC. This fee includes:

- DANC Electrical Costs
- DANC O+M Costs
- DANC Capital and Overhead Costs
- City of Watertown Capital Costs

Cost was taken from DANC Water Line Schedule "A" for the period of 4/1/95 to 3/31/96:

$$\boxed{\text{Total DANC Cost} = \$6.25/\text{KGal}}$$

Note: Ft. Drum is contractually obligated to pay for 1.5 MGD (547,500,000 gal/yr) or more, if more is used.

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JOB Ft. Drum Water Study 1406-012
SHEET NO. 2 OF 4
CALCULATED BY TCP DATE 1-31-96
CHECKED BY ______ DATE ______
SCALE Water Costs - Ft. Drum

Ft. Drum Electrical Charges

From the Ft. Drum utility office:

Monthly electrical charge = \$3,172/mo.
Demand KW = \$7.02/KW
On Peak KWH = \$0.06196/KWH
Off Peak KWH = \$0.05197/KWH

Bundled electrical charge = **\$0.072/KWH** which includes all demand, consumption, customer charges that Ft. Drum pays.

Pump Electrical Costs - Wells

Total Cost (Wells) = Σ (All well KWH)

$$KWH_{well} = KW(Hours)$$

$$KW_{well} = \frac{(HP)(0.746)(LF)}{\eta_m}$$

$$\boxed{\therefore \text{Electrical Cost}_{wells} = \Sigma \frac{(HP)(0.746)(LF)(Hours)}{\eta_m}}$$

where:
KW = demand
KWH = consumption
HP = motor horsepower
LF = motor load factor (assume 75%)
0.746 = HP to KW conversion
η_m = motor efficiency (Assume standard efficiency motor)
Hours = Annual Operating Hours

Table 2. Nominal Full-Load Efficiencies from the National Energy Policy Act of 1992

Motor (hp)	Number of Poles					
	Open Motors			Closed Motors		
	2	4	6	2	4	6
1	—	82.5	80.0	75.5	82.5	80.0
1.5	82.5	84.0	84.0	82.5	84.0	85.5
2	84.0	84.0	85.5	84.0	84.0	86.5
3	84.0	86.5	86.5	85.5	87.5	87.5
5	85.5	87.5	87.5	87.5	87.5	87.5
7.5	87.5	88.5	88.5	88.5	89.5	89.5
10	88.5	89.5	90.2	89.5	89.5	89.5
15	89.5	91.0	90.2	90.2	91.0	90.2
20	90.2	91.0	91.0	90.2	91.0	90.2
25	91.0	91.7	91.7	91.0	92.4	91.7
30	91.0	92.4	92.4	91.0	92.4	91.7
40	91.7	93.0	93.0	91.7	93.0	93.0
50	92.4	93.0	93.0	92.4	93.0	93.0
60	93.0	93.6	93.6	93.0	93.6	93.6
75	93.0	94.1	93.6	93.0	94.1	93.6
100	93.0	94.1	94.1	93.6	94.5	94.1
125	93.6	94.5	94.1	94.5	94.5	94.1
150	93.6	95.0	94.5	94.5	95.0	95.0
200	94.5	95.0	94.5	95.0	95.0	95.0

Notes: 1) Manufactured by October 25, 1997
2) Manufactured by October 25 1999 for motors requiring certification from a nationally recognized safety testing laboratory.

otors where efficiency, full load speed, power factor, cost and other formation are available. Because no one manufacturer has the most ficient motor in every size or type, users should comparison shop. anufacturers also change their designs from time to time, so it is very portant to obtain up-to-date efficiency, full load speed, cost, etc., information from the manufacturers.

Table 3. Typical Efficiencies of Electric Motors

Typical Standard Motors			Typical Energy-Efficient Motors		
Full Load Efficiencies of NEMA Design B Induction Motors			Full Load Efficiencies of Three Phase, Four Pole Motors		
hp	Nominal Efficiency Range	Average Nominal Efficiency	hp	Nominal Efficiency Range	Average Nominal Efficiency
1.0	68.0-78.0	73.0	1.0	80.0-84.0	83.0
1.5	68.0-80.0	75.0	1.5	81.0-84.0	83.0
2.0	72.0-81.0	77.0	2.0	81.0-84.0	83.0
3.0	74.0-83.0	80.0	3.0	83.5-89.5	86.5
5.0	78.0-85.0	82.0	5.0	85.0-90.2	87.6
7.5	80.0-87.0	84.0	7.5	86.0-91.0	88.5
10.0	81.0-88.0	85.0	10.0	87.5-91.7	89.6
15.0	83.0-89.0	86.0	15.0	89.5-92.4	91.0
20.0	84.0-89.0	87.5	20.0	90.0-93.2	91.6
25.0	85.0-90.0	88.0	25.0	91.0-94.1	92.6
30.0	86.0-90.5	88.5	30.0	91.0-94.5	92.8
40.0	87.0-91.5	89.5	40.0	91.5-94.5	93.0
50.0	88.0-92.0	90.0	50.0	91.5-95.0	93.2
60.0	88.5-92.0	90.5	60.0	91.7-95.0	93.3
75.0	89.5-92.5	91.0	75.0	92.0-95.0	93.5
100.0	90.0-93.0	91.5	100.0	93.0-95.0	94.0
125.0	90.5-93.0	92.0	125.0	93.0-95.4	94.2
150.0	91.0-93.5	92.5	150.0	93.5-95.8	94.6
200.0	91.5-94.0	93.0	200.0	94.4-96.2	95.3

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JOB Ft. Drum Water Study 1406-012
SHEET NO. 3 OF 4
CALCULATED BY TCP DATE 1/31/96
CHECKED BY ______ DATE ______
SCALE Water Costs - Ft. Drum

Ft. Drum Operation and Maintenance Costs

Costs taken from Ft. Drum personnel:

FY-94: $22,127

FY-95: $25,655

Costs include labor, equipment rental, and supplies (including $5,550 for chemicals in FY-95) directly attributed to the water distribution system.

O+M Cost = $\frac{\text{Annual O+M Cost}}{\text{Annual Water Production}}$ ($/KGAL)

- Assume O+M Cost will be product of FY-95 figure.
- Assume that O+M Costs will be applied to entire water distribution system, with both DANC and Ft. Drum well production figures used.

∴ Total O+M Cost = $\frac{\text{Annual Budgeted O+M Cost}}{\text{DANC Water + Ft. Drum Well Water}}$ [$/KGAL]

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JOB Ft. Drum Water Study 1406-012
SHEET NO. 4 OF 4
CALCULATED BY TCP DATE 1/31/96
CHECKED BY ______ DATE ______
SCALE Water Costs - Ft. Drum

Reservoir Pump Costs

In addition to the electrical and O+M costs directly attributed to water production (wells and DANC), there is an additional electrical cost for operating the 40 hp draining pump at the ground reservoir.

This cost is calculated separately of the wells because the reservoir stores water from both the wells and from DANC. Therefore, a cost per total volume of water was determined.

Assume that O+M costs for the reservoir are covered under Ft. Drum's total O+M budget. The cost for just the reservoir should be small compared to the rest of the distribution system.

Reservoir Pump Cost:

Avg. Operating Hours = 156,850 min. = 2614 hrs.
(taken from telemetry data)

$$\text{Cost} = \frac{(HP)(0.746)(LF)(\text{Hours})}{\eta_m} = \frac{(40)(0.746)(0.75)(2614)(\$0.072/\text{kWH})}{0.895}$$

Cost = $\underline{\underline{\$4707}}$ for $\underline{65,369 \text{ KWH/year}}$

$$\text{Cost/KGal} = \frac{\text{Total Electrical Cost}}{\text{Water Pumped}} = \frac{\text{Total Electrical Cost}}{(\text{Pump GPM})(\text{Operating Time})}$$

$$\text{Cost/KGAL} = \frac{\$4707}{(450\text{gpm})(156,850\text{ min})(1/1000\text{ Kgal})}$$

$$\boxed{\text{Cost/Kgal} = \$0.067/\text{Kgal}}$$

Ft. Drum Electrical Rates provided by Ft. Drum utility office:

Rates effective 15 Sep 93 EFFECTIVE 27 APR 95

Rate 3A	Customer Charge:	$3,172.00
	Demand KW:	$7.02
	On Peak KWH:	$0.06196
	Off Peak KWH:	$0.05197
	Refund Credit	0
	RKVA	$1.02

1/31/96 Joe Ozba 7:48 called him for O&M info. Joe say Ft. Drum O&M is comprized of 3 items. Labor, Equip Rental & Supplies #22,127 FY 1994
#25,655 FY 1995

Just Chlorine # 5550 and is included in 1995

Development Authority of the North Country
Water Line
Schedule "A"

Year	City Capital	DANC Capital	DANC Overhead	Combined Capital and Overhead	City O&M	DANC O&M	O&M /KGal.	Guar. MGD	Total /KGal.
4/1/91 - 3/31/92	316,696	2,532,805	75,000	2,918,500	159,517	184,820	0.63	1.50	5.96
4/1/92 - 3/31/93	326,817	2,799,105	71,000	3,196,925	176,126	307,211	0.28	1.50	6.72
4/1/93 - 3/31/94	314,049	2,568,159	38,000	2,920,208	217,379	307,685	0.56	1.50	6.29
4/1/94 - 3/31/95	314,049	2,295,832	84,100	2,693,981	217,379	252,007	0.86	1.50	5.78
4/1/95 - 3/31/96	314,049	2,632,305	86,203	3,032,557	222,075	167,451	0.71	1.50	6.25
4/1/96 - 3/31/97	314,049	1,535,136	88,350	1,937,565	228,364	171,637	0.73	1.50	4.27
4/1/97 - 3/31/98	314,049	0	90,567	404,616	234,093	175,028	0.75	1.50	1.49
4/1/98 - 3/31/99	314,049	0	92,831	406,880	239,946	180,326	0.77	1.50	1.51
4/1/99 - 3/31/00	314,049	0	95,151	409,201	245,944	184,835	0.79	1.50	1.53
4/1/00 - 3/31/01	314,049	0	97,530	411,579	252,093	189,455	0.81	1.50	1.56
4/1/01 - 3/31/02	314,049	0	99,968	414,018	258,395	194,192	0.83	1.50	1.58
4/1/02 - 3/31/03	314,049	0	102,468	416,517	264,855	199,047	0.85	1.50	1.61
4/1/03 - 3/31/04	314,049	0	105,029	419,079	271,477	204,023	0.87	1.50	1.63
4/1/04 - 3/31/05	314,049	0	107,655	421,704	278,263	209,123	0.89	1.50	1.66
4/1/05 - 3/31/06	314,049	0	110,346	424,395	285,220	214,351	0.91	1.50	1.69
4/1/06 - 3/31/07	314,049	0	113,105	427,154	292,351	219,710	0.94	1.50	1.72
4/1/07 - 3/31/08	314,049	0	115,933	429,982	299,659	225,203	0.96	1.50	1.74
4/1/08 - 3/31/09	266,661	0	118,831	385,492	307,151	230,833	0.98	1.50	1.67
4/1/09 - 3/31/10	180,434	0	121,802	302,236	314,830	236,604	1.01	1.50	1.56
4/1/10 - 3/31/11	145,235	0	124,847	270,082	322,700	242,519	1.03	1.50	1.53
4/1/11 - 3/31/12	26,076	0	127,968	154,044	330,768	248,582	1.06	1.50	1.36
4/1/12 - 3/31/13	0	0	131,167	131,167	339,037	254,796	1.08	1.50	1.32
4/1/13 - 3/31/14	0	0	134,446	134,446	347,513	261,165	1.11	1.50	1.36

I have estimated the City Capital Pmts. based on the issue date of the debt and current payments.

I have also estimated an annual increase of 2.5% on O&M and DANC Overhead.

THIS SCHEDULE HAS BEEN PREPARED BY SPECIAL REQUEST. IT MAY BE IN VARIANCE WITH CURRENT OR FUTURE SCHEDULE A's

ECO #1 LCCA

LIFE CYCLE COST ANALYSIS SUMMARY
FEDERAL ENERGY MANAGEMENT PROGRAM (FEMP)

LOCATION:	Ft. Drum, NY	REGION: 1 (New York)		PROJECT NO:	1406-012
PROJECT TITLE:	Water Conservation Study			FISCAL YEAR:	1996
ANALYSIS DATE:	05/10/96	ECONOMIC LIFE:	20	PREPARED BY:	TCP

1. INVESTMENT: **ECO #1 - Repair Main Line, Service Line Leaks**

A. CONSTRUCTION COST	=	$2,332	
B. SIOH COST	(6.0% of 1A) =	$140	
C. DESIGN COST	(6.0% of 1A) =	$140	
D. TOTAL COST	(1A +1B +1C) =	$2,612	
E. SALVAGE VALUE OF EXISTING EQUIPMENT =		$0	
F. PUBLIC UTILITY COMPANY REBATE =			
G. TOTAL INVESTMENT	(1D -1E -1F) =	------->	$2,612

2. ENERGY SAVINGS (+) OR COST (-):

DATE OF NISTR 85-3273-10 USED FOR DISCOUNT FACTORS: OCT 1995

ENERGY SOURCE	FUEL COST $/KGAL (1)	SAVINGS KGAL/YR (2)	ANNUAL $ SAVINGS (3)	DISCOUNT FACTOR (4)	DISCOUNTED SAVINGS (5)	
A. ELECTRICAL	$0.025	56,210	$1,405	13.86	$19,477	
B. DIST	$0.00	0	$0	16.99	$0	
C. RESID	$0.00	0	$0	17.38	$0	
D. NAT GAS	$0.00	0	$0	17.14	$0	
E. COAL	$0.00	0	$0	13.56	$0	
F.						
G. TOTAL		56,210	$1,405		-------->	$19,477

3. NON-ENERGY SAVINGS (+) OR COST (-)

A. ANNUAL RECURRING (+/-)

	Unit Cost * 56,210 KGAL			
1 DANC Variable Savings ($0.67/KGAL)	$37,773	13.47	$508,804	
2 Ft. Drum O&M Savings ($0.028/KGAL)	$1,574	13.47	$21,200	
3 Ft Drum Chemical Savings ($0.031/KGAL)	$1,743	13.47	$23,472	
4 Reservoir Savings ($0.067/KGAL)	$3,766	13.47	$50,729	
5 TOTAL ANNUAL DISC. SAVINGS (+) / COST (-)	$44,856		$604,205	

B. NON-RECURRING (+/-)

ITEM	SAVINGS (+) COST(-) (1)	YEAR OF OCCURRENCE (2)	DISCOUNT FACTOR (3) (TABLE A-2)	DISCOUNTED SAVINGS/COST (4)
a.				$0
b.				$0
c. TOTAL	$0			$0

C. TOTAL NON-ENERGY DISCOUNTED SAVINGS (+) OR COST (-)	(3A5 + 3Bc4) =	$604,205
4. FIRST YEAR DOLLAR SAVINGS (+) / COSTS (-)	(2G3+3A+(3Bc1/Economic Life))	$46,261
5. SIMPLE PAYBACK (SPB) IN YEARS (MUST BE < 10 YEARS TO QUALIFY)	(1G/4) =	0.06
6. TOTAL NET DISCOUNTED SAVINGS	(2H5 + 3C) =	$623,681
7. DISCOUNTED SAVINGS-TO-INVESTMENT RATIO (SIR) (MUST HAVE SIR > 1.25 TO QUALIFY)	(6/1G) =	238.82

ENGINEER'S OPINION OF PROBABLE COST

SHEET 1 OF 1

AREA	ACTIVITY	LOCATION	AMENDMENT NO.
		FT. DRUM, NY	

PROJECT TITLE	DESCRIPTION	CONTRACT NO.
WATER CONSERVATION STUDY	FIX MAIN LINE, SERVICE LINE LEAKS	DACA01-94-D-0033

Line No.	Item Description	Unit of Measure	Qty.	MATERIAL COST Unit Cost	MATERIAL COST Total	LABOR COST Unit Cost	LABOR COST Total	EQUIPMENT COST Unit Cost	EQUIPMENT COST Total	TOTAL COST Unit Cost	TOTAL COST Total
1	**MAIN LINE LEAK REPAIR (1 LEAK)**										
2	EXCAVATION	CY	24	$0.00	$0	$1.56	$37	$1.58	$38	$3	$75
3	DEWATERING	DAY	1	$0.00	$0	$71.00	$71	$8.05	$8	$79	$79
4	PATCH PIPE LEAK	EA	1	$200.00	$200	$130.00	$130	$0.00	$0	$330	$330
5	CRUSHED ROCK BEDDING	CY	4	$13.00	$52	$3.43	$14	$1.39	$6	$18	$71
6	BACKFILL	CY	20	$0.00	$0	$0.71	$14	$0.58	$12	$1	$26
7	COMPACTION	CY	24	$0.00	$0	$0.86	$21	$0.33	$8	$1	$29
8											
9	**SERVICE LINE LEAK REPAIR (2 LEAKS)**										
10	EXCAVATION	CY	36	$0.00	$0	$1.56	$56	$1.58	$57	$3	$113
11	DEWATERING	DAY	1	$0.00	$0	$71.00	$71	$8.05	$8	$79	$79
12	PATCH PIPE LEAK	EA	2	$200.00	$400	$130.00	$260	$0.00	$0	$330	$660
13	CRUSHED ROCK BEDDING	CY	6	$13.00	$78	$3.43	$21	$1.39	$8	$18	$107
14	BACKFILL	CY	30	$0.00	$0	$0.71	$21	$0.58	$17	$1	$39
15	COMPACTION	CY	36	$0.00	$0	$0.86	$31	$0.33	$12	$1	$43
16											
17	**CONSTRUCTION SUBTOTAL**				$730		$747		$174		$1,651
18	LOCATION FACTOR	%		**81.80%**	$597	**111.80%**	$835	**100.00%**	$174		$1,606
19	OVERHEAD & BOND	%	20		$119		$167		$35		$321
20	SUBTOTAL				$717		$1,002		$208		$1,927
21	PROFIT	%	10		$72		$100		$21		$193
22	SUBTOTAL				$788		$1,102		$229		$2,120
23	CONTINGENCY	%	10		$79		$110		$23		$212
24	**GRAND TOTAL**				$867		$1,213		$252		$2,332

PREPARED BY	APPROVED BY	TITLE OR ORGANIZATION	DATE
TCP		E M C Engineers, Inc.	2/1/96

ECO #2 LCCA

LIFE CYCLE COST ANALYSIS SUMMARY

FEDERAL ENERGY MANAGEMENT PROGRAM (FEMP)

LOCATION:	Ft. Drum, NY	REGION: 1 (New York)		PROJECT NO:	1406-012
PROJECT TITLE:	Water Conservation Study			FISCAL YEAR:	1996
ANALYSIS DATE:	05/10/96	ECONOMIC LIFE:	20	PREPARED BY:	TCP

1 INVESTMENT: **ECO #2 - Repair Valve Leaks**

A. CONSTRUCTION COST	=	$828	
B. SIOH COST	(6.0% of 1A) =	$50	
C. DESIGN COST	(6.0% of 1A) =	$50	
D. TOTAL COST	(1A +1B +1C) =	$927	
E. SALVAGE VALUE OF EXISTING EQUIPMENT =		$0	
F. PUBLIC UTILITY COMPANY REBATE =			
G. TOTAL INVESTMENT	(1D -1E -1F) =	------->	$927

2 ENERGY SAVINGS (+) OR COST (-):

DATE OF NISTR 85-3273-10 USED FOR DISCOUNT FACTORS: OCT 1995

ENERGY SOURCE	FUEL COST $/KGAL (1)	SAVINGS KGAL/YR (2)	ANNUAL $ SAVINGS (3)	DISCOUNT FACTOR (4)	DISCOUNTED SAVINGS (5)	
A. ELECTRICAL	$0.025	730	$18	13.86	$253	
B. DIST	$0.00	0	$0	16.99	$0	
C. RESID	$0.00	0	$0	17.38	$0	
D. NAT GAS	$0.00	0	$0	17.14	$0	
E. COAL	$0.00	0	$0	13.56	$0	
F.						
G. TOTAL		730	$18		-------->	$253

3 NON-ENERGY SAVINGS (+) OR COST (-)

A. ANNUAL RECURRING (+/-)	Unit Cost * 730 KGAL		
1 DANC Variable Savings ($0.67/KGAL)	$491	13.47	$6,608
2 Ft. Drum O&M Savings ($0.028/KGAL)	$20	13.47	$275
3 Ft Drum Chemical Savings ($0.031/KGAL)	$23	13.47	$305
4 Reservoir Savings ($0.067/KGAL)	$49	13.47	$659
5 TOTAL ANNUAL DISC. SAVINGS (+) / COST (-)	$583		$7,847

B. NON-RECURRING (+/-)

ITEM	SAVINGS (+) COST(-) (1)	YEAR OF OCCURRENCE (2)	DISCOUNT FACTOR (3) (TABLE A-2)	DISCOUNTED SAVINGS/COST (4)
a.				$0
b.				$0
c. TOTAL	$0			$0

C. TOTAL NON-ENERGY DISCOUNTED SAVINGS (+) OR COST (-)	(3A5 + 3Bc4) =	$7,847
4 FIRST YEAR DOLLAR SAVINGS (+) / COSTS (-)	(2G3+3A+(3Bc1/Economic Life))	$601
5 SIMPLE PAYBACK (SPB) IN YEARS (MUST BE < 10 YEARS TO QUALIFY)	(1G/4) =	1.54
6 TOTAL NET DISCOUNTED SAVINGS	(2H5 + 3C) =	$8,100
7 DISCOUNTED SAVINGS-TO-INVESTMENT RATIO (SIR) (MUST HAVE SIR > 1.25 TO QUALIFY)	(6/1G) =	8.74

ENGINEER'S OPINION OF PROBABLE COST

SHEET 1 OF 1

AREA	ACTIVITY	LOCATION	AMENDMENT NO.
		FT. DRUM, NY	

PROJECT TITLE	DESCRIPTION	CONTRACT NO.
WATER CONSERVATION STUDY	FIX VALVE LEAK	DACA01-94-D-0033

Line No.	Item Description	Unit of Measure	Qty.	MATERIAL COST Unit Cost	MATERIAL COST Total	LABOR COST Unit Cost	LABOR COST Total	EQUIPMENT COST Unit Cost	EQUIPMENT COST Total	TOTAL COST Unit Cost	TOTAL COST Total
1	**REPLACE LEAKING VALVE**										
2	EXCAVATION	CY	18	$0.00	$0	$1.56	$28	$1.58	$28	$3.14	$57
3	DEWATERING	DAY	1	$0.00	$0	$71.00	$36	$8.05	$4	$79.05	$40
4	VALVE DEMOLITION, TO 8"	EA	1	$0.00	$0	$30.00	$30	$0.00	$0	$30.00	$30
5	GATE VALVE, 04"	EA	1	$270.00	$270	$108.00	$108	$0.00	$0	$378.00	$378
6	CRUSHED ROCK BEDDING	CY	3	$13.00	$39	$3.43	$10	$1.39	$4	$17.82	$53
7	BACKFILL	CY	15	$0.00	$0	$0.71	$11	$0.58	$9	$1.29	$19
8	COMPACTION	CY	18	$0.00	$0	$0.86	$15	$0.33	$6	$1.19	$21
9											
10											
11											
12											
13											
14											
15											
16											
17	**CONSTRUCTION SUBTOTAL**				$309		$238		$51		$598
18	LOCATION FACTOR	%		**81.80%**	$253	**111.80%**	$266	**100.00%**	$51		$570
19	OVERHEAD & BOND	%	20		$51		$53		$10		$114
20	SUBTOTAL				$303		$319		$62		$684
21	PROFIT	%	10		$30		$32		$6		$68
22	SUBTOTAL				$334		$351		$68		$753
23	CONTINGENCY	%	10		$33		$35		$7		$75
24	GRAND TOTAL				$367		$386		$74		$828

PREPARED BY	APPROVED BY	TITLE OR ORGANIZATION	DATE
TCP		E M C Engineers, Inc.	2/1/96

ECO #3 LCCA

LIFE CYCLE COST ANALYSIS SUMMARY
FEDERAL ENERGY MANAGEMENT PROGRAM (FEMP)

LOCATION:	Ft. Drum, NY	REGION: 1 (New York)		PROJECT NO:	1406-012
PROJECT TITLE:	Water Conservation Study			FISCAL YEAR:	1996
ANALYSIS DATE:	05/10/96	ECONOMIC LIFE:	20	PREPARED BY:	TCP

1. INVESTMENT: **ECO #3 - Repair Hydrant Leaks**

A. CONSTRUCTION COST	=	$32,061		
B. SIOH COST	(6.0% of 1A) =	$1,924		
C. DESIGN COST	(6.0% of 1A) =	$1,924		
D. TOTAL COST	(1A +1B +1C) =	$35,908		
E. SALVAGE VALUE OF EXISTING EQUIPMENT =		$0		
F. PUBLIC UTILITY COMPANY REBATE =				
G. TOTAL INVESTMENT	(1D -1E -1F) =		------->	$35,908

2. ENERGY SAVINGS (+) OR COST (-):

DATE OF NISTR 85-3273-10 USED FOR DISCOUNT FACTORS: OCT 1995

ENERGY SOURCE	FUEL COST $/KGAL (1)	SAVINGS KGAL/YR (2)	ANNUAL $ SAVINGS (3)	DISCOUNT FACTOR (4)	DISCOUNTED SAVINGS (5)	
A. ELECTRICAL	$0.025	4,745	$119	13.86	$1,644	
B. DIST	$0.00	0	$0	16.99	$0	
C. RESID	$0.00	0	$0	17.38	$0	
D. NAT GAS	$0.00	0	$0	17.14	$0	
E. COAL	$0.00	0	$0	13.56	$0	
F.						
G. TOTAL		4,745	$119		-------->	$1,644

3. NON-ENERGY SAVINGS (+) OR COST (-)

A. ANNUAL RECURRING (+/-)	Unit Cost * 4,745 KGAL		
1 DANC Variable Savings ($0.67/KGAL)	$3,189	13.47	$42,951
2 Ft. Drum O&M Savings ($0.028/KGAL)	$133	13.47	$1,790
3 Ft Drum Chemical Savings ($0.031/KGAL)	$147	13.47	$1,981
4 Reservoir Savings ($0.067/KGAL)	$318	13.47	$4,282
5 TOTAL ANNUAL DISC. SAVINGS (+) / COST (-)	$3,787		$51,004

B. NON-RECURRING (+/-)

ITEM	SAVINGS (+) COST(-) (1)	YEAR OF OCCURRENCE (2)	DISCOUNT FACTOR (3) (TABLE A-2)	DISCOUNTED SAVINGS/COST (4)
a.				$0
b.				$0
c. TOTAL	$0			$0

C. TOTAL NON-ENERGY DISCOUNTED SAVINGS (+) OR COST (-)	(3A5 + 3Bc4) =	$51,004
4. FIRST YEAR DOLLAR SAVINGS (+) / COSTS (-)	(2G3+3A+(3Bc1/Economic Life))	$3,905
5. SIMPLE PAYBACK (SPB) IN YEARS (MUST BE < 10 YEARS TO QUALIFY)	(1G/4) =	9.20
6. TOTAL NET DISCOUNTED SAVINGS	(2H5 + 3C) =	$52,648
7. DISCOUNTED SAVINGS-TO-INVESTMENT RATIO (SIR) (MUST HAVE SIR > 1.25 TO QUALIFY)	(6/1G) =	1.47

ENGINEER'S OPINION OF PROBABLE COST

SHEET 1 **OF** 1			
AREA	**ACTIVITY**	**LOCATION** FT. DRUM, NY	**AMENDMENT NO.**
PROJECT TITLE WATER CONSERVATION STUDY	**DESCRIPTION** FIX HYDRANT LEAKS		**CONTRACT NO.** DACA01-94-D-0033

Line No.	Item Description	Unit of Measure	Qty.	MATERIAL COST Unit Cost	MATERIAL COST Total	LABOR COST Unit Cost	LABOR COST Total	EQUIPMENT COST Unit Cost	EQUIPMENT COST Total	TOTAL COST Unit Cost	TOTAL COST Total
1	**HYDRANT REPLACEMENT**										
2	EXCAVATION	CY	24	$0.00	$0	$1.56	$37	$1.58	$38	$3.14	$75
3	HYDRANT DEMOLITION	EA	1	$0.00	$0	$102.00	$102	$0.00	$0	$102.00	$102
4	PIPE REMOVAL, TO 12" DIA.	LF	10	$0.00	$0	$3.43	$34	$1.39	$14	$4.82	$48
5	HYDRANT	EA	1	$1,250.00	$1,250	$129.00	$129	$21.50	$22	$1,400.50	$1,401
6	THRUST BLOCK	CY	1	$81.50	$61	$110.10	$83	$0.00	$0	$191.60	$144
7	BACKFILL	CY	20	$0.00	$0	$0.71	$14	$0.58	$12	$1.29	$26
8	CRUSHED ROCK BEDDING	CY	4	$13.00	$52	$3.43	$14	$1.39	$6	$17.82	$71
9	COMPACTION	CY	24	$0.00	$0	$0.86	$21	$0.33	$8	$1.19	$29
10											
11											
12											
13	**TOTAL - ONE HYDRANT**		**1**		**$1,363**		**$434**		**$98**		**$1,895**
14	**REPLACE 13 HYDRANTS**		**13**		**$17,721**		**$5,640**		**$1,279**		**$24,640**
15											
16											
17	**CONSTRUCTION SUBTOTAL**				$17,721		$5,640		$1,279		$24,640
18	LOCATION FACTOR	%		**81.80%**	$14,495	**111.80%**	$6,306	**100.00%**	$1,279		$22,081
19	OVERHEAD & BOND	%	20		$2,899		$1,261		$256		$4,416
20	SUBTOTAL				$17,395		$7,567		$1,535		$26,497
21	PROFIT	%	10		$1,739		$757		$154		$2,650
22	SUBTOTAL				$19,134		$8,324		$1,689		$29,146
23	CONTINGENCY	%	10		$1,913		$832		$169		$2,915
24	**GRAND TOTAL**				$21,047		$9,156		$1,857		$32,061

PREPARED BY	APPROVED BY	TITLE OR ORGANIZATION	DATE
TCP		E M C Engineers, Inc.	2/10/96

ECO #4 LCCA

LIFE CYCLE COST ANALYSIS SUMMARY
FEDERAL ENERGY MANAGEMENT PROGRAM (FEMP)

LOCATION:	Ft. Drum, NY	REGION: 1 (New York)		PROJECT NO:	1406-012
PROJECT TITLE:	Water Conservation Study			FISCAL YEAR:	1996
ANALYSIS DATE:	05/10/96	ECONOMIC LIFE:	20	PREPARED BY:	TCP

1. INVESTMENT: **ECO #4 - Repair Discovered Leaks**

A. CONSTRUCTION COST		=	$35,221	
B. SIOH COST	(6.0% of 1A)	=	$2,113	
C. DESIGN COST	(6.0% of 1A)	=	$2,113	
D. TOTAL COST	(1A +1B +1C)	=	$39,447	
E. SALVAGE VALUE OF EXISTING EQUIPMENT		=	$0	
F. PUBLIC UTILITY COMPANY REBATE		=		
G. TOTAL INVESTMENT	(1D -1E -1F)	=	------->	$39,447

2. ENERGY SAVINGS (+) OR COST (-):

DATE OF NISTR 85-3273-10 USED FOR DISCOUNT FACTORS: OCT 1995

ENERGY SOURCE	FUEL COST $/KGAL (1)	SAVINGS KGAL/YR (2)	ANNUAL $ SAVINGS (3)	DISCOUNT FACTOR (4)	DISCOUNTED SAVINGS (5)	
A. ELECTRICAL	$0.025	61,685	$1,542	13.86	$21,374	
B. DIST	$0.00	0	$0	16.99	$0	
C. RESID	$0.00	0	$0	17.38	$0	
D. NAT GAS	$0.00	0	$0	17.14	$0	
E. COAL	$0.00	0	$0	13.56	$0	
F.						
G. TOTAL		61,685	$1,542		-------->	$21,374

3. NON-ENERGY SAVINGS (+) OR COST (-)

A. ANNUAL RECURRING (+/-)	Unit Cost * 61,685 KGAL		
1 DANC Variable Savings ($0.67/KGAL)	$41,452	13.47	$558,363
2 Ft. Drum O&M Savings ($0.028/KGAL)	$1,727	13.47	$23,265
3 Ft Drum Chemical Savings ($0.031/KGAL)	$1,912	13.47	$25,758
4 Reservoir Savings ($0.067/KGAL)	$4,133	13.47	$55,670
5 TOTAL ANNUAL DISC. SAVINGS (+) / COST (-)	$49,225		$663,056

B. NON-RECURRING (+/-)

ITEM	SAVINGS (+) COST(-) (1)	YEAR OF OCCURRENCE (2)	DISCOUNT FACTOR (3) (TABLE A-2)	DISCOUNTED SAVINGS/COST (4)
a.				$0
b.				$0
c. TOTAL	$0			$0

C. TOTAL NON-ENERGY DISCOUNTED SAVINGS (+) OR COST (-)	(3A5 + 3Bc4) =	$663,056
4. FIRST YEAR DOLLAR SAVINGS (+) / COSTS (-)	(2G3+3A+(3Bc1/Economic Life))	$50,767
5. SIMPLE PAYBACK (SPB) IN YEARS (MUST BE < 10 YEARS TO QUALIFY)	(1G/4) =	0.78
6. TOTAL NET DISCOUNTED SAVINGS	(2H5 + 3C) =	$684,430
7. DISCOUNTED SAVINGS-TO-INVESTMENT RATIO (SIR) (MUST HAVE SIR > 1.25 TO QUALIFY)	(6/1G) =	17.35

ENGINEER'S OPINION OF PROBABLE COST

SHEET 1 OF 3

AREA	ACTIVITY	LOCATION	AMENDMENT NO.
		FT. DRUM, NY	

PROJECT TITLE	DESCRIPTION	CONTRACT NO.
WATER CONSERVATION STUDY	FIX ALL LEAKS	DACA01-94-D-0033

Line No.	Item Description	Unit of Measure	Qty.	MATERIAL COST		LABOR COST		EQUIPMENT COST		TOTAL COST	
				Unit Cost	Total	Unit Cost	Total	Unit Cost	Total	Unit Cost	Total
1	**MAIN LINE LEAK REPAIR**										
2	EXCAVATION	CY	24	$0.00	$0	$1.56	$37	$1.58	$38	$3	$75
3	DEWATERING	DAY	1	$0.00	$0	$71.00	$71	$8.05	$8	$79	$79
4	PATCH PIPE LEAK	EA	1	$200.00	$200	$130.00	$130	$0.00	$0	$330	$330
5	CRUSHED ROCK BEDDING	CY	4	$13.00	$52	$3.43	$14	$1.39	$6	$18	$71
6	BACKFILL	CY	20	$0.00	$0	$0.71	$14	$0.58	$12	$1	$26
7	COMPACTION	CY	24	$0.00	$0	$0.86	$21	$0.33	$8	$1	$29
8	**TOTAL - ONE MAIN LEAK**		**1**		**$252**		**$287**		**$71**		**$610**
9											
10											
11	**SERVICE LINE LEAK REPAIR**										
12	EXCAVATION	CY	18	$0.00	$0	$1.56	$28	$1.58	$28	$3	$57
13	DEWATERING	DAY	1	$0.00	$0	$71.00	$36	$8.05	$4	$79	$40
14	PATCH PIPE LEAK	EA	1	$200.00	$200	$130.00	$130	$0.00	$0	$330	$330
15	CRUSHED ROCK BEDDING	CY	3	$13.00	$39	$3.43	$10	$1.39	$4	$18	$53
16	BACKFILL	CY	15	$0.00	$0	$0.71	$11	$0.58	$9	$1	$19
17	COMPACTION	CY	18	$0.00	$0	$0.86	$15	$0.33	$6	$1	$21
18	**TOTAL - ONE SERVICE LEAK**		**1**		**$239**		**$230**		**$51**		**$520**
19	**TOTAL - TWO SERVICE LEAKS**		**2**		**$478**		**$460**		**$103**		**$1,041**
20											
21											
22											
23											
24											

PREPARED BY	APPROVED BY	TITLE OR ORGANIZATION	DATE
TCP		E M C Engineers, Inc.	2/10/96

ENGINEER'S OPINION OF PROBABLE COST

SHEET 2 OF 3

AREA	ACTIVITY	LOCATION	AMENDMENT NO.
		FT. DRUM, NY	

PROJECT TITLE	DESCRIPTION	CONTRACT NO.
WATER CONSERVATION STUDY	FIX ALL LEAKS	DACA01-94-D-0033

Line No.	Item Description	Unit of Measure	Qty.	MATERIAL COST		LABOR COST		EQUIPMENT COST		TOTAL COST	
				Unit Cost	Total	Unit Cost	Total	Unit Cost	Total	Unit Cost	Total
1	**REPLACE LEAKING VALVE**										
2	EXCAVATION	CY	18	$0.00	$0	$1.56	$28	$1.58	$28	$3.14	$57
3	DEWATERING	DAY	0.5	$0.00	$0	$71.00	$36	$8.05	$4	$79.05	$40
4	VALVE DEMOLITION, TO 8"	EA	1	$0.00	$0	$30.00	$30	$0.00	$0	$30.00	$30
5	GATE VALVE, 04"	EA	1	$270.00	$270	$108.00	$108	$0.00	$0	$378.00	$378
6	CRUSHED ROCK BEDDING	CY	3	$13.00	$39	$3.43	$10	$1.39	$4	$17.82	$53
7	BACKFILL	CY	15	$0.00	$0	$0.71	$11	$0.58	$9	$1.29	$19
8	COMPACTION	CY	18	$0.00	$0	$0.86	$15	$0.33	$6	$1.19	$21
9	**REPAIR VALVE LEAKS**		**1**		**$309**		**$238**		**$51**		**$598**
10											
11											
12	**HYDRANT REPLACEMENT**										
13	EXCAVATION	CY	24	$0.00	$0	$1.56	$37	$1.58	$38	$3.14	$75
14	HYDRANT DEMOLITION	EA	1	$0.00	$0	$102.00	$102	$0.00	$0	$102.00	$102
15	PIPE REMOVAL, TO 12" DIA.	LF	10	$0.00	$0	$3.43	$34	$1.39	$14	$4.82	$48
16	HYDRANT	EA	1	$1,250.00	$1,250	$129.00	$129	$21.50	$22	$1,400.50	$1,401
17	THRUST BLOCK	CY	1	$81.50	$61	$110.10	$83	$0.00	$0	$191.60	$144
18	BACKFILL	CY	20	$0.00	$0	$0.71	$14	$0.58	$12	$1.29	$26
19	CRUSHED ROCK BEDDING	CY	4	$13.00	$52	$3.43	$14	$1.39	$6	$17.82	$71
20	COMPACTION	CY	24	$0.00	$0	$0.86	$21	$0.33	$8	$1.19	$29
21	**TOTAL - ONE HYDRANT**		**1**		**$1,363**		**$434**		**$98**		**$1,895**
22	**REPLACE 13 HYDRANTS**		**13**		**$17,721**		**$5,640**		**$1,279**		**$24,640**
23											
24	**GRAND TOTAL**				$17,721		$5,640		$1,279		$24,640

PREPARED BY	APPROVED BY	TITLE OR ORGANIZATION	DATE
TCP		E M C Engineers, Inc.	2/10/96

ENGINEER'S OPINION OF PROBABLE COST

SHEET 3 OF 3

AREA	ACTIVITY	LOCATION	AMENDMENT NO.
		FT. DRUM, NY	

PROJECT TITLE	DESCRIPTION	CONTRACT NO.
WATER CONSERVATION STUDY	FIX ALL LEAKS	DACA01-94-D-0033

Line No.	Item Description	Unit of Measure	Qty.	MATERIAL COST Unit Cost	MATERIAL COST Total	LABOR COST Unit Cost	LABOR COST Total	EQUIPMENT COST Unit Cost	EQUIPMENT COST Total	TOTAL COST Unit Cost	TOTAL COST Total
1											
2	**MAIN LINE LEAK REPAIR**	EA	1		$252		$287		$71		$610
3	**SERVICE LINE LEAK REPAIR**	EA	2	$239	$478	$230	$460	$51	$103	$520	$1,041
4	**REPLACE LEAKING VALVE**	EA	1		$309		$238		$51		$598
5	**HYDRANT REPLACEMENT**	EA	13	$1,363	$17,721	$434	$5,640	$98	$1,279	$1,895	$24,640
6											
7											
8											
9											
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11											
12											
13											
14											
15											
16											
17	**CONSTRUCTION SUBTOTAL**				$18,760		$6,625		$1,504		$26,889
18	LOCATION FACTOR	%		**81.80%**	$15,345	**111.80%**	$7,407	**100.00%**	$1,504		$24,257
19	OVERHEAD & BOND	%	20		$3,069		$1,481		$301		$4,851
20	SUBTOTAL				$18,414		$8,889		$1,805		$29,108
21	PROFIT	%	10		$1,841		$889		$180		$2,911
22	SUBTOTAL				$20,256		$9,777		$1,985		$32,019
23	CONTINGENCY	%	10		$2,026		$978		$199		$3,202
24	**GRAND TOTAL**				$22,281		$10,755		$2,184		$35,221

PREPARED BY	APPROVED BY	TITLE OR ORGANIZATION	DATE
TCP		E M C Engineers, Inc.	2/10/96

ECO #5 LCCA

LIFE CYCLE COST ANALYSIS SUMMARY
FEDERAL ENERGY MANAGEMENT PROGRAM (FEMP)

LOCATION: Ft. Drum, NY	REGION: 1 (New York)	PROJECT NO:	1406-012
PROJECT TITLE: Water Conservation Study		FISCAL YEAR:	1996
ANALYSIS DATE: 05/13/96	ECONOMIC LIFE: 20	PREPARED BY:	TCP

1. INVESTMENT: **ECO #5 - Implement Leak Detection Program**

A.	CONSTRUCTION COST	=	$26,000	
B.	SIOH COST	(6.0% of 1A) =	$1,560	
C.	DESIGN COST	(6.0% of 1A) =	$1,560	
D.	TOTAL COST	(1A +1B +1C) =	$29,120	
E.	SALVAGE VALUE OF EXISTING EQUIPMENT	=	$0	
F.	PUBLIC UTILITY COMPANY REBATE	=		
G.	TOTAL INVESTMENT	(1D -1E -1F) =	------->	$29,120

2. ENERGY SAVINGS (+) OR COST (-):

DATE OF NISTR 85-3273-10 USED FOR DISCOUNT FACTORS: OCT 1995

	ENERGY SOURCE	FUEL COST $/KGAL (1)	SAVINGS KGAL/YR (2)	ANNUAL $ SAVINGS (3)	DISCOUNT FACTOR (4)	DISCOUNTED SAVINGS (5)	
A.	ELECTRICAL	$0.025	62,621	$1,566	13.86	$21,698	
B.	DIST	$0.00	0	$0	16.99	$0	
C.	RESID	$0.00	0	$0	17.38	$0	
D.	NAT GAS	$0.00	0	$0	17.14	$0	
E.	COAL	$0.00	0	$0	13.56	$0	
F.			0	$0		$0	
G.	TOTAL		62,621	$1,566		-------->	$21,698

3. NON-ENERGY SAVINGS (+) OR COST (-)

		Unit Cost * 62,621 KGAL		
A.	ANNUAL RECURRING (+/-)			
	1 DANC Variable Savings ($0.67/KGAL)	$42,081	13.47	$566,832
	2 Ft. Drum O&M Savings ($0.028/KGAL)	$1,753	13.47	$23,618
	3 Ft Drum Chemical Savings ($0.031/KGAL)	$1,941	13.47	$26,148
	4 Reservoir Savings ($0.067/KGAL)	$4,196	13.47	$56,514
	5 Annual Leak Detection Cost	($29,120)	13.47	($392,246)
	6 TOTAL ANNUAL DISC. SAVINGS (+) / COST (-)	$20,851		$280,866

B. NON-RECURRING (+/-)

ITEM	SAVINGS (+) COST(-) (1)	YEAR OF OCCURRENCE (2)	DISCOUNT FACTOR (3) (TABLE A-2)	DISCOUNTED SAVINGS/ COST (4)
a.				$0
b.				$0
c.				$0
d. TOTAL	$0			$0

C. TOTAL NON-ENERGY DISCOUNTED SAVINGS (+) OR COST (-) (3A6 + 3Bd4) = $280,866

4.	FIRST YEAR DOLLAR SAVINGS (+) / COSTS (-)	(2H3+3A+(3Bd1/Economic Life))	$22,417
5.	SIMPLE PAYBACK (SPB) IN YEARS (MUST BE < 10 YEARS TO QUALIFY)	(1G/4) =	1.30
6.	TOTAL NET DISCOUNTED SAVINGS	(2H5 + 3C) =	$302,564
7.	DISCOUNTED SAVINGS-TO-INVESTMENT RATIO (SIR) (MUST HAVE SIR > 1.25 TO QUALIFY)	(6/1G) =	10.39

WATER AUDIT WORKSHEET

			Gallons/Year	Gallons/Min.	Percentage
Total Amount of Water Available (Flow into system minus storage):			709,300,653	1,350	100.00%
Water Uses (From annual average data from 1994-1995 provided by Ft. Drum):					
Domestic Water Consumption:		=	596,420,000	1,135	84.09%
Metered Water Users:		=	17,308,500	33	2.44%
Fire Hydrants (Fire Protection):		=	576,000	1	0.08%
Fire Hydrants (Maintenance):		=	528,000	1	0.07%
Once-through Cooling Units:		=	6,450,000	12	0.91%
Landscaping:		=	4,524,000	9	0.64%
Total Identified Water Consumed:			625,806,500	1,191	88.23%
Potential Water System Losses:			83,494,153	159	11.77%
Recoverable Leakage (AWWA Manual 36 estimates 75% is recoverable):			62,620,615	119	8.83%
Cost of Water Supply (per 1000 gallons):			$0.82		
One Year Benefit from Recoverable Leakage:			$51,349		
Total Cost of Leak Detection Program:	$200 / mile x 130 miles	=	$26,000		
Benefit to Cost Ratio:			1.97		
Simple Payback (years):			0.51		

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JOB Ft. Drum Water Study 1406-012
SHEET NO. 1 OF 7
CALCULATED BY TCP DATE 2/7/96
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SCALE Water Audit

Water Audit - Ft. Drum

Water audit is based on procedures outlined by American Water Works Association (AWWA) Manual 36, "Water Audits and Leak Detection." Total water usage is estimated by combining those usages which are metered, or can be reasonably estimated, and add water usage for unrecoverable leakage.

Telemetry data does provide any average flow usage, which is based on:

Flow = (All well + DANC incoming flow) - (All tank + Storage increases)

$\boxed{\text{Flow} = 724,511,133 \text{ gal/year}}$ (Avg. value over 2 years) Datalog #1

Telemetry data from DANC and from the wells, Datalog #3:

	DANC	Wells	Total
Aug-93 to July-94	528,571,812	183,677,992	712,249,804
Aug-94 to July-95	529,463,573	176,887,928	706,351,501
Average	529,017,693	180,282,960	$\boxed{709,300,653}$ gal.

* Use Datalog #3 data, which is slightly more accurate because it calculates specific areas at 5 min. intervals, not 15 min.

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CALCULATED BY TCP DATE 2-8-96
CHECKED BY DATE
SCALE Water Consumption Figures

Population / Water Consumption - Ft. Drum

Source: "Total Army Quality Self Assessment, 1995" Ft. Drum

- No. of Installation Bldgs: 2,159 (total)
- No. of Temporary / Semi-Permanent: 930
- No. of Permanent Bldgs: 1,229

- Units of Family Housing: 4,272 units
- Family Housing On-Post: 2,272 "
- " " Off-Post: 2,000 "
  (in 13 off-post locations)

- Active Duty Military: 9,951 persons
- Family Members: 13,965 "
- Military Retirees: 6,300 "
- Civilian Employees: 1,865 "
- Reserve Component Troops: 43,000 "
  (Train annually or weekends)

According to Army Technical Manual TM-5-813-1 "Water Supply Sources and General Considerations", the design allowances for water consumption is:

- Residents = 150 gal/person/day
- Non-Residents = 50 gal/person/day

PRINCIPAL CUSTOMERS

The garrison's principle customers include: the 10th Mountain Division (Light Infantry); U.S. Army Medical Department Activity; U.S. Army Dental Activity; Defense Finance and Accounting Office; American Red Cross; Defense Commissary Agency; Army and Air Force Exchange Service; Defense Logistics Agency; Defense Investigative Service; Defense Printing Service; Defense Reutilization and Marketing Office; Army Reserve Command Equipment Concentration Site; Resident Agency Third Military Police Group; New York District Army Corps of Engineering; Non-Commissioned Officers Academy; New York Army National Guard Maintenance Assistance Teams Support; Readiness Group Drum; Trial Defense Service; 20th Air Support Operations Squadron; New Jersey Army National Guard Maintenance Assistance Teams Support; 95th Maintenance Company ATST-10 Test, Measurement, Diagnostic, Equipment Support; 145th Maintenance Company; 174th Fighter Wing, Detachment. 1 New York Army National Guard; 10th Military Police Battalion (Provisional); Federal Employee Unions; soldier's families; military retirees; Fort Indiantown Gap and Charles E. Kelly Support Facility in Pennysylvania; general public and local civilian communities; higher headquarters; Army Reserve components including 35 Reserve Centers owned or lease by Fort Drum around the state, and government contractors.

Fort Drum has approximately 9,951 active duty military, 13,965 family members, and 8,300 military retirees supported through installation products and services

Of the active duty military: 51.9% are married; 91.9% are male; 14.8% are under age 21, 56.2% are between the ages of 21-30 ; 68.5% are Caucasian, 22.8% Afro-American, 1.2% Asian, 0.4% American Indian, 6.9% Other; 47.8% of the children of military families are age 5 or under.

EMPLOYEE BASE

Fort Drum has 1,856 Department of Army civilian employees, of which 85.5% are appropriated funded positions and 14.5% non-appropriated funded. Approximately 93% of Fort Drum's employees have earned either a high school diploma, attended college and earned a degree (Associate, Bachelor, Masters or Doctorate) or have had some level of college training. The total workforce is 61% male, 39% female. In the General Schedule grade structure, 20% are GS-04 and under, 48% GS-05 to GS-08, 26% between GS-09-GS-11, and 6% between GS-12-GS-14. The average age of a typical worker is 44 years.

KEY CUSTOMER REQUIREMENTS

Timeliness, with respect to customer requirements, is critical to customer satisfaction. Our willingness to help customers in a prompt and timely manner is one of the performance factors used to judge the quality of our service.

Reliability, which is the customer's perception of our ability to provide the promised service dependably and accurately is another performance factor used to gauge customer satisfaction. Do it right the first time, every time, is our key to success.

Cost Effectiveness is a quality that must be managed and monitored closely in today's climate of dwindling resources.

Legal and Regulatory Compliance is essential to everyone's physical well-being. As stewards of the environment, we are obliged to maintain a safe and secure environment for our military, civilians, family members and local civilian communities.

LOCATION AND SIZE

Fort Drum is located in northern New York State between Lake Ontario and the Adirondack Mountains, approximately 25 miles southeast of the Thousand Islands of the St. Lawrence River, and the United States-Canadian border.

The largest city adjacent to Fort Drum is the city of Watertown, population 30,000 located approximately 10 miles southwest of the post. The next largest city is Syracuse, population 163,860, approximately 80 miles to the south.

The installation contains 107,265 acres, is rectangular in shape and oriented in a northeast / southwest linear alignment, approximately 10 miles wide by 21 miles long. The cantonment area contains 11,369 acres of land. The remaining

95, 896 acres, which are used for training, includes a 24,007 acre main impact area. There are 2,159 buildings on the installation of which 930 are temporary and semi-permanent World War II vintage. The remaining 1,229 permanent facilities were constructed between 1975 and 1994. The majority of the buildings were constructed during the 1985 - 1992 time frame when a new cantonment area was built for the stationing of the 10th Mountain Division (Light Infantry).

Fort Drum has 4,272 units of family housing. Of these, 2,272 are on-post while 2,000 units are in Army Community Housing areas located in 13 separate off-post locations in three counties, up to 30 miles from the main cantonment area.

Fort Drum's geographic location places it in a four-season environment that allows soldiers to train in all types of weather. Winter snows generally average over 100 inches while summer temperatures rise into the 80 - 90 degree Fahrenheit range. The beauty of the area and recreational opportunities make tourism one of the major businesses. Besides being home to the 10th Mountain Division (Light Infantry), Fort Drum also supports approximately 43,000 Reserve Component troops who train on the installation annually or on weekends

MAJOR EQUIPMENT, FACILITIES, TECHNOLOGY

In addition to Fort Drum's own large land area, it is the support installation for both Fort Indiantown Gap and Charles E. Kelly Support Facility, located in southeastern and western Pennsylvania, respectively.

The installation has an active Army Airfield that was expanded in the early 1990's to support the aviation units of the 10th Mountain Division. The new heliport, dedicated in May 1992, contains four aviation maintenance hangars, a control tower and operations building, fire crash rescue station, fuel storage facilities, hot refuel points, and parking apron for approximately 120 helicopters

Additionally, the United States Air Force is in the process of developing plans to extend our primary runway to 10,000 feet, allowing Fort Drum troops to deploy in C141 aircraft directly from the installation instead of from Griffiss Airforce Base, approximately 90 miles to our southwest.

Fort Drum has 29 fixed training ranges that support the training needs of both armor and infantry units, an ammunition supply point, and rail -loading facilities. A Military Operations in Urban Terrain facility, opened this year and is the newest training facility on Fort Drum. Between 1985 and 1991 Fort Drum was the site of the largest peace time military construction expansion in the continental United States since World War II. A recent six-year $1.3 billion investment resulted in the construction of an entire new cantonment area along with an improved airfield to support the stationing of the 10th Mountain Division (Light Infantry), producing the most modern military installation in the world.

Many of the facilities constructed are unique to the Army and Fort Drum. As an example, the Information Management Facility is the only structure of its kind in the Army. It is the hub of all voice and data networks on the installation. Nine remote switching offices located throughout the post are linked to this facility by underground fiber optics. The Safety and Law Enforcement building is the most modern military police station in the Army. It contains a $10 million intrusion detection system that monitors arms rooms and ammunition storage for the entire post from a single location. All brigade maintenance facilities were designed to accommodate the M1 Abrams Tank. A new state-of-the-art central vehicle wash facility that includes both an indoor winter wash and outdoor facilities for tracked and wheeled vehicles opened this year. In addition, a new environmental-safe state-of-the-art consolidated refueling point was opened this spring replacing World War II fuel dispensing facilities. A new consolidated general purpose warehouse is nearing completion, as is a community club for both officers and enlisted service members.

SUPPLIERS OF GOODS AND SERVICES

The civilian commercial sector supplies many goods and services to the installation. A state agency, Development Authority of the North Country, was formed during the expansion of Fort Drum to assist with the disposal of solid waste, treatment of sewage, and to supplement potable water needs throughout the area.

In addition, local utilities provide telephone and power distribution support. Other support services provided by the public sector include snow

CHAPTER 1

GENERAL

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1-1. Purpose

This manual provides guidance for selecting water sources, in determining water requirements for Army and Air Force installations including special projects, and for developing suitable sources of supply from ground or surface sources.

1-2. Scope

This manual is applicable in selection of all water sources and in planning or performing construction of supply systems. Other manuals in this series are:

TM 5-813-3/AFM 88-10, Vol. 3-Water Treatment
TM 5-813-4/AFM 88-10, Vol. 4-Water Storage
TM 5-813-5/AFM 88-10, Vol. 5-Water Distribution
TM 5-813-6/AFM 88-10, Chap. 6-Water Supply for Fire Protection
TM 5-813-7/AFM 88-10, Vol. 7-Water Supply for Special Projects
TB MED-229-Sanitary Control and Surveillance of Water Supplies at Fixed and Field Installations
AFR 161-44-Management of the Drinking Water Surveillance Program

1-3. Definitions

a. General definitions. The following definitions, relating to all water supplies, are established.

(1) Water works. All construction (structures, pipe, equipment) required for the collection, transportation, pumping, treatment, storage and distribution of water.

(2) Supply works. Dams, impounding reservoirs, intake structures, pumping stations, wells and all other construction required for the development of a water supply source.

(3) Supplyline. The pipeline from the supply source to the treatment works or distribution system.

(4) Treatment works. All basins, filters, buildings and equipment for the conditioning of water to render it acceptable for a specific use.

(5) Distribution system. A system of pipes and appurtenances by which water is provided for domestic and industrial use and firefighting.

(6) Feeder mains. The principal pipelines of a distribution system.

(7) Distribution mains. The pipelines that constitute the distribution system.

(8) Service line. The pipeline extending from the distribution main to building served.

(9) Effective population. This includes resident military and civilian personnel and dependents plus an allowance for nonresident personnel, derived as follows: The design allowance for nonresidents is 50 gal/person/day whereas that for residents is 150 gal/person/day. Therefore, an "effective-population" value can be obtained by adding one-third of the population figure for nonresidents to the figure for residents.

$$\text{Effective Population} = \frac{\text{Nonresident Population}}{3} + \text{Resident Population}$$

(10) Capacity factor. The multiplier which is applied to the effective population figure to provide an allowance for reasonable population increase, variations in water demand, uncertainties as to actual water requirements, and for unusual peak demands whose magnitude cannot be accurately estimated in advance. The Capacity Factor varies inversely with the magnitude of the population in the water service area.

(11) Design population. The population figure obtained by multiplying the effective-population figure by the appropriate capacity factor.

$$\text{Design Population} = [\text{Effective Population}] \times [\text{Capacity Factor}]$$

(12) Required daily demand. The total daily water requirement. Its value is obtained by multiplying the design population by the appropriate per capita domestic water allowance and adding to this quantity any special industrial, aircraft-wash, irrigation, air-conditioning, or other demands. Other demands include the amount necessary to replenish in 48 hours the storage required for fire protection and normal

CHAPTER 2

WATER REQUIREMENTS

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2-1. Domestic requirements

The per-capita allowances, given in table 2-1, will be used in determining domestic water requirements. These allowances do NOT include special purpose water uses, such as industrial, aircraft-wash, air-conditioning, irrigation or extra water demands at desert stations.

2-2. Fire-flow requirements

The system must be capable of supplying the fire flow specified plus any other demand that cannot be reduced during the fire period at the required residual pressure and for the required duration. The requirements of each system must be analyzed to determine whether the capacity of the system is fixed by the domestic requirements, by the fire demands, or by a combination of both. Where fire-flow demands are relatively high, or required for long duration, and population and/or industrial use is relatively low, the total required capacity will be determined by the prevailing fire demand. In some exceptional cases, this may warrant consideration of a special water system for fire purposes, separate, in part or in whole, from the domestic system. However, such separate systems will be appropriate only under exceptional circumstances and, in general, are to be avoided.

2-3. Irrigation

The allowances indicated in table 2-1 include water for limited watering or planted and grassed areas. However, these allowances do not include major lawn or other irrigation uses. Lawn irrigation provisions for facilities, such as family quarters and temporary structures, in all regions will be limited to hose bibbs on the outside of buildings and risers for hose connections. Where substantial irrigation is deemed necessary and water is available, underground sprinkler systems may be considered. In general, such systems should receive consideration only in arid or semiarid areas where rainfall is less than about 25 inches annually. For Army Projects, all proposed installations require specific authorization from HQDA (DAEN-ECE-G), WASH, DC 20314. For Air Force projects, refer to AFM 88-15 and AFM 88-10, Vol. 4. Each project proposed must include thorough justification, detailed plans of connection to water source, estimated cost and a statement as to the adequacy of the water supply to support the irrigation system. The use of underground sprinkler systems will be limited as follows: Air Force Projects--Areas adjacent to hospitals, chapels, clubs, headquarters and administration buildings, and Army Projects--Areas adjacent to hospitals, chapels, clubs, headquarters and administration buildings, athletic fields, parade grounds, EM barracks, BOQ's, and other areas involving improved vegetative plantings which require frequent irrigation to maintain satisfactory growth.

a. Backflow prevention. Backflow prevention devices, such as a vacuum breaker or an air gap, will be provided for all irrigation systems connected to potable water systems. Installation of backflow preventers will be in accordance with AFM 88-21, Operation and Maintenance of Cross Connection Control and Backflow Prevention Systems (for Air Force facilities) and the National Association of Plumbing-Heating-Cooling Contractors (NAPHCC) "National Standard Plumbing Code," (see app. A for references). Single or multiple check valves are not acceptable backflow prevention devices and will not be used. Direct cross connections between potable and nonpotable water systems will not be permitted under any circumstances.

b. Use of treated wastewater. Effluent from wastewater treatment plants can be used for irrigation when authorized. Only treated effluent having a detectable chlorine residual at the most remote discharge point will be used. Where state or local regulations require additional treatment for irrigation, such requirement will be complied with. The effluent irrigation system must be physically separated from any distribution systems carrying potable water. A detailed plan will be provided showing the location of the effluent irrigation system in relation to the potable water distribution system and buildings. Provision will be made either for locking the sprinkler irrigation control valves or removing the valve handles so that only authorized personnel can operate the system. In addition, readily identifiable "nonpotable" or "contaminated" notices, markings or codings for wastewater conveyance facilities and appurtenances will be provided. Another possibility for reuse of treated effluent is for industrial operations where substantial volumes of water for washing or cooling purposes are required. For any re use situation, great care must be exercised to avoid direct cross connections between the reclaimed water system and the potable water system.

c. Review of effluent irrigation projects. Concept plans for proposed irrigation projects using wastewater treatment plant effluent will be reviewed by the engineer and surgeon at Installation Command level and the Air Force Major Command, as appropriate. EM 1110-1-501 will serve as the basic criteria for such projects, as amended by requirements herein. This publication is available through HQ USACE publications channels (see app. A, References). Such projects will only be authorized after approval by HQDA (DAEN-ECE-G), WASH DC 20314 and HQDA (DASG-PSP-E), WASH DC 20310 for Army projects and by HQUSAF (HQ USAF/LEEEU), WASH DC 20332 and The Surgeon General, (HQ AFMSC/SGPA), Brooks AFB, TX 78235 for Air Force projects.

Table 2-1. Domestic Water Allowances for Army and Air Force Projects.[1]

	Gallons/Capita/Day[2]	
	Permanent Construction	Field Training Camps
USAF Bases and Air Force Stations	150[3]	--
Armored/Mech. Divisions	150	75
Camps and Forts	150[4]	50
POW and Internment Camps	--	50[4]
Hospital Units[5]	600/Bed	400/Bed
Hotel[6]	70	--
Depot, Industrial, Plant and Similar Projects	50 gal/employee/8-hr shift; 150 gal/capita/day for resident personnel	

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Notes:

[1] For Aircraft Control and Warning Stations, National Guard Stations, Guided Missile Stations, and similar projects, use TM 5-813-7/AFM 88-10, Volume 7 for water supply for special projects.

[2] The allowances given in this table include water used for laundries to serve resident personnel, washing vehicles, limited watering of planted and grassed areas, and similar uses. The allowances tabulated do NOT include special industrial or irrigation uses. The per capita allowance for nonresidents will be one-third that allowed for residents.

[3] An allowance of 150 gal/capita/day will also be used for USAF semi-permanent construction.

[4] For populations under 300, 50 gal capita/day will be used for base camps and 25 gal/capita/day for branch camps.

[5] Includes hotels and similar facilities converted to hospital use.

[6] Includes similar facilities converted for troop housing.

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Population / Water Consumption (cont.)

Because of limited demographical data, assume:

- Number of military personnel and family members living on-post (@ 150 gpd/person):
  (Number of Family On-Post Housing)(4 person/housing unit)
  = (2272 units)(4 persons/unit)(150 gpd/person)
  = (1,363,200 gal/day)(350 days/year)*
  $\boxed{= 477,120,000 \text{ gal/year}}$ (Military, family on-post)

*Assume military personnel spend at least two weeks/year off-post, including their family members, on leave/holidays.

- Number of civilian employees:
  = (1865 people)(50 gpd/person)(250** days/year)
  $\boxed{= 23,312,500 \text{ gal/year}}$ Civilian employees

- Number of military personnel living off-post: (@ 50 gpd)
  = (Total number of military personnel − Number living on-post)
  = (9,951 − 2,272 people)(50 gpd/person)(250** days/year)
  $\boxed{= 95,987,500 \text{ gal/year}}$

** Note: Assume off-post residents work on post:
(5 days/week)(52 weeks/year) − 10 days holiday = 250 days/yr.

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Population / Water Consumption (cont)

Estimated domestic water usage =

- Military personnel, family members on-post:
  = = 477,120,000 gal/yr.
- Civilian employees : = 23,312,500 gal/yr.
- Military personnel off-post = 95,987,500 gal/yr.

$\boxed{596,420,000 \text{ gal/yr.}}$

- Assume military retirees, off-post family members and reserve troops do not significantly affect total domestic water consumption.

Metered Water Usage - Ft. Drum

According to data provided by Ft. Drum, meters are read for water usage in 15 buildings on post, including:

Bldg.	Avg. Water Use (2 yrs.)	
PX	1663	Kgal
Burger King	382.5	"
Spinners	547.5	"
Old PX	578.5	"
Mini Mall	3416.5	"
Pennants	502	"
Gas Station	54	"
Commissary	802.5	"
Inn @ Ft. Drum	5232.5	"

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SHEET NO. 5 OF 7
CALCULATED BY TCP DATE 2/8/96
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Metered Water Usage (cont.)

Bldg.	Avg. Water Use (1994-1995)	
NJNG	332.5	Kgal
NJNG	468.5	"
Credit Union	111	"
J.A. Jones	3,152.5	"
Key Bank	65	"

Total: 17,308,500 gal/year

Fire Hydrants

- Assume hydrants are used for two purposes: Fire protection and maintenance (improving circulation in stagnated lines).
- Assume hydrants have flow capacity of 1200 gpm (hydrant test data)

Fire Protection:

- Assume hydrants are used 8 hrs/year for fire protection:

Flow = (8 hrs/yr)(60 min/hr)(1,200 gal/min) = 576,000 gal/year

Maintenance:

- Assume hydrants are opened twice a week for 22 weeks (which includes May through September)
- Assume hydrants are opened for 10 min. at a time for maintenance purposes.
- Assume hydrant flow = 1,200 gpm

Flow = (2/week)(22 wks/yr)(10 min.)(1200 gpm)

Flow = 528,000 gal/year

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JOB Ft. Drum Water Study 1406-012
SHEET NO. 6 OF 7
CALCULATED BY TLP DATE 2/8/96
CHECKED BY ______ DATE ______
SCALE Water Audit

Water Consumed - Once through Cooling Units

- Water is used for cooling in the following units, according to Ft. Drum HVAC Shop:
  - 3 ton unit = (7.5 gal/min)(60 min/hr)(1,000 hrs/yr) = 450,000 gal/yr
  - 10 ton unit = (25 gal/min)(60 min/hr)(1,000 hrs/yr) = 1,500,000 gal/yr
  - 4 Walk in coolers = 4(7.5 gal/min)(60 min/hr)(2,500 hrs/yr) = 4,500,000 gal/yr

$\boxed{\text{Total usage} = 6{,}450{,}000 \text{ gal/yr.}}$

Landscaping / Irrigation

- Water is consumed on new post for landscaping.
- Assume any water used for landscaping of housing units is accounted for under domestic water consumption.
- Assume remaining water use for landscaping occurs at headquarters bldgs, parade field, and football fields.
- Assume these areas are irrigated every other day from May through September (5 months/year), according to information from Ft. Drum. Assume approx. 80 days/year.
- Assume for a football field (approx 150' x 300') and a sprinkler head with a throw of 50 feet, approximately 28 sprinkler heads are required. Assume the parade grounds are about twice the area and 49 heads are required.
- Assume only 4 sprinkler heads are utilized at one time.

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JOB Ft. Drum Water Study 1406-012
SHEET NO. 7 OF 7
CALCULATED BY TCP DATE 2/8/96
CHECKED BY ______ DATE ______
SCALE Water Audit

Landscaping / Irrigation

- Assume a flow rate of 10 gpm for sprinklers serving the football fields and parade field. Assume a flow of 5 gpm per head for sprinklers serving headquarters bldgs.
- Assume sprinkler heads are operated in 1 hour cycles in all areas.

Football / Parade Fields

$$Flow = \left[\frac{(28+49)\text{ heads}}{4\text{ heads/cycle/day}}\right]\left[60\frac{\text{min}}{\text{cycle}}\right]\left[10\frac{\text{gal}}{\text{min}}\right]\left[80\frac{\text{days}}{\text{yr}}\right]$$

Flow = (19.25 cycles/day)(60 min/cycle)(10 gpm)(80 day/yr)

$$\boxed{Flow = 924,000 \text{ gal/year}}$$

Headquarters Bldgs.

- Assume 5 buildings with significant irrigation.
- Assume each building has 5 zones, with 6 heads/zone
- Assume smaller sprinkler heads = 5 gpm/head
- Assume irrigation every other day @ 60 min per zone.

$$Flow = (5\text{ bldgs.})(5\text{ zones/bldg})(6\text{ heads/zone})(5\text{ gpm/head})\left(80\frac{\text{days}}{\text{yr}}\right)(60\text{ min/zone})$$

Flow = (45,000 gal/day)(80 days/yr)

$$\boxed{Flow = 3,600,000 \text{ gal/year}}$$

$$\boxed{\text{Total Landscaping Flow} = 4,524,000 \text{ gal/year}}$$

FORT DRUM'S WATER USAGE

	DANC WATER	WELL WATER	TOTAL WATER GALLONS	GALS PER DAY	% OF WATER PURCHASED	% OF WELL WATER
OCT 93	43,488,630	15,313,635	58,802,265	1,896,847	73.96%	26.04%
NOV 93	42,813,663	9,806,692	52,620,355	1,754,012	81.36%	18.64%
DEC 93	46,743,913	11,572,348	58,316,261	1,881,170	80.16%	19.84%
JAN 94	46,503,684	15,353,848	61,857,532	1,995,404	75.18%	24.82%
FEB 94	41,222,663	10,786,765	52,009,428	1,857,480	79.26%	20.74%
MAR 94	46,726,426	15,474,860	62,201,286	2,006,493	75.12%	24.88%
APR 94	41,829,710	7,526,368	49,356,078	1,645,203	84.75%	15.25%
MAY 94	45,029,906	11,867,234	56,897,140	1,835,392	79.14%	20.86%
JUN 94	44,536,151	21,973,407	66,509,558	2,216,985	66.96%	33.04%
JUL 94	46,427,149	24,059,671	70,486,820	2,273,768	65.87%	34.13%
AUG 94	46,500,721	17,838,670	64,339,391	2,075,464	72.27%	27.73%
SEP 94	40,857,108	11,493,547	52,350,655	1,745,022	78.05%	21.95%
FY 94	532,679,724	173,067,045	705,746,769	1,933,553	75.48%	24.52%
OCT 94	38,856,675	7,094,404	45,951,079	1,482,293	84.56%	15.44%
NOV 94	36,107,144	6,330,919	42,438,063	1,414,602	85.08%	14.92%
DEC 94	46,306,777	7,823,514	54,130,291	1,746,138	85.55%	14.45%
JAN 95	46,471,194	14,400,370	60,871,564	1,963,599	76.34%	23.66%
FEB 95	41,133,980	10,328,010	51,461,990	1,837,928	79.93%	20.07%
MAR 95	46,226,124	9,866,787	56,092,911	1,809,449	82.41%	17.59%
APR 95	46,010,361	7,600,496	53,610,857	1,787,029	85.82%	14.18%
MAY 95	47,105,160	17,641,697	64,746,857	2,088,608	72.75%	27.25%
JUN 95	51,915,343	33,108,355	85,023,698	2,834,123	61.06%	38.94%
JUL 95	45,275,548	36,901,399	82,176,947	2,650,869	55.10%	44.90%
AUG 95	45,425,295	32,655,708	78,081,003	2,518,742	58.18%	41.82%
SEP 95	44,865,012	22,623,044	67,488,056	2,249,602	66.48%	33.52%
FY 95	535,698,613	206,374,703	742,073,316	2,033,078	72.19%	27.81%

FORT DRUM

METERED WATER USERS

		FY 94 K GALS	FY 95 METERED
P-10730B	PX	1,623	1,703
P-10720	BURGER KING	389	376
P-10502	SPINNERS	538	557
P-2300	OLD PX	558	599
P-4320	MINI MALL	3,511	3,149
P-11005	N ENTRY MINI MALL	93	80
P-10207	PENNANTS	559	445
P-11110	GAS STATION	55	53
-10730A	COMMISSARY	790	815
4205	INN @ FT DRUM	5,252	5,213
P-6000	NJNG	358	307
P-6001	NJNG	345	592
	CREDIT UNION	71	151
P-4515	J.A. JONES	2,366	3,939
P-10762	KEY BANK	95	35

WATER AUDIT WORKSHEET

For: Ft. Drum, NY

Audit Study Period: August 1993- July 1995

Line	Item	Water Volume Subtotal	Total Cumulative	Units*
	Task 1—Measure Supply			
1	Uncorrected total water supply to the distribution system (total of master meters)	709,300,653		gal/gal
2A-C	Adjustments to total water supply			
2A	Source meter error (+ or –)			
2B	Change in reservoir and tank storage (+ or –)			
2C	Other contributions or losses (+ or –)			
3	Total adjustments to total water supply (add lines 2A, 2B, and 2C)			
4	Adjusted total water supply to the distribution system (add line 1 and line 3)	709,300,653		"
	Task 2—Measure Metered Use			
5	Uncorrected total metered water use	17,308,500		"
6	Adjustments due to meter reading lag time (+ or –)			
7	Metered deliveries (add lines 5 and 6)			
8A-C	Total sales meter error and system-service meter errors (+ or –)			
8A	Residential meter error			
8B	Large meter error			
8C	Total (add line 8A and 8B)			
9	Corrected total metered water deliveries (add lines 7 and 8C)	17,308,500		
10	Corrected total unmetered water (subtract line 9 from line 4)		691,992,153	"
11A-M	Authorized unmetered water uses			
11A	Firefighting and firefighting training	576,006		"
11B	Main flushing	528,000		"

NOTE: 1 ac-ft = 43,560 ft^3 = 325,851 gal.

*Units of measure must be consistent throughout the worksheet. The particular unit used (that is, acre-feet, millions of gallons, cubic feet, cubic metres, or other unit) is left to the user.

Form continues on next page.

Line	Item	Water Volume: Subtotal	Water Volume: Total Cumulative	Water Volume: Units*
11A-M	Authorized unmetered water uses (continued)			
11C	Domestic water consumption ~~Storm drain flushing~~	596,420,000		gal/yr.
11D	Sewer cleaning			
11E	Street cleaning			
11F	Schools			
11G	Landscaping in large public areas:			
	Parks	4,524,000		"
	Golf courses			
	Cemeteries			
	Playgrounds			
	Highway median strips			
	Other landscaping			
11H	Decorative water facilities			
11I	Swimming pools			
11J	Construction sites			
11K	Water quality and other testing (pressure testing pipe, water quality, etc.)			
11L	Process water at treatment plants			
11M	Other unmetered uses	6,450,000		"
12	Total authorized unmetered water (add lines 11A through 11M)	608,498,000		"
13	Total water losses (subtract line 12 from line 10)		83,494,153	"
14A-H	Identified water losses			
14A	Accounting procedure errors			
14B	Illegal connections			
14C	Malfunctioning distribution system controls			
14D	Reservoir seepage and leakage			
14E	Evaporation			

NOTE: 1 ac-ft = 43,560 ft^3 = 325,851 gal.

*Units of measure must be consistent throughout the worksheet. The particular unit used (that is, acre-feet, millions of gallons, cubic feet, cubic metres, or other unit) is left to the user.

Form continues on next page.

Line	Item	Water Volume Subtotal	Water Volume Total Cumulative	Units*
14A-H	Identified water losses (continued)			
14F	Reservoir overflow			
14G	Discovered leaks			
14H	Theft			
15	Total identified water losses (add lines 14A through 14H)			
16	Potential water system leakage (subtract line 15 from line 13)		83,494,153	gal/yr.
17	Recoverable leakage (multiply line 16 by 0.75)		62,620,615	"

Line	Item	Dollars per Unit of Volume
18A-B	Cost savings	
18A	Cost of water supply	$0.697/Kgal
18B	Variable operation and maintenance costs	$0.126/Kgal
19	Total costs per unit of recoverable leakage (add line 18A and line 18B)	$0.823/Kgal

Line	Item	Dollars per Year
20	One-year benefit from recoverable leakage (multiply line 17 by line 19)	$51,536
21	Total benefits from recovered leakage (multiply line 20 by 2)	$103,072
22	Total costs of leak detection project	$26,000
23	Benefit to cost ratio (divide line 21 by line 22)	4.0

Prepared by:

Name Tom Poling

Title EMC Engineers, Inc. Date 2/14/96

NOTE: 1 ac-ft = 43,560 ft^3 = 325,851 gal.

*Units of measure must be consistent throughout the worksheet. The particular unit used (that is, acre-feet, millions of gallons, cubic feet, cubic metres, or other unit) is left to the user.

ECO #6 LCCA

LIFE CYCLE COST ANALYSIS SUMMARY
FEDERAL ENERGY MANAGEMENT PROGRAM (FEMP)

LOCATION: Ft. Drum, NY	REGION: 1 (New York)	PROJECT NO:	1406-012
PROJECT TITLE: Water Conservation Study		FISCAL YEAR:	1996
ANALYSIS DATE: 05/10/96	ECONOMIC LIFE: 20	PREPARED BY:	TCP

1. INVESTMENT: **ECO #6 - Connecting Valve Pit Actuators to Telemetry System**

A.	CONSTRUCTION COST	=	$2,899	
B.	SIOH COST	(6.0% of 1A) =	$174	
C.	DESIGN COST	(6.0% of 1A) =	$174	
D.	TOTAL COST	(1A +1B +1C) =	$3,247	
E.	SALVAGE VALUE OF EXISTING EQUIPMENT =		$0	
F.	PUBLIC UTILITY COMPANY REBATE =			
G.	TOTAL INVESTMENT	(1D -1E -1F) =	------->	$3,247

2. ENERGY SAVINGS (+) OR COST (-):

DATE OF NISTR 85-3273-10 USED FOR DISCOUNT FACTORS: OCT 1995

	ENERGY SOURCE	FUEL COST $/KGAL (1)	SAVINGS KGAL/YR (2)	ANNUAL $ SAVINGS (3)	DISCOUNT FACTOR (4)	DISCOUNTED SAVINGS (5)	
A.	ELECTRICAL	$0.025	396	$10	13.86	$137	
B.	DIST	$0.00	0	$0	16.99	$0	
C.	RESID	$0.00	0	$0	17.38	$0	
D.	NAT GAS	$0.00	0	$0	17.14	$0	
E.	COAL	$0.00	0	$0	13.56	$0	
F.			0	$0		$0	
G.	TOTAL		396	$10		-------->	$137

3. NON-ENERGY SAVINGS (+) OR COST (-)

		Unit Cost * 396 KGAL		
A.	ANNUAL RECURRING (+/-)			
	1 DANC Variable Savings ($0.67/KGAL)	$266	13.47	$3,585
	2 Ft. Drum O&M Savings ($0.028/KGAL)	$11	13.47	$149
	3 Ft Drum Chemical Savings ($0.031/KGAL)	$12	13.47	$165
	4 Reservoir Savings ($0.067/KGAL)	$27	13.47	$357
	5 TOTAL ANNUAL DISC. SAVINGS (+) / COST (-)	$316		$4,257

B. NON-RECURRING (+/-)

ITEM	SAVINGS (+) COST(-) (1)	YEAR OF OCCURRENCE (2)	DISCOUNT FACTOR (3) (TABLE A-2)	DISCOUNTED SAVINGS/ COST (4)
a.				$0
b.				$0
c.				$0
d. TOTAL	$0			$0

C.	TOTAL NON-ENERGY DISCOUNTED SAVINGS (+) OR COST (-)	(3A4 + 3Bd4) =	$4,257
4.	FIRST YEAR DOLLAR SAVINGS (+) / COSTS (-)	(2H3+3A+(3Bd1/Economic Life))	$326
5.	SIMPLE PAYBACK (SPB) IN YEARS (MUST BE < 10 YEARS TO QUALIFY)	(1G/4) =	9.96
6.	TOTAL NET DISCOUNTED SAVINGS	(2H5 + 3C) =	$4,394
7.	DISCOUNTED SAVINGS-TO-INVESTMENT RATIO (SIR) (MUST HAVE SIR > 1.25 TO QUALIFY)	(6/1G) =	1.35

ENGINEER'S OPINION OF PROBABLE COST

SHEET 1 OF 1

AREA	ACTIVITY	LOCATION	AMENDMENT NO.
		FT. DRUM, NY	

PROJECT TITLE	DESCRIPTION	CONTRACT NO.
WATER CONSERVATION STUDY	CONNECT VALVE ACTUATORS	DACA01-94-D-0033

Line No.	Item Description	Unit of Measure	Qty.	MATERIAL COST Unit Cost	MATERIAL COST Total	LABOR COST Unit Cost	LABOR COST Total	EQUIPMENT COST Unit Cost	EQUIPMENT COST Total	TOTAL COST Unit Cost	TOTAL COST Total
1	**CONNECT VALVE ACTUATORS**										
2	LABOR HOURS - TANK 3	HRS	30	$0.00	$0	$29.30	$864	$0.00	$0	$29	$864
3	LABOR HOURS - VALVE PIT #4	HRS	30	$0.00	$0	$29.30	$864	$0.00	$0	$29	$864
4	LABOR HOURS - T-4000 PANEL	HRS	30	$0.00	$0	$29.30	$864	$0.00	$0	$29	$864
5											
6											
7											
8											
9											
10											
11											
12											
13											
14											
15											
16											
17											
18											
19											
20											
21											
22	**CONSTRUCTION SUBTOTAL**		89		$0		$2,593		$0		$2,593
23	LOCATION FACTOR	%		**81.80%**	$0	**111.80%**	$2,899	**100.00%**	$0		$2,899
24	**GRAND TOTAL**				$0		$2,899		$0		$2,899

PREPARED BY	APPROVED BY	TITLE OR ORGANIZATION	DATE
TCP		E M C Engineers, Inc.	2/22/96

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JOB Ft. Drum Water Study 1406-012
SHEET NO. 1 OF 3
CALCULATED BY TLP DATE 2/8/96
CHECKED BY DATE
SCALE

Connecting Valve Actuators

Ft. Drum is currently experiencing problems with stagnating water and low chlorine residuals in areas in the old Post. Conversations with Ft. Drum personnel revealed that main line valves must be manually opened to send water from the old Post to the new Post. If the valves could be automatically opened, more water could be circulated through these areas (Area 8500 is an example), alleviating some stagnation problems.

There are three main lines that connect the old and new Post:

1. Valve Pit #3: 20" main line connection in the 4400 Area near 4th Street East
2. Valve Pit #4: 16" main line connection in the 4300 Area near Conway Road.
3. Valve Vault: 8" main line connection in the 8300 Area near Lewis Ave.

Valve Vault #3 is already connected to the telemetry system.

Valve Vault #4 is not connected to the telemetry system, but the material has been procured and installed.

The valve vault in the 8300 Area does not have valve actuators installed.

Plumbing shop personnel would like to be able to automatically alternate flow through Valve Vaults 3 and 4 to increase water circulation to the west end of the old post.

Materials have already been procured for connection of Vault 4 valves to the telemetry system. Manpower is needed to connect these wires to the master control panel at Bldg. T-4000.

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JOB Ft. Drum Water Study 1406-012
SHEET NO. 2 OF 3
CALCULATED BY TCP DATE 2/8/96
CHECKED BY DATE
SCALE

Connecting Valve Actuators - (cont)

Cost:

According to interviews with Ft. Drum personnel, a minimum of 3-4 people would be required to connect the existing valve pit valve actuators to the telemetry system:

- One person located in Valve Vault #4.
- One person located at Tank #3
- One person located at Area 5500 PRV.
- One person located at master telemetry panel (T-4000)

Assume labor costs similar to electricians (labor cost taken from Means Mechanical 1996) for 4 persons to connect the actuators to the telemetry system.

Savings

- Total water lost through hydrants for maintenance purposes: 528,000 gal/year (according to water audit)
- Assume hydrants are opened twice a week for 22 weeks (May through September)
- Assume hydrants are opened for 10 min. at a time.
- Assume hydrant flow = 1200 gpm
- Assume about 75% of hydrant use (stagnation) is attributed to improving circulation in western end of old Post.

$\therefore$ Savings = (2)(22 weeks)(10 min.)(1200 gpm)(0.75)

$\boxed{\text{Savings} = 396{,}000 \text{ gal/year}}$

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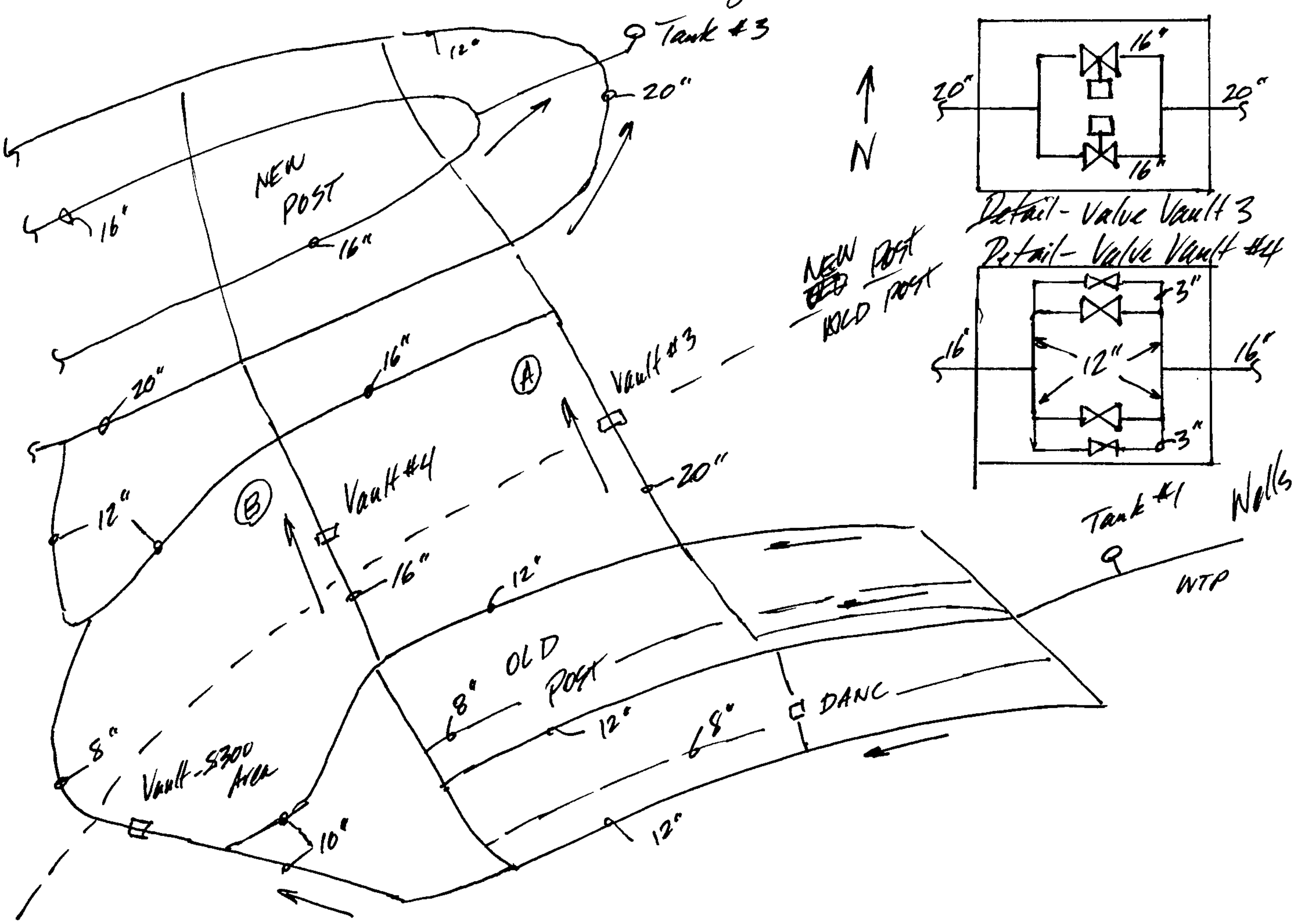
JOB Ft. Drum Water Study 1406-012
SHEET NO. 3 OF 3
CALCULATED BY TCP DATE 2/8/96
CHECKED BY DATE
SCALE

Schematic of Water Distribution System - Valve Vaults



Ⓐ • Water tends to flow from the old Post and wells toward the Tank #3. If the valve at Vault #3 is open, water does not circulate towards the west end of the old Post.

Ⓑ If the valves in Vault #4 can be opened on regular basis, water will tend to flow towards the west end of the old Post, improving stagnation problems.

ECO #7 LCCA

LIFE CYCLE COST ANALYSIS SUMMARY
FEDERAL ENERGY MANAGEMENT PROGRAM (FEMP)

LOCATION:	Ft. Drum, NY	REGION: 1 (New York)		PROJECT NO:	1406-012
PROJECT TITLE:	Water Conservation Study			FISCAL YEAR:	1996
ANALYSIS DATE:	05/10/96	ECONOMIC LIFE:	20	PREPARED BY:	TCP

1. INVESTMENT: **ECO #7 - Reconnect Isolated Main Line**

A. CONSTRUCTION COST	=	$10,119		
B. SIOH COST	(6.0% of 1A) =	$607		
C. DESIGN COST	(6.0% of 1A) =	$607		
D. TOTAL COST	(1A +1B +1C) =	$11,333		
E. SALVAGE VALUE OF EXISTING EQUIPMENT =		$0		
F. PUBLIC UTILITY COMPANY REBATE =				
G. TOTAL INVESTMENT	(1D -1E -1F) =		------->	$11,333

2. ENERGY SAVINGS (+) OR COST (-):

DATE OF NISTR 85-3273-10 USED FOR DISCOUNT FACTORS: OCT 1995

ENERGY SOURCE	FUEL COST $/KGAL (1)	SAVINGS KGAL/YR (2)	ANNUAL $ SAVINGS (3)	DISCOUNT FACTOR (4)	DISCOUNTED SAVINGS (5)	
A. ELECTRICAL	$0.025	132	$3	13.86	$46	
B. DIST	$0.00	0	$0	16.99	$0	
C. RESID	$0.00	0	$0	17.38	$0	
D. NAT GAS	$0.00	0	$0	17.14	$0	
E. COAL	$0.00	0	$0	13.56	$0	
F.						
G. TOTAL		132	$3		-------->	$46

3. NON-ENERGY SAVINGS (+) OR COST (-)

A. ANNUAL RECURRING (+/-)	Unit Cost * 132 KGAL			
1 DANC Variable Savings ($0.67/KGAL)	$89	13.47	$1,195	
2 Ft. Drum O&M Savings ($0.028/KGAL)	$4	13.47	$50	
3 Ft Drum Chemical Savings ($0.031/KGAL)	$4	13.47	$55	
4 Reservoir Savings ($0.067/KGAL)	$9	13.47	$119	
5 TOTAL ANNUAL DISC. SAVINGS (+) / COST (-)	$105		$1,419	

B. NON-RECURRING (+/-)

ITEM	SAVINGS (+) COST(-) (1)	YEAR OF OCCURRENCE (2)	DISCOUNT FACTOR (3) (TABLE A-2)	DISCOUNTED SAVINGS/COST (4)
a.				$0
b.				$0
c.				$0
d. TOTAL	$0			$0

C. TOTAL NON-ENERGY DISCOUNTED SAVINGS (+) OR COST (-)	(3A4 + 3Bd4) =	$1,419
4. FIRST YEAR DOLLAR SAVINGS (+) / COSTS (-)	(2G3+3A+(3Bd1/Economic Life))	$109
5. SIMPLE PAYBACK (SPB) IN YEARS (MUST BE < 10 YEARS TO QUALIFY)	(1G/4) =	104.32
6. TOTAL NET DISCOUNTED SAVINGS	(2H5 + 3C) =	$1,465
7. DISCOUNTED SAVINGS-TO-INVESTMENT RATIO (SIR) (MUST HAVE SIR > 1.25 TO QUALIFY)	(6/1G) =	0.13

ENGINEER'S OPINION OF PROBABLE COST

SHEET 1 OF 2

AREA	ACTIVITY	LOCATION	AMENDMENT NO.
		FT. DRUM, NY	

PROJECT TITLE	DESCRIPTION	CONTRACT NO.
WATER CONSERVATION STUDY	RECONNECT ISOLATED MAIN LINE	DACA01-94-D-0033

Line No.	Item Description	Unit of Measure	Qty.	MATERIAL COST Unit Cost	MATERIAL COST Total	LABOR COST Unit Cost	LABOR COST Total	EQUIPMENT COST Unit Cost	EQUIPMENT COST Total	TOTAL COST Unit Cost	TOTAL COST Total
1	**RECONNECT ISOLATED MAIN LINE**										
2	EXCAVATION	CY	24	$0.00	$0	$1.56	$37	$1.58	$38	$3	$75
3	PIPING DEMO, UP TO 12"	LF	5	$0.00	$0	$3.43	$17	$1.39	$7	$5	$24
4	PIPING, 12"	LF	10	$18.50	$185	$9.00	$90	$1.51	$15	$29	$290
5	CRUSHED ROCK BEDDING	CY	4	$13.00	$52	$3.43	$14	$1.39	$6	$18	$71
6	BACKFILL	CY	20	$0.00	$0	$0.71	$14	$0.58	$12	$1	$26
7	COMPACTION	CY	24	$0.00	$0	$0.86	$21	$0.33	$8	$1	$29
8	**TOTAL - ONE MAIN CONNECTION**		1		**$237**		**$193**		**$85**		**$515**
9											
10											
11											
12											
13	**HYDRANT REPLACEMENT**										
14	EXCAVATION	CY	30	$0.00	$0	$1.56	$47	$1.58	$47	$3.14	$94
15	TEE, 12"	EA	1	$258.00	$258	$38.50	$39	$0.00	$0	$296.50	$297
16	PIPING, 06"	LF	20	$8.45	$169	$4.29	$86	$0.00	$0	$12.74	$255
17	GATE VALVE, 06"	EA	1	$450.00	$450	$135.00	$135	$0.00	$0	$585.00	$585
18	HYDRANT	EA	1	$1,250	$1,250	$129.00	$129	$21.50	$22	$1,401	$1,401
19	THRUST BLOCK	CY	3	$81.50	$245	$110.10	$330	$0.00	$0	$191.60	$575
20	BACKFILL	CY	20	$0.00	$0	$0.71	$14	$0.58	$12	$1.29	$26
21	CRUSHED ROCK BEDDING	CY	10	$13.00	$130	$3.43	$34	$1.39	$14	$17.82	$178
22	COMPACTION	CY	30	$0.00	$0	$0.86	$26	$0.33	$10	$1.19	$36
23	**TOTAL - ONE HYDRANT**		1		**$2,502**		**$793**		**$57**		**$3,351**
24											

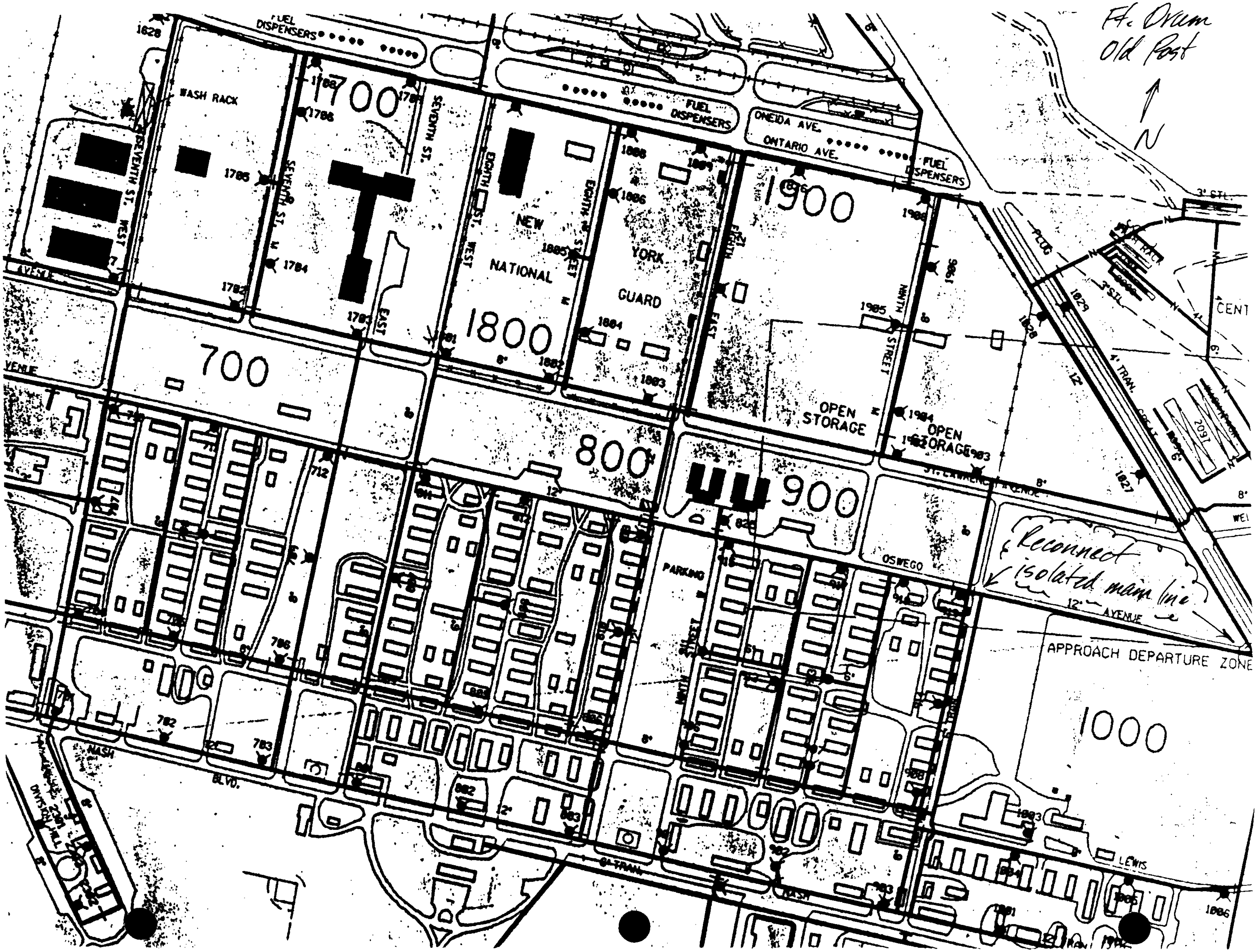
PREPARED BY	APPROVED BY	TITLE OR ORGANIZATION	DATE
TCP		E M C Engineers, Inc.	2/14/96

ENGINEER'S OPINION OF PROBABLE COST

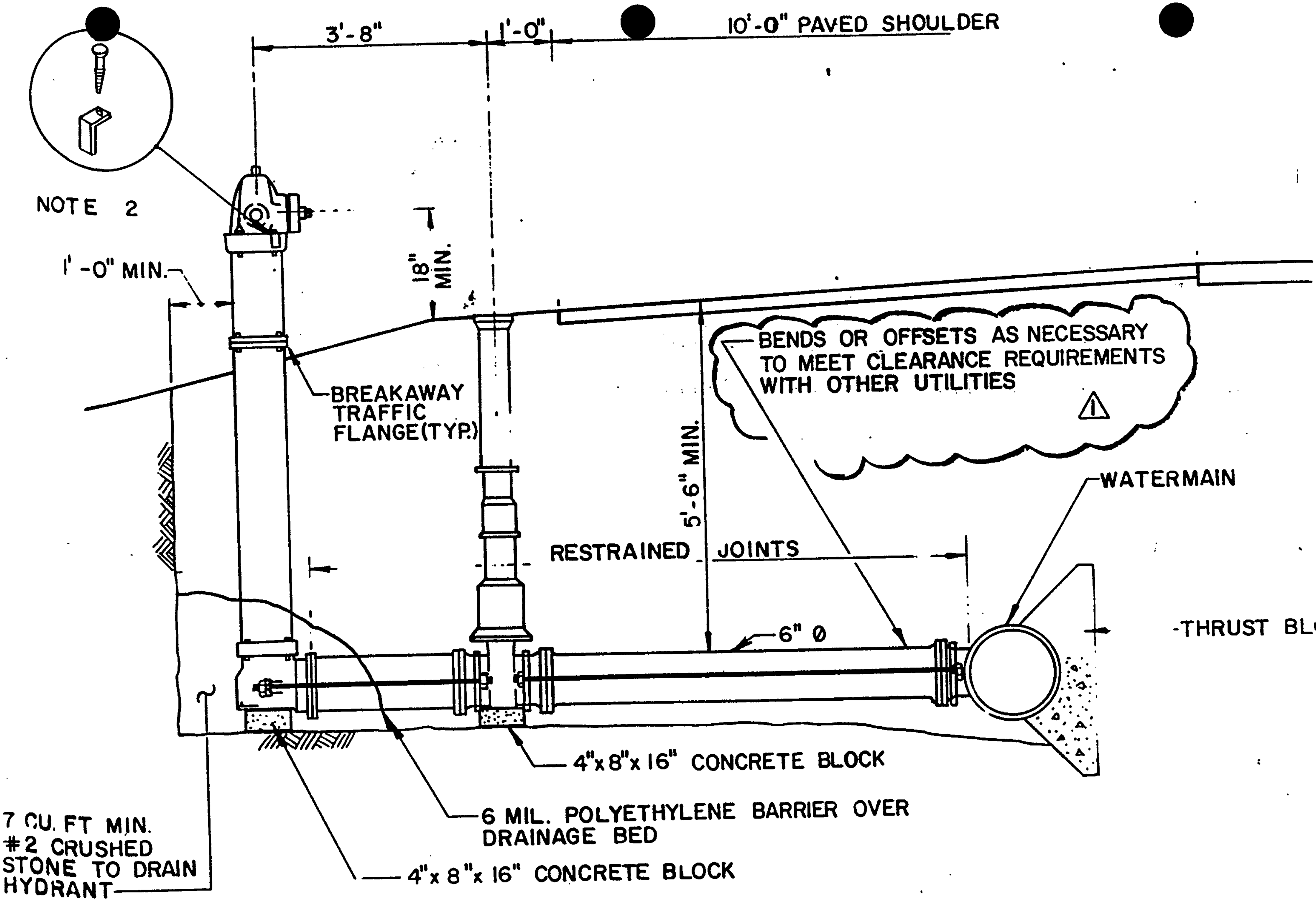
SHEET 2 **OF** 2			
AREA	**ACTIVITY**	**LOCATION** FT. DRUM, NY	**AMENDMENT NO.**
PROJECT TITLE WATER CONSERVATION STUDY	**DESCRIPTION** RECONNECT ISOLATED MAIN LINE	**CONTRACT NO.** DACA01-94-D-0033	

Line No.	Item Description	Unit of Measure	Qty.	MATERIAL COST Unit Cost	MATERIAL COST Total	LABOR COST Unit Cost	LABOR COST Total	EQUIPMENT COST Unit Cost	EQUIPMENT COST Total	TOTAL COST Unit Cost	TOTAL COST Total
1											
2	**MAIN LINE LEAK REPAIR**	EA	2	$237	$474	$193	$386	$85	$170		$1,030
3	**HYDRANT REPLACEMENT**	EA	2	$2,502	$5,003	$793	$1,586	$57	$114	$1,401	$6,703
4											
5											
6											
7											
8											
9											
10											
11											
12											
13											
14											
15											
16											
17	**CONSTRUCTION SUBTOTAL**				$5,477		$1,972		$284		$7,733
18	LOCATION FACTOR	%		**81.80%**	$4,480	**111.80%**	$2,205	**100.00%**	$284		$6,969
19	OVERHEAD & BOND	%	20		$896		$441		$57		$1,394
20	SUBTOTAL				$5,376		$2,646		$341		$8,363
21	PROFIT	%	10		$538		$265		$34		$836
22	SUBTOTAL				$5,914		$2,910		$375		$9,199
23	CONTINGENCY	%	10		$591		$291		$37		$920
24	**GRAND TOTAL**				$6,505		$3,201		$412		$10,119

PREPARED BY	APPROVED BY	TITLE OR ORGANIZATION	DATE
TCP		E M C Engineers, Inc.	2/14/96



Ft. Drum
Old Post
N
WASH RACK
FUEL DISPENSERS
ONEIDA AVE.
ONTARIO AVE.
SEVENTH ST. WEST
SEVENTH ST.
SEVENTH ST. EAST
EIGHTH ST. WEST
EIGHTH ST.
EIGHTH EAST
NINTH STREET
NEW YORK NATIONAL GUARD
1700
1800
1900
700
800
900
1000
OPEN STORAGE
ST. LAWRENCE AVENUE
OSWEGO
PARKING
NINTH STREET
NASH BLVD.
LEWIS
DIVISION HILL
PLUG
APPROACH DEPARTURE ZONE
12" AVENUE
Reconnect isolated main line
CENT



FILL OR CUT

FIRE HYDRANT—EARTH SECTION

N.T.S.

Cost Estimate Back-up Data

OPTIMUM COST OF WATER AT FT. DRUM - BASED ON 1995 WATER PRICES

Assume total water consumption:	709,300,653	(Assume water demand equal to 1994 and 1995 average)
Assume DANC Cost:	$0.90	(Assume only variable costs, not fixed costs, apply)
Assume Electrical Cost:	$0.072	(Assume annual increase of 4.1% - based on FEMP discount factors)
Assume Ft. Drum O&M Cost:	$20,105	(Assume annual increase of 10%, based on Ft. Drum data)
Assume Chemical Treatment Cost:	$5,550	(Assume chemical treatment cost will increase as well flow increases, cost based on Ft. Drum data)
Assume Reservoir Cost:	$0.067	(Assume 65,368.6 kWh x $0.072/kWh = $4,707 / 70,582.275 kgal)

						DANC Cost				Ft. Drum Cost					
Usage Per Well (gpm)	Total Well Hours	Well Flow (gal)	% of Total Flow	DANC Flow (gal)	% of Total Flow	DANC Cost	O&M Cost - DANC	Reservoir Cost	Total Cost - DANC	Well Elect. Cost	O&M Cost - Drum	Chemical Treatment	Reservoir Cost - Drum	Total Cost - Drum	Total Cost
Existing	16,515	180,282,960	25.42%	529,017,693	74.58%	$0.671	$0.0211	$0.050	$0.742	$0.026	$0.0072	$0.031	$0.017	$0.081	$0.823
2,000	22,000	270,000,000	38.07%	439,300,653	61.93%	$0.557	$0.0176	$0.041	$0.616	$0.035	$0.0108	$0.031	$0.026	$0.103	$0.719
2,200	24,200	297,000,000	41.87%	412,300,653	58.13%	$0.523	$0.0165	$0.039	$0.579	$0.039	$0.0119	$0.031	$0.028	$0.110	$0.688
2,400	26,400	324,000,000	45.68%	385,300,653	54.32%	$0.489	$0.0154	$0.036	$0.541	$0.043	$0.0129	$0.031	$0.031	$0.117	$0.658
2,600	28,600	351,000,000	49.49%	358,300,653	50.51%	$0.455	$0.0143	$0.034	$0.503	$0.046	$0.0140	$0.031	$0.033	$0.124	$0.627
2,800	30,800	378,000,000	53.29%	331,300,653	46.71%	$0.420	$0.0132	$0.031	$0.465	$0.050	$0.0151	$0.031	$0.036	$0.131	$0.596
3,000	33,000	405,000,000	57.10%	304,300,653	42.90%	$0.386	$0.0122	$0.029	$0.427	$0.053	$0.0162	$0.031	$0.038	$0.138	$0.565
3,200	35,200	432,000,000	60.91%	277,300,653	39.09%	$0.352	$0.0111	$0.026	$0.389	$0.057	$0.0173	$0.031	$0.041	$0.146	$0.535
3,400	37,400	459,000,000	64.71%	250,300,653	35.29%	$0.318	$0.0100	$0.024	$0.351	$0.060	$0.0183	$0.031	$0.043	$0.153	$0.504
3,600	39,600	486,000,000	68.52%	223,300,653	31.48%	$0.283	$0.0089	$0.021	$0.313	$0.064	$0.0194	$0.031	$0.046	$0.160	$0.473
3,800	41,800	513,000,000	72.32%	196,300,653	27.68%	$0.249	$0.0078	$0.019	$0.275	$0.067	$0.0205	$0.031	$0.048	$0.167	$0.443
4,000	44,000	540,000,000	76.13%	169,300,653	23.87%	$0.215	$0.0068	$0.016	$0.238	$0.071	$0.0216	$0.031	$0.051	$0.174	$0.412
4,200	46,200	567,000,000	79.94%	142,300,653	20.06%	$0.181	$0.0057	$0.013	$0.200	$0.074	$0.0227	$0.031	$0.054	$0.181	$0.381
4,400	48,400	594,000,000	83.74%	115,300,653	16.26%	$0.146	$0.0046	$0.011	$0.162	$0.078	$0.0237	$0.031	$0.056	$0.189	$0.350
4,600	50,600	621,000,000	87.55%	88,300,653	12.45%	$0.112	$0.0035	$0.008	$0.124	$0.081	$0.0248	$0.031	$0.059	$0.196	$0.320
4,650	51,150	627,750,000	88.50%	81,550,653	11.50%	$0.103	$0.0033	$0.008	$0.114	$0.082	$0.0251	$0.031	$0.059	$0.198	$0.312
4,700	51,700	634,500,000	89.45%	74,800,653	10.55%	$0.095	$0.0030	$0.007	$0.105	$0.083	$0.0254	$0.031	$0.060	$0.199	$0.304
4,750	52,250	641,250,000	90.41%	68,050,653	9.59%	$0.086	$0.0027	$0.006	$0.095	$0.084	$0.0256	$0.031	$0.061	$0.201	$0.297
4,800	52,800	648,000,000	91.36%	61,300,653	8.64%	$0.078	$0.0024	$0.006	$0.086	$0.085	$0.0259	$0.031	$0.061	$0.203	$0.289
5,000	55,000	675,000,000	95.16%	34,300,653	4.84%	$0.044	$0.0014	$0.003	$0.048	$0.089	$0.0270	$0.031	$0.064	$0.210	$0.258
5,100	56,100	688,500,000	97.07%	20,800,653	2.93%	$0.026	$0.0008	$0.002	$0.029	$0.090	$0.0275	$0.031	$0.065	$0.214	$0.243
5,180	56,980	699,300,000	98.59%	10,000,653	1.41%	$0.013	$0.0004	$0.001	$0.014	$0.092	$0.0279	$0.031	$0.066	$0.217	$0.231
5,190	57,090	700,650,000	98.78%	8,650,653	1.22%	$0.011	$0.0003	$0.001	$0.012	$0.092	$0.0280	$0.031	$0.066	$0.217	$0.229
5,200	57,200	702,000,000	98.97%	7,300,653	1.03%	$0.009	$0.0003	$0.001	$0.010	$0.092	$0.0281	$0.031	$0.066	$0.217	$0.227

E M C Engineers, Inc.
Water Conservation Study
Ft. Drum, NY

Prepared by: TCP
2/22/96
EMC #1406.012

ELECTRICAL CONSUMPTION - FT. DRUM (WELLS, RESERVOIR PUMPS) & DANC

A full year of data taken from the telemetry system was taken from August to July.

Date	Well No. 2	Well No. 3	Well No. 4	Well No. 5	Well No. 6	Well No. 7	Well No. 8	Well No. 9	Well No. 10	Well No. 11	Well No. 12	Total	Reservoir Pump
Avg. (Hours)	1,098	2,070	1,585	1,050	1,954	1,315	2,146	1,331	1,676	1,007	1,283	16,515	2,614
Flow (gpm)	410	125	75	410	125	150	75	185	220	285	190	2,249	450
Flow (gal)	27,004,212	15,512,580	7,122,039	25,823,700	14,642,104	11,827,110	9,642,975	14,765,315	22,112,138	17,213,054	14,617,732	180,282,960	
Motor HP	40	20	15	40	15	15	15	20	25	40	30	-	40
Motor Effic.	89.5%	87.5%	86.0%	89.5%	86.0%	86.0%	86.0%	87.5%	88.0%	89.5%	88.5%	-	89.5%
Motor kW	25.0	12.8	9.8	25.0	9.8	9.8	9.8	12.8	15.9	25.0	19.0	174.49	25.0
Motor kWh	27,456.1	26,472.3	15,467.6	26,255.9	19,068.5	12,832.7	20,942.2	17,021.6	26,639.8	25,180.6	24,333.5	241,670.9	65,364.6
kWh Cost	$1,977	$1,906	$1,114	$1,890	$1,373	$924	$1,508	$1,226	$1,918	$1,813	$1,752	$17,400	$4,706

COST OF WATER - DISTRIBUTION SYSTEM - BASED ON 1995 WATER PRICES

Avg. KW: 15.86
Avg. GPM: 204.44

Total Ft. Drum O&M Cost:	$20,105	(Based on FY95 value supplied by Ft. Drum)
Total Chemical Treatment Cost:	$5,550	(=5550 * Flow Rate/180,282,960)
Total Well Operation (hrs):	16,515	
Total Well kWh Cost:	$17,400	(Based on $0.072/kWh)
Total Well Production (gal):	180,282,960	(Average value per year from Aug-93 to Jul-95)
Cost of Drum Water (per kGal)	**$0.097**	
Total Reservoir Pump Cost:	$4,706	(Based on $0.072/kWh)
Total Reservoir Pump (gal):	70,578,000	(Based on flow rate of 450 gpm)
Cost of Res. Water (per kGal):	**$0.067**	
DANC - Variable Costs:	$476,527	
DANC Production (gal):	529,017,693	(Average value per year from Aug-93 to Jul-95)
Total DANC Cost (per KGal):	**$0.90**	(Taken from Schedule A for 1997)

	DANC Water Cost / kGal			Ft. Drum Electrical Cost / kGal			Ft. Drum O & M Cost/ kGal		Ft. Drum Chem. Cost		Reservoir Pump Cost/ kGal
Total Cost:	$0.90	529,018 / 709,301	+	$0.097	180,283 / 709,301	+	$20,105 / 709,301	+	$5,550 / 180,283	+	$4,706 / 70,578
Total Cost:	$0.90	74.58%	+	$0.097	25.42%	+	$0.028	+	$0.031	+	$0.067
Total Cost:	$0.672		+	$0.025		+	$0.028	+	$0.031	+	$0.067

Total Cost: $0.82 per kGal

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ELECTRICAL CONSUMPTION - FT. DRUM (WELLS, RESERVOIR PUMPS) & DANC

A full year of data taken from the telemetry system was taken from August to July.

Date	Well No. 2	Well No. 3	Well No. 4	Well No. 5	Well No. 6	Well No. 7	Well No. 8	Well No. 9	Well No. 10	Well No. 11	Well No. 12	Total	Reservoir Pump
Avg. (Hours)	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	22,000	2,614
Flow (gpm)	410	125	75	410	125	150	75	185	220	285	190	2,249	450
Flow (gal)	49,188,000	14,988,000	8,986,800	49,188,000	14,986,800	17,988,000	8,986,930	22,186,800	26,386,800	34,186,800	22,786,800	269,859,730	
Motor HP	40	20	15	40	15	15	15	20	25	40	30	-	40
Motor Effic.	89.5%	87.5%	86.0%	89.5%	86.0%	86.0%	86.0%	87.5%	88.0%	89.5%	88.5%	-	89.5%
Motor kW	25.0	12.8	9.8	25.0	9.8	9.8	9.8	12.8	15.9	25.0	19.0	174.49	25.0
Motor kWh	50,011.2	25,577.1	19,517.4	50,011.2	19,517.4	19,517.4	19,517.4	25,577.1	31,789.8	50,011.2	37,932.2	348,979.5	65,364.6
kWh Cost	$3,601	$1,842	$1,405	$3,601	$1,405	$1,405	$1,405	$1,842	$2,289	$3,601	$2,731	$25,127	$4,706

COST OF WATER - DISTRIBUTION SYSTEM - BASED ON 1995 WATER PRICES

Avg. kW: 15.86
Avg. gpm: 204.44

Total O&M Cost:	$20,105	(Based on FY95 value supplied by Ft. Drum minus chemical treatment costs)
Total Chemical Treatment Cost:	$8,308	(=5550 * Flow Rate/180,282,960)
Total Well Operation (hrs):	22,000	
Total Well kWh Cost:	$25,127	(Based on $0.072/kWh)
Total Well Production (gal):	269,859,730	(Average value per year from Aug-93 to Jul-95)
Cost of Drum Water (per kGal	**$0.093**	
Total Reservoir Pump (min.):	156,840	
Total Reservoir Pump Cost:	$4,706	(Based on $0.078/kWh)
Total Reservoir Pump (gal):	70,578,000	(Based on flow rate of 450 gpm)
Cost of Res. Water (per kGal)	**$0.067**	
DANC Production:	439,440,923	(Equal total usage of 709,300,653 minus well production)
Total DANC Cost (per KGal):	**$0.90**	(Taken from Schedule "A" for 1995, only variable water costs were included)

	DANC Water Cost / kGal			Ft. Drum Electrical Cost / kGal			O & M Cost/ kGal		Ft. Drum Chem. Cost		Reservoir Pump Cost/ kGal
Total Cost:	$0.90	439,441 / 709,301	+	$0.093	269,860 / 709,301	+	$20,105 / 709,301	+	$8,308 / 269,860	+	$4,706 / 70,578
Total Cost:	$0.90	61.95%	+	$0.093	38.05%	+	$0.028	+	$0.031	+	$0.067
Total Cost:	$0.558		+	$0.035		+	$0.028	+	$0.031	+	$0.067

Total Cost: $0.72 per kGal

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ELECTRICAL CONSUMPTION - FT. DRUM (WELLS, RESERVOIR PUMPS) & DANC

A full year of data taken from the telemetry system was taken from August to July.

Date	Well No. 2	Well No. 3	Well No. 4	Well No. 5	Well No. 6	Well No. 7	Well No. 8	Well No. 9	Well No. 10	Well No. 11	Well No. 12	Total	Reservoir Pump
Avg. (Hours)	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	33,000	2,614
Flow (gpm)	410	125	75	410	125	150	75	185	220	285	190	2,249	450
Flow (gal)	73,782,000	22,482,000	13,480,200	73,782,000	22,480,200	26,982,000	13,480,394	33,280,200	39,580,200	51,280,200	34,180,200	404,789,594	
Motor HP	40	20	15	40	15	15	15	20	25	40	30	-	40
Motor Effic.	89.5%	87.5%	86.0%	89.5%	86.0%	86.0%	86.0%	87.5%	88.0%	89.5%	88.5%	-	89.5%
Motor kW	25.0	12.8	9.8	25.0	9.8	9.8	9.8	12.8	15.9	25.0	19.0	174.49	25.0
Motor kWh	75,016.8	38,365.7	29,276.2	75,016.8	29,276.2	29,276.2	29,276.2	38,365.7	47,684.7	75,016.8	56,898.3	523,469.3	65,364.6
kWh Cost	$5,401	$2,762	$2,108	$5,401	$2,108	$2,108	$2,108	$2,762	$3,433	$5,401	$4,097	$37,690	$4,706

COST OF WATER - DISTRIBUTION SYSTEM - BASED ON 1995 WATER PRICES

Avg. kW: 15.86
Avg. gpm: 204.44

Total O&M Cost:	$20,105	(Based on FY95 value supplied by Ft. Drum minus chemical treatment costs)
Total Chemical Treatment Cost:	$12,461	(=5550 * Flow Rate/180,282,960)
Total Well Operation (hrs):	33,000	
Total Well kWh Cost:	$37,690	(Based on $0.072/kWh)
Total Well Production (gal):	404,789,594	(Average value per year from Aug-93 to Jul-95)
Cost of Drum Water (per kGal	**$0.093**	
Total Reservoir Pump (min.):	156,840	
Total Reservoir Pump Cost:	$4,706	(Based on $0.078/kWh)
Total Reservoir Pump (gal):	70,578,000	(Based on flow rate of 450 gpm)
Cost of Res. Water (per kGal)	**$0.067**	
DANC Production:	304,511,059	(Equal total usage of 709,300,653 minus well production)
Total DANC Cost (per KGal):	**$0.90**	(Taken from Schedule "A" for 1995, only variable water costs were included)

	DANC Water Cost / kGal			Ft. Drum Electrical Cost / kGal			O & M Cost/ kGal		Ft. Drum Chem. Cost		Reservoir Pump Cost/ kGal
Total Cost:	$0.90	304,511 / 709,301	+	$0.093	404,790 / 709,301	+	$20,105 / 709,301	+	$12,461 / 404,790	+	$4,706 / 70,578
Total Cost:	$0.90	42.93%	+	$0.093	57.07%	+	$0.028	+	$0.031	+	$0.067
Total Cost:	$0.386		+	$0.053		+	$0.028	+	$0.031	+	$0.067

Total Cost: $0.57 per kGal

E M C Engineers, Inc.
Water Conservation Study
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2/22/96
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ELECTRICAL CONSUMPTION - FT. DRUM (WELLS, RESERVOIR PUMPS) & DANC

A full year of data taken from the telemetry system was taken from August to July.

Date	Well No. 2	Well No. 3	Well No. 4	Well No. 5	Well No. 6	Well No. 7	Well No. 8	Well No. 9	Well No. 10	Well No. 11	Well No. 12	Total	Reservoir Pump
Avg. (Hours)	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	44,000	2,614
Flow (gpm)	410	125	75	410	125	150	75	185	220	285	190	2,249	450
Flow (gal)	98,376,000	29,976,000	17,973,600	98,376,000	29,973,600	35,976,000	17,973,859	44,373,600	52,773,600	68,373,600	45,573,600	539,719,459	
Motor HP	40	20	15	40	15	15	15	20	25	40	30	-	40
Motor Effic.	89.5%	87.5%	86.0%	89.5%	86.0%	86.0%	86.0%	87.5%	88.0%	89.5%	88.5%	-	89.5%
Motor kW	25.0	12.8	9.8	25.0	9.8	9.8	9.8	12.8	15.9	25.0	19.0	174.49	25.0
Motor kWh	100,022.3	51,154.3	39,034.9	100,022.3	39,034.9	39,034.9	39,034.9	51,154.3	63,579.5	100,022.3	75,864.4	697,959.1	65,364.6
kWh Cost	$7,202	$3,683	$2,811	$7,202	$2,811	$2,811	$2,811	$3,683	$4,578	$7,202	$5,462	$50,253	$4,706

COST OF WATER - DISTRIBUTION SYSTEM - BASED ON 1995 WATER PRICES

Avg. kW: 15.86
Avg. gpm: 204.44

Total O&M Cost:	$20,105	(Based on FY95 value supplied by Ft. Drum minus chemical treatment costs)
Total Chemical Treatment Cost:	$16,615	(=5550 * Flow Rate/180,282,960)
Total Well Operation (hrs):	44,000	
Total Well kWh Cost:	$50,253	(Based on $0.072/kWh)
Total Well Production (gal):	539,719,459	(Average value per year from Aug-93 to Jul-95)
Cost of Drum Water (per kGal	**$0.093**	
Total Reservoir Pump (min.):	156,840	
Total Reservoir Pump Cost:	$4,706	(Based on $0.078/kWh)
Total Reservoir Pump (gal):	70,578,000	(Based on flow rate of 450 gpm)
Cost of Res. Water (per kGal)	**$0.067**	
DANC Production:	169,581,194	(Equal total usage of 709,300,653 minus well production)
Total DANC Cost (per KGal):	**$0.90**	(Taken from Schedule "A" for 1995, only variable water costs were included)

	DANC Water Cost / kGal			Ft. Drum Electrical Cost / kGal			O & M Cost/ kGal		Ft. Drum Chem. Cost		Reservoir Pump Cost/ kGal
Total Cost:	$0.90	$\frac{169,581}{709,301}$	+	$0.093	$\frac{539,719}{709,301}$	+	$\frac{\$20,105}{709,301}$	+	$\frac{\$16,615}{539,719}$	+	$\frac{\$4,706}{70,578}$
Total Cost:	$0.90	23.91%	+	$0.093	76.09%	+	$0.028	+	$0.031	+	$0.067
Total Cost:	$0.215		+	$0.071		+	$0.028	+	$0.031	+	$0.067

Total Cost: $0.41 per kGal

E M C Engineers, Inc.
Water Conservation Study
Ft. Drum, NY

Prepared by: TCP
2/22/96
EMC #1406.012

ELECTRICAL CONSUMPTION - FT. DRUM (WELLS, RESERVOIR PUMPS) & DANC

A full year of data taken from the telemetry system was taken from August to July.

Date	Well No. 2	Well No. 3	Well No. 4	Well No. 5	Well No. 6	Well No. 7	Well No. 8	Well No. 9	Well No. 10	Well No. 11	Well No. 12	Total	Reservoir Pump
Avg. (Hours)	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	55,000	2,614
Flow (gpm)	410	125	75	410	125	150	75	185	220	285	190	2,249	450
Flow (gal)	122,970,000	37,470,000	22,467,000	122,970,000	37,467,000	44,970,000	22,467,324	55,467,000	65,967,000	85,467,000	56,967,000	674,649,324	
Motor HP	40	20	15	40	15	15	15	20	25	40	30	-	40
Motor Effic.	89.5%	87.5%	86.0%	89.5%	86.0%	86.0%	86.0%	87.5%	88.0%	89.5%	88.5%	-	89.5%
Motor kW	25.0	12.8	9.8	25.0	9.8	9.8	9.8	12.8	15.9	25.0	19.0	174.49	25.0
Motor kWh	125,027.9	63,942.9	48,793.6	125,027.9	48,793.6	48,793.6	48,793.6	63,942.9	79,474.4	125,027.9	94,830.5	872,448.9	65,364.6
kWh Cost	$9,002	$4,604	$3,513	$9,002	$3,513	$3,513	$3,513	$4,604	$5,722	$9,002	$6,828	$62,816	$4,706

COST OF WATER - DISTRIBUTION SYSTEM - BASED ON 1995 WATER PRICES

Avg. kW: 15.86
Avg. gpm: 204.44

Total O&M Cost:	$20,105	(Based on FY95 value supplied by Ft. Drum minus chemical treatment costs)
Total Chemical Treatment Cost:	$20,769	(=5550 * Flow Rate/180,282,960)
Total Well Operation (hrs):	55,000	
Total Well kWh Cost:	$62,816	(Based on $0.072/kWh)
Total Well Production (gal):	674,649,324	(Average value per year from Aug-93 to Jul-95)
Cost of Drum Water (per kGal	**$0.093**	
Total Reservoir Pump (min.):	156,840	
Total Reservoir Pump Cost:	$4,706	(Based on $0.078/kWh)
Total Reservoir Pump (gal):	70,578,000	(Based on flow rate of 450 gpm)
Cost of Res. Water (per kGal)	**$0.067**	
DANC Production:	34,651,329	(Equal total usage of 709,300,653 minus well production)
Total DANC Cost (per KGal):	**$0.90**	(Taken from Schedule "A" for 1995, only variable water costs were included)

	DANC Water Cost / kGal			Ft. Drum Electrical Cost / kGal			O & M Cost/ kGal		Ft. Drum Chem. Cost		Reservoir Pump Cost/ kGal
Total Cost:	$0.90	34,651 / 709,301	+	$0.093	674,649 / 709,301	+	$20,105 / 709,301	+	$20,769 / 674,649	+	$4,706 / 70,578
Total Cost:	$0.90	4.89%	+	$0.093	95.11%	+	$0.028	+	$0.031	+	$0.067
Total Cost:	$0.044		+	$0.089		+	$0.028	+	$0.031	+	$0.067

Total Cost: $0.26 per kGal

ELECTRICAL CONSUMPTION - FT. DRUM (WELLS, RESERVOIR PUMPS) & DANC

A full year of data taken from the telemetry system was taken from August to July.

Date	Well No. 2	Well No. 3	Well No. 4	Well No. 5	Well No. 6	Well No. 7	Well No. 8	Well No. 9	Well No. 10	Well No. 11	Well No. 12	Total	Reservoir Pump
Avg. (Hours)	5,200	5,200	5,200	5,200	5,200	5,200	5,200	5,200	5,200	5,200	5,200	57,200	2,614
Flow (gpm)	410	125	75	410	125	150	75	185	220	285	190	2,249	450
Flow (gal)	127,888,800	38,968,800	23,365,680	127,888,800	38,965,680	46,768,800	23,366,017	57,685,680	68,605,680	88,885,680	59,245,680	701,635,297	
Motor HP	40	20	15	40	15	15	15	20	25	40	30	-	40
Motor Effic.	89.5%	87.5%	86.0%	89.5%	86.0%	86.0%	86.0%	87.5%	88.0%	89.5%	88.5%	-	89.5%
Motor kW	25.0	12.8	9.8	25.0	9.8	9.8	9.8	12.8	15.9	25.0	19.0	174.49	25.0
Motor kWh	130,029.1	66,500.6	50,745.3	130,029.1	50,745.3	50,745.3	50,745.3	66,500.6	82,653.4	130,029.1	98,623.7	907,346.8	65,364.6
kWh Cost	$9,362	$4,788	$3,654	$9,362	$3,654	$3,654	$3,654	$4,788	$5,951	$9,362	$7,101	$65,329	$4,706

COST OF WATER - DISTRIBUTION SYSTEM - BASED ON 1995 WATER PRICES

Avg. kW: 15.86
Avg. gpm: 204.44

Total O&M Cost:	$20,105	(Based on FY95 value supplied by Ft. Drum minus chemical treatment costs)
Total Chemical Treatment Cost:	$21,600	(=5550 * Flow Rate/180,282,960)
Total Well Operation (hrs):	57,200	
Total Well kWh Cost:	$65,329	(Based on $0.072/kWh)
Total Well Production (gal):	701,635,297	(Average value per year from Aug-93 to Jul-95)
Cost of Drum Water (per kGal	**$0.093**	
Total Reservoir Pump (min.):	156,840	
Total Reservoir Pump Cost:	$4,706	(Based on $0.078/kWh)
Total Reservoir Pump (gal):	70,578,000	(Based on flow rate of 450 gpm)
Cost of Res. Water (per kGal)	**$0.067**	
DANC Production:	7,665,356	(Equal total usage of 709,300,653 minus well production)
Total DANC Cost (per KGal):	**$0.90**	(Taken from Schedule "A" for 1995, only variable water costs were included)

	DANC Water Cost / kGal			Ft. Drum Electrical Cost / kGal			O & M Cost/ kGal		Ft. Drum Chem. Cost		Reservoir Pump Cost/ kGal
Total Cost:	$0.90	7,665 / 709,301	+	$0.093	701,635 / 709,301	+	$20,105 / 709,301	+	$21,600 / 701,635	+	$4,706 / 70,578
Total Cost:	$0.90	1.08%	+	$0.093	98.92%	+	$0.028	+	$0.031	+	$0.067
Total Cost:	$0.010		+	$0.092		+	$0.028	+	$0.031	+	$0.067

Total Cost: $0.23 per kGal

PRICE LIST - FT. DRUM WATER CONSERVATION STUDY

Item	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Comments
BACKFILL	CY	$0.00	$0.71	$0.58	Approx 2/3 CY per LF piping
BLIND FLANGE, 06"	EA	$107.00	$112.00	$0.00	250 PSI
BLIND FLANGE, 08"	EA	$163.00	$168.00	$0.00	250 PSI
BLIND FLANGE, 10"	EA	$350.00	$198.00	$0.00	250 PSI
BLIND FLANGE, 12"	EA	$470.00	$240.00	$0.00	250 PSI
BLIND FLANGE, 14"	EA	$745.00	$240.00	$0.00	250 PSI
BLIND FLANGE, 16"	EA	$865.00	$335.00	$0.00	250 PSI
BLIND FLANGE, 24"	EA	$2,425.00	$675.00	$0.00	250 PSI
COMPACTION	CY	$0.00	$0.86	$0.33	Walk behind vibrating plate
CRUSHED ROCK BEDDING	CY	$13.00	$3.43	$1.39	For pipe bedding, hydrant leakage
DEWATERING	DAY	$0.00	$71.00	$8.05	2" Diaphragm pump for 8 hours
ELBOW, 06"	EA	$121.00	$21.50	$0.00	
ELBOW, 08"	EA	$197.00	$25.50	$0.00	
ELBOW, 12"	EA	$335.00	$36.00	$6.00	
ELBOW, 14"	EA	$540.00	$40.50	$6.75	
ELBOW, 16"	EA	$610.00	$46.00	$7.75	
ELBOW, 24"	EA	$1,400.00	$108.00	$18.05	
EXCAVATION	CY	$0.00	$1.56	$1.58	Approx 2/3 CY per LF piping
GATE VALVE, 04"	EA	$270.00	$108.00	$0.00	Add $100 matl/$20 labor for valve box
GATE VALVE, 06"	EA	$450.00	$135.00	$0.00	With valve box
GATE VALVE, 08"	EA	$755.00	$185.00	$31.00	With valve box
GATE VALVE, 10"	EA	$1,220.00	$216.00	$36.00	With valve box
GATE VALVE, 12"	EA	$1,695.00	$216.00	$36.00	With valve box
GATE VALVE, 16"	EA	$4,495.00	$645.00	$108.00	With valve box
GATE VALVE, 24"	EA	$12,070.00	$1,300.00	$217.00	With valve box
HYDRANT	EA	$1,250.00	$129.00	$21.50	Add for three-way valve (7%)
HYDRANT DEMOLITION	EA	$0.00	$102.00	$0.00	
PATCH PIPE LEAK	EA	$200.00	$130.00	$0.00	Assume Crew B-20, 6 manhours
PAVEMENT REMOVAL, 3" THICK	SY	$0.00	$1.30	$1.80	
PIPE LINING, 06"	LF	$16.95	$33.45	$0.96	Sizes 6" - 10"
PIPE LINING, 10"	LF	$20.85	$34.35	$1.00	Sizes 10" - 12"
PIPE LINING, 12"	LF	$21.75	$37.50	$1.08	Sizes 12" - 16"

PRICE LIST - FT. DRUM WATER CONSERVATION STUDY

Item	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Comments
PIPE LINING, 16"	LF	$22.95	$44.55	$1.29	Sizes 16" - 20"
PIPE LINING, 24"	LF	$27.45	$48.15	$1.41	Sizes 24" - 36"
PIPE REMOVAL, 24" DIAMETER	LF	$0.00	$4.29	$1.73	
PIPE REMOVAL, 36" DIAMETER	LF	$0.00	$5.70	$2.31	
PIPE REMOVAL, TO 12" DIA.	LF	$0.00	$3.43	$1.39	
PIPING, 06"	LF	$8.45	$4.29	$0.00	
PIPING, 08"	LF	$11.15	$6.00	$1.00	
PIPING, 12"	LF	$18.50	$9.00	$1.51	
PIPING, 14"	LF	$23.00	$12.00	$2.01	
PIPING, 16"	LF	$25.50	$14.05	$2.36	
PIPING, 24"	LF	$45.50	$19.45	$4.51	
TEE, 06"	EA	$182.00	$32.00	$0.00	
TEE, 08"	EA	$258.00	$38.50	$0.00	
TEE, 14"	EA	$655.00	$64.50	$10.85	
TEE, 16"	EA	$920.00	$81.00	$13.55	
TEE, 24"	EA	$2,125.00	$216.00	$36.00	
THRUST BLOCK	CY	$81.50	$110.10	$0.00	
VALVE DEMOLITION, TO 16"	EA	$0.00	$50.00	$0.00	Includes valve box demo
VALVE DEMOLITION, TO 8"	EA	$0.00	$30.00	$0.00	Includes valve box demo
WELDING METAL PIPE	MAN-HR	$3.00	$30.00	$9.90	Cost per welder. Assume 2 welders.

*Note: Pipe lining costs include costs for pipe cleaning, protection of connections, lining placement, curing & protection of lining, and access openings

	DIVISION	NEW YORK																	
		BUFFALO			HICKSVILLE			NEW YORK			RIVERHEAD			ROCHESTER			SCHENECTADY		
		MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL
2	SITE WORK	100.7	95.1	96.4	119.2	134.0	130.6	141.1	134.2	135.8	119.5	134.0	130.7	75.9	110.4	102.4	74.9	110.4	102.2
031	CONCRETE FORMWORK	106.6	121.3	119.1	90.7	162.6	151.7	110.7	171.3	162.1	95.7	157.2	147.9	105.5	107.0	106.7	107.9	96.8	98.5
032	CONCRETE REINFORCEMENT	103.3	118.4	111.8	100.0	194.4	153.0	100.0	203.0	157.8	101.9	194.3	153.8	104.2	104.4	104.3	98.6	104.5	101.9
033	CAST IN PLACE CONCRETE	104.9	124.1	113.1	101.5	153.3	123.6	129.1	156.9	141.0	99.7	153.3	122.6	95.9	113.5	103.4	99.7	107.1	102.9
3	CONCRETE	103.5	120.5	112.1	107.6	163.7	135.9	131.9	170.4	151.3	106.7	161.3	134.3	108.4	109.5	109.0	109.0	103.0	106.0
4	MASONRY	110.4	126.4	120.4	117.4	167.5	148.5	118.1	177.9	155.3	125.3	167.5	151.5	106.3	113.3	110.6	98.2	105.1	102.5
5	METALS	99.4	100.7	99.9	108.9	145.4	122.7	111.8	149.7	126.2	109.0	145.4	122.7	102.6	117.5	108.3	99.8	118.2	106.8
6	WOOD & PLASTICS	109.2	122.4	115.8	92.7	165.5	129.1	116.8	173.1	145.0	98.4	158.2	128.3	105.3	106.5	105.9	113.1	95.0	104.1
7	THERMAL & MOISTURE PROTECTION	103.2	114.9	108.6	106.4	152.3	127.6	107.0	162.5	132.6	106.5	151.6	127.3	98.7	111.2	104.5	92.1	101.4	96.4
8	DOORS & WINDOWS	92.6	115.0	98.0	91.0	169.1	109.8	98.2	177.1	117.2	91.0	165.2	108.8	97.9	102.7	99.1	98.0	92.8	96.7
092	LATH, PLASTER & GYPSUM BOARD	105.6	122.4	116.5	99.3	167.6	143.6	116.2	175.4	154.5	101.1	160.0	139.3	103.7	106.3	105.4	110.5	94.5	100.1
095	ACOUSTICAL TREATMENT & WOOD FLOORING	92.9	122.4	112.0	81.6	167.6	137.3	105.4	175.4	150.7	81.6	160.0	132.4	95.9	106.3	102.7	97.7	94.5	95.6
096	FLOORING & CARPET	92.3	120.9	99.1	90.8	120.3	97.9	95.1	158.8	110.4	92.2	120.3	98.9	80.8	114.6	88.9	82.3	95.9	85.5
099	PAINTING & WALL COVERINGS	79.5	118.9	102.4	102.8	153.6	132.4	100.3	146.9	127.4	102.8	153.6	132.4	76.5	109.6	95.8	80.0	85.6	83.3
9	FINISHES	95.7	121.9	109.1	105.4	153.2	129.8	112.7	166.3	140.0	106.0	148.9	127.9	96.3	108.9	102.7	96.3	94.9	95.6
10-14	TOTAL DIV. 10-14	100.0	110.4	102.2	100.0	140.3	108.6	100.0	150.2	110.7	100.0	139.3	108.4	100.0	104.8	101.0	100.0	97.9	99.6
15	MECHANICAL	100.1	102.0	100.9	100.0	153.9	123.8	100.2	168.1	130.2	100.0	153.9	123.8	100.1	99.8	99.9	100.3	96.1	98.4
16	ELECTRICAL	101.3	103.0	102.4	105.2	158.4	140.7	115.2	165.9	149.0	106.4	158.4	141.1	106.8	97.3	100.5	105.4	101.9	103.1
1-16	WEIGHTED AVERAGE	99.9	109.8	104.7	103.7	154.7	128.4	110.4	163.4	136.1	104.3	153.6	128.1	100.9	106.4	103.6	100.0	102.2	101.1

	DIVISION	NEW YORK															NORTH CAROLINA		
		SYRACUSE			UTICA			WATERTOWN			WHITE PLAINS			YONKERS			ASHEVILLE		
		MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL
2	SITE WORK	97.9	110.0	107.2	72.9	109.3	100.9	81.8	111.8	104.9	129.7	134.0	133.0	140.8	133.5	135.2	104.1	72.9	80.1
031	CONCRETE FORMWORK	106.7	92.0	94.2	107.8	83.6	87.2	84.9	94.6	93.1	111.7	140.5	136.1	110.5	140.4	135.9	93.3	52.5	58.7
032	CONCRETE REINFORCEMENT	99.9	99.7	99.8	99.9	90.0	94.4	100.4	84.3	91.4	93.8	178.1	141.1	97.5	129.0	115.2	95.3	47.8	68.6
033	CAST IN PLACE CONCRETE	99.7	99.4	99.6	92.1	98.0	94.7	107.3	104.2	106.0	113.8	143.0	126.2	127.3	143.1	134.0	100.1	58.0	82.1
3	CONCRETE	107.1	97.4	102.2	105.6	91.4	98.4	118.7	97.2	107.9	118.5	147.7	133.3	130.9	139.3	135.1	101.0	55.7	78.1
4	MASONRY	104.8	95.0	98.7	96.9	93.2	94.6	98.0	101.7	100.3	111.5	151.5	136.3	117.7	151.8	138.9	80.0	44.2	57.8
5	METALS	99.7	114.5	105.3	98.0	111.0	102.9	98.0	109.5	102.4	101.7	142.9	117.3	108.9	142.7	121.7	93.9	85.1	90.6
6	WOOD & PLASTICS	113.1	90.6	101.8	113.1	81.2	97.1	87.1	93.5	90.3	119.1	136.5	127.8	117.4	136.5	127.0	93.0	53.6	73.3
7	THERMAL & MOISTURE PROTECTION	99.8	98.1	99.0	92.1	96.2	94.0	92.2	100.7	96.1	107.7	144.6	124.8	108.1	148.2	126.6	93.6	50.4	73.7
8	DOORS & WINDOWS	96.1	89.0	94.4	98.0	78.8	93.3	98.0	84.8	94.8	94.5	153.5	108.7	98.3	155.4	112.0	93.9	50.6	83.5
092	LATH, PLASTER & GYPSUM BOARD	110.5	89.8	97.1	110.5	80.2	90.9	101.3	92.9	95.9	112.3	137.6	128.7	115.8	137.6	130.0	93.8	51.9	66.7
095	ACOUSTICAL TREATMENT & WOOD FLOORING	97.7	89.8	92.6	97.7	80.2	86.4	97.7	92.9	94.6	86.3	137.6	119.5	103.9	137.6	125.7	87.1	51.9	64.3
096	FLOORING & CARPET	84.4	85.0	84.6	82.3	89.5	84.0	75.1	89.5	78.6	91.2	158.8	107.4	90.8	158.8	107.1	84.1	52.8	76.6
099	PAINTING & WALL COVERINGS	85.2	90.3	88.2	80.0	90.3	86.0	80.0	83.9	82.3	97.4	135.3	119.5	97.4	135.3	119.5	102.7	51.8	73.1
9	FINISHES	97.9	89.9	93.9	96.3	84.8	90.5	93.3	92.1	92.7	106.4	142.4	124.7	110.7	142.5	126.9	88.7	52.3	70.2
10-14	TOTAL DIV. 10-14	100.0	97.5	99.5	100.0	93.6	98.6	100.0	84.7	96.8	100.0	136.4	107.7	100.0	143.2	109.2	100.0	74.0	94.5
15	MECHANICAL	100.3	96.4	98.6	100.3	92.5	96.8	100.3	96.5	98.6	100.3	136.8	116.4	100.3	137.5	116.7	100.1	57.7	81.3
16	ELECTRICAL	105.4	91.7	96.3	105.4	85.5	92.1	105.4	87.2	93.3	98.9	140.9	126.9	112.8	157.5	142.6	99.5	56.8	71.0
1-16	WEIGHTED AVERAGE	101.0	97.6	99.4	99.2	93.2	96.3	100.5	97.1	98.9	104.4	142.1	122.6	109.5	144.2	126.3	96.0	59.3	78.3

	DIVISION	NORTH CAROLINA																	
		CHARLOTTE			DURHAM			FAYETTEVILLE			GREENSBORO			RALEIGH			WILMINGTON		
		MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL
2	SITE WORK	104.4	72.9	80.2	104.3	82.8	87.8	102.4	82.8	87.3	104.1	82.8	87.7	104.6	82.8	87.8	105.2	73.0	80.4
031	CONCRETE FORMWORK	102.6	52.5	60.1	95.4	52.6	59.1	90.3	52.6	58.3	95.4	52.6	59.1	98.8	52.6	59.6	95.2	52.6	59.1
032	CONCRETE REINFORCEMENT	95.7	47.8	68.8	95.7	54.5	72.6	94.8	54.5	72.1	95.7	54.5	72.6	95.7	54.5	72.6	96.0	54.5	72.7
033	CAST IN PLACE CONCRETE	101.3	58.1	82.9	100.3	58.1	82.3	96.8	58.1	80.3	99.4	58.1	81.8	103.3	58.1	84.0	99.6	58.1	81.9
3	CONCRETE	101.6	55.8	78.5	100.6	57.1	78.6	98.0	57.1	77.3	100.1	57.1	78.4	102.2	57.1	79.4	100.9	57.1	78.7
4	MASONRY	81.0	44.2	58.1	79.5	44.2	57.6	83.9	44.2	59.2	79.5	44.2	57.5	86.4	44.2	60.2	69.0	44.2	53.6
5	METALS	95.2	85.2	91.4	95.2	87.8	92.4	94.1	87.8	91.8	96.0	87.8	92.9	95.3	87.8	92.4	94.2	87.8	91.8
6	WOOD & PLASTICS	103.6	53.6	78.6	94.7	53.6	74.1	89.3	53.6	71.4	94.7	53.6	74.1	99.0	53.6	76.3	95.2	53.6	74.4
7	THERMAL & MOISTURE PROTECTION	94.0	51.6	74.5	94.2	51.1	74.3	93.8	51.1	74.1	94.2	51.1	74.3	94.0	50.4	73.9	93.6	51.1	74.0
8	DOORS & WINDOWS	98.0	50.6	86.6	98.0	52.9	87.1	94.1	52.9	84.1	98.0	52.9	87.1	94.8	52.9	84.7	94.1	52.9	84.2
092	LATH, PLASTER & GYPSUM BOARD	98.3	51.9	68.2	98.3	51.9	68.2	94.2	51.9	66.8	98.3	51.9	68.2	98.3	51.9	68.2	94.7	51.9	67.0
095	ACOUSTICAL TREATMENT & WOOD FLOORING	91.5	51.9	65.8	91.5	51.9	65.8	88.5	51.9	64.8	91.5	51.9	65.8	91.5	51.9	65.8	88.5	51.9	64.8
096	FLOORING & CARPET	87.3	52.8	79.0	87.3	52.8	79.0	84.2	52.8	76.7	87.3	52.8	79.0	87.3	52.8	79.0	84.8	52.8	77.1
099	PAINTING & WALL COVERINGS	102.7	51.8	73.1	102.7	51.8	73.1	102.7	51.8	73.1	102.7	51.8	73.1	102.7	51.8	73.1	102.7	51.8	73.1
9	FINISHES	91.2	52.3	71.4	91.3	52.3	71.4	89.1	52.3	70.4	91.3	52.3	71.4	91.3	52.3	71.4	89.3	52.3	70.5
10-14	TOTAL DIV. 10-14	100.0	73.9	94.5	100.0	73.9	94.5	100.0	73.9	94.5	100.0	73.9	94.5	100.0	73.9	94.5	100.0	73.9	94.5
15	MECHANICAL	100.1	57.7	81.4	100.1	57.8	81.4	100.1	57.8	81.4	100.1	57.8	81.4	100.1	57.8	81.4	100.1	57.8	81.4
16	ELECTRICAL	98.6	51.0	66.8	98.6	54.3	69.0	92.8	54.3	67.1	98.6	54.3	69.0	98.6	54.3	69.0	99.3	54.3	69.3
1-16	WEIGHTED AVERAGE	97.2	58.4	78.4	96.9	60.5	79.3	95.4	60.5	78.5	96.9	60.5	79.3	97.1	60.4	79.4	95.6	59.5	78.1

020 120 | Std Penetration Tests

		020 120 Std Penetration Tests	CREW	DAILY OUTPUT	LABOR-HOURS	UNIT	1996 BARE COSTS MAT.	LABOR	EQUIP.	TOTAL	TOTAL INCL O&P	
125	2050	6" diameter core	B-89A	6.40	2.500	Total		57	8.65	65.65	101	125
	2100	8" diameter core		5.80	2.759			63	9.50	72.50	112	
	2150	10" diameter core		5	3.200			73	11.05	84.05	129	
	2200	12" diameter core		4.10	3.902			89.50	13.45	102.95	158	
	2250	14" diameter core		3.55	4.507			103	15.55	118.55	182	
	2300	18" diameter core		3.30	4.848			111	16.75	127.75	195	
	3010	Bits for core drill, diamond, premium, 1" diameter				Ea.	145			145	160	
	3040	4" diameter					375			375	415	
	3080	8" diameter					750			750	825	
	3120	12" diameter					1,000			1,000	1,100	
	3180	18" diameter					1,575			1,575	1,750	
	3240	24" diameter					2,250			2,250	2,475	
128	0010	TEST PITS Hand digging, light soil	1 Clab	4.50	1.778	C.Y.		35		35	56	128
	0100	Heavy soil	"	2.50	3.200			63.50		63.50	101	
	0120	Loader-backhoe, light soil	B-11M	28	.571			13	10.20	23.20	32	
	0130	Heavy soil	"	20	.800			18.20	14.30	32.50	44	
	1000	Subsurface exploration, mobilization				Mile				4.75	5.45	
	1010	Difficult access for rig, add				Hr.				95	110	
	1020	Auger borings, drill rig, incl. samples				L.F.				11.25	12.95	
	1030	Hand auger								16.85	19.45	
	1050	Drill and sample every 5', split spoon								14.95	16.35	
	1060	Extra samples				Ea.				19.45	20.80	

020 550 | Site Demolition

		020 550 Site Demolition	CREW	DAILY OUTPUT	LABOR-HOURS	UNIT	MAT.	LABOR	EQUIP.	TOTAL	TOTAL INCL O&P	
554	0010	SITE DEMOLITION No hauling, abandon catch basin or manhole	B-6	7	3.429	Ea.		73.50	29.50	103	149	554
	0020	Remove existing catch basin or manhole		4	6			129	52	181	259	
	0030	Catch basin or manhole frames and covers stored		13	1.846			39.50	16	55.50	80	
	0040	Remove and reset		7	3.429			73.50	29.50	103	149	
	0100	Roadside delineators, remove only	B-80	175	.183			3.96	2.64	6.60	9.10	
	0110	Remove and reset	"	100	.320			6.95	4.61	11.56	15.95	
	0600	Fencing, barbed wire, 3 strand	2 Clab	430	.037	L.F.		.74		.74	1.18	
	0650	5 strand	"	280	.057			1.13		1.13	1.81	
	0700	Chain link, remove only, 8' to 10' high	B-6	445	.054			1.16	.47	1.63	2.33	
	0750	Remove and reset		70	.343			7.35	2.97	10.32	14.80	
	0755	Remove only, 6' high		520	.046			.99	.40	1.39	2	
	0756	Remove and reset		84	.286			6.10	2.47	8.57	12.35	
	0757	Farm field fence (ASTM A116), remove only	B-1	500	.048			.98		.98	1.57	
	0760	Wood to 6' remove only, minimum	2 Clab	500	.032			.63		.63	1.01	
	0770	Maximum		250	.064			1.27		1.27	2.02	
	0775	Fencing, wood, all types, 4'to 6' high		432	.037			.73		.73	1.17	
	0780	Fence post, wood, 4" x 4", 6' to 8' high		96	.167	Ea.		3.30		3.30	5.25	
	0785	Fence rail, 2" x 4", 8' long		7,680	.002	L.F.		.04		.04	.07	
	0790	Remove and store	B-80	235	.136			2.95	1.96	4.91	6.80	
	0800	Guide rail, corrugated steel, remove only	2 Clab	85	.188			3.73		3.73	5.95	
	0850	Remove and reset	"	35	.457			9.05		9.05	14.45	
	0860	Guide posts, remove only	B-55	90	.267	Ea.		5.35	6.85	12.20	15.95	
	0870	Remove and reset	"	50	.480			9.60	12.35	21.95	29	
	0900	Hydrants, fire, remove only	2 Plum	4.70	3.404			102		102	157	
	0950	Remove and reset	"	1.40	11.429			345		345	525	
	1000	Masonry walls, block or tile, solid, remove	B-5	1,800	.036	C.F.		.80	.54	1.34	1.85	
	1100	Cavity wall		2,200	.029			.65	.44	1.09	1.51	
	1200	Brick, solid		900	.071			1.60	1.08	2.68	3.70	
	1300	With block back-up		1,130	.057			1.27	.86	2.13	2.94	
	1400	Stone, with mortar		900	.071			1.60	1.08	2.68	3.70	
	1500	Dry set		1,500	.043			.96	.65	1.61	2.22	
	1600	Median barrier, precast concrete, remove and store	B-3	430	.112	L.F.		2.39	3.90	6.29	8.05	

020 550 | Site Demolition

			CREW	DAILY OUTPUT	LABOR-HOURS	UNIT	1996 BARE COSTS MAT.	LABOR	EQUIP.	TOTAL	TOTAL INCL O&P
554	1610	Remove and reset	B-3	390	.123	L.F.		2.64	4.30	6.94	8.85
	1710	Pavement removal, bituminous, 3" thick	B-38	690	.058	S.Y.		1.30	1.80	3.10	4.01
	1750	4" to 6" thick		420	.095			2.13	2.96	5.09	6.60
	1800	Bituminous driveways		680	.059			1.32	1.83	3.15	4.07
	1900	Concrete to 6" thick, mesh reinforced		255	.157			3.51	4.87	8.38	10.85
	2000	Rod reinforced		200	.200			4.47	6.20	10.67	13.85
	2100	Concrete 7" to 24" thick, plain		33	1.212	C.Y.		27	37.50	64.50	84
	2200	Reinforced		24	1.667	"		37.50	52	89.50	116
	2210	Patio/carport, not incl. foundation	2 Clab	1,066	.015	S.F.		.30		.30	.47
	2220	Roof cover only	1 Carp	1,000	.008			.20		.20	.32
	2230	Remove and reset roof cover		320	.025			.63		.63	1.01
	2240	Column only		53	.151	Ea.		3.80		3.80	6.10
	2300	With hand held air equipment, bituminous	B-39	1,900	.025	S.F.		.53	.08	.61	.93
	2320	Concrete to 6" thick, no reinforcing		1,200	.040			.84	.13	.97	1.47
	2340	Mesh reinforced		830	.058			1.21	.18	1.39	2.12
	2360	Rod reinforced		765	.063			1.31	.20	1.51	2.30
	2400	Curbs, concrete, plain	B-6	325	.074	L.F.		1.58	.64	2.22	3.19
	2500	Reinforced		220	.109			2.34	.94	3.28	4.72
	2600	Granite curbs		355	.068			1.45	.59	2.04	2.92
	2700	Bituminous curbs		830	.029			.62	.25	.87	1.26
	2800	Wood		570	.042			.90	.36	1.26	1.82
	2900	Pipe removal, concrete, no excavation, 12" diameter		175	.137			2.94	1.19	4.13	5.95
	2930	15" diameter		150	.160			3.43	1.39	4.82	6.90
	2960	24" diameter		120	.200			4.29	1.73	6.02	8.65
	3000	36" diameter		90	.267			5.70	2.31	8.01	11.55
	3200	Steel, welded connections, 4" diameter		160	.150			3.21	1.30	4.51	6.50
	3300	10" diameter		80	.300			6.45	2.60	9.05	12.95
	3500	Railroad track removal, ties and track	B-14	110	.436			9.15	1.89	11.04	16.60
	3600	Ballast		500	.096	C.Y.		2.01	.42	2.43	3.65
	3700	Remove and re-install ties & track using new bolts & spikes		50	.960	L.F.		20	4.16	24.16	36.50
	3800	Turnouts using new bolts and spikes		1	48	Ea.		1,000	208	1,208	1,825
	4000	Sidewalk removal, bituminous, 2-1/2" thick	B-6	325	.074	S.Y.		1.58	.64	2.22	3.19
	4050	Brick, set in mortar		185	.130			2.78	1.12	3.90	5.60
	4060	Dry set		270	.089			1.90	.77	2.67	3.85
	4100	Concrete, plain, 4"		160	.150			3.21	1.30	4.51	6.50
	4200	Mesh reinforced		150	.160			3.43	1.39	4.82	6.90
	5000	Slab on grade removal, plain	B-5	45	1.422	C.Y.		32	21.50	53.50	73.50
	5100	Mesh reinforcing		33	1.939			43.50	29.50	73	101
	5200	Rod reinforcing		25	2.560			57.50	39	96.50	133
	5500	For congested sites or small quantities, add up to								200%	200%
	5550	For disposal on site, add	B-11A	232	.069			1.57	3.68	5.25	6.50
	5600	To 5 miles, add	B-34D	76	.105			2.18	6.85	9.03	10.90

020 600 | Building Demolition

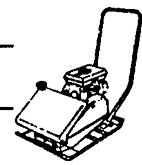
			CREW	DAILY OUTPUT	LABOR-HOURS	UNIT	MAT.	LABOR	EQUIP.	TOTAL	TOTAL INCL O&P
604	0010	BUILDING DEMOLITION Large urban projects, incl. 20 Mi. haul									
	0012	Not including dump fee, steel	B-8	21,500	.003	C.F.		.07	.10	.17	.21
	0050	Concrete		15,300	.004			.09	.14	.23	.30
	0080	Masonry		20,100	.003			.07	.11	.18	.23
	0100	Mixture of types, average		20,100	.003			.07	.11	.18	.23
	0500	Small bldgs, or single bldgs, no salvage included, steel	B-3	14,800	.003			.07	.11	.18	.23
	0600	Concrete		11,300	.004			.09	.15	.24	.30
	0650	Masonry		14,800	.003			.07	.11	.18	.23
	0700	Wood		14,800	.003			.07	.11	.18	.23
	1000	Single family, one story house, wood, minimum				Ea.				2,050	2,250
	1020	Maximum								3,500	3,825
	1200	Two family, two story house, wood, minimum								2,325	2,550

2 SITE WORK

		021 140 | Stripping	CREW	DAILY OUTPUT	LABOR-HOURS	UNIT	1996 BARE COSTS MAT.	LABOR	EQUIP.	TOTAL	TOTAL INCL O&P	
144	0500	Adverse conditions	B-10X	2,000	.006	C.Y.		.14	.65	.79	.94	144
	0600	Clay, dry and soft, 200 HP dozer, ideal conditions	B-10B	1,600	.008			.18	.53	.71	.87	
	0601	Strip topsoil, clay, dry & soft, 200 HP dozer, ideal conditions		1,600	.008			.18	.53	.71	.87	
	0700	Adverse conditions	↓	800	.015			.36	1.07	1.43	1.72	
	1000	Medium hard, 300 HP dozer, ideal conditions	B-10M	2,000	.006			.14	.56	.70	.83	
	1100	Adverse conditions	•	1,100	.011			.26	1.01	1.27	1.51	
	1200	Very hard, 400 HP dozer, ideal conditions	B-10X	2,600	.005			.11	.50	.61	.72	
	1300	Adverse conditions	•	1,340	.009	↓		.21	.98	1.19	1.40	
		021 150 | Selective Clearing										
154	0010	SELECTIVE CLEARING										154
	1000	Stump removal on site by hydraulic backhoe, 1-1/2 C.Y.										
	1040	4" to 6" diameter	B-17	60	.533	Ea.		11.35	9.30	20.65	28	
	1050	8" to 12" diameter	B-30	33	.727			16.25	47.50	63.75	77.50	
	1100	14" to 24" diameter		25	.960			21.50	63	84.50	102	
	1150	26" to 36" diameter		16	1.500			33.50	98	131.50	160	
	1151	Stump removal, 19" to 24" diameter	↓	16	1.500	↓		33.50	98	131.50	160	
	2000	Remove selective trees, on site using chain saws and chipper,										
	2050	not incl. stumps, up to 6" diameter	B-7	18	2.667	Ea.		56.50	62.50	119	158	
	2100	8" to 12" diameter		12	4			84.50	94	178.50	237	
	2150	14" to 24" diameter		10	4.800			101	113	214	285	
	2200	26" to 36" diameter	↓	8	6			127	141	268	355	
	2300	Machine load, 2 mile haul to dump, 12" diam. tree, add				↓				150	225	
		021 200 | Structure Moving										
204	0010	MOVING BUILDINGS One day move, up to 24' wide										204
	0020	Reset on new foundation, patch & hook-up, average move				Total					8,700	
	0040	Wood or steel frame bldg., based on ground floor area	B-4	185	.259	S.F.		5.25	2.44	7.69	11.05	
	0060	Masonry bldg., based on ground floor area	•	137	.350			7.10	3.29	10.39	14.90	
	0200	For 24' to 42' wide, add				↓					15%	
	0220	For each additional day on road, add	B-4	1	48	Day		975	450	1,425	2,050	
	0240	Construct new basement, move building, 1 day										
	0300	move, patch & hook-up, based on ground floor area	B-3	155	.310	S.F.	5.50	6.65	10.80	22.95	28.50	
		021 400 | Dewatering										
404	0010	DEWATERING Excavate drainage trench, 2' wide, 2' deep	B-11C	90	.178	C.Y.		4.04	2.31	6.35	8.85	404
	0100	2' wide, 3' deep, with backhoe loader	•	135	.119			2.70	1.54	4.24	5.90	
	0200	Excavate sump pits by hand, light soil	1 Clab	7.10	1.127			22.50		22.50	35.50	
	0300	Heavy soil	•	3.50	2.286	↓		45.50		45.50	72	
	0500	Pumping 8 hr., attended 2 hrs. per day, including 20 L.F.										
	0550	of suction hose & 100 L.F. discharge hose										
	0600	2" diaphragm pump used for 8 hours	B-10H	4	3	Day		71	8.05	79.05	120	
	0620	Add per additional pump							30	30	33	
	0650	4" diaphragm pump used for 8 hours	B-10I	4	3			71	21	92	134	
	0670	Add per additional pump							65	65	71	
	0800	8 hrs. attended, 2" diaphragm pump	B-10H	1	12			285	32	317	475	
	0820	Add per additional pump							32	32	35	
	0900	3" centrifugal pump	B-10J	1	12			285	49.50	334.50	495	
	0920	Add per additional pump							41	41	45	
	1000	4" diaphragm pump	B-10I	1	12			285	83	368	530	
	1020	Add per additional pump							65	65	71	
	1100	6" centrifugal pump	B-10K	1	12			285	221	506	685	
	1120	Add per additional pump				↓			105	105	115	
	1300	Re-lay CMP, incl. excavation 3' deep, 12" diameter	B-6	115	.209	L.F.	5.70	4.47	1.81	11.98	15.30	
	1400	18" diameter	↓	100	.240	•	8.25	5.15	2.08	15.48	19.50	

Important: See the Reference Section for critical supporting data - Reference Nos., Crews, & City Cost Indexes

022 200 | Excav./Backfill/Compact.



		022 200 Excav./Backfill/Compact.	Crew	Daily Output	Labor-Hours	Unit	1996 Bare Costs Mat.	Labor	Equip.	Total	Total Incl O&P	
226	6270	4 passes (R022-220)	B-10C	2,600	.005	C.Y.		.11	.37	.48	.57	226
	7000	Walk behind, vibrating plate 18" wide, 6" lifts, 2 passes	A-1	280	.029			.57	.22	.79	1.14	
	7020	3 passes		185	.043			.86	.33	1.19	1.73	
	7040	4 passes		140	.057			1.13	.43	1.56	2.28	
	7200	12" lifts, 2 passes		560	.014			.28	.11	.39	.57	
	7220	3 passes		375	.021			.42	.16	.58	.85	
	7240	4 passes		280	.029			.57	.22	.79	1.14	
	7500	Vibrating roller 24" wide, 6" lifts, 2 passes	B-10A	420	.029			.68	.20	.88	1.27	
	7520	3 passes		280	.043			1.02	.31	1.33	1.92	
	7540	4 passes		210	.057			1.36	.41	1.77	2.56	
	7600	12" lifts, 2 passes		840	.014			.34	.10	.44	.64	
	7620	3 passes		560	.021			.51	.15	.66	.96	
	7640	4 passes		420	.029			.68	.20	.88	1.27	
	8000	Rammer tamper, 6" to 11", 4" lifts, 2 passes	A-1	130	.062			1.22	.46	1.68	2.45	
	8050	3 passes		97	.082			1.63	.62	2.25	3.29	
	8100	4 passes		65	.123			2.44	.93	3.37	4.91	
	8200	8" lifts, 2 passes		260	.031			.61	.23	.84	1.22	
	8250	3 passes		195	.041			.81	.31	1.12	1.64	
	8300	4 passes		130	.062			1.22	.46	1.68	2.45	
	8400	13" to 18", 4" lifts, 2 passes		390	.021			.41	.15	.56	.82	
	8450	3 passes		290	.028			.55	.21	.76	1.10	
	8500	4 passes		195	.041			.81	.31	1.12	1.64	
	8600	8" lifts, 2 passes		780	.010			.20	.08	.28	.40	
	8650	3 passes		585	.014			.27	.10	.37	.54	
	8700	4 passes		390	.021			.41	.15	.56	.82	
230	0010	**DRILLING ONLY** 2" hole for rock bolts, average	B-47	395	.061	L.F.		1.34	1.43	2.77	3.69	230
	0800	2-1/2" hole for pre-splitting, average		540	.044			.98	1.05	2.03	2.70	
	1600	Quarry operations, 2-1/2" to 3-1/2" diameter		715	.034			.74	.79	1.53	2.04	
	1610	6" diameter drill holes	B-47A	1,350	.018			.42	.33	.75	1.01	
234	0010	**DRILLING AND BLASTING** Only, rock, open face, under 1500 C.Y.	B-47	225	.107	C.Y.	1.50	2.36	2.52	6.38	8.15	234
	0100	Over 1500 C.Y.		300	.080		1.50	1.77	1.89	5.16	6.50	
	0300	Bulk drilling and blasting, can vary greatly, average									3.95	
	0500	Pits, average									20	
	1300	Deep hole method, up to 1500 C.Y.	B-47	50	.480		1.50	10.60	11.30	23.40	31	
	1400	Over 1500 C.Y.		66	.364		1.50	8.05	8.55	18.10	24	
	1900	Restricted areas, up to 1500 C.Y.		13	1.846		1.50	41	43.50	86	114	
	2000	Over 1500 C.Y.		20	1.200		1.50	26.50	28.50	56.50	74	
	2200	Trenches, up to 1500 C.Y.		22	1.091		4.50	24	25.50	54	71.50	
	2300	Over 1500 C.Y.		26	.923		4.29	20.50	22	46.79	60.50	
	2500	Pier holes, up to 1500 C.Y.		22	1.091		1.50	24	25.50	51	68	
	2600	Over 1500 C.Y.		31	.774		1.50	17.10	18.25	36.85	48.50	
	2800	Boulders under 1/2 C.Y., loaded on truck, no hauling	B-100	80	.150			3.56	6.15	9.71	12.30	
	2900	Drilled, blasted and loaded on truck, no hauling	B-47	30	.800		1.50	17.70	18.85	38.05	50.50	
	3100	Jackhammer operators with foreman compressor, air tools	B-9	1	40	Day		810	152	962	1,475	
	3300	Track drill, compressor, operator and foreman	B-47	1	24			530	565	1,095	1,450	
	3500	Blasting caps				Ea.	2.50			2.50	2.75	
	3700	Explosives				Lb.	1.50			1.50	1.65	
	3900	Blasting mats, rent, for first day				Ea.	80			80	88	
	4000	Per added day					25			25	27.50	
	4200	Preblast survey for 6 room house, individual lot, minimum	A-6	2.40	6.667			155		155	239	
	4300	Maximum		1.35	11.852			276		276	425	
	4500	City block within zone of influence, minimum	A-8	25,200	.001	S.F.		.03		.03	.04	
	4600	Maximum		15,100	.002			.05		.05	.07	
	5000	Excavate and load boulders, less than 0.5 C.Y.	B-10T	80	.150	C.Y.		3.56	5.35	8.91	11.40	
	5020	0.5 C.Y. to 1 C.Y.	B-10U	100	.120			2.85	8.95	11.80	14.25	

022 | Earthwork

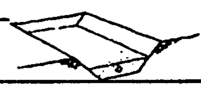
022 200 | Excav./Backfill/Compact.

				CREW	DAILY OUTPUT	LABOR-HOURS	UNIT	1996 BARE COSTS MAT.	LABOR	EQUIP.	TOTAL	TOTAL INCL O&P
250	2050	1-1/2 C.Y. bucket	R022-240	B-12B	144	.111	C.Y.		2.70	4.93	7.63	9.60
	2060	2 C.Y. bucket		B-12C	200	.080			1.95	4.88	6.83	8.35
	2070	Sand and gravel, 3/4 C.Y. bucket		B-12F	100	.160			3.89	4.51	8.40	10.95
	2080	1 C.Y. bucket		B-12A	120	.133			3.24	4.59	7.83	10.05
	2090	1-1/2 C.Y. bucket		B-12B	160	.100			2.43	4.44	6.87	8.65
	3000	2 C.Y. bucket		B-12C	220	.073			1.77	4.44	6.21	7.60
	3010	Clay, till, or blasted rock, 3/4 C.Y. bucket		B-12F	80	.200			4.87	5.65	10.52	13.70
	3020	1 C.Y. bucket		B-12A	95	.168			4.10	5.80	9.90	12.70
	3030	1-1/2 C.Y. bucket		B-12B	130	.123			2.99	5.45	8.44	10.60
	3040	2 C.Y. bucket		B-12C	175	.091			2.22	5.60	7.82	9.55
	9010	For mobilization or demobilization, see div. 022-274										
	9020	For dewatering, see div. 021-404										
	9022	For larger structures, see Bulk Excavation, div. 022-238										
	9024	For loading onto trucks, add									15%	
	9026	For hauling, see div. 022-266										
	9030	For sheeting or soldier beams & lagging, see div. 021-614 & 624										
	9040	For trench excavation of strip footings, see div. 022-254										
254	0010	EXCAVATING, TRENCH or continuous footing, common earth	R022-240									
	0020	No sheeting or dewatering included										
	0050	1' to 4' deep, 3/8 C.Y. tractor loader/backhoe		B-11C	150	.107	C.Y.		2.43	1.39	3.82	5.30
	0060	1/2 C.Y. tractor loader/backhoe		B-11M	200	.080			1.82	1.43	3.25	4.41
	0062	3/4 C.Y. hydraulic backhoe		B-12F	270	.059			1.44	1.67	3.11	4.06
	0090	4' to 6' deep, 1/2 C.Y. tractor loader/backhoe		B-11M	200	.080			1.82	1.43	3.25	4.41
	0100	5/8 C.Y. hydraulic backhoe		B-12Q	250	.064			1.56	1.58	3.14	4.12
	0110	3/4 C.Y. hydraulic backhoe		B-12F	300	.053			1.30	1.50	2.80	3.64
	0120	1 C.Y. hydraulic backhoe		B-12A	400	.040			.97	1.38	2.35	3.02
	0130	1-1/2 C.Y. hydraulic backhoe		B-12B	540	.030			.72	1.32	2.04	2.56
	0300	1/2 C.Y. hydraulic excavator, truck mounted		B-12J	200	.080			1.95	3.15	5.10	6.45
	0500	6' to 10' deep, 3/4 C.Y. hydraulic backhoe		B-12F	225	.071			1.73	2	3.73	4.86
	0510	1 C.Y. hydraulic backhoe		B-12A	400	.040			.97	1.38	2.35	3.02
	0600	1 C.Y. hydraulic excavator, truck mounted		B-12K	400	.040			.97	2.17	3.14	3.88
	0610	1-1/2 C.Y. hydraulic backhoe		B-12B	600	.027			.65	1.18	1.83	2.30
	0620	2-1/2 C.Y. hydraulic backhoe		B-12S	1,000	.016			.39	1.74	2.13	2.51
	0900	10' to 14' deep, 3/4 C.Y. hydraulic backhoe		B-12F	200	.080			1.95	2.25	4.20	5.45
	0910	1 C.Y. hydraulic backhoe		B-12A	360	.044			1.08	1.53	2.61	3.34
	1000	1-1/2 C.Y. hydraulic backhoe		B-12B	540	.030			.72	1.32	2.04	2.56
	1020	2-1/2 C.Y. hydraulic backhoe		B-12S	1,000	.016			.39	1.74	2.13	2.51
	1030	3 C.Y. hydraulic backhoe		B-12D	1,400	.011			.28	1.56	1.84	2.15
	1300	14' to 20' deep, 1 C.Y. hydraulic backhoe		B-12A	320	.050			1.22	1.72	2.94	3.77
	1310	1-1/2 C.Y. hydraulic backhoe		B-12B	480	.033			.81	1.48	2.29	2.88
	1320	2-1/2 C.Y. hydraulic backhoe		B-12S	850	.019			.46	2.04	2.50	2.95
	1330	3 C.Y. hydraulic backhoe		B-12D	1,000	.016			.39	2.18	2.57	3
	1400	By hand with pick and shovel to 6' deep, light soil		1 Clab	8	1			19.80		19.80	31.50
	1500	Heavy soil		"	4	2			39.50		39.50	63
	1700	For tamping backfilled trenches, air tamp, add		A-1	100	.080			1.58	.60	2.18	3.19
	1900	Vibrating plate, add			90	.089			1.76	.67	2.43	3.55
	2100	Trim sides and bottom for concrete pours, common earth			600	.013	S.F.		.26	.10	.36	.53
	2300	Hardpan			180	.044	"		.88	.33	1.21	1.77
	2400	Pier and spread footing excavation, add to above					C.Y.				30%	30%
	3000	Backfill trench, F.E. loader, wheel mtd., 1 C.Y. bucket										
	3020	Minimal haul		B-10R	400	.030	C.Y.		.71	.58	1.29	1.75
	3040	100' haul			200	.060			1.42	1.17	2.59	3.49
	3060	200' haul			100	.120			2.85	2.33	5.18	7
	3080	2-1/4 C.Y. bucket, minimum haul		B-10T	600	.020			.47	.71	1.18	1.5[illegible]
	3090	100' haul			300	.040			.95	1.42	2.37	3.03

025 | Paving & Surfacing

		025 800 | Pavement Marking	CREW	DAILY OUTPUT	LABOR-HOURS	UNIT	1996 BARE COSTS MAT.	LABOR	EQUIP.	TOTAL	TOTAL INCL O&P
810	0110	13"x7-1/2"x2-1/2" high, non-plowable install	2 Clab	96	.167	Ea.	17	3.30		20.30	24
	0200	8" x 8"x 3-1/4" high, non-plowable, install	↓	96	.167		18	3.30		21.30	25
	0230	4" x 4" x 3/4" high, non-plowable, install	↓	120	.133		1.62	2.64		4.26	6
	0240	9-1/4" x 5-7/8" x 1/4" high, plowable, concrete pav't	A-2A	70	.343		13.85	6.85	3.92	24.62	30.50
	0250	9-1/4" x 5-7/8" x 1/4" high, plowable, asphalt pav't	"	120	.200		1.75	4	2.28	8.03	10.75
	0300	Barrier and curb delineators,reflectorized, 2" x 4"	2 Clab	150	.107		1.15	2.11		3.26	4.64
	0310	3" x 5"	"	150	.107	↓	2.45	2.11		4.56	6.05
	0500	Rumble strip, polycarbonate									
	0510	24" x 3-1/2" x 1/2" high	2 Clab	50	.320	Ea.	4.55	6.35		10.90	15.10

026 | Piped Utilities

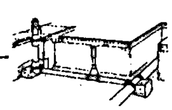
		026 010 | Piped Utilities	CREW	DAILY OUTPUT	LABOR-HOURS	UNIT	1996 BARE COSTS MAT.	LABOR	EQUIP.	TOTAL	TOTAL INCL O&P
012	0010	**BEDDING** For pipe and conduit, not incl. compaction									
	0050	Crushed or screened bank run gravel	B-6	150	.160	C.Y.	12.55	3.43	1.39	17.37	20.50
	0100	Crushed stone 3/4" to 1/2" 	↓	150	.160		13	3.43	1.39	17.82	21
	0200	Sand, dead or bank,	↓	150	.160		3.75	3.43	1.39	8.57	11.05
	0500	Compacting bedding in trench	A-1	90	.089	↓		1.76	.67	2.43	3.55
014	0010	**EXCAVATION AND BACKFILL** See division 022-204 & 254									
	0100	Hand excavate and trim for pipe bells after trench excavation									
	0200	8" pipe	1 Clab	155	.052	L.F.		1.02		1.02	1.63
	0300	18" pipe	"	130	.062	"		1.22		1.22	1.94
		026 050 | Manholes & Cleanouts									
054	0010	**UTILITY VAULTS** Precast concrete, 6" thick									
	0040	4' x 6' x 6' high, I.D.	B-13	2	28	Ea.	1,400	600	256	2,256	2,750
	0050	5' x 10' x 6' high, I.D.		2	28		1,725	600	256	2,581	3,125
	0100	6' x 10' x 6' high, I.D.		2	28		1,775	600	256	2,631	3,175
	0150	5' x 12' x 6' high, I.D.		2	28		1,900	600	256	2,756	3,300
	0200	6' x 12' x 6' high, I.D.		1.80	31.111		2,125	665	285	3,075	3,700
	0250	6' x 13' x 6' high, I.D.		1.50	37.333		2,775	800	340	3,915	4,675
	0300	8' x 14' x 7' high, I.D.	↓	1	56	↓	3,000	1,200	515	4,715	5,775
	0350	Hand hole, precast concrete, 1-1/2" thick									
	0400	1'-0" x 2'-0" x 1'-9", I.D., light duty	B-1	4	6	Ea.	260	123		383	480
	0450	4'-6" x 3'-2" x 2'-0", O.D., heavy duty	B-6	3	8		550	171	69.50	790.50	950
	0460	Meter pit, 4' x 4', 4' deep		2	12		880	257	104	1,241	1,500
	0470	6' deep		1.60	15		1,250	320	130	1,700	2,025
	0480	8' deep		1.40	17.143		1,650	365	148	2,163	2,575
	0490	10' deep		1.20	20		2,100	430	173	2,703	3,175
	0500	15' deep		1	24		3,075	515	208	3,798	4,425
	0510	6' x 6', 4' deep		1.40	17.143		1,000	365	148	1,513	1,850
	0520	6' deep		1.20	20		1,500	430	173	2,103	2,525
	0530	8' deep		1	24		2,000	515	208	2,723	3,250
	0540	10' deep		.80	30		2,500	645	260	3,405	4,025
	0550	15' deep	↓	.60	40	↓	3,800	855	345	5,000	5,900

026 400 | Valves & Cocks

404		CREW	DAILY OUTPUT	LABOR-HOURS	UNIT	1996 BARE COSTS MAT.	LABOR	EQUIP.	TOTAL	TOTAL INCL O&P
3820	12" diameter	B-21	3	9.333	Ea.	1,625	216	36	1,877	2,175
3822	14" diameter		2	14		3,025	325	54	3,404	3,900
3824	16" diameter		1	28		4,425	645	108	5,178	6,000
3826	18" diameter		.80	35		6,575	810	135	7,520	8,675
3828	20" diameter		.80	35		8,700	810	135	9,645	11,000
3830	24" diameter		.50	56		12,000	1,300	217	13,517	15,500
3831	30" diameter		.35	80		25,500	1,850	310	27,660	31,300
3832	36" diameter		.30	93.333		32,400	2,150	360	34,910	39,500
3840	With boxes									
3842	4" diameter	B-20	5	4.800	Ea.	270	108		378	470
3844	6" diameter	"	4	6		450	135		585	710
3846	8" diameter	B-21	3.50	8		755	185	31	971	1,150
3848	10" diameter		3	9.333		1,220	216	36	1,472	1,725
3850	12" diameter		3	9.333		1,695	216	36	1,974	2,250
3852	14" diameter		2	14		3,095	325	54	3,747	3,975
3854	16" diameter		1	28		4,495	645	108	5,248	6,075
3856	18" diameter		0.8	35		6,645	810	135	7,590	8,750
3858	20" diameter		0.8	35		8,770	810	135	9,715	11,100
3860	24" diameter		.50	56		12,070	1,300	217	13,587	15,600
3880	Sleeve, for tapping mains, 8" x 4", add					425			425	470
3900	Globe valves, flanged, iron body, class 125									
3910	4" diameter	B-20	10	2.400	Ea.	335	54		389	455
3912	5" diameter		10	2.400		555	54		609	695
3914	6" diameter		9	2.667		585	60		645	735
3916	8" diameter	B-21	6	4.667		1,075	108	18.05	1,201.05	1,400
3918	10" diameter		5	5.600		2,000	129	21.50	2,150.50	2,425
3920	12" diameter		4	7		2,800	162	27	2,989	3,350
3922	14" diameter		3	9.333		3,000	216	36	3,252	3,675
3924	16" diameter		2	14		4,400	325	54	4,779	5,425
3926	18" diameter		.80	35		4,850	810	135	5,795	6,750
3928	20" diameter		.60	46.667		7,250	1,075	181	8,506	9,900
3930	24" diameter		.50	56		8,600	1,300	217	10,117	11,700
5010	Piping, site utility, fittings, corporations, brass, 3/4" diameter	1 Plum	19	.421		10.50	12.65		23.15	31
5040	1" diameter		16	.500		17.10	15		32.10	42
5060	1-1/2" diameter		13	.615		47.50	18.50		66	80.50
5080	2" diameter		11	.727		81	22		103	123
5200	Curb stops, brass, 3/4" diameter		19	.421		15	12.65		27.65	36
5220	1" diameter		16	.500		23.50	15		38.50	48.50
5240	1-1/2" diameter		13	.615		58.50	18.50		77	93
5260	2" diameter		11	.727		94	22		116	137
5400	Curb box, cast iron, 3/4" diameter		12	.667		28	20		48	61.50
5420	2" diameter		8	1		75	30		105	129
5500	Saddles, cast iron, 3/4", add					30			30	33
5550	2", add					35			35	38.50

026 450 | Hydrants

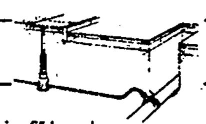
454		CREW	DAILY OUTPUT	LABOR-HOURS	UNIT	MAT.	LABOR	EQUIP.	TOTAL	TOTAL INCL O&P
0010	**PIPING, WATER DISTRIBUTION** Mech. joints unless noted									
1000	Fire hydrants, two way; excavation and backfill not incl.									
1100	4-1/2" valve size, depth 2'-0"	B-21	10	2.800	Ea.	735	64.50	10.85	810.35	925
1120	2'-6"		10	2.800		760	64.50	10.85	835.35	950
1140	3'-0"		10	2.800		785	64.50	10.85	860.35	980
1160	3'-6"		9	3.111		810	72	12.05	894.05	1,025
1200	4'-6"		9	3.111		835	72	12.05	919.05	1,050
1220	5'-0"		8	3.500		860	81	13.55	954.55	1,100
1240	5'-6"		8	3.500		915	81	13.55	1,009.55	1,150
1260	6'-0"		7	4		1,000	92.50	15.50	1,108	1,275



SITE WORK 2

026 650 | Water Systems

		026 650 Water Systems	CREW	DAILY OUTPUT	LABOR-HOURS	UNIT	1996 BARE COSTS MAT.	LABOR	EQUIP.	TOTAL	TOTAL INCL O&P
662	7250	For copper fittings, see Div. 151-430									
666	0010	PIPING, WATER DISTRIBUTION, DUCTILE IRON cement lined									
	0020	Not including excavation or backfill									
	2000	Pipe, class 50 water piping, 18' lengths									
	2020	Mechanical joint, 4" diameter	B-20	144	.167	L.F.	7.40	3.75		11.15	14.15
	2040	6" diameter	"	126	.190		8.45	4.29		12.74	16.15
	2060	8" diameter	B-21	108	.259		11.15	6	1	18.15	23
	2080	10" diameter		90	.311		14.20	7.20	1.20	22.60	28.50
	2100	12" diameter		72	.389		18.50	9	1.51	29.01	36.50
	2120	14" diameter		54	.519		23	12	2.01	37.01	47
	2140	16" diameter		46	.609		25.50	14.05	2.36	41.91	53
	2160	18" diameter	B-22	38	.789		28.50	18.45	4.27	51.22	64.50
	2170	20" diameter		37	.811		32.50	18.95	4.39	55.84	70.50
	2180	24" diameter		36	.833		45.50	19.45	4.51	69.46	86
	3000	Tyton, Push-on joint, 4" diameter	B-20	158	.152		6.15	3.42		9.57	12.25
	3020	6" diameter	"	138	.174		6.85	3.92		10.77	13.80
	3040	8" diameter	B-21	118	.237		8.70	5.50	.92	15.12	19.25
	3060	10" diameter		100	.280		11.50	6.45	1.08	19.03	24
	3080	12" diameter		80	.350		14.65	8.10	1.35	24.10	30.50
	3100	14" diameter		60	.467		17.95	10.80	1.81	30.56	39
	3120	16" diameter		54	.519		21	12	2.01	35.01	45
	3140	18" diameter	B-22	44	.682		24	15.95	3.69	43.64	55.50
	3160	20" diameter		42	.714		26.50	16.70	3.86	47.06	60
	3180	24" diameter		40	.750		32.50	17.50	4.06	54.06	67.50
	4000	Drill and tap pressurized main (labor only)									
	4100	6" main, 1" to 2" service	Q-1	3	5.333	Ea.		144		144	221
	4150	8" main, 1" to 2" service	"	2.75	5.818	"		157		157	241
	4500	Tap and insert gate valve									
	4600	8" main, 4" branch	B-21	3.20	8.750	Ea.		202	34	236	355
	4650	6" branch		2.70	10.370			240	40	280	425
	4651	Piping, drill, tap & insert gate valve, 8" main, 6" branch		2.70	10.370			240	40	280	425
	4700	10" main, 4" branch		2.70	10.370			240	40	280	425
	4750	6" branch		2.35	11.915			275	46	321	485
	4800	12" main, 6" branch		2.35	11.915			275	46	321	485
	4850	8" branch		2.35	11.915			275	46	321	485
	8000	Fittings									
	8006	Mechanical joint, 90° bend or elbows, 4" diameter	B-20	37	.649	Ea.	90	14.60		104.60	123
	8020	6" diameter		25	.960		121	21.50		142.50	168
	8040	8" diameter		21	1.143		197	25.50		222.50	258
	8060	10" diameter	B-21	21	1.333		253	31	5.15	289.15	335
	8080	12" diameter		18	1.556		335	36	6	377	430
	8100	14" diameter		16	1.750		540	40.50	6.75	587.25	665
	8120	16" diameter		14	2		610	46	7.75	663.75	750
	8140	18" diameter		10	2.800		940	64.50	10.85	1,015.35	1,150
	8160	20" diameter		8	3.500		1,050	81	13.55	1,144.55	1,325
	8180	24" diameter		6	4.667		1,400	108	18.05	1,526.05	1,725
	8200	Wye or tee, 4" diameter	B-20	25	.960		131	21.50		152.50	179
	8220	6" diameter		17	1.412		182	32		214	251
	8240	8" diameter		14	1.714		258	38.50		296.50	345
	8260	10" diameter	B-21	14	2		410	46	7.75	463.75	530
	8280	12" diameter		12	2.333		535	54	9.05	598.05	685
	8300	14" diameter		10	2.800		655	64.50	10.85	730.35	835
	8320	16" diameter		8	3.500		920	81	13.55	1,014.55	1,150
	8340	18" diameter		6	4.667		1,375	108	18.05	1,501.05	1,700
	8360	20" diameter		4	7		1,575	162	27	1,764	2,000



026 650 | Water Systems

		CREW	DAILY OUTPUT	LABOR-HOURS	UNIT	1996 BARE COSTS MAT.	LABOR	EQUIP.	TOTAL	TOTAL INCL O&P
8380	* 24" diameter	B-21	3	9.333	Ea.	2,125	216	36	2,377	2,700
8400	45° bends, 6" diameter	B-20	24	1		111	22.50		133.50	158
8410	12" diameter	"	16	1.500		293	34		327	375
8420	16" diameter	B-21	12	2.333		505	54	9.05	568.05	650
8430	20" diameter		6	4.667		855	108	18.05	981.05	1,125
8440	24" diameter		4	7		1,225	162	27	1,414	1,625
8450	Decreaser, 6" x 4" diameter	B-20	12	2		92	45		137	173
8460	8" x 6" diameter		10	2.400		143	54		197	244
8470	10" x 6" diameter		9	2.667		173	60		233	287
8480	12" x 6" diameter		8	3		214	67.50		281.50	345
8490	6" x 16" diameter	B-21	6	4.667		355	108	18.05	481.05	585
8500	6" x 20" diameter		5	5.600		565	129	21.50	715.50	855
8510	6" x 24" diameter		4	7		1,075	162	27	1,264	1,450
8610	Blind flanges, 150 psi., 4" diameter	Q-1	10	1.600		39	43.50		82.50	109
8620	5" diameter	"	8	2		51	54		105	139
8630	6" diameter	Q-2	10	2.400		59	67.50		126.50	168
8640	8" diameter		8	3		97	84		181	236
8650	10" diameter		7	3.429		189	96		285	355
8660	12" diameter		6	4		281	112		393	480
8670	14" diameter		5	4.800		430	135		565	675
8680	16" diameter		5	4.800		480	135		615	730
8690	18" diameter		4	6		580	168		748	900
8700	20" diameter		3	8		725	224		949	1,150
8710	24" diameter		2	12		1,100	335		1,435	1,725
8720	250 psi, 4" diameter	Q-1	6	2.667		61	72		133	178
8730	5" diameter	"	4	4		117	108		225	295
8740	* 6" diameter	Q-2	6	4		107	112		219	290
8750	* 8" diameter		4	6		163	168		331	440
8760	* 10" diameter		3.40	7.059		350	198		548	690
8770	* 12" diameter		2.80	8.571		470	240		710	885
8780	* 14" diameter		2.80	8.571		745	240		985	1,200
8790	* 16" diameter		2	12		865	335		1,200	1,475
8800	18" diameter		2	12		1,175	335		1,510	1,825
8810	20" diameter		1.50	16		1,325	450		1,775	2,125
8820	* 24" diameter		1	24		2,425	675		3,100	3,700
9020	Slip on weld flanges, 150lbs., 4" diameter	Q-15	6	2.667		31.50	72	8.75	112.25	155
9030	5" diameter	"	5	3.200		44	86.50	10.55	141.05	192
9040	6" diameter	Q-16	6	4		51	112	8.75	171.75	238
9050	8" diameter		5	4.800		78.50	135	10.50	224	305
9060	10" diameter		4	6		143	168	13.15	324.15	430
9070	12" diameter		3	8		209	224	17.50	450.50	595
9080	14" diameter		3	8		281	224	17.50	522.50	675
9090	16" diameter		2	12		340	335	26.50	701.50	920
9100	18" diameter		2	12		495	335	26.50	856.50	1,100
9110	20" diameter		1	24		570	675	52.50	1,297.50	1,725
9120	24" diameter		1	24		810	675	52.50	1,537.50	1,975
9130	300 lbs., 4" diameter	Q-15	6	2.667		52	72	8.75	132.75	177
9140	5" diameter	"	4	4		84.50	108	13.15	205.65	274
9150	6" diameter	Q-16	6	4		86.50	112	8.75	207.25	277
9160	8" diameter		4	6		143	168	13.15	324.15	430
9170	10" diameter		3.40	7.059		275	198	15.45	488.45	625
9180	12" diameter		2.80	8.571		340	240	18.75	598.75	765
9190	14" diameter		2.80	8.571		630	240	18.75	888.75	1,075
9200	16" diameter		2	12		690	335	26.50	1,051.50	1,300
9210	18" diameter		2	12		805	335	26.50	1,166.50	1,425
9220	20" diameter		1.50	16		1,125	450	35	1,610	1,950

050 500 | Metal Fastening

Line	Description	Crew	Daily Output	Labor-Hours	Unit	1996 Bare Costs Mat.	Labor	Equip.	Total	Total Incl O&P	
8250	1/2" diameter, 2-3/4" long	1 Carp	140	.057	Ea.	.98	1.44		2.42	3.37	520
[illegible]	7" long		130	.062		1.69	1.55		3.24	4.34	
85[illegible]	1" diameter, 6" long		100	.080		8.25	2.02		10.27	12.30	
8600	12" long		80	.100		11.50	2.52		14.02	16.70	
8750	For type 303 stainless steel, add					350%					
8800	For type 316 stainless steel, add					450%					
0010	**LAG SCREWS** Steel, 1/4" diameter, 2" long	1 Carp	140	.057	Ea.	.05	1.44		1.49	2.36	530
0100	3/8" diameter, 3" long		105	.076		.13	1.92		2.05	3.21	
0200	1/2" diameter, 3" long		95	.084		.24	2.12		2.36	3.65	
0300	5/8" diameter, 3" long		85	.094		.40	2.37		2.77	4.23	
0010	**MACHINE SCREWS** Steel, #8 x 1" long, round head				C	.90			.90	.99	535
0110	#8 x 2" long					1.80			1.80	1.98	
0200	#10 x 1" long					1.10			1.10	1.21	
0300	#10 x 2" long					1.88			1.88	2.07	
0010	**MACHINERY ANCHORS** Standard, flush mounted,										540
0020	incl. stud w/fiber plug, nut & washer, anchor & anchor bolt										
0200	Material only, 1/2" diameter stud & bolt				Ea.	22			22	24.50	
0300	5/8" diameter					25.50			25.50	28	
0500	3/4" diameter					27.50			27.50	30	
0600	7/8" diameter					31.50			31.50	35	
0800	1" diameter					35			35	38.50	
0900	1-1/4" diameter					44			44	48.50	
0010	**STUDS** .22 caliber stud driver, minimum				Ea.	245			245	270	550
0100	Maximum				"	395			395	435	
0300	Powder charges for above, low velocity				C	18.50			18.50	20.50	
0400	Standard velocity				"	22.50			22.50	25	
0010	**TRACK** Railroad, bolts				Cwt.	100			100	110	555
[illegible]	Joint bars				Pr.	20			20	22	
[illegible]	Spikes				Cwt.	37.50			37.50	41.50	
0300	Tie plates				Ea.	12.20			12.20	13.40	
0010	**WELD ROD** Steel, type E6010/E6011, 1/8" diameter, less than 500#				Lb.	1			1	1.10	570
0100	500# to 2,000#				"	.97			.97	1.07	
0200	2,000# to 5,000#				Lb.	.90			.90	.99	
0400	Steel, type E6011, 3/16" diameter, less than 500#					.97			.97	1.07	
0500	500# to 2,000#					.89			.89	.98	
0600	2000# to 5000#					.84			.84	.92	
0650	Steel, type E7018, (low hydrogen) 1/8" diam., less than 500#					.91			.91	1	
0660	500# to 2000#					.93			.93	1.02	
0670	2,000# to 5,000#					.82			.82	.90	
0700	Steel, type E7024, (jet weld) 1/8" diam., less than 500#					.95			.95	1.05	
0710	500# to 2,000#					.87			.87	.96	
0720	2,000# to 5,000#					.84			.84	.92	
0800	Deduct for 5/32" diameter, type E6010 or type E6011					.02			.02	.02	
0810	Semi-automatic coils, 1/16" diameter, 3000# lots					.83			.83	.91	
1550	Aluminum, type 4043, 1/8" diameter					4.05			4.05	4.46	
1600	5/32" diameter, 50-100#					3.95			3.95	4.35	
1810	3/16" diameter, 100-500#					3.85			3.85	4.23	
1900	Cast iron, 1/8" diameter					2.40			2.40	2.64	
2000	Stainless steel, type 308-15, 1/8" diam., less than 499#					5.10			5.10	5.60	
2100	500# to 999#					4.80			4.80	5.30	
2220	Over 1000#					3.90			3.90	4.29	
0010	**WELDING** Field. Cost per welder, no operating engineer R050-520	E-14	8	1	Hr.	3	30	9.90	42.90	70	575
[illegible]	With 1/2 operating engineer	E-13	8	1.500		3	42	9.90	54.90	89	
[illegible]	With 1 operating engineer	E-12	8	2		3	54.50	9.90	67.40	108	
0500	With no operating engineer, minimum	E-14	13.30	.602	Ton	2	17.95	5.95	25.90	42.50	

LCCA Economic Factors

NISTIR 85-3273-10
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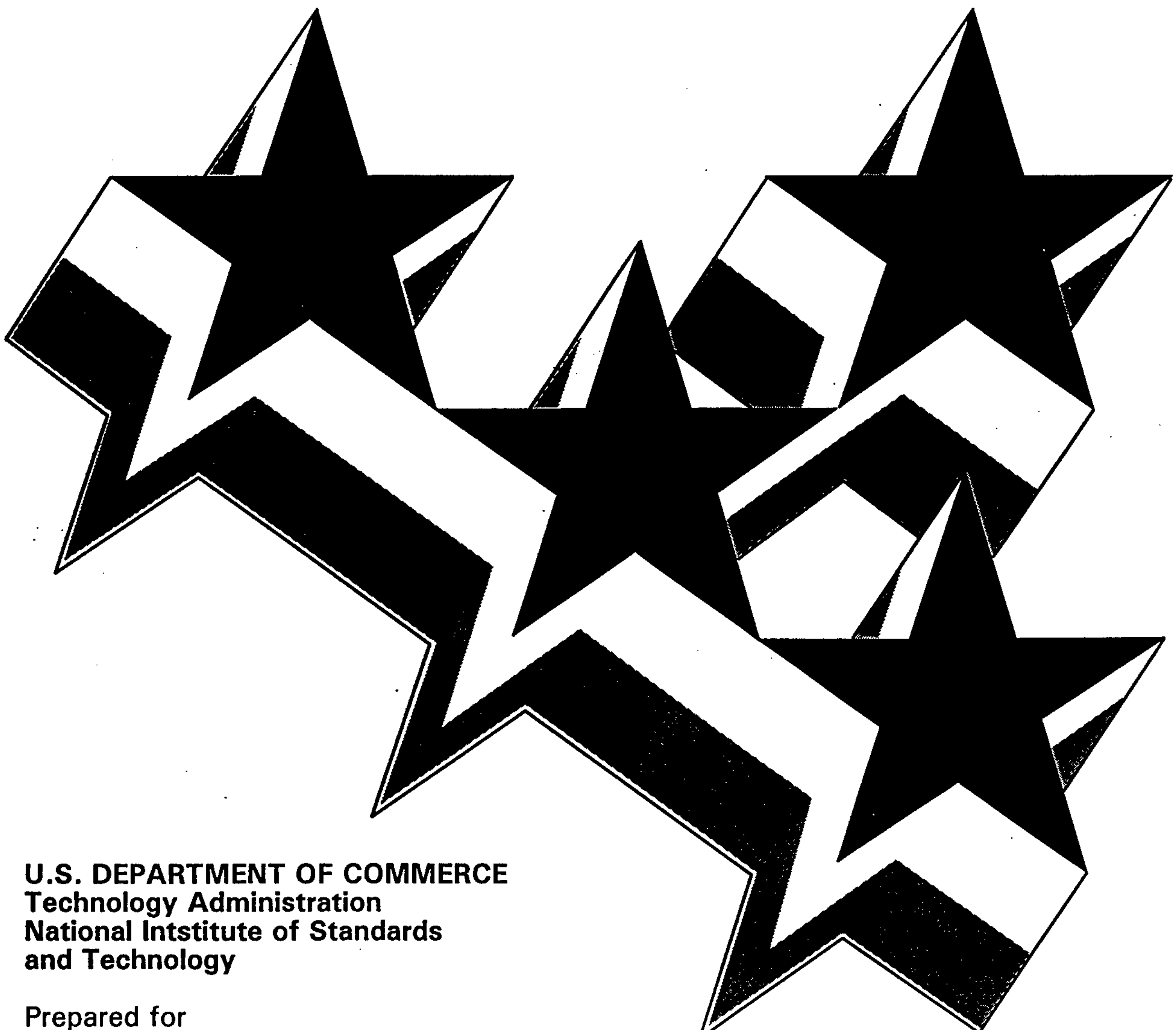
Energy Price Indices and Discount Factors for Life-Cycle Cost Analysis 1996

Annual Supplement to
NIST Handbook 135 and
NBS Special Publication 709

Stephen R. Petersen



U.S. DEPARTMENT OF COMMERCE
Technology Administration
National Intstitute of Standards and Technology

Prepared for
United States Department of Energy
Federal Energy Management Program

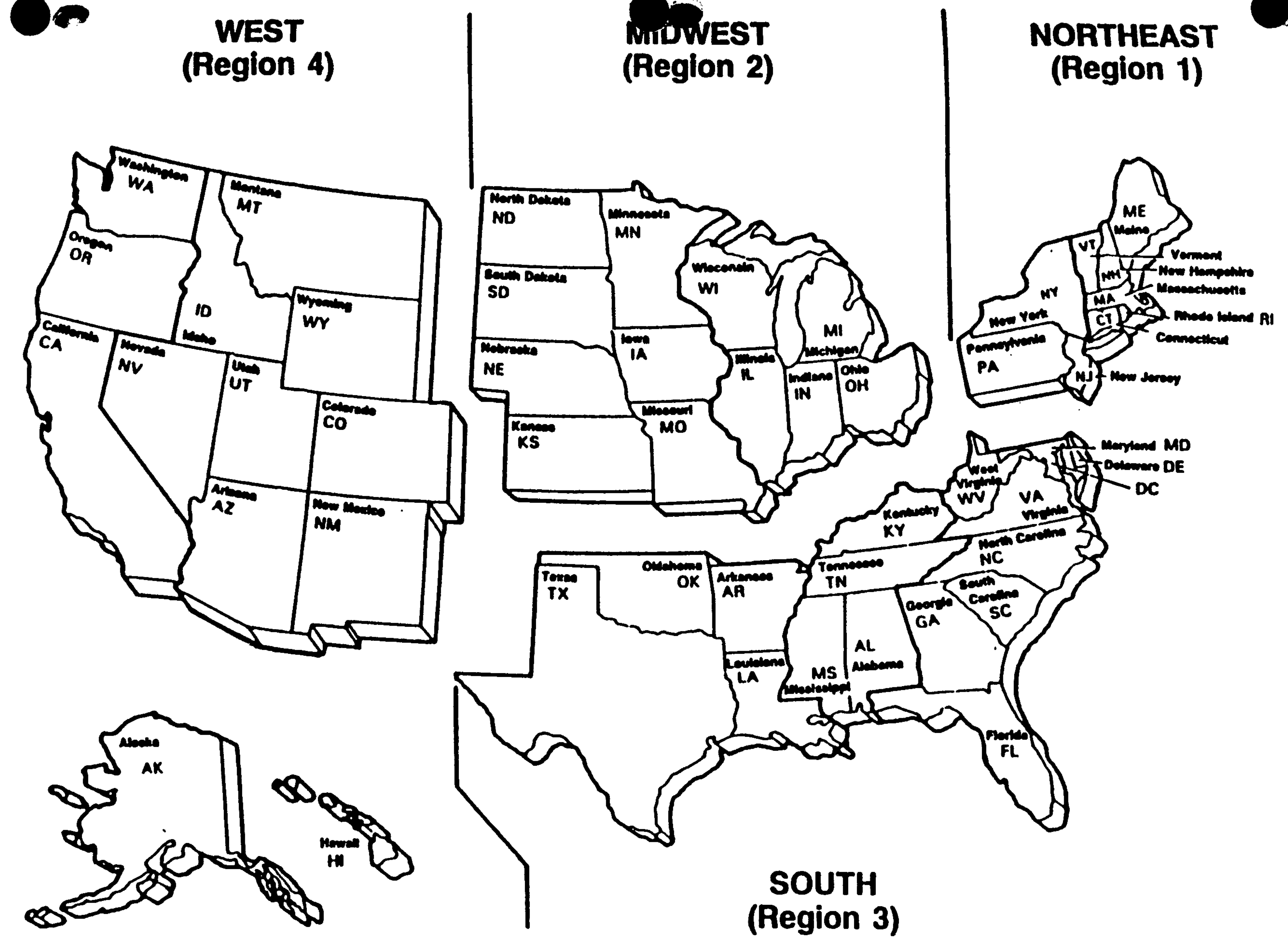
October 1995

Table Ba-1. FEMP UPV* Discount Factors adjusted for fuel price escalation, by end-use sector and fuel type.[a]
Discount rate = 4.1 percent (DOE)

Census Region 1 (Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont)

	RESIDENTIAL				COMMERCIAL					INDUSTRIAL					TRANSPORT	
N	ELEC	DIST	LPG	NTGAS	ELEC	DIST	RESID	NTGAS	COAL	ELEC	DIST	RESID	NTGAS	COAL	GASLN	N
-	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-
1	0.96	1.00	0.98	0.95	0.95	1.01	0.99	0.95	0.96	0.95	1.01	0.99	0.95	0.97	0.99	1
2	1.88	1.99	1.95	1.86	1.87	2.03	1.97	1.86	1.88	1.87	2.04	1.97	1.88	1.90	1.98	2
3	2.77	2.96	2.89	2.74	2.76	3.04	2.94	2.74	2.77	2.76	3.05	2.94	2.80	2.79	2.96	3
4	3.63	3.91	3.80	3.59	3.62	4.02	3.89	3.60	3.62	3.61	4.04	3.90	3.71	3.63	3.91	4
5	4.45	4.83	4.69	4.43	4.44	4.99	4.83	4.46	4.41	4.44	5.01	4.85	4.63	4.44	4.84	5
6	5.25	5.73	5.56	5.26	5.24	5.93	5.77	5.31	5.15	5.23	5.95	5.79	5.57	5.21	5.75	6
7	6.02	6.60	6.39	6.06	6.00	6.84	6.70	6.14	5.87	6.00	6.88	6.72	6.49	5.96	6.62	7
8	6.77	7.45	7.20	6.85	6.75	7.74	7.60	6.95	6.56	6.74	7.78	7.64	7.42	6.67	7.48	8
9	7.49	8.27	7.98	7.62	7.46	8.62	8.50	7.75	7.22	7.46	8.66	8.54	8.34	7.36	8.30	9
10	8.20	9.08	8.74	8.37	8.15	9.48	9.37	8.54	7.86	8.15	9.53	9.42	9.26	8.03	9.10	10
11	8.87	9.86	9.48	9.09	8.81	10.31	10.23	9.30	8.47	8.81	10.37	10.29	10.16	8.67	9.87	11
12	9.53	10.62	10.19	9.79	9.45	11.13	11.07	10.04	9.07	9.46	11.19	11.14	11.03	9.29	10.61	12
13	10.18	11.36	10.88	10.47	10.08	11.92	11.90	10.75	9.67	10.08	11.99	11.97	11.89	9.89	11.32	13
14	10.80	12.07	11.55	11.11	10.68	12.69	12.72	11.43	10.25	10.68	12.77	12.80	12.72	10.47	12.01	14
15	11.40	12.77	12.20	11.73	11.27	13.44	13.52	12.08	10.80	11.27	13.52	13.61	13.52	11.04	12.67	15
16	11.98	13.44	12.82	12.33	11.83	14.17	14.30	12.72	11.33	11.83	14.26	14.40	14.29	11.58	13.31	16
17	12.54	14.09	13.43	12.91	12.37	14.88	15.06	13.33	11.84	12.37	14.97	15.17	15.04	12.10	13.93	17
18	13.08	14.72	14.01	13.46	12.88	15.56	15.81	13.91	12.33	12.89	15.67	15.92	15.76	12.61	14.53	18
19	13.60	15.33	14.57	14.00	13.38	16.23	16.54	14.48	12.80	13.38	16.34	16.66	16.46	13.09	15.11	19
20	14.10	15.92	15.12	14.51	13.85	16.88	17.25	15.03	13.26	13.86	16.99	17.38	17.14	13.56	15.66	20
21	14.59	16.49	15.64	15.01	14.31	17.50	17.95	15.56	13.69	14.32	17.62	18.09	17.80	14.01	16.20	21
22	15.05	17.04	16.14	15.49	14.75	18.11	18.63	16.07	14.11	14.76	18.24	18.78	18.43	14.44	16.73	22
23	15.50	17.58	16.63	15.96	15.17	18.70	19.29	16.56	14.51	15.19	18.83	19.45	19.04	14.85	17.23	23
24	15.93	18.10	17.10	16.40	15.58	19.27	19.93	17.04	14.90	15.60	19.41	20.10	19.64	15.25	17.71	24
25	16.35	18.60	17.55	16.83	15.96	19.82	20.56	17.50	15.27	15.99	19.96	20.73	20.21	15.64	18.18	25
26/a	16.75	19.08	17.99	17.25	16.34	20.35	21.16	17.94	15.62	16.37	20.50	21.35	20.77	16.01	18.64	26
27/a	17.14	19.54	18.41	17.65	16.69	20.86	21.75	18.37	15.96	16.73	21.02	21.95	21.31	16.37	19.07	27
28/a	17.51	19.99	18.81	18.04	17.04	21.36	22.33	18.79	16.29	17.08	21.53	22.53	21.83	16.71	19.49	28
29/a	17.87	20.43	19.20	18.41	17.37	21.84	22.88	19.19	16.61	17.41	22.01	23.09	22.33	17.04	19.90	29
30/a	18.22	20.84	19.57	18.78	17.68	22.31	23.42	19.57	16.91	17.73	22.48	23.64	22.82	17.36	20.29	30

[a] UPV* factors are reported for years 26-30 to accommodate a planning/construction period of up to 5 years. (See p. 6 for instructions on use.)



Source: U.S. Bureau of the Census

Figure B-1. Map of the United States Showing Census Regions.

Table A-2. UPV factors for finding the present value of future annually recurring uniform costs (non-fuel)

Number of years from base date	Uniform Present Value (UPV) Factors		
	DOE Discount rate 4.1%	OMB Discount Rates[a] Short term[b] 4.6%	Long Term[c] 4.9%
1	0.96	0.96	0.95
2	1.88	1.87	1.86
3	2.77	2.74	2.73
4	3.62	3.58	3.55
5	4.44	4.38	4.34
6	5.23	5.14	5.09
7	5.98	5.87	5.81
8	6.71	6.57	6.49
9	7.40	7.24	7.14
10	8.07	7.87	7.76
11	8.71		8.35
12	9.33		8.91
13	9.92		9.45
14	10.49		9.96
15	11.04		10.45
16	11.57		10.92
17	12.07		11.36
18	12.56		11.78
19	13.02		12.18
20	13.47		12.57
21	13.90		12.93
22	14.31		13.28
23	14.71		13.62
24	15.09		13.93
25	15.46		14.24
26	15.81		14.52
27	16.15		14.80
28	16.47		15.06
29	16.78		15,31
30	17.08		15.55

[a] OMB discount rates as of January 1995. OMB rates are expected to be revised in January 1996.

[b] Short-term discount rate based on OMB discount rate for 7-year study period.

[c] Long-term discount rate based on OMB discount rate for 30-year study period.

Table A-1. SPV factors for finding the present value of future single costs (non-fuel)

Number of years from base date	Single Present Value (SPV) Factors: DOE Discount rate 4.1%	OMB Discount Rates[a]: Short term[b] 4.6%	OMB Discount Rates[a]: Long Term[c] 4.9%
0.25	0.990	0.989	0.988
0.50	0.980	0.978	0.976
0.75	0.970	0.967	0.965
1	0.961	0.956	0.953
2	0.923	0.914	0.909
3	0.886	0.874	0.866
4	0.852	0.835	0.826
5	0.818	0.799	0.787
6	0.786	0.764	0.750
7	0.755	0.730	0.715
8	0.725	0.698	0.682
9	0.697	0.667	0.650
10	0.669	0.638	0.620
11	0.643		0.591
12	0.617		0.563
13	0.593		0.537
14	0.570		0.512
15	0.547		0.488
16	0.526		0.465
17	0.505		0.443
18	0.485		0.423
19	0.466		0.403
20	0.448		0.384
21	0.430		0.366
22	0.413		0.349
23	0.397		0.333
24	0.381		0.317
25	0.366		0.302
26	0.352		0.288
27	0.338		0.275
28	0.325		0.262
29	0.312		0.250
30	0.300		0.238

[a] OMB discount rates as of January 1995. OMB rates are expected to be revised in January 1996.
[b] Short-term discount rate based on OMB discount rate for 7-year study period.
[c] Long-term discount rate based on OMB discount rate for 30-year study period.

1. COMPONENT ARMY	FY 1996 MILITARY CONSTRUCTION PROJECT DATA	2. DATE Apr-96

3. INSTALLATION AND LOCATION Ft. Drum; Watertown, NY	4. PROJECT TITLE Various Water Distribution Projects

5. PROGRAM ELEMENT	6. CATEGORY CODE	7. PROJECT NUMBER	8. PROJECT COST ($000)

9. COST ESTIMATES

ITEM	U/M	QUANTITY	UNIT COST	COST
FEMP: Repair Discovered Leaks	LS			$35,221
FEMP: Implement Leak Detection Program	LS			26,000
FEMP: Connect Valve Pit Actuators to Improve Stagnation	LS			2,899
FEMP: Reconnect Isolated Main Line to Improve Stagnation	LS			10,119
TOTAL CONTRACT COST				74,239
SIOH (6%)				4,454
DESIGN COST (6%)				4,454
TOTAL PROJECT COST				83,148
TOTAL REQUEST (ROUNDED)				84,000

10. DESCRIPTION OF PROPOSED CONSTRUCTION

This project consists of the following separate tasks proposed for the water distribution system at Ft. Drum:

- Repair seventeen leaks discovered by a leak detection survey performed on the water distribution piping system. These leaks consist of one main line leaks, two service line leaks, one valve leak, and thirteen fire hydrant leaks. The total leakage savings that can be claimed by repairing these leaks was estimated at 169,000 gallons per day (61,685,000 gallons per year).
- Implement a water audit and leak detection program for approximately 130 miles of water distribution piping.
- Provide labor hours to connect existing water valve actuators to the telemetry system. Automatic control of valves connecting the old and new Posts will allow for improved circulation, thus alleviating stagnation problems which occur in areas of the old Post.
- Approximately 1,200 LF of a 12" main line located in Area 1000 of the old Post is isolated from the water distribution system. Reinstatement of this line will allow for improved water circulation in the system.

11. REQUIREMENT:

Project: This Federal Energy Management Program (FEMP) project will:

- Repair seventeen water distribution leaks discovered during a leak detection survey performed in November 1995.
- Implement a leak detection program for the water distribution system at Ft. Drum.
- Connect existing valve pit actuators to the telemetry system to improve stagnation problems in the western end of the old Post.
- Reconnect an isolated 12" water main line in Area 1000 to improve water circulation in the old Post.

Requirement: This project is required to reduce water distribution leakage and use at Ft. Drum. A reduction of leakage and use in the water distribution system would result in immediate energy and maintenance savings.

Current Situation: Ft. Drum pumps approximately 709,300,000 gallons of water per year into the water distribution system. Water is currently lost in the form of leakage or manual release from fire hydrants to improve stagnation problems. Water is lost in the following forms:

- A leak detection survey has revealed that about 61,685,000 gallons of water (8.7% of total usage) is currently being lost in the form of leakage. The estimated leakage quantity is made up of one main line leak (46,625,000 gallons per year), two service line leaks (10,585,000 gallons per year), one valve leak (730,000 gallons per year), and thirteen hydrant leaks (4,745,000 gallons per year).

1. COMPONENT ARMY	FY 1996 MILITARY CONSTRUCTION PROJECT DATA	2. DATE Apr-96
3. INSTALLATION AND LOCATION Ft. Drum; Watertown, NY		
4. PROJECT TITLE Various Water Distribution Projects		5. PROJECT NUMBER

Current Situation: (cont.)

- A water audit has calculated that about 62,620,615 gallons per year is in the form of leakage that can be recovered. This matches well with the amount of actual leakage uncovered during the leak detection survey.
- It was estimated that 396,000 gallons per year are annually released from hydrants to improve stagnation problems in the western end of the old Post.
- It was estimated that 132,000 gallons per year are annually released from hydrants to improve stagnation problems in Area 1000 of the old Post.

Impact If Not Provided: Failure to implement this project will cause Ft. Drum to not realize a $73,618 annual savings with a 1.13 year simple payback and a savings-to-investment ratio of 11.94.

Supporting Documentation: Results of the leak detection survey and water audit, as well as basic engineering calculations which present energy and cost savings are documented in a report under COE Contract No. DACA01-94-D-0033, performed by an A/E firm in FY96.

Verification of Savings: Detailed annual water production and maintenance costs are recorded by Ft. Drum. The production rate of water at Ft. Drum is recorded from an existing telemetry system. These meters are able to collect various data from the water distribution system in increments as short as every five minutes. Historic data was obtained for the period of October 1993 through September 1995 as a basis for the report mentioned above. Annual water production and maintenance costs, as well as the quantity of water produced for the period after the projects are implemented, can be compared to historical data. Assuming that water demand at Ft. Drum will remain fairly constant, the amount of water saved in repairing the leakage and reducing use should be the difference.

Amount of Water Conserved: The amount of water conserved is estimated to be 124,834,000 gallons per year.

ECONOMIC ANALYSIS: REPAIR DISCOVERED LEAKS

A leak detection survey was performed on water distribution piping during November 1995 at Ft. Drum, New York. By the direction of Ft. Drum personnel, a total of 130 miles of piping was surveyed. The water surveyor used a combination of listening devices and preamplified-transducer systems to identify and locate the majority of leaks.

Seventeen leaks were located during the survey. Some nonvisible leaks were excavated and inspected. Leakage quantities were estimated by the technician based on the size of the leak, size of the pipe, pressure in the pipe and measurement techniques recommended by the American Water Works Association (AWWA). The total estimated leakage quantity of 169,000 gallons per day was comprised of the following:

- One main line leak estimated at 125,000 gallons per day
- Two service line leak estimated at 29,000 gallons per day
- One valve leak estimated at 2,000 gallons per day
- Thirteen fire hydrant leaks estimated at 13,000 gallons per day

A detailed list of the leaks discovered by the leak detection survey can be found on page 7 of this report.

The cost savings associated with repairing the leakage was calculated. The total cost savings equals the quantity of water saved by repairing the discovered leakage multiplied by the cost of water per gallon. The cost of water at Ft. Drum is a combination of several factors:

- **Ft. Drum Well Electrical Charges.** Ft. Drum utilizes eleven wells with electrical motors ranging in size from 15 to 40 horsepower. These wells collectively operate for an average of 16,515 hours per year. Based on a total annual water production of 180,282,960 gallons, the total electrical cost of the water produced from the wells is **$0.097 per thousand gallons**.

1. COMPONENT ARMY	FY 1996 MILITARY CONSTRUCTION PROJECT DATA	2. DATE Apr-96
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ECONOMIC ANALYSIS (cont.)

- **Ft. Drum Operation & Maintenance (O&M) Costs.** These costs include the labor costs associated with operating and maintaining the water distribution system and the water treatment plant, and includes chemical treatment costs. The annual costs for O&M, provided by Ft. Drum personnel, was divided by the total quantity of water produced for Ft. Drum to obtain an O&M cost of **$0.031 per thousand gallons**.
- **Ground Reservoir Pump Electrical Costs.** There are two pumps which serve a 750,000 gallon ground reservoir. One pump, 40 hp, is used to circulate water through the reservoir. The other pump, 75 hp, is necessary to maintain water volume in the reservoir in case of excessive demand. The cost was calculated by taking the total annual energy consumption costs for these pumps divided by the total annual water production. Annual energy consumption was calculated based on pump operating schedules and electrical rate data provided by Ft. Drum personnel. Water consumption was based on telemetry data provided by Ft. Drum personnel. The electrical cost was calculated to be **$0.067 per thousand gallons**.
- **Development of the North Country (DANC) Costs.** Ft. Drum contractually pays for a minimum 1.5 mgd of water from the DANC. The cost of the water is comprised of fixed and variable costs incurred by the DANC and the City of Watertown. The fixed costs are the capital costs incurred to build the pipeline from the City of Watertown to Ft. Drum, as well as a water booster station, which is located in the old Post. Variable costs include those costs which vary according to the amount of water produced, such as operation, maintenance and overhead charges. It was assumed that any water savings resulting from implementation of the ECOs would only result in variable cost savings. Ft. Drum is contractually obligated to pay for the fixed capital costs. Based on variable costs provided by the DANC, the cost of water provided by the DANC is **$0.90 per thousand gallons**.

A detailed cost estimate was performed to determine the cost of repairing the leaks. Costs for necessary site work were included with the repair and replacement costs.

A life cycle cost analysis was performed to determine the economic feasibility of repairing the leaks over a 20 year economic life. The economic analysis was based upon the leakage quantities identified by the leak detection survey.

A summary of the life cycle cost analysis, along with a summary of the leaks located by the leak detection survey, is provided in the backup calculations.

ECONOMIC ANALYSIS: IMPLEMENT LEAK DETECTION PROGRAM

A water audit was performed on the water distribution system at Ft. Drum according to the guidelines set by American Water Works Association (AWWA) Manual 36, entitled "Water Audits and Leak Detection". The audit was based on information supplied by Ft. Drum personnel. Water usage at Ft. Drum can be separated into the following categories:

- **Domestic Water Consumption.** The amount of water consumed by all military and civilian occupants of Ft. Drum was estimated. Demographic data, obtained from Ft. Drum personnel, provided the number of people who use and occupy the base. These demographics, taken from the Total Army Quality Self-Assessment (1995), were separated into active duty military and civilian personnel, family members, military retirees, and reserve component personnel. According to guidelines in the Army Technical Manual TM 5-813-1, "Water Supply Sources and General Considerations", the design allowances for water consumption are 150 gallons per day (gpd) per person for residents and 50 gpd for non-residents. Multiplying these design allowances by the number of residents and non-residents produces an estimate of the amount of water consumed for domestic use.

ECONOMIC ANALYSIS (cont.)

- **Metered Water Usage.** Water usage for specific buildings on Post, such as the PX, Commissary, and the steam central plant, is metered. Ft. Drum personnel provided meter data for 15 specific buildings for the past two years. The average water usage over the last two years was used for the water audit. It was assumed for this study that the metered water usage is separate from the domestic water consumption value.
- **Fire Hydrants.** According to Ft. Drum personnel, water is consumed through fire hydrants for two purposes, fire protection and maintenance. Because no specific data was available on the amount of water consumed, estimates for water usage were made based on water requirements provided by Ft. Drum personnel.
- **Once-through Cooling Units.** Domestic water is used for cooling in the condenser units of six HVAC and refrigeration units throughout the Post. The amount of water used by these units was provided by Ft.
- **Irrigation Water.** From mid-May to September, water from the distribution system is used to irrigate the lawns at the headquarters buildings, parade fields, and athletic fields at Ft. Drum. The estimation of the total amount of water consumed was based on estimating the number of sprinkler heads that serve each area, the flow produced by each sprinkler head, and the amount of time required for each sprinkler cycle.
- **Discovered Leaks**. According to Ft. Drum personnel, no documented water main breaks have occurred in the water distribution system over the past two years. Therefore, water loss attributed to discovered water main breaks was assumed to be negligible.

The results of the water audit are given on page 8. The amount of recoverable leakage, which is estimated as 75% of the potential water system leakage, was calculated to be 62,620,615 gallons per year. This value represents approximately 9% of Ft. Drum's total water production.

The total beneficial cost of performing a leak detection survey to recover leakage from the water distribution system was assumed to be only the costs that vary with the amount of water delivered. These include the production, maintenance and energy costs. The cost of leak repair is not included. According to AWWA Manual 36, because leaks are continually discovered and repaired in the normal course of operations, the leaks found in the leak detection program would be repaired eventually. If the leaks are repaired as part of a leak detection program, as is Ft. Drum's policy, the expense of repairing leaks as they are accidentally discovered is avoided. Although some cost savings would be realized in fixing the leaks when they are discovered by a leak detection program, as opposed to discovering them accidentally, AWWA Manual 36 allows the auditor to assume that the savings is negligible.

The total payback of the leak detection program was calculated by dividing the total cost of the leak detection program by the cost savings of recovering leakage. The total cost of the leak detection survey was taken from the average cost of previous leak detection surveys in the region and from cost information provided by AWWA. The cost of leak detection was given as $200 per mile of pipe surveyed. Approximately 130 miles of piping in the water distribution system would need to be investigated.

A summary of the water audit, along with the LCCA, is provided on the following pages.

ECONOMIC ANALYSIS: CONNECT VALVE PIT ACTUATORS

Ft. Drum is currently experiencing problems with stagnating water and low chlorine residuals in the western portion of the old Post (specifically Areas 0, 100, 1100, 4000, and 6000). The stagnation problems are thought to arise from two

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Ft. Drum; Watertown, NY

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ECONOMIC ANALYSIS (cont.)

conditions. The first condition is the decreased flow of water through the old Post. The low water demand has been created from the shift of activity at Ft. Drum from the old Post to the new Post. The lower demand slows the turnover rate of water in the lines in that area, creating stagnated water. Secondly, most of the flow between the Posts occurs through Valve Vault #3, which is attached to a 20" main line on the east side of the old Post. There is an additional valve vault, Vault #4, that is connected to a 16" main line which directs water through the western end of the Post. The electric actuators and control valves have already been installed in the 16" line, but the actuators have not been connected to the telemetry system. The valves in Valve Vault #4 are currently closed, thereby creating a short circuit condition in the flow of water between the Posts, especially along the western end of the old Post. By connecting the actuators to the existing telemetry system, Ft. Drum personnel can automatically alternate or combine water flows through Valve Vaults #3 and #4, thus improving water circulation problems.

The amount of water annually lost for the purpose of improving stagnation in the water distribution system was estimated. The estimate was based on data provided by Ft. Drum personnel as to the number of times that fire hydrants are exercised in the western end of the old Post to improve stagnation problems. The cost of water lost was determined by multiplying the amount of water lost, by the cost of water (per thousand gallons) at Ft. Drum, which was explained previously.

A cost estimate was performed to calculate the cost of implementing this project. The FM and hardware connections required to connect the actuators in Valve Vault #4 to the telemetry system have already been procured. Only labor is required to complete the connection.

A life cycle cost analysis was performed to determine the economic feasibility of implementing this ECO. Cost savings was based upon the estimated quantity of water saved from hydrant exercising each year. A summary of the LCCA is provided on the following pages.

ECONOMIC ANALYSIS: RECONNECT ISOLATED MAIN LINE

Approximately 1,200 LF of a 12" main line located in Area 1000 is isolated from the water distribution system, the result of repair work performed a few years ago. This section of piping is one of six main lines that transport water from the water treatment plant to the old Post. Hydraulic and stagnation problems exist because water is forced through the other mains, thus bypassing the area served directly by this 12" line.

The amount of water annually lost for the purpose of improving stagnation in this particular area was estimated. The estimate was based on data provided by Ft. Drum personnel as to the number of times that fire hydrants are exercised in Area 1000 to improve stagnation problems. The cost of water lost was determined by multiplying the amount of water lost, by the cost of water (per thousand gallons) at Ft. Drum, which was explained previously.

A cost estimate was performed to determine the cost of reinstating the water line back into the distribution system. The estimate included site work and mechanical costs required to connect both ends of the isolated pipe, as well as the cost to connect a fire hydrant to each end to allow for proper flushing of the line.

A life cycle cost analysis was performed to determine the economic feasibility of implementing this ECO. Cost savings was based upon the estimated quantity of water saved from hydrant exercising each year. A summary of the LCCA is provided on the following pages.

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3. INSTALLATION AND LOCATION Ft. Drum, NY		
4. PROJECT TITLE Water Conservation Study		5. PROJECT NUMBER

LIFE CYCLE COST ANALYSIS SUMMARY

ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

LOCATION:	Ft. Drum, NY	REGION: 1 (New York)		PROJECT NO:	1406-012
PROJECT TITLE:	Water Conservation Study			FISCAL YEAR:	1996
ANALYSIS DATE:	05/13/96	ECONOMIC LIFE:	20	PREPARED BY:	TCP

1. INVESTMENT: **ECO #9 - Ft. Drum Water Projects**

A.	CONSTRUCTION COST	=	$74,239	
B.	SIOH COST	(6.0% of 1A) =	$4,454	
C.	DESIGN COST	(6.0% of 1A) =	$4,454	
D.	TOTAL COST	(1A +1B +1C) =	$83,148	
E.	SALVAGE VALUE OF EXISTING EQUIPMENT =		$0	
F.	PUBLIC UTILITY COMPANY REBATE =			
G.	TOTAL INVESTMENT	(1D -1E -1F) =	------->	$83,148

2. ENERGY SAVINGS (+) OR COST (-):

DATE OF NISTR 85-3273-10 USED FOR DISCOUNT FACTORS: OCT 1995

	ENERGY SOURCE	FUEL COST $/KGAL (1)	SAVINGS KGAL/YR (2)	ANNUAL $ SAVINGS (3)	DISCOUNT FACTOR (4)	DISCOUNTED SAVINGS (5)	
A.	ELECTRICAL	$0.025	124,834	$3,121	13.86	$43,255	
B.	DIST	$0.00	0	$0	16.99	$0	
C.	RESID	$0.00	0	$0	17.38	$0	
D.	NAT GAS	$0.00	0	$0	17.14	$0	
E.	COAL	$0.00	0	$0	13.56	$0	
F.	TOTAL		124,834	$3,121		-------->	$43,255

3. NON-ENERGY SAVINGS (+) OR COST (-)

		Unit Cost * 124,834 KGAL		
A.	ANNUAL RECURRING (+/-)			
	1 DANC Variable Savings ($0.67/KGAL)	$83,888	13.47	$1,129,977
	2 Ft. Drum O&M Savings ($0.028/KGAL)	$3,495	13.47	$47,082
	3 Ft Drum Chemical Savings ($0.031/KGAL)	$3,870	13.47	$52,127
	4 Reservoir Savings ($0.067/KGAL)	$8,364	13.47	$112,661
	5 Annual Leak Detection Cost	($29,120)	13.47	($392,246)
	6 TOTAL ANNUAL DISC. SAVINGS (+) / COST (-)	$70,498		$949,602

B. NON-RECURRING (+/-)

ITEM	SAVINGS (+) COST(-) (1)	YEAR OF OCCURRENCE (2)	DISCOUNT FACTOR (3) (TABLE A-2)	DISCOUNTED SAVINGS/ COST (4)
a.				$0
b.				$0
c. TOTAL	$0			$0

C.	TOTAL NON-ENERGY DISCOUNTED SAVINGS (+) OR COST (-)	(3A6 + 3Bc4) =	$949,602
4.	FIRST YEAR DOLLAR SAVINGS (+) / COSTS (-)	(2F3+3A+(3Bc1/Economic Life))	$73,618
5.	SIMPLE PAYBACK (SPB) IN YEARS (MUST BE < 10 YEARS TO QUALIFY)	(1G/4) =	1.13
6.	TOTAL NET DISCOUNTED SAVINGS	(2H5 + 3C) =	$992,857
7.	DISCOUNTED SAVINGS-TO-INVESTMENT RATIO (SIR) (MUST HAVE SIR > 1.25 TO QUALIFY)	(6/1G) =	11.94

1. COMPONENT ARMY	FY 1996 MILITARY CONSTRUCTION PROJECT DATA	2. DATE Apr-96

3. INSTALLATION AND LOCATION
Ft. Drum, NY

4. PROJECT TITLE Water Conservation Study	5. PROJECT NUMBER

DISCOVERED LEAKS AT FT. DRUM

LEAK NO.	TYPE OF LEAK	LOCATION/ DESCRIPTION	SIZE (GPD)	PIPE/VALVE SIZE ADDITIONAL COMMENTS
1-1	Service Line	Building #9224	14,000	
1-2	Fire Hydrant	Memorial Drive at South Entrance to Commissary	1,000	Leak noise quit when hydrant was tightened
2-1	Fire Hydrant	At Building #10270	1,000	Leak noise quit when hydrant was tightened
2-2	Fire Hydrant	Fourth Street East	1,000	Leak noise quit when hydrant was tightened
2-3	Valve	Fourth Street East at 4th Armored Division	2,000	
2-4	Fire Hydrant	Fourth Street East at 4th Armored Division	1,000	Leak noise quit when hydrant was tightened
2-5	Fire Hydrant	Memorial Drive	1,000	Leak noise quit when hydrant was tightened
2-6	Valve	Fourth Street East at Lake Garda Lane	5,000	Leak noise quit when valve was tightened
2-7	Fire Hydrant	Building #10050	1,000	Leak noise quit when hydrant was tightened
2-8	Fire Hydrant	Riva Ridge, North Loop	1,000	Leak noise quit when hydrant was tightened
2-9	Fire Hydrant	Memorial Drive at 45th Infantry Division Drive	1,000	Leak noise quit when hydrant was tightened
2-10	Fire Hydrant	Motor Pool Building #10173	1,000	Leak noise quit when hydrant was tightened
2-11	Fire Hydrant	Memorial Drive at 2nd Street	1,000	Leak noise quit when hydrant was tightened
3-1	Fire Hydrant	Building #4325	1,000	Leak noise quit when hydrant was tightened
3-2	Fire Hydrant	Building #4485	1,000	Leak noise quit when hydrant was tightened
4-1	Fire Hydrant	Rail Road Street at Oswego Avenue	1,000	
4-2	Fire Hydrant	Rail Road Street at Lewis Avenue	1,000	
4-3	Fire Hydrant	Building #T-145	1,000	
4-4	Fire Hydrant	First Street East at Nash Blvd.	1,000	
4-5	Fire Hydrant	Second Street at St. Lawrence Avenue	1,000	
4-6	Fire Hydrant	Second Street at Lewis Avenue	1,000	
4-7	Fire Hydrant	Pine Lane, Building #T-2256	1,000	
5-1	Fire Hydrant	George Street at Cannon Avenue	1,000	
5-2	Fire Hydrant	Cannon Avenue at Delahanty Street	1,000	
5-3	Service Line	Building #T-2315	15,000	1-1/2" service line
5-4	Fire Hydrant	Lewis Avenue, Building #T-1050	1,000	
5-5	Fire Hydrant	Nash Blvd., Building #T-1004	1,000	
5-6	Main Line	Hospital Area, Building #T-2473	125,000	12" main line connected to old 2" service
5-7	Fire Hydrant	Coyler Drive at Dunn Avenue	1,000	
6-1	Fire Hydrant	Airport Access Road, across from Bldg. #2074	1,000	
7-1	Fire Hydrant	Building #8527	1,000	Leak noise quit when hydrant was tightened

LEAK SUMMARY

Leak Type	No. of Leaks	Size (GPD)	Size (KGal/Yr)
Main Line	1	125,000	45,625
Service Line	2	29,000	10,585
Valve	1	2,000	730
Valve (Fixed)	1	5,000	1,825
Fire Hydrant	13	13,000	4,745
Hydrant (Fixed)	13	13,000	4,745
Total Leakage	17	169,000	61,685
Leakage (Fixed)	14	18,000	6,570
Total	31	187,000	68,255

1. COMPONENT ARMY	FY 1996 MILITARY CONSTRUCTION PROJECT DATA	2. DATE Apr-96
3. INSTALLATION AND LOCATION Ft. Drum, NY		
4. PROJECT TITLE Water Conservation Study	5. PROJECT NUMBER	

WATER AUDIT

			Gallons/Year
Total Amount of Water Available (Flow into system minus storage):			709,300,653
Water Uses (From annual average data from 1994-1995 provided by Ft. Drum):			
Domestic Water Consumption:		=	596,420,000
Metered Water Users:		=	17,308,500
Fire Hydrants (Fire Protection):		=	576,000
Fire Hydrants (Maintenance):		=	528,000
Once-through Cooling Units:		=	6,450,000
Landscaping/Irrigation:		=	4,524,000
Total Identified Water Consumed:			625,806,500
Potential Water System Losses:			83,494,153
Recoverable Leakage (AWWA Manual 36 estimates 75% is recoverable):			62,620,615
Cost of Water Supply (per 1000 gallons):			$0.82
One Year Benefit from Recoverable Leakage:			$51,349
Total Cost of Leak Detection Program:	$200 / mile x 130 miles	=	$26,000
Benefit to Cost Ratio:			1.97
Simple Payback (years):			0.51

ENGINEER'S OPINION OF PROBABLE COST

SHEET 1 OF 3

AREA	ACTIVITY	LOCATION	AMENDMENT NO.
		FT. DRUM, NY	

PROJECT TITLE	DESCRIPTION	CONTRACT NO.
WATER CONSERVATION STUDY	FIX ALL LEAKS	DACA01-94-D-0033

Line No.	Item Description	Unit of Measure	Qty.	MATERIAL COST		LABOR COST		EQUIPMENT COST		TOTAL COST	
				Unit Cost	Total	Unit Cost	Total	Unit Cost	Total	Unit Cost	Total
1	**MAIN LINE LEAK REPAIR**										
2	EXCAVATION	CY	24	$0.00	$0	$1.56	$37	$1.58	$38	$3	$75
3	DEWATERING	DAY	1	$0.00	$0	$71.00	$71	$8.05	$8	$79	$79
4	PATCH PIPE LEAK	EA	1	$200.00	$200	$130.00	$130	$0.00	$0	$330	$330
5	CRUSHED ROCK BEDDING	CY	4	$13.00	$52	$3.43	$14	$1.39	$6	$18	$71
6	BACKFILL	CY	20	$0.00	$0	$0.71	$14	$0.58	$12	$1	$26
7	COMPACTION	CY	24	$0.00	$0	$0.86	$21	$0.33	$8	$1	$29
8	**TOTAL - ONE MAIN LEAK**		1		**$252**		**$287**		**$71**		**$610**
9											
10											
11	**SERVICE LINE LEAK REPAIR**										
12	EXCAVATION	CY	18	$0.00	$0	$1.56	$28	$1.58	$28	$3	$57
13	DEWATERING	DAY	1	$0.00	$0	$71.00	$36	$8.05	$4	$79	$40
14	PATCH PIPE LEAK	EA	1	$200.00	$200	$130.00	$130	$0.00	$0	$330	$330
15	CRUSHED ROCK BEDDING	CY	3	$13.00	$39	$3.43	$10	$1.39	$4	$18	$53
16	BACKFILL	CY	15	$0.00	$0	$0.71	$11	$0.58	$9	$1	$19
17	COMPACTION	CY	18	$0.00	$0	$0.86	$15	$0.33	$6	$1	$21
18	**TOTAL - ONE SERVICE LEAK**		1		**$239**		**$230**		**$51**		**$520**
19	**TOTAL - TWO SERVICE LEAKS**		2		**$478**		**$460**		**$103**		**$1,041**
20											
21											
22											
23											
24											

PREPARED BY	APPROVED BY	TITLE OR ORGANIZATION	DATE
TCP		E M C Engineers, Inc.	4/26/96

ENGINEER'S OPINION OF PROBABLE COST

SHEET 2 OF 3

AREA	ACTIVITY	LOCATION	AMENDMENT NO.
		FT. DRUM, NY	

PROJECT TITLE	DESCRIPTION	CONTRACT NO.
WATER CONSERVATION STUDY	FIX ALL LEAKS	DACA01-94-D-0033

Line No.	Item Description	Unit of Measure	Qty.	MATERIAL COST Unit Cost	MATERIAL COST Total	LABOR COST Unit Cost	LABOR COST Total	EQUIPMENT COST Unit Cost	EQUIPMENT COST Total	TOTAL COST Unit Cost	TOTAL COST Total
1	**REPLACE LEAKING VALVE**										
2	EXCAVATION	CY	18	$0.00	$0	$1.56	$28	$1.58	$28	$3.14	$57
3	DEWATERING	DAY	0.5	$0.00	$0	$71.00	$36	$8.05	$4	$79.05	$40
4	VALVE DEMOLITION, TO 8"	EA	1	$0.00	$0	$30.00	$30	$0.00	$0	$30.00	$30
5	GATE VALVE, 04"	EA	1	$270.00	$270	$108.00	$108	$0.00	$0	$378.00	$378
6	CRUSHED ROCK BEDDING	CY	3	$13.00	$39	$3.43	$10	$1.39	$4	$17.82	$53
7	BACKFILL	CY	15	$0.00	$0	$0.71	$11	$0.58	$9	$1.29	$19
8	COMPACTION	CY	18	$0.00	$0	$0.86	$15	$0.33	$6	$1.19	$21
9	**REPAIR VALVE LEAKS**		1		**$309**		**$238**		**$51**		**$598**
10											
11											
12	**HYDRANT REPLACEMENT**										
13	EXCAVATION	CY	24	$0.00	$0	$1.56	$37	$1.58	$38	$3.14	$75
14	HYDRANT DEMOLITION	EA	1	$0.00	$0	$102.00	$102	$0.00	$0	$102.00	$102
15	PIPE REMOVAL, TO 12" DIA.	LF	10	$0.00	$0	$3.43	$34	$1.39	$14	$4.82	$48
16	HYDRANT	EA	1	$1,250.00	$1,250	$129.00	$129	$21.50	$22	$1,400.50	$1,401
17	THRUST BLOCK	CY	1	$81.50	$61	$110.10	$83	$0.00	$0	$191.60	$144
18	BACKFILL	CY	20	$0.00	$0	$0.71	$14	$0.58	$12	$1.29	$26
19	CRUSHED ROCK BEDDING	CY	4	$13.00	$52	$3.43	$14	$1.39	$6	$17.82	$71
20	COMPACTION	CY	24	$0.00	$0	$0.86	$21	$0.33	$8	$1.19	$29
21	**TOTAL - ONE HYDRANT**		1		**$1,363**		**$434**		**$98**		**$1,895**
22	**REPLACE 13 HYDRANTS**		13		**$17,721**		**$5,640**		**$1,279**		**$24,640**
23											
24											

PREPARED BY	APPROVED BY	TITLE OR ORGANIZATION	DATE
TCP		E M C Engineers, Inc.	4/26/96

ENGINEER'S OPINION OF PROBABLE COST

SHEET 3 OF 3

AREA	ACTIVITY	LOCATION	AMENDMENT NO.
		FT. DRUM, NY	

PROJECT TITLE	DESCRIPTION	CONTRACT NO.
WATER CONSERVATION STUDY	FIX ALL LEAKS	DACA01-94-D-0033

Line No.	Item Description	Unit of Measure	Qty.	MATERIAL COST		LABOR COST		EQUIPMENT COST		TOTAL COST	
				Unit Cost	Total	Unit Cost	Total	Unit Cost	Total	Unit Cost	Total
1											
2	**MAIN LINE LEAK REPAIR**	EA	1		$252		$287		$71		$610
3	**SERVICE LINE LEAK REPAIR**	EA	2	$239	$478	$230	$460	$51	$103	$520	$1,041
4	**REPLACE LEAKING VALVE**	EA	1		$309		$238		$51		$598
5	**HYDRANT REPLACEMENT**	EA	13	$1,363	$17,721	$434	$5,640	$98	$1,279	$1,895	$24,640
6											
7											
8											
9											
10											
11											
12											
13											
14											
15											
16											
17	**CONSTRUCTION SUBTOTAL**				$18,760		$6,625		$1,504		$26,889
18	LOCATION FACTOR	%		**81.80%**	$15,345	**111.80%**	$7,407	**100.00%**	$1,504		$24,257
19	OVERHEAD & BOND	%	20		$3,069		$1,481		$301		$4,851
20	SUBTOTAL				$18,414		$8,889		$1,805		$29,108
21	PROFIT	%	10		$1,841		$889		$180		$2,911
22	SUBTOTAL				$20,256		$9,777		$1,985		$32,019
23	CONTINGENCY	%	10		$2,026		$978		$199		$3,202
24	**GRAND TOTAL**				$22,281		$10,755		$2,184		$35,221

PREPARED BY	APPROVED BY	TITLE OR ORGANIZATION	DATE
TCP		E M C Engineers, Inc.	4/26/96

ENGINEER'S OPINION OF PROBABLE COST

SHEET 1 OF 1

AREA	ACTIVITY	LOCATION	AMENDMENT NO.
		FT. DRUM, NY	

PROJECT TITLE	DESCRIPTION	CONTRACT NO.
WATER CONSERVATION STUDY	CONNECT VALVE ACTUATORS	DACA01-94-D-0033

Line No.	Item Description	Unit of Measure	Qty.	MATERIAL COST Unit Cost	MATERIAL COST Total	LABOR COST Unit Cost	LABOR COST Total	EQUIPMENT COST Unit Cost	EQUIPMENT COST Total	TOTAL COST Unit Cost	TOTAL COST Total
1	**CONNECT VALVE ACTUATORS**										
2	LABOR HOURS - TANK 3	HRS	30	$0.00	$0	$29.30	$864	$0.00	$0	$29	$864
3	LABOR HOURS - VALVE PIT #4	HRS	30	$0.00	$0	$29.30	$864	$0.00	$0	$29	$864
4	LABOR HOURS - T-4000 PANEL	HRS	30	$0.00	$0	$29.30	$864	$0.00	$0	$29	$864
5											
6											
7											
8											
9											
10											
11											
12											
13											
14											
15											
16											
17											
18											
19											
20											
21											
22	**CONSTRUCTION SUBTOTAL**		89		$0		$2,593		$0		$2,593
23	LOCATION FACTOR	%		**81.80%**	$0	**111.80%**	$2,899	**100.00%**	$0		$2,899
24	**GRAND TOTAL**				$0		$2,899		$0		$2,899

PREPARED BY	APPROVED BY	TITLE OR ORGANIZATION	DATE
TCP		E M C Engineers, Inc.	4/26/96

ENGINEER'S OPINION OF PROBABLE COST

SHEET 1 OF 2

AREA	ACTIVITY	LOCATION	AMENDMENT NO.
		FT. DRUM, NY	

PROJECT TITLE	DESCRIPTION	CONTRACT NO.
WATER CONSERVATION STUDY	RECONNECT ISOLATED MAIN LINE	DACA01-94-D-0033

Line No.	Item Description	Unit of Measure	Qty.	MATERIAL COST		LABOR COST		EQUIPMENT COST		TOTAL COST	
				Unit Cost	Total	Unit Cost	Total	Unit Cost	Total	Unit Cost	Total
1	**RECONNECT ISOLATED MAIN LINE**										
2	EXCAVATION	CY	24	$0.00	$0	$1.56	$37	$1.58	$38	$3	$75
3	PIPING DEMO, UP TO 12"	LF	5	$0.00	$0	$3.43	$17	$1.39	$7	$5	$24
4	PIPING, 12"	LF	10	$18.50	$185	$9.00	$90	$1.51	$15	$29	$290
5	CRUSHED ROCK BEDDING	CY	4	$13.00	$52	$3.43	$14	$1.39	$6	$18	$71
6	BACKFILL	CY	20	$0.00	$0	$0.71	$14	$0.58	$12	$1	$26
7	COMPACTION	CY	24	$0.00	$0	$0.86	$21	$0.33	$8	$1	$29
8	**TOTAL - ONE MAIN CONNECTION**		1		**$237**		**$193**		**$85**		**$515**
9											
10											
11											
12											
13	**HYDRANT REPLACEMENT**										
14	EXCAVATION	CY	30	$0.00	$0	$1.56	$47	$1.58	$47	$3.14	$94
15	TEE, 12"	EA	1	$258.00	$258	$38.50	$39	$0.00	$0	$296.50	$297
16	PIPING, 06"	LF	20	$8.45	$169	$4.29	$86	$0.00	$0	$12.74	$255
17	GATE VALVE, 06"	EA	1	$450.00	$450	$135.00	$135	$0.00	$0	$585.00	$585
18	HYDRANT	EA	1	$1,250	$1,250	$129.00	$129	$21.50	$22	$1,401	$1,401
19	THRUST BLOCK	CY	3	$81.50	$245	$110.10	$330	$0.00	$0	$191.60	$575
20	BACKFILL	CY	20	$0.00	$0	$0.71	$14	$0.58	$12	$1.29	$26
21	CRUSHED ROCK BEDDING	CY	10	$13.00	$130	$3.43	$34	$1.39	$14	$17.82	$178
22	COMPACTION	CY	30	$0.00	$0	$0.86	$26	$0.33	$10	$1.19	$36
23	**TOTAL - ONE HYDRANT**		1		**$2,502**		**$793**		**$57**		**$3,351**
24											

PREPARED BY	APPROVED BY	TITLE OR ORGANIZATION	DATE
TCP		E M C Engineers, Inc.	4/26/96

ENGINEER'S OPINION OF PROBABLE COST

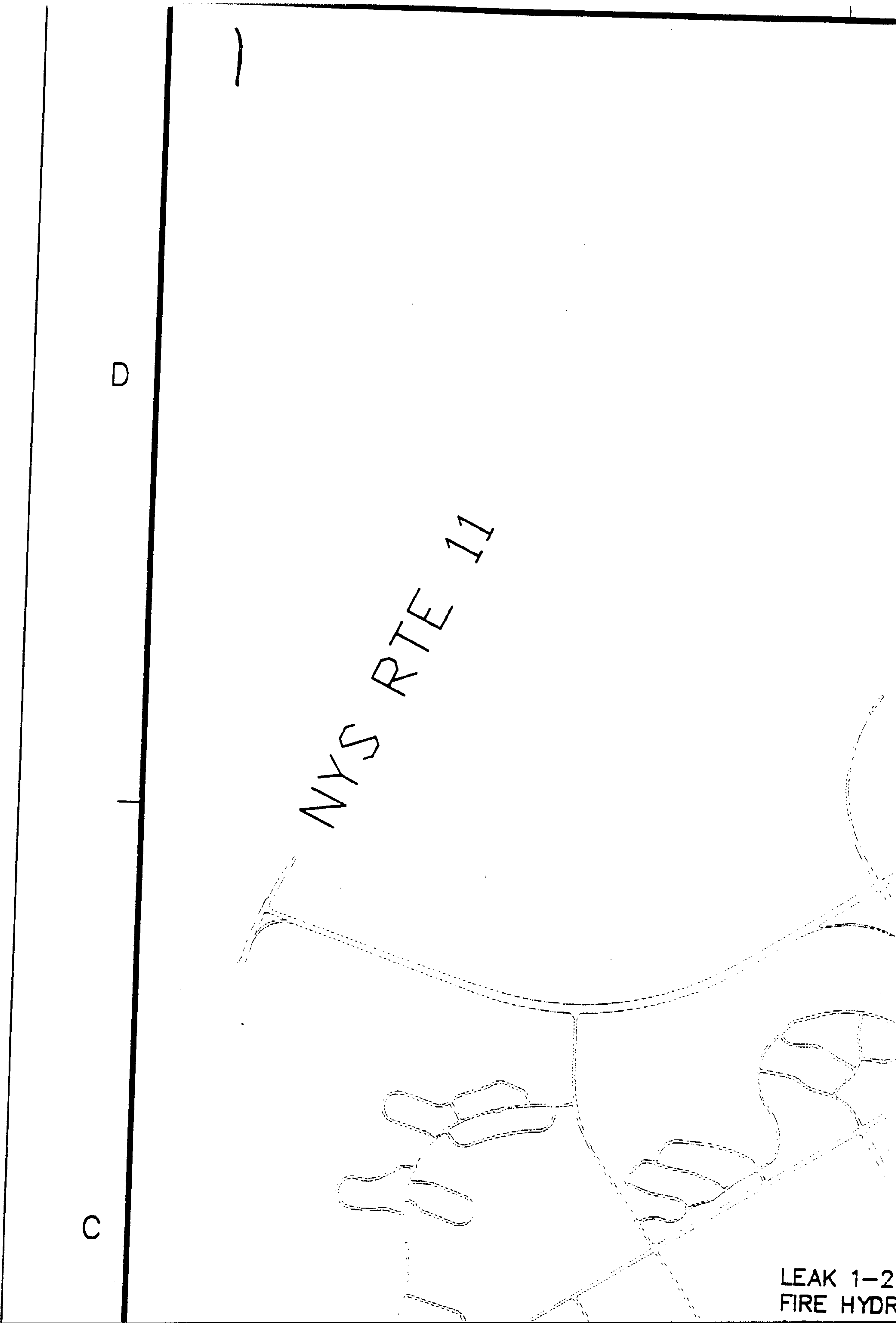
SHEET 2 OF 2

AREA	ACTIVITY	LOCATION	AMENDMENT NO.
		FT. DRUM, NY	

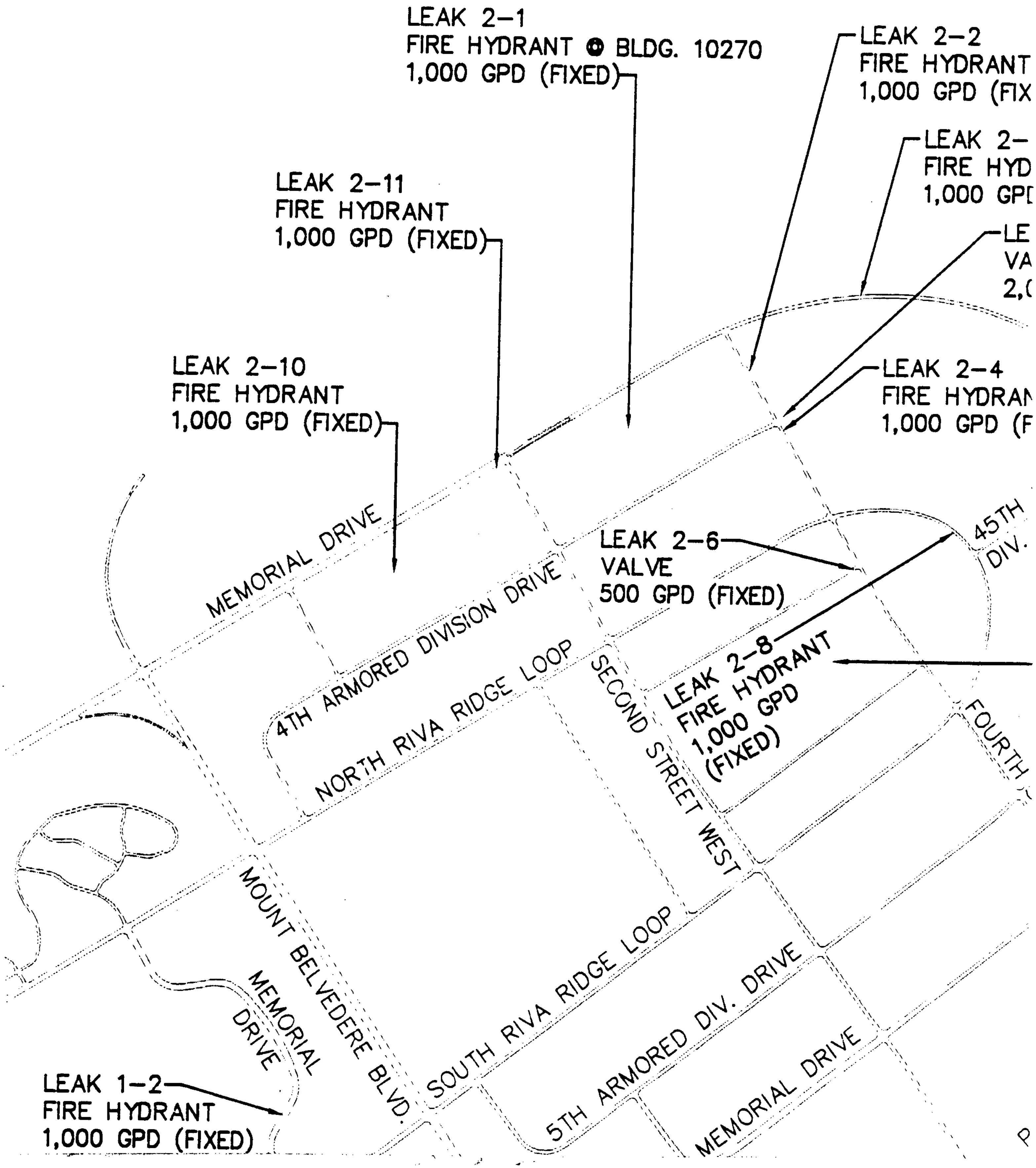
PROJECT TITLE	DESCRIPTION	CONTRACT NO.
WATER CONSERVATION STUDY	RECONNECT ISOLATED MAIN LINE	DACA01-94-D-0033

Line No.	Item Description	Unit of Measure	Qty.	MATERIAL COST Unit Cost	MATERIAL COST Total	LABOR COST Unit Cost	LABOR COST Total	EQUIPMENT COST Unit Cost	EQUIPMENT COST Total	TOTAL COST Unit Cost	TOTAL COST Total
1											
2	**MAIN LINE LEAK REPAIR**	EA	2	$237	$474	$193	$386	$85	$170		$1,030
3	**HYDRANT REPLACEMENT**	EA	2	$2,502	$5,003	$793	$1,586	$57	$114	$1,401	$6,703
4											
5											
6											
7											
8											
9											
10											
11											
12											
13											
14											
15											
16											
17	**CONSTRUCTION SUBTOTAL**				$5,477		$1,972		$284		$7,733
18	LOCATION FACTOR	%		**81.80%**	$4,480	**111.80%**	$2,205	**100.00%**	$284		$6,969
19	OVERHEAD & BOND	%	20		$896		$441		$57		$1,394
20	SUBTOTAL				$5,376		$2,646		$341		$8,363
21	PROFIT	%	10		$538		$265		$34		$836
22	SUBTOTAL				$5,914		$2,910		$375		$9,199
23	CONTINGENCY	%	10		$591		$291		$37		$920
24	**GRAND TOTAL**				$6,505		$3,201		$412		$10,119

PREPARED BY	APPROVED BY	TITLE OR ORGANIZATION	DATE
TCP		E M C Engineers, Inc.	4/26/96

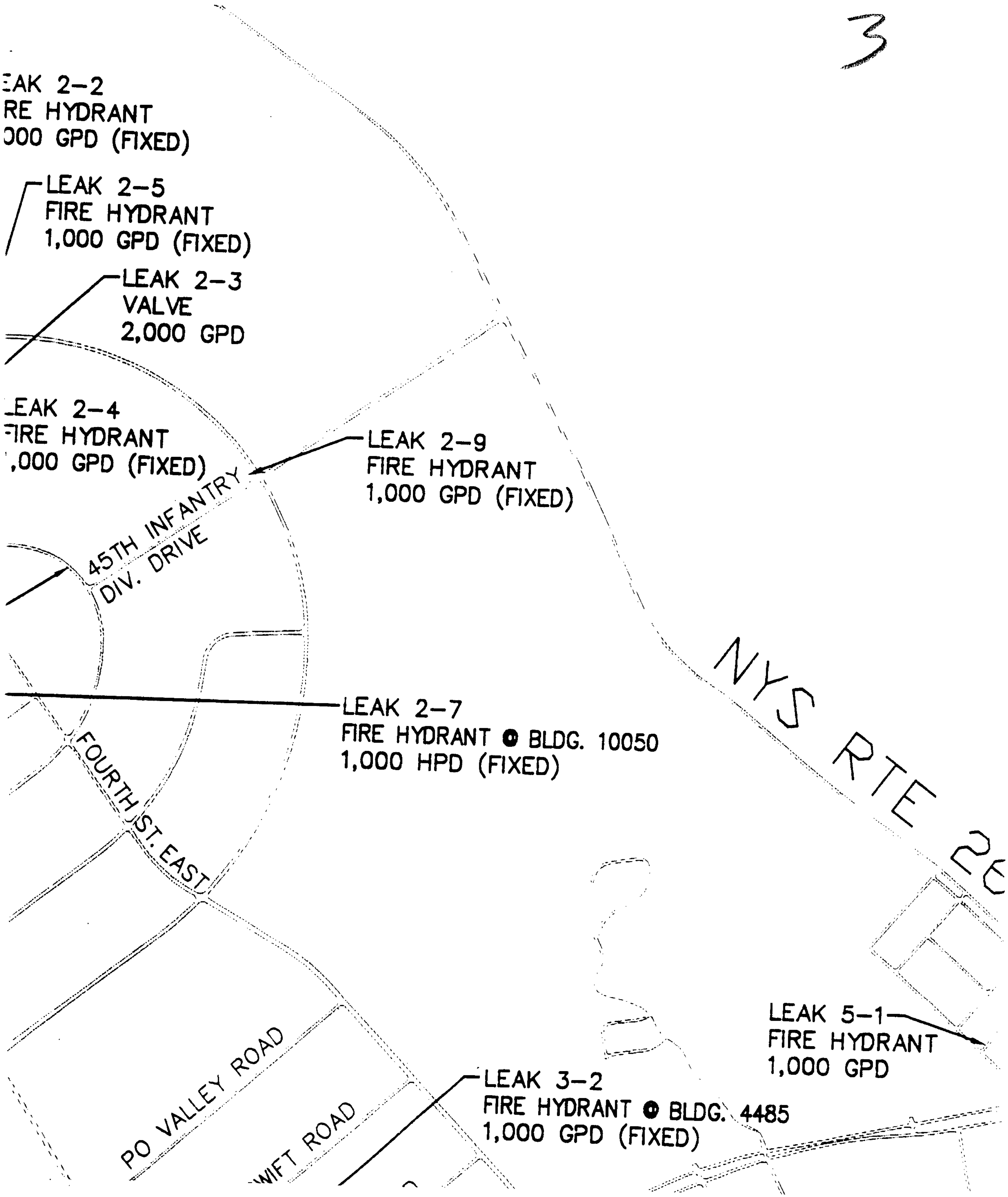

D
NYS RTE 11
C
LEAK 1–2-
FIRE HYDR

2



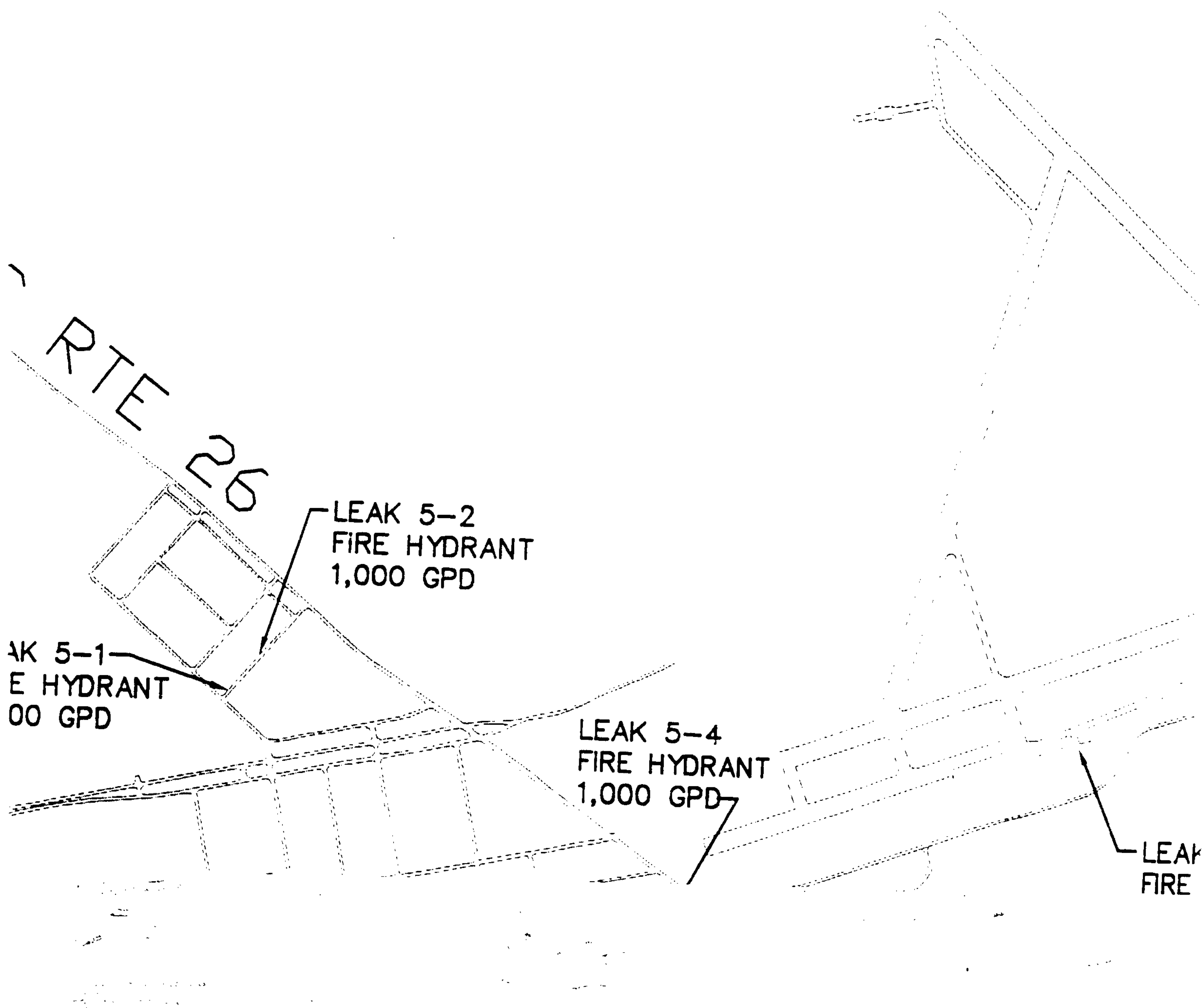
LEAK 2-1
FIRE HYDRANT @ BLDG. 10270
1,000 GPD (FIXED)
LEAK 2-2
FIRE HYDRANT
1,000 GPD (FIX
LEAK 2-
FIRE HYD
1,000 GPI
LEAK 2-11
FIRE HYDRANT
1,000 GPD (FIXED)
LEAK 2-10
FIRE HYDRANT
1,000 GPD (FIXED)
LEAK 2-4
FIRE HYDRAN
1,000 GPD (F
LEAK 2-6
VALVE
500 GPD (FIXED)
LEAK 2-8
FIRE HYDRANT
1,000 GPD
(FIXED)
MEMORIAL DRIVE
4TH ARMORED DIVISION DRIVE
NORTH RIVA RIDGE LOOP
SECOND STREET WEST
45TH DIV.
FOURTH
MOUNT BELVEDERE BLVD.
MEMORIAL DRIVE
SOUTH RIVA RIDGE LOOP
5TH ARMORED DIV. DRIVE
MEMORIAL DRIVE
LEAK 1-2
FIRE HYDRANT
1,000 GPD (FIXED)

3



EAK 2-2
RE HYDRANT
000 GPD (FIXED)
LEAK 2-5
FIRE HYDRANT
1,000 GPD (FIXED)
LEAK 2-3
VALVE
2,000 GPD
EAK 2-4
IRE HYDRANT
,000 GPD (FIXED)
LEAK 2-9
FIRE HYDRANT
1,000 GPD (FIXED)
45TH INFANTRY DIV. DRIVE
NYS RTE 26
LEAK 2-7
FIRE HYDRANT @ BLDG. 10050
1,000 HPD (FIXED)
FOURTH ST. EAST
LEAK 5-1
FIRE HYDRANT
1,000 GPD
PO VALLEY ROAD
WIFT ROAD
LEAK 3-2
FIRE HYDRANT @ BLDG. 4485
1,000 GPD (FIXED)

4



RTE 26
LEAK 5-2
FIRE HYDRANT
1,000 GPD
AK 5-1
E HYDRANT
00 GPD
LEAK 5-4
FIRE HYDRANT
1,000 GPD
FIRE

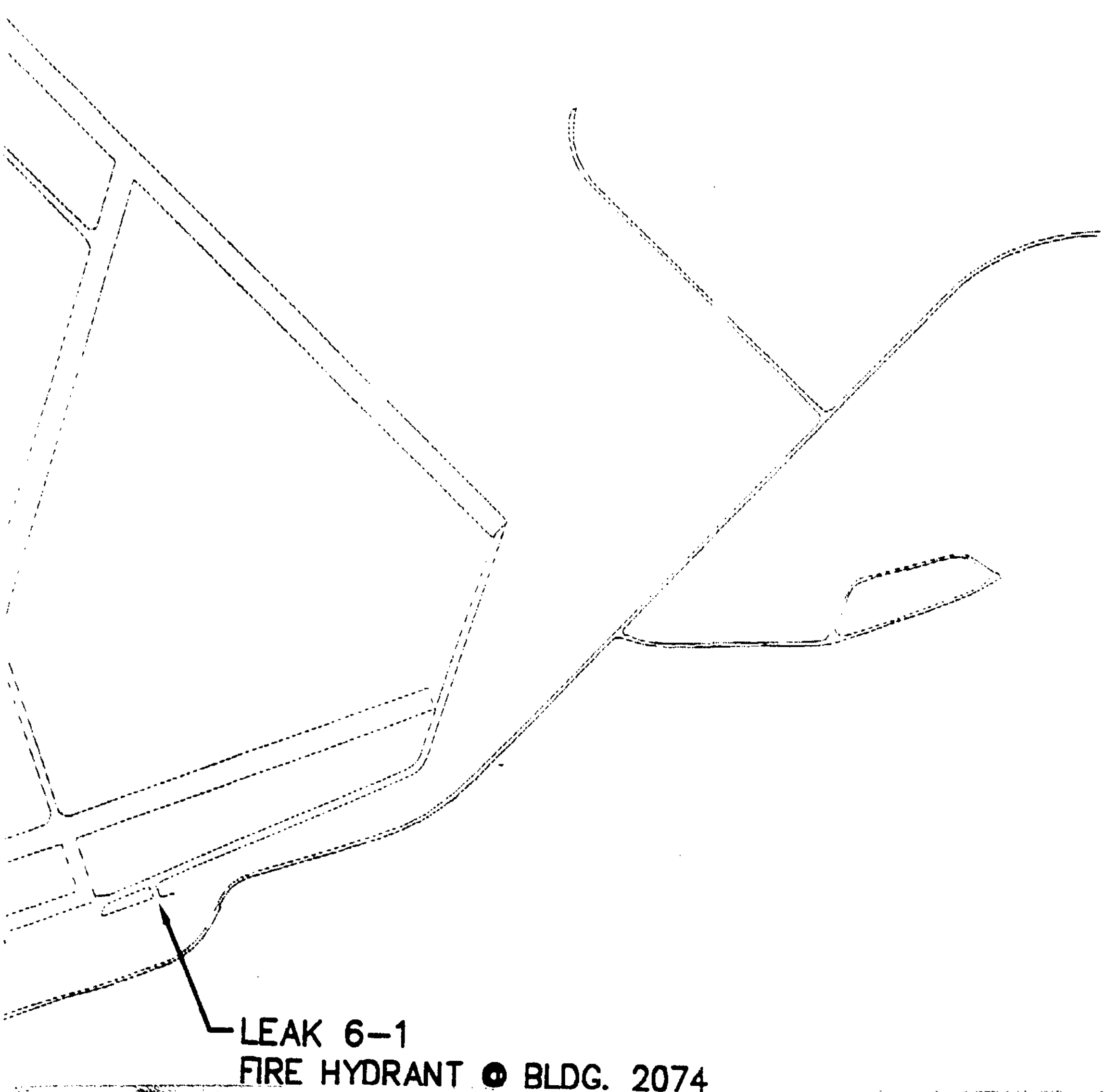
5

NOTES:

1. ROAD DRAWING F

2. FOR MORE SPECI
REFERENCE LEAK
FOR SPECIFIC LE

3. LEAKS MARKED "
WERE STOPPED B
SURVEY BY TIGHT



6

NOTES:

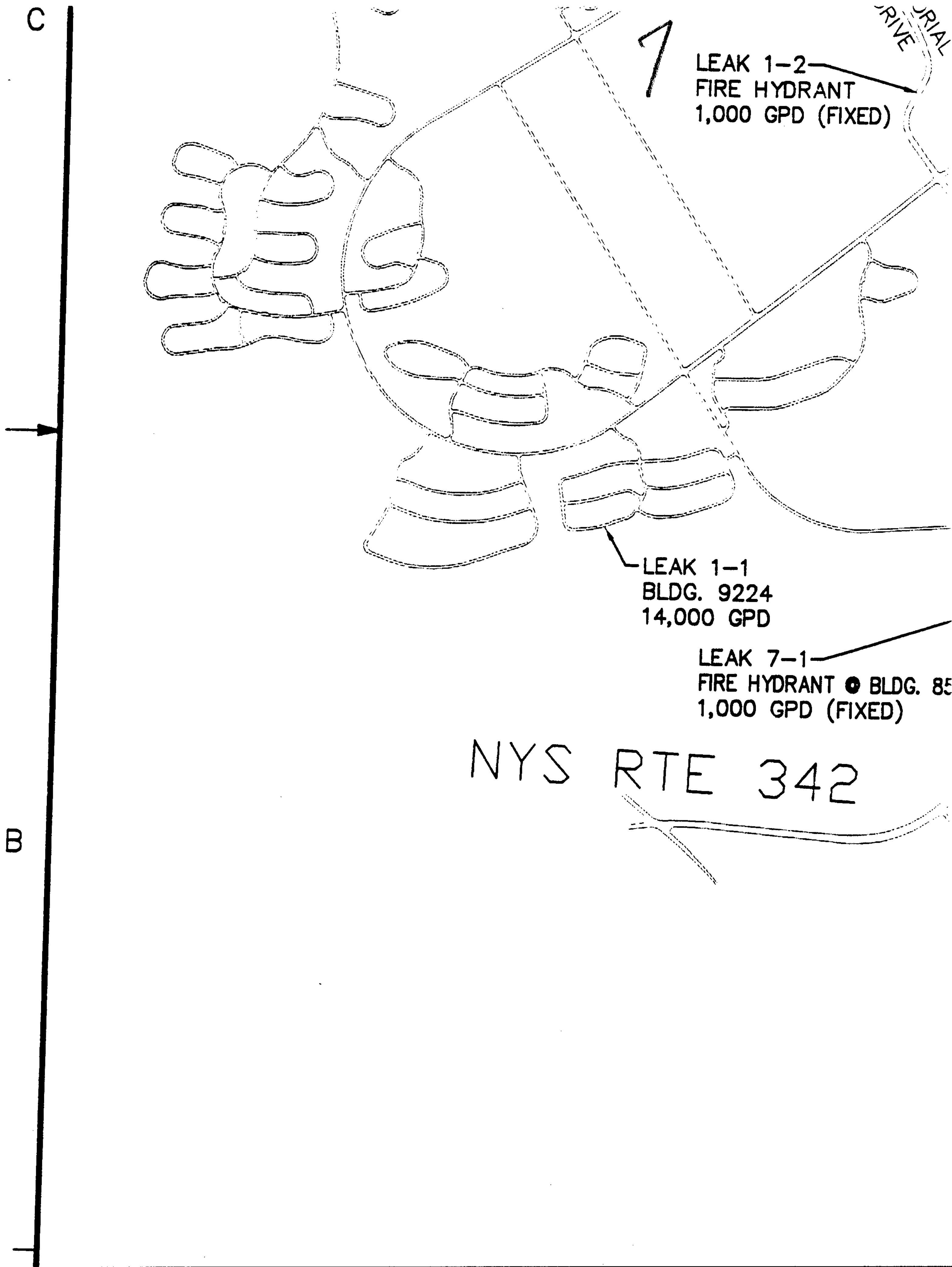
1. ROAD DRAWING FURNISHED BY FT. DRUM

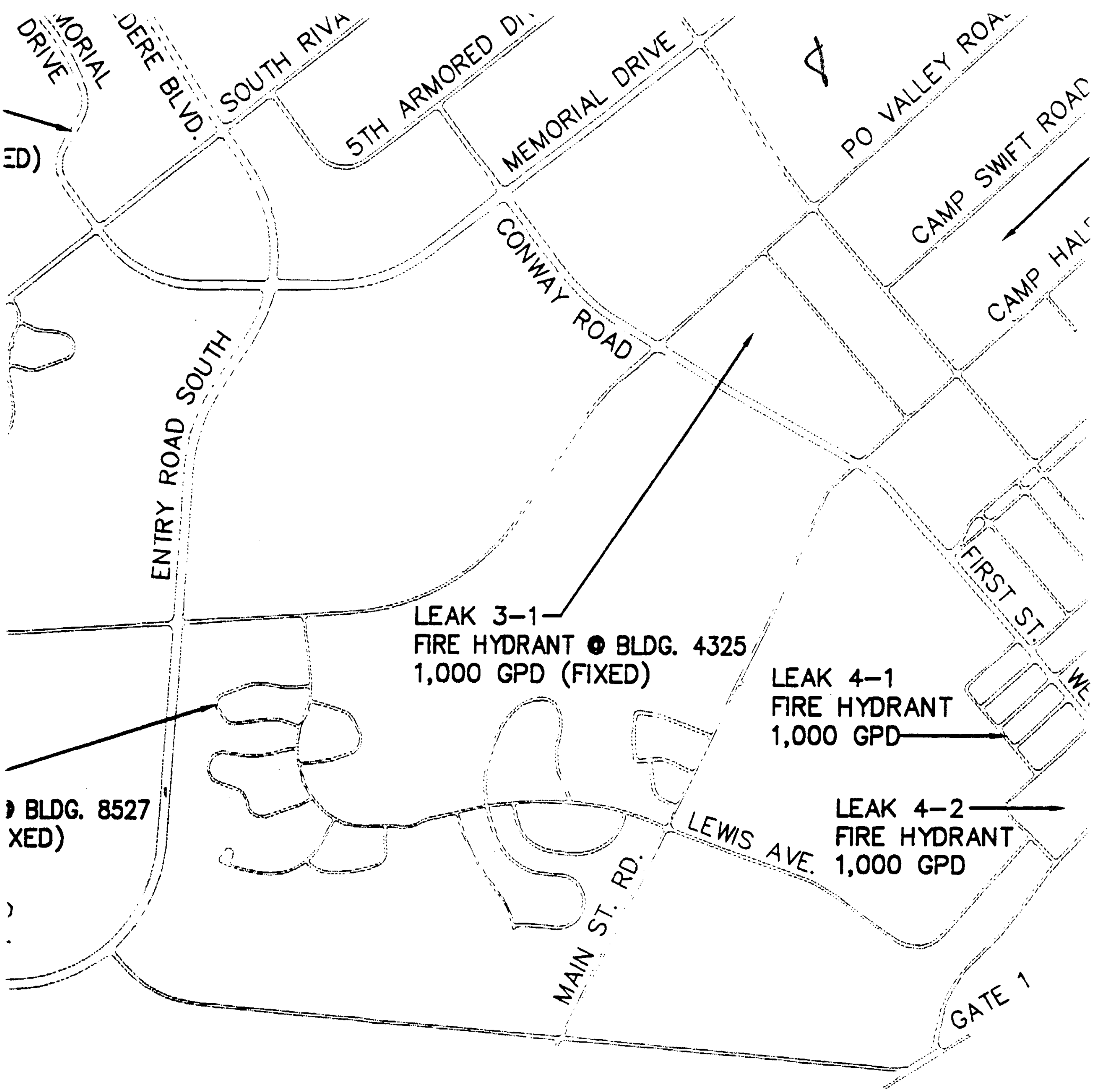
2. FOR MORE SPECIFIC LEAK LOCATION INFORMATION REFERENCE LEAK LOCATION DIAGRAM IN REPORT FOR SPECIFIC LEAK

3. LEAKS MARKED "(FIXED)" REPRESENT LEAKS WHICH WERE STOPPED BY LEAK SURVEY CREW DURING SURVEY BY TIGHTENING HYDRANT OF VALVE.

D

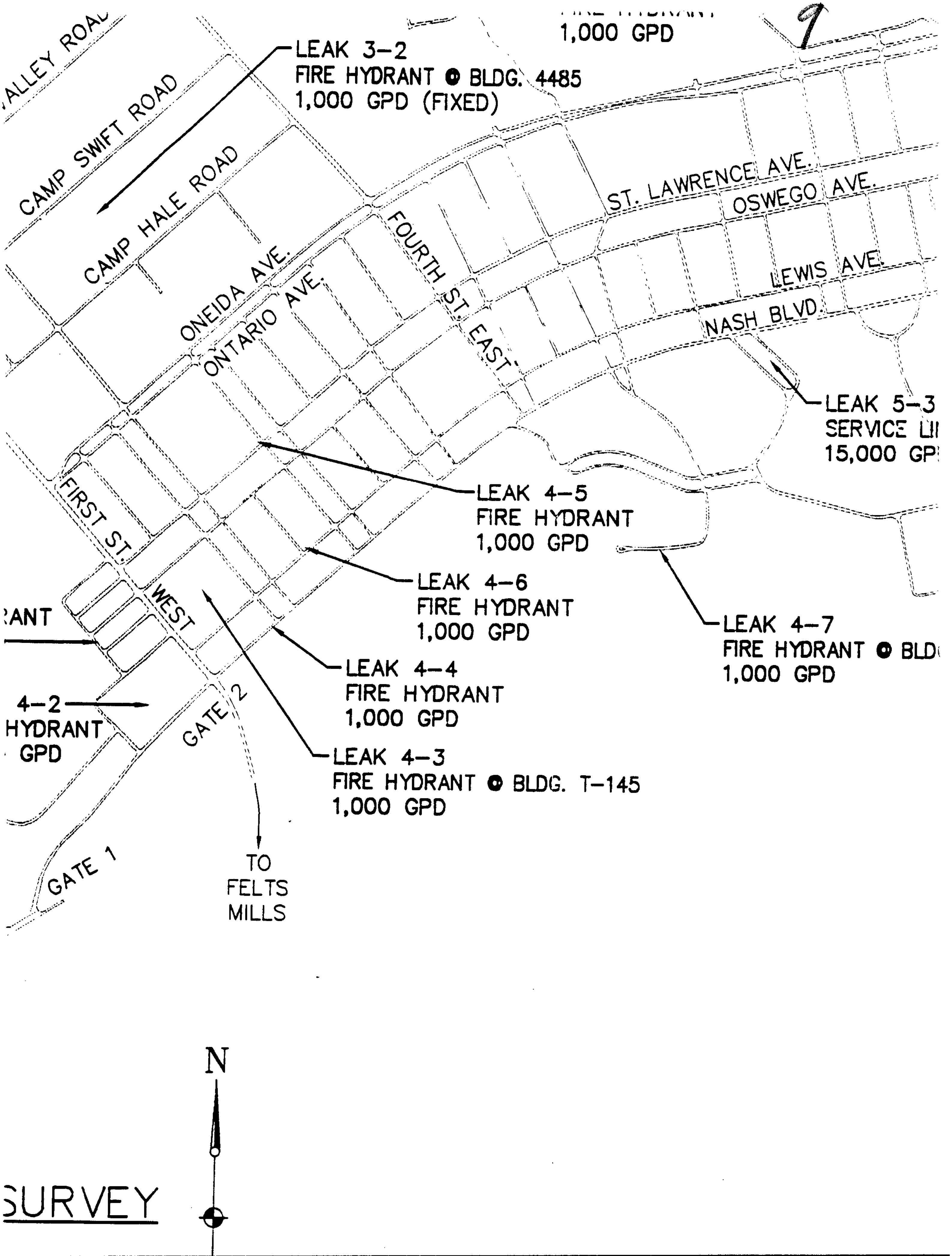
C


C
B
ORIAL
DRIVE
7
LEAK 1-2
FIRE HYDRANT
1,000 GPD (FIXED)
LEAK 1-1
BLDG. 9224
14,000 GPD
LEAK 7-1
FIRE HYDRANT @ BLDG. 85
1,000 GPD (FIXED)
NYS RTE 342



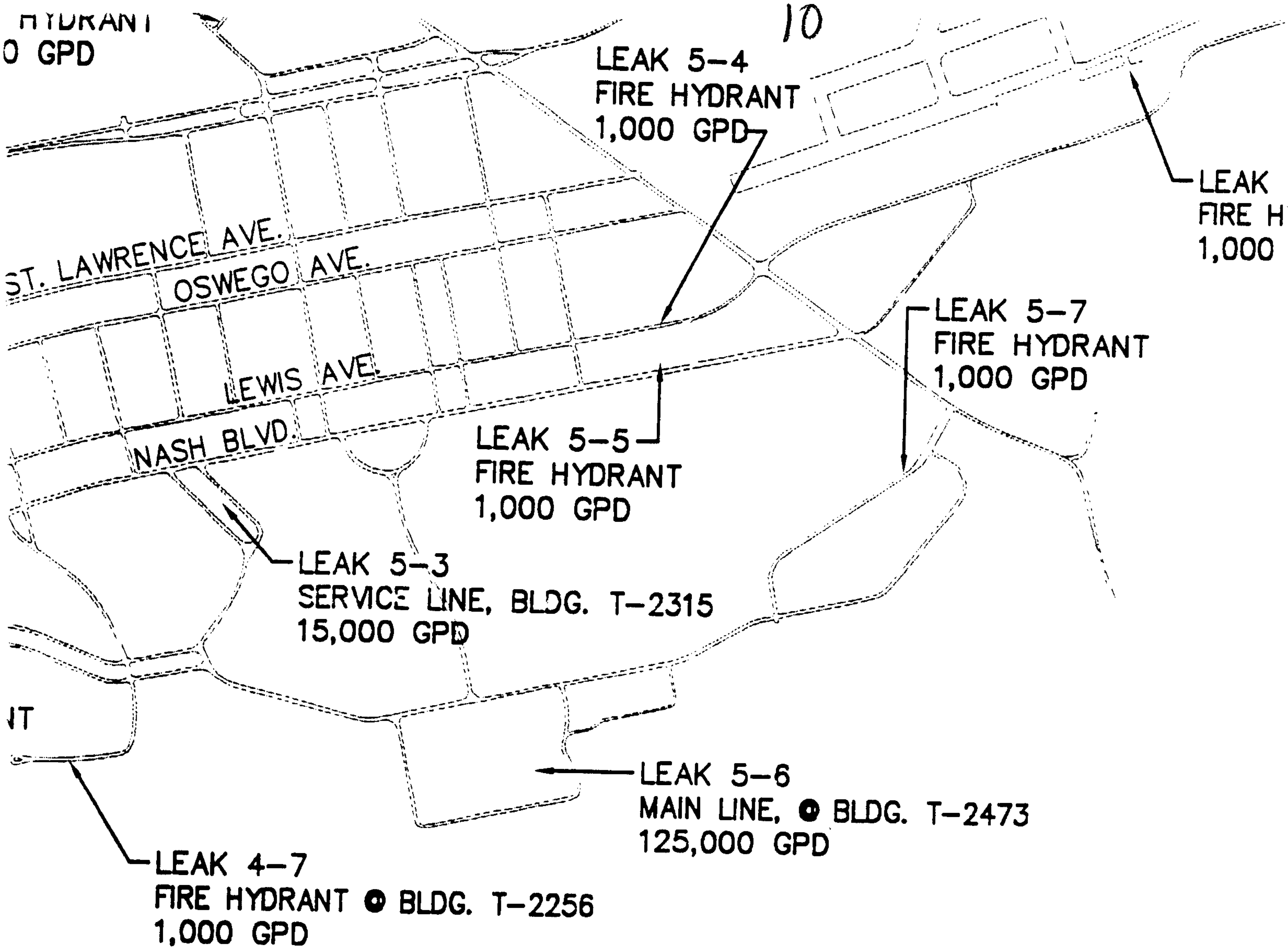
LEAK DETECTION SURVEY

LEAK LOCATIONS

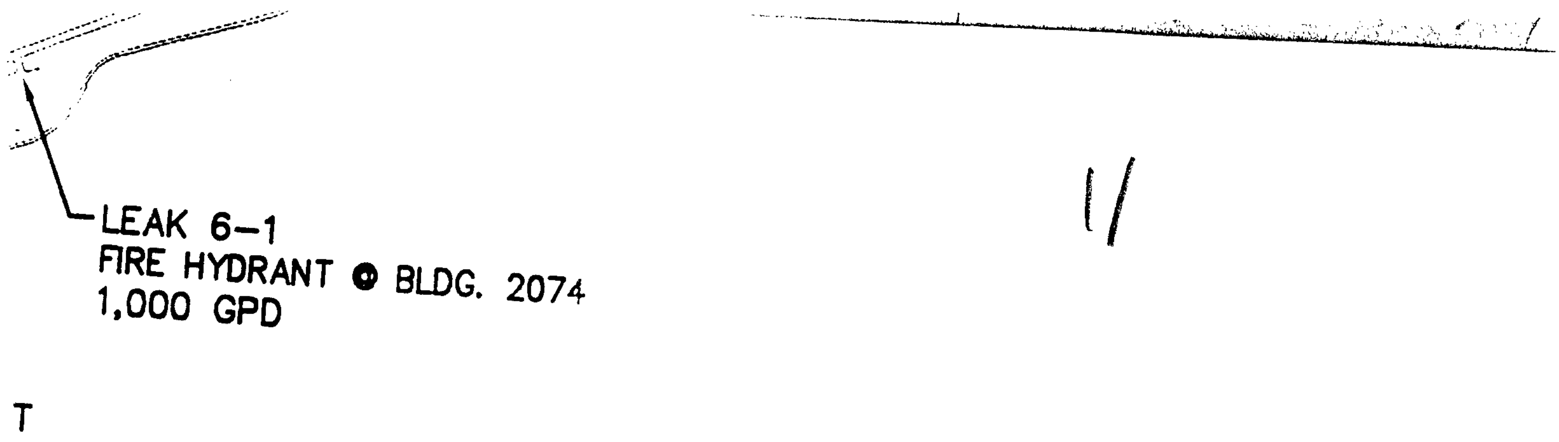


9
1,000 GPD
LEAK 3-2
FIRE HYDRANT @ BLDG. 4485
1,000 GPD (FIXED)
VALLEY ROAD
CAMP SWIFT ROAD
CAMP HALE ROAD
ST. LAWRENCE AVE.
OSWEGO AVE.
LEWIS AVE.
NASH BLVD.
ONEIDA AVE.
ONTARIO AVE.
FOURTH ST. EAST
FIRST ST. WEST
LEAK 5-3
SERVICE LI
15,000 GP
LEAK 4-5
FIRE HYDRANT
1,000 GPD
LEAK 4-6
FIRE HYDRANT
1,000 GPD
RANT
LEAK 4-7
FIRE HYDRANT @ BLD
1,000 GPD
LEAK 4-4
FIRE HYDRANT
1,000 GPD
4-2
HYDRANT
GPD
GATE 2
LEAK 4-3
FIRE HYDRANT @ BLDG. T-145
1,000 GPD
GATE 1
TO
FELTS
MILLS
N

SURVEY



HYDRANT
0 GPD
10
LEAK 5-4
FIRE HYDRANT
1,000 GPD
LEAK
FIRE H
1,000
ST. LAWRENCE AVE.
OSWEGO AVE.
LEWIS AVE.
NASH BLVD.
LEAK 5-7
FIRE HYDRANT
1,000 GPD
LEAK 5-5
FIRE HYDRANT
1,000 GPD
LEAK 5-3
SERVICE LINE, BLDG. T-2315
15,000 GPD
NT
LEAK 5-6
MAIN LINE, @ BLDG. T-2473
125,000 GPD
LEAK 4-7
FIRE HYDRANT @ BLDG. T-2256
1,000 GPD


LEAK 6-1
FIRE HYDRANT @ BLDG. 2074
1,000 GPD
T

LEAK DETECTION SURVEY
LEAK LOCATIONS

SCALE: 1"=1000'

SCALE: 1" = 1000'

1000' 0 1000'

12

5	4

13

SYMBOL	DESCRIPTION	DATE	APPR

EMC ENGINEERS, INC.
• Denver
• Atlanta
• Dallas

US Army Corps of Engineers

DESIGNED BY: M. SCHOLZ	FORT DRUM NEW YORK, N.Y. POTABLE WATER CONSERVATION STUDY DELIVERY ORDER NO. 012
DRAWN BY: M. CARREON	**LEAK DETECTION SURVEY LEAK LOCATIONS**
CHECKED BY: B. CENTER	

PLOT SCALE: AS NOTED		CONTRACT DATE: FEBRUARY 1996	SHEET REFERENCE NUMBER
PLOT DATE: <Plot Date: 02/22/96>	SHEET # OF #	CONTRACT NO. DACA01-94-D-0033	X

A

1

DRUMMAP.DWG
PROJECT NO. 1406.012