Cadiz Water Treatment Facility - Energy Audit, Level II

Submitted by: Ohio RCAP

Administered by

WSOS Community Action Commission, Inc.

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Acronyms:

ARC – Appalachian Regional Commission
ECO – Energy Conservation Opportunity
EPA – Environmental Protection Agency
RCAP – Rural Community Assistance Program
RCDI – Rural Community Development Initiative
SCADA – Supervisory Control and Data Acquisition
USDA – United States Department of Agriculture
VFD – Variable Frequency Drive
WTP – Water Treatment Plant
WWTP – Waste Water Treatment Plant

Definitions: (with respect to Ohio RCAP Energy Audit reports)

Benchmarking – Energy consumption or costs for a specified time period to which future usage or costs are compared
Cogeneration – Generating electricity using a waste heat fuel source which comes from another process
Demand –The rate of electrical usage over a specified period of time, measures in kilowatts (kW)
Efficiency – The ratio of the useful energy to the thermal energy input
Energy – Includes electricity, gas, and all other source of energy used at the Facility. The capacity for doing work as measured by the capability of doing work (potential energy) or the conversion of this capability to motion (kinetic energy).
Energy Audit, Level I – A cursory and basic assessment of the energy flows in a Facility or process, usually used to identify simple and low-cost opportunities to reduce consumption.
Energy Audit, Level II – A detailed assessment of the energy flows in a Facility or process, usually used to identify and quantify opportunities to reduce consumption.
Energy Action Plan – A plan used to prioritize facility energy projects, establish an implementation plan and schedule, and provide a method for tracking the results
Energy Use Indices – A representation of annual energy usage per a quantifiable benchmark, such as kWh/MG.
GPD – Gallons per Day
hp – Horsepower (1 horsepower = 746 watts or 42.4 Btu per minute)
kW – (kilowatt) Active power, Watts measure that portion of electrical power which does work
kWh – (kilowatt-hour) A unit of electrical energy equivalent of 1,000 watts of power provided for 1 hour. One kWh equals 3,413 Btus.
MGD – Million Gallons per Day
Simple Pay Back – The length of time required for an investment to pay for itself determined by dividing the initial investment by the annual savings, (the Cost / the Savings)
(WTP/WWTP) Facility – The Facility refers to all of the components within the system, including the plant, pump stations, lighting, and all other uses associated with the treatment process
(WTP/WWTP) Plant – The Plant refers to the actual treatment plant only, and does not include any other buildings, structures, or uses associated with the treatment process

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Section 1.0 – Executive Summary

Representatives from the Ohio Rural Communities Assistance Program (Ohio RCAP) conducted a Level II Energy Audit for the Cadiz, Ohio Water Treatment Facility on November 9, 2010. The purpose of the facility Energy Audit is to gain an understanding of the facility processes and of the major end uses, with an ultimate objective of identifying potential energy conservation opportunities. Utility Superintendent Thomas Carter and Ohio Mid-Eastern Governments Association Project Manager Cindi Kerschbaumer were also present during the site visit.

This Level II Energy Audit, herein referred to as the Audit, is a continuance of technical assistance provided through the USDA Rural Community Development Initiative by Ohio RCAP. The opportunities addressed by this Audit, along with any other energy initiatives you may identify now or in the future, will form the basis of your Energy Action Plan, or EAP. The proposed opportunities will be reviewed with you to determine if they are appropriate for your facility and budget. All acceptable project opportunities should be included in your EAP. The purpose of the EAP is to prioritize your facility energy projects, establish an implementation plan and schedule, and provide a method for tracking the results.

This report presents the findings from the Audit. Each available opportunity is described herein to ensure that our understanding of the affected system is accurate. Estimates of annual energy savings and implementation costs are provided for each project, along with approximate simple payback period. The savings and cost estimates are based on limited information gathered during the assessment and upon potential facility and operational modifications to align with the Audit recommendations.

For the time period Audited, the total energy costs for operating and maintaining the Facility amounts to $69,810.82 per year (Refer to Table 4.1). For the total energy usage of 1,027,502 kWh per year, the average cost of $0.068/kWh can be estimated for the overall Facility usage. Proper Facility planning and budgeting requires estimates of future demands and costs for the Facility, industrial trends and regulations, and the regional forecasts as a whole.

In planning for the future, it must be taken into account that the United States Environmental Protection Agency (EPA) is projecting a 20% increase in the use of energy for water and wastewater facilities over the next 15 years, as a direct result of both population growth and increasing agency regulations and requirements. This will increase the total annual energy costs of operations and maintenance for the Facility from $69,811 to approximately $83,773 per year (a potential increase of $13,962). The Village of Cadiz will need to plan for this potential increase to the annual budget, either through billing rate increases, or by reductions to the energy usage and increased operations efficiency.

Assuming that the energy conservation opportunities (ECO) and operational recommendations presented within this report are utilized, the Facility may realize an approximate reduction in energy usage of 19.4% (a 195,606 kWh usage reduction, using only 813,801 kWh per year). However, due to the available no-cost opportunities identified in the Audit and the cost per kWh within the Facility, the reduction in energy costs increases to 20.1%. Refer to Table 1.1.

TABLE 1.1 - SUMMARY OF ENERGY CONSERVATION OPPORTUNITIES:

ECO No.	Opportunity Description	Est. Cost ($)	Annual kWh Savings	Annual kW Savings	Annual Energy Cost Savings	Simple Payback Estimate (years)	Notes
1	Billing Tariff Reclassification						
2	Demand Management and Load Shifting	$0	54,458	74.6	$1,630	0.0	1
3	Install Energy-Efficient Interior Lighting	$4,600	11,557	3.5	$982	4.7	2
4	Install Interior Occupancy Sensors	$500	10,535	0.00	$895	0.6	
5	Install LED Exit Light Fixtures	$200	1,226	0.14	$104	1.9	
6	Address Building Envelope / Climate Control Issues						
7	Exterior Lighting Controls						
8	Install Premium-Efficiency Motors (60 Hp)	$5,000	8,695	2.38	$739	6.8	3
9	Modify Lead High-Service Pump	$0	109,135	29.9	$9,275	0.0	4
10	Install VFDs on Raw and High-Service Pumps						5
	Pre-Conservation Totals (Refer to Table 4.2)		*1,009,407*		*$67,635*		
	Total Estimated Implementation Cost	**$10,300**					
	Total Potential Electrical Energy Savings		**195,606**				
	Total Potential Electrical Demand Savings			**110.52**			
	Total Potential Cost Savings				**$13,625**		
	Total Simple Payback					**0.75**	
	Potential Post-Conservation Difference Totals		*813,801*		*$54,010*		
	Potential Post-Conservation Savings Percentages		19.4%		20.1%		

Notes:

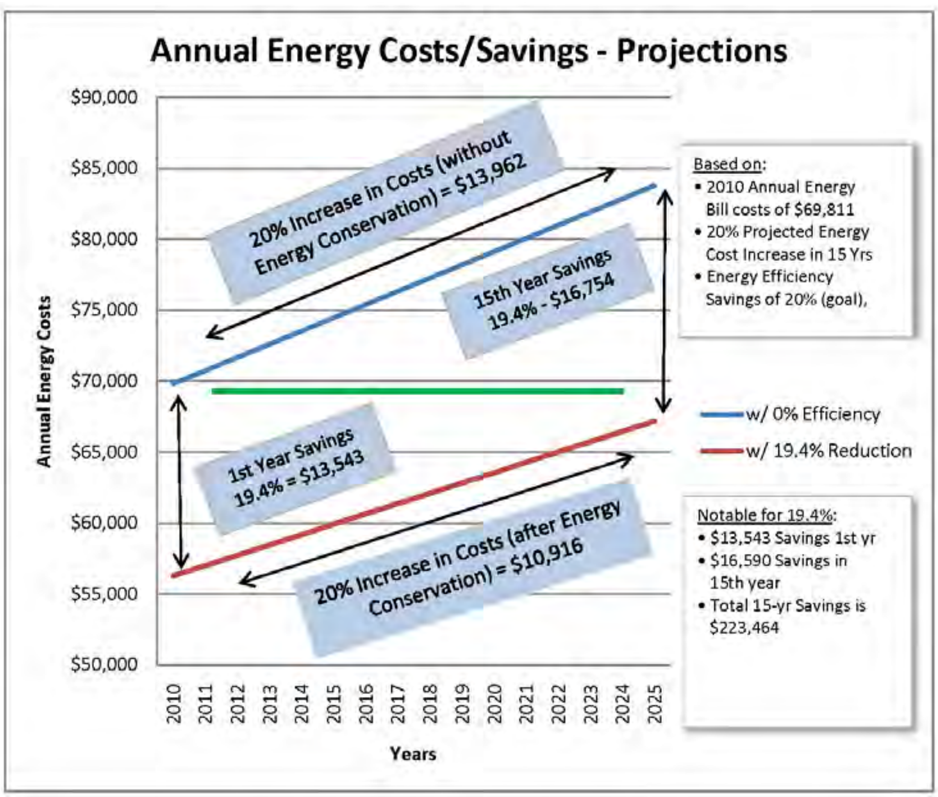
1. The Load Shifting may require changes to staffing and hours of operation, and may have increased costs (labor, benefits, lighting, etc.). The Village is encouraged to address these potential issues.
2. Energy savings and simple payback for lighting opportunities depends on lighting retrofits and whether lighting is upgraded on an as-failed basis or all at once. See Section 5.0 and the calculations in the Appendix.
3. Energy savings and simple payback associated with motor replacement depend on the size, operating hours, efficiencies, and quantity of motors involved. See Section 5.0 and the calculations in the Appendix.
4. This opportunity is highly recommended and will not cost anything to implement.
5. The facility is currently operating the Raw Pump (100-hp) and the High Service Pump (100-hp) at full speed, throttling the High Service pump with a partially open valve. At this time, without any operational changes, VFD's are not recommended; however, the 'order-of-magnitude' calculations are included in the report for the information of the Village.

The unofficial goal of the Ohio RCAP Energy Audit is to assist facilities in identifying their optimum energy efficiency point, while attempting to achieve a minimum of 20% energy conservation. The conservatively estimated 19.4% energy savings identified in this Audit for the Village of Cadiz Water Treatment Plant is possible with a projected improvement cost of $10,300, and can be realized with a Simple Payback Period of 0.75 years. The projected savings of $13,625 per year not only offsets the improvement cost, but there is also a compounding effect that must be taken into consideration.

Chart 1.1 identifies the Village of Cadiz Water Treatment Plant annual estimated energy costs, potential savings opportunities, and future cost projections. The estimated savings are based upon the minimum 20% reduction goal and the estimated 19.4% reduction due to energy conservation from this Audit. The future cost projections are based on the EPA estimated 15-year 20% increase in energy use, and are projected for both the 0% energy conservation and the 19.4% conservation model.

The 19.4% reduction 15-year energy budget cost is reduced from $69,811 to only $56,268 per year in the year 2025. This new energy cost amount is a significant reduction to the current operating budget, and will compound to produce a 15-year savings of over $223,464. By subtracting the energy conservation improvement cost of $10,300, the facility could see a potential savings of over $213,000 during that time period. This savings will allow the Village of Cadiz to plan for capital improvements, manage emergency events, and establish a long-term asset for the Community.

<u>CHART 1.1 – ANNUAL ENERGY COST INCREASE AND POTENTIAL SAVINGS PROJECTIONS:</u>



Disclaimer:

The energy conservation opportunities contained in this report have been reviewed for technical accuracy. However, because energy savings ultimately depend on behavioral factors, the weather, and many other factors outside its control, Ohio RCAP does not guarantee the energy or cost savings estimated in this report. Ohio RCAP shall in no event be liable should the actual energy savings vary from the savings estimated herein.

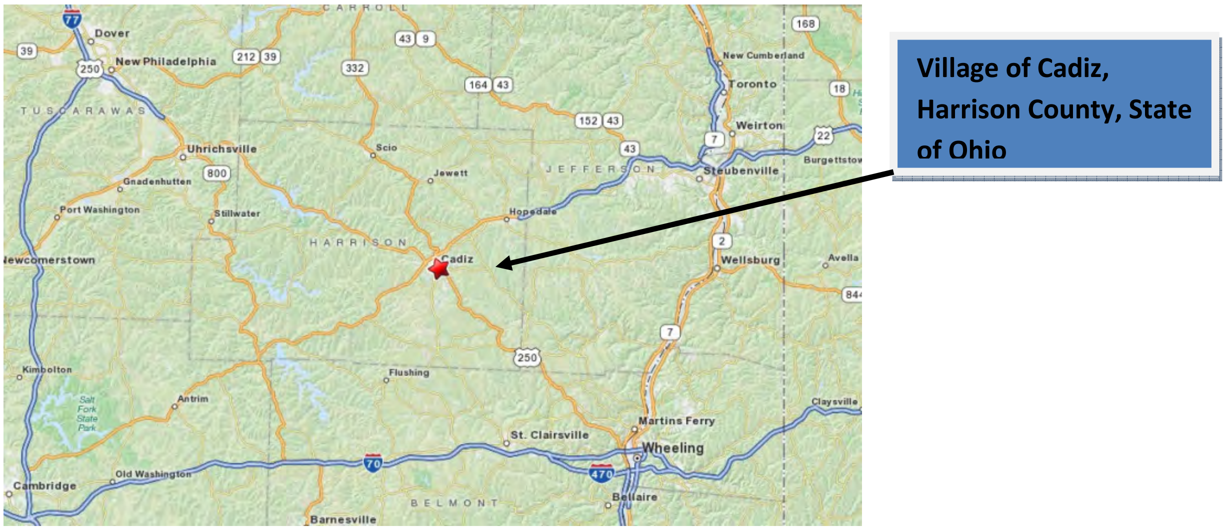
Estimated installation costs are based on a variety of sources, including our own experience at similar facilities, our own pricing research using local contractors and suppliers, and cost handbooks such as RS Means Facilities Construction Cost Data. The cost estimates represent the best judgment of the auditors for the proposed action. The facility owner and staff are encouraged to confirm these cost estimates independently.

Since actual installed costs can vary widely for a particular installation, and for conditions which cannot be known prior to in-depth investigation and design, Ohio RCAP does not guarantee installed cost estimates and shall in no event be liable should actual installed costs vary from the estimated costs herein.

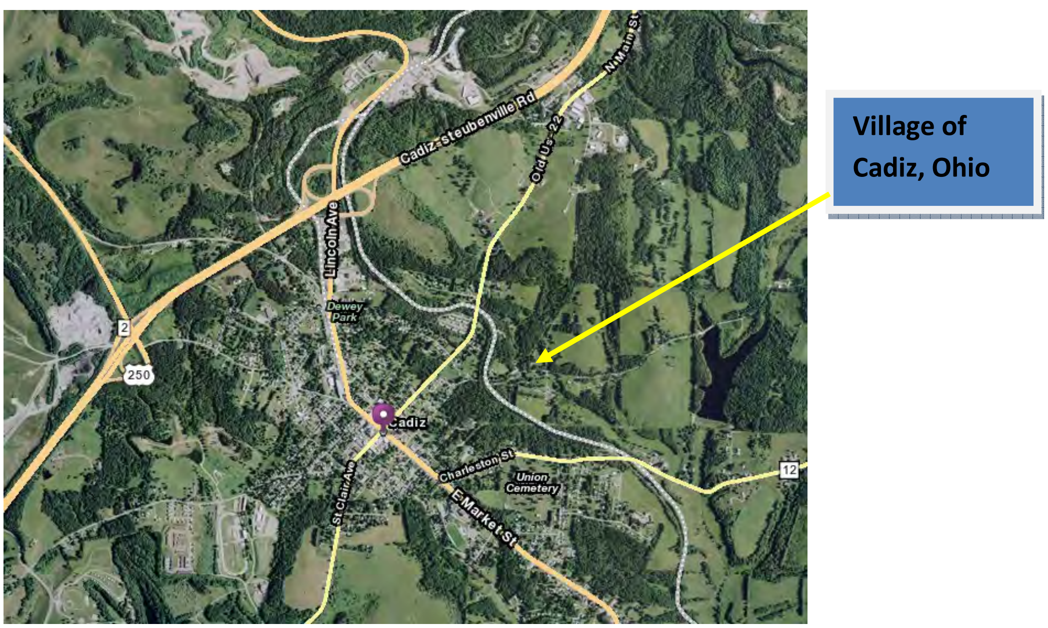
Ohio RCAP will not benefit in any way from any decision by the Owner to select a particular contractor, vendor or manufacturer to supply or install any materials described or recommended in this report.

Section 2.0 – Introduction

The Village of Cadiz is a small, rural community located in the East-Central part of Harrison County in Eastern Ohio. With a total population listed at 3,308 people (2000 Census), there are 1,391 households and 917 families residing in the Village. The Village has a total median household income of $29,518. The community is served by the Village owned Water Treatment Facility (WTF), which has a total of 1,382 connections, and 45 of the connections are not serviced by municipal wastewater.



Map of the State of Ohio, Identifying the Village of Cadiz, Ohio



Aerial Map of the Village of Cadiz, Ohio

Aerial Map of the Village of Cadiz, Ohio, Identifying the Water Treatment Facility

Section 3.0 – Water Facility Description and Operations

The Cadiz WTF finished construction and was put into operation in 1993, and opened with a design flow capacity of 1,000,000 gallons per day (1 MGD). The current actual flow at the facility is roughly 401,000 gallons per day (0.401 MGD), with a peak flow of 543,000 gallons per day (0.543 MGD), as reported by the facility personnel. The surface water source facility draws water from the nearby Tappan Reservoir for the water supply. In addition, there are two (2) old ground water wells that were formerly utilized for water production, but have been taken off-line. There have been many changes with time, including flow capacity, discharge limits, technology, and even energy costs. These items will continue to change in the future, as well, and the Village should remain vigilant of this dynamic portion of the infrastructure.

The existing facility consists of the following components and equipment:

Tappan Reservoir – Raw Water Pump Station: The pump house at the Tappan Reservoir location consists of 3 pumps, a Carbon-feed unit, and an Emergency Back-up Generator. This approximately 1,200 square-foot concrete block facility is built partially into the hillside and is designed to blend into the natural surroundings of the lake and hillside terrain. It uses light-sensing technology for security lighting due to reservoir aesthetics, however, these are currently inoperable. The raw pumps include:

Two (2) each 100-hp pumps (one was off-line during the facility audit), installed 2004
Deming Vertical Turbine, 700 GPM at 431' Head, 1,770 RPM, avg. 120 psi (95-220 psi)
One (1) each 75-hp pump (rarely used), installed 2004
Deming Vertical Turbine, 550 GPM at 409' Head, 1,770 RPM
One (1) each Raw Water Sample Pump, 1.5-hp (operated 0.5 hr per day)

The water is pumped 10 miles from the Reservoir to the Water Treatment Plant. The measured flow rates are between 600-610 gallons per minute (610 gpm x 60 min/hr x 10.5 hrs/day = 384,300 gpd).

Water Treatment Plant: The Water Treatment Plant, located at 316 West Warren Street in Cadiz, was put into operation in 1993. The Plant consists of the following rooms, processes, and structures:

Pre-Treatment Room (Lime, Carbon):
Two (2) each Lime Mixers, 0.33-hp, 1,725 RPM, operated 24 hrs/7 days
Lighting – 18-each 2-bulb (34-watt T-12 fluorescent) fixtures

Flocculation/Settlement Room:
Four (4) each Flocculation Pump, 1.0-hp, 75% Efficient
Lighting – 36-each 2-bulb (34-watt T-12 fluorescent) fixtures

Heating/Ventilation, 2-hp
Four (4) each Exhaust Fans, 0.75-hp

Laboratory:
Lighting – 8-each 4-bulb (34-watt T-12 fluorescent) fixtures

SCADA:
Lighting – 4-each 4-bulb (34-watt T-12 fluorescent) fixtures

Office:
Lighting – 4-each 4-bulb (34-watt T-12 fluorescent) fixtures

Break Room:
Lighting – 4-each 2-bulb (34-watt T-12 fluorescent) fixtures

Locker Room:
Lighting – 8-each 2-bulb (34-watt T-12 fluorescent) fixtures

Filter Room:
Backwash Air Blower, 20-hp, 2,490 RPM, 88.5% Efficient
Backwash Pump/Supplement Air, 15-hp, 1,150 RPM (operates 0.5 hrs/day)
Two (2) each Waste Backwash Pump, 2-hp, 1,750 RPM
Lighting – 12-each 2-bulb (34-watt T-12 fluorescent) fixtures

Fluoride Feed Room:
Lighting – 4-each 2-bulb (34-watt T-12 fluorescent) fixtures

Chlorine Disinfection Room:
Lighting – 4-each 2-bulb (34-watt T-12 fluorescent) fixtures

High Service Pumps:
One (1) each 100-hp pump
Deming Vertical Turbine, 1,050 GPM at 267' Head, 1,800 RPM
One (1) each 60-hp pump
Deming Vertical Turbine, 700 GPM at 246' Head, 1,800 RPM
One (1) each 50-hp pump
Deming Vertical Turbine, 550 GPM at 240' Head, 1,800 RPM
Lighting – 13-each 2-bulb (34-watt T-12 fluorescent) fixtures

New Garage:
Lighting – 20-each 2-bulb (34-watt T-12 fluorescent) fixtures
3 exterior wall-mounted security lights with motion sensors

Old Garage:

Shared space with the Village Street Department, Utilities paid for by Village
Lighting – 19-each 2-bulb (34-watt T-12 fluorescent) fixtures

Sludge Storage:

Aerator Blower, 0.5 hp
Two (2) each Sludge Mixers, 10-hp, 1,750 RPM (operated once per year)
Two (2) each Sludge Loading Pumps, 4-hp, 1,750 RPM (operated once per year)

The Clear Well:

Storage Capacity of 465,000 gallons

__Storage Tanks:__ There are two (2) storage tanks located within the system with a total storage capacity of 1,281,000 gallons:

531,000 Gallon Elevated Tank, located on Grant Street
750,000 Gallon Tank, located on Edgar Hill

There are six full-time employees, two of which are certified Class III operators. The Plant operates 365 days per year, 10 hours per day and uses Supervisory Control and Data Acquisition (SCADA) technology throughout. In the previous two quarters to this audit, it was noted that THM (Trihalomethanes) levels were high. It was noted that the facility experienced 11% water loss in 2009. The distribution pressure ranges from 40-150 psi.

Section 4.0 – Energy Use History and Utility Analysis

Monthly electric utility costs were provided by The Village of Cadiz for the WTF, and are tabulated in Table 4.1. The electrical energy providers for the facility are AEP and South Central Power. With respect to the electric energy, South Central Power only provides service to the Water Tower on Grant Avenue. In addition, the Plant is heated with gas energy, provided by Columbia Gas. In a recent 12-month period, the total cost of energy over this period was tabulated to be $69,810.82. The total energy use for the facility in this period was 1,027,502 kWh. The average cost per kWh was $0.068 (including demand charges). For these values, the quantity of gas has been converted to equate to electrical units for comparative purposes.

Based on the Facility-provided annual water production rate of 146.4 million gallons (0.401 MGD), energy use indices for the electricity and gas is 7,020 kWh/MG-yr. The total annual energy cost per million gallons is $477.37. Please refer to Table 4.2. However, these averages utilize the data from the inactive well production system (2 pumps and a pump station), which will skew the indices and average costs to be slightly higher for comparative systems.

Therefore, for the same production rate, but only taking into account the active system components (the raw water pump station, the plant and its equipment and buildings, and the two water storage tanks), the energy use indices is reduced to 6,897 kWh/MG-yr. The total annual energy cost per million gallons of water is $462.07. This is a comparative cost associated with typical surface water treatment systems, and is slightly higher than typical due to the local terrain, raw water pumping distance, and system layout.

The energy use index and cost per gallon are higher than the average groundwater facility of similar size, which is expected for a surface water facility. In addition, with the facility's age, relatively efficient equipment, SCADA system, and the knowledgeable staff, there will not be many non-operational opportunities for energy savings. However, we do have several opportunities identified that will warrant review by the owner for potential savings. As we analyze this facility, please note that the largest energy user at a water facility is the pumping, both raw and distribution, and is typically between 60-80% of the energy use for the total utility.

As the energy conservation opportunities are analyzed, they will be compared to and calculated against their specific location and use within the system. For example, if we are auditing the fluorescent lights at the Plant, the associated 'average energy cost/kWh' will be related to the use and costs metered at the Plant, and will not reflect the energy use and costs metered at the raw pumping, the converted gas usage, or the weighted total. In that example, the associated cost/kWh for the Plant, the raw pumping station, the gas, and the weighted total is $0.085, $0.080, $0.033, and $0.068 respectively. The variations of these costs and the direct comparison association for the calculations and comparisons will provide a more accurate reflection of the actual potential for energy and cost savings.

Additionally, it is our understanding that the old water well system is not planned for use or operation by the Village of Cadiz in the near future. Until those uses are completely taken off-line and removed from service, there will continue to be a small cost associated with their existence, including lighting, heating, or similar energy use.

The following table identifies the 9 metered energy users, 1 gas and 8 electrical, along with the amount of energy used, the cost of the energy used, and the average cost per kWh for each metered user, as well as an average for the overall system.

TABLE 4.1 – CADIZ WATER TREATMENT FACILITY ANNUAL ENERGY USE:

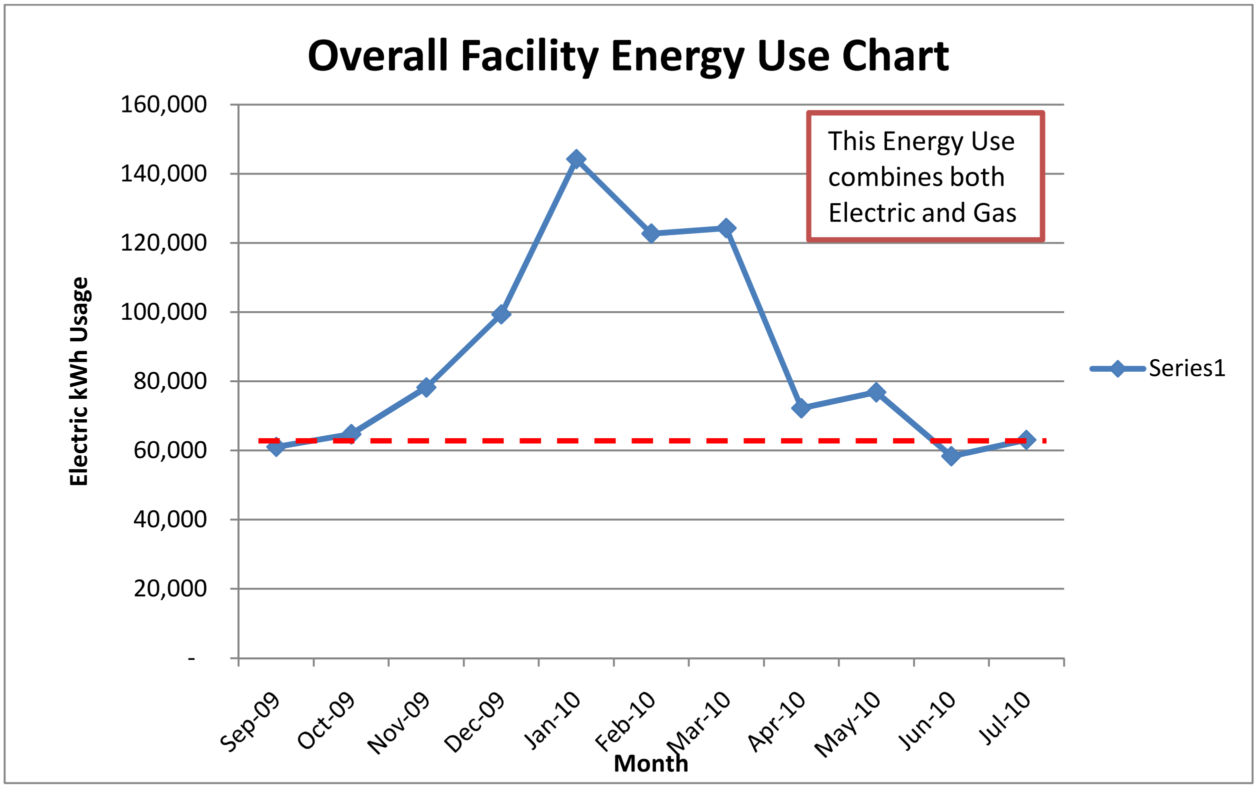
Cadiz Water Treatment Facility Annual Energy Use				
Use Type	Metered Location	Energy Use (kWh)	Energy Cost ($)	Cost/ kWh
G-1 - Gas	Water Plant, W. Warren St., Cadiz	332,520	$ 11,118.75	$ 0.033
E-1 - Electric	Raw Water Pumping, Tappan Res.	320,280	$ 25,610.33	$ 0.080
E-2 - Electric	Water Plant, W. Warren St., Cadiz	355,000	$ 30,221.30	$ 0.085
E-3 - Electric	Garage, W. Warren St., Cadiz	1,010	$ 253.72	$ 0.251
E-4 - Electric	Water Tower, Grant St., Cadiz	487	$ 246.00	$ 0.505
E-5 - Electric	Water Tank, Edgar Hill, Cadiz	110	$ 185.31	$ 1.685
E-6 - Electric	Pump Station, Cambridge Rd.	1,280	$ 275.15	$ 0.215
E-7 - Electric	Water Pump, Reservoir Lane	8,201	$ 811.03	$ 0.099
E-8 - Electric	Water Pump, Reservoir Lane	8,614	$ 1,089.24	$ 0.126
	Totals	1,027,502	$ 69,810.83	$ 0.068
	Average	85625	$ 5,817.57	$ 0.068

The supporting data for the table above is located in Appendix B of this report.

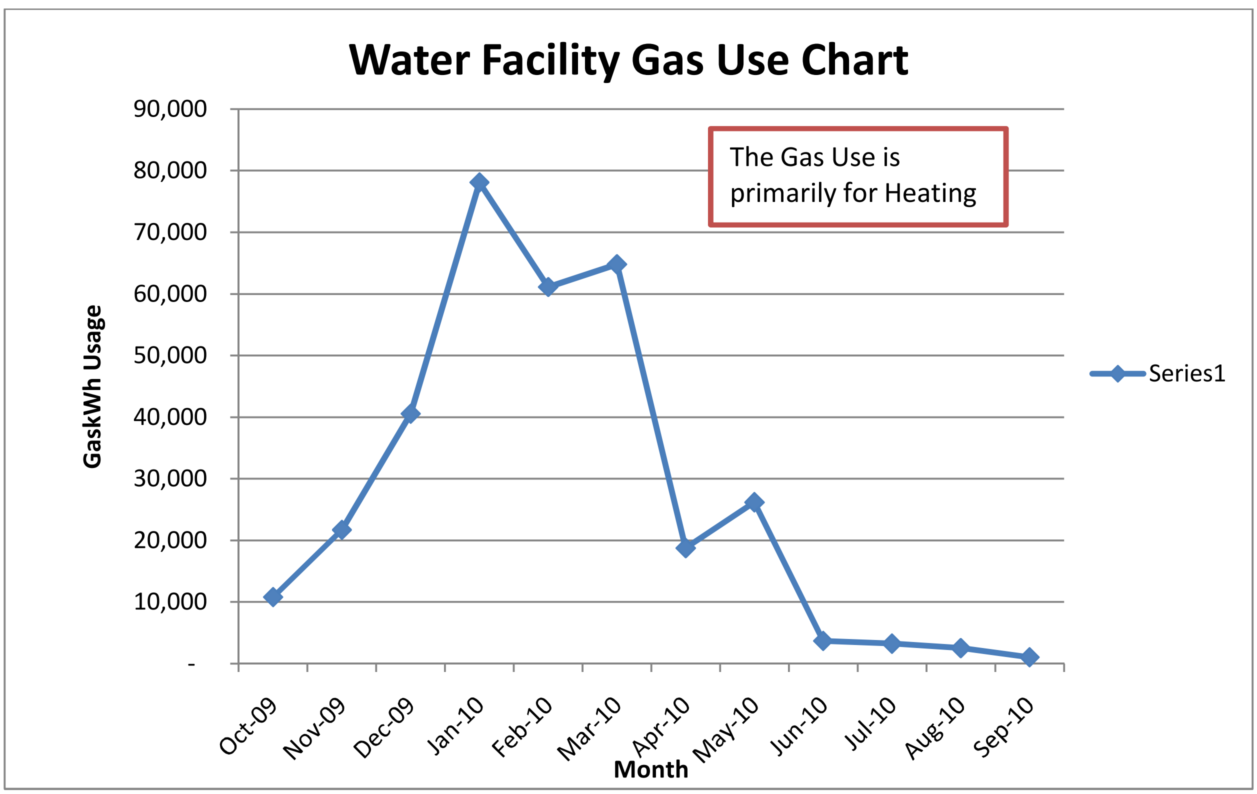
TABLE 4.2 – CADIZ WATER TREATMENT ANNUAL FACILITY PRODUCTION

Cadiz WTF Loading - All Facilities				
Given:	1027502	= Annual Energy Use Average		
	$ 0.068	= Average Cost/kWh		
Avg Flow/Day MGD	Days/ Year	MG/ Year	kWh/Mg/Yr	$/MG/Yr
0.401	365	146.4	7020	$ 477.37
Cadiz WTF Loading - Minus the Old Well Uses				
Given:	1009407	= Annual Energy Use Average		
	$ 0.067	= Average Cost/kWh		
Avg Flow/Day MGD	Days/ Year	MG/ Year	kWh/Mg/Yr	$/MG/Yr
0.401	365	146.4	6897	$ 462.07

GRAPH 4.1 – CADIZ WATER TREATMENT ANNUAL ENERGY USAGE



GRAPH 4.2 – CADIZ WATER TREATMENT ANNUAL GAS USAGE



Section 5.0 – Energy Conservation Opportunities

This section presents a preliminary analysis of quantifiable energy efficiency opportunities identified during the site audit. Each opportunity is described to ensure that our understanding of the affected system is accurate. An estimate of annual energy savings and implementation cost is provided for each project, along with approximate simple payback period. The savings and cost estimates are based on limited information gathered during the Audit.

Energy conservation can be defined for the purpose of this report as, 'using fewer resources to complete the same work, with no compromise to treatment quality, customer service, facility comfort, or safety'. It is important to evaluate the entire facility operation, from the source, to treatment, to distribution. Even small, initial efforts can be rewarding, and may lead to larger, more beneficial projects down the road. However, these opportunities must make economical sense to your community, in both the immediate and the long-term planning goals.

In addition to the opportunities within this section, there are additional opportunities listed in Sections 6 and 7 pertaining to this site. Some of these opportunities are difficult to evaluate due to limitations in testing equipment, research analysis, or questions in the implementation and/or use. Most of them can be evaluated and implemented by facility staff, and a few of them will require the additional study and the assistance of design professionals.

**NOTE: The Energy Conservation Opportunities (ECO's) in this report that are identified as 'Sample Only' are opportunities that have been evaluated as a representative sample, and are not to be reviewed as conclusive. The evaluation should give the client the 'order-of-magnitude' of the opportunity and a scale of the simple payback in order to identify if further study or evaluation is required and/or warranted. The other opportunities are provided as potential projects at the time of the Audit and with respect to the energy data provided for review. All actual projects should take into account the current operations, maintenance, and costs associated with the facility at the time they are implemented.*

ECO 1 – Billing Tariff Reclassification (Sample Only)

The facility currently has two AEP Billing Tariff classifications for its metered energy uses. They are classified as Tariff 211 – Small General Business and Tariff 215 – Medium General Business. Two (2) of the AEP metered users are classified as Tariff 215, the raw water pumping station and the treatment plant. These classifications and uses seem appropriate to the facility, and do not lend themselves to savings by reclassification. The various classifications relate to specific billing schemes, including the costs for energy consumption, demand charges, distribution charges, and transmission charges. The opportunities identified in ECO 2 are listed for information only, and may only be possible with a reclassification. The Village should be aware of the ramifications of the potential of reclassification should they pursue those directions.

ECO 2 – Evaluate Demand Management with Load Shifting and Shedding

A Time-of-Use (TOU) electric rate schedule, from a typical AEP utility contract, designates certain hours of the day as being “on-peak” and charges a higher rate for kWh consumed during these time periods. The time period designated as “on-peak” is between 7 am and 9 pm, weekdays Monday through Friday. Those periods designated as “off-peak” are between 9 pm and 7 am weekdays Monday through Friday, all day Saturday and Sunday, as well as all legal Holidays. In addition to the higher energy rates, peak demand charges also increase. Demand management can substantially lower energy costs by reducing and/or avoiding extensive energy use during on-peak periods.

Load Shifting:

Load shifting, the practice of scheduling energy intensive processes for off-peak periods, is a common method of demand management. This not only reduces and/or avoids expensive demand charges, but also lowers the amount of electricity purchased at the higher on-peak rates. Demand management is achieved for water systems by using available storage to accumulate treated potable water during off-peak periods for later distribution. Additionally, demand management is often achieved for wastewater treatment by using available storage to accumulate influent during on-peak periods for later treatment. Both of these methods will thereby lower the process demand during on-peak periods for their respective operations.

The current operations take place within a 10-hour window, and are typically in the on-peak demand period, or daytime hours. The flow of potable water is used to re-fill the two storage tanks, and at the same time is also meeting the customer demand requirements. The storage tanks are ‘topped-off’ prior to the end of the work shift. The two tanks gravity-feed the distribution system during the night, and the next day are again refilled. The opportunity exists to shift some of this filling to off-peak hours.

If the Village can modify its operations procedure to allow at least a portion of the refilling of the tanks to take place during off-peak hours, it can recognize potential savings. An example would be for the high-service pumps to be allowed to kick on prior to the on-peak hour of 7 am, to begin refilling the tanks before they reach the typical 'low-level' morning start elevation. By filling the tanks to make up for the overnight usage, the daytime operations to fill the tanks and to also meet the daily customer demands would be reduced, thereby reducing the on-peak pumping use.

It can be estimated that the night-time water usage could approximately equal a two (2) hour water pumping window prior to the 7 am on-peak timeframe. This amounts to an estimated 84,000 gallons of water to recharge the water towers, or 20% of the daily demand. The operation of the main 100-hp pump for a two hour window off-peak should see the cost per kWh drop $0.03, from an average of $0.085 to approximately $0.055.

Shaft hp x 0.746 kW/hp = kW
100 hp x 0.746 kw/hp = 74.6 kW
74.6 kW x 2 hr/day x 365 days/year = 54,458 kWh/year baseline energy use
54,458 kWh/yr x $0.03/kWh = $1,630 per year (Potential with Operations Modifications)

Demand Shedding:

Demand shedding can be used to control peak loads. Demand shedding can be achieved by turning off all non-critical electric equipment during on-peak periods. This practice is not limited to large process equipment, but also applies to lighting, etc. Alarm systems are available to alert facility staff when demand is approaching a pre-set value, allowing them to turn off any non-critical equipment before peak demand is reached.

Load Shifting and Shedding Summary:

Currently the electric service at the WTF is not metered by AEP on a TOU basis, so there is no immediate opportunity here. It may be possible to work with AEP to enact a TOU billing system, but this may mean a reclassification of the metered user, and potential increased billing costs. Moreover, this would only be possible with a modification to the Plant Operations, by altering the working hours of the Facility. The Village should be aware of this rate structure and consider it in any future upgrades, improvements, purchases, or contract changes. The Village is encouraged to contact their local AEP representative to discuss any potential options.

ECO 3 – Install Energy-Efficient Interior Lighting

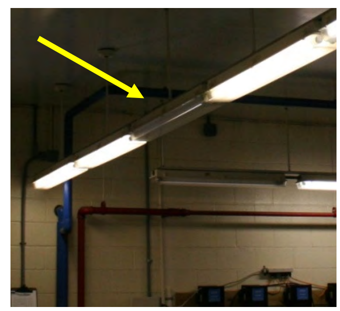
During the site audit, it was noted there were 138 two-lamp and 16 four-lamp four-foot fluorescent light fixtures containing T12 fluorescent lamps throughout the WTP. It is typical for older T12 fluorescent fixtures to utilize inefficient magnetic ballasts, which we will assume for this opportunity. Please note that as of July 1, 2010, the US Department of Energy has prohibited the manufacture of all magnetic ballasts. In addition, no T-12 fluorescent lamps will be manufactured after 2015. 34-watt lamps were observed on site. Hours of operation have been stated by facility staff to be 10 hours per day. However, the facility has some lights wired directly on full-time for safety issues, and some lights were burnt out. We will estimate that these full-time lights equate to 20% of the total number of fixtures, and that the other lights are utilized 20% of the time, with all lights working.

The energy conservation opportunity exists by retrofitting all interior T12 fluorescent fixtures with more energy efficient T8 lamps and electronic ballasts. In this retrofit, the lamp housing does not require replacement. In addition, both the T12 and T8 lamp pins are the same size and spacing, therefore, both can fit the same plug end. The retrofit consists of re-wiring the fixture with the new electronic ballast, and installing the new T8 lamps.

This retrofit allows the total lighting energy use to be reduced by approximately 11,557 kWh per year leading to an annual cost savings of $982. The estimated cost to replace a fixture with energy efficient T8 lamps is about $40 per fixture, or $4,600 total. This project is not recommended based on the lengthy projected simple payback. However, the economic return would improve if lamps and ballasts were upgraded by facility staff on an as-failed basis in lieu of all at once.

A sample calculation to illustrate the magnitude of energy savings that may be expected by retrofitting the existing fixtures with electronic ballasts and 32-Watt T8 lamps is in the Appendix.

Retrofit of 115 Fixtures:
Electric Energy Savings: 11,557 kWh
Annual Cost Savings: $ 982
Estimated Project Cost: $ 4,600
Simple Payback: 4.7 years



It is important to note that with the older style magnetic ballasts, even when a bulb is burnt out it can still draw power and cost both energy and money. The only way to make sure that the fixture is 'dormant' is to remove the bulb entirely.

ECO 4 – Install Interior Occupancy Sensors

This opportunity considers the application of occupancy sensors to control lighting in areas of the facility that are intermittently occupied. Occupancy sensors monitor motion in a room and keep lights on while someone is in the room. After a specified amount of time when no motion is detected, the sensor shuts the lights off. The length of time for this delay can typically be adjusted to fit the needs of the space.

Occupancy sensors are suitable for a wide range of lighting control applications and should be considered in every upgrade decision. The amount of savings depends on the number and type of fixtures controlled and the length of time the fixtures would be on without a person in the space. They should provide reliable operation when properly specified, installed, and adjusted.

Two motion-sensing technologies are commonly used in occupancy sensors: passive infrared and ultrasonic. Either technology can be housed in ceiling-mounted or wall-mounted sensors. Some manufacturers combine these two technologies into a hybrid or dual-technology sensor.

Passive infrared (PIR) sensors respond to motion between horizontal and vertical cones of vision defined by the faceted lens surrounding the sensor. Most PIR sensors are sensitive to hand movement up to a distance of about 10 feet. They sense arm and upper torso movement up to 20 feet, and are more sensitive to motion occurring perpendicular to the line-of-site of the sensor. Because infrared sensors require direct line-of-sight to the moving object, obstructions impair their performance. For example, they will not operate properly in spaces with furniture, partitions or other objects between the sensor and occupant.

Ultrasonic sensors emit and receive high-frequency sound waves. These waves reflect off people, objects and room surfaces and the sensor measures the frequency of the waves that return to the receiver. If motion occurs within the space, the frequency of the reflected waves will shift. The receiver detects this change, and lights are turned on. Ultrasonic sensors are much more sensitive to movement directly toward or away from the sensor compared to lateral movements. To ensure accuracy, the sensor should have a clear view of the area controlled. High partitions, especially those over 48 inches, can block its ability to detect people. Additionally, plush carpet and fabric partitions may absorb the sound waves and decrease effectiveness.

Lighting may operate continuously in many low-occupancy areas of the water treatment facility. For example, lights probably remain on in break areas that are used infrequently as well as areas that require only an occasional inspection of process equipment. Lighting energy costs can be reduced dramatically in these and other similarly occupied areas if occupancy sensors are installed to automatically switch light fixtures on and off.

For this opportunity, savings estimates have been calculated for installing occupancy sensors to control all of the existing linear fluorescent fixtures in the office, the laboratory, the SCADA control room, the break room, and the locker room. The total fixtures included in this opportunity are 16 each 4-bulb fixtures and 12 each 2-bulb fixtures. Installing occupancy sensors to control these fixtures would result in annual energy savings of 10,535 kWh or about $895 per year in energy cost savings if lighting operation was reduced by 80%.

The order-of-magnitude cost estimate to implement this measure is $500 resulting in a 0.6-year simple payback. This estimate is based on an assumption that five occupancy sensors would be required and wall switch sensors would be appropriate in most areas. Savings estimates assume that the existing lighting system is retained. If T8 lamps and electronic ballasts were installed throughout the plant (see Opportunity 3), savings associated with the occupancy sensor measure would be reduced. These calculations are also shown in the Appendix.

<u>Occupancy Sensors in the Office, Lab, SCADA, Break Room, and Locker Room</u>:
Power Savings: 0 kW
Electric Energy Savings: 10,535 kWh
Annual Cost Savings: $ 895
Estimated Project Cost: $ 500
Simple Payback: 0.6 years

<u>ECO 5</u> – Install LED Exit Lighting Fixtures

Most of the older, typical exit signs utilize incandescent lamps for lighting. Incandescent lamps are very inefficient, and lend themselves to improvement opportunities with other lighting alternative.

One very strong opportunity is to replace the incandescent lamp exit sign with a new LED exit sign. LED technology is steadily improving, and costs are dropping, to make this highly efficient and effective source of light a real energy conservation tool.

During the facility walk through, the exit signs were observed in the Main Plant and the New Garage facilities. For this opportunity, we will calculate four (4) exit signs at the Main Plant, and one (1) exit sign in the New Garage.

Retrofit of 5 LED Exit Lights:
Power Savings: 0.14 kW
Electric Energy Savings: 1,226 kWh
Annual Cost Savings: $ 104
Estimated Project Cost: $ 200
Simple Payback: 1.9 years

ECO 6 – Address Building Envelope and Climate Control Issues (Sample Only)

During the walk-through, it was noted that the facility has gas heating. Windows are sparse, double pane, and in good condition. A ceiling grid tile was missing in the older garage space (utilities paid for by the Street Department).

Energy efficient windows could be considered as the existing windows require replacement only. It is typical for the cost of replacing existing windows with energy efficient windows to have a very high simple payback. Therefore, the replacement for energy reasons alone is not favorable to the owner.

Energy savings from projects related to updating building envelope components (i.e. – windows, wall or roof insulation) are often cost prohibitive. Thus, simple maintenance of the existing windows, as opposed to complete replacement, is advisable. Similarly, energy savings calculations associated with this type of project are not precise unless detailed data on interior air pressure, infiltration rate, space temperature set points, outdoor air temperatures, etc, are available and/or a comprehensive building energy simulation model is used. Thus, detailed calculations are not provided as the analysis itself is cost prohibitive given the size of the facility and related HVAC systems.

ECO 7 – Address Exterior Lighting Controls (Sample Only)

The exterior lighting is on permanently and controlled by photocells or other control devices. It was noted during the walkthrough that the lights appear to be functioning as designed. It is important to maintain these fixtures in order to avoid unnecessary energy use.

Assuming that a typical existing exterior fixture is high pressure sodium with a nominal 250 watt lamp, the actual watts consumed are 295 watts. If this fixture were allowed to operate continuously for one year it would use:

(295 watts/lamp x 1 lamp/fixture x 1 fixture x 8,760 hr/year) / 1,000 w/kW = 2,584 kWh/year

This amounts to $220 per year. Keep in mind this is for a single fixture 24 hours a day. A photocell only allows the light to work at night, approximately eight hours, saving two-thirds of the energy consumption saving about 1723 kWh or $145.

ECO 8 – Install Premium-Efficiency Motor (60 Hp High Service Motor)

Replacement of older electric motors with premium efficiency models is often a very cost-effective energy cost reduction measure. Although an efficient motor can cost 15 to 30% more than a standard-efficiency motor, in most cases these additional costs pay back well within the lifetime of the motor. A typical standard motor easily consumes 50 to 60 times its initial purchase price in electricity during a 10-year operating period. Thus improvements of just a few efficiency percentage points in motor efficiency can often pay back within 2 to 3 years.

For all sizes of motors, premium high-efficiency replacement should be considered whenever the motor requires major repair or overhaul. In general, if the cost to repair the motor exceeds 60% of the price of a new efficient motor, replacement is the recommended course.

When a motor is replaced on an “as-failed basis,” the actual cost of the new, high-efficiency motor is the difference between the purchase price of the replacement and the cost to repair the existing motor. Consequently, the preferred time to purchase a premium-efficiency motor is when an existing one fails.

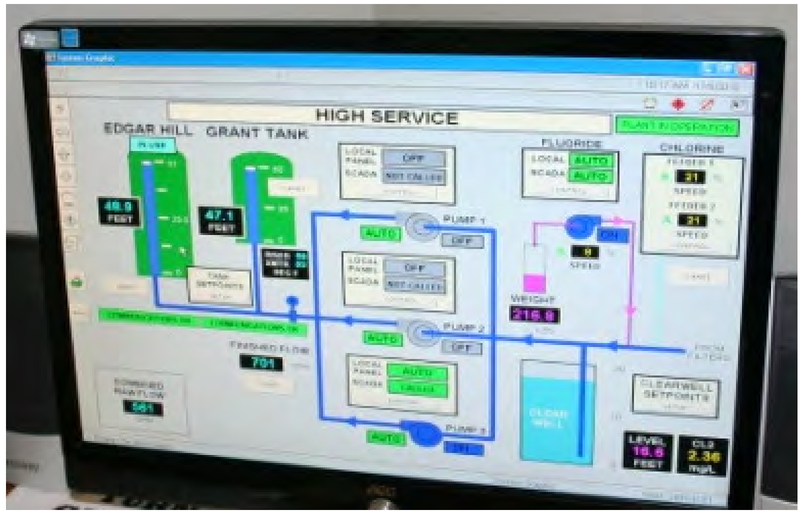
However, in some situations, it may be cost-effective to replace a working motor with a premium high-efficiency motor. Replacing oversized motors, particularly those oversized by 50% or more, with properly sized, premium high-efficiency motors can offer very quick payback because savings are achieved through higher efficiencies over the range of loading conditions. Generally, any motors that are above 5 to 10 hp and that operate at least half the year should be considered for replacement based on energy savings.

The chart presented in the appendix lists savings estimates possible by replacing a standard efficiency motor with a premium efficiency motor for motors that operate continuously, with an energy cost of $0.085/kWh.

Replacing the primary 60 Hp high-service motor with a Premium Efficiency Motor would save approximately $739 per year. The cost of the motor would be paid back in about 6.8 years.

For the High Service 60 Hp Motor:
Power Savings: 2.38 kW
Electric Energy Savings: 8,695 kWh
Annual Cost Savings: $ 739
Estimated Project Cost: $ 5,000
Simple Payback: 6.8 years

ECO 9 – Modify Lead High-Service Pump



There are three (3) high-service pumps providing service to the distribution system. With the current demand on the system to maintain tank elevations and to provide potable service with the current operating procedures and processes, the pumps must convey approximately 700 gallons per minute (gpm). The approach to meet this need has been to utilize the large pump (100-hp, 1,050 gpm) with a partially closed valve to restrict the flow (1,050 gpm to 700 gpm). This process is using more energy than is necessary.

It is possible to modify the high-service pumping process to utilize the mid-size pump (60-hp, 700 gpm) to meet the daily needs of the system at its current operating capacity. The flow capacity of 700 gpm has been able to keep the two (2) tanks filled while simultaneously meeting the domestic demands in the system, all the while maintaining a high available level of potable water in the clear well. In the event that the flow capacity would increase, the larger pump would be ready to boost the flow and the distribution amount. The photo above is the actual SCADA data from the audit walk through on November 9, 2010, and the time is 10:17am. It is noted that both tanks are nearly full, the clear well is nearly full, the combined Raw Water flow is 561 gpm, and the flow into the system is 700 gpm.

100 hp x 0.746 kw/hp = 74.6 kW ; 60 hp x 0.746 kw/hp = 44.7 kW
74.6 kW x 10 hr/day x 365 days/year = 272,290 kWh/year (baseline energy use)
44.7 kW x 10 hr/day x 365 days/year = 163,155 kWh/year (potential energy use)
272,290 kWh/yr – 163,155 kWh/yr = 109,135 kWh/yr
109,135 kWh/yr x $0.085/kWh = $9,275 per year (Potential with Operations Modifications)

<u>To change the Lead High-Service Pump</u>:
Power Savings: 29.9 kW
Electric Energy Savings: 109,135 kWh
Annual Cost Savings: $ 9,275
Estimated Project Cost: $ 0
Simple Payback: 0 years

ECO 10 – Install VFD's on Raw and High Service Pumps

The use of variable frequency drives (VFD) on the raw and high service pumps should be assessed at a level higher than this report in order to identify their ultimate benefit to the energy consumption of the system. The current mode of operations for the Facility is to have one of the 100-hp Raw-Water pumps running full-speed for the daily hours of operation. In addition, the 100-hp High-Service pump is also running at full-speed, throttled back with a partially open valve. This process does not require a variable flow, and therefore is not viable for a VFD. However, if the Village alters or modifies any of their operations, this opportunity may become increasingly beneficial.

If a VFD were installed, it will allow for the pumps to operate at multiple flows and partial loading, thereby optimizing the energy use. Please note that the addition of a VFD may cause harmonics within the system, and the addition of capacitors may be required. Moreover, the installation of VFD's on motors under 30 Hp are typically not cost effective, due to the cost versus the amount of savings. The owner should evaluate this option carefully before proceeding.

For the addition of a VFD in the system, drive efficiency will be neglected. Other assumed values are the same as for Opportunities 7 and 8 above. The baseline energy use for the existing system assuming the 100-hp raw water pump and the 60-hp high service pump are utilized and be quantified as follows:

<u>Raw Pump</u>: 100 hp x 0.746 kW/hp = 74.6 kW
74.6 kW x 10 hr/day x 365 days/year = 272,290 kWh/year (baseline energy use – <u>Raw</u>)

<u>High Service Pump</u>: 60 hp x 0.746 kW/hp = 44.7 kW
44.7 kW x 10 hr/day x 365 days/year = 163,155 kWh/year (baseline energy use – <u>High Service</u>)

If a VFD was installed to control the pump motor, energy savings would be realized by allowing the system to run at a partial load. A load profile can be estimated using the total annual operation hours and then distributing them across several "flow fractions" that correspond to the Load Factor (sometimes referred to a Part Load Ratio or PLR). Without detailed operating analysis, this method is difficult to be accurate. For the purposes of this report, we will assume that the pump will operate at 100% for 25% of the time, at 80% for 50% of the time, and at 60% for 25% of the time. The facility may break the time down further with more accurate tracking measures if they desire. The reduced energy use related to the addition of a VFD is as follows:

<u>Raw Pump VFD</u>
(100 hp x 1.0^3 x 0.746 kW/hp x (10hr/day x 365 days/yr x .25 percent of use) = 68,073 kWh/yr
(100 hp x 0.8^3 x 0.746 kW/hp x (10hr/day x 365 days/yr x .50 percent of use) = 69,706 kWh/yr
(100 hp x 0.6^3 x 0.746 kW/hp x (10hr/day x 365 days/yr x .25 percent of use) = <u>14,704 kWh/yr</u>
Total energy use with VFD installed for Raw Pump is = 152,483 kWh/yr

<u>High Service Pump VFD</u>
(60 hp x 1.0^3 x 0.746 kW/hp x (10hr/day x 365 days/yr x .25 percent of use) = 40,844 kWh/yr
(60 hp x 0.8^3 x 0.746 kW/hp x (10hr/day x 365 days/yr x .50 percent of use) = 41,824 kWh/yr
(60 hp x 0.6^3 x 0.746 kW/hp x (10hr/day x 365 days/yr x .25 percent of use) = <u>8,822 kWh/yr</u>
Total energy use with VFD installed for High Service is = 91,490 kWh/yr

By using the PLR noted above, the proposed VFD system will provide an energy savings of 119,807 kWh/yr at the Raw Water Pump Station, and an energy savings of 91,490 kWh/yr for the 60-hp High Service Pump. This translates to roughly $9,580 and $6,090, respectively, in energy cost savings. It is noteworthy that no peak demand savings are attributed to this modification because a VFD does not prevent a system from reaching 100% load. Thus, the potential peak demands are the same for both the baseline and proposed systems.

To Install a VFD for the Raw Pump:
Power Savings: 0 kW
Electric Energy Savings: 119,807 kWh
Annual Cost Savings: $ 9,580
Estimated Project Cost: $ 20,000
Simple Payback: 2.1 years

To Install a VFD for the High Service Pump:
Power Savings: 0 kW
Electric Energy Savings: 71,665 kWh
Annual Cost Savings: $ 6,090
Estimated Project Cost: $ 20,000
Simple Payback: 3.3 years

Section 6.0 – Sustainable Energy Opportunities

An evaluation of sustainable design concepts is proposed for the owner to review and evaluate. These include community initiatives, renewable energy alternatives, and Village policies that may be able to improve the facilities environmental impact.

Personnel Behavior Changes: The staff and personnel at the facility will have the most significant impact with respect to energy use. The personnel must be comfortable in the work environment, or any modifications will be deemed unacceptable and will be changed back. This includes quality of light, climate control, noise generation, and the overall 'feel' of the work space. Working with the personnel to take responsibility for the facility, and encouraging positive changes to climate control, use of lighting, and use of electronic equipment will result in increased energy savings at the facility.

Buying 'Green': This means the selection of products and services that minimize environmental impacts. It includes the evaluation of not only the product itself, but also its lifecycle including raw materials, manufacturing processes, transportation of goods, storing, handling, the use of, and the actual disposal of the products. These include not only electronic goods (computers, lab equipment, etc.), but also cleaning products and office supplies.

Facility Vehicle Fuel Options: As new vehicles are purchased for the facility, the Village should consider hybrid or alternative fuel models.

Solar Renewable Energy: There is the potential to install solar panels to allow the facility to produce additional energy in an effort to offset the overall energy costs at the facility. If the owner is interested, we recommend contacting a professional designer to assist with this opportunity.

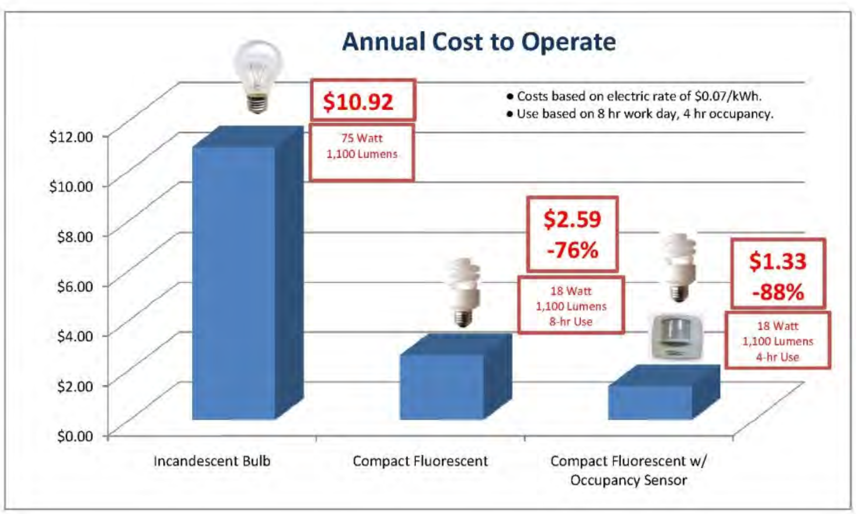
Wind Renewable Energy: There is the potential to install small wind turbines to allow the facility to produce additional energy in an effort to offset the overall energy costs. The Plant is situated in the Village, and the Raw Water Pump Station is at the reservoir, so the opportunity may or may not be feasible. If the owner is interested, we recommend contacting a professional designer to assist with this opportunity.

Section 7.0 – Additional Energy Conservation Opportunities

The following additional opportunities are herein listed for the owner to review and evaluate. Some of these opportunities will be simplistic in nature, while others will be highly complex and require the assistance of additional design professionals for development, design, and implementation. We hope that this list is thorough, however, it may spark the facility personnel into additional ideas and thought processes to further benefit the facility.

Facility Day-lighting where Appropriate: A good way to reduce the need for interior lighting is to take advantage of the natural lighting through the use of skylights or other measures. This method of lighting can lead to higher interior heat due to radiant and convective processes, which will aid the costs of heating during the winter months, but will be a detriment to cooling in the summer.

Replace Incandescent Lamps with Compact Fluorescent Lamps: There were several incandescent lamps identified in the facility. Incandescent lamps are a very inefficient source of light, with less than 10% of their energy used converted to light. In addition, they have a relatively short life (750 – 3,500 hours) and have a very high heat output. Fluorescent technology provides a much more efficient lamp, with 20% of the energy used converted to light (more than twice as efficient as incandescent). In addition, compared to the incandescent, the life expectancy is between 10-20 times greater, and with the lower heat generation and low cost, this is a strong opportunity. Compact fluorescent technology has come a long way with respect to aesthetics. By paying attention to the rated lumen output, the Color Rendering Index (CRI), and the Correlated Color Temperature (CCT), the end user will often find the change non-intrusive.



Installation of Wind Break/Shade Opportunities: Planting trees adjacent to the facility may provide for benefits at various times of the year. The use of trees near exterior doorways may help to reduce the rush of cold air to the inside, assisting the heating process. In addition, fully developed trees may provide shading in the summer months, reducing the radiant and conductive heating to assist the cooling process. There are potential downfalls to site vegetation, which may include additional maintenance (watering, raking, debris removal), storm damage, visual obstructions, or even the potential for safety concerns.

Periodic Replacement of Air Filters: All heating and cooling systems operate most efficiently when air is allowed to move with as little obstruction as possible. Keeping the filters clean and free of debris will only serve to optimize the system and conserve energy.

Lowering the Temperature of the Hot Water Heater: Hot water heaters have multiple heating settings, and most of them are set too high, which is only wasting energy. A periodic check of the temperature setting can assure that the facility is getting the temperature it needs, without being inefficient.

Energy Tracking: Tracking and trending of the facility energy use can lead to energy conservation opportunities. Seasonal fluctuations, as well as changes in loading during the day, may offer the ability to adjust settings and rates. This can be accomplished through manual tracking, the use of spreadsheets, or the implementation of SCADA equipment (Supervisory Control and Data Acquisition).

Equipment Operation and Maintenance: A well serviced, well maintained piece of equipment will always outperform and outlast a neglected one. The facility should have operation and maintenance guidelines, to include inspection, service, maintenance, and even the documentation of this process. The facility staff should already have these measures in place. It is typically only a matter of execution.

Proper Insulation of Walls and Ceilings: As stated in ECO 6, typically the cost of insulating the walls and ceilings of a facility has a very high simple payback, and the results are difficult to estimate. However, the facility staff can perform some additional insulating opportunities a portion at a time, and each area or section completed will help the overall energy use at the facility.

Minimize the Effects of Infiltration and Inflow (I&I): No system is leak-proof. It was noted that the system does experience some minor losses, recorded at 11% in 2009. All leaks increase in size and volume over time, so this issue will only become greater in the future. Perform a water audit, system inspection, and system analysis to determine where the water in your system is going. It is easy to educate the system residents on the effects of a leaky system by placing flyers in their billing invoices, and by providing community meetings periodically.

Section 8.0 – What is the Next Step?

This report outlines multiple opportunities for the Village of Cadiz to implement at their Water Treatment Facility. It is imperative that the facility must continue to meet all safety and permit requirements, with no exception. Quality treatment must never be sacrificed. There is no cost saving measure that is worth compromised treatment quality.

The opportunity costs range from zero cost to very significant investments. It is strongly recommended that the Village start with some of the lower cost opportunities, and to continue to track the electric utility bills over time. Once the Village notices some cost savings, other opportunities may become more feasible.

The Village is encouraged to include the community in this process, by updating the customers and raising awareness through various means. It is in the customer's best interest for the utility to decrease its costs, potentially avoiding unnecessary rate increases due to inefficient operations. In the event that some of the larger projects are strongly preferred, the owner is always welcome to contact Ohio RCAP for possible grant, loan, and utility incentive options.

Section 9.0 – Energy Audit Resume's

As mentioned previously, the Ohio RCAP brings a wealth of knowledge and experience to the community for the purpose of an energy audit. The team assisting the community includes:

Larry Baxa:

Larry Baxa is a graduate of Bowling Green State University, where he earned a Bachelor of Science Degree with a major in biology and a Master's Degree in Business Administration with a concentration in Finance and Economics. Previous to joining RCAP in September of 2009, he served as Village Administrator in Loudonville, Richwood, and McComb, Ohio. Larry holds current Ohio EPA licenses in Water and Wastewater, and has served as a wastewater superintendent and as a superintendent of both surface and ground water plants. Additionally, he has experience as a business manager and bank financial analyst. Larry retired from the U.S. Navy with 25 years of service on Active Duty and in the Navy Reserve. While in the Navy, he was certified as a Navy Instructor, Training Facilitator, and Material Maintenance Management coordinator. With RCAP, Larry primarily has been working with CUP$$ training (EPA Asset Management software) and as a member of the Energy Efficiency Audit Team.

Thomas Fishbaugh:

Thomas Fishbaugh is a water and wastewater operator certified in the State of Ohio for Class II facilities who retired in 2004 and came to work as a RCAP Field Agent. Tom spent over thirty years operating and managing water and wastewater systems while employed by the City of St. Mary's, Sandusky County, the Village of Republic, and the Northwestern Water and Sewer District. While at St. Mary's, Tom was an operator at the water plant. He assisted in establishing the Sanitary Engineering Department for the County of Sandusky with the development of the Rules and Regulations, Accounting Procedures, Rate Setting, and more. He was the Village Administrator in Republic and was instrumental in guiding the Village to the construction of a new wastewater collection and treatment system. Just prior to RCAP, Tom served as Superintendent for the Northwestern Water and Sewer District overseeing eighteen employees and nearly 20,000 customers. Tom is a Past-President of the Ohio County Sanitary Engineer's Association and the Ohio Water Environment Association. He also served on the Board of Directors for the Water Environment Federation. Tom is a member of WEF and a life member of AWWA.

Scott Strahley:

Scott Strahley is a graduate of Ohio Northern University with a Bachelor of Science in Civil Engineering. He has earned his professional engineering license in the State of Ohio, as well as a Certification in Energy Auditing from the Association of Energy Engineers. A native of Paulding, Ohio, Scott will focus on providing energy audits and engineering services for the rural communities in Ohio.

Appendix A - Calculations

ENERGY EFFICIENCY MEASURES - INSTALLING ENERGY-EFFICIENT LIGHTING AND CONTROLS

Most desirable energy efficient measures:

1. Retrofit Fluorescent T-12 with T-8 and Electronic Ballast
2. Replace Incandescent Bulbs with CFL Bulbs
3. Retrofit Incandescent Exit Signs with LED Exit Signs
4. Install Occupancy Sensors or other type of Control

   (Switch Control, Dimmer, Photo-Electric, Time clock, Occupancy Sensor, Daylighting)

Incandescent

Very Inefficient (10%), Short Life (750-3,500 hrs), High Heat
Low Cost, Simple, Instant Start
Replace with Tungsten Halogen or Compact Fluorescent Light (CFL)

Fluorescent

4-Times more Efficient and 10-20 Times Life than Incandescent, Low Cost, Less Heat
Ballasts can Hum and create Harmonic Distortion, Contain Mercury, Hard Cold Start
Replace Standard Ballasts with Electronic ones, Replace T-12 with T-8

Mercury Vapor (HID)

6-7% Efficient
Poor LLD, 5-7 min Warmup, Poor CRI (blue cast), 4-5 min cool and restart
Replace with Metal Halide for color issue, with high-pressure sodium otherwise

Metal Halide (HID)

General Lighting, 20,000 Lamp Life, Good Crisp White Light, 12-15% Efficient than I, F, and MV
Shorter HID Life, 2-5 min warmup, 10 min cool down, closed fixture due to breaking
Good color rendition, good for high-ceiling apps

High-Pressure Sodium

30% Efficient with good color rendition, 3-4 min warmup, 24,000 hour life
Golden yellow light, 1 min cool down, lamp cycles on and off at end of life
Yellow light may not be acceptable in all apps

Low-Pressure Sodium

Extremely Poor Color Rendition

LED

50,000 hour life...costs coming down

Lighting Schematic and Terminology

Each light fixture consists of a lamp (or bulb), and perhaps a ballast.

Each lamp converts energy (watts) to light (lumens). **Efficacy** is a ratio of lumens/watt.

A **lumen** is a measurement of the light that a lamp produces.

A **footcandle** is a measurement of the light density striking a surface (1 footcandle = 1 lumen over 1 square foot.

IES Recommended Light Levels

Task Area	Footcandles
General Offices	50-100
Conference Room	20-50
Drafting	100-200
Corridors/Stairs	10-20
Gymnasiums	30-50
Storage Rooms	10-50
Manufacturing	50-500

The primary rating system for the 'color' of light is the Color Rendering Index (**CRI**). It is a rating system from 0-100, and describes how well a light source brings out the true color of an object. A typical incandescent lamp has a CRI of 99, whereas a warm white fluorescent has a CRI of 52. Determine the appropriate CRI level for your work first!

Another parameter is the **CCT**, or Correlated Color Temperature, measured in °K. CCT is a measure of the color appearance to describe the apparent 'warmth' (reddish) or 'coolness' (bluish) of the lamp. 2700°K is considered friendly, personal, and intimate; and is appropriate for homes, libraries, restaurants. 3500°K is considered friendly, inviting, non-threatening; and is appropriate for new offices and public reception areas. 4100°K is considered neat, clean, and efficient; and is appropriate for older offices, classrooms, and merchandisers. 5000°K is considered bright, alert, exacting coloration; and is appropriate for graphics, jewelry stores, and medical exam areas.

ENERGY EFFICIENCY MEASURES - INSTALLING ENERGY-EFFICIENT FLUORESCENT LIGHTING AND OCCUPANCY SENSORS

Village of Cadiz, Ohio WTF Calculations
December 21, 2010: Date of Calculations

Legend: Input — Input data in the yellow cells
Totals — Calculated data cells for comparison and payback

$ 0.085 — $/kWh, Average Cost of Electricity
365 — Number of Operating Days per Year

5 — Number of Rooms for Occupancy Sensor

Energy Assessment for Existing Interior Fluorescent T-12 Fixtures w/ Standard Ballasts | Proposed Occupancy Sensor Installation[2]

Existing Facility	Fixture Quantity	Bulbs/ Fixture	Total Bulbs	Total Ballasts	Fixture Watts[1]	Total Watts	Op Hrs/Day	Total kWh/day	Total kWh/yr	Dollars per Day	Dollars per Year	Total Watts	Operating Hrs/Day	Total kWh/day	Total kWh/yr	Dollars per Day	Dollars per Year
Office	4	4	16	4	164	656	10	6.56	2,394	$ 0.56	$ 203.52	656	2	1.31	479	$ 0.11	$ 40.70
Lab	8	4	32	8	164	1,312	10	13.12	4,789	$ 1.12	$ 407.05	1,312	2	2.62	958	$ 0.22	$ 81.41
SCADA	4	4	16	4	164	656	10	6.56	2,394	$ 0.56	$ 203.52	656	2	1.31	479	$ 0.11	$ 40.70
Break	4	2	8	4	82	328	10	3.28	1,197	$ 0.28	$ 101.76	328	2	0.66	239	$ 0.06	$ 20.35
Locker	8	2	16	8	82	656	10	6.56	2,394	$ 0.56	$ 203.52	656	2	1.31	479	$ 0.11	$ 40.70
All Other[3]	87	2	174	87	82	7,134	8	57.07	20,831	$ 4.85	$ 1,770.66	7,134	8	57.07	20,831	$ 4.85	$ 1,770.66
Totals	115		262	115		10,742		93.15	34,000	$ 7.92	$ 2,890.04	10,742		64.29	23,465	$ 5.46	$ 1,994.54

Yearly Cost Saving = $ 895.51

[1] *Assume 2-bulb fixtures @ 82 watts, 4-bulb fixtures @ 164 watts*
[2] *Occupancy Sensors only placed in the Office, Lab, Restroom, SCADA, and Break Room. Assume 80% reduction in lighting requirement, 5 rooms total*
[3] *Consists of Pre-Treatment, Flocculation, Filter, Fluoride, Chlorine, and High Service Rooms. Operating hours are estimated at 8, some lights are on all of the time, and some are occupancy dependent*

5 — Number of Rooms for Occupancy Sensor

Energy Assessment for Proposed Retrofit of Interior Fixtures with T-8 Fluorescent Bulbs and Electronic Ballasts | Proposed Occupancy Sensor Installation[2]

Existing Facility	Fixture Quantity	Bulbs/ Fixture	Total Bulbs	Total Ballasts	Fixture Watts[3]	Total Watts	Op Hrs/Day	Total kWh/day	Total kWh/yr	Dollars per Day	Dollars per Year	Total Watts	Operating Hrs/Day	Total kWh/day	Total kWh/yr	Dollars per Day	Dollars per Year
Office	4	2	8	4	63	252	10	2.52	920	$ 0.21	$ 78.18	252	2	0.50	184	$ 0.04	$ 15.64
Lab	8	2	16	8	63	504	10	5.04	1,840	$ 0.43	$ 156.37	504	2	1.01	368	$ 0.09	$ 31.27
SCADA	4	2	8	4	63	252	10	2.52	920	$ 0.21	$ 78.18	252	2	0.50	184	$ 0.04	$ 15.64
Break	4	2	8	4	63	252	10	2.52	920	$ 0.21	$ 78.18	252	2	0.50	184	$ 0.04	$ 15.64
Locker	8	2	16	8	63	504	10	5.04	1,840	$ 0.43	$ 156.37	504	2	1.01	368	$ 0.09	$ 31.27
All Other[3]	87	2	174	87	63	5,481	8	43.85	16,005	$ 3.73	$ 1,360.38	5,481	8	43.85	16,005	$ 3.73	$ 1,360.38
						7,245		61.49	22,443	$ 5.23	$ 1,907.67	7,245			17,292	$ 4.03	$ 1,469.84

[2] *Occupancy Sensors only placed in the Office, Lab, Restroom, SCADA, and Break Room. Assume 80% reduction in lighting requirement, 5 rooms total*
[3] *T-8 Bulb fixtures estimated to be 63 watts per 2-bulb fixture*

Yearly Cost Saving = $ 982.38

Yearly Cost Saving = $ 437.82

$ 100.00 — The est. cost to purchase and install and occupancy sensor, per room
$ 40.00 — The est. cost to purchase and replace the lights and ballast, per fixture

11,557	Total kWh/year saved with Fixture Retrofit
10,535	Total kWh/year saved with Occupancy Sensor (no Retrofit)
$ 895.51	Total Saved per Year with Occupancy Sensor Installation
$ 982.38	Total Saved per Year with Fixture Retrofit
$ 1,420.20	Total Saved per Year with Fixture Retrofit and Sensor Installation

Simple Payback Calculations:

$ 500	Cost of Measure	0.56	years for Simple Payback
$ 4,600	Cost of Measure	4.68	years for Simple Payback
$ 5,100	Cost of Measure	3.59	years for Simple Payback

Note: All calculations are based on assumptions and standard values. Actual figures will be based on manufacturer, installation, and actual use.

ENERGY EFFICIENCY MEASURES - INSTALLING ENERGY-EFFICIENT LED LIGHTED EXIT SIGNS

Village of Cadiz, Ohio WTF Calculations

December 21, 2010: Date of Calculations

Legend: Input — Input data in the yellow cells; Totals — Calculated data cells for comparison and payback

$ 0.085	$/kWh, Average Cost of Electricity
365	Number of Operating Days per Year

Energy Assessment for Existing Interior Incandescent Exit Signs

Existing Facility	Fixture Quantity	Bulbs per Fixture	Total Bulbs	Fixture Watts[1]	Total Watts	Operating Hrs/Day	Total kWh/day	Dollars per Day	Total kWh/yr	Dollars per Year
Plant/Garage	5	2	10	30	150	24	3.6	$ 0.31	1314	$ 111.69
Totals	5		10		150		3.6	$ 0.31	1314	$ 111.69

[1] *Assume fixtures with 2 bulbs @ 15 watts each*

Energy Assessment for Proposed Retrofit of Interior Fixtures with T-8 Fluorescent Bulbs and Electronic Ballasts

Existing Facility	Fixture Quantity	Bulbs per Fixture	Total Bulbs	Fixture Watts[2]	Total Watts	Operating Hrs/Day	Total kWh/day	Dollars per Day	Total kWh/yr	Dollars per Year
Office	5	n/a	n/a	2	10	24	0.24	$ 0.02	88	$ 7.45
					10		0.24	$ 0.02	88	$ 7.45

[2] *LED Bulb fixtures estimated to be 2 watts per fixture*

1,226	Total kWh/year saved with Fixture Retrofit
$ 0.29	Total Saved per Day with Fixture Retrofit
$ 104.24	Total Saved per Year with Fixture Retrofit

$ 40.00 — The est. cost to purchase and replace the exit signs, per fixture

Simple Payback Calculations:

$ 200 — Cost of Measure; 1.92 — years for Simple Payback

Note: All calculations are based on assumptions and standard values. Actual figures will be based on manufacturer, installation, and actual use.

ENERGY EFFICIENCY MEASURES - INSTALLING ENERGY-EFFICIENT MOTORS; 60 Hp MOTOR

Village of Cadiz, Ohio WTF Calculations
December 21, 2010: Date of Calculations

Legend: Input — Input data in the yellow cells

Annual Savings Based On:

$ 0.085	$/kWh, Average Cost of Electricity
10	Number of Operating Hours per Day
365	Number of Operating Days per Year
75%	Estimated Loading Factor

Potential Savings for Premium Efficiency Motors

			Pre - Retrofit			Post - Retrofit							
Motor hp	Est. Annual Hours	Est. Loading Factor	Est. [1] Efficiency	Full-Load Input(kW)	Est. Input(kW)	NEMA Rated [2] Efficiency	Rated Full-Load Input(kW)	Est. Input(kW)	Power Savings (kW)	Annual Energy Savings (kWh)	Annual Cost Savings ($)	Est. Motor Cost $	Simple Payback years
1.0	3650	75%	75%	0.99	0.75	85.5%	0.87	0.65	0.09	334	$ 28.42		
1.5	3650	75%	77%	1.45	1.09	86.5%	1.29	0.97	0.12	437	$ 37.14		
2.0	3650	75%	79%	1.89	1.42	86.5%	1.72	1.29	0.12	448	$ 38.10		
3.0	3650	75%	81%	2.76	2.07	89.5%	2.50	1.88	0.20	718	$ 61.06		
5.0	3650	75%	82%	4.55	3.41	89.5%	4.17	3.13	0.29	1,043	$ 88.70		
7.5	3650	75%	84%	6.66	5.00	91.7%	6.10	4.58	0.42	1,531	$ 130.14		
10.0	3650	75%	85%	8.78	6.58	91.7%	8.14	6.10	0.48	1,755	$ 149.21		
15.0	3650	75%	86%	13.01	9.76	92.4%	12.11	9.08	0.68	2,467	$ 209.71		
20.0	3650	75%	87%	17.15	12.86	93.0%	16.04	12.03	0.83	3,029	$ 257.45		
25.0	3650	75%	88%	21.19	15.89	93.6%	19.93	14.94	0.95	3,471	$ 295.04		
30.0	3650	75%	89%	25.15	18.86	93.6%	23.91	17.93	0.93	3,383	$ 287.56		
40.0	3650	75%	89%	33.53	25.15	94.1%	31.71	23.78	1.36	4,974	$ 422.83		
50.0	3650	75%	89%	41.91	31.43	94.5%	39.47	29.60	1.83	6,677	$ 567.57		
60.0	3650	75%	89%	50.29	37.72	95.0%	47.12	35.34	2.38	8,695	$ 739.10	$ 5,000	6.77
75.0	3650	75%	90%	62.17	46.63	95.4%	58.65	43.99	2.64	9,633	$ 818.80		
100.0	3650	75%	90%	82.89	62.17	95.4%	78.20	58.65	3.52	12,844	$ 1,091.73		
125.0	3650	75%	90%	103.61	77.71	95.4%	97.75	73.31	4.40	16,055	$ 1,364.66		
150.0	3650	75%	91%	122.97	92.23	95.8%	116.81	87.60	4.62	16,866	$ 1,433.63		
200.0	3650	75%	91%	163.96	122.97	95.8%	155.74	116.81	6.16	22,488	$ 1,911.51		

Notes:
[1] Existing efficiency based on ASHRAE Fundamentals
[2] Proposed efficiency based on NEMA nominal efficiencies for premium efficiency motors

Appendix B – Energy Data

Customer: Cadiz Water & Sewer **Analysis Date:** October 19, 2010

G-1 **Acct #:** 11125537-001-000-9 **Service Provider:** Columbia Gas of Ohio

Meter Number: 9220384 - W. Warren Street **Customer CHOICE Progam**

Billing Month	Gas Used (Ccf)	Equiv Therm (Therm)[1]	Energy Used (kWh)			Reading Act/ Est	Energy Cost ($)	Energy Cost/kWh ($)
10/14/2009	360	369	10812	/	/	Est	$ 314.06	$ 0.029
11/12/2009	723	741	21713	/	/	Act	$ 746.75	$ 0.034
12/15/2009	1350	1384	40544	/	/	Est	$ 1,273.46	$ 0.031
1/18/2010	2600	2665	78085	/	/	Act	$ 2,806.90	$ 0.036
2/16/2010	2035	2086	61116	/	/	Est	$ 2,063.38	$ 0.034
3/17/2010	2158	2212	64810	/	/	Act	$ 2,122.34	$ 0.033
4/16/2010	624	640	18740	/	/	Est	$ 602.02	$ 0.032
5/17/2010	872	894	26188	/	/	Act	$ 740.26	$ 0.028
6/16/2010	123	126	3694	/	/	Est	$ 137.68	$ 0.037
7/16/2010	108	111	3244	/	/	Act	$ 137.79	$ 0.042
8/16/2010	84	86	2523	/	/	Est	$ 110.82	$ 0.044
9/15/2010	35	36	1051	/	/	Act	$ 63.29	$ 0.060
Total 12	11072		332520				$ 11,118.75	$ 0.033
Month Average	923		27710				$ 926.56	$ 0.033

[1] Thermal Factors vary due to quality, temperature, fuel line pressures, etc.

E-1 **Acct #:** 072-388-216-0-2 **Service Provider:** AEP Ohio

Meter Number: 428107911 **Raw Water, Tappan Res. Tariff 215 - Medium General Service**

Billing Month	Energy Use (kWh)	Energy Demand (kW)	Power Factor	Power Factor Constant	Multiplier	Reading Act/ Est	Energy Cost ($)	Energy Cost/kWh ($)
9/8/2009	26880	82.400	100	0.9510	40.0	Act	$ 2,023.61	$ 0.075
10/7/2009	24880	84.880	100	0.9510	40.0	Act	$ 1,910.85	$ 0.077
11/5/2009	26760	91.040	100	0.9510	40.0	Act	$ 2,051.37	$ 0.077
12/8/2009	27600	83.840	100	0.9510	40.0	Act	$ 2,073.61	$ 0.075
1/13/2010	31000	88.440	100	0.9510	40.0	Est	$ 2,488.65	$ 0.080
2/9/2010	29320	85.720	100	0.9510	40.0	Est	$ 2,364.62	$ 0.081
3/11/2010	26720	85.720	100	0.9510	40.0	Act	$ 2,190.43	$ 0.082
4/9/2010	24440	81.400	100	0.9510	40.0	Act	$ 2,019.48	$ 0.083
5/10/2010	24240	81.400	100	0.9510	40.0	Act	$ 2,006.10	$ 0.083
6/9/2010	26000	83.240	100	0.9510	40.0	Act	$ 2,199.44	$ 0.085
7/9/2010	25400	83.240	100	0.9510	40.0	Act	$ 2,100.89	$ 0.083
8/9/2010	27040	75.160	100	0.9510	40.0	Act	$ 2,181.28	$ 0.081
Total 12	320280	1006.480					$ 25,610.33	$ 0.080
Month Average	26690	91.498					$ 2,134.19	$ 0.080

E-2 **Acct #:** 074-479-200-0 **Service Provider:** AEP Ohio

Meter Number: 86404475 **Water Plant, W Warren St, Cadiz**

Billing Month	Energy Use (kWh)	Energy Demand (kW)	Power Factor	Power Factor Constant	Multiplier	Reading Act/ Est	Energy Cost ($)	Energy Cost/kWh ($)
8/24/2009	30000	/	75.8	1.0453	200.0	RC	$ 2,423.81	$ 0.081
9/23/2009	33000	/	74.4	1.0536	200.0	RC	$ 2,616.08	$ 0.079
10/22/2009	27200	/	73.4	1.0604	200.0	RC	$ 2,256.60	$ 0.083
11/20/2009	28000	/	75.1	1.0494	200.0	RC	$ 2,306.55	$ 0.082
12/23/2009	28000	/	75.9	1.0447	200.0	RC	$ 2,308.56	$ 0.082
1/26/2010	32400	/	77.3	1.0369	200.0	RC	$ 2,786.30	$ 0.086
2/24/2010	30000	/	77.3	1.0367	200.0	RC	$ 2,616.57	$ 0.087
3/25/2010	30800	/	76.7	1.0405	200.0	RC	$ 2,605.31	$ 0.085
4/26/2010	27600	/	74.9	1.0506	200.0	RC	$ 2,472.99	$ 0.090
5/26/2010	25800	/	73.8	1.0577	200.0	RC	$ 2,338.89	$ 0.091
6/25/2010	28600	/	74.3	1.0548	200.0	RC	$ 2,618.90	$ 0.092
7/26/2010	33600	/	75.9	1.0447	200.0	Est	$ 2,870.74	$ 0.085
Total 12	355000						$ 30,221.30	$ 0.085
Month Average	29583						$ 2,518.44	$ 0.085

E-3 **Acct #:** 077-857-691-0 **Service Provider:** AEP Ohio

Meter Number: 436041825 **New Garage at W. Warren St.**

Billing Month	Energy Use (kWh)	Energy Demand (kW)	Power Factor	Power Factor Constant	Multiplier	Reading Act/ Est	Energy Cost ($)	Energy Cost/kWh ($)
8/24/2009	66	/	/	/	/	RC	$ 19.30	$ 0.292
8/24/2009	71	/	/	/	/	RC	$ 19.39	$ 0.273
9/23/2009	82	/	/	/	/	RC	$ 20.19	$ 0.246
10/22/2009	63	/	/	/	/	RC	$ 18.82	$ 0.299
11/20/2009	103	/	/	/	/	RC	$ 21.72	$ 0.211
12/23/2009	137	/	/	/	/	RC	$ 24.17	$ 0.176
1/26/2010	160	/	/	/	/	RC	$ 27.76	$ 0.174
2/24/2010	81	/	/	/	/	RC	$ 21.52	$ 0.266
3/25/2010	77	/	/	/	/	RC	$ 21.20	$ 0.275
4/26/2010	64	/	/	/	/	RC	$ 20.16	$ 0.315
5/26/2010	56	/	/	/	/	RC	$ 19.53	$ 0.349
6/25/2010	56	/	/	/	/	RC	$ 19.68	$ 0.351
7/26/2010	78	/	/	/	/	RC	$ 21.42	$ 0.275
Total 13	1094						$ 274.86	$ 0.251
Month Average	84						$ 21.14	$ 0.251
Estimated Yearly Total	1010						$ 253.72	$ 0.251

E-4 **Acct #:** 09-811-281-003-000-9 **Service Provider:** South Central Power Co
Meter Number: 100075840 **Water Tower, Grant Street**

	Billing Month	Energy Use (kWh)	Energy Demand (kW)	Power Factor	Power Factor Constant	Multiplier	Reading Act/ Est	Energy Cost ($)	Energy Cost/kWh ($)
	8/24/2009	44	0	/	/	1.0	CO	$ 20.50	$ 0.466
	9/24/2009	42	0	/	/	1.0	CO	$ 20.50	$ 0.488
	10/24/2009	42	0	/	/	1.0	CO	$ 20.50	$ 0.488
	11/24/2009	31	0	/	/	1.0	CO	$ 20.50	$ 0.661
	12/24/2009	33	0	/	/	1.0	CO	$ 20.50	$ 0.621
	1/24/2010	40	0	/	/	1.0	CO	$ 20.50	$ 0.513
	2/24/2010	40	0	/	/	1.0	CO	$ 20.50	$ 0.513
	3/23/2010	30	0	/	/	1.0	CO	$ 20.50	$ 0.683
	4/24/2010	35	0	/	/	1.0	CO	$ 20.50	$ 0.586
	5/24/2010	45	0	/	/	1.0	CO	$ 20.50	$ 0.456
	6/24/2010	38	0	/	/	1.0	CO	$ 20.50	$ 0.539
	7/24/2010	67	0	/	/	1.0	CO	$ 20.50	$ 0.306
Total	12	487						$ 246.00	$ 0.505
Month Average		41						$ 20.50	$ 0.505

E-5 **Acct #:** 075-569-996-0 **Service Provider:** AEP Ohio
Meter Number: 533602358 **Water Tank, Dennison Ave, Cadiz**

	Billing Month	Energy Use (kWh)	Energy Demand (kW)	Power Factor	Power Factor Constant	Multiplier	Reading Act/ Est	Energy Cost ($)	Energy Cost/kWh ($)
	8/24/2009	7	/	/	/	/	RC	$ 14.76	$ 2.109
	9/23/2009	9	/	/	/	/	RC	$ 14.89	$ 1.654
	10/22/2009	9	/	/	/	/	RC	$ 14.89	$ 1.654
	11/20/2009	8	/	/	/	/	RC	$ 14.84	$ 1.855
	12/23/2009	10	/	/	/	/	RC	$ 14.98	$ 1.498
	1/26/2010	13	/	/	/	/	RC	$ 16.11	$ 1.239
	2/24/2010	11	/	/	/	/	RC	$ 15.97	$ 1.452
	3/25/2010	10	/	/	/	/	RC	$ 15.89	$ 1.589
	4/26/2010	9	/	/	/	/	RC	$ 15.79	$ 1.754
	5/26/2010	8	/	/	/	/	RC	$ 15.72	$ 1.965
	6/25/2010	8	/	/	/	/	RC	$ 15.74	$ 1.968
	7/26/2010	8	/	/	/	/	RC	$ 15.73	$ 1.966
Total	12	110						$ 185.31	$ 1.685
Month Average		9						$ 15.44	$ 1.685

E-6 **Acct #:** 072-142-007-0 **Service Provider:** AEP Ohio

Meter Number: 38518841 **Water Pump Sta, Cambridge Road, Cadiz**

	Billing Month	Energy Use (kWh)	Energy Demand (kW)	Power Factor	Power Factor Constant	Multiplier	Reading Act/ Est	Energy Cost ($)	Energy Cost/kWh ($)
	8/24/2009	0	/	/	40.0000	/	RC	$ 14.24	$ -
	9/23/2009	0	/	/	40.0000	/	RC	$ 14.24	$ -
	10/22/2009	0	/	/	40.0000	/	RC	$ 14.24	$ -
	11/20/2009	0	/	/	40.0000	/	RC	$ 14.24	$ -
	12/23/2009	640	/	/	40.0000	/	RC	$ 60.64	$ 0.095
	1/26/2010	0	/	/	40.0000	/	RC	$ 15.08	$ -
	2/24/2010	0	/	/	40.0000	/	RC	$ 15.08	$ -
	3/25/2010	0	/	/	40.0000	/	RC	$ 15.08	$ -
	4/26/2010	0	/	/	40.0000	/	RC	$ 15.08	$ -
	5/26/2010	0	/	/	40.0000	/	RC	$ 15.08	$ -
	6/25/2010	0	/	/	40.0000	/	RC	$ 15.08	$ -
	7/26/2010	640	/	/	40.0000	/	RC	$ 67.07	$ 0.105
Total	12	1280						$ 275.15	$ 0.215
Month Average		107						$ 22.93	$ 0.215

E-7 **Acct #:** 074-045-010-0 **Service Provider:** AEP Ohio

Meter Number: 83730118 **Water Pump, Reservoir Ln, Cadiz**

	Billing Month	Energy Use (kWh)	Energy Demand (kW)	Power Factor	Power Factor Constant	Multiplier	Reading Act/ Est	Energy Cost ($)	Energy Cost/kWh ($)
	8/24/2009	34	/	/	/	/	RC	$ 16.71	$ 0.491
	9/23/2009	38	/	/	/	/	RC	$ 17.00	$ 0.447
	10/22/2009	714	/	/	/	/	RC	$ 65.99	$ 0.092
	11/20/2009	688	/	/	/	/	RC	$ 64.11	$ 0.093
	12/23/2009	1223	/	/	/	/	RC	$ 102.88	$ 0.084
	1/26/2010	1284	/	/	/	/	RC	$ 116.86	$ 0.091
	2/24/2010	1144	/	/	/	/	RC	$ 105.75	$ 0.092
	3/25/2010	897	/	/	/	/	RC	$ 86.18	$ 0.096
	4/26/2010	993	/	/	/	/	Est	$ 93.80	$ 0.094
	5/26/2010	438	/	/	/	/	RC	$ 49.81	$ 0.114
	6/25/2010	/	/	/	/	/	/	/	/
	7/26/2010	65	/	/	/	/	RC	$ 24.35	$ 0.375
Total	11	7518						$ 743.44	$ 0.099
Month Average		683						$ 67.59	$ 0.099
		8201						$ 811.03	$ 0.099

E-8 **Acct #:** 076-272-996-0 **Service Provider:** AEP Ohio

Meter Number: 428640077 **Water Pump, Reservoir Ln, Cadiz**

	Billing Month	Energy Use (kWh)	Energy Demand (kW)	Power Factor	Power Factor Constant	Multiplier	Reading Act/ Est	Energy Cost ($)	Energy Cost/kWh ($)
	8/24/2009	894	/	/	/	/	RC	$ 79.04	$ 0.088
	9/23/2009	1011	/	/	/	/	RC	$ 87.52	$ 0.087
	10/22/2009	1012	/	/	/	/	RC	$ 87.59	$ 0.087
	11/20/2009	941	/	/	/	/	RC	$ 82.45	$ 0.088
	12/23/2009	1173	/	/	/	/	RC	$ 99.25	$ 0.085
	1/26/2010	1232	/	/	/	/	RC	$ 112.73	$ 0.092
	2/24/2010	981	/	/	/	/	Est	$ 92.85	$ 0.095
	3/25/2010	951	/	/	/	/	Est	$ 90.45	$ 0.095
	4/26/2010	347	/	/	/	/	Est	$ 42.58	$ 0.123
	5/26/2010	72	/	/	/	/	RC	$ 20.79	$ 0.289
	6/25/2010	0	/	/	/	/	RC	$ -	$ -
	7/26/2010	0	/	/	/	/	RC	$ 293.99	$ -
Total	12	8614						$ 1,089.24	$ 0.126
Month Average		718						$ 90.77	$ 0.126

	Electric	Gas(Ccf)		
Site Year Total	**1027502**	11072	**$ 69,810.82**	**$ 0.068**

Cadiz Water and Sewer - Water Energy Costs

	Account	Meter #	Location	Yearly kWh	Yearly $	Yearly $/kWh
G-1	11125537-001-000-9 Gas converted to kWh	9220384	Water Plant W. Warren Street	332,520	$ 11,118.75	$ 0.033
E-1	072-388-216-0-2	428107911	Raw Water, Tappan Facility Tariff 215-Med Gen Serv	320,280	$ 25,610.33	$ 0.080
E-2	074-479-200-0	86404475	Water Plant W Warren St, Cadiz	355,000	$ 30,221.30	$ 0.085
E-3	077-857-691-0	436041825	New Garage W. Warren Street	1,010	$ 253.72	$ 0.251
E-4	09-811-281-003-000-9	100075840	Water Tower, Grant St. South Central Power	487	$ 246.00	$ 0.505
E-5	075-569-996-0	533602358	Water Tank, Edgar Hill Dennison Ave, Cadiz	110	$ 185.31	$ 1.685
E-6	072-142-007-0	38518841	Water Pump Station Cambridge Rd, Cadiz	1,280	$ 275.15	$ 0.215
E-7	074-045-010-0	83730118	Water Pump Reservoir Lane, Cadiz	8,201	$ 811.03	$ 0.099
E-8	076-272-996-0	428640077	Water Pump Reservoir Lane, Cadiz	8,614	$ 1,089.24	$ 0.126
			Total Cumulative Metered Uses for Water Utility	1,027,502	$ 69,810.82	$ 0.068
			Total Cumulative Metered Non-Well Uses for Water Utility	1,009,407	$ 67,635.41	$ 0.067
			Total Cumulative Metered Electrical Uses for Water Utility	694,982	$ 58,692.07	$ 0.084

G-1 The heating cost may be high, but further study is warranted, $11k/yr
E-6 The Pump Station was run 2 times in the time period studied, in Dec '09 and July '10
E-7 In the billing statements submitted, there was no usage recorded for 06/2010
E-8 The Water Pump usage drops to zero in 05/2010, and remains at zero thru 07/2010.

Appendix C – Facility Data

Table DP-1. Profile of General Demographic Characteristics: 2000

Geographic Area: Cadiz village, Ohio

[For information on confidentiality protection, nonsampling error, and definitions, see text]

Subject	Number	Percent
Total population	**3,308**	**100.0**
SEX AND AGE		
Male	1,493	45.1
Female	1,815	54.9
Under 5 years	202	6.1
5 to 9 years	194	5.9
10 to 14 years	218	6.6
15 to 19 years	195	5.9
20 to 24 years	178	5.4
25 to 34 years	353	10.7
35 to 44 years	428	12.9
45 to 54 years	502	15.2
55 to 59 years	178	5.4
60 to 64 years	168	5.1
65 to 74 years	301	9.1
75 to 84 years	268	8.1
85 years and over	123	3.7
Median age (years)	42.6	(X)
18 years and over	2,569	77.7
Male	1,121	33.9
Female	1,448	43.8
21 years and over	2,456	74.2
62 years and over	795	24.0
65 years and over	692	20.9
Male	246	7.4
Female	446	13.5
RACE		
One race	3,217	97.2
White	2,901	87.7
Black or African American	297	9.0
American Indian and Alaska Native	-	-
Asian	13	0.4
Asian Indian	5	0.2
Chinese	-	-
Filipino	5	0.2
Japanese	2	0.1
Korean	1	-
Vietnamese	-	-
Other Asian [1]	-	-
Native Hawaiian and Other Pacific Islander	1	-
Native Hawaiian	1	-
Guamanian or Chamorro	-	-
Samoan	-	-
Other Pacific Islander [2]	-	-
Some other race	5	0.2
Two or more races	91	2.8
Race alone or in combination with one or more other races: [3]		
White	2,989	90.4
Black or African American	380	11.5
American Indian and Alaska Native	8	0.2
Asian	15	0.5
Native Hawaiian and Other Pacific Islander	2	0.1
Some other race	8	0.2

Subject	Number	Percent
HISPANIC OR LATINO AND RACE		
Total population	**3,308**	**100.0**
Hispanic or Latino (of any race)	9	0.3
Mexican	3	0.1
Puerto Rican	4	0.1
Cuban	-	-
Other Hispanic or Latino	2	0.1
Not Hispanic or Latino	3,299	99.7
White alone	2,896	87.5
RELATIONSHIP		
Total population	**3,308**	**100.0**
In households	3,196	96.6
Householder	1,391	42.0
Spouse	684	20.7
Child	892	27.0
Own child under 18 years	686	20.7
Other relatives	118	3.6
Under 18 years	43	1.3
Nonrelatives	111	3.4
Unmarried partner	75	2.3
In group quarters	112	3.4
Institutionalized population	112	3.4
Noninstitutionalized population	-	-
HOUSEHOLD BY TYPE		
Total households	**1,391**	**100.0**
Family households (families)	917	65.9
With own children under 18 years	393	28.3
Married-couple family	684	49.2
With own children under 18 years	250	18.0
Female householder, no husband present	185	13.3
With own children under 18 years	122	8.8
Nonfamily households	474	34.1
Householder living alone	430	30.9
Householder 65 years and over	223	16.0
Households with individuals under 18 years	419	30.1
Households with individuals 65 years and over	445	32.0
Average household size	2.30	(X)
Average family size	2.85	(X)
HOUSING OCCUPANCY		
Total housing units	**1,524**	**100.0**
Occupied housing units	1,391	91.3
Vacant housing units	133	8.7
For seasonal, recreational, or occasional use	11	0.7
Homeowner vacancy rate (percent)	2.2	(X)
Rental vacancy rate (percent)	10.0	(X)
HOUSING TENURE		
Occupied housing units	**1,391**	**100.0**
Owner-occupied housing units	922	66.3
Renter-occupied housing units	469	33.7
Average household size of owner-occupied units	2.28	(X)
Average household size of renter-occupied units	2.33	(X)

- Represents zero or rounds to zero. (X) Not applicable.

[1] Other Asian alone, or two or more Asian categories.

[2] Other Pacific Islander alone, or two or more Native Hawaiian and Other Pacific Islander categories.

[3] In combination with one or more of the other races listed. The six numbers may add to more than the total population and the six percentages may add to more than 100 percent because individuals may report more than one race.

Source: U.S. Census Bureau, Census 2000.

1

U.S. Census Bureau

Table DP-2. Profile of Selected Social Characteristics: 2000

Geographic area: Cadiz village, Ohio

[Data based on a sample. For information on confidentiality protection, sampling error, nonsampling error, and definitions, see text]

Subject	Number	Percent	Subject	Number	Percent
SCHOOL ENROLLMENT			**NATIVITY AND PLACE OF BIRTH**		
Population 3 years and over enrolled in school	**633**	**100.0**	**Total population**	**3,270**	**100.0**
Nursery school, preschool	26	4.1	Native	3,236	99.0
Kindergarten	24	3.8	Born in United States	3,236	99.0
Elementary school (grades 1-8)	347	54.8	State of residence	2,412	73.8
High school (grades 9-12)	172	27.2	Different state	824	25.2
College or graduate school	64	10.1	Born outside United States	-	-
			Foreign born	34	1.0
EDUCATIONAL ATTAINMENT			Entered 1990 to March 2000	10	0.3
Population 25 years and over	**2,306**	**100.0**	Naturalized citizen	29	0.9
Less than 9th grade	162	7.0	Not a citizen	5	0.2
9th to 12th grade, no diploma	267	11.6			
High school graduate (includes equivalency)	1,061	46.0	**REGION OF BIRTH OF FOREIGN BORN**		
Some college, no degree	386	16.7	**Total (excluding born at sea)**	**34**	**100.0**
Associate degree	188	8.2	Europe	18	52.9
Bachelor's degree	136	5.9	Asia	16	47.1
Graduate or professional degree	106	4.6	Africa	-	-
			Oceania	-	-
Percent high school graduate or higher	81.4	(X)	Latin America	-	-
Percent bachelor's degree or higher	10.5	(X)	Northern America	-	-
MARITAL STATUS			**LANGUAGE SPOKEN AT HOME**		
Population 15 years and over	**2,682**	**100.0**	**Population 5 years and over**	**3,076**	**100.0**
Never married	489	18.2	English only	2,972	96.6
Now married, except separated	1,555	58.0	Language other than English	104	3.4
Separated	48	1.8	Speak English less than "very well"	32	1.0
Widowed	320	11.9	Spanish	37	1.2
Female	255	9.5	Speak English less than "very well"	10	0.3
Divorced	270	10.1	Other Indo-European languages	44	1.4
Female	173	6.5	Speak English less than "very well"	22	0.7
			Asian and Pacific Island languages	-	-
GRANDPARENTS AS CAREGIVERS			Speak English less than "very well"	-	-
Grandparent living in household with one or more own grandchildren under 18 years	**44**	**100.0**	**ANCESTRY (single or multiple)**		
Grandparent responsible for grandchildren	12	27.3	**Total population**	**3,270**	**100.0**
			Total ancestries reported	*3,147*	*96.2*
VETERAN STATUS			Arab	23	0.7
Civilian population 18 years and over	**2,548**	**100.0**	Czech[1]	11	0.3
Civilian veterans	501	19.7	Danish	17	0.5
			Dutch	114	3.5
DISABILITY STATUS OF THE CIVILIAN NONINSTITUTIONALIZED POPULATION			English	391	12.0
Population 5 to 20 years	**615**	**100.0**	French (except Basque)[1]	84	2.6
With a disability	32	5.2	French Canadian[1]	-	-
			German	509	15.6
Population 21 to 64 years	**1,744**	**100.0**	Greek	25	0.8
With a disability	332	19.0	Hungarian	52	1.6
Percent employed	42.5	(X)	Irish[1]	348	10.6
No disability	1,412	81.0	Italian	106	3.2
Percent employed	78.1	(X)	Lithuanian	-	-
			Norwegian	7	0.2
Population 65 years and over	**605**	**100.0**	Polish	219	6.7
With a disability	230	38.0	Portuguese	-	-
			Russian	7	0.2
RESIDENCE IN 1995			Scotch-Irish	167	5.1
Population 5 years and over	**3,076**	**100.0**	Scottish	123	3.8
Same house in 1995	1,793	58.3	Slovak	5	0.2
Different house in the U.S. in 1995	1,230	40.0	Subsaharan African	-	-
Same county	879	28.6	Swedish	11	0.3
Different county	351	11.4	Swiss	13	0.4
Same state	249	8.1	Ukrainian	-	-
Different state	102	3.3	United States or American	405	12.4
Elsewhere in 1995	53	1.7	Welsh	51	1.6
			West Indian (excluding Hispanic groups)	-	-
			Other ancestries	459	14.0

-Represents zero or rounds to zero. (X) Not applicable.

[1]The data represent a combination of two ancestries shown separately in Summary File 3. Czech includes Czechoslovakian. French includes Alsatian. French Canadian includes Acadian/Cajun. Irish includes Celtic.

Source: U.S. Bureau of the Census, Census 2000.

2

U.S. Census Bureau

Table DP-3. Profile of Selected Economic Characteristics: 2000

Geographic area: Cadiz village, Ohio

[Data based on a sample. For information on confidentiality protection, sampling error, nonsampling error, and definitions, see text]

Subject	Number	Percent
EMPLOYMENT STATUS		
Population 16 years and over	**2,642**	**100.0**
In labor force	1,457	55.1
Civilian labor force	1,457	55.1
Employed	1,422	53.8
Unemployed	35	1.3
Percent of civilian labor force	2.4	(X)
Armed Forces	-	-
Not in labor force	1,185	44.9
Females 16 years and over	**1,468**	**100.0**
In labor force	708	48.2
Civilian labor force	708	48.2
Employed	685	46.7
Own children under 6 years	**205**	**100.0**
All parents in family in labor force	90	43.9
COMMUTING TO WORK		
Workers 16 years and over	**1,412**	**100.0**
Car, truck, or van - - drove alone	1,189	84.2
Car, truck, or van - - carpooled	121	8.6
Public transportation (including taxicab)	-	-
Walked	53	3.8
Other means	-	-
Worked at home	49	3.5
Mean travel time to work (minutes)[1]	22.3	(X)
Employed civilian population 16 years and over	**1,422**	**100.0**
OCCUPATION		
Management, professional, and related occupations	283	19.9
Service occupations	255	17.9
Sales and office occupations	366	25.7
Farming, fishing, and forestry occupations	16	1.1
Construction, extraction, and maintenance occupations	190	13.4
Production, transportation, and material moving occupations	312	21.9
INDUSTRY		
Agriculture, forestry, fishing and hunting, and mining	67	4.7
Construction	81	5.7
Manufacturing	238	16.7
Wholesale trade	76	5.3
Retail trade	124	8.7
Transportation and warehousing, and utilities	78	5.5
Information	13	0.9
Finance, insurance, real estate, and rental and leasing	65	4.6
Professional, scientific, management, administrative, and waste management services	81	5.7
Educational, health and social services	333	23.4
Arts, entertainment, recreation, accommodation and food services	91	6.4
Other services (except public administration)	103	7.2
Public administration	72	5.1
CLASS OF WORKER		
Private wage and salary workers	1,091	76.7
Government workers	205	14.4
Self-employed workers in own not incorporated business	126	8.9
Unpaid family workers	-	-

Subject	Number	Percent
INCOME IN 1999		
Households	**1,388**	**100.0**
Less than $10,000	157	11.3
$10,000 to $14,999	164	11.8
$15,000 to $24,999	245	17.7
$25,000 to $34,999	223	16.1
$35,000 to $49,999	246	17.7
$50,000 to $74,999	203	14.6
$75,000 to $99,999	63	4.5
$100,000 to $149,999	45	3.2
$150,000 to $199,999	30	2.2
$200,000 or more	12	0.9
Median household income (dollars)	29,518	(X)
With earnings	959	69.1
Mean earnings (dollars)[1]	41,824	(X)
With Social Security income	482	34.7
Mean Social Security income (dollars)[1]	10,711	(X)
With Supplemental Security Income	120	8.6
Mean Supplemental Security Income (dollars)[1]	7,335	(X)
With public assistance income	45	3.2
Mean public assistance income (dollars)[1]	1,961	(X)
With retirement income	352	25.4
Mean retirement income (dollars)[1]	16,161	(X)
Families	**925**	**100.0**
Less than $10,000	53	5.7
$10,000 to $14,999	54	5.8
$15,000 to $24,999	131	14.2
$25,000 to $34,999	161	17.4
$35,000 to $49,999	216	23.4
$50,000 to $74,999	175	18.9
$75,000 to $99,999	48	5.2
$100,000 to $149,999	45	4.9
$150,000 to $199,999	30	3.2
$200,000 or more	12	1.3
Median family income (dollars)	42,049	(X)
Per capita income (dollars)[1]	17,405	(X)
Median earnings (dollars):		
Male full-time, year-round workers	33,233	(X)
Female full-time, year-round workers	17,192	(X)

Subject	Number below poverty level	Percent below poverty level
POVERTY STATUS IN 1999		
Families	**116**	**12.5**
With related children under 18 years	82	19.5
With related children under 5 years	33	24.4
Families with female householder, no husband present	**48**	**35.3**
With related children under 18 years	48	46.2
With related children under 5 years	24	88.9
Individuals	**497**	**15.7**
18 years and over	322	13.2
65 years and over	54	8.9
Related children under 18 years	175	24.2
Related children 5 to 17 years	122	23.1
Unrelated individuals 15 years and over	113	21.5

-Represents zero or rounds to zero. (X) Not applicable.

[1]If the denominator of a mean value or per capita value is less than 30, then that value is calculated using a rounded aggregate in the numerator. See text.

Source: U.S. Bureau of the Census, Census 2000.

3

U.S. Census Bureau

Table DP-4. Profile of Selected Housing Characteristics: 2000
Geographic area: Cadiz village, Ohio
[Data based on a sample. For information on confidentiality protection, sampling error, nonsampling error, and definitions, see text]

Subject	Number	Percent	Subject	Number	Percent
Total housing units	**1,512**	**100.0**	**OCCUPANTS PER ROOM**		
UNITS IN STRUCTURE			**Occupied housing units**	**1,380**	**100.0**
1-unit, detached	1,057	69.9	1.00 or less	1,367	99.1
1-unit, attached	28	1.9	1.01 to 1.50	13	0.9
2 units	99	6.5	1.51 or more	-	-
3 or 4 units	111	7.3			
5 to 9 units	64	4.2	**Specified owner-occupied units**	**779**	**100.0**
10 to 19 units	8	0.5	**VALUE**		
20 or more units	12	0.8	Less than $50,000	256	32.9
Mobile home	133	8.8	$50,000 to $99,999	416	53.4
Boat, RV, van, etc	-	-	$100,000 to $149,999	62	8.0
			$150,000 to $199,999	22	2.8
YEAR STRUCTURE BUILT			$200,000 to $299,999	7	0.9
1999 to March 2000	15	1.0	$300,000 to $499,999	16	2.1
1995 to 1998	21	1.4	$500,000 to $999,999	-	-
1990 to 1994	-	-	$1,000,000 or more	-	-
1980 to 1989	136	9.0	Median (dollars)	63,200	(X)
1970 to 1979	191	12.6			
1960 to 1969	230	15.2	**MORTGAGE STATUS AND SELECTED**		
1940 to 1959	388	25.7	**MONTHLY OWNER COSTS**		
1939 or earlier	531	35.1	With a mortgage	418	53.7
			Less than $300	12	1.5
ROOMS			$300 to $499	82	10.5
1 room	-	-	$500 to $699	157	20.2
2 rooms	8	0.5	$700 to $999	125	16.0
3 rooms	66	4.4	$1,000 to $1,499	26	3.3
4 rooms	271	17.9	$1,500 to $1,999	-	-
5 rooms	378	25.0	$2,000 or more	16	2.1
6 rooms	249	16.5	Median (dollars)	639	(X)
7 rooms	241	15.9	Not mortgaged	361	46.3
8 rooms	142	9.4	Median (dollars)	235	(X)
9 or more rooms	157	10.4			
Median (rooms)	5.6	(X)	**SELECTED MONTHLY OWNER COSTS**		
			AS A PERCENTAGE OF HOUSEHOLD		
Occupied housing units	**1,380**	**100.0**	**INCOME IN 1999**		
YEAR HOUSEHOLDER MOVED INTO UNIT			Less than 15.0 percent	437	56.1
1999 to March 2000	233	16.9	15.0 to 19.9 percent	137	17.6
1995 to 1998	353	25.6	20.0 to 24.9 percent	64	8.2
1990 to 1994	178	12.9	25.0 to 29.9 percent	68	8.7
1980 to 1989	181	13.1	30.0 to 34.9 percent	6	0.8
1970 to 1979	192	13.9	35.0 percent or more	67	8.6
1969 or earlier	243	17.6	Not computed	-	-
VEHICLES AVAILABLE			**Specified renter-occupied units**	**447**	**100.0**
None	89	6.4	**GROSS RENT**		
1	483	35.0	Less than $200	56	12.5
2	572	41.4	$200 to $299	25	5.6
3 or more	236	17.1	$300 to $499	268	60.0
			$500 to $749	68	15.2
HOUSE HEATING FUEL			$750 to $999	4	0.9
Utility gas	939	68.0	$1,000 to $1,499	7	1.6
Bottled, tank, or LP gas	60	4.3	$1,500 or more	-	-
Electricity	317	23.0	No cash rent	19	4.3
Fuel oil, kerosene, etc	49	3.6	Median (dollars)	405	(X)
Coal or coke	8	0.6			
Wood	7	0.5	**GROSS RENT AS A PERCENTAGE OF**		
Solar energy	-	-	**HOUSEHOLD INCOME IN 1999**		
Other fuel	-	-	Less than 15.0 percent	109	24.4
No fuel used	-	-	15.0 to 19.9 percent	39	8.7
			20.0 to 24.9 percent	43	9.6
SELECTED CHARACTERISTICS			25.0 to 29.9 percent	43	9.6
Lacking complete plumbing facilities	7	0.5	30.0 to 34.9 percent	51	11.4
Lacking complete kitchen facilities	-	-	35.0 percent or more	143	32.0
No telephone service	101	7.3	Not computed	19	4.3

-Represents zero or rounds to zero. (X) Not applicable.

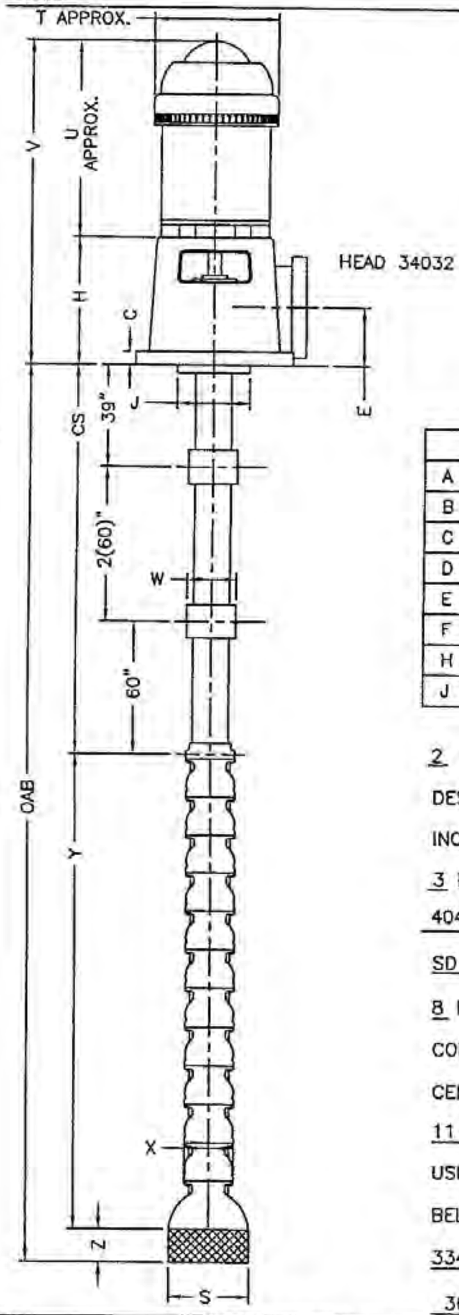
Source: U.S. Bureau of the Census, Census 2000.

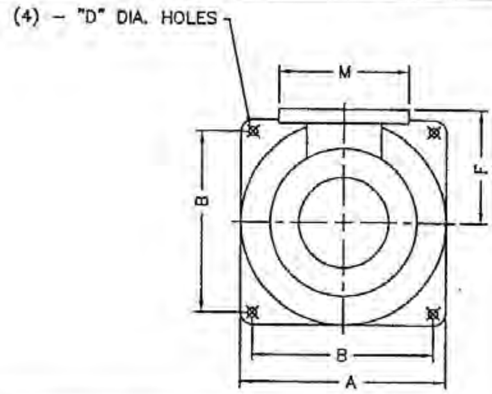
4

U.S. Census Bureau

DEMING PUMP
SALEM, OHIO
U.S.A.

DIMENSION
PAGE
MARCH 2004





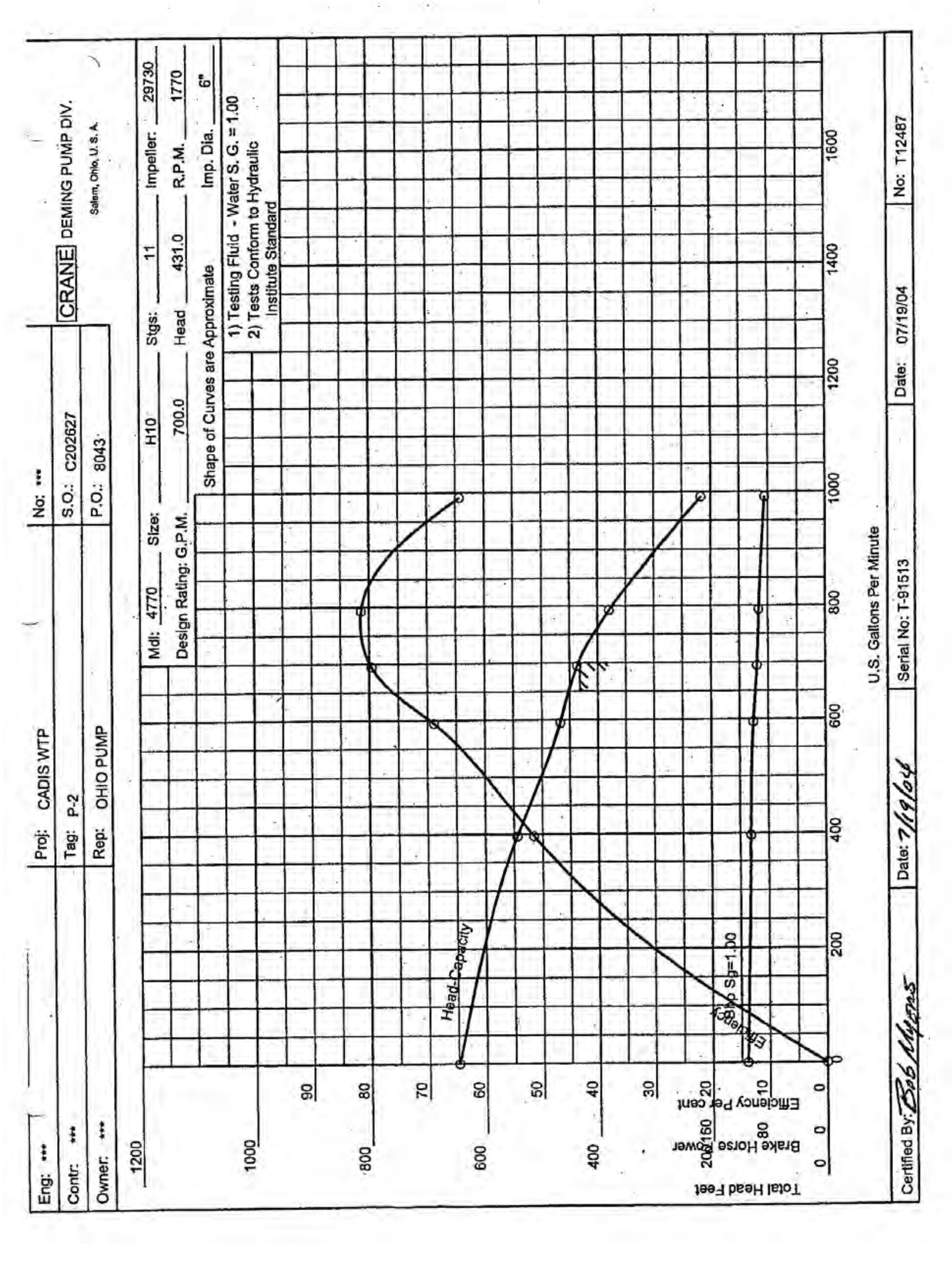
DIMENSIONS					
A	20" SQ.	M	15" DIA	CS	219"
B	17 11/16"			OAB	326"
C	2 1/8"	T	23 1/4"		
D	7/8" DIA.	U	42 11/16"		
E	7 3/4"	V	59 3/16"	W	9 1/2"
F	10 1/2"	X	9 1/2"	S	11 3/4" DIA
H	16 1/2"	Y	100 3/8"	Z	6 5/8"
J	12 3/4"				

2 DEMING FIG. 4700 VERTICAL TURBINE PUMP(S)
DESIGNED FOR 700 GPM AT 431 FEET HEAD,
INCLUDING: 100 HP 1770 R.P.M. 460 VOLT
3 PHASE 60 CYCLE VERTICAL HOLLOW SHAFT MOTOR:
404TP, ODP, NRR, PREMIUM EFFICIENT

SD 8 8 – 16 1/2 (300#) SURFACE DISCHARGE HEAD WITH
8 INCH DISCHARGE FLANGE. 219" OF 8" X 1 1/2"
COLUMN & SHAFT. WITH RUBBER BEARINGS ON 10 FOOT
CENTERS
11 STAGE H10 BELLMOUTH SUCTION BOWL ASSEMBLY
USING IMPELLER 29730 FROM CURVE PC3195ZZ . WITH
BELLMOUTH SUCTION BOWL 34586, DISCHARGE BOWL
33414, INTERMEDIATE BOWL 33414 . BASKET STRAINER
36119 .

ENGR:	PROJ: CADIZ WATER PROJECT	P.O.: 8043	P.O. NO:
CONTR:	EQUIP NO. /TAG: P-2 & P-3	S.O.: C202627	QUOTE NO: 7409JE
OWNER: ***	REP: OHIO PUMP	SERIAL NO. ***	SUBM. BY DATE MLC/JE 3/10/04

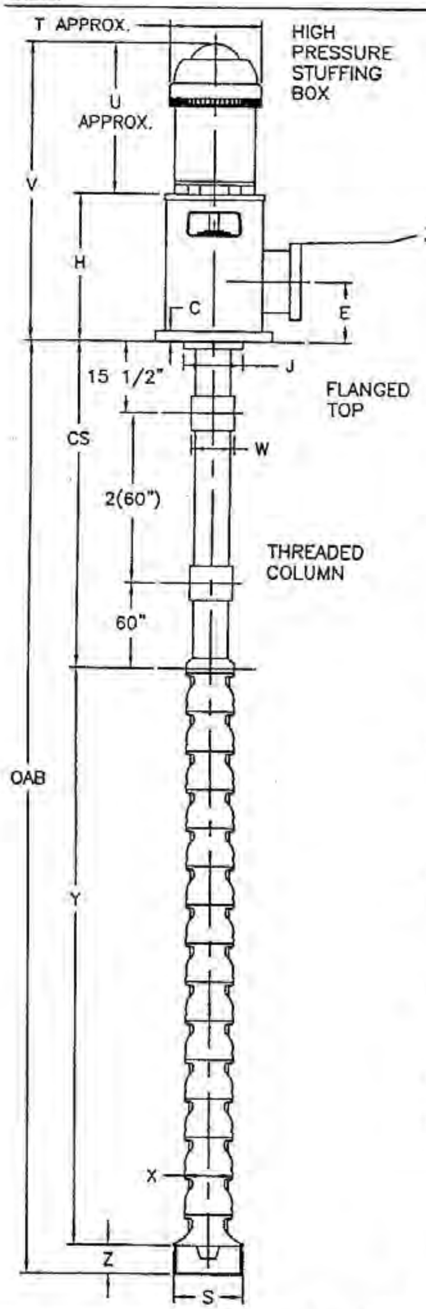
A01257470C – ACAD, REVISED 4/15/04 MLC, REVISED 4/18/04, MLC
SUBJECT TO CHANGE WITHOUT NOTICE
PRINTED IN U.S.A.

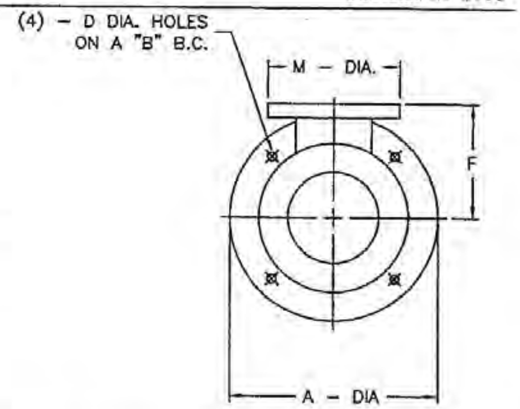


Eng: ***
Contr: ***
Owner: ***
Proj: CADIS WTP
Tag: P-2
Rep: OHIO PUMP
No: ***
S.O.: C202627
P.O.: 8043
CRANE DEMING PUMP DIV.
Salem, Ohio, U.S.A.
Mdl: 4770
Size: H10
Stgs: 11
Impeller: 29730
Design Rating: G.P.M. 700.0
Head 431.0
R.P.M. 1770
Shape of Curves are Approximate
Imp. Dia. 6"
1) Testing Fluid - Water S. G. = 1.00
2) Tests Conform to Hydraulic Institute Standard
Head-Capacity
Efficiency
BHP Sg=1.00
Total Head Feet
Brake Horse Power
Efficiency Per cent
U.S. Gallons Per Minute
Certified By: Bob Myers
Date: 7/19/04
Serial No: T-91513
Date: 07/19/04
No: T12487

DEMING PUMP
SALEM, OHIO
U.S.A.

DIMENSION
PAGE
SEPTEMBER 2003





DIMENSIONS IN INCHES					
A	19" DIA	J	8 3/4"	X	9 1/2"
B	17"			Y	125 1/8"
C	1 1/8"	M	12 1/2"	Z	6 5/8"
D	1"	S	12 1/4"	CS	195 1/2"
E	6 1/2"	T	21"	OAB	327 1/4"
F	12"	U	35 9/16"	W	7 5/16"
H	22"	V	57 9/16"		

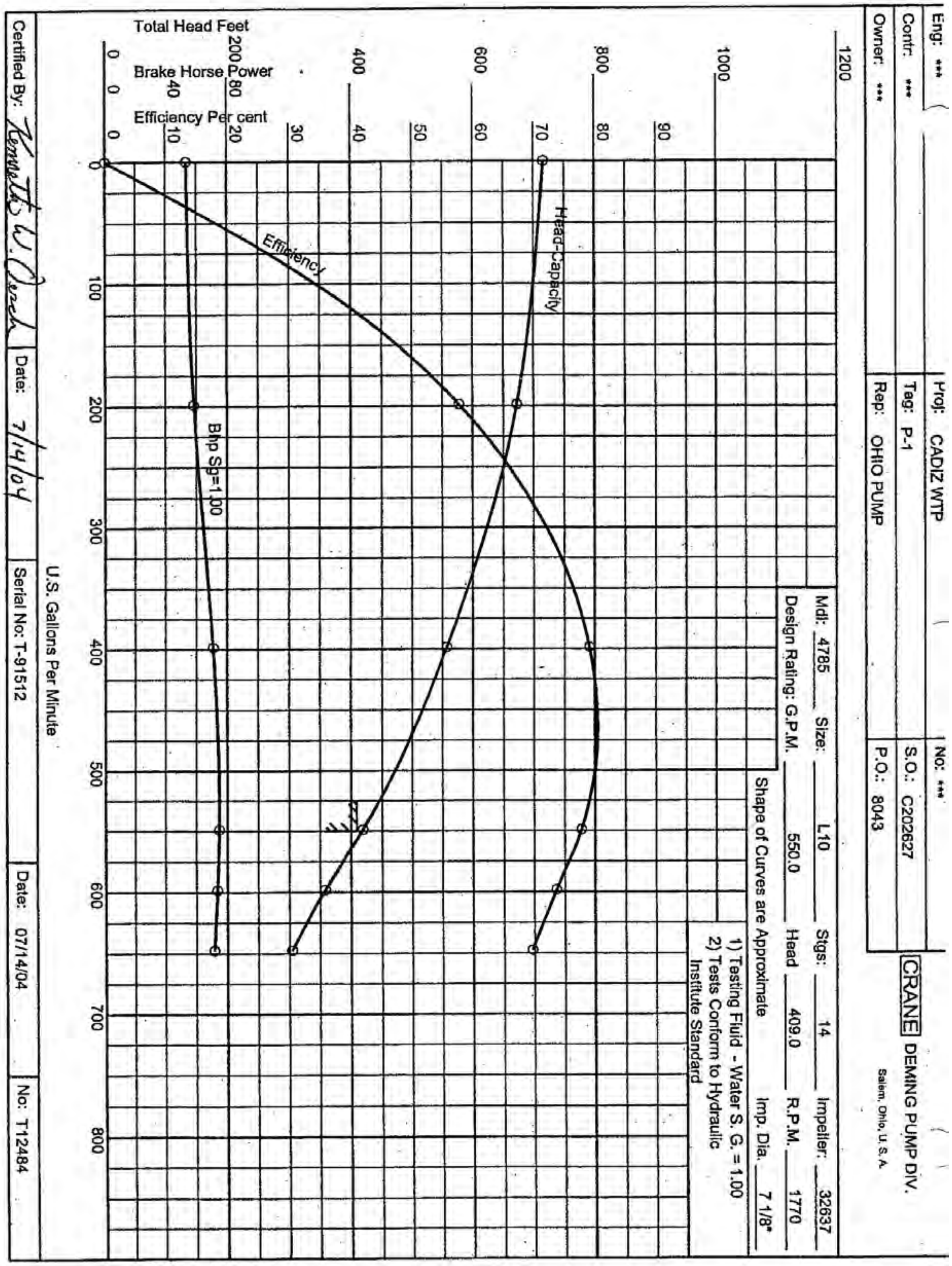
1 DEMING FIG. 4700 VERTICAL TURBINE PUMP(S)
DESIGNED FOR 550 GPM AT 409 FEET HEAD,
INCLUDING: 75 HP 1770 R.P.M. 460 VOLT
3 PHASE 60 CYCLE VERTICAL HOLLOW SHAFT
MOTOR. WP-1, N.R.R., 365TP FRAME, PREM EFF
W/NORMALLY CLOSED THERMOSTRATS

FSD 6 6 -12 SURFACE DISCHARGE HEAD WITH 6 INCH
300# DISCHARGE FLANGE. 195 1/2" OF 6" X 1 1/4"
COLUMN & SHAFT WITH RUBBER BEARINGS ON 10 FOOT
CENTERS

14 STAGE L10 BELLMOUTH BOWL ASSEMBLY USING
IMPELLER 32637. WITH BELLMOUTH SUCTION BOWL 34584
DISCHARGE BOWL 4141, INTERMEDIATE BOWL 4141
BASKET STRAINER 36119

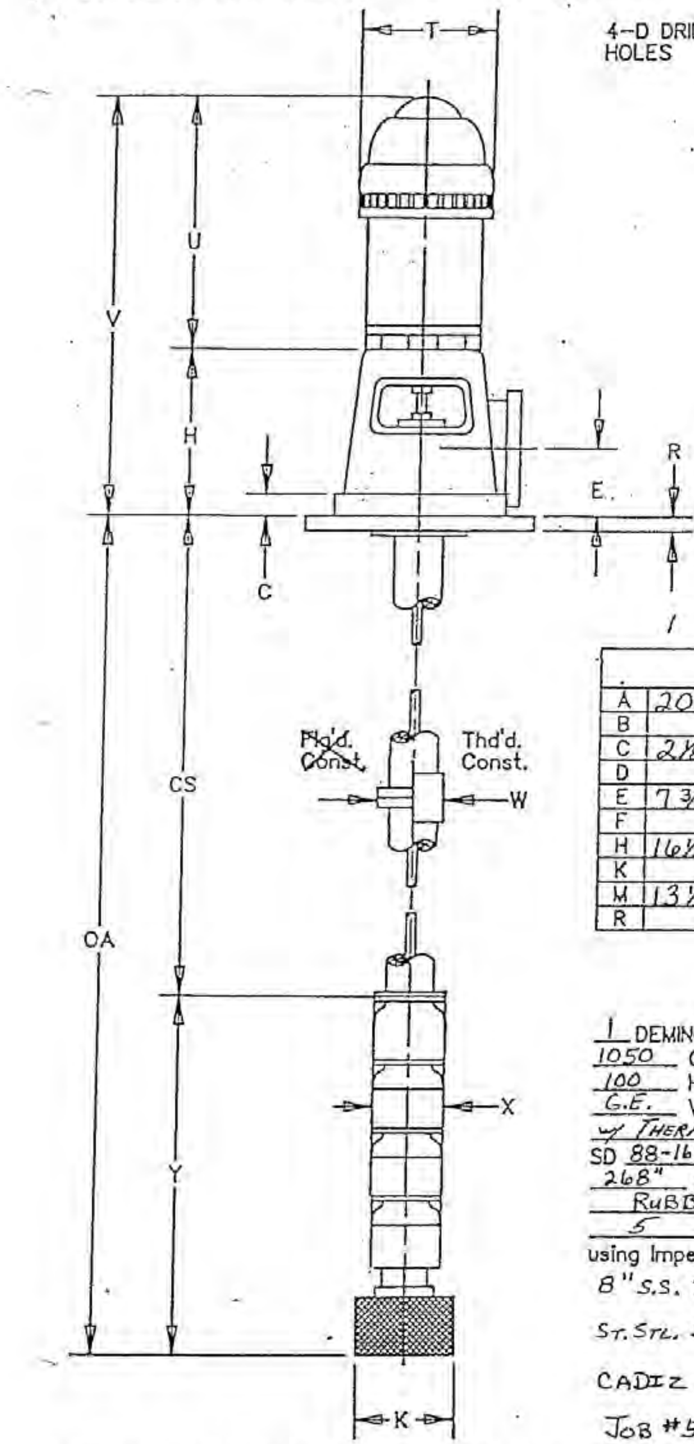
ENGR:	PROJ: LOW SERVICE	P.O.: 8043	P.O. NO:
CONTR:	EQUIP NO. /TAG: PUMP 1	S.O.: C202627	CETR. BY/DATE
OWNER:	REP: OHIO PUMP	SERIAL NO. ***	SUBM. BY DATE MLC/SKM 09/30/03

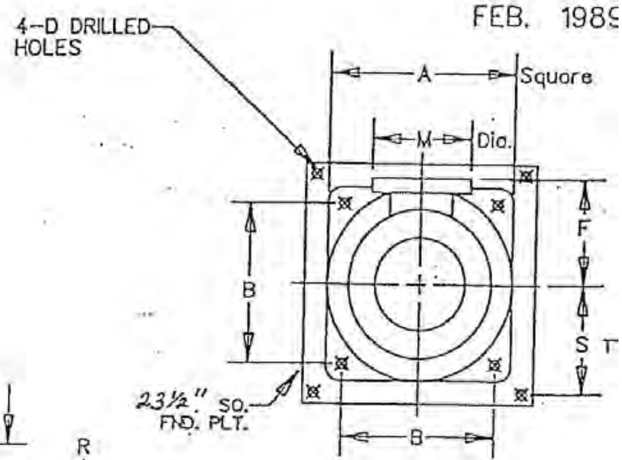
A0121347DC, REVISED 4/15/04 MLC, REVISED 4/16/04 MLC, REVISED 5/18/04 MLC
SUBJECT TO CHANGE WITHOUT NOTICE
PRINTED IN U.S.A.


Eng: ***
Contr: ***
Owner: ***
Proj: CADIZ WTP
Tag: P-1
Rep: OHIO PUMP
No: ***
S.O.: C202627
P.O.: 8043
CRANE DEMING PUMP DIV.
Salem, Ohio, U.S.A.
Mdl: 4785 Size: L10 Stgs: 14 Impeller: 32637
Design Rating: G.P.M. 550.0 Head 409.0 R.P.M. 1770
Shape of Curves are Approximate Imp. Dia. 7 1/8"
1) Testing Fluid - Water S. G. = 1.00
2) Tests Conform to Hydraulic Institute Standard
Total Head Feet
Brake Horse Power
Efficiency Per cent
Efficiency
Head-Capacity
Bhp Sg=1.00
U.S. Gallons Per Minute
Certified By:
Date: 7/14/04
Serial No: T-91512
Date: 07/14/04
No: T12484

SALEM, OHIO U.S.A. VERTICAL TURBINE PAGE

FEB. 1989





DIMENSIONS

A	20"	S	10½"
B	17 7/16"	T	28"
C	2⅛"	U	45½
D	⅞"	V	62"
E	7 ¾"	W	9½"
F	10½"	X	11 ¾"
H	16½"	Y	79 ⅞"
K	15 ¼"	Z	~
M	13 ½"	CS	268
R	¾"	OA	347 ⅞"

SPECIFICATIONS

1 DEMING Fig. 4772 Vertical Turbine Pump designed fo
1050 GPM at 267 feet head, including:
100 HP 1800 RPM 460 Volt 3 Phase 60 Cyc
G.E. Vertical Hollowshaft Motor WP1 FR L404TP16
w/ THERMOSTAT
SD 88-16½ Surface Discharge Head
268" feet 8 x 1¼ Column and shaft with
RUBBER Bearings on 10 foot centers
5 Stage m12 inch Bowl Assembly
using Impeller 3982 from Curve

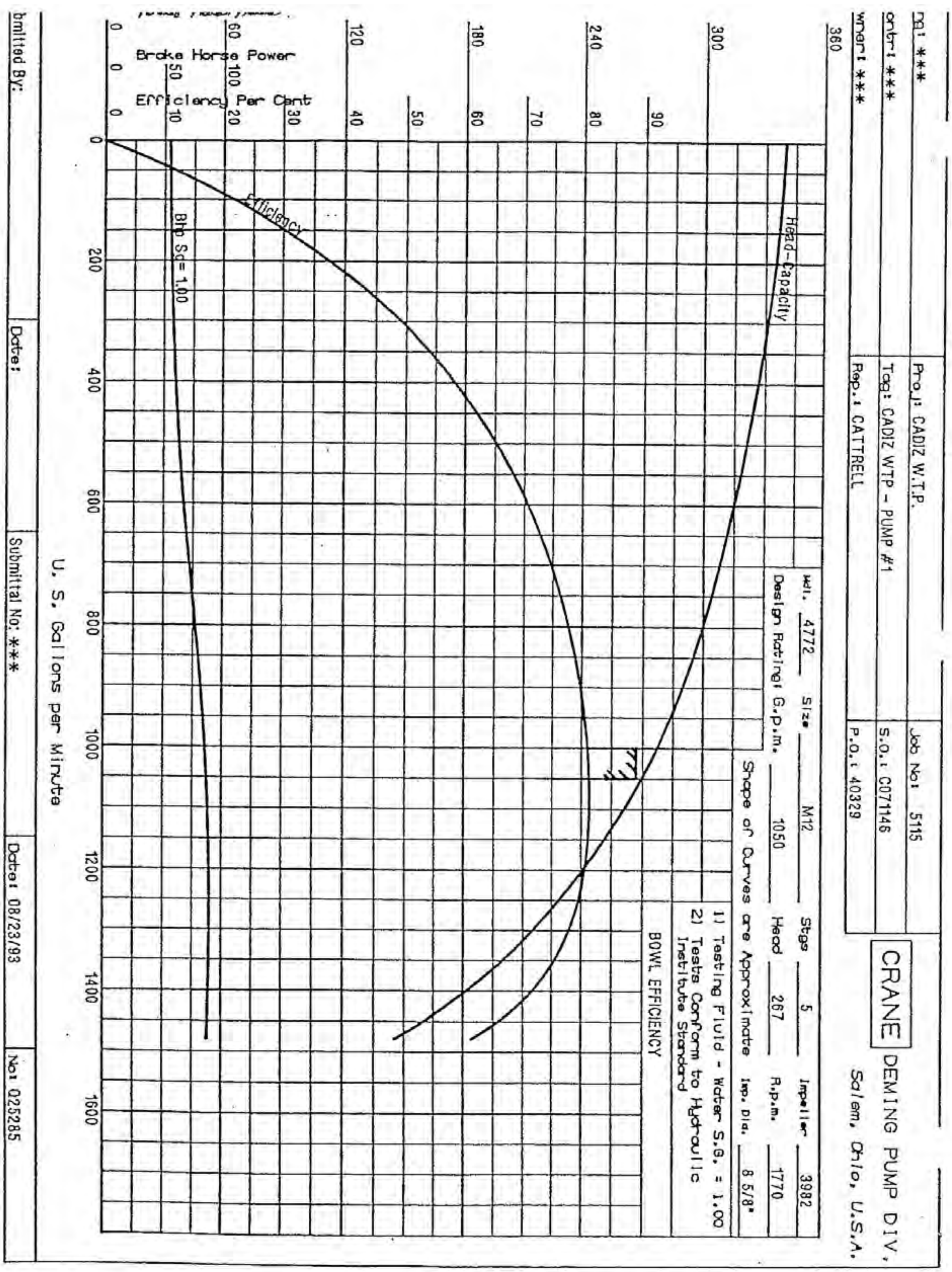
8" S.S. BASKET STRAINER

ST. STL. SHAFT CPLG'S.

CADIZ WTP – Pump #1

JOB #5115 FILE 465

WHEN PROPERLY ENDORSED THIS PRINT IS CORRECT FOR
CATTRELL COMPANIES P.O. 40329 S.O. C071146
PUMP SERIAL NO. DATE 9/10/03 BY


Proj: CADIZ W.T.P.
Job No: 5115
Tag: CADIZ WTP - PUMP #1
S.O.: C071146
Rep.: CATTRELL
P.O.: 40329
CRANE DEMING PUMP DIV.
Salem, Ohio, U.S.A.
Mdl. 4772 Size M12 Stgs 5 Impeller 3982
Design Rating: G.p.m. 1050 Head 267 R.p.m. 1770
Shape of Curves are Approximate Imp. Dia. 8 5/8"
1) Testing Fluid - Water S.G. = 1.00
2) Tests Conform to Hydraulic Institute Standard
BOWL EFFICIENCY
Head-Capacity
Efficiency
Bhp Sg= 1.00
Brake Horse Power
Efficiency Per Cent
U. S. Gallons per Minute
Date:
Submittal No: ***
Date: 08/23/93
No: 025285

Index No. C-303

EQUIPMENT REGISTRATION

Schedule No. 134

Equipment Name HIGH SERVICE PUMP 3

Location WTP POST-TREATMENT AREA

Priority 2

Manufacturer CRANE DEMING PUMP COMPANY

Telephone (216) 337-7861

Address 1453 ALLEN ROAD

SALEM, OH 44460

Sales Rep. CRANE DEMING PUMP COMPANY

Telephone (216) 337-7861

Address 1453 ALLEN ROAD

SALEM, OH 44460

Service Rep. CRANE DEMING PUMP COMPANY

Telephone (216) 337-7861

Address 1453 ALLEN ROAD

SALEM, OH 44460

EQUIPMENT INFORMATION

Manufacturer CRANE DEMING

Model No. 4772

Serial No. T-87318

RPM 1750 CAPACITY 1050

TDH 267 Size M10A

Impeller No. 3910

Impeller Diameter 8 5/8"

Lubricant

REDUCER INFORMATION

Manufacturer

Model No.

Serial No.

Ratio Torque

Service Factor

Additional Info

DRIVE MOTOR DATA

Number C-303

Manufacturer GENERAL ELECTRIC	Time Rating CONT
Serial No.	Service factor 1.15
Model No. 5K404DT6005R4	Frame 2464TP16 Type K
HP 100 RPM 1750	NEMA Design B Style
Volts 460	Kva Code G
Amps 12.1	Ambient Temperature 40¦C
HZ 60 Phase 3	Insulation Class F

ADDITIONAL EQUIPMENT AND LUBRICATION DATA

Upper Bearing 235A2531AA01

Lower Bearing 6215ZZ

Gear Ratio

Efficiency

Lubricant UPPER BEARING OIL: 3.0 QTS. ISO 32
LOWER BEARING GREASE: #2

DEMING PUMP CO.
SALEM, OHIO U.S.A.

FIG. 4700
VERTICAL TURBINE

DIMENSION
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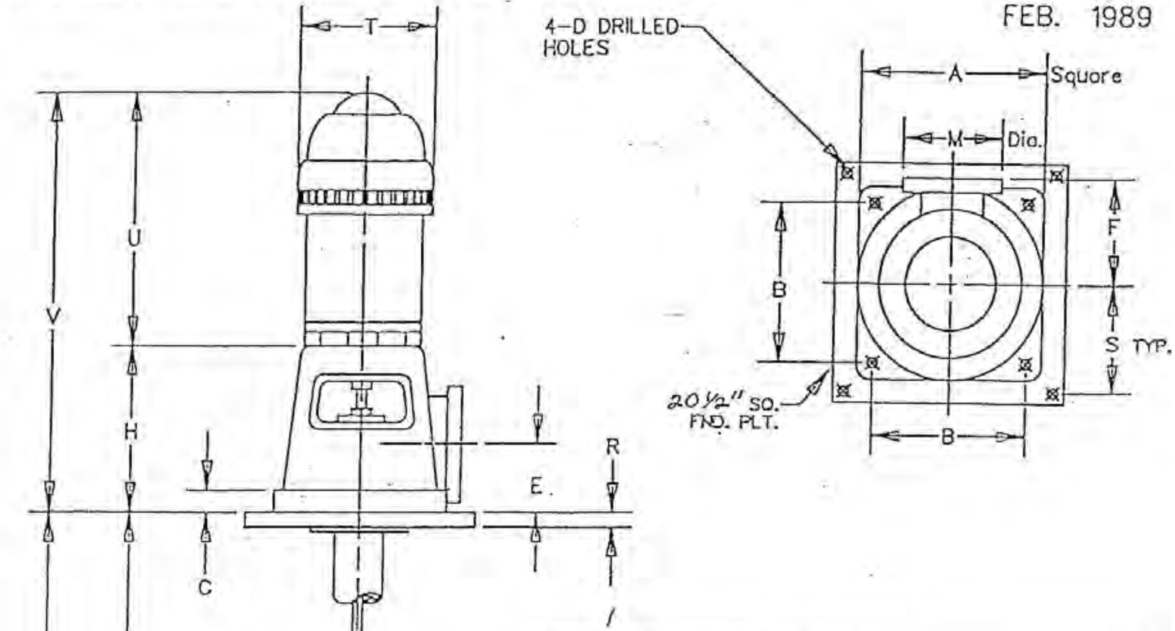
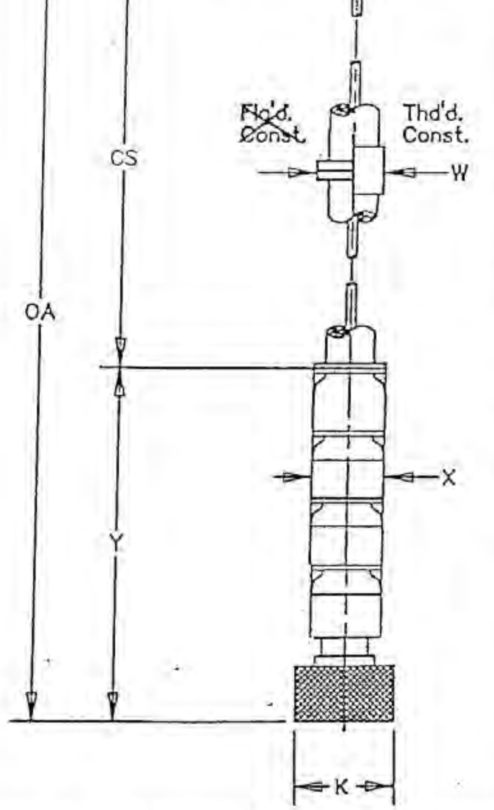




DIMENSIONS			
A	17"	S	9"
B	14½"	T	25"
C	2"	U	40½"
D	7/8"	V	56"
E	6½"	W	7 5/16"
F	9"	X	9½"
H	15½"	Y	101 7/8"
K	12½"	Z	~
M	11"	CS	246
R	3/4"	OA	347 7/8"

SPECIFICATIONS

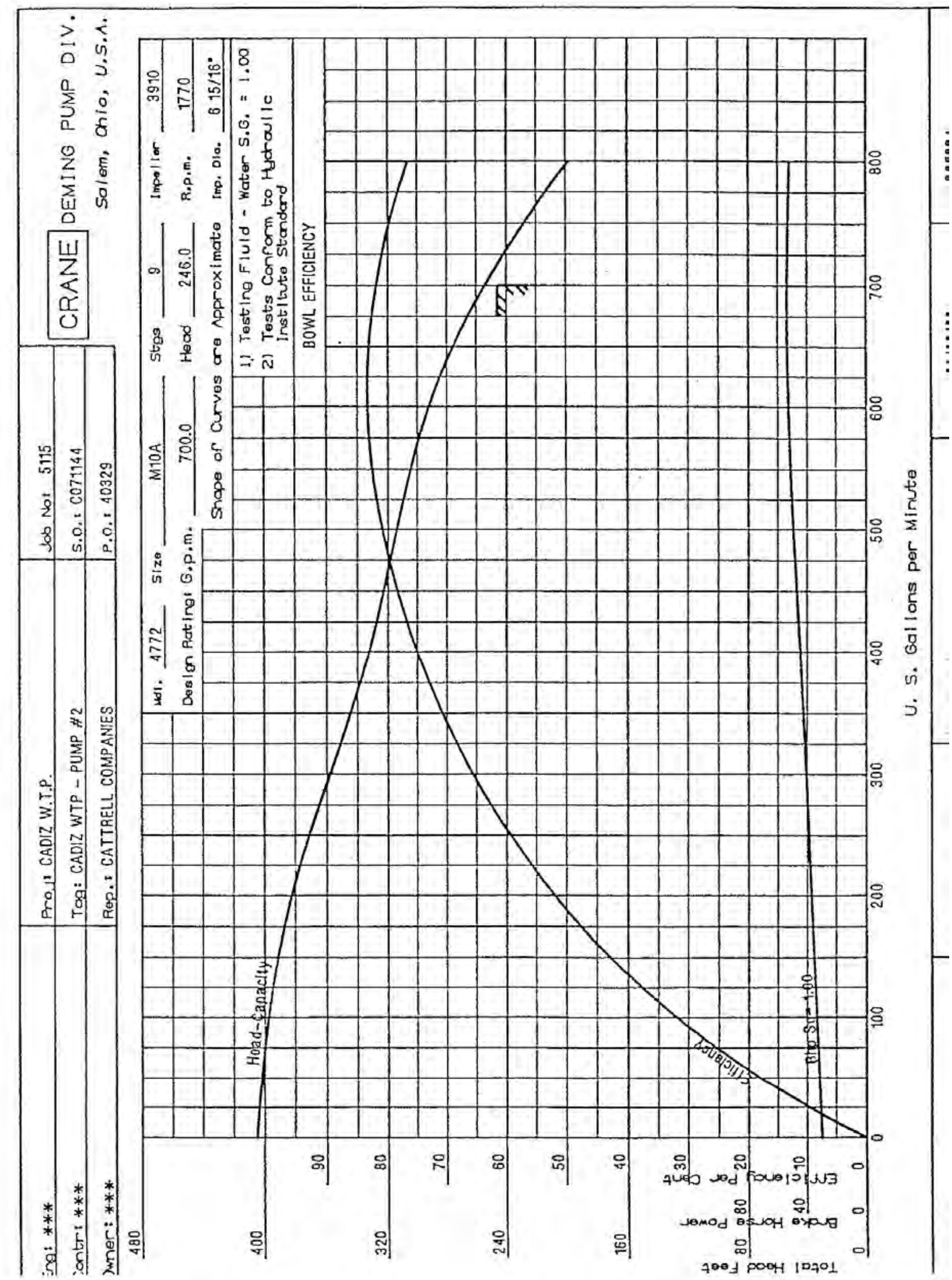
1 DEMING Fig. 4772 Vertical Turbine Pump designed for 700 GPM at 246 feet head, including:
60 HP 1800 RPM 460 Volt 3 Phase 60 Cycle
G.E. Vertical Hollowshaft Motor WP1 FR364TP12
w/ THERMOSTAT
SD 66-12 Surface Discharge Head
246" ~~feet~~ 6 x 1¼ Column and shaft with
RUBBER Bearings on 10 foot centers
9 Stage M10A inch STD Bowl Assembly
using Impeller 3910 from Curve

6" S.S. BASKET STRAINER

ST. STL. SHAFT CPLG'S.

CADIZ WTP - PUMP #2
JOB #5115 FILE 465

WHEN PROPERLY ENDORSED THIS PRINT IS CORRECT FOR
CATTRELL COMPANIES P.O. 40329 S.O. C071144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Contr: ***
Owner: ***
Proj: CADIZ W.T.P.
Tag: CADIZ WTP – PUMP #2
Rep.: CATTRELL COMPANIES
Job No: 5115
S.O.: C071144
P.O.: 40329
CRANE DEMING PUMP DIV.
Salem, Ohio, U.S.A.
Mdl. 4772
Size M10A
Stgs 9
Impeller 3910
Design Rating: G.p.m. 700.0
Head 246.0
R.p.m. 1770
Imp. Dia. 6 15/16"
Shape of Curves are Approximate
1.) Testing Fluid - Water S.G. = 1.00
2) Tests Conform to Hydraulic Institute Standard
BOWL EFFICIENCY
Head-Capacity
Efficiency
Bhp Sg - 1.00
Total Head Feet
Brake Horse Power
Efficiency Per Cent
U. S. Gallons per Minute

Index No. C-302

EQUIPMENT REGISTRATION

Schedule No. 134

Equipment Name HIGH SERVICE PUMP 2

Location WTP POST-TREATMENT AREA

Priority 2

Manufacturer CRANE DEMING PUMP COMPANY

Telephone (216) 337-7861

Address 1453 ALLEN ROAD
SALEM, OH 44460

Sales Rep. CRANE DEMING PUMP COMPANY

Telephone (216) 337-7861

Address 1453 ALLEN ROAD
SALEM, OH 44460

Service Rep. CRANE DEMING PUMP COMPANY

Telephone (216) 337-7861

Address 1453 ALLEN ROAD
SALEM, OH 44460

EQUIPMENT INFORMATION

Manufacturer CRANE DEMING

Model No. 4772

Serial No. T-87316

RPM 1750 CAPACITY 700

TDH 246 Size M10A

Impeller No. 3910

Impeller Diameter 6 15/16"

Lubricant

REDUCER INFORMATION

Manufacturer

Model No.

Serial No.

Ratio Torque

Service Factor

Additional Info

DRIVE MOTOR DATA

Number C-302

Manufacturer GENERAL ELECTRIC	Time Rating CONT
Serial No. 0JG075H07	Service factor 1.15
Model No. 5K364DT6008RZ	Frame L364TP12 Type K
HP 60 RPM 1750	NEMA Design B Style
Volts 460	Kva Code G
Amps 71.1	Ambient Temperature 40½C
HZ 60 Phase 3	Insulation Class F

ADDITIONAL EQUIPMENT AND LUBRICATION DATA

Upper Bearing 235A2525C

Lower Bearing 6212ZZ

Gear Ratio

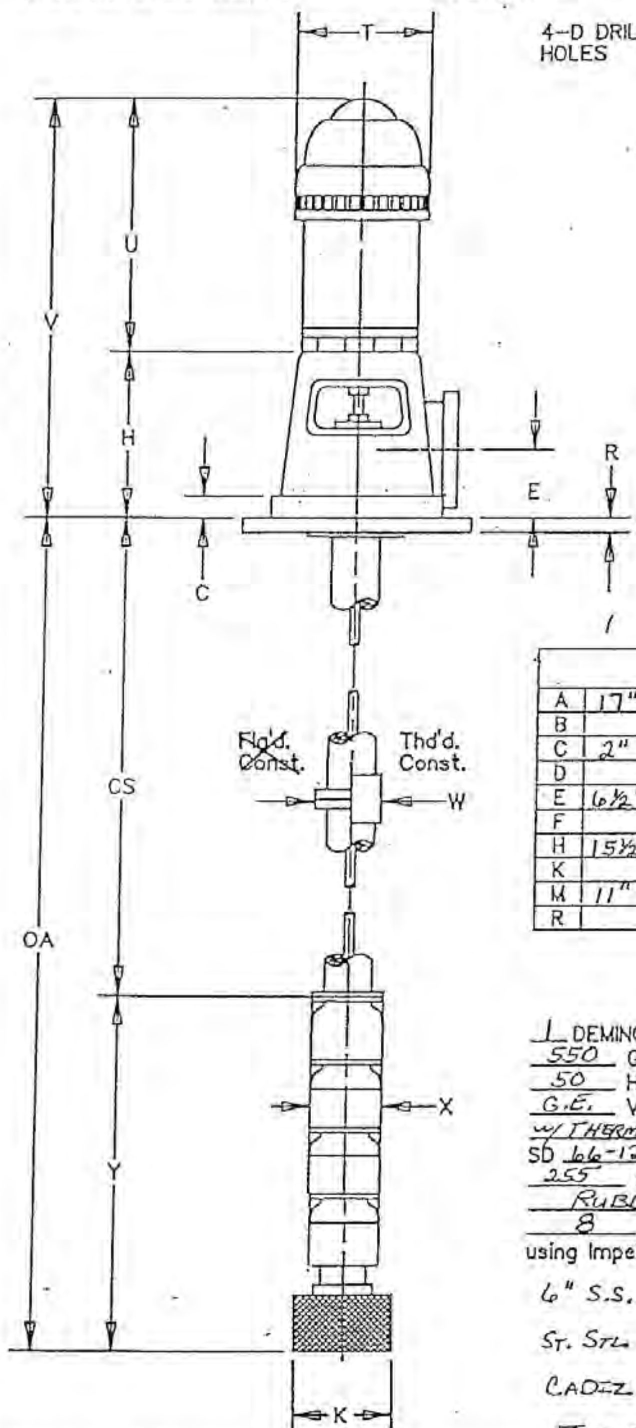
Efficiency 91%

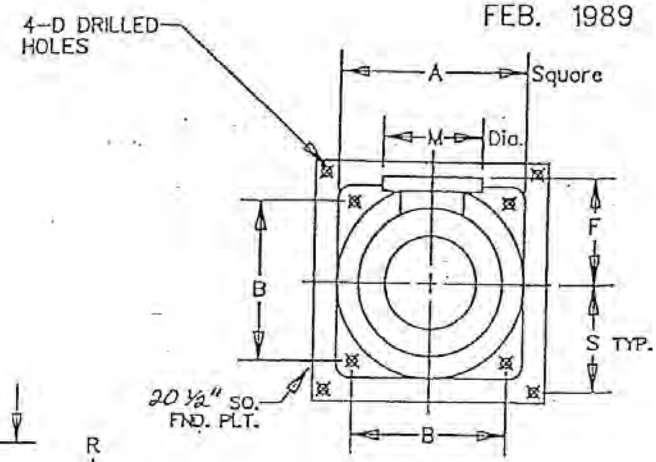
Lubricant UPPER BEARING OIL: 3.0 QTS. ISO 32
LOWER BEARING GREASE: #2

DEMING PUMP CO.
SALEM, OHIO U.S.A.

FIG. 4700
VERTICAL TURBINE

DIMENSION
PAGE
FEB. 1989





DIMENSIONS

A	17"	S	9"
B	14½"	T	22½"
C	2"	U	37"
D	7/8"	V	52½
E	6½"	W	7 5/16"
F	9"	X	9½"
H	15½"	Y	92 5/8"
K	12½"	Z	~
M	11"	CS	255
R	3/4"	OA	347 5/8

SPECIFICATIONS

1 DEMING Fig. 4772 Vertical Turbine Pump designed for 550 GPM at 240 feet head, including: 50 HP 1800 RPM 230/460 Volt 3 Phase 60 Cycle G.E. Vertical Hollowshaft Motor WPI FR L3746 TP12 w/ THERMOSTAT

SD 66-12 Surface Discharge Head

255 ~~feet~~ 6 x 1¼ Column and shaft with RUBBER Bearings on 10 foot centers 8 Stage M10A inch STD Bowl Assembly using Impeller 3910 from Curve

6" S.S. BASKET STRAINER

ST. STL. SHAFT CPLG'S.

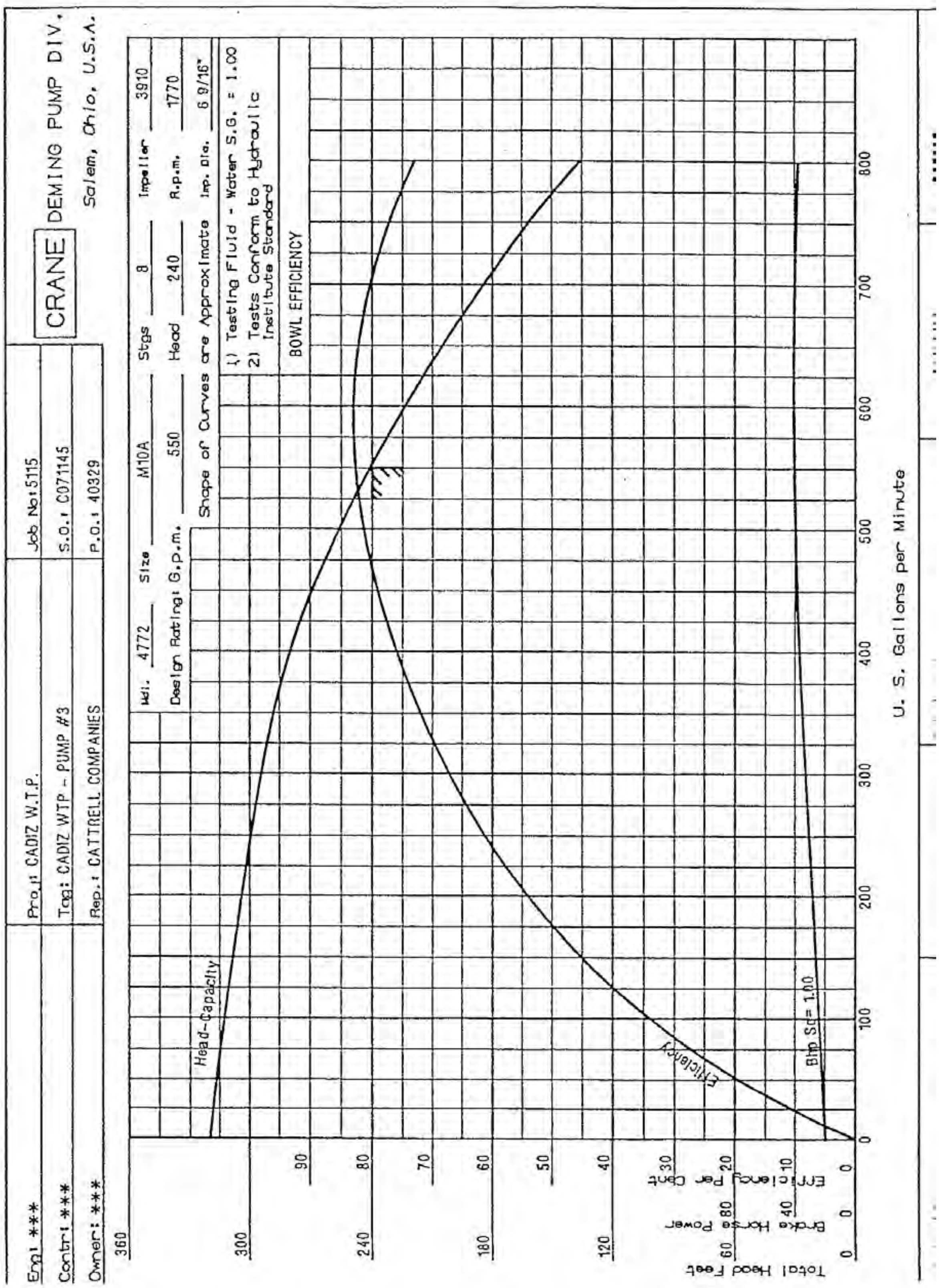
CADIZ WTP - Pump #3

JOB #5115 FILE 465

WHEN PROPERLY ENDORSED THIS PRINT IS CORRECT FOR

CATTRELL COMPANIES P.O. 40329 S.O. C071145

PUMP SERIAL NO.



Engr: ***
Contr: ***
Owner: ***
Proj: CADIZ W.T.P.
Tag: CADIZ WTP - PUMP #3
Rep.: CATTRELL COMPANIES
Job No: 5115
S.O.: C071145
P.O.: 40329
CRANE DEMING PUMP DIV.
Salem, Ohio, U.S.A.
Wt. 4772 Size M10A Stgs 8 Impeller 3910
Design Rating: G.p.m. 550 Head 240 R.p.m. 1770
Shape of Curves are Approximate Imp. Dia. 6 9/16"
1) Testing Fluid - Water S.G. = 1.00
2) Tests Conform to Hydraulic Institute Standard
BOWL EFFICIENCY
Head-Capacity
Efficiency
Bhp Sg= 1.00
Total Head Feet
Brake Horse Power
Efficiency Per Cent
U. S. Gallons per Minute
0
100
200
300
400
500
600
700
800
120
180
240
300
360
40
60
80
10
20
30
50
70
90

Index No. C-301

EQUIPMENT REGISTRATION

Schedule No. 134

Equipment Name HIGH SERVICE PUMP 1

Location WTP POST-TREATMENT AREA

Priority 2

Manufacturer CRANE DEMING PUMP COMPANY
Telephone (216) 337-7861

Address 1453 ALLEN ROAD
SALEM, OH 44460

Sales Rep. CRANE DEMING PUMP COMPANY
Telephone (216) 337-7861

Address 1453 ALLEN ROAD
SALEM, OH 44460

Service Rep. CRANE DEMING PUMP COMPANY
Telephone (216) 337-7861

Address 1453 ALLEN ROAD
SALEM, OH 44460

EQUIPMENT INFORMATION

Manufacturer CRANE DEMING

Model No. 4772

Serial No. T-87318

RPM 1750 CAPACITY 550

TDH 240 Size M12

Impeller No. 3910

Impeller Diameter 6 3/16"

Lubricant

REDUCER INFORMATION

Manufacturer

Model No.

Serial No.

Ratio Torque

Service Factor

Additional Info

DRIVE MOTOR DATA

Number C-301

Manufacturer GENERAL ELECTRIC	Time Rating CONT
Serial No.	Service factor 1.15
Model No. 5K326DT6009RZ	Frame L326TP12 Type K
HP 50 RPM 1775	NEMA Design B Style
Volts 460	Kva Code G
Amps 63.1	Ambient Temperature 40¦C
HZ 60 Phase 3	Insulation Class F

ADDITIONAL EQUIPMENT AND LUBRICATION DATA

Upper Bearing 235A2S22AC

Lower Bearing 6212ZZ

Gear Ratio

Efficiency

Lubricant UPPER BEARING OIL: 3.0 QTS. ISO 32
LOWER BEARING GREASE: #2