ENERGY SAVINGS THROUGH PUMP REFURBISHMENT AND COATING

Prepared for

THE NEW YORK STATE
ENERGY RESEARCH AND DEVELOPMENT AUTHORITY

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Contract #9322

NOTICE

ABSTRACT

This report examines the improvements in pump efficiency and performance resulting from mechanical refurbishment and coating the interiors of horizontal split case pumps with brush-on ceramic epoxy coatings. Nineteen pumps ranging in size from 20 to 1,750 horsepower were refurbished and coated, with efficiency being tested at each step.

The overall results of the study showed average efficiency increases of about 12% (5% from mechanical refurbishment, 6% from coating the internal pump casing, and about 1% from impeller coating.) The study concluded that both mechanical refurbishment and pump sandblasting and coating are generally needed to return a pump to its original manufacturer curve. Additionally, coated pumps had higher efficiencies and maintained those efficiencies longer than identical pumps that were only sandblasted and not coated.

Coating and refurbishing pumps can be very economical. Energy savings from pump restoration showed pay back periods were often less than one year for pumps running continuously.

Subsequent inspections of the epoxy coatings over a four year period on the inside of several of the first pumps coated has shown that although the coatings are often rust stained, the coatings have adhered well and remain in good shape without any significant signs of failure.

KEY WORDS: Pump Epoxy Coating, Efficiency, Energy, Refurbishment

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SUMMARY

Pumping systems account for nearly 20% of the world's electrical energy demand. Any technology which produces even moderate gains in pumping efficiency can lead to substantial savings in terms of nationwide energy use, costs and associated greenhouse gas emissions.

The Monroe County Water Authority (MCWA) was able to demonstrate significant gains in pumping efficiency on existing horizontal split case (HSC) pumps by utilizing a pump coating technology which is more common in Europe, but vastly underutilized in the United States. These efficiency improvements and performance restoration gains are beyond what could be achieved through normal pump mechanical refurbishment, such as replacing worn parts and restoring proper clearances. The coating technology employed involves sandblasting and applying an ultra smooth epoxy ceramic polyamide coating to the interior surfaces of existing centrifugal pumps. This greatly reduces interior roughness and pump friction losses which lead to inefficiency. Gains of between 5 and 10% pump efficiency were measured during a 2005 pilot project that included pumps up to 100 HP in size. Simple energy savings pay-back periods for continuously running pumps were often less than 1 year. Furthermore, the protective coating prevents the inevitable re-growth of future corrosion (tuberculation), which can rob efficiency and negate the gains of pumps that are only sandblasted or scraped smooth.

In 2006, the MCWA received funding through the New York State Energy and Research Development Authority to conduct a larger pump coating study over a two year period on an additional 19 pumps.

The project is focused on the energy efficiency improvement and performance restoration achievable due to: a) mechanical rehabilitation and b) the coating process. The pump size range under consideration was expanded to include units up to 1,750 HP (17,000 gpm) to ascertain if the gains from smaller, pilot study pumps could be translated to the revitalization of large pumps as well. Pumps were also selected to have a wide range of specific speeds since a European study suggested a correlation between performance improvement from coating and specific speed. Also included is an assessment of the improvements resulting from sandblasting by itself versus coating, over an extended period of time. The study results include generalized guidelines for cost-effective coating of various pump sizes and examines the correlation between efficiency gains and pump size or specific speed.

Energy and performance enhancement from the application of epoxy pump coatings have been similar to what was observed in the pilot study; up to 10% increases in pump efficiency from the pump coatings alone have been measured. The mean efficiency increase from the coating process alone of all pumps is 6.3%. The coated pumps continue to be periodically measured and inspected for signs of coating degradation or

efficiency decline. Additional efficiency improvements of over 5% were seen through standard mechanical refurbishment (replacement of wear rings and bearings, restoring clearances, etc.)

Pump coating is not only cost effective for refurbishing existing pumps, but can also help to minimize lifecycle costs for new installations. Most existing pumps can be easily coated by in-house personnel without special tools or skills. New pumps can be ordered coated from the factory, or can be coated before installation. However, some paradigms will need to change. Often, pump users are looking for lowest initial cost, and competing vendors will submit uncoated pumps to minimize their bid unless otherwise specified. Pump efficiency is seldom considered to be a significant factor in pump selection as long as it is in the 'normal range'. But life cycle cost analysis shows there can be significant savings from small efficiency gains because the energy costs of running a pump, over time, will be far greater than the purchase price. Bidding specifications can be modified to give credits for higher pump efficiency and result in the lowest life cycle cost.

1.0 PROJECT HISTORY AND DEVELOPMENT

Pumping systems account for nearly 20% of the world's electrical energy demand and range from 25 – 50% of the energy usage in certain industrial and municipal plant operations[1]. Pumping systems are widespread in government and industry, including drinking water and waste water treatment plants and distribution/collection systems. Any technology which produces even moderate gains in pumping efficiency can lead to massive savings in terms of world wide energy use, costs and reduction of greenhouse gasses.

The Monroe County Water Authority (MCWA) is the third largest water supplier in New York State, supplying the suburban areas of Monroe County and portions of the five surrounding counties. The MCWA's treatment plant is located on the shore of Lake Ontario and produces an average 55 million gallons per day (mgd). The maximum plant capacity is 140 mgd. The MCWA system includes over 30 pumping stations containing over 110 individual pumps ranging in size from 5 horsepower (hp) up to 1750 hp. Most of the pumps in the system are horizontal split case (HSC). The MCWA lifts water over 1,000 feet from its treatment plant to the highest pressure zone in the system.

In 2002, MCWA initiated a pump efficiency testing program. This field testing was prompted by the inability to reconcile computer models of the distribution system with actual field data. Manufacturer pump curves were used during development of the computer model and once the model was completed, it was impossible to calibrate due to discrepancies between the expected flows and pressures and actual pump performance. Field pump curves for each pump in the system were developed through this field testing where flow, suction and discharge pressure information was gathered for at least three points. Field curves were then compared to the original pump manufacturer curves to determine just how far pumps in the MCWA system had declined in performance relative to original specifications and to prioritize pumps for mechanical refurbishment based on the magnitude of the decline. Before this, prioritizing pump maintenance at the MCWA had been based on "sensory field testing", giving all the attention to leaky, noisy, or overheated pumps.

The results of comparing field test pump curves to original manufacturer pump curves was an eye opening experience for MCWA personnel. Every pump tested in the system operated to some degree below original manufacturer specifications for head and flow. To the extreme, it was not uncommon to have pumps operating 35% below the manufacturer's curve. Once actual field curves were used to replace manufacturer curves in the computer hydraulic model, the model behaved much closer to reality.

In 2004, all MCWA pump stations were retro-fitted with power monitors that display and store digital kilowatt (kW) readings. With the addition of this kW data along with flow, suction pressure, discharge pressure and rotation speed in rpm, it was now possible to calculate field pump efficiency as well. The pump data verified that many pumps were operating significantly below the manufacturer's efficiency curve as well as the performance curve. In extreme cases it wasn't uncommon to have pumps operating 20 to 30% below original manufacturer efficiency specifications.

Based on the prevalence of poor pump performance revealed through field testing and assuming the performance problems were due to internal component wear, several of the worst performing HSC pumps were identified and assigned to MCWA maintenance personnel for mechanical refurbishment. The planned refurbishment included replacement of impeller and casing rings, shaft sleeves and packing or mechanical seals. The first pump selected for refurbishment was a 100 hp 8x8 pump installed in 1972. When the cover was removed, the inside of the pump was found to be corroded with a hard rough layer of tuberculation buildup, similar to what can be found inside old unlined cast iron pipe. Tuberculation can be defined as a by-product of corrosion (tubercles) mixed with mineral deposits, such as iron, manganese and carbonates. If active corrosion is taking place inside the pump casing, the interior of the pump will contain pits from which material is being removed, and tubercles to where material is being deposited[2]. An example of tuberculation buildup is shown in Figure 1-1.

Figure 1-1 Tuberculation Buildup

The impact of corrosion and tuberculation inside pipelines is well known and documented. The Hazen-Williams Coefficient of Friction (C-Factor) is a universally accepted measurement of pipeline roughness used to calculate the relationship between flow and head loss through pipelines based on a pipe's interior roughness. Unfortunately, the impact of tuberculation on the inside of a pump, with respect to pump flow, head, efficiency and energy consumption, is not as well known or documented.

Historically, the corrosion and rough internal surface of pumps was ignored, and pumps were mechanically refurbished and put back in service. Subsequent mechanical field testing of the 100 HP pump showed that although pump performance was improved after mechanical refurbishment, the pump still fell significantly below original manufacturer's specifications for head, flow and efficiency. Other similarly sized HSC pumps showed comparable results to the 100 hp 8x8 pump.

Having observed the internal roughness of the HSC pumps, it was hypothesized that it might be the reason why the pumps were not returning to their original manufacturer specifications after mechanical refurbishment. Sandblasting the inside casings of HSC pumps to eliminate roughness and applying coatings that could be applied to the inside of a pump to prevent future corrosion were considered. Coatings were researched, but very little supportive information could be found. The information available at the time was focused on how coatings could increase a pump's resistance to internal abrasion and chemical resistance rather than potential benefits towards restoring or preserving pump performance and efficiency. Because of this, most pump coating applications were found in the industrial, chemical and wastewater markets.

Despite the lack of research in the potable water sector on this topic, a pilot study was undertaken to refurbish the interior casings of three HSC pumps that had just been mechanically refurbished to see if reducing interior pump roughness of these three pumps would have any positive impact on pump performance and efficiency. Due to their availability, ease of application and relative low cost, potable water approved (NSF-61[3]) brushable ceramic filled epoxy coatings were used in the pilot study.

The results of post coating field testing surprised even the most skeptical staff at the MCWA. In each of the three cases, pump efficiency was increased by greater than 8% from sandblasting and coating, and the overall performance of all three pumps was restored to original manufacturer specifications.

Based on the results of the pilot study, in 2006 the MCWA applied for and received a grant from the New York State Energy Research and Development Authority (NYSERDA) to conduct the research described in this study on the use of ceramic epoxy coatings to increase HSC pump performance and efficiency.

2.0 EXPERIMENTAL DESIGN

During the application process with NYSERDA for this project, an *Experimental Design Report* (Appendix B) was prepared with the assistance of O'Brien and Gere Engineers. In the report, issues such as required sample size, measurement accuracy and statistical analysis were addressed to ensure the results would be meaningful. In section 3.1 of the *Experimental Design Report*, a pre-specified margin of error method was used to verify that a set of 18 pumps would be the minimum sample size to be able to statistically characterize MCWA's 120 pump population.

A wide range of HSC pumps were selected based on horsepower (hp), specific speed (NS) and using information from field test results. Ultimately 21 HSC pumps were selected ranging in size from 20 hp up to 1750 hp with specific speeds between 1071 and 3190. The project required that performance changes from mechanical refurbishment and sandblasting and coating would be evaluated independently so that the relative contribution of each towards pump performance improvement could be measured.

After initial performance testing was completed prior to any restoration work being performed, the pumps were disassembled and either sandblasted and coated or mechanically refurbished as the first step in the process. Once this was completed, the pumps were reinstalled for performance testing. After testing, the pumps were again disassembled for the second step (sandblasting and coating if the first step was mechanical refurbishment and vice versa). Once the second step was completed, the pumps were reinstalled again so that performance testing could be done to measure the performance impact of the second step of the restoration.

The impact of coating pump impellers was also evaluated. Three HSC pumps were selected to have their impellers coated as an independent third step of the restoration process. The others would have their impellers coated during the mechanical refurbishment step.

A comparison of performance improvement between just sandblasting (not coating) the interior of a pump and sandblasting with coating was included. Three sets of identical HSC pumps were selected for this comparison. The testing was done to determine if the coating had a positive effect on pump efficiency and performance, or if the increases in performance being measured were simply the result of eliminating internal roughness and tuberculation.

Finally, follow-up performance testing and periodic internal inspections of all the pumps in the study were planned. Performance testing would be performed every six months on each pump and internal inspections to evaluate coating adhesion and durability would be performed at one to two year intervals.

2.1 PUMP MECHANICAL REFURBISHMENT

Pump mechanical refurbishment generally consisted of replacing internal components such as wear rings (impeller and casing), shaft sleeves and shaft bearings. In cases of extreme wear, impellers and or shafts were also replaced.

The reason pump performance and efficiency diminishes over time is primarily due to increased clearances in the wear rings. New pumps generally have 0.010 – 0.015 inch clearances between the impeller and casing wear rings. Over time these clearances will increase due to wear. This can cause internal recirculation between the discharge side and the suction side of the pump. As the clearance increases, so does recirculation. As wear ring clearances increase over time, recirculation continues to reduce pump flow, head and efficiency. An increasing percentage of water no longer goes through the pump, but recirculates within it.

2.2 COATING TECHNOLOGY AND SELECTION

Several types of coatings were considered for the pump coating project. Ultimately, brushable type ceramic filled epoxy coatings were selected for the following reasons:

- The coating can be applied in-house without sophisticated tools or equipment and minimal training.
- The coatings have good adhesion and abrasion characteristics. Both are characteristics of epoxies.
- Coatings had to be NSF-61 approved to satisfy regulations for contact with potable water.
- The coatings have a reasonable cost.

Additional considerations were also given to the type of base resin used in the coating. There are generally three types of epoxy resins used in the ceramic coating industry: Bisphenol A, Bisphenol F and Novolac resins[4]. Bisphenol A base resins are the original epoxy resins available since the 1930's. Bisphenol F resins are more modern resins designed to have lower viscosity than the A types (easier to apply) and have greater adhesion and chemical resistance properties. Novolac resins are a class of base resins that have even higher adhesion and chemical resistance than the F types, but also have the added property of heat resistance. Heat and chemical resistance were not significant concerns to MCWA, but any adhesion differences based on a coating's base resin was.

Coatings selected for the study and their base resin types are shown in Table 2-1.

Table 2-1 Brushable Coatings and Base Resin Type

Manufacturer	***Coating Name***	***Base Resin***
Loctite/Nordbak	Brushable Ceramic Grey	Bisphenol A
Belzona	1341 Supermetalglide	Bisphenol A/F Blend
Enecon	Chem Clad XC	Novolac

Pump impellers were also coated, but by a different method. It is difficult to get an even coating with a brush, and on such a fast rotating element this could cause imbalance issues. To avoid this problem, powder coating was selected as the preferred method of application. The specific powder coating chosen was Arkema's Rilsan© Polyamide 11 Nylon Powder Coating. This coating was selected because manufacturer testing of this NSF-61 approved nylon coating material indicated that the coating had similar friction coefficients to epoxy powder coatings, but was far more resistant to abrasion and pump cavitation damage than epoxy coatings. Manufacturer testing claimed that the material was equivalent if not superior to stainless steel in terms of resistance to abrasion and pump cavitation damage.[5]

2.3 PUMP EFFICIENCY TESTING

Pump efficiency and field testing was conducted in accordance with the Hydraulic Institute's "American National Standard for Centrifugal Pump Tests", Level B. For each of the test points, suction and discharge pressures were taken at the suction and discharge flanges. Flow was recorded through the pump station's magnetic (mag.) meter or venturi meter. Pump speed was measured with a hand held stroboscope and power readings were recorded from digital display power monitors within each pump station.

3.0 PUMP RESTORATION PROCESS

As previously mentioned, mechanical refurbishment consisted of replacing the impeller and casing wear rings, bearings and shaft sleeves as necessary to achieve proper clearances and operation. Powder coating of the impeller was also included in the mechanical refurbishment step for most of the pumps, unless it was done as an independent third step of a pump's restoration. Figure 3-1 shows a powder coated impeller with new rings and shaft sleeves being readied for reinstallation into the pump.

Figure 3-1 Powder Coated Impeller

Figure 3-2 shows the typical internal condition of a pump prior to sandblasting. This particular casing section is from a 600 hp bottom suction pump that was installed in the mid 1980's. As shown in the photo, the interior of this pump was corroded and had a considerable amount of tuberculation build up.

Figure 3-2 Internal Condition of Pump

Figure 3-3 shows the interior of the pump after sandblasting. After each pump was sandblasted, the interior of the pump was evaluated to see if the condition warranted the application of metal filler prior to two coats of the epoxy ceramic top coating. Those pumps that had a significant amount of metal loss or were severely pitted had the metal filler applied prior to top coating. Metal filler was applied as recommended by the top coating manufacturer.

Figure 3-3 Interior after Sandblasting

Figure 3-4 shows the interior of the pump after the application of metal filler. Often the metal filler was not applied to the entire interior casing of the pump, but only as necessary to fill in most of the deepest pitting and corrosion damage.

After the application of the metal filler, or if it was decided that the pump did not need metal filler, two coats of ceramic epoxy topcoat, approximately 15 mils thick each, were applied to the interior of the pump.

Figure 3-5 shows the interior cover of the same pump after the application of two coats of the ceramic filled epoxy material.

Roughly half of the 21 pumps were mechanically refurbished first and then coated, while the other half were sandblasted and coated first, then mechanically refurbished.   Whatever the sequence, after each step in the process the pump would be re-assembled and put back in service for field testing prior to proceeding to the next step of the restoration process.

Figure 3-4   Interior after Metal Filler

Figure 3-5   Ceramic Filled Epoxy

4.0 EFFICIENCY, PERFORMANCE GAINS, METHODOLOGY AND RESULTS

As previously mentioned, pumps were selected for the project based on size (hp), specific speed (Ns) and how poorly they were performing relative to original manufacturer specifications. Unfortunately, not all pumps in the MCWA system, even when new, operate at their best efficiency point (BEP). Furthermore, field system curves vary with demands, tank levels, and system configuration. Therefore, for the purposes of uniform evaluation and comparison of each pump's head, flow, efficiency and operating costs, it was important that each pump be evaluated against a standardized system curve. Therefore, a system curve formula was developed which generated a standardized system curve for each pump based on each pump's BEP. This way, the effects of performance improvement could be compared across different pumps in a similar manner.

The system curve formula takes the flow (Q) and head (H) at the BEP of each pump in the study and generates a standardized system curve for each pump based on Table 4-1.

Table 4-1 Standardized System Curve

Flow	Head
0.5(Q)	0.8(H)
0.75(Q)	0.88(H)
Q (at BEP)	H (at BEP)
1.25(Q)	1.2(H)

Figure 4-1 below is a theoretical representation of how pump efficiency and performance gains were estimated utilizing the standardized system curve. As shown in the graph, the system curve, by definition, intersects the pump's original manufacturer curve at the BEP: 6,000 gallons per minute (gpm) at 150 feet of head. The pre-restoration pump curve as measured in the field is then plotted on the graph and in this theoretical example intersects the calculated system curve at 4,700 gpm, 135 feet of head at 72% efficiency. After pump restoration is completed, the post restoration head and flow curve as measured in the field is plotted on the graph and in this example intersects the calculated system curve at 6,200 gpm, 154 feet of head at 91% efficiency.

Figure 4-1 Estimated Point of Pump Operation

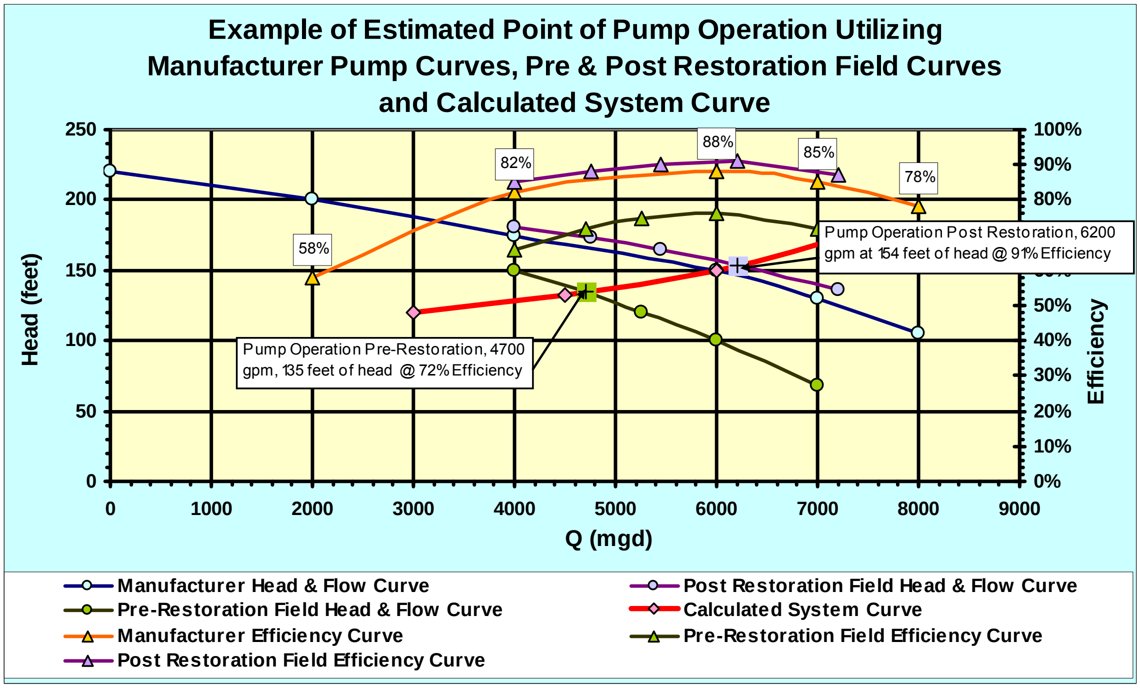


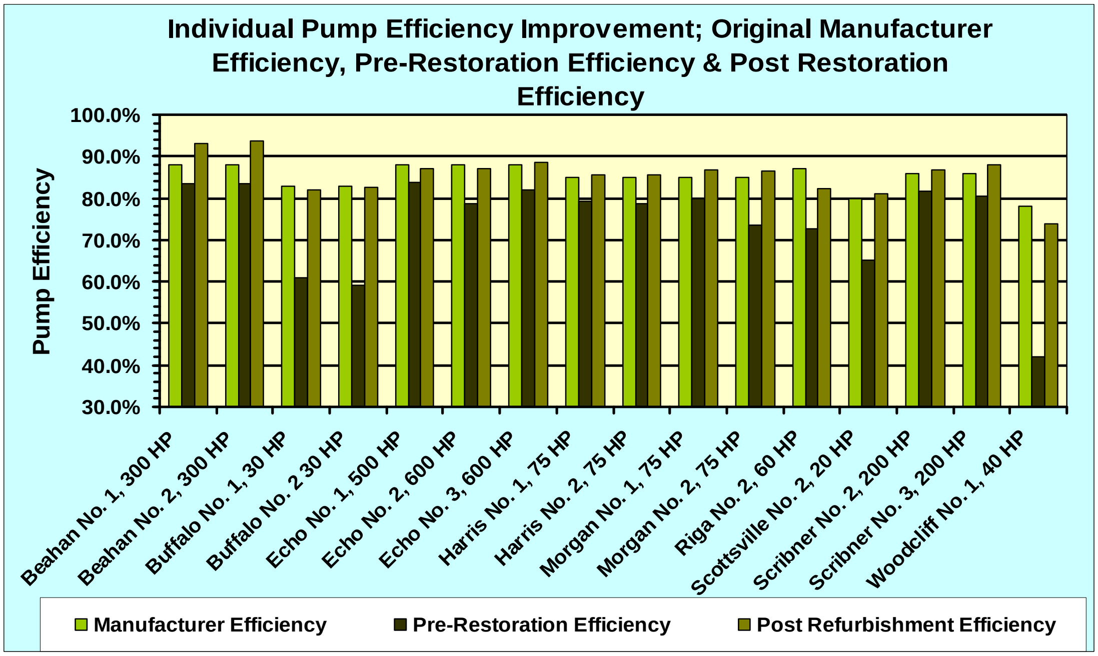
Table 4-2 Pump Performance Comparison

	Flow (gpm)	Head (feet)	Efficiency %
Pump Pre-Restoration	4700	135	72%
Pump Post Restoration	6200	154	91%

Therefore, for the purposes of establishing performance (head and flow) and efficiency gains and for calculating energy usage, energy savings and energy payback periods, this methodology was similarly applied to the pumps in the project. Each step of the restoration effort could be evaluated for its relative contribution towards increased pump performance. For example, using field pump curves along with the standardized system curves makes it possible to measure the performance contributions between pre and post sandblasting and coating, mechanical refurbishment and impeller coating.

Figure 4-2 below shows each pump's original manufacturer efficiency at the BEP, the pre-restoration efficiency and the post restoration efficiency for the 16 pumps that were both refurbished and coated (the three pumps that were sandblasted but not coated were excluded, and are discussed in section 5.3).

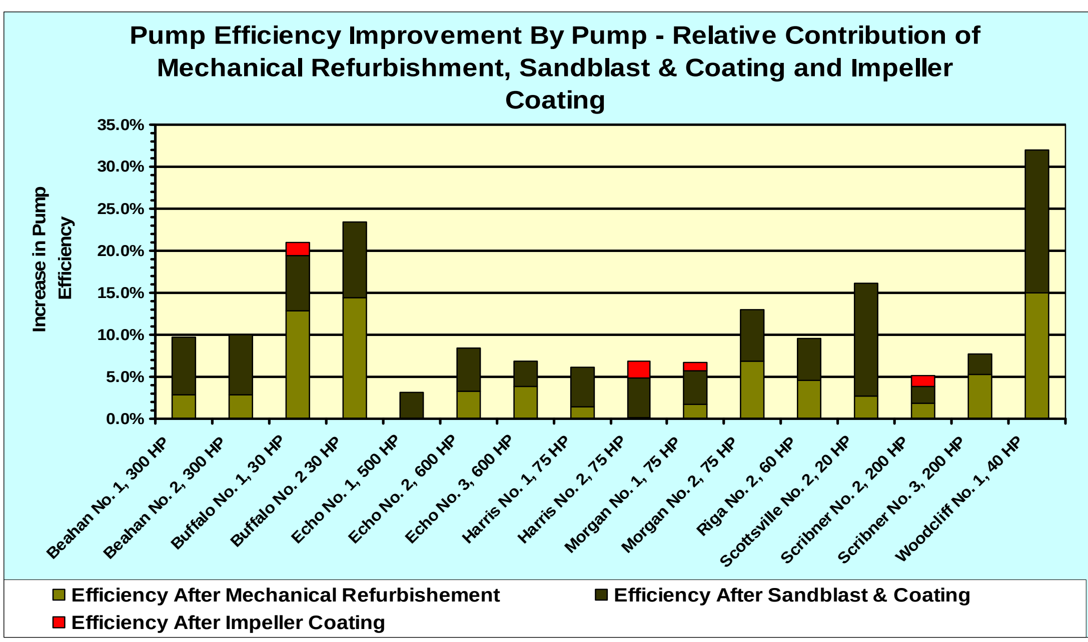
Figure 4-2 Pump Efficiency Comparisons



Overall, the average increase in pump efficiency through restoration (sandblasting and coating and mechanical refurbishment) for the sixteen pumps shown in Figure 4-2 is 11.6%.

Figure 4-3 breaks down the relative contribution of each step to the restoration effort (mechanical refurbishment, sandblasting and coating and impeller coating) for these same sixteen pumps.

Figure 4-3 Pump Efficiency Relative Contributions



As shown in the graph, mechanical refurbishment on average increased pump efficiency by 5.3%, sandblasting and coating on average increased pump efficiency by 6.3 % and impeller coating when done as a separate step increased pump efficiency an average of 1.5%.

The data in Figure 4-3 shows that the relative increase in pump efficiency obtained from mechanical refurbishment and sandblasting and coating is split about evenly. Approximately 50% of the return can be attributed to mechanical refurbishment while the other 50% can be attributed to sandblasting and coating. Although this distribution is only an approximation and doesn't completely fit some of the pumps in Figure 4-3, this can be accounted for by the uneven distribution of wear in the internal components compared to the roughness and tuberculation. Pumps where the degree of interior corrosion, roughness and tuberculation was greater than the degree of internal component wear responded better to sandblasting and coating, while those pumps where the degree of internal component wear was greater than the degree of interior roughness responded better to mechanical refurbishment. In either case, the graph demonstrates the importance of both steps in maximizing post restoration efficiency gains.

Impeller coating increased pump efficiency by an average of 1.5% in the four pumps where it was done as an independent third step. Although this is less than one quarter of the efficiency increases attributed to sandblasting and coating, it is important to remember that where impeller coating wasn't done as an independent step it was combined with component replacement during mechanical refurbishment on all the other pumps. Therefore, of the 5.3% average increase in efficiency due to mechanical refurbishment, approximately 1.5% of that amount could arguably be attributed to impeller coating. Although this is still less than one third of the total increase in efficiency attributed to mechanical refurbishment, if the coating does increase an impeller's resistance to cavitation damage as the coating manufacturer claims, that coupled with the 1.5% increase in efficiency seems to make it a worthwhile step in the restoration process.

Head and flow changes for this group of sixteen pumps are summarized in Table 4-3 below. As shown in the table, the head and flow of all pumps increased from sandblasting and coating. The head and flow of most pumps increased from mechanical refurbishment. However impeller coating slightly reduced head and flow of all four pumps where it was done as an independent step.

Table 4-3 Pump Head and Flow Percent Changes

Pump Head and Flow Percent Changes, Pre to Post Restoration									
		Mechanical Refurbishment		Casing Sandblasting and Coating		Impeller Powder Coating			
Pump	HP	% Head Change	% Q Change	% Head Change	% Q Change	% Head Change	% Q Change	Total % Change Head	Total % Change Q
Beahan No. 1	300	-1.8%	-3.4%	3.1%	5.4%			1.3%	2.0%
Beahan No. 2	300	-1.5%	-2.3%	3.0%	4.8%			1.5%	2.5%
Buffalo No. 1	30	8.3%	20.2%	2.6%	4.5%	-1.3%	-2.5%	9.6%	22.2%
Buffalo No. 2	30	10.0%	20.5%	2.6%	5.8%			12.6%	26.3%
Echo No. 1	500			1.0%	1.6%			1.0%	1.6%
Echo No. 2	600	0.5%	1.1%	2.0%	6.5%			2.5%	7.6%
Echo No. 3	600	0.9%	1.7%	1.3%	2.6%			2.2%	4.3%
Harris No. 1	75	-0.5%	-2.8%	0.9%	4.7%			0.4%	1.9%
Harris No. 2	75	-0.1%	-0.3%	2.1%	3.0%	-0.6%	-0.9%	1.4%	1.8%
Morgan No. 1	75	1.5%	2.3%	1.5%	3.2%	-1.4%	-2.2%	1.6%	3.3%
Morgan No. 2	75	1.0%	2.0%	0.5%	1.2%			1.5%	3.2%
Riga No. 2	60	1.9%	3.6%	2.8%	3.3%			4.7%	6.9%
Scottsville No. 2	20	1.6%	2.5%	7.5%	15.2%			9.1%	17.7%
Scribner No. 2	200	2.0%	7.6%	1.0%	1.8%	-1.0%	-1.3%	2.0%	8.1%
Scribner No. 3	200	3.3%	4.9%	1.3%	2.1%			4.6%	7.0%
Woodcliff No. 1	40	4.9%	14.6%	9.3%	29.5%			14.2%	44.1%

(Shaded) Impeller coated as an independent 3rd step in the restoration

The reason head and flow decreased from coating the impeller is not entirely known, but discussions between MCWA personnel and pump industry representatives[6] and an article provided by Corrocoat Limited[7] suggest one possibility.

All of the impellers coated were of the enclosed double suction design. Coating the interior passageways of an impeller with a 10 – 20 mil thick coating would reduce the cross-sectional area of these passageways. The article supplied by Corrocoat points out, "considering that frictional resistance increases by the square of flow velocity, even very thin coatings can have a significant impact on flow through narrow impeller passageways". It may be possible that the powder coating is thick enough to have a minor negative impact on pump head and flow, but not thick enough to negate the friction reducing benefits of the coating application. Hence head and flow slightly decrease but overall pump efficiency increases from the impeller coatings due to less power required relative to the hydraulic work being done.

In any event, head and flow reductions from impeller coating for whatever reasons were relatively minor. On average head was reduced 1.4% and flow was reduced 2.2%.

The reduction of head and flow from impeller coatings may also explain why several pumps experienced head and flow reductions after mechanical refurbishment. Specifically, the head and flow of the Beahan and Harris pumps were measured in the field to be less after mechanical refurbishment than before the work was done (Table 4-3). One possible explanation is that coating the impellers resulted in slightly lower head and flow that wasn't offset by mechanical refurbishment. Even though head and flow slightly declined due to narrowed passageways in the impeller, overall pump efficiency improved due to less internal recirculation (from mechanical refurbishment) and from the positive effects of friction reduction associated with coating the impeller.

Field performance testing of all sixteen pumps at six month intervals has shown that most pumps have remained operating at or very near their post restoration levels with respect to head, flow and efficiency. Some of the first pumps restored in the study were in service for close to two years and in some cases have had slight drops in head or efficiency, but this could be attributed to normal performance declines associated with mechanical wear. Coating inspections, which will be discussed in greater detail later, have shown that the coatings are holding up well inside the pumps. There are occasional spots of rust, but this is probably the result of not completely filling a corrosion pit with coating material. Overall, coatings didn't show signs of significant loss or failure.

5.0 ENERGY PAY BACK PERIOD AND KILOWATT HOUR SAVINGS

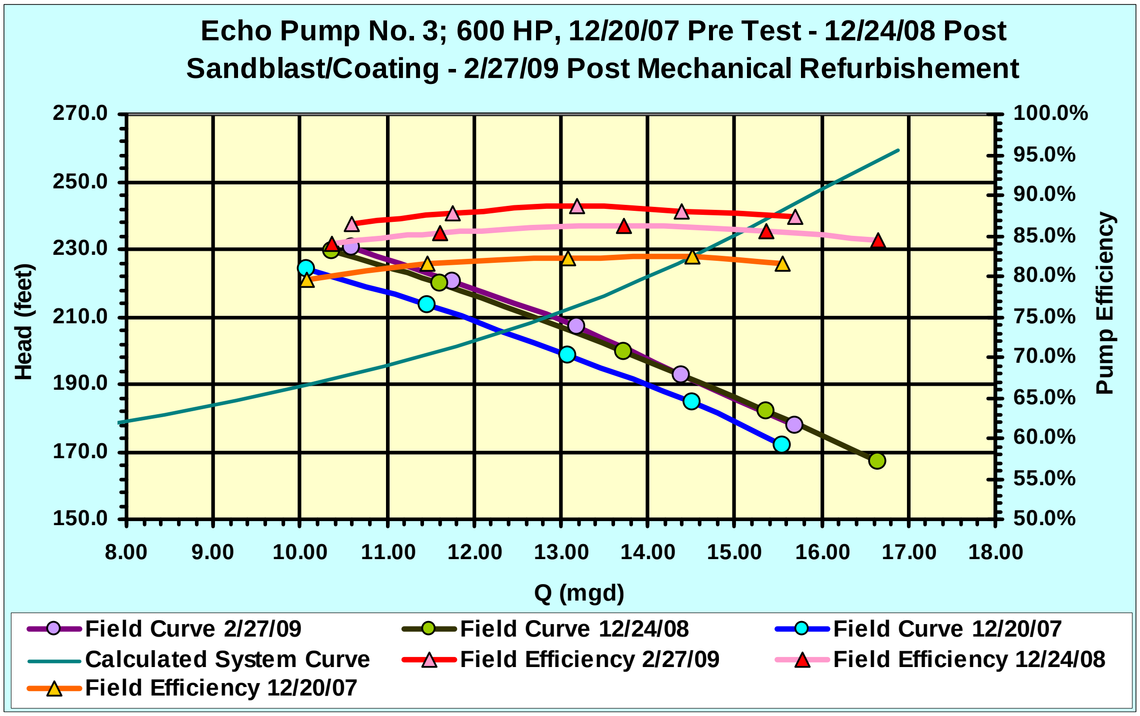
5.1 GENERAL

In order for a pump improvement project to be worthwhile, it must be economical. Performance gains can improve system operations, but it is the energy savings that help pay for the cost of pump refurbishment and coating. The cost-benefit calculations depend not only on efficiency gains, but on pump run time, electricity rates and rate structure (i.e. demand charges), and hydraulic system curves. A refurbished pump often runs at a higher head and flow rate, and the additional head losses that come from higher flow rates can negate a fraction of the efficiency gains. As part of this study, MCWA calculated the pay back period for each pump, and the methodology is illustrated by the example in the following section.

5.2 ECHO PUMP NO. 3 PERFORMANCE

Figure 5-1 shows the performance curves for a 600 HP 18x16 bottom suction pump installed in the mid 1980's and named Echo No. 3. Its interior had significant corrosion and tuberculation. Sandblasting and coating increased efficiency by 2.7% and mechanical refurbishment increased efficiency by an additional 3.9%. The total increase in head was 4.5 feet and the total increase in flow (Q) was 0.54 million gallons per day (mgd).

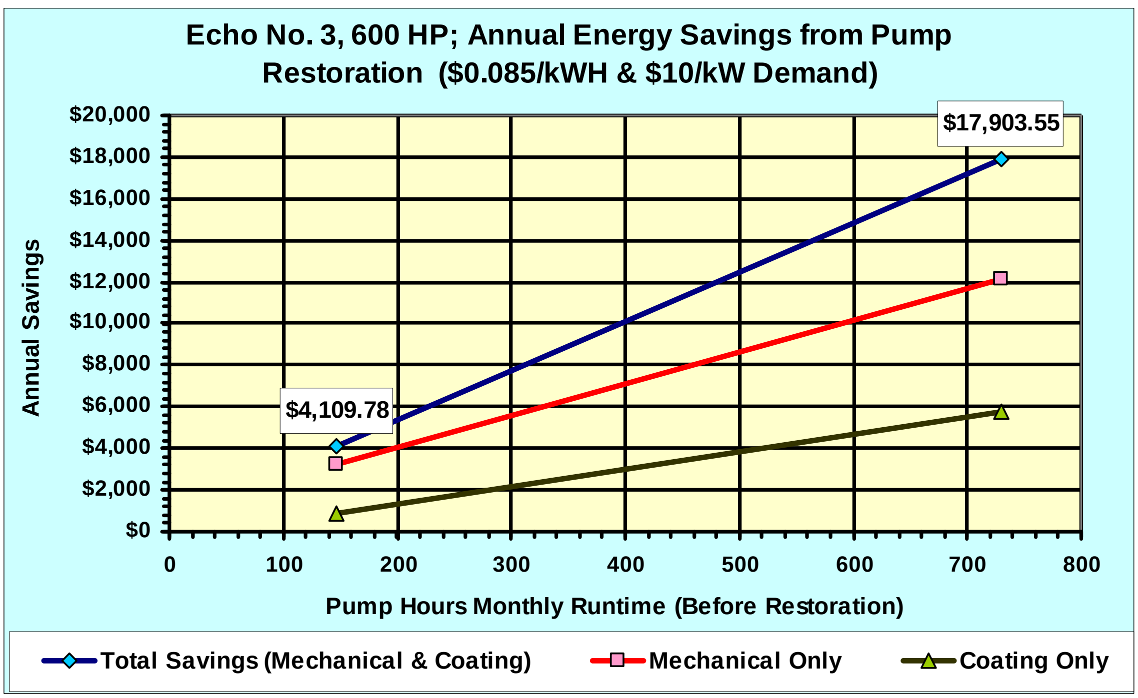
Figure 5-1 Echo Pump No. 3 Pre Test vs. Post Sandblasting/Coating



When looking at the potential of energy savings versus restoration cost, it's important to note the obvious: the more a pump runs, the greater the energy savings and the shorter the pay back period will be after restoration. Therefore, when evaluating energy savings and energy pay back period, it is important to know pump run time and consider it in the pay back calculation.

Figure 5-2 estimates the annual energy savings (Y-axis) resulting from restoring the Echo No. 3 pump and the estimated energy savings contribution split between mechanical refurbishment and sandblasting and coating. Annual Energy savings are based on an MCWA's energy rate of $.085/kWh, a monthly demand charge of $10/kW, and hours of operation that the pump typically runs. Had the pump been running more or less continuous prior to restoration, annual energy savings of approximately $17,904 would be achieved from less hours of pump operation due to increased head and flow, increased efficiency and reduced power consumption to supply the same quantity of water.

Figure 5-2 Echo Pump No. 3 Annual Energy Savings From Restoration



Cost of this pump's restoration was $13,121. Under continuous operation prior to restoration (730 hours/month), the payback period in terms of energy savings would be 0.73 years. However, had the pump been running only 20% of the time (146 hours/month) estimated total annual savings would have been approximately $4,110 resulting in an energy savings restoration payback period of 3.19 years.

As shown in the graph, the energy savings resulting from mechanical refurbishment was about two thirds of the total savings, while sandblasting and coating was about a third of the total savings. As previously discussed, mechanical refurbishment yielded greater improvement with some pumps, while sandblasting and coating improved others to a greater degree. In this particular case the pump's impeller had been significantly worn and damaged from cavitation and was replaced during mechanical refurbishment. The conclusion is that the wear on the internal components had contributed more to pump inefficiency than the roughness of the internal casing.

Individual pump performance data and energy savings for each pump being part of this study are included in the Appendix C.

5.3 PROJECT WIDE IMPROVEMENTS

Table 5-1 summarizes the estimated costs, energy savings, energy savings pay back periods and kilowatt hour savings assuming the pumps operated continuously prior to restoration. Energy Savings are again based on $10/kW demand charge and $0.085/kWh charge.

Table 5-1 Estimated Cost of Restoration and Energy Savings Pay Back Period

Table No. 3 Per Pump Estimated Cost of Restoration and Energy Savings Pay Back Period and Annual kWh Savings, Based on Continuous 24/7 Pre-Restoration Pump Operation

Pump	*HP*	*Labor Cost*	*Mechanical & Misc Cost*	*Sandblast Cost*	*Coating Cost*	*Imp Coating Cost*	*Estimated Restoration Total Cost*	*24/7 Operation Annual Energy Savings $*	*24/7 Energy Payback Period (Years)*	*24/7 kWh Annual Savings*
Echo 1	500	$3,344	$1,400	$1,400	$2,567	$0	**$8,711**	**$7,420**	**1.17**	**81,884**
Echo 2	600	$5,016	$4,199	$1,050	$2,577	$0	**$12,842**	**$23,849**	**0.54**	**278,411**
Echo 3	600	$5,016	$4,199	$1,050	$2,146	$830	**$13,241**	**$17,904**	**0.74**	**202,850**
Beahan 1	300	$3,344	$2,799	$645	$811	$509	**$8,108**	**$15,740**	**0.52**	**163,015**
Beahan 2	300	$3,344	$2,799	$840	$862	$509	**$8,354**	**$16,462**	**0.51**	**172,168**
Scribner 2	200	$3,344	$2,799	$675	$629	$454	**$7,901**	**$2,976**	**2.65**	**41,907**
Scribner 3	200	$3,344	$2,799	$840	$575	$0	**$7,558**	**$3,909**	**1.93**	**50,135**
Harris 1	75	$1,672	$1,400	$350	$255	$406	**$4,083**	**$3,021**	**1.35**	**31,594**
Harris 2	75	$1,672	$1,400	$375	$608	$406	**$4,461**	**$3,066**	**1.45**	**32,170**
Morgan 1	75	$1,672	$1,400	$720	$410	$405	**$4,607**	**$2,979**	**1.55**	**32,309**
Morgan 2	75	$1,672	$1,400	$720	$299	$0	**$4,091**	**$7,204**	**0.57**	**75,095**
Riga 2	60	$1,672	$1,400	$375	$437	$399	**$4,283**	**$2,586**	**1.66**	**29,716**
Scottsville 2	60	$1,672	$1,400	$310	$358	$0	**$3,740**	**$1,303**	**2.87**	**14,959**
Woodcliff 1	40	$1,672	$1,400	$280	$375	$0	**$3,727**	**$7,905**	**0.47**	**91,533**
Buffalo 1	30	$1,672	$1,400	$360	$402	$399	**$4,233**	**$2,959**	**1.43**	**38,416**
Buffalo 2	30	$1,672	$1,400	$440	$246	$399	**$4,157**	**$2,907**	**1.43**	**35,065**
						Totals	**$104,093**	**$122,190**	**0.83 Avg**	**1,371,227**

As shown in the table, the estimated post-restoration annual energy savings of all sixteen pumps, assuming they all would have been operating continuously prior to restoration is in excess of $122,000, while total estimated pump restoration costs are estimated to be a little over $104,000. The estimated total project cost and energy payback period assuming continuous pump operation of all sixteen pumps shown is 0.83 years.

Looking at the post restoration energy pay back periods of individual pumps shows that six pumps have estimated pay back periods of less than one year, eight pumps have estimated pay back periods of between one to two years and two have estimated pay back periods of between two to three years. The assumption of continuous operation was done to get all pumps onto a uniform economic basis. In reality, the payback period above would be divided by the percent of time the pump actually runs to arrive at the actual payback period for that pump (i.e. for a pump that runs 25% of the time, the payback period is four times longer).

Kilowatt hour (kWh) savings of all sixteen pumps based on continuous pump operation is estimated to be just less than 1.37 million kilowatt hours. This is equivalent to the average annual greenhouse gas emissions of 188 passenger vehicles.[8]

5.4 SHOREMONT HIGH LIFT 1750 HP PUMPS

The project included an analysis of the performance enhancement of sandblasting and coating two 1750 HP pumps at the MCWA treatment plant. These two pumps were not mechanically refurbished as it was determined upon disassembly that the internal clearance between casing and impeller rings was not yet to the point where replacement was required. Upon removing the covers of the two pumps it was discovered that the discharge side (and only the discharge side) of each pump had been previously coated. The coating apparently was applied by the pump manufacturer at the time of manufacture. It could not be determined whether or not the purchase specifications required the coating (purchased in the early 1980s) and/or why the coating was applied to the discharge side of the pumps only. Figure 6-1 shows this coating on the discharge side of the pump. It was not determined what type of coating was used or how it had been applied, but based on the lack of visible brush strokes a good guess would be that it was some type of powder coating. Overall the coating was in very good shape with only minimal small rust spot areas where the coating had failed.

Figure 5-3 Previous Coatings Found

The suction side interior casing of the two pumps were not originally coated, but were coated as part of this study. Figure 5-2 shows the suction side of one of the pumps. Despite it being uncoated, it did not have the same level of corrosion and tuberculation build up as was evident on most other pumps in the study.

Figure 5-4 Interior Suction Side

The two figures below show the overall changes in pump efficiency of both pumps from restoration efforts and the relative contribution of coating the casing and the impeller of pump No. 6. As shown in Figure 5-3, although Shoremont No. 7 increased its overall efficiency by 3.2% from the restoration effort, Pump No. 6's efficiency declined by 2.5% after restoration.

Figure 5-5 1750 hp Pump Efficiency

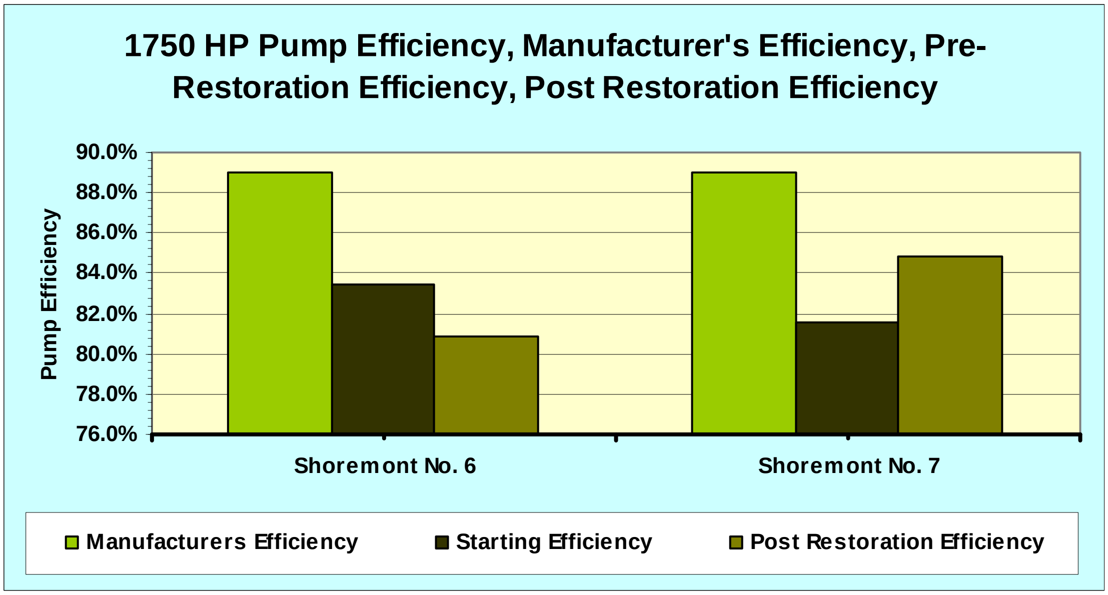
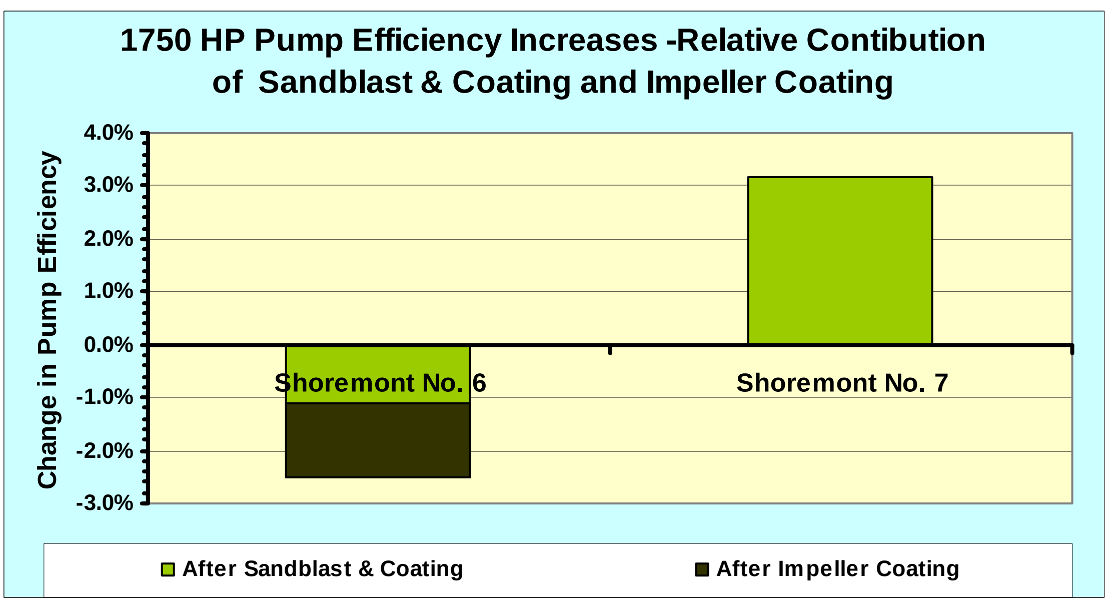


Figure 5-4 shows the break down of the relative contribution of sandblasting and coating and from the impeller coating of Shoremont Pump No. 6. As shown, both reduced the efficiency of the pump.

Figure 5-6 1750 hp Pump Efficiency Increases



Pump No. 6 had its pre-restoration field testing done more than six months prior to the pump being disassembled for restoration. It is possible that pump performance declined due to an internal mechanical problem that resulted in reduced performance sometime in the six months between the pre-restoration field test and the day that the pump was taken out of service to begin the sandblasting and coating. This potential decline therefore wouldn't have been accounted for in any of the pre or post-restoration field testing.

Another possible explanation for the negative change relative to Pump No. 6 is that although the impeller for this pump was coated as an individual second step, this impeller was not powder coated but instead was coated with the brush on epoxy material. To get the pump back in service quickly, the impeller coating step was expedited by coating it with two coats of the brushable ceramic epoxy coating. This coating goes on much thicker than the powder coating. As previously discussed, the thickness of the two coats may have diminished pump performance due to reducing the impeller passageways to the point that it negated any potential benefits derived from the friction reduction capabilities of the coating.

Pump no. 7 did show a performance gain of 3.2% between pre and post-restoration field testing. However, the pump casing was coated at the same time and in the step as the impeller powder coating. Therefore, although the field testing indicates that pump efficiency of this pump increased by 3.2%, it is impossible to determine what portion of that increase could be attributed to the casing coating and what portion could be attributed to impeller coating.

5.5 SANDBLASTING ONLY VS. SANDBLASTING and COATING

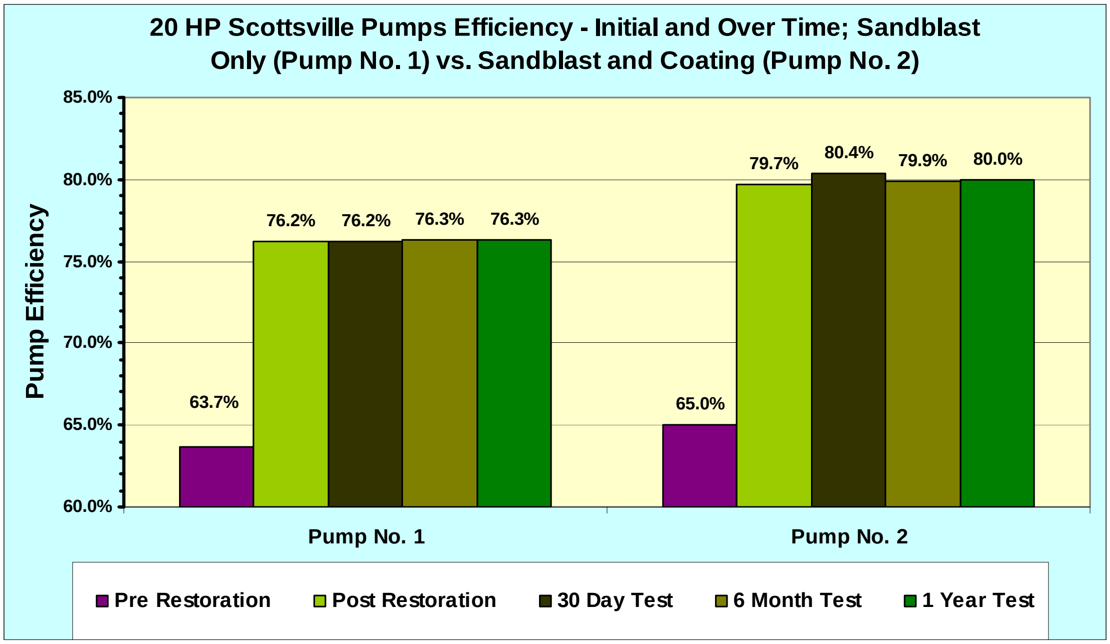
At the request of NYSERDA, to compare performance gains of several pumps that would be sandblasted and coated to pumps that would be sandblasted only was included in the study. The pilot study showed that removing internal pump roughness and tuberculation and coating the interior of the pump improved pump efficiency and performance, but it didn't necessarily prove or show that the increase in efficiency and performance could be directly attributed to the coating itself. NYSERDA wondered if the performance and efficiency improvements shown in the pilot study were just the results of simply removing internal roughness and built up tuberculation and that perhaps the coating had little effect. Additionally, NYSERDA wanted to determine whether or not the coatings eliminated or significantly delayed future internal corrosion and accumulation of tuberculation.

To test this, 3 sets of identical pairs of pumps were tested. In each set one pump was mechanically refurbished and sandblasted but not coated. The other pump was mechanically refurbished, sandblasted and coated. The tests were designed to answer two questions:

- Does the sandblasted and coated pump show different performance and efficiency gains than the sandblasted only pump?
- Does the performance of the uncoated pump decline more rapidly over time compared to the coated pump?

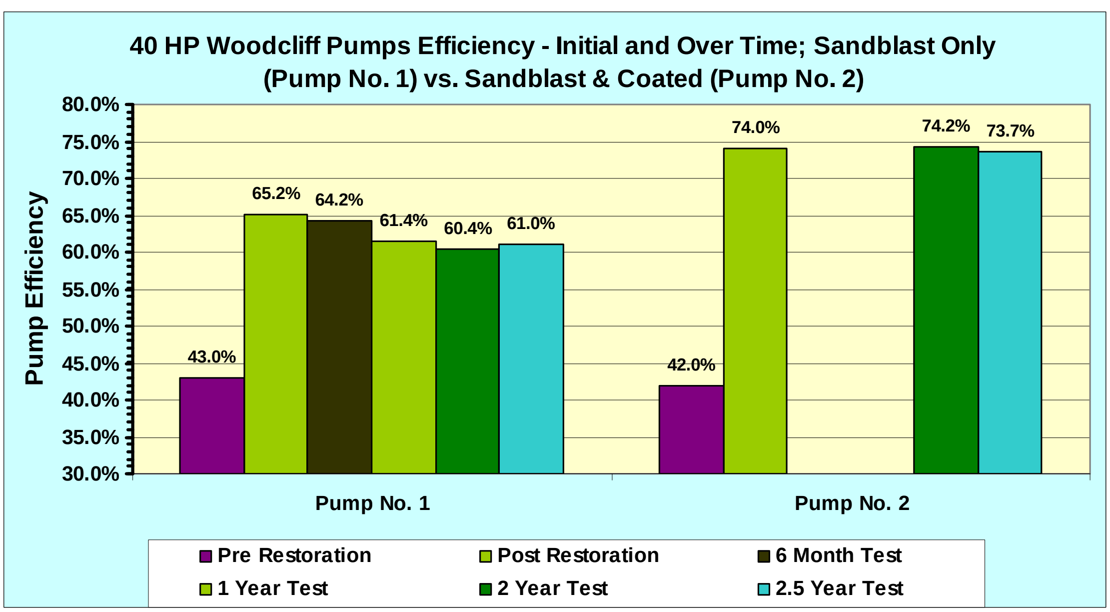
The first of these test comparisons is shown in Figure 5-5. Initial pump efficiency of the two 20 hp pumps prior to restoration was about the same. However, post restoration efficiency of the uncoated pump has consistently tested lower than the coated pump. The performance (head and flow) of the uncoated pump has also consistently tested lower than the coated pump. Post restoration testing of the uncoated pump has not shown a significant drop off in efficiency. Internal corrosion and roughness inside the uncoated pump has returned to the point that it impacts pump performance.

Figure 5-7 20 hp Scottsville Pumps Efficiency



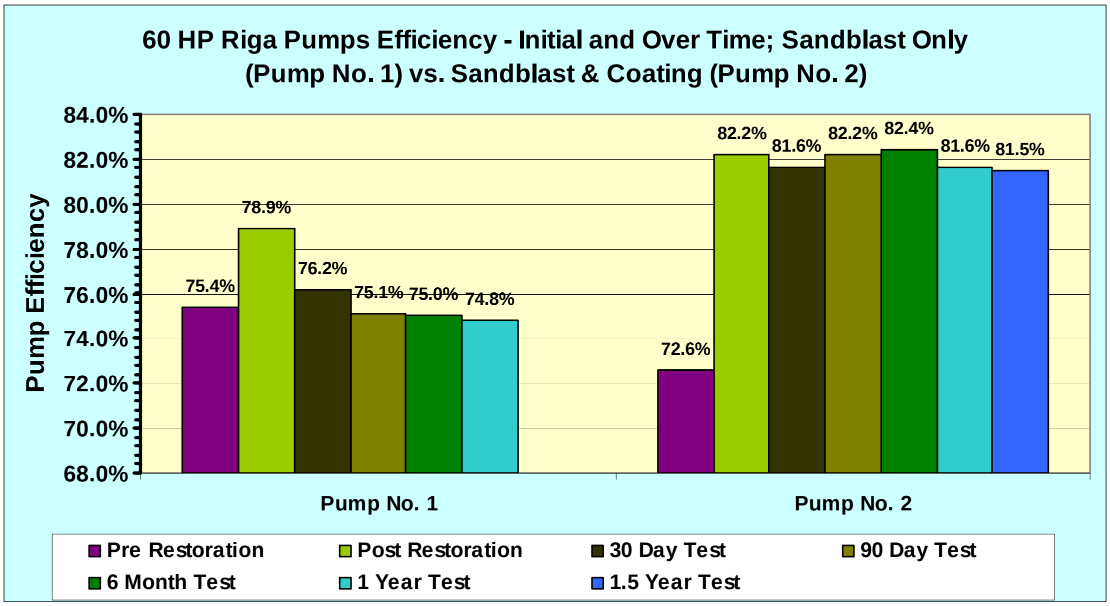
The second test is of two 40 hp pumps and results are shown in Figure 5-6. The initial pump efficiency of both pumps was again comparable. Post-restoration testing of both pumps revealed that the efficiency of the coated pump was 8.8% higher than the sandblasted only pump immediately after restoration. Subsequent field testing has shown that the uncoated pump's efficiency fell 4.2% after two years while the coated pump's efficiency declined less than 1% over the same time period. This suggests that corrosion and tuberculation build up inside the uncoated pump is causing a decline in pump efficiency, while the coated pump is not.

Figure 5-8 40 hp Woodcliff Pumps Efficiency



The results of the third test are shown in Figure 5-7. The initial efficiency of the 60 hp pump that was to be sandblasted only was 2.8% higher than the initial pump efficiency of the pump that was scheduled for sandblasting and coating. However, post restoration testing of the sandblasted and coated pump resulted in efficiency measurements that were 3.3% higher than the uncoated pump, 82.2% compared to 78.9%.

Figure 5-9 60 hp Riga Pumps Efficiency



The uncoated pump's efficiency reduced 4.1% after two years of service while the coated pump's efficiency declined less than 1% over the same time period. Again, this suggests that the return of corrosion and tuberculation inside the uncoated pump is causing a decline in pump efficiency.

The comparison between sandblasting and coating compared to just sandblasting shows the importance and benefits of ceramic epoxy coating. In all three cases the coated pump had higher initial post restoration efficiency than the uncoated pump. Furthermore, continued testing up to 2.5 years later showed that in two of the three comparisons the efficiency of the uncoated pumps began dropping quickly after restoration while the efficiency of the coated pumps more or less stayed the same.

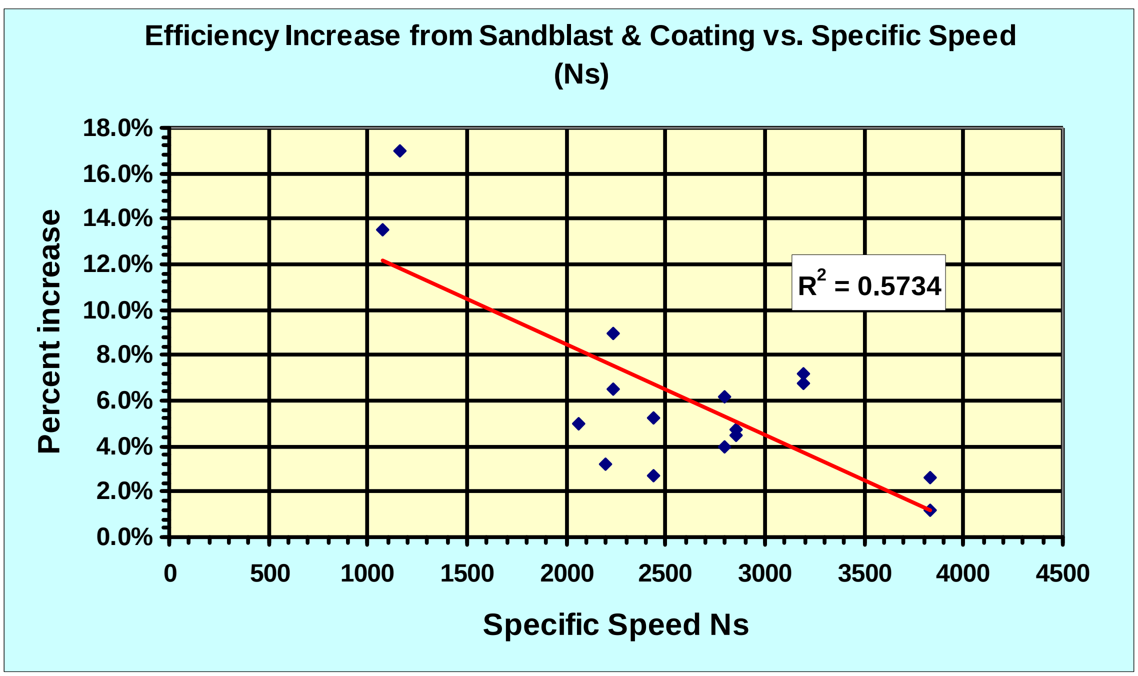
6.0 COATING EFFECTIVENESS VS. SPECIFIC SPEED, HORSEPOWER

6.1 SPECIFIC SPEED AND EFFICIENCY IMPROVEMENT FROM COATING

Specific speed can be defined as the correlation of pump capacity, head and speed at optimum efficiency, which classifies the pump impellers with respect to their geometric similarity.[9] Although coating the interior of HSC pumps in the United States isn't common, European pump manufacturers and pump users have been tinkering with pump coatings for quite some time. The paper entitled "Study on Improving the Energy Efficiency of Pumps"[10] suggests that due to internal passageway and impeller configuration, pumps of *lower* specific speed would theoretically respond *better* to coating application as far as efficiency enhancement through reduction of a pump's internal roughness. Pumps with low specific speeds tend to have higher head relative to flow rate, where pumping is generated more through centrifugal force than axial force.

The specific speeds of all sixteen pumps were calculated, and Figure 6-1 shows the correlation between specific speed and the increase in pump efficiency from sandblasting and coating.

Figure 6-1 Efficiency Increase from Coating



As shown by the linear regression R^2 analysis, 57% of the variance in pump efficiency increase from sandblasting and coating is accounted for by considering the pump's specific speed. One point about this analysis that may effect the R^2 calculation is that not all of the pumps started at the same degree of interior roughness prior to restoration. It wasn't possible to quantify the differences in the initial surface roughness for later use in efficiency improvement calculations and comparisons. Because of this, it is possible that variations in initial internal roughness between pumps might tend to negatively impact the correlation between efficiency and specific speed. For example, it might be the case that coating a higher specific speed pump with greater initial roughness would show higher efficiency gains than a lower specific speed pump that wasn't very rough. However, had they been of the same degree of initial internal roughness the lower specific speed pump would have indeed increased more in efficiency than the higher specific speed pump. Nevertheless, the summary statistics are as follows:

Table 6-1 Regression analysis for Efficiency Gain / Specific Speed Relationship

Regression Statistics	
Multiple R	**0.7572**
R Square	**0.5734**
Adjusted R Square	**0.5429**
Standard Error	**0.0276**
Observations	**16**

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	**1**	**0.014384185**	**0.0143842**	**18.81910633**	**0.000681468**
Residual	**14**	**0.010700752**	**0.0007643**		
Total	**15**	**0.025084938**			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	**0.164210341**	**0.024540118**	**6.6915**	**1.02456E-05**	**0.111577023**	**0.216843659**
Ns	**-3.96816E-05**	**9.14723E-06**	**-4.3381**	**0.000681468**	**-5.93004E-05**	**-2.00627E-05**

Having a P-value less than 0.05 indicates we can reject the null hypothesis and confirm the influence of specific speed on coating effectiveness for improving efficiency. Also, given the previously mentioned concern that not all pumps started with the same degree of internal roughness, the correlation between specific speed and the increase in pump efficiency from sandblasting and coating may actually be much stronger than calculated above.

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6.2 HORSEPOWER AND EFFICIENCY IMPROVEMENT FROM COATING

As shown in Figure 6-2 below, the relationship between horsepower (hp) and efficiency improvement is much more tenuous than that of specific speed and efficiency. Initially it was thought that there might be a relationship between increases in efficiency and the overall horsepower of a pump. However, judging by the data in Table 6-2, this does not appear to be the case.

Figure 6-2 Increase and Horsepower

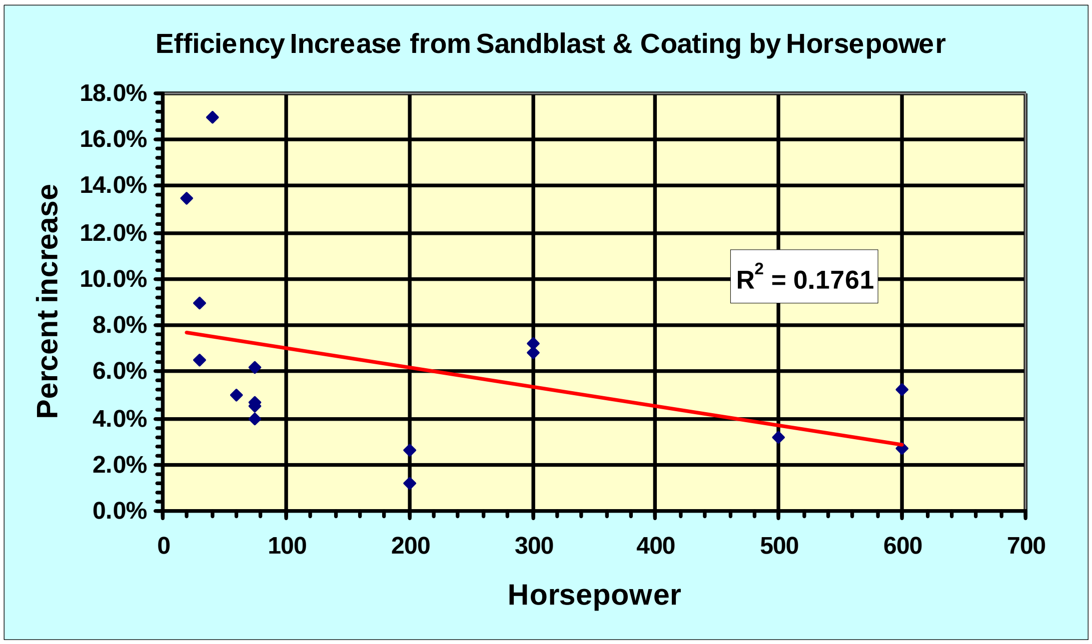


Table 6-2 Regression analysis for Efficiency Gain / Horsepower Relationship

Regression Statistics	
Multiple R	0.419592
R Square	0.176058
Adjusted R Square	0.117205
Standard Error	0.038423
Observations	16

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.004416395	0.0044164	2.991479849	0.105678628
Residual	14	0.020668543	0.0014763		
Total	15	0.025084938			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	0.078731306	0.013606999	5.7860888	4.71654E-05	0.049547195	0.107915417
Horsepower	-8.38682E-05	4.84902E-05	-1.7295895	0.105678628	-0.000187869	2.0133E-05

A P-value of greater than 0.05 (in this case, 0.1057), indicates there's not enough of a relationship to conclusively say that horsepower has an effect on coating effectiveness. Looking at the graph, one might be tempted to believe that coating is more effective on smaller pumps, but the statistical analysis indicates that other factors such as specific speed are more important.

7.0 EFFICIENCY INCREASES BETWEEN COATINGS

Three coatings were selected for this project based on resin type. The three coatings and their base resins (shown in parentheses) are as follows:

- Loctite/Nordbak (Bisphenol A)
- Belzona (Bisphenol A and F blend)
- Enecon (Novolac)

During development of the experimental design, it was initially proposed to compare these coatings on several sets of identical pumps to see if one of the coatings could be shown to be statistically better at increasing pump performance and efficiency than the others. The idea being that the type of coating could be isolated as a variable in the analysis. This was not possible because:

- There was a large difference in initial internal roughness between pumps in the study. This was also true (although to a lesser extent) in identical pumps side by side within a pump station. Even though pairs of pumps were installed at the same time and operated similarly, there were varying degrees of internal corrosion and tuberculation between sets of pumps.
- There were differences in impeller conditions and in pre and post mechanical refurbishment wear ring clearances between sets of pumps. Although the mechanical refurbishment brought pumps back within wear ring clearance tolerances, post mechanical refurbishment wear ring clearance between sets of pumps were not identical which might explain small differences in pump performance. This is especially true of the sets of pumps where one pump was sandblasted and coated before mechanical refurbishment while the other pump was mechanically refurbished first and coated second. It's possible that variances in impeller conditions and wear ring clearances between these and other sets of pumps would make a difference in post sandblasting and coating performance testing.
- Coating with the epoxy ceramic material was somewhat like painting with honey; hence coating thickness is highly variable. Differences in coating thickness or uneven coating thickness might also result in differences in post sandblasting and coating performance test results.
- The sample size of sets of pumps for coating comparison was reduced by the sandblasting and coating vs. sandblasting only comparisons. Ultimately the available sample size dropped form 10 sets of pumps (20 total pumps) to 6 sets of pumps (12 total). Also, because of the statistical relationship between specific speed and efficiency improvement from coatings, it wasn't possible to make any coating-specific pump efficiency improvement comparisons between pumps outside of the six sets.

Regardless of whether or not this study was able to isolate "coating type" as an independent variable for comparison, a simple review of the efficiency gains between sets of pumps and coating type shown in

Figures 7-1, 7-2, and 7-3 would seem to suggest that any one coating is no better than another as far as restoring lost pump performance.

Figure 7-1 shows the comparison between Loctite/Nordbak and Belzona. As shown in the Graph, the Loctite/Nordbak product showed greater efficiency improvement in two cases while Belzona was higher in one. All three sets of impellers in this comparison had significant differences in their pre-mechanical refurbishment conditions.

Figure 7-1 Coating Comparison between Loctite/Nordbak and Belzona

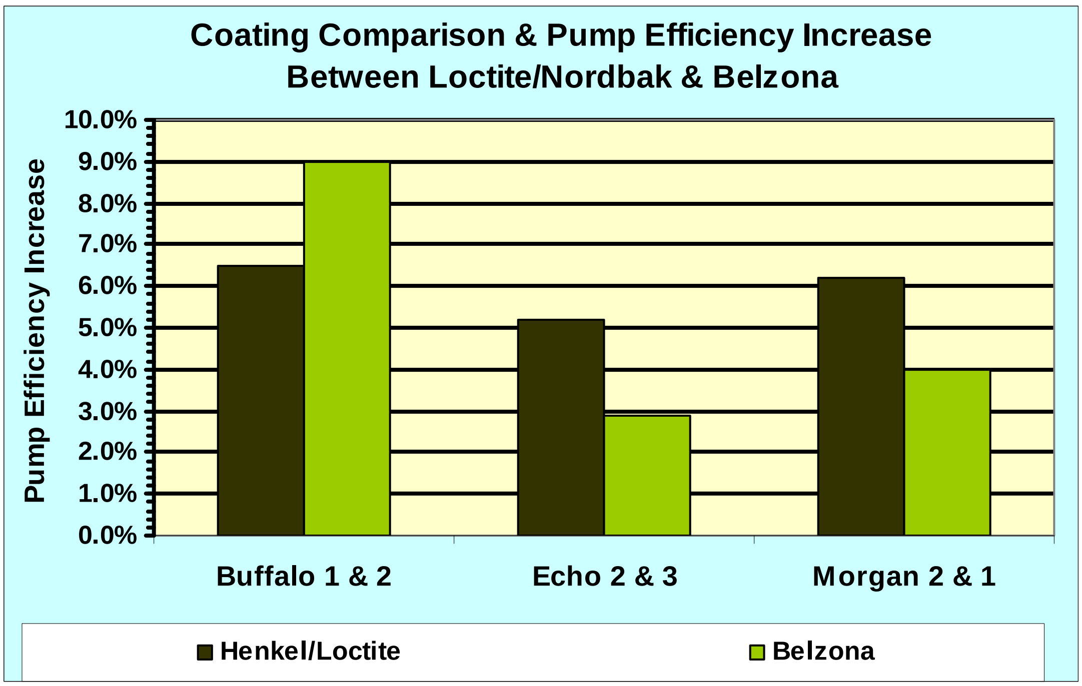


Figure 7-2 shows the comparison between Loctite/Nordbak and Enecon. In this comparison, both coatings were very close in pump efficiency improvement. In the fist example the Enecon product resulted in slightly higher post sandblasting and coating pump efficiency while in the second example the results were equal. These slight differences in post sandblasting and coating efficiencies could be explained by slightly different degrees of initial internal roughness.

Figure 7-2 Coating Comparison between Loctite/Nordbak and Enecon

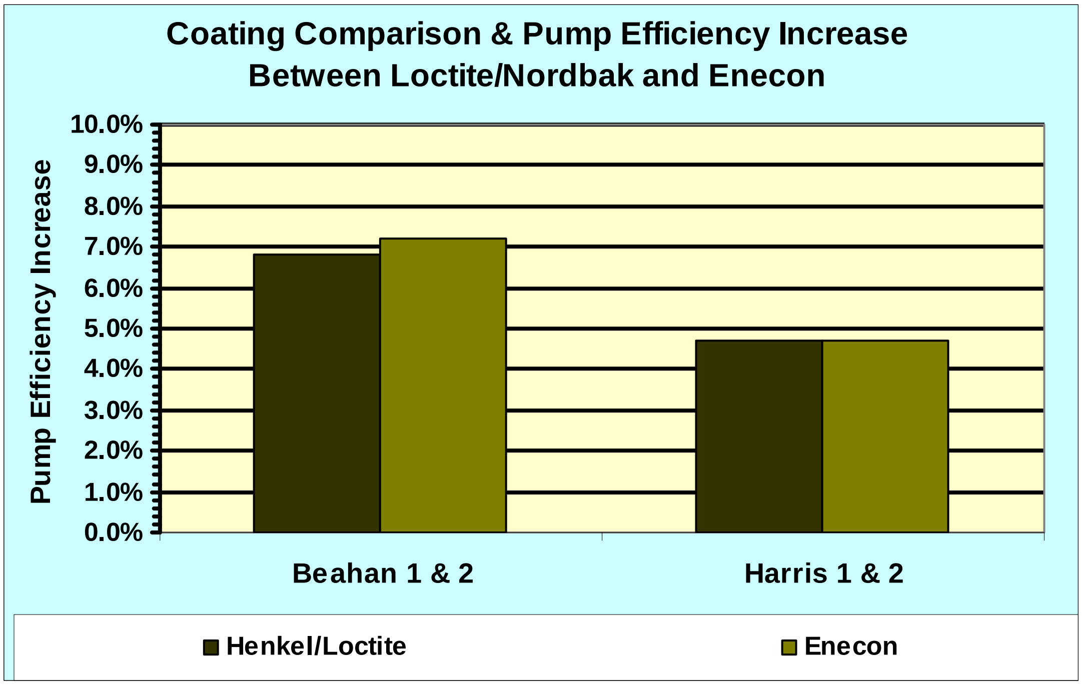
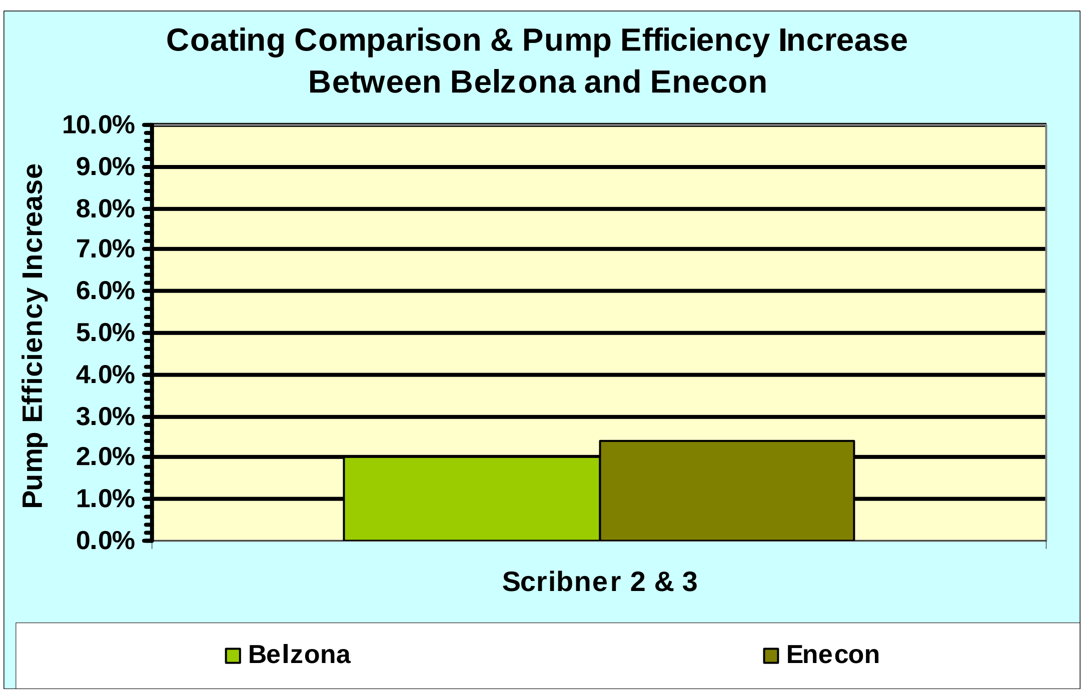


Figure 7-3 shows a one pump comparison between Belzona and Enecon. These pumps were the two highest specific speed pumps part of the study and were the pumps that increased the least from sandblasting and coating. The slight differences in efficiency improvement between these two pumps could also be explained by varying degrees of pre sandblasting and coating internal roughness.

Figure 7-3 Coating Comparison between Belzona and Enecon



8.0 BRUSH ON COATING DURABILITY AND EASE OF APPLICATION

As this project developed over the past several years, MCWA staff has had many conversations with pump users and manufacturers about pump coatings. In addition, MCWA staff has given several presentations and co-authored several magazine articles on the encouraging preliminary findings of the study. After discussions and presentations detailing the preliminary results, the most often asked question is "how long will the coating last?" Now that the project is complete and the data seems to unequivocally show that coating a HSC is an essential step in pump performance restoration and preservation, the durability question remains.

Reliable data on the longevity of epoxy coatings in centrifugal water pumps is not available in the literature. As a continuation of this study, MCWA will continue to field test the pumps at six to twelve month intervals for the next five years to look for any changes in performance that could be a sign of premature coating failure. Additionally, the MCWA has and will continue to remove pump covers and inspect the coatings on pumps in this study every one to two years for the next five years to check for coating integrity.

8.1 DURABILITY RESULTS FROM PILOT PROJECT

To shed some light on the durability issues, the MCWA pulled the covers off two of the first pumps coated in the original pilot study that have been in service for approximately five years. The photos and descriptions below are the results of that inspection

Woodcliff Pump No. 1 was originally part of the pilot study, but was included in this overall study when it was decided to use the second 40 hp pump at the station as a sandblasting-only comparison to this pump. Woodcliff No. 1 was coated in May of 2005. Figure 10-1 shows the interior of the pump cover just after coating.

Figure 8-1 Interior of Pump after Coating (2005)

Figure 8-2 shows the same cover just after removal from the pump for the coating inspection in May of 2009. At first glance it appeared that the coating was failing and that rust and corrosion had returned. However, when examined closely the rust was only rust staining from the small uncoated seam area of the machined surfaces between the cover and base of the pump that was exposed to water. The coating itself remained smooth to the touch and couldn't be "flaked off" at the edges.

Figure 8-2 Coating Inspection May 2009

Figure 8-3 shows the same cover after cleaning one side and the middle of the cover with a steel wool soap pad. As shown, once the rust stains were removed the coating was found to be in good shape with virtually no signs of failure. The dark areas of the cleaned coating are dimples where the coating couldn't be scrubbed clean due to pitting in the cover that existed prior to coating. These areas are not areas of coating failure.

Figure 8-3 After Cleaning with Steel Wool Pad

As shown in the photos, the coating inside Woodcliff Pump No. 1 has been durable and adhered well to the cast iron casing. Performance testing of the pump over the past four years has shown very little decline in efficiency, head and flow from what was originally measured immediately after pump restoration in 2005.

Denise Pump No. 4 was part of the original pilot study and not one of the pumps that was evaluated for this study. However Denise No. 4 is an excellent pump to look at for coating durability as this pump was coated in February 2005.

Figures 8-4, 8-5 and 8-6 show the inside cover of the Denise pump. Figure 8-4 shows the inside cover immediately after application of the coating. Figure 8-5 shows the cover after being removed from the pump for inspection. While Figure 8-6 shows the inside cover after cleaning with a steel wool soap pad.

Figure 8-4 Denise Pump Post Coating

Figure 8-5 Denise Pump Inspection 2009

Figure 8-6 Denise Pump after Cleaning with steel wool

As in the Woodcliff example, at first glance rust staining of the coating inside the cover gave the appearance of coating failure. However, after cleaning with steel wool soap pads the coating on the Denise pump was shown to be in excellent shape.

8.2 CERAMIC EPOXY COATINGS AND BASE METAL FILLERS

Application of the epoxy ceramic coatings was similar to painting with honey. Stiff short nap brushes designed for epoxy application and stiff bristle cleaning brushes (a.k.a. toilet bowl brushes), were the applicators of choice. All of the ceramic epoxy coatings were two component, 100% solids and solvent free. Coating Technical Sheets for the three coatings used can be found in Appendix A. Figure 8-7 shows the mixing of the Belzona material. The photo gives a good example as to the thickness of the coatings. Overall the Loctite/Nordbak material was the most viscous of the coatings to apply, but its relative difficulty in its application was comparable to the others. One of the claimed benefits of the Bisphenol A and F blend (Belzona) or the Novolac (Enecon) is that they are less viscous and therefore supposedly easier to apply than the traditional Bisphenol A coatings (Loctite/Nordbak). However, after extensive use and application of all three coating products, the MCWA didn't find this to be the case. The key to successful application of any of the coatings is having a stiff enough brush to work the epoxy into the cast iron.

Figure 8-7 Mixing of Belzona

While coating viscosity was determined not to be a comparison criteria there are two advantages of the Belzona and Enecon coatings over the Loctite/Nordbak coating. The first advantage is that both Belzona and Enecon have NSF-61 approved coatings in more than one color. Loctite/Nordbak only has one color that is NSF-61 approved. Applying two coats, each in a different color, will make future internal coating inspections easier to evaluate. If the second coat starts to wear off the color of the first coat will start to show through. Also, during application of the second coat having two colors made it easier to visually verify that the second coat had been applied uniformly and had entirely covered the first.

The second advantage is that the Belzona and Enecon coatings allow up to 24 hours between application of the first and second coat, while Loctite/Nordbak recommends application of the second coat within 1 to 3 hours after application of the first coat. MCWA discovered that practical limitations make application of the second coating within the 1 to 3 hour time frame inconvenient. Typically a pump would be picked up at the sandblasting facility late morning or early afternoon. After getting the pump back to the shop it had to be cleaned, taped off and prepared for the application of metal filler (if used) or the application of the first coat of the epoxy ceramic material. These steps would typically require 8 hours or more for larger units. Thus, the second coat would necessitate a second (or third) shift to complete.

During a post coating internal inspection of one of the first pumps coated with the Loctite/Nordbak material, there were areas on the casing and impeller where the second coat had begun to peel away from the first coat (the first coat remained properly adhered to the bare cast iron). To try and eliminate this phenomenon, beginning with the third or forth pump coated in this study, the first coat was roughed up with 100 grit sandpaper prior to application of the second coat. This was done regardless of which coating was being used or how much time had elapsed between coating applications. Later internal coating inspections on pumps that were coated using this procedure showed no peeling of the second coat.

Base metal fillers are much stiffer than the ceramic epoxy top coatings and have a much higher percentage of ceramic filler content than the top coatings. Metal fillers are designed to fill in areas of metal loss such as deep pits and severely corroded areas. To ensure compatibility, the metal filler was selected and used based on the recommendations of each of the three ceramic epoxy coating manufacturers. The metal filler material itself was applied with plastic scrapers and trowels. Initially, all pumps had the metal filler applied prior to coating with the epoxy. After several pumps were coated the need for metal filler was evaluated on a case-by-case basis. Metal filler was only used on those pumps that were severely pitted or had significant metal loss. Metal filler was not used where mild pitting could be adequately filled with two coats of the ceramic epoxy top coating material alone.

During several pump restorations not included in this study, MCWA experimented with powder coating interior casings of pumps instead of using the brush on type epoxy coatings. Evaluation of the coating after application showed that the powder coating didn’t fill in the pitting very well. Powder coating wasn’t able to build up the coating thick enough to fill in pitted areas the way brush on epoxy coatings do. Also, powder coating can’t be done in-house. Coating a pump with brush on materials is pretty “low tech” and doesn’t require much training or sophisticated equipment.

9.0 IMPELLER COATING

Arkema's Rilsan Polyamide 11 Nylon powder coating was chosen as the coating material to be used on pump impellers. The powder coating applicator was selected by competitive bid from a list of approved coating vendors provided by Arkema. Ethylene Corporation out of Kentwood, Michigan had the low quote. Inspections of the first several impellers coated with the Rilsan material showed that the coating was very smooth and was applied at a very uniform thickness. Figure 11-1 shows one of the first impellers coated with the Rilsan powder coating material.

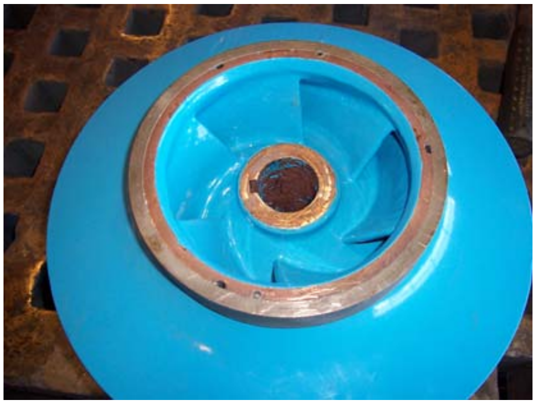


Figure 9-1 Rilsan Power Coating Material

The coated impellers were installed in the pumps and several were inspected after being in operation for six months. Unfortunately, the inspections revealed that in several cases the coating had failed and had started to peel off the impeller. Figure 11-2 shows one of these impellers where the coating had failed.

Figure 9-2 Failed Impeller Coating

Impellers where the coating failed were sent back to Ethylene for analysis. Ethylene got together with the manufacturer to discuss the application process in an attempt to determine what went wrong. From these discussions it was decided to try a different approach when applying the primer material prior to powder coating. Previously, the impellers were dipped into the primer, but the coating manufacturer suggested a spray application instead. The impeller shown in Figure 11-2 was recoated utilizing the new spray method of primer application. Figure 11-3 is of the same impeller after being in operation for six months after recoating. As shown, the coating is adhering to the impeller well and there are no signs of coating failure.

Figure 9-3 Six Months After Recoating

All of the impellers where the primer was applied by the spray method have performed well in the field. The powder coatings adhered well and show minimal signs of wear.

10.0 PROJECT CONCLUSIONS AND RECOMMENDATIONS

10.1 CONCLUSIONS

The MCWA's goal with respect to pump coatings is not only to increase pumping efficiency but to prevent or at least significantly delay what seems to be the inevitable decline of pump performance and increase in energy consumption over a relatively short period of time caused by internal corrosion and the resulting roughness and tuberculation build up.

At this point the MCWA believes it has achieved its goal and concludes that sandblasting and coating should be a routine part of any horizontal split case pump restoration effort. The field data collected on the sixteen pumps during each step of the pump restoration process shows that overall, sandblasting and coating had the greatest impact on returning a pump's efficiency to original manufacturer specifications. Sandblasting and coating on average increased pump efficiency by 6.3%. Mechanical refurbishment on average increased pump efficiency by 5.3%, while impeller coating increased pump efficiency by an average of 1.5%. Sandblasting and coating also significantly increased pump capacity.

The field data shows that however much a horizontal split case pump's performance has declined below original manufacturer's specifications, mechanical refurbishment can only restore about half of the decline from original specifications. This is because a substantial part of the decline is due to corrosion roughness and tuberculation, which isn't addressed by typical mechanical work. This remaining gap in performance can be restored through sandblasting and coating the interior casing of the pump, thereby smoothing hydraulic flow and returning efficiency to its original range. The same is true of energy savings. The data from this study showed that on average 50% of the total energy savings potential of a pump's restoration can be attributed to sandblasting and coating. Based on the number of HSC pumps world wide, the potential for reduced global energy use, energy cost savings and greenhouse gas emission reduction from sandblasting and coating HSC pumps is very large.

These points are further demonstrated when comparing sandblasting and coating with sandblasting only. Those pumps that were sandblasted but not coated did not achieve the same levels of pump efficiency as pumps that were both sandblasted and coated. The efficiency of several non-coated pumps dropped off quickly after restoration (due to the return of corrosion) while the efficiencies of the coated pumps remained at more or less their post-restoration levels.

Applying brush on epoxy coatings is also economical. It can be done with in-house personnel without special skills or tools, and the payback period in energy savings can be less than one year, depending on pump run time, energy rates, and efficiency gains.

Coatings have, so far, passed the test of durability. They have performed and adhered well inside pumps and have shown minimal signs of wear and/or failure after being in service for over five years. Although there were some initial performance problems associated with the impeller powder coatings, after some application changes these coatings are performing well too, and not only improve a pump's efficiency, but have the added potential benefit of protecting the impeller from abrasion and cavitation. It is anticipated that the pumps in this study will continue to reap the performance and energy benefits of the coatings for many years to come.

Over fifty years ago municipal water suppliers stopped purchasing and pipeline manufacturers stopped recommending the use of unlined cast iron pipes for use in public water systems. As an industry they moved to and required that all new cast iron pipes be manufactured with an interior cement lining to prevent the devastating effects on pipeline flow of internal corrosion and tuberculation build up associated with unlined cast iron pipe. Based on the data provided in this study, as an industry, municipal/industrial pump users and manufacturers should question the wisdom of continued purchasing and manufacturing of unlined pumps as well.

10.2 RECOMMENDATIONS

Sandblasting and coating should be part of any pump restoration program. In addition, it is also recommended that new pumps be coated by the manufacturer or by a coating vendor selected by the manufacturer prior to pump delivery to the customer. Internal pump coatings are now a requirement of the MCWA's new pump specification, and bidding methods have been adjusted to include a credit for higher efficiency, resulting in lower lifecycle costs even if the initial pump price is higher.

It is recommended that during the restoration of an existing pump, brush on coatings should be used (with metal filler is pits are especially deep). On the other hand, new pumps are better suited for powder coating. A new pump's interior is smooth and corrosion free, and the filling of pits and/or metal loss is not an issue. Additionally, powder coating requires that the pump casing be heated up to several hundred degrees Fahrenheit which has the added benefit of driving out any latent moisture or contaminants hiding in the bare cast iron prior to coating.

Impeller coating should be evaluated on a case by case basis. Most of the impellers in this study were coated with a nylon powder coating material, but very good results have been achieved with brush on epoxy as well. Two key factors that should be considered when deciding which type of coating to use during pump restoration are how fast the pump has to be returned to service and the configuration of the impeller. Because powder coating can't be done in house, it may take several weeks to get an impeller powder coated, while brush on coatings could be applied when coating the pump casing. Configuration of the impeller is important too because it might not be possible to coat smaller impellers with brush on material due to the narrow passageways through it. If a pump has to be returned to service quickly and the configuration of the pump's impeller is not conducive to brush coating, impeller coating can be skipped altogether since the efficiency gains would be modest compared to coating the casing.

When purchasing brand new pumps, the impeller should be powder coated along with the pump. Any minor reductions in head and/or flow as a result of powder coating the impeller will be more than made up in the potential of energy savings and increased resistance to abrasion and cavitation over the life of the pump.

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[1] US Dept of Energy Office of Industrial Technology, "Pump Life Cycle Costs: A Guide to LCC Analysis for Pumping Systems:, Dec.2000

[2] American Water Works Association, "Cleaning and Lining Water Mains", Manual AWWA M28 1st Edition, 1987

[3] NSF – National Sanitation Foundation

[4] "Comparison of Epoxy technology for Protective coatings and Linings" John D. Durig, Sherwin-Williams, Cincinnati, Ohio, USA

[5] "Tackling Cavitation Erosion with Polyamide-11 Powder Coatings", T. Page McAndrews, Jerry Petersheim, Arkema Inc. and Marc Audenaert, Ph.D. and Danny C.S. Foong, Arkema S.A.; Pump and Systems, January 2005

[6] Interview with Barry Erickson, Siewert Equipment, Rochester, NY; Flowserve Pump Manufacturers Representative

[7] "Scientific Evaluation of the Characteristics of Energy Efficiency Coatings", article provided by Corrocoat USA Inc., Jacksonville, Florida author and date of publication unknown.

[8] "Greenhouse Gas Equivalencies Calculator" U.S. Environmental Protection Agency web site, www.epa.gov/cleanenergy/energy-resources.calculator/html

[9] "Centrifugal Pumps", National Technology Transfer, Inc., 4th Edition, March 1999

[10] "Study on Improving the Energy Efficiency of Pumps", European Commission, February 2001, CETIM (France), David T. Reeves (United Kingdom), NESA (Denmark) Technical University Darmstadt (Germany)

APPENDIX A

TECHNICAL SHEETS

Coatings Information Sheet
Top Coatings NSF 61 Certified (must be verified with supplier to assure certification is current)
*Coatings Used in MCWA NYSERDA Study

Brushable Traditional Ceramic Epoxy Coatings

Devcon/Permatex
www.devcon.com
Metal Filler – Ceramic Repair Putty 11700
Top Coating – Brushable Ceramic 11770

***Henkle/Locktite**
www.henkelna.com
Metal Filler – Fix Master Superior Metal
Top Coating – Loctite/Norbak Brushable Ceramic Grey

A.W. Chesterton
www.chesterton.com
Metal Filler – ARC 858
Top Coating – ARC 855

Brushable Blended Ceramic Epoxy Coatings

Thortex
www.thortex.com
Metal Filler – Metal-Tech E.G.
Top Coating – Chemi-Tech P.W.

***Belzona**
www.belzona.com
Metal Filler - 1111 Super Metal Filler
Top Coating – 1341 Super Metal Glide

Brushable Novolak Ceramic Epoxy Coatings

***Enecon**
www.enecon.com
Metal Filler – Metalclad CeramAlloy CP+ AC
Top Coating – Chemclad XC

Epoxy Powder Coatings

3M Corporation
www.3m.com
Top Coating – Scotchkote 134

Nylon Powder Coatings

***Arkema, Inc.**
www.arkema-inc.com
Top Coating – Rilsan Polyamide 11 Nylon Coating

Misc Supplies, Epoxy Brushes & Tube Brushes

Solo Horton Brushes
www.solobrushes.com
- 88 White China Bristle Glue Brush
- Manual Operation Tube Brushes

Misc Equipment

Telog Instruments
www.telog.com
Pressure recorders

Monarch
www.monarchinstruments.com
Stroboscope for pump RPM

Technical Data Sheet

LOCTITE® Nordbak® Brushable Ceramic Gray

March 2006

PRODUCT DESCRIPTION

LOCTITE® Nordbak® Brushable Ceramic Gray provides the following product characteristics:

Technology	Epoxy
Chemical Type	Epoxy
Appearance (Resin)	Gray[LMS]
Appearance (Hardener)	Amber[LMS]
Appearance (Mixed)	Gray flowable liquid
Components	Two component - requires mixing
Mix Ratio, by volume - Resin : Hardener	2.75 : 1
Mix Ratio, by weight - Resin : Hardener	4.8 : 1
Cure	Room temperature cure
Application	Coating
Specific Benefit	● Ceramic and silicon carbide filled - to provide maximum protection ● Ultra-smooth brushable consistency ● Easy to mix and use ● Reduces downtime ● Superior adhesion - forms a solid bond

LOCTITE® Nordbak® Brushable Ceramic Gray is an ultra smooth, ceramic reinforced epoxy that provides a high gloss, low friction coating designed to protect against turbulence, abrasion and cavitation under typical dry service temperatures of -29 °C to +93 °C. Used by itself, LOCTITE® Nordbak® Brushable Ceramic Gray is recommended for sealing and protecting equipment from corrosion and wear. It also works as a top coat over Loctite® Nordbak® Wearing Compounds for applications requiring surface rebuilding and lasting protection. Typical applications include providing a smooth, protective abrasion resistant coating, repairing heat exchangers and condensers, lining tanks and chutes, resurfacing and repairing rudders and pintel housings, and repairing cooling pump impellers, butterfly valves and cavitated pumps.

NSF International
Certified to ANSI/NSF Standard 61 for use in commercial and residential potable water systems not exceeding 82° C.

TYPICAL PROPERTIES OF UNCURED MATERIAL

Resin:

Viscosity, Brookfield - RV, 25 °C, mPa·s (cP):	
Spindle 7, speed 10 rpm	200,000 to 260,000[LMS]
Weight Per Gallon, lbs/gal	14.35 to 14.85[LMS]

Hardener:

Viscosity, Brookfield - RV, 25 °C, mPa·s (cP):	
Spindle 2, speed 20 rpm	500 to 900[LMS]
Weight Per Gallon, lbs/gal	8.6 to 8.9[LMS]

Mixed:

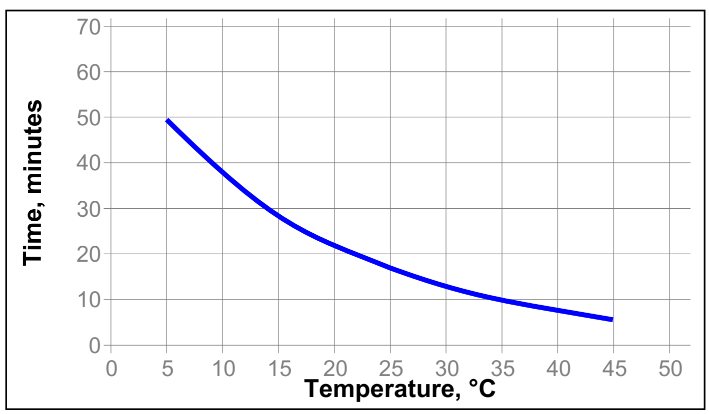
Viscosity, Cone & Plate, 25 °C, mPa·s (cP):	
Shear rate 10 s^{-1}	20,000
Coverage	1.1 m² @ 0.5 mm thick/0.9 kg (12 ft² @ 20 mils thick/2 lb)

TYPICAL CURING PERFORMANCE

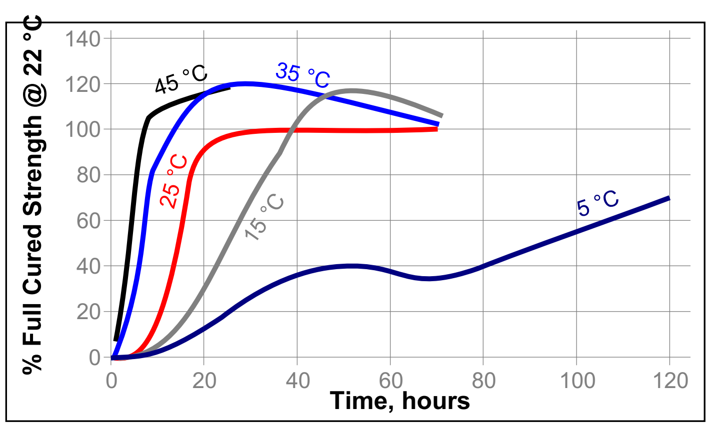
Curing Properties

Gel Time @ 25 °C, minutes:	
400 g mass	34 to 48[LMS]
Recoat Time @ 25 °C, hours	1 to 3
Wet Temperature Resistance, °C	>93

Working Life



Cure Time



TYPICAL PROPERTIES OF CURED MATERIAL

Cured @ 25 °C

Physical Properties:

Compressive Strength, ISO 604	N/mm²	86.2
	(psi)	(12,500)
Shore Hardness, ISO 868, Durometer D		85

TYPICAL PERFORMANCE OF CURED MATERIAL

Adhesive Properties

Cured for 24 hours @ 25 °C

Lap Shear Strength, ISO 4587:

Steel (grit blasted)	N/mm²	24.2
	(psi)	(3,500)

GENERAL INFORMATION

This product is not recommended for use in pure oxygen and/or oxygen rich systems and should not be selected as a sealant for chlorine or other strong oxidizing materials.

For safe handling information on this product, consult the Material Safety Data Sheet (MSDS).

Directions for use

Surface Preparation

Proper surface preparation is critical to the long-term performance of this product. The exact requirements vary with the severity of the application, expected service life, and initial substrate conditions.

1. Clean, dry and abrade application surface. The more thorough the degree of surface preparation the better the performance of the application. If possible, it is recommended that the surface be grit blasted to a Near White Metal (SSPC-SP10/NACE No. 2) Standard. For less severe applications roughening the surface with hand tools is suitable.
2. Solvent cleaning with a residue-free solvent is recommended as the final step to aid in adhesion.

Mixing:

1. Material temperature should be between 20 °C to 30 °C.
2. Add hardener contents to resin. Mix material vigorously until uniform in color. Be sure to mix along the bottom and sides of mixing container. Mix three to five minutes.

Application Method:

1. Apply fully mixed material to the prepared surface.

Caution: Use an approved, positive-pressure, supplied air respirator when welding or torch cutting near cured compound. **Do Not** use open flame on compound.

Loctite Material Specification^LMS

LMS dated May 22, 2001 (Resin) and LMS dated May 22, 2001 (Hardener). Test reports for each batch are available for the indicated properties. LMS test reports include selected QC test parameters considered appropriate to specifications for customer use. Additionally, comprehensive controls are in place to assure product quality and consistency. Special customer specification requirements may be coordinated through Henkel Loctite Quality.

Storage

Store product in the unopened container in a dry location. Material removed from containers may be contaminated during use. Do not return liquid to original container. Storage information may be indicated on the product container labeling.

Optimal Storage: 8 °C to 21 °C. Storage below 8 °C or greater than 28 °C can adversely affect product properties. Henkel cannot assume responsibility for product which has been contaminated or stored under conditions other than those recommended. If additional information is required, please contact your local Technical Service Center or Customer Service Representative.

Conversions

(°C x 1.8) + 32 = °F
kV/mm x 25.4 = V/mil
mm / 25.4 = inches
µm / 25.4 = mil
N x 0.225 = lb
N/mm x 5.71 = lb/in
N/mm² x 145 = psi
MPa x 145 = psi
N·m x 8.851 = lb·in
N·m x 0.738 = lb·ft
N·mm x 0.142 = oz·in
mPa·s = cP

Note

The data contained herein are furnished for information only and are believed to be reliable. We cannot assume responsibility for the results obtained by others over whose methods we have no control. It is the user's responsibility to determine suitability for the user's purpose of any production methods mentioned herein and to adopt such precautions as may be advisable for the protection of property and of persons against any hazards that may be involved in the handling and use thereof. In light of the foregoing, **Henkel Corporation specifically disclaims all warranties expressed or implied, including warranties of merchantability or fitness for a particular purpose, arising from sale or use of Henkel Corporation's products. Henkel Corporation specifically disclaims any liability for consequential or incidental damages of any kind, including lost profits.** The discussion herein of various processes or compositions is not to be interpreted as representation that they are free from domination of patents owned by others or as a license under any Henkel Corporation patents that may cover such processes or compositions. We recommend that each prospective user test his proposed application before repetitive use, using this data as a guide. This product may be covered by one or more United States or foreign patents or patent applications.

Trademark usage

Except as otherwise noted, all trademarks in this document are trademarks of Henkel Corporation in the U.S. and elsewhere. ® denotes a trademark registered in the U.S. Patent and Trademark Office.

Reference 1.1

LOCTITE

1001 Trout Brook Crossing
Rocky Hill, CT 06067-3910
Telephone: (860) 571-5100
FAX: (860) 571-5465

Product Description Sheet
Fixmaster® Superior Metal

Maintenance, Repair & Operations October 1998

PRODUCT DESCRIPTION

Fixmaster Superior Metal is a two-part ferro-silicon filled epoxy resin system. It is extremely resistant to corrosion, chemical attack, and abrasion under typical dry service temperatures of –29° to +121°C (–20° to +250°F). It is ideal for restoring worn surfaces.

Advantages:

- High ferro-silicon content
- Resists corrosion, abrasion, and chemicals
- Rebuilds worn parts fast – limits downtime
- Application versatility
- Long lasting

TYPICAL APPLICATIONS

- Leaks on pipes, elbows
- Fuel and gas tank holes
- Stripped threads
- Cracked battery cases
- Leaking storage tanks

PROPERTIES OF UNCURED MIXED MATERIAL

Mixture	Typical Value
Appearance	Thick Dark Grey Paste
Mix Ratio (R:H) by Volume	4:1
by Weight	7.25:1
Coverage	232 cm^2 @ 6 mm thick per 1 lb. kit 36 in^2 @ ¼" thick per 1 lb. kit

TYPICAL CURING PERFORMANCE

Curing Properties (@ 25°C unless noted)	Typical Value
Working Life, minutes	20
Cure Time, hours	6

TYPICAL PROPERTIES OF CURED MATERIAL

(@ 25°C unless noted)

Physical Properties	Typical Value
Compressive Strength, ASTM D695, psi	18,000
Shear Strength ASTM D1002, psi .005" gap, acid etched aluminum	1,800
Hardness ASTM D-2240, Shore D	90
Tensile Strength, ASTM D638, psi	5,500

ORDERING INFORMATION

Part Number	Container Size
97473	**1 lb. kit**

GENERAL INFORMATION

This product is not recommended for use in pure oxygen and/or oxygen rich systems and should not be selected as a sealant for chlorine or other strong oxidizing materials.

For safe handling information on this product, consult the Material Safety Data Sheet, (MSDS).

DIRECTIONS FOR USE

- Clean and dry surface of application. Grind or sandblast surface for best adhesion.
- Mix 4 parts resin to 1 part hardener by volume or transfer entire kit onto a clean and dry mixing surface and mix material vigorously until a uniform color is obtained.
- Apply fully mixed material to prepared surface.
- At 25°C (77°F), working time of material is 20 minutes, and Superior Metal is hard in 6 hours.

TECHNICAL TIPS FOR WORKING WITH EPOXIES

Working time and cure time depends on temperature and mass:

- The higher the temperature, the faster the cure.
- The larger the mass of material mixed, the faster the cure.

To speed the cure of epoxies at low temperatures:

- Store epoxy at room temperature.
- Pre-heat repair surface until warm to the touch.

To slow the cure of epoxies at high temperatures:

- Mix epoxy in small masses to prevent rapid curing.
- Cool resin/hardener component(s).

Storage

Product shall be ideally stored in a cool, dry location in unopened containers at a temperature between 8°C to 28°C (46°F to 82°F) unless otherwise labeled. Optimal storage is at the lower half of this temperature range. To prevent contamination of unused product, do not return any material to its original container. For further specific shelf life information, contact your local Technical Service Center.

Data Ranges

The data contained herein may be reported as a typical value and/or range. Values are based on actual test data and are verified on a periodic basis.

Note

The data contained herein are furnished for information only and are believed to be reliable. We cannot assume responsibility for the results obtained by others over whose methods we have no control. It is the user's responsibility to determine suitability for the user's purpose of any production methods mentioned herein and to adopt such precautions as may be advisable for the protection of property and of persons against any hazards that may be involved in the handling and use thereof. In light of the foregoing, **Loctite Corporation specifically disclaims all warranties expressed or implied, including warranties of merchantability or fitness for a particular purpose, arising from sale or use of Loctite Corporation's products. Loctite Corporation specifically disclaims any liability for consequential or incidental damages of any kind, including lost profits.** The discussion herein of various processes or compositions is not to be interpreted as representation that they are free from domination of patents owned by others or as a license under any Loctite Corporation patents that may cover such processes or compositions. We recommend that each prospective user test his proposed application before repetitive use, using this data as a guide. One or more United States or foreign patents or patent applications may cover this product.

BELZONA® World leaders in the conservation of man-made resources and the environment

PRODUCT SPECIFICATION SHEET
BELZONA® 1111

1. PRODUCT NAME
Belzona® 1111
(Super Metal)
Engineering grade repair system for repairing and rebuilding machinery and equipment.

Also used as a high strength structural adhesive for bonding or for creation of irregular load bearing shims with good electrical insulation characteristics.

For use in Original Equipment Manufacture or repair situations.

2. MANUFACTURER
Belzona Inc.,
2000 N.W. 88th Court
Miami, Florida 33172

Belzona Polymerics Ltd.
Claro Road, Harrogate,
HG1 4AY, England.

3. PRODUCT DESCRIPTION
A two component paste grade system based on a silicon steel alloy blended with high molecular weight reactive polymers and oligomers. When cured, the material is durable yet fully machinable.

Applications
Shafts
Hydraulic rams
Bearing housings
Keyways
Engine blocks
Casings
Pipes
Tanks
Flange faces

4. TECHNICAL DATA
Base Component

Appearance	Paste
Color	Dark gray
Gel strength at 77°F (25°C)	>150 g/cm HF
Density	2.70 - 2.90 g/cm³

Solidifier Component

Appearance	Paste
Color	Light gray
Gel strength at 77°F (25°C)	>70 g/cm QV
Density	1.63 - 1.69 g/cm³

Mixed Properties at 68°F (20°C)

Mixing Ratio by Weight (Base : Solidifier)	5 : 1
Mixing Ratio by Volume (Base : Solidifier)	3 : 1
Mixed Form	Paste
Peak Exotherm Temperature	239 - 284°F (115 - 140°C)
Time to Peak Exotherm	25 - 42 mins.
Slump Resistance	nil at 0.5 inch (1.27 cm)
Mixed Density	2.5 g/cm³

• *Shelf Life:*
Separate base and solidifier components shall have a shelf life of at least 5 years when stored between 32°F (0°C) and 86°F (30°C).

• *Working Life:*
Will vary according to temperature. At 77°F (25°C) the usable life of mixed material is 15 minutes.

• *Volume Capacity:*
The volume capacity of a 1 kg. unit of mixed **Belzona® 1111** is 24.3 in.³ (398 cm³).

• *Cure Time:*
Will be reduced for thicker sections and extended for thinner applications. At a thickness of approximately 1/4 in. (6 mm), allow to solidify for the times shown in the chart below before subjecting it to the conditions indicated.

5. PHYSICAL/MECHANICAL PROPERTIES
Determined after 7 days cure at 77°F (25°C). Post curing the material with heat results in a more highly cross-linked polymer.

For enhanced performance this material may be post-cured by heating to 212°F (100°C) for a period of up to 24 hours.

• *Abrasion Resistance:*
Taber
The Taber abrasion resistance with 1 kg load is typically:
H10 Wheels (Wet) 889 mm³
CS17 Wheels (Dry) 56 mm³
loss per 1000 cycles

• *Adhesion:*
Cleavage
When tested to ASTM D1062 typical values will be:
Mild steel 1400 lbs./in. (25 kgs/mm)

Tensile Shear
When tested in accordance with ASTM D1002, using degreased strips, grit blasted to a 3-4 mil profile, typical values will be:

Aluminum	1,800 psi (126 kgs/cm²)
Brass	1,670 psi (117 kgs/cm²)
Copper	1,900 psi (133 kgs/cm²)
Formica	>500 psi (35 kgs/cm²)*
Mild steel	2,700 psi (190 kgs/cm²)
Polyester/glass fiber	>700 psi (49 kgs/cm²)*
Stainless steel	2,800 psi (197 kgs/cm²)

* *breakdown of substrate*

• *Chemical Resistance:*
Once fully cured, the material will demonstrate excellent resistance to the following chemicals;
- carbonic acid
- 10% hydrochloric acid
- 10% nitric acid
- 5% phosphoric acid
- 10% sulfuric acid
- 20% ammonia solution
- lime water
- 20% potassium hydroxide
- 20% sodium hydroxide

Continued . . .

CURE TIMES

TEMPERATURE	41°F (5°C)	50°F (10°C)	59°F (15°C)	68°F (20°C)	77°F (25°C)	86°F (30°C)
Movement or use involving no loading or immersion	4 hrs	3 hrs	2¼ hrs	1¾ hrs	1 hr	¾ hr
Machining and/or light loading	6 hrs	4 hrs	3 hrs	2 hrs	1½ hrs	1 hr
Full electrical, mechanical or thermal loading	4 days	2 days	1½ day	1 day	20 hrs	16 hrs
Immersion in chemicals	5 days	4 days	3 days	2 days	1½ days	1 day

propanol
butanol
ethylene glycol
diethanolamine
methylamine (25% in water)
hydrocarbons
mineral oils
inorganic salts

* *For a more detailed description of chemical resistance properties, refer to Product Data M501.*

• *Compressive Strength:*

When tested in accordance with ASTM D695, typical values obtained will be:

13,000 psi (914 kgs/cm^2)	ambient cure
15,000 psi (1055 kgs/cm^2)	post cure

• *Compressive Modulus:*

When tested in accordance with ASTM D695, typical values obtained will be:

ambient cure	2.7×10^5 psi (1.9×10^4 kgs/cm^2)
post cure	3.7×10^5 psi (2.6×10^4 kgs/cm^2)

• *Corrosion Resistance:*

Will show no visible signs of corrosion after 5,000 hours exposure in the ASTM B117 salt spray cabinet.

• *Electrical Properties:*

Dielectric Strength
Tested to ASTM D149 is typically
84 volts/mil (3360 volts/mm)

Dielectric Constant
Tested to ASTM D150 is typically
10 at 1000Hz
6 at 1 MHz

Dissipation Factor
Tested to ASTM D150 is typically
< 0.0005 at 1 MHz
0.0120 at 1000 HZ

Volume Resistivity
Tested to ASTM D257 is typically
5.3×10^{12} ohm cm.

Surface Resistivity
Tested to ASTM D257 is typically
4.7×10^{13} ohm.

• *Flexural Strength:*

When tested to ASTM D790, typical values obtained will be:

9,000 psi (633 kgs/cm^2)	ambient cure
13,000 psi (914 kgs/cm^2)	post cure

• *Flexural Modulus:*

When tested in accordance with ASTM D790, typical values obtained will be:

ambient cure	10.6×10^5 psi (7.45×10^4 kgs/cm^2)
post cure	9.1×10^5 psi (6.4×10^4 kgs/cm^2)

• *Hardness:*

The hardness of the material when tested to ASTM D2240 is typically 89 Shore D.

• *Heat Distortion Temperature:*

Tested to ASTM D648 (264 psi fiber stress), typical values obtained will be:

136°F (58°C)	ambient cure
216°F (102°C)	post cure

• *Heat Resistance:*

For many typical applications, the product is thermally stable up to 392°F (200°C) dry and 200°F (93°C) wet, and down to -40°F (-40°C)

• *Impact Strength:*

The impact strength when tested to ASTM D256 is typically:
1.3 ft.lb./in., 70 J/m (un-notched) or
0.65 ft.lb./in., 35 J/m (reverse notched)

• *Shrinkage:*

Shrinkage is typically <0.025% when tested in accordance with DOD-C-24176A method 4.6.12.

• *Thermal Expansion:*

Tested to ASTM E228 the coefficient of thermal expansion is typically 31.7 ppm/°C.

6. SURFACE PREPARATION AND APPLICATION PROCEDURES

For proper technique, refer to the Belzona® Instructions For Use leaflet which is enclosed with each packaged product.

7. AVAILABILITY AND COST

Belzona® 1111 is available from a network of Belzona® Distributors throughout the world for prompt delivery to the application site. For information, consult the Belzona® Distributor in your area.

8. WARRANTY

Belzona® guarantees this product will meet the performance claims stated herein when material is stored and used as instructed in the Belzona® Instructions For Use leaflet. Belzona® further guarantees that all its products are carefully manufactured to ensure the highest quality possible and tested strictly in accordance with universally recognised standards (ASTM, ANSI, BS, DIN, etc.). Since Belzona® has no control over the use of the product described herein, no warranty for any application can be given.

9. TECHNICAL SERVICES

Complete technical assistance is available and includes fully trained Technical Consultants, technical service personnel and fully staffed research, development and quality control laboratories.

10. HEALTH AND SAFETY

Prior to using this material, please consult the relevant Material Safety Data Sheets.

11. APPROVALS/ ACCEPTANCES

The material has received recognition from organisations worldwide including:

AMERICAN BUREAU OF SHIPPING
BUREAU VERITAS
U.S. DEPARTMENT OF NAVY
GAZ DE FRANCE
RJB MINING
AIR B.P.
NATO
NUCLEAR INDUSTRY (DBA TESTED)
U.S.D.A.
GENERAL MOTORS
TOYOTA
NIPPON KAIJI KYOKI
RUSSIAN REGISTER OF SHIPPING

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ISO 9001:2000
Q 09335

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Printed in England Publication No. 4-1-05

BELZONA® World leaders in the conservation of man-made resources and the environment

PRODUCT SPECIFICATION SHEET
BELZONA® 1341N

1. PRODUCT NAME

Belzona® 1341N (Supermetalglide)
A drinking water approved coating system for improving the efficiency of fluid handling systems and protecting metals from the effects of erosion-corrosion.

NSF
Certified to ANSI/NSF 61

2. MANUFACTURER

Belzona Polymerics Ltd.,
Claro Road, Harrogate,
HG1 4AY, England.

Belzona Inc.,
2000 N.W. 88 Court,
Miami, Florida 33172, U.S.A.

3. PRODUCT DESCRIPTION

A two component system specifically designed to improve the efficiency of fluid handling equipment and to protect all metals from the effects of erosion-corrosion.

Applications
Pumps
Heat exchangers
Water boxes
Valves
Water tanks
Pipes
Tube sheets

4. TECHNICAL DATA

Base component

Appearance	Thixotropic paste
Color	Gray or Blue
Density	1.58-1.63 g/cm³

Solidifier component

Appearance	Clear liquid
Color	Clear
Density	1.17-1.19 g/cm³

Mixed properties

Mixing ratio by weight	2 : 1
Mixing ratio by volume	3 : 2
Density	1.42-1.46 g/cm³

• *Limitations of Use*

Belzona® 1341N should not be used at temperatures below 50°F (10°C). Where material has been stored below this temperature, warm the Base and Solidifier units until they attain a temperature of 68-77°F (20-25°C).

• *Shelf life*

Separate Base and Solidifier components shall have a shelf life of at least 3 years when stored between 32°F (0°C) and 86°F (30°C).

• *Working life*

Will vary according to temperature:

Temperature	Working life
50°F (10°C)	70 minutes
59°F (15°C)	50 minutes
68°F (20°C)	35 minutes
77°F (25°C)	25 minutes
86°F (30°C)	16 minutes

• *Coverage rate*

To achieve the correct film thickness of 10 mils (250 microns), a practical coverage rate of 19.5 sq. ft (1.8 sq. m) per 750g unit should be obtained or 130 sq. ft (12 sq. m) per 5kg.

• *Volume capacity*

The volume capacity of mixed **Belzona® 1341N** is 31.73 in³ / 750g or 212 in.³ (3.475 litres) / 5kg.

• *Cure time*

Allow to cure for the times shown in the chart below before subjecting it to the conditions indicated.

5. PHYSICAL/MECHANICAL PROPERTIES

Determined after 7 days cure at 68°F (20°C).

• *brasion resistance*

Taber
The sliding abrasion resistance using Taber Abraser using H10/CS17 wheels and 1kg load is typically:

Wet	52 mm³
Dry	6 mm³

Loss per 1000 cycles.

• *dhesion*

Tensile shear
When tested in accordance with ASTM D1002 using degreased strips, grit blasted to a 3-4mil (75 micron) profile, typical values obtained will be:

20°C cure

Mild steel	2,500 psi (175 kg/cm²)
Stainless steel	2,780 psi (195 kg/cm²)
Copper	2,230 psi (156 kg/cm²)
Aluminum	1,570 psi (110 kg/cm²)

100°C cure

Mild steel	3,250 psi (228 kg/cm²)

• *Cathodic disbondment*

When tested in accordance with ASTM G8 typical values obtained will be Class B.

• *Cavitation resistance*

When tested to a modified version of ASTM G32 using stationary specimens at 20KHz frequency and 50 microns amplitude a typical volume loss will be 12 mm³/hour.

• *Chemical resistance*

Once fully cured, the material will demonstrate excellent resistance to the following chemicals:
- Water
- Sea water
- Inorganic salt solutions
- 10% sodium hydroxide

CURE TIMES

TEMPERATURE	50°F (10°C)	59°F (15°C)	68°F (20°C)	77°F (25°C)	86°F (30°C)
Movement or use involving no loading	24 hours	12 hours	8 hours	7 hours	6 hours
Movement or use involving light loading	48 hours	24 hours	16 hours	14 hours	12 hours
Full mechanical/thermal loading or water immersion	14 days	7 days	3 days	2½ days	2 days
Immersion in chemicals	21 days	10 days	7 days	6 days	5 days

• *Compressive yield strength*

When tested in accordance with ASTM D695 typical values obtained will be:

68°F (20°C) cure	6,900 psi (485 kg/cm^2)
212°F (100°C) cure	8,500 psi (598 kg/cm^2)

• *Flexural strength*

When tested in accordance with ASTM D790 typical values obtained will be:

68°F (20°C) cure	5,900 psi (415 kg/cm^2)
212°F (100°C) cure	6,400 psi (450 kg/cm^2)

• *Heat distortion temperature*

When tested in accordance with ASTM D648 typical values obtained will be:

68°F (20°C) cure	111°F (44°C)
212°F (100°C) cure	156°F (69°C)

• *Heat resistance*

For many typical applications the material is suitable for continuous immersion in aqueous solutions up to 140°F (60°C).
The material will be stable under dry conditions up to 392°F (200°C) and down to -40°F (-40°C).

• *Impact strength*

When tested in accordance with ASTM D256 typical values obtained will be:

68°F (20°C) cure	1 ft.lb./in (54 J/m)
212°F (100°C) cure	1.15 ft.lb./in (62 J/m)

• *Potable Water pproval*

Belzona® 1341 bearing the **NSF** mark is listed for contact with drinking water subject to the following restrictions.
For use on distribution line pumps of >4 inch diameter with a minimum daily output of 4800 gallons/ft^2 of coated pump surface
For use on tanks of > 100,000 gallons

• *Pump Efficiency Enhancement*

The **Belzona® 1341N** system has been shown to be capable of bringing about an increase in pump efficiency of up to 7% in Independent tests carried out by the National Engineering Laboratory, East Kilbride, Glasgow, Scotland, test number 0230 432/88 BEM/01 and the Aurora Pump Company, North Aurora, Illinois, test number 0789089/1089037.

• *Thermal expansion*

When tested in accordance with ASTM E228 typical values obtained will be:
74.7 ppm/°C

6. SURFACE PREPARATION AND APPLICATION PROCEDURES

For proper technique, refer to the Belzona Instructions For Use leaflet which is enclosed with each packaged product.

7. AVAILABILITY AND COST

Belzona® 1341N is available from a network of Belzona Distributors throughout the world for prompt delivery to the application site. For information, consult the Belzona Distributor in your area.

8. WARRANTY

Belzona guarantees this product will meet the performance claims stated herein when material is stored and used as instructed in the Belzona Instructions For Use leaflet. Belzona further guarantees that all its products are carefully manufactured to ensure the highest quality possible and tested strictly in accordance with universally recognized standards (ASTM, ANSI, BS, DIN, etc.). Since Belzona has no control over the use of the product described herein, no warranty for any application can be given.

9. TECHNICAL SERVICES

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10. HEALTH AND SAFETY

Prior to using this material, please consult the Material Safety Data Sheet provided with each packaged product

11. APPROVALS/ACCEPTANCES

NSF
U.S.D.A.
INGERSOL RAND
SULZER PUMPS
SPP LTD.
SSW PUMP SERVICES
AURORA PUMPS

The technical data contained herein is based on the results of long term tests carried out in our laboratories and to the best of our knowledge is true and accurate on the date of publication. It is however subject to change without prior notice and the user should contact Belzona to verify the technical data is correct before specifying or ordering. No guarantee of accuracy is given or implied. We assume no responsibility for rates of coverage, performance or injury resulting from use. Liability, if any, is limited to the replacement of products. No other warranty or guarantee of any kind is made by Belzona, express or implied, whether statutory, by operation of law or otherwise, including merchantability or fitness for a particular purpose.

Nothing in the foregoing statement shall exclude or limit any liability of Belzona to the extent such liability cannot by law be excluded or limited.

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ISO 9001:2000
Q 09335

www.belzona.com

Printed in England Publication No. 33-4-04

revolutionary products . . .

. . . for rebuilding, resurfacing and protecting all types of fluid flow machinery, equipment and structures.

METALCLAD CeramAlloy™ CP+AC

METALCLAD CeramAlloy™ CP+AC
(Advanced Composite)

Trowelable
Requires No Heat
Unlimited Shelf Life
100% Solids
Safe & Simple To Use

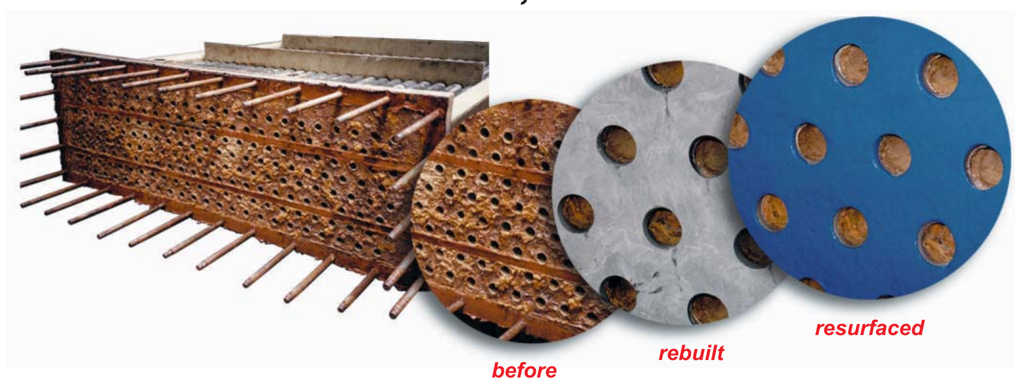
METALCLAD CeramAlloy™ CP+AC is the best material to use when making repairs to areas deeply damaged by erosion/corrosion environments on all types of fluid flow equipment.

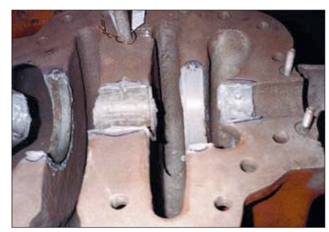
METALCLAD CeramAlloy™ CP+AC

Repair & rebuild all types of equipment!

Engineered to Repair Deeply Damaged Components.

Cures to a Metal Hard, Ceramic-Like Finish.





METALCLAD CeramAlloy™ CP+AC is a two component, 100% solids, polymer composite specifically formulated to provide effective repair and rebuilding characteristics on all types of fluid flow equipment.

METALCLAD CeramAlloy™ CP+AC is a paste when mixed, so it is easily applied. When cured, however, CP+AC becomes a metal-hard, ceramic-like compound.

Heat Exchanger Tube Sheets & Water Boxes, Pumps, Valves & Pipework, Housings & Tanks, Cooling Towers, etc.

ENECON® Corporation
The Fluid Flow Systems Specialists.
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Tel: 516 349 0022 · Fax: 516 349 5522
Email: info@enecon.com
6 Platinum Court · Medford, NY 11763-2251

Technical Data

Volume capacity per kg.	$36\ in^3$ / 592 cc	
Mixed density	0.061 lbs per in^3 / 1.69 gm per cc	
Coverage rate per kg. @ 0.25 in / 6mm	$144\ in^2$ / $0.092\ m^2$	
Shelf life	Indefinite	
Volume solids	100%	
Mixing ratio	Base	Activator
By volume	5	2
By weight	3.6	1

Cure Times

Ambient Temperature		Working Life	Machining Light Load	Full Mechanical	Chemical Immersion
41°F	5°C	4 hrs	48 hrs	96 hrs	8 days
59°F	15°C	2 hrs	24 hrs	48 hrs	5 days
77°F	25°C	1 hr	12 hrs	24 hrs	3 days
86°F	30°C	40 min	8 hrs	20 hrs	2 days

Physical Properties

	Typical Values		Test Method
Compressive strength	13,500 psi	945 kg/cm²	ASTM D-695
Flexural strength	8,500 psi	595 kg/cm²	ASTM D-790
Izod impact strength	1.3 ft lbs/in	0.69 j/cm	ASTM D-256
Hardness - Shore D	86		ASTM D-2240
Tensile Shear Adhesion			
Steel	4000 psi	280 kg/cm²	ASTM D-1002
Aluminum	2800 psi	196 kg/cm²	ASTM D-1002
Copper	2500 psi	175 kg/cm²	ASTM D-1002
Stainless steel	4100 psi	287 kg/cm²	ASTM D-1002
Surface resistivity	1×10^{15} ohms		ASTM D-257
Volume resistivity	1×10^{15} ohm/cm		ASTM D-257
Dielectric constant	7.5		ASTM D-150
Dielectric strength	500 volts / mil		ASTM D-115
Breakdown voltage	18.6 Kv		ASTM D-115

Chemical Resistance

Acetic acid (0-10%)	EX	Methyl alcohol	G
Acetic acid (10-20%)	G	Methyl ethyl ketone	G
Acetone	G	Nitric acid (0-10%)	EX
Aviation fuel	EX	Nitric acid (10-20%)	G
Butyl alcohol	EX	Phosphoric acid (0-5%)	EX
Calcium chloride	EX	Phosphoric acid (5-10%)	G
Crude oil	EX	Potassium chloride	EX
Diesel fuel	EX	Propyl alcohol	EX
Ethyl alcohol	G	Sodium chloride	EX
Gasoline	EX	Sodium hydroxide	EX
Heptane	EX	Sulfuric acid (0-10%)	EX
Hydrochloric acid (0-10%)	EX	Sulfuric acid (10-20%)	G
Hydrochloric acid (10-20%)	G	Toluene	G
Kerosene	EX	Xylene	EX

EX - Suitable for most applications including immersion.
G - Suitable for intermittent contact, splashes, etc.

Your Local ENECON® Fluid Flow Systems Specialist

Using CeramAlloy™ CP+AC

Surface Preparation - METALCLAD CeramAlloy™ CP+AC should only be applied to clean, dry and well-roughened surfaces.

1. Remove all loose material and surface contamination and clean with a suitable solvent which leaves no residue on the surface after evaporation such as acetone, MEK, isopropyl alcohol, etc.
2. Clean/roughen surface by abrasive blasting.
3. If necessary, apply moderate heat and/or allow the component(s) to 'leach' to remove ingrained contaminants.
4. Thoroughly roughen surfaces by abrasive blasting to achieve a 'white metal' degree of cleanliness and an anchor pattern of 3 mils.

Please note: In situations where adhesion is not desired, such as when making molds and patterns or to ease future disassembly, apply a suitable release agent (mold release compound, paste wax, etc.) to the appropriate surfaces.

Mixing & Application - For your convenience, the METALCLAD CeramAlloy™ CP+AC Base and Activator have been supplied in precisely measured quantities to simplify mixing of full units. Should a small amount of material be required, measure out 5 parts Base and 2 parts Activator by volume (5:2, v/v) on a clean mixing surface. Keep Base and Activator separated until ready to mix and apply.

Using a spatula, putty knife or other appropriate tool, mix thoroughly until all streaks disappear, resulting in a uniform color and consistency. Spread material out in a thin layer over the mixing surface to force out any trapped air. This procedure will also maximize working time.

Some deeply eroded areas, e.g. cut-waters, impeller leading edges, diffuser vanes, etc. may require the use of reinforcement tape or other suitable means to bridge the damaged area(s) followed by the application of additional material.

Health & Safety - Every effort is made to insure that ENECON® products are as simple and safe to use as possible. Normal industry standards and practices for housekeeping, cleanliness and personal protection should be observed.

Please refer to the detailed MATERIAL SAFETY DATA SHEETS (MSDS) supplied with the material (also available on request) for more information.

Cleaning Equipment - Wipe excess material from tools immediately. Use acetone, MEK, isopropyl alcohol or similar solvent as needed.

Technical Support - The ENECON® engineering team is always available to provide technical support and assistance. For guidance on difficult application procedures or for answers to simple questions, call your local ENECON® Fluid Flow Systems Specialist or the ENECON® Engineering Center.

All information contained herein is based on long term testing in our laboratories as well as practical field experience and is believed to be reliable and accurate. No condition or warranty is given covering the results from use of our products in any particular case, whether the purpose is disclosed or not, and we cannot accept liability if the desired results are not obtained.

Printed in the USA
February, 2010

revolutionary products . . .

. . . for rebuilding, resurfacing and protecting all types of fluid flow machinery, equipment and structures.

CHEMCLAD® XC

CHEMCLAD® XC

Extraordinary Chemical Resistance

Apply by Brush or Roller

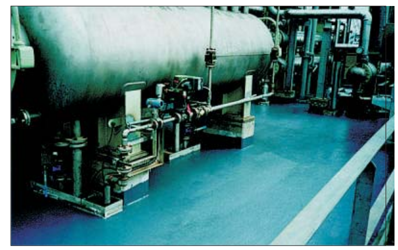
Unlimited Shelf Life

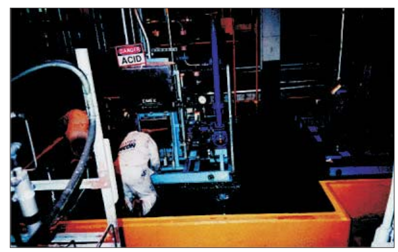
100% Solids

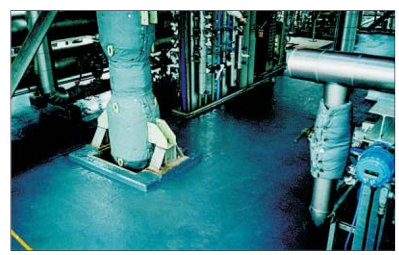
Ultra High Performance

CHEMCLAD® XC

Outstanding protection in some of the most aggressive chemical environments.

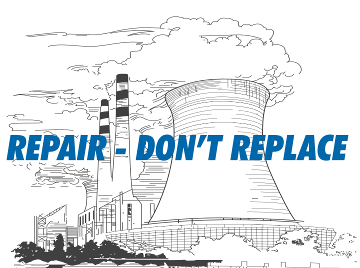






CHEMCLAD® XC is a two component, 100% solids, ultra high performance, chemical resistant coating that provides unrivaled protection in some of the toughest chemical environments. **CHEMCLAD® XC** is resistant to a very broad range of organic and inorganic acids, alkalis, solvents, salts, hydrocarbons, etc. It is easily applied by brush or roller and can be used to protect all types of metal and cementitious surfaces. For your toughest chemical attack problems, use **CHEMCLAD® XC**.

The finest chemical protection polymer system available!
For machinery, equipment & structures.



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6 Platinum Court · Medford, NY 11763-2251

Technical Data

Volume capacity per kg.	$52\ in^3$ / 854 cc	
Mixed density	0.042 lbs per in^3 / 1.17 gm per cc	
Coverage rate per kg. @ 10-12 mils.	30 - 35 ft² / 3 m²	
Shelf life	Indefinite	
Volume solids	100%	
Mixing ratio	Base	Activator
By volume	1.4	1
By weight	5	3

Cure Times

Ambient Temperature		Working Life	Touch Dry	Maximum Overcoating	Full Cure
41°F	5°C	50 min	24 hrs	30 hrs	7 days
59°F	15°C	40 min	8 hrs	24 hrs	6 days
77°F	25°C	30 min	4 hrs	24 hrs	4 days
86°F	30°C	25 min	3 hrs	24 hrs	3 days

Physical Properties

Tensile Shear Adhesion	Typical Values		Test Method
Steel	2900 psi	203 kg/cm^2	ASTM D-1002
Aluminum	2400 psi	168 kg/cm^2	ASTM D-1002
Copper	2500 psi	175 kg/cm^2	ASTM D-1002
Stainless steel	2700 psi	189 kg/cm^2	ASTM D-1002

Elcometer Adhesion - to properly prepared cementitious surfaces is greater than the cohesive strength of the substrate.

CHEMCLAD® P4C Technical Data

Theoretical coverage rate per kg. @ 3 mils. 70 - 80 ft^2 / 6 - 7 m^2

Mixing ratio	Base	Activator
-by volume	2	5
-by weight	2	5

Ambient Temperature	Working Life	Minimum Overcoating	Maximum Overcoating
41°F 5°C	120 min	16 hrs	48 hrs
59°F 15°C	75 min	12 hrs	36 hrs
77°F 25°C	60 min	8 hrs	24 hrs
86°F 30°C	50 min	5 hrs	16 hrs

Chemical Resistance

Acetic acid (0-10%)	EX	Methyl alcohol	G
Acetic acid (10-20%)	G	Methyl ethyl ketone	G
Acetone	G	Naptha	EX
Aviation fuel (JP-4)	EX	Nitric acid (0-20%)	EX
Brake fluid	EX	Phenol	G
Butyl alcohol	EX	Phosphoric acid (0-50%)	EX
Calcium chloride	EX	Potassium chloride	EX
Carbon tetrachloride	G	Propyl alcohol	EX
Chloroform	G	Skydrol	EX
Crude oil	EX	Sodium chloride	EX
Diesel oil	EX	Sodium hydroxide	EX
Ethyl alcohol	EX	Sulfuric acid (0-20%)	EX
Gasoline	EX	Sulfuric acid (50%)	EX
Heptane	EX	Sulfuric acid (98%)	EX
Hydrochloric acid (0-20%)	EX	Toluene	EX
Kerosene	EX	Xylene	EX

EX - Suitable for most applications including immersion.
G - Suitable for intermittent contact, splashes, etc.

Your Local ENECON® Fluid Flow Systems Specialist

Printed in the USA
February, 2010

Using CHEMCLAD® XC

Surface Preparation - CHEMCLAD® XC should only be applied to clean, firm, dry, and well roughened surfaces.

1. Remove all loose material and surface contamination.
2. Depending on the surface, solvent clean and / or remove contamination by abrasive blasting, steam cleaning, pressure washing or other suitable means.
3. New concrete should be allowed to cure for a minimum of 28 days prior to treatment. Insure that all laitance is removed from cementitious surfaces before applying CHEMCLAD®.
4. After removing all surface and sub-surface contamination, flush the area as necessary and allow to dry completely.
5. Metallic surfaces should be abrasive blasted to achieve a 'white metal' finish and a 3 mil profile. Commence the application of the CHEMCLAD® XC immediately upon completion of surface preparation and before any oxidation takes place.

Priming Concrete Surfaces - Prior to applying CHEMCLAD® XC to concrete and / or cementitious substrates, the surface should be treated with CHEMCLAD® P4C to seal the surface, minimize out-gassing and insure that optimum adhesion is obtained. After mixing, P4C should be applied using a brush or roller at the rate of 70 - 80 square feet (6 - 7 square meters) per kilogram to achieve the recommended film thickness of 3 mils.

Please note: Coverage will be reduced on very rough and / or porous surfaces.

The application of the CHEMCLAD® XC may commence when the applied P4C reaches its minimum overcoating time and should be completed within its maximum overcoating time as listed in the chart on the left. For additional details concerning the use of the P4C, please refer to the appropriate section of the CHEMCLAD® XC instructions supplied with the material.

Mixing & Application - CHEMCLAD® XC is supplied in pre-measured quantities to simplify mixing of full units. Simply pour the contents of the Activator container into the Base container; then, using the supplied stirrer or a paint mixer in an electric drill, mix thoroughly until a uniform, streak-free color is achieved. Apply the mixed CHEMCLAD® XC to the prepared (and / or primed) surface using a brush, squeegee or roller. As a guide, a coverage rate of 30 - 35 square feet (3 square meters) per kilogram should result in an applied thickness of approximately 10 - 12 mils on a relatively smooth surface.

Please note: Shape, contour, porosity, roughness, etc. will affect the coverage obtainable. Since a minimum of two coats are recommended, CHEMCLAD® XC is available in different colors to simplify overcoating.

Health & Safety - Every effort is made to insure that ENECON® products are as simple and safe to use as possible. Normal industry standards and practices for housekeeping, cleanliness and personal protection should be observed. For further information and guidance, please refer to the detailed MATERIAL SAFETY DATA SHEETS (MSDS) supplied with the material and also available on request.

Cleaning of Equipment - Wipe excess material from tools immediately. Use acetone, MEK, isopropyl alcohol or similar solvent as needed.

Technical Support - The ENECON® engineering team is always available to provide technical support and assistance. For guidance on difficult application procedures or for answers to simple questions, call your local ENECON® Fluid Flow Systems Specialist or the ENECON® Engineering Center.

All information contained herein is based on long term testing in our laboratories as well as practical field experience and is believed to be reliable and accurate. No condition or warranty is given covering the results from use of our products in any particular case, whether the purpose is disclosed or not, and we cannot accept liability if the desired results are not obtained.

Rilsan®

COATING PHYSICAL AND CHEMICAL PROPERTIES

ARKEMA

Physical properties of the coatings

Typical results for coating applied according to Arkema specifications

Melting point	ISO 11357	186 °C
VICAT point	ISO 306	181°C
Specific gravity at 20°C natural powders dipping and ES powders, white	ISO 1183	 1.040 g/cm^3 1.065 g/cm^3 to 1.25 g/cm^3
Water absorption to saturation at 20 °C and 65% RH at 20 °C and 100% RH at 100 °C and 100% RH (boiling water)	ISO 62/1	 0.9 to 1.1% according to the type of powder 1.6 to 1.9% according to the type of powder 2.4 to 3% according to the type of powder
Shore D hardness at 20 °C, measured at a thickness greater than 5 mm to eliminate the influence of the substrate	ISO 868	75-85
Hardness measured with a Persoz pendulum at 20 °C	ISO 1522	180-200
Surface hardness at 20 °C 10 sec. under load	DIN 53-456	80 N/mm^2
Scratch resistance measured with the Clemen apparatus; load necessary to induce a scratch which reaches the underlying metal for a coating of 0.4 mm thickness	ISO 1518	59 N
Pencil hardness	ECCA T4	Note: B
Shear strength	ASTM D 732	35-42 N/mm^2
Impact resistance Dip coating powder (thickness 350 µm ES powders (thickness 100 µm)	 ASTM G14 ISO 3678 ISO 6272	 > 2 J > 2.5 J > 19 J
Abrasion resistance Taber abrasimeter (wheel type CS 17, load 1 kg) loss of weight after 1,000 cycles	 ISO 9352	 15 mg
Coefficient of friction Black powders	NFT 54-112 (8)	Static K: 0.15-0.3 Dynamic K: 0.05-0.2
Flexibility Conical mandrel folding	 ISO 6860	 > 35%
Specific heat		2.09 kJ/kg K
Thermal conductivity		0.29 W/mK between 323 and 443 K (50° and 170 °C)

Latent heat of fusion		83,7 kJ/kg
Surface resistivity at 20 °C and 65% RH at 500 V	ASTM D 257	2.4 x 10^{14} Ω
Inflammability measured at a thickness greater than 3 mm to eliminate the influence of the substrate	ASTM D 635	self-extinguishing
Dielectric constant	102 Hz 106 Hz	3.9 3.1
Transverse or volume resistivity at 20 °C and 65% RH at 500 V	ASTM D 257	10^{14} to 10^{16} Ω.cm
Tangent of the angle of loww (power factor) at 1,000 V R.M.S., with a current of 1,000 Hz (at 20 °C and 65% RH)		0.05
Resistance to surface tracking KA method	DIN 53-480	Grade KA3c
Dielectric rigidity ES powders thickness ± 100 µm Dipping powders, thickness 350 to 450 µm	ASTM D 149	55 to 90 kV/mm 30 to 36 kV/MM
Dielectric strength Influence of the thickness studied on a natural coating (measured at 20 °C and 65% RH) 0.20 mm 0.43 mm 0.70 mm 0.90 mm		 52.8 kV/mm 38.4 kV/mm 34.7 kV/mm 33.1 kV/mm
Resistance to boiling water	ISO 1521	Excellent adhesion after 2,000 hours; neither bubbing nor modification
Resistance to oudoor exposure	ASTM D 1235	3 years Florida exposure: Adhesion 4, NFT 58-112 without any corrosion
Resistance to salt water		No corrosion after 10 years exposure
Salt spray resistance	ISO 9227, on scribed primed plates (testing according to WIS 4-52-01)	< 1 mm corrosion after 2000 hours

Chemical properties of the coatings

Resistance of Rilsan® to various chemicals, as a function of temperature

In general, Rilsan® coatings have good resistance to inorganic salts, alkalis, most solvents, and to organic acids. Greater caution must be observed in uses involving inorganic acids, phenols and certain chlorinated solvents. In such cases, it is advisable to consult the Arkema Technical Service Department, specifying the practical problem involved: e.g nature of metal to be protected and the temperature and chemical composition of the liquid.

Resistance (ºC)	20	40	60	90
Inorganic bases				
ammonium hydroxide (concentrated)	G	G	G	G
ammonia (liquid or gas)	G	G		
lime-wash		G	G	G
potassium hydroxide (50%)	G	L	P	P
sodium hydroxide (5%)	G	G	L	
sodium hydroxide (10%)	G	L	L	
sodium hydroxide (50%)	G	L	P	P
Inorganic acids				
chromic acid (10%)	P	P	P	P
hydrochloric acid (1%)	G	L	P	P
hydrochloric acid (10%)	G	L	P	P
nitric acid (all concentrations)	P	P	P	P
phosphoric acid (50%)	G	L	P	P
sulphuric acid (1%)	G	L	L	P
sulphuric acid (10%)	G	L	P	P
sulphuric trioxide	L	P	P	P
Inorganic salts				
alum	G	G	G	
aluminium suplhate	G	G	G	G
ammonium nitrate	G	G	G	
ammonium sulphate	G	G	L	
barium chloride	G	G	G	G
calcium arsenate (concentrated solutions of slurries)	G	G	G	
calcium chloride	G	G	G	G
calcium sulphate	G	G	L	
copper sulphate	G	G	G	G
diammonium phosphate	G	G	L	
magnesium chloride (50%)	G	G	G	G
potassium ferrocyanide	G	G	G	
potassium nitrate	G1	G[1]	P	P
potassium sulphate	G	G	G	G
sodium carbonate	G	G	L	P
sodium chloride (satured)	G	G	G	G
sodium silicate	G	G	G	
sodium sulphide	G	L	L	
trisodium phosphate	G	G	G	G

Resistance (ºC)	20	40	60	90
Other inorganic products				
agricultural sprays	G	G		
bleach solution	L	P	P	P
bromine	P	P		
chlorine	P	P	P	P
fluorine	p	p	p	p
hydrogen	G	G	G	G
hydrogen peroxide (20 volumes)	G	L		
mercury	G	G	G	G
oxygen	G	G	L	P
ozone	L	P	P	P
potassium permanganate (5%)	P	P		
sea water	G	G	G	
soda water	G	G	G	G
sulphur	G	G		
water	G	G	G	G
Adehydes and ketones				
acetaldehyde	G	L	P	
acetone (pure)	G	G[3]	L	P
benzaldehyde	G	L	P	
cyclohexanone	G	L	P	
formaldehyde (technical)	G	L	P	
methylethylketone	G	G	L	P
methylisobutylketone	G	G	L	P
Hydrocarbons				
acetylene	G	G	G	G
benzene	G	G[2]	L	
butane	G	G	G	
cyclohexane	G	G	L	
decalin	G	G	G	L
HFA (Forane®)	G			
hexane	G	G	G	
methane	G	G	G	
naphthalene	G	G	G	L
propane	G	G	G	
styrene	G	G[3]		
toluene	G	G[3]	L	L
xylene	G	G[3]	L	L

Condition after 18 months contact: G: Good - L: Limited - P: Poor

1: Slight yellowing - 2: Yellowing - 3: Swelling action

Resistance (°C)	20	40	60	90
Organic bases				
aniline (pure)	L	P	P	P
diethanolamine (20%)	G	G[3]	G[3]	L
pyridine (pure)	L	P	P	P
urea	G	G	L	L
Organic acids and anhydrides				
acetic acid	L	P	P	P
acetic anhydride	L	P	P	P
citric acid	G	G	L	P
formic acid	P	P	P	P
lactic acid	G	G	G	L
oleic acid	G	G	G	L
oxalic acid	G	G	L	P
picric acid	L	P	P	P
stearic acid	G	G	G	L
tartaric acid (saturated solution)	G	G	G	L
uric acid	G	G	G	L
Various organic compounds				
anethole	G			
carbon disulphide	G3	L[2]	P	
diacetone alcohol	G	G[3]	L	P
dimethyl formamide	G	G	L	
ethylene chlorhydrin	P	P		
ethylene oxyde	G	G	L	P
furfurol	G	G[3]	L	P
glucose	G	G	G	G
tetraethyl lead	G			
tetrahydrofurane	G	G	L	
Salts, esters, ethers				
amyl acetate	G	G	G	L
butyl acetate	G	G	G	L
diethyl ether	G			
dioctylphosphate	G	G	G	L
diotylphthalate	G	G	G	L
ethyl acetate	G	G	G	
fatty acid esters	G	G	G	G
methyl acetate	G	G	G	
methyl sulfate	G	L		
tributylphosphate	G	G	G	L
tricesylphosphate	G	G	G	L

Condition after 18 months contact: G: Good - L: Limited - P: Poor

Resistance (°C)	20	40	60	90
Alcohols				
benzyl alcohol	L	P	P	P
butanol	G[3]	L	P	
ethanol (pure)	G[3]	G	L	
glucerine (pure)	G	G	L	P
glycol	G	G	G	P
methanol (pure)	G[3]	L	P	
Chlorinated solvents				
carbon tetrachloride	P			
methyl bromide	G	P		
methyl chloride	G	P		
perchloroethylene	G	G	L	
trichloroethane	L	P		
trichloroethylene	G	L		
Phenols	P	P	P	P
Various products				
beet	G			
cider	G			
crude petroleum	G	G	G[3]	
diesel fuel	G	G	G[3]	
fruit juices	G	G		
fuel-oil	G	G	G	
greases	G	G	G	G
ground-nut oil	G	G		
high octane petrol	G	G	G[3]	
kerosene (paraffin)	G	G	G[3]	
linseed cake	G	G	G	G
milk	G	G	G	G
mustard	G			
normal petrol	G	G	G[3]	
oils	G	G	G	G
solutions or emulsions D.D.T. or lindane				
hydroxy-quionoline (agricultural sprays)	G			
soap solution	G			
stearin	G	G	G	
solvent naphtha	G	G	G[3]	
town gas	G	G		
turpentine	G	G	G[3]	
winegar	G			
wine	G			

1: Slight yellowing - 2: Yellowing - 3: Swelling action

A world-class chemical concern, Arkema combines three strategically related, integrated businesses: Vinyl Products, Industrial Chemicals and Performance Products. With operations in more than 40 countries and 17,700 employees, the company reported revenue of € 5.7 billion in 2005. Leveraging six research centers in France, the United States and Japan and internationally recognized brands, Arkema holds leadership positions in each of its principal markets.

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Arkema - société anonyme au capital de 604 538 230 euros - 445 074 685 RCS Nanterre
DIRCOM - 3927E / 01.2007 / pdf - Tech (ex Dpt) - Photos: Arkema - Conception: DUFOUR communication

ATOFINA

MATERIAL SAFETY DATA SHEET

Printed: 10/8/03

RILSAN® T BLEU/BLUE 7174

PRODUCT IDENTIFICATION AND USE

MANUFACTURER:	ATOFINA CANADA INC. 700 THIRD LINE OAKVILLE, ONTARIO L6J 5A3
EMERGENCY PHONE NUMBER:	(905) 827-9841 (ATOFINA) (613) 996-6666 (CANUTEC)
PRODUCT IDENTIFIER:	RILSAN® T BLEU/BLUE 7174
PRODUCT CODE:	AP08496
PRODUCT USE:	DECORATIVE PROTECTIVE POWDER COATING FOR METALS.
WHMIS CLASSIFICATION:	D2B – TOXIC MATERIAL CAUSING OTHER EFFECTS

HAZARDOUS INGREDIENTS

	PERCENT	CAS #	TLV
QUARTZ LD50: NE	1-5	14808-60-7	0.05 MG/M3 (RESPIRABLE PARTICLE)
MICA LD50: NE	1-5	12001-26-2	3 MG/M3
BLUE PIGMENT WITH COBALT ZINC ALUMINATE LD50: NE	1-5	68186-87-8	NE
CHLORITE LD50: NE	1-5	1318-59-8	NE

ADDITIONAL INGREDIENT INFORMATION (WHMIS NOT CONTROLLED):

POLYAMIDE 11	NE
TITANIUM DIOXIDE	10 MG/M3

PHYSICAL DATA

PHYSICAL STATE:	POWDER
ODOUR AND APPEARANCE:	BLUE POWDER WITH MINIMAL ODOUR.
ODOUR THRESHOLD:	NE
SPECIFIC GRAVITY/DENSITY (G/ML):	1.0 – 1.3
VAPOUR PRESSURE:	NE
VAPOUR DENSITY (AIR=1):	NE
VOLATILITY/VOL(%):	NE
SOLUBILITY IN H20:	NEGLIGIBLE
EVAPORATION RATE:	NE
BOILING POINT:	NE
FREEZING POINT:	184 – 192°C (MELTING POINT)
PH:	NA
LOG KOW:	NE

SHIPPING INFORMATION

THIS PRODUCT IS NOT TDG REGULATED.

FIRE AND EXPLOSION HAZARD

FLAMMABILITY:	NOT FLAMMABLE.
CONDITIONS:	WILL BURN AT ELEVATED TEMPERATURES.
MEANS OF EXTINCTION:	WATER SPRAY, CARBON DIOXIDE, FOAM OR DRY CHEMICAL DO **NOT** USE SOLID STREAM OF WATER.

MATERIAL SAFETY DATA SHEET

Printed: 10/8/03

RILSAN® T BLEU/BLUE 7174

FLASHPOINT:	NE
UPPER EXPLOSION LIMIT (% V):	NA
LOWER EXPLOSION LIMIT (%V):	NA
AUTO-IGNITION TEMPERATURE:	NE
HAZARDOUS COMBUSTION PRODUCTS:	OXIDES / HYDRIDES OF CARBON, NITROGEN.
EXPLOSION DATA:	AVOID DISPERSION OF DUST INTO THE AIR.
SENSITIVITY TO IMPACT:	NO
SENSITIVITY TO STATIC DISCHARGE:	AVOID ACCUMULATION OF STATIC ELECTRICITY AND POSSIBLE FORMATION OF DUST DURING TRANSFER OF POWDER INTO METALLIC INSTALLATIONS. PROVIDE GROUNDING.

REACTIVITY

CHEMICAL STABILITY:	STABLE
INCOMPATIBLE MATERIALS:	ACIDS, STRONG OXIDIZERS.
CONDITIONS OF REACTIVITY:	NE
HAZARDOUS DECOMPOSITION PRODUCTS:	NE

HEALTH HAZARD INFORMATION

ROUTE OF ENTRY	
SKIN CONTACT:	PROCESS VAPOURS MAY CAUSE IRRITATION
SKIN ABSORPTION:	NE
EYE:	PROCESS VAPOURS MAY CAUSE IRRITATION.
INGESTION:	NE
INHALATION:	PROCESS VAPOURS MAY CAUSE RESPIRATORY TRACT IRRITATION.
ACUTE OVER EXPOSURE EFFECTS:	NE
CHRONIC OVER EXPOSURE EFFECTS:	NE
SENSITIZATION:	MAY CAUSE ALLERGIC SKIN REACTION.
CARCINOGENICITY:	QUARTZ IS LISTED BY IARC AS GROUP 1 CARCINOGEN, CARCINOGENIC TO HUMANS.
TERATOGENICITY:	DOES NOT MEET WHMIS CRITERIA.
MUTAGENICITY:	DOES NOT MEET WHMIS CRITERIA.
REPRODUCTIVE TOXICITY:	DOES NOT MEET WHMIS CRITERIA.

PREVENTIVE MEASURES

PERSONAL PROTECTIVE EQUIPMENT:	WEAR SAFETY GLASSES AND USE IMPERVIOUS GLOVES. AN NIOSH APPROVED DUST RESPIRATOR IS ADVISED.
SPECIFIC ENGINEERING CONTROLS:	LOCAL EXHAUST IS RECOMMENDED WHERE HEAT CAN CAUSE POLYMER BREAKDOWN.
LEAK AND SPILL PROCEDURES:	SWEEP OR SCOOP UP AND PLACE IN A CLOSED CONTAINER.
WASTE DISPOSAL:	CONSULT FEDERAL OR LOCAL AUTHORITIES FOR APPROVED DISPOSAL METHODS.
HANDLING PROCEDURES AND EQUIPMENT:	KEEP AWAY FROM HEAT, SPARKS AND OPEN FLAMES. WASH BEFORE EATING, DRINKING, USING TOBACCO PRODUCTS OR REST ROOMS.
STORAGE REQUIREMENTS:	KEEP IN A CLOSED, LABELED CONTAINER IN A VENTILATED AREA.

FIRST AID MEASURES

EYE	FLUSH EYES WITH LARGE AMOUNT OF WATER FOR 15 MINUTES WHILE HOLDING

	EYELIDS OPEN. SEEK MEDICAL ATTENTION IF IRRITATION OCCURS OR PERSISTS.
SKIN	WASH SKIN WITH WATER AND SOAP. SEEK MEDICAL ATTENTION IF IRRITATION OCCURS OR PERSISTS.
INGESTION	DO NOT GIVE LIQUIDS IF PERSON IS UNCONSCIOUS OR VERY DROWSY. OTHERWISE GIVE TWO GLASSES OF WATER OR MILK AND SEEK IMMEDIATE MEDICAL ATTENTION. INDUCE VOMITING.
INHALATION	REMOVE PERSON TO FRESH AIR IMMEDIATELY. IF BREATHING HAS STOPPED, APPLY ARTIFICIAL RESPIRATION AND ADMINISTER OXYGEN IF NECESSARY. SEEK MEDICAL ATTENTION.

PREPARATION DATE

PREPARED BY:	TECHNICAL DEPARTMENT.
PHONE NUMBER OF PREPARER:	905-827-9841
DATE PREPARED (MM/DD/YY):	04/05/93
DATE REVISED (MM/DD/YY):	09/24/03

MINIMUM CONTACT WITH THIS AND ALL CHEMICALS IS RECOMMENDED AS A GOOD GENERAL POLICY TO FOLLOW.

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APPENDIX B

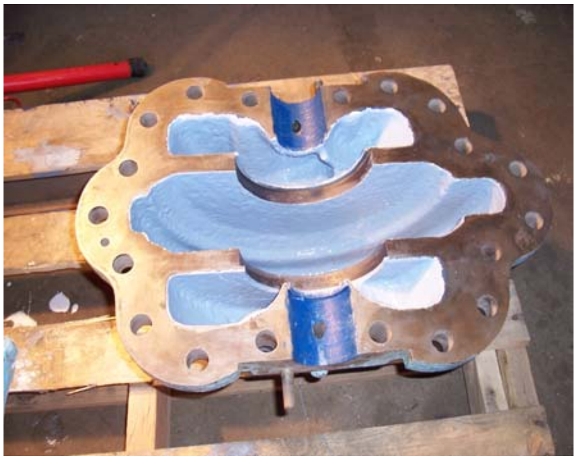
EXPERIMENTAL DESIGN REPORT

NYSERDA Project # 9322

(P.O.N. 935)

Energy Savings through Pump Refurbishment and Coating

Experimental Design Report



Monroe County Water Authority

September 2006

1. Introduction

The aim of NYSERDA project #9322, *Energy Savings through Pump Refurbishment and Coating,* is to determine the effect of mechanical repair and pump coating on pump energy efficiency. A number of existing pumps in Monroe County Water Authority (MCWA) system will be accurately tested for pumping efficiency before and after the steps of mechanical refurbishment and interior surface coating to determine how much each method contributes to an increase in energy efficiency for pumps that have been in potable water service for a period of time.

The project is divided into two phases. The first phase was to develop this *Experimental Design Report*, which, according to section 1.2 of the Project Agreement between NYSERDA and the MCWA, would at a minimum contain the following items:

- Problem Definition and Goals
- Identification of specific questions to be answered by this project and the overall methodology to be used to answer the questions.
- Identification of the parameters to be measured, and the quality control methods and field protocols implemented to ensure valid data.
- Specification of what work will be accomplished, how it will be accomplished, and by whom.
- Definition of how the data will be used and evaluated to support conclusions.
- An outline of the Phase 2 deliverable report.

After reviewing this experimental design, NYSERDA will make a determination as to whether or not to authorize MCWA to proceed with the Phase 2 part of the project and implement the plan as described in this report.

2. Problem Definition and Goals

Background

The Monroe County Water Authority (MCWA) is the third largest potable water supplier in New York State, delivering an average of 60 million gallons per day to its customers. On average MCWA consumes 7 megawatts of power, with summer peak daily usage near 14 megawatts. MCWA typically consumes 60-70 million kilowatt hours of electricity per year at a cost of about $4 million dollars. Over 90 percent of this electricity is directly consumed by its 110 individual pumps ranging in size from 5 to 1,750 horsepower. With such large dollar amounts being expended, even small gains of pump efficiency can have a large impact on savings, both in terms of kilowatt hours and cost. Pumps used for water potable supply and other clean water applications are rarely coated, and have bare cast iron surfaces exposed to the water. Over a relatively short period of time, usually within a few years, a buildup of corrosion products on the internal surfaces of the casing occurs. This buildup is called tuberculaton, and it alters the internal clearances, geometry and friction coefficients of the interior casing. Figure 1 shows the tuberculation in a typical pump interior. Pumps older than the one shown in Figure 1 inspected by the Water Authority have exhibited significantly worse conditions.

Through recent pilot testing on smaller pumps (100 HP or less), MCWA was able to demonstrate significant gains in pumping efficiency using a technology which is vastly underutilized in the water sector. The technology involves cleaning and coating the interior surface of existing pumps with an ultra smooth epoxy ceramic polyamide coating, which eliminates roughness and protects the surface against future corrosion growth, which robs efficiency. Reclaimed efficiency gains of over 10 percent were achieved on test pumps, with total efficiencies approaching the original manufacturer specifications. If a pump also needed refurbishment in terms of new wear rings, bearings or other mechanical items, such improvements provided an additional efficiency gain.

With this project, co-funded by NYSERDA, MCWA hopes to demonstrate that pump refurbishment, in conjunction with internal coatings, is an easy and economical way for any industry or municipality to save energy.

Technology Being Evaluated

Through previous pump rebuilding projects, it was observed that the interior of many of the pump casings had a significant amount of corrosion related roughness and pitting (tuberculation) which was theorized to be a significant factor associated with poor pump efficiency as measured in the field. Figures 1 and 2, below, are examples of this internal tuberculation build up.

Rough surfaces prior to coating

Figure 1

Figure 2

The increased surface roughness creates additional friction losses which lower the efficiency of the pump by dissipating energy and restricting flow.   Declines in efficiency of 15-20 percent or more are common where surface roughness grows unchecked.

Once this tuberculation is removed and the surfaces restored to near original smoothness, efficiency is reclaimed.   Figures 3 and 4 show pump surfaces after coating. Some pitting is still visible through the coating in figure 4, but the dimples can be nearly eliminated with a filler coat prior to coating.

After Coating

Figure 3

Figure 4

Based on MCWA's desire to understand the effect of internal pump tuberculation from an efficiency and energy standpoint, MCWA began research into what it would take to completely disassemble a pump, remove it from its base, have it sandblasted to remove all tuberculation, fill deep pits if necessary, and then coat it with a durable coating suitable for the interior of potable water pumps.

It was decided that the ideal interior pump coating would be one that would:

- Form a molecular bond to the inside of the cast iron pump casing.
- Eliminate future corrosion and tuberculation (act as a barrier between the bare metal of the pump casing and the water being pumped).
- Minimize internal pump friction losses and reduce energy consumption (have a very low friction coefficient).
- Increase internal pump durability and resistance to cavitation.
- Must be National Sanitation Foundation (NSF) approved.[1]

Based on MCWA's own full scale testing of coatings, (described in detail in sections D and E of MCWA's project application), there were measurable energy savings with economical payback periods. Efficiency gains of over 10 percent were achieved just due to the cleaning and coating application. Additionally, pump refurbishing in terms of wear ring clearances, bearing work, etc. were measured to have about 5 to 10 percent efficiency gain. In all of the preliminary coating and refurbishing pilot projects completed by MCWA, the pump efficiency was restored to within 4.5 percent of the original ('off the shelf') operating efficiency points.

Simply sandblasting the interior surface of a corroded pump would produce some efficiency gain by eliminating the tuberculation. However, the pitting which accompanies tuberculation would remain, leaving a fairly rough surface as compared with epoxy coating. Also, the cast iron surface would remain unprotected, and tuberculation would likely return in just a few years, negating the effect of sandblasting and reducing efficiencies again. A document entitled "Study on Improving the Energy Efficiency of Pumps" by the European Commission, February 2001, noted that most of the efficiency deterioration occurs in the first 5 years of pump operation. The study goes on to say "The use of glass or resin coatings can help to increase and maintain a good hydraulic efficiency over a long period of time, and for larger pumps many users specify these coatings as standard. Improvements in efficiency of 2-3% are typical. This is a practice that should be encouraged." If such improvements can be seen on a brand new pump, then coating an existing, tuberculated pump should yield better efficiency gains over just sand blasting for the reasons stated above.

Epoxy coating the inside of pumps to increase resistance to abrasive slurries and aggressive chemicals is not new and has been found in certain specialty pumping applications for years. In the municipal water and wastewater sector, however, there is minimal information available from coating manufacturers and/or pump manufacturers on the potential efficiency and durability benefits of coating the interiors of pumps, new or used. The application of coatings to brand new pumps for efficiency maintenance and improvement is far from common practice.

[1] NSF Association certification is required of any product(s) that come in contact with a potable water supply

There are several barriers to the widespread use of pump coatings. Interior pump coatings cost extra and must be specifically requested by the customer and are not generally presented as an option from pump manufacturers prior to pump purchase, especially in the municipal (low-bid) market. Additionally, it is the coating manufacturer and not the pump manufacturer who performs most coating applications of new pumps. This additional step increases pump shipping cost and delays pump delivery to the customer. Most customers are also more focused on minimizing initial capital expense rather than lifecycle costs, including energy consumption, even though lifecycle costs can be significantly greater.

Project Goals

Through this project, MCWA will fully evaluate if pump refurbishment and coating is an effective and economical long term solution for regaining and maintaining pump efficiency. The ultimate improved efficiency may be no higher than when the pump was brand new, but it is the efficiency decline of 10 to 30 percent or more during a typical pump's service life that can be reclaimed with these techniques, leading to significant long-term savings. MCWA will also examine the effect of sandblasting without coating, and it's effect on short term efficiency gains as well as longer term decline.

This project will expand MCWA's original pilot study to include a larger range of pump sizes in order to conclusively demonstrate the effectiveness of this energy saving technology over a range of conditions. MCWA shall clean and coat approximately sixteen pumps ranging in size from 20 HP up to 1750 HP, using three different manufacturer coatings. All pumps will also receive mechanical refurbishing.

The goals of the project are as follows:

1. Confirm, with greater detail and experimental control, the very encouraging increases in pump efficiency from interior pump coatings and refurbishing as shown in the results of the MCWA pilot study on small pumps (less than 100 HP).
2. Determine if the results in increased pump efficiency on the small pumping systems can be duplicated on medium to large size pump systems (200 HP up to 1750 HP pump/motor systems).
3. Compare the effectiveness, application, and costs of different coating materials and methods, and determine the efficiency gains due to refurbishing vs. coating.
4. Compare the short and long term effects of coating vs. sandblasting only.
5. Write a final report documenting all of the data, results and conclusions and submit it to NYSERDA for review and approval.
6. Disseminate the results to other entities within the water sector and industry through trade associations, organizations and possibly publications and presentations to increase energy efficiency and expand the pump coating business across New York State.

3. Statistical Design

A statistically based experimental design is described below to address the two main experimental goals of this project:

- To compare pump efficiency gains pre/post rehabilitation and pre/post coating
- To correlate efficiency gains with other parameters such as pump size, type of coating, and specific speed.

3.1. Effect of rehabilitation and coating on pump efficiency

Determining the effect of rehabilitation and coating on pump efficiency is the primary experimental goal and will be used to determine the experimental sample size needed to conduct a statistically valid experiment. The task is to characterize the effect of rehabilitation and coating on pump efficiency for the total population of (120) pumps deployed by the MCWA. Since it is not possible to include the total population of pumps in the experiment, a subset of pumps must be sampled to statistically characterize the total population. The method taken to determine the appropriate experimental sample size involves a "prespecified margin of error" approach (Gilbert, 1987):

$$n = \frac{(t_{1-\alpha/2,n-1} s/d)^2}{1 + (t_{1-\alpha/2,n-1} s/d)^2 / N} \qquad \text{(Equation 3.1.1)}$$

Where:
n = Experimental sample size required to achieve prespecified margin of error
d = Prespecified margin of error = Difference between sample mean pump efficiency gain for the n experimental samples and the true mean pump efficiency gain for the total population of pumps = 1.0 to 5.0 (see discussion below)
α = Acceptable probability of exceeding the margin of error = 1 – confidence level (95%) = 0.05
s = Best estimate of the standard deviation of pump efficiency gain (from pilot study; see Table 3.1a)
t = Student t distribution for sampling from a normal distribution

N = Size of total population of pumps = 120

The above approach requires two main inputs: prior information about the population being sampled (from a pilot study), and a prespecified margin of error. These inputs and the t distribution for sampling from a normal distribution are used to estimate the experimental sample size required to meet the prespecified margin of error with a given level of confidence (e.g. 95%). In this case, a pilot study conducted using four pumps (Woodcliff No. 1, Denise No. 2, Mosely No. 3, and Denise No. 4) can be used to provide a best estimate of the standard deviation (s) of pump efficiency gain. One of the pumps (Denise No. 2) was tested using a coating that is not being considered in the experiment proposed here. Therefore, the pilot study results for that pump are not considered. For the three remaining pumps, pump efficiency was measured before rehabilitation and coating and after rehabilitation and coating. The standard deviation of the pump efficiency gains (%) for the three samples was 6.9 (Table 3.1a). This value will be used as the best estimate of the standard deviation (s) of the pump efficiency gain for the entire population of pumps. Since the pilot study pumps had a range of coating types, sizes, and specific speeds (Table 3.1a), they are likely to be representative of the larger population of pumps.

Table 3.1a. Pump efficiency (%) before rehabilitation and coating (Pre) and after rehabilitation and coating (Post) from pilot study.

Pump	*Coating Type*	*Size (hp)*	*Specific Speed*	*Pre*	*Post*	*Difference*
Woodcliff No. 1	Belzona	40	1157	43.5	73.3	29.8
Moseley No. 3	Devcon	75	2052	66.4	86.5	20.1
Denise No. 4	Belzona	100	1617	62.0	78.5	16.5
Standard deviation (s)						6.9

It should be noted that the pump efficiency values in Table 3.1a are for the best efficiency point (BEP) for each pump (i.e., the flow rate that results in the maximum efficiency for that pump). When more than one efficiency test was performed for a given pump before rehabilitation and coating (Pre) or after rehabilitation and coating (Post), the BEP efficiencies for the multiple Pre-tests were averaged together as were those for the multiple Post-tests. These averages are shown in Table 3.1a.

It should also be noted that the above prespecified margin of error approach for determining experimental sample size (Equation 3.1.1) assumes that the experimental pump efficiency data is normally distributed. To verify this assumption, all the BEP efficiencies from the pilot study tests (Pre and Post, prior to averaging) were compiled and evaluated with the Shapiro-Wilk test for normality, using USEPA ProUCL software (V. 3.0). Since the calculated Shapiro-Wilk test statistic (0.92) exceeded the critical value for normality (0.84) given a confidence level of 95%, it can be concluded with 95% confidence that the pump efficiency data is normally distributed.

In addition to verifying the assumption of normality and providing a best estimate of the standard deviation of pump efficiency gains, the investigator must prespecify the margin of error with which the pump efficiency gain should be known (e.g., ±5.0). In this analysis, a range of ±1.0 to ±5.0 is considered for the margin of error, and a corresponding range of required sample sizes is determined. In order to solve Equation 3.1.1, an iterative calculation is required, since n appears in both the right and left side of the equation. The calculation involves first assuming a large value of n in the right side of the equation, solving for n on the left side, and then reinserting the new value of n into the right side of the equation. This process is repeated until successive values of n converge to within 10% (Table 3.1b).

Table 3.1b. Experimental sample size (n_{final}) required to achieve a prespecified margin of error (±d) for estimating pump efficiency gain (%) from before rehabilitation and coating to after rehabilitation and coating. See equation 3.1.1 for parameter definitions.

Inputs				Iteration 1		Iteration 2		Iteration 3		Iteration 4		
d	α	s	N	t_1	n_1	t_2	n_2	t_3	n_3	t_4	n_4	n_{final}
1.0	0.05	6.9	120	2.0	72	2.0	73	2.0	73	2.0	73	73
2.0	0.05	6.9	120	2.0	33	2.0	35	2.0	35	2.0	35	35
3.0	0.05	6.9	120	2.0	17	2.1	20	2.1	19	2.1	19	19
3.2	0.05	6.9	120	2.0	15	2.1	18	2.1	18	2.1	18	18
4.0	0.05	6.9	120	2.0	10	2.3	13	2.2	13	2.2	13	13
5.0	0.05	6.9	120	2.0	7	2.6	11	2.2	9	2.4	10	9

Depending on the prespecified margin of error (d = ±1.0 to ±5.0), the required experimental sample size ranges from 73 to 9. A mid-range prespecified margin of error (±3) requires a sample size of 19. This value is similar to the sample size of 18 independently determined based on time and logistic constraints. The above analysis shows that with 95% confidence (1-α), a sample size of 18 results in a margin of error of ±3.2.

It should be noted that the above analysis relates to pump efficiency gain from before rehabilitation and coating to after rehabilitation and coating. In the proposed experiment, the pump efficiency gain will actually be sampled pre/post rehabilitation and pre/post coating. Therefore, the pump efficiency gain for each separate step (rehabilitation and coating) will be determined. When the two steps are combined, the overall mean pump efficiency gain will have a margin of error of ±3.2.

Additionally, any experimental results regarding pump efficiency gain will be further informed by periodic monitoring after the conclusion of the experiment to determine over what period of time the coatings and their efficiency gains last.

3.2 Correlating efficiency gains with pump size, specific speed, and coating type

With the experimental sample size (18) already determined, the statistical basis for correlating efficiency gains with other parameters must be addressed. Since the 18 pump samples will have a variety of coatings, pump sizes, and specific speeds (see sampling matrix in Table 3.1b), it will be possible to plot pump efficiency gains versus these parameters, along with correlation coefficients (r^2) to measure the strength of the correlation. However, in order to show with a specified level of confidence whether or not the above parameters have a statistically significant effect on pump efficiency gain, a multivariable regression analysis is required. Since the coating type parameter is not a numerical parameter, it cannot be included in the regression. However, pump size and specific speed can be evaluated:

Pump efficiency gain = constant + β(Pump size) + γ(Specific speed) (Equation 3.1.2)

The 18 pump samples will be regressed according to Equation 3.1.1 to obtain both an estimate of the regression coefficients (β and γ), and the 95% confidence interval for these coefficients. If the 95% confidence interval for a coefficient does not overlap with 0, the null hypothesis (that the true value of the coefficient is 0) can be rejected, and it can be concluded with 95% confidence that the parameter is significantly related to pump efficiency gain. For pump size, it is theoretically expected that the larger the pump size, the less the pump efficiency gain. Such an expectation would be statistically confirmed by a negative regression coefficient (β) with a 95% confidence interval that does not include 0. The same holds true for the specific speed parameter and its regression coefficient (γ).

With regards to the effect of coating type on pump efficiency gain, a related approach is proposed to statistically determine which coating type results in the most pump efficiency gain. Based on the sampling plan for the 18 proposed samples (Table 3.1b), six samples will be obtained for each coating type. The pump efficiency gains for each coating type over the six samples can averaged and the 95% confidence interval for the true mean pump efficiency gain can be determined using the t-distribution:

$$m - \frac{t_{\alpha/2,n-1} s}{\sqrt{n}} < \mu < m + \frac{t_{\alpha/2,n-1} s}{\sqrt{n}}$$

Where:
m = sample mean
s = sample standard deviation
μ = true mean
n = sample size = 6
α: 1 – confidence level (95%) = 0.05

The 95% confidence intervals for the true mean pump efficiency gain for the three coating types (A,B,C) will be calculated and compared. If there is overlap between two confidence intervals, it cannot be concluded with 95% confidence that there is a significant difference between the true mean pump efficiency gain for the two coating types. However, if there is no overlap, it can be concluded that one coating type has a significantly higher mean pump efficiency gain than the other. These results can be further confirmed by checking the head-to-head pump efficiency comparisons proposed in the sampling plan (2; Coating A versus B – 3 cases; Coating A versus C – 3 cases; Coating B versus C – 3 cases).

Summary

- Using a prespecified margin of error approach for determining experimental sample size, it can be concluded with 95% confidence that a sample size of 18 will provide a sample mean pump efficiency gain (%; from before rehabilitation and coating to after rehabilitation and coating) that is within ±3.2 of the true mean pump efficiency gain for the total population of (120) pumps deployed by the MCWA.

- A regression analysis of the pump efficiency gains for the 18 samples against two parameters (pump size and specific speed) will be performed to determine if there is a statistically significant relationship between the parameters and pump efficiency gain.

- 95% confidence intervals for the true mean pump efficiency gain for the three coating types will be compared to determine whether a given coating type has a significantly higher pump efficiency gain than the other coatings.

References

Gilbert, R.O. 1987. Statistical Methods for Environmental Pollution Monitoring. NY: Wiley.

4. Measuring Parameters

The key results of this project will be related to pump efficiency and an assessment of mechanical deficiencies such as clearances and wear. Pump efficiency calculations depend on field measurement of pressure, water flow, and energy consumption. The methods used in the field to test pumps will follow the Hydraulic Institute's "American National Standard for Centrifugal Pump Tests", level B.

Flow is often measured through pressure differential on a venturi or orifice plate. Mechanical wear is usually a measurement of dimensions and clearances as compared with design values. A brief discussion of the above measurements as well has the quality control methods used to ensure accurate results are presented below.

Pressure - Measurements must be taken on pump suction and discharge to calculate pump work as part of the efficiency calculation. For each pump test, the pressures will be measured as close to the pump as possible, normally on the factory pump fittings on the suction and discharge. These ports will be checked to verify they are unobstructed. Pressure data will be obtained using digital pressure recorders made by the Telog Corporation (model HPR-31). These recorders will be calibrated by Telog prior to the field testing. Several data points will be taken along the pump curve by throttling flow, simultaneously recording suction and discharge pressures at least once per second. Half way through the test, the recorders will be switched, and the data averaged to cancel out any recorder error. The manufacturer stated accuracy on the recorders is +/- 0.25 percent of full scale.

Flow Rate - Each pumping station has a venturi meter or magnetic flow meter for measuring flow rate. During each pump test, the only flow through the meter will be from the pump being tested.

For the pump stations measured by venturi, the specifications, including transmitter and accuracy data are summarized in Table 1. Manufacturer data for each venturi is presented in Appendix A. For a typical venturi application, the manufacturer stated accuracy ranges from 1 percent or less for standard venturis, to several percent for Dall tube inserts. Differential pressure transmitter accuracy is generally within 0.5 percent or less, depending on flow rater. These meters are tested for accuracy periodically vs. a pitot rod measurement. Before each pump test, the pressure sensing lines will be rodded out or blown out to ensure good differential pressure readings. This may vary from site to site and will be documented with the testing. When testing the pumps at the Shoremont Treatment Plant, the venturi data will be compared with tank drawdown data as a check on the venturi accuracy. Unfortunately, this is the only location in the study in which tank drawdown can be used to directly compare with venturi measured flow.

For stations having a magnetic flow meter, the meter specifications are shown in Table 1.

Power consumption - During each pump test, the power usage of the motor, in kilowatts will be measured to the nearest tenth of a kilowatt. The stated efficiency of the motor will be used to derive the power at the pump shaft. Kilowatt measurements will be made using installed power monitors made by Square D (model Powerlogic 800). According to the manufacturer, the kilowatt measurement accuracy of these meters is +/- 0.15 percent. Where such monitors measure total station power, the additional loads besides the pumps will be either turned off or accounted for during the test period.

RPM - The motor speed will be measured with a strobe light to verify the field pump impeller speed vs. the speed assumed by the manufacturer's curve.

5. Work Plan

Table 2 outlines the project tasks and schedule. Eighteen pumps will be tested for efficiency before and after mechanical refurbishment, and again after pump coating. Two pumps will be left uncoated to compare the effect of sandblasting only. These pumps will be tested after mechanical work and again after sandblasting. A third pump, which is identical to one of the pumps coated in the pilot study, will also be sandblasted and left uncoated to compare its efficiency with its coated twin. Pumps will be disassembled and reassembled by MCWA mechanical personnel. Mechanical refurbishment of wear rings, seals and rotating elements will be performed by local machine shops with the goal of returning the clearances and dimensions to manufacturer's specifications. Sandblasting of pump surfaces will be done at local companies.

Coating of interior pump casing surfaces will be performed by MCWA personnel following the manufacturer's directed methods of application. Impeller coating will be performed by either powder coating firms specializing in the fluidized bed method of coating application for smaller impellers, or hand applied by MCWA personnel in the case of large impellers. Pump efficiency testing will be performed by MCWA personnel. Photographs will be taken to document each step in the process. Since this is a long term project (approximately two years), quarterly and annual status reports will be sent to NYSERDA reviewing the work done and data collected during each period.

Table 3 shows the wide range of pump horsepower (20-1750 HP) and specific speeds (1071-3837) that will be used in the project as well as which coatings will be applied to which pumps. The paired sequence of pumps allows for more direct comparisons of different coatings.

1. Test existing pump efficiency in the field.
2. Disassemble pump and send rotating element to machine shop for mechanical refurbishment. This can include new wear rings, bearings, sleeves, and/or shaft. Wear rings will be fitted and turned to the final dimensions. Element will be balanced.

3. For 12 of the 18 pumps, the rotating element will be sent to powder coater to coat the impeller. The efficiency gains due to impeller coating will appear as part of the overall mechanical work efficiency. For large pumps, the extra work of disassembling the rotating element twice in order to obtain separate measurements of pump efficiency improvement for refurbishment and impeller coating were considered not cost effective. However, for four pumps, a separate measurement will be taken to give an indication of the effect of impeller coating by itself on pump efficiency. The specific speed of these four pumps ranges from low to high so that a relationship may be detected between the specific speed and effectiveness of impeller coating, if there is one.
4. The rotating element will then be sent back to MCWA and the pump will be reassembled.
5. The pump efficiency will be field tested again to measure the improvement due to refurbishing (and impeller coating for 12 of the pumps).
6. For the four pumps mentioned in step 3 above, the pumps will be disassembled and the impeller sent for coating. The pumps will be reassembled and field tested for efficiency gain.
7. The pump will be disassembled again and the interior casing surfaces of the pump will be sandblasted at a local shop. Photographs will be taken before sandblasting to provide an indication of the degree of roughness and corrosion.
8. Surface pitting will be smoothed using a metal filler material, and the coating will be applied to all interior pump surfaces by MCWA personnel per vendor directions.
9. Pump will be reassembled and installed.
10. Pump efficiency will be measured again in the field to determine the improvement due to pump coating.
11. Every six months after a pump has been coated, efficiency measurements be taken and plotted over time.
12. Every six months, for the first 2 years after coating, the inside of each pump will be inspected for coating wear and adhesion. After that, inspections will be annual.

Quarterly Reports

MCWA shall submit quarterly progress reports to the NYSERDA Project Manger. Progress Reports shall be in a letter format and shall include information on the following subjects in the order indicated, with appropriate explanation and discussion:

a) Title of project;

b) Agreement number;

c) Reporting period;

d) Project progress including findings, data, analyses, and results from all tasks carried out in the covered period;

e) Planned work for the next reporting period;

f) Identification of problems;

g) Planned or proposed solutions to resolve problems described in (f) above;

h) Ability to meet schedule, reasons for slippage in schedule;

i) Schedule – percentage completed and projected percentage of completion of performance by months – could be a bar chart or milestone chart;

j) Budget analysis of actual cost incurred in relation to the budget.

6. Data Evaluation

The evaluation of data will be done throughout the project, rather than waiting until the end. The efficiency data collected from each test will be entered into spreadsheets and pump curves will be plotted. The subsequent test data (after refurbishment and after coating) will be tabulated and plotted along side the original data so comparisons can readily be made.

A propagation of error analysis will be performed on each calculation that determines the improvement in efficiency of a pump. The analysis will show the average error that can be expected in measuring pump efficiency due to the error inherent in the measurement of each parameter that contributes to the calculation. Instrument error will be estimated based on manufacturer's literature. A sample calculation has been included in this report (Appendix B).

Efficiency will be calculated by dividing the hydraulic power output from the pump by the brake horsepower input to the pump.

$$\text{Pump efficiency} = \frac{P_{bhp}}{P_{hyd}}$$

$$\text{Power input to pump} = P_{bhp} = \frac{P_{kw} \text{ x } e_m}{0.746}$$

where,

P_{kw} = the kilowatt measurement at the pump motor

e_m = Estimated motor efficiency using MotorMaster+ 4.0 software. The software incorporates several methods for determining motor load. These involve the use of motor nameplate data in conjunction with selected combinations of input power, voltage, current, and/or operating speed. With the percent load known, the software determines the as-loaded efficiency from default tables based on the motor type, condition, and horsepower. MotorMaster+ automatically chooses the best available method based upon the data it is given.

and,

$$\text{Hydraulic power output of pump} = P_{hyd} = \frac{H \times Q}{3960}$$

where,

H = head developed by the pump (feet)

Q = measured flow rate of the pump (gpm)

And, pump head will be calculated as follows:

$$\text{Pump Head} = H = [P_d \times 2.31 + \frac{V_d^2}{2g} + z_d] - [P_s \times 2.31 + \frac{V_s^2}{2g} + z_s]$$

where,

P_d = Pump discharge pressure (psi)

V_d = Pump discharge velocity (fps)

Z_d = Pump discharge pipe center line elevation

P_s = Pump suction pressure (psi)

V_s = Pump suction velocity (fps)

Z_s = Pump suction pipe center line elevation

g = acceleration due to gravity (32.2 fps^2)

Pump suction and discharge velocity will be calculated from the flow rate and pipe diameters using the equation:

$$V = \frac{Q}{A}$$

where,

Q = measured flow (cfs)

A = pipe cross section area (ft^2)

Correlations will be explored between efficiency gains and pump size, pump specific speed, rpm, and pump horsepower to determine if pump coating and refurbishment is more effective on certain types of pump applications. An effort will be made to qualitatively assess the original roughness of each pump surface prior to sandblasting so that a correlation between initial roughness and efficiency gain can be explored. Roughness will be documented with photographs and measurements of tubercule/corrosion height will be made. The effect of efficiency improvement on the operating point of the pump will also be examined, with a look at how increasing corrosion and roughness may effect the operating point, as well as efficiency, over time.

Economic analysis - The cost/benefit of pump coating will be examined with reference to coating material costs vs. electric bill savings. Helpful graphs will be developed to assist decision makers in calculating energy savings based on pump run time, horsepower and efficiency improvements. A sample energy savings calculation will also be presented.

Theoretically, the number of kilowatt hours a pump uses on an annual basis can be estimated from the formula:

$$KWH_{year} = \frac{H_{total} \cdot D}{873 \varepsilon_m \varepsilon_p}$$

Where,

H = Average total head generated by the pump

D = Daily quantity pumped

ε_m = motor efficiency

ε_p = pump efficiency

And the percent change in annual KWH usage (assuming the motor efficiency and daily pumping quantity remain the same) is given by the formula:

$$\%\text{ change in KWH} = 1 - \frac{H_2 \varepsilon_1}{H_1 \varepsilon_2}$$

Where,

H_1 = Initial average total head on pump before refurbishment/coating

ε_1 = Initial pump efficiency

H_2 = Average total head on pump after refurbishment/coating

ε_2 = Pump efficiency after refurbishment/coating

Note that the electric bill savings on KWH is not only dependent on the change in pump efficiency, but on total head. It is not unusual for a pump to exhibit stronger pumping characteristics when refurbished or coated, leading to some increase in flow rate and head. If a pump's new operating point is further up on the system curve, it will tend to counteract the savings generated from the increased efficiency. The actual energy savings from a given project will depend on the combined effect of improved efficiency minus any head gain. It is also worth noting that even though an increase in pump flow rate will lead to less hours of pump run time, these two effects exactly cancel each other out. That is why flow rate is not a factor in the equation of KWH usage.

Also, if pump electric usage is a significant part of the billed kilowatt demand charge, an increase in pump head or flow will slightly raise that portion of the monthly bill.

All data, analysis and conclusions will be organized and presented in a final Phase 2 report.

7. Outline of Phase 2 Report

After the completion of Phase 2, MCWA shall prepare a draft Final Report written in accordance with NYSERDA's 'Report format and style guidelines' as presented in Exhibit C of the P.O.N. 935 documentation. The draft report will include all project results, focusing on energy, environmental and economic benefits. This report will be peer reviewed by a third party and submitted to NYSERDA for review within 90 days of the completion of phase 2 work. Changes recommended by the third party consultant and/or NYSERDA will be incorporated into a revised report. The Final Report shall be submitted to the NYSERDA Project Manager within 30 days of receiving his/her comments. MCWA shall send the NYSERDA Project Manager two unbound paper copies and one computer disk of the Final Report.

Report Outline:

- Title Page
- Notice
- Abstract
- Acknowledgements
- Table of Contents
- Summary
- Problem definition and background
  - History and development of project
  - Pump rehabilitation discussion
    - What work is done
    - Why it effects pump efficiency
  - Coating technology discussion
    - Types of coatings
    - Application and effect on efficiency

- Project approach and methodology
  - How pump efficiency tests were carried out
  - Steps in the rehabilitation and coating process for each pump
- Data collected and calculations
  - Summary of raw and calculated data from pump tests
  - Summary of pump efficiency gains
- Discussion of results
  - Comparison of pump efficiency gains pre/post rehabilitation and pre/post coating
  - Correlation of efficiency gains with other parameters such as pump size, type of coating, specific speed
  - Cost-Benefit energy analysis of pump rehabilitation and coating
  - Comparison of efficiency gains through coating vesus just sandblasting
  - The relative efficiency gains from coating the impeller vesus the casing
- Conclusions
  - Is pump rehabilitation and coating worth recommending to other entities in New York State as a way to reduce energy usage?
  - What are the pros and cons of the tested technologies?
  - What was learned in this study which can help other entities?
  - Proposed plan for market transfer of ideas.

Two hard copies of the draft final report will be submitted to the NYSERDA Project Manager for review and comment by NYSERDA staff. Recommended corrections to the draft report will be made, and a final report issued in accordance with the PON 935 guidelines.

Tables

Table 1 Monroe County Water Authority Venturi Data

Scottsville BPS

D/P Transmitter		Venturi
Manufacturer:	Foxboro	**Manufacturer:** Primary Flow Signal
Model:	823DP-D3515MO-M	**Model:** 12" HVT-PS
Serial/Reference No.:	94452251	**Size:** 12.00" x 5.00", β=.4167
Signal Calibrated Span (inches)	0 - 68.7	**Serial No.:** 2945
Q Span (mgd)	0 - 1.7	**Dwg No.:** PS-12x5-2945

Flow Rate (mgd)	Flow Rate (gpm)	Venturi Accuracy	Rd Number	DP Transmitter Accuracy	Combined Accuracy Venturi & DP Transmitter
0.4	278	0.60%	64635	1.5166	1.7855 plus to 1.5895 minus
0.8	556	0.50%	129270	0.3969	0.6384
1.2	833	0.50%	193673	0.1576	0.5243
1.4	972	0.50%	225990	0.1249	0.5154

Scribner BPS

D/P Transmitter		Venturi
Manufacturer:	Foxboro	**Manufacturer:** Primary Flow Signal
Model:	823DP-I3515MO-S	**Model:** 24" C HVT-PI, β=.6863, C = 0.9222
Serial/Reference No.:	89N361110-1A1	**Size:** 24.48" x 16.80"
Signal Calibrated Span (inches)	0 - 116.59	**Serial No.:** 714
Q Span (mgd)	0 - 23.0	**Dwg No.:** P-24-C-714

Flow Rate (mgd)	Flow Rate (gpm)	Venturi Accuracy	Rd Number	DP Transmitter Accuracy	Combined Accuracy Venturi & DP Transmitter
4	2778	0.50%	322942	1.187	1.2254
6	4167	0.50%	484413	0.5253	0.7252
8	5556	0.50%	645885	0.2605	0.5638
12	8333	0.50%	968711	0.1249	0.5154

Echo BPS II & III

D/P Transmitter		Venturi
Manufacturer:	Foxboro	**Manufacturer:** BIF
Model:	843DP-HOJISK-M	**BIF Order No.:**90685-G
Serial/Reference No.:	90F35191-2A1	**Size:** 30.73 x 17.671 Reverse Dall Tube, β=.5750, C = 0.8343
Signal Calibrated Span (inches)	0 - 241.38	**Serial No.:** 90685-1
Q Span (mgd)	0 - 35	**Tube Code.:** 0129-03

Flow Rate (mgd)	Flow Rate (gpm)	Venturi Accuracy	Rd Number	DP Transmitter Accuracy	Combined Accuracy Venturi & DP Transmitter
9	6250	4.80%	581250	0.4988	5.0248
12	8333	2.50%	775969	0.2605	5.0068
15	10417	2.35%	968781	0.1744	5.003
18	12500	2.60%	1162500	0.1249	5.0016

Harris BPS

D/P Transmitter		Venturi
Manufacturer:	Foxboro	**Manufacturer:** BIF
Model:	IDP10-D2OC21F-MILIH	**BIF Product No.:**122-09
Serial/Reference No.:	96201128	**Size:** 11.91 x 6.33 Dall Tube Insert
Signal Calibrated Span (inches)	0 - 347.74	**Serial No.:** ?
Q Span (mgd)	0 - 4.5	

Flow Rate (mgd)	Flow Rate (gpm)	Venturi Accuracy	Rd Number	DP Transmitter Accuracy	Combined Accuracy Venturi & DP Transmitter
1	694	3.85%	161355	0.4789	2.0565
2	1389	3.80%	322942	0.1034	2.0027
3	2083	2.10%	484297	0.0507	2.006
4	2778	2.05%	645885	0.03	2.0002

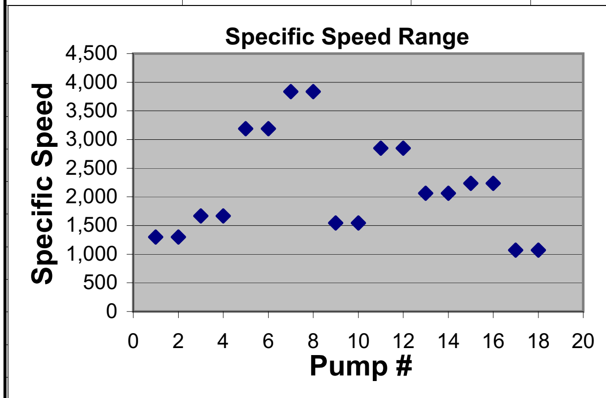
Table 1 (continued)					
Riga BPS					
D/P Transmitter		*Venturi*			
Manufacturer:	Foxboro	**Manufacturer:** Primary Flow Signal			
Model:	823DP-D3SINH2-M	**Model:** 12" HVT-PI, β=.450			
Serial/Reference No.:	91F30356-3AI	**Size:** 12.00" x 5.40"			
Signal Calibrated Span (inches)	0 - 214.64	**Serial No.:** 1627			
Q Span (mgd)	0 - 3.5	**Dwg No.:** P-12x5.4-1627			
				DP Transmitter	**Combined Accuracy**
Flow Rate (mgd)	*Flow Rate (gpm)*	*Venturi Accuracy*	*Rd Number*	*Accuracy*	*Venturi & DP Transmitter*
1	694	0.5%	161355	1.9804	2.0425
2	1389	0.5%	322942	0.4302	0.6596
3	2083	0.5%	484297	0.211	0.5427
4	2778	0.5%	645885	0.1249	0.5154
Shoremont WTP					
D/P Transmitter		*Venturi*			
Manufacturer:	Foxboro	**Manufacturer:** BIF			
Model:	IDP10-D22BOIF-MN1	**BIF Product No.:**122-09	VTS-4		
Serial/Reference No.:	2190188	**Size:** 60 x 32, β=.5333, C=0.984			
Signal Calibrated Span (inches)	0 -15.3	**Hw =** (150 mgd)² = 306.05"			
Q Span (mgd)	0 - 33.54	**Order No.:** 064020			
				DP Transmitter	**Combined Accuracy**
Flow Rate (mgd)	*Flow Rate (gpm)*	*Venturi Accuracy*	*Rd Number*	*Accuracy*	*Venturi & DP Transmitter*
10	6944	1%	322896	0.1561	1.0121
15	10417	1%	484390	0.0628	1.002
20	13889	1%	645838	0.0376	1.0007
25	17361	1%	807286	0.025	1.0003
Beahan Road					
Magnetic Flow Meter	Rosemount 20"	Model 8705 (flow tube)	Accuracy 0.5% over entire flow range		
		Model 8712 (transmitter)			
Buffalo Road					
Magnetic Flow Meter	Siemens 8"	7ME6510 (flow tube)	Accuracy 0.5% over entire flow range		
	Sitrans F M MagFlo	7ME6910 (transmitter)			
North Road					
Magnetic Flow Meter	Rosemount 16"	Model 8705 (flow tube)	Accuracy 0.5% over entire flow range		
		Model 8712 (transmitter)			

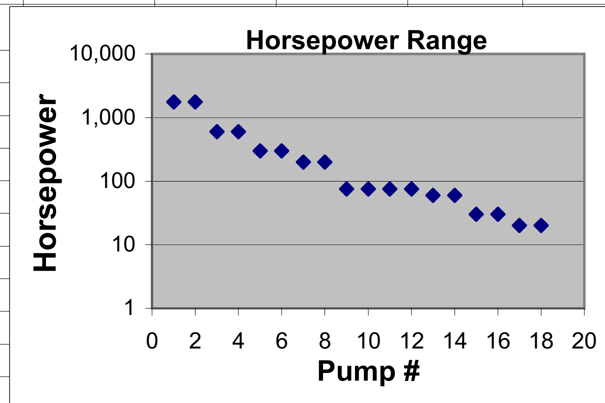
Table 2 - MCWA/NYSERDA Pump Coating Project Schedule

	1	2	3	4	5	6	7	8	9
Pump	***Buffalo No. 1***	***Riga No. 1***	***Echo No. 2***	***Shoremont No. 6***	***Scottsville No. 2***	***Harris No. 2***	***Buffalo No 2***	***Scottville No 1***	***North Road No. 2***
Horsepower	30 HP	60 HP	600	1750 HP	20 HP	75 HP	30 HP	20 HP	75 HP
Manuf.	Goulds	Peerless	ITT AC	AC	ITT AC	Goulds	Goulds	ITT AC	Crane
Schedule									
Removed From Service	Mar-06	Sep-06	Oct-06	Nov-06	Dec-06	Jan-07	Feb-07	Mar-07	Apr-07
Mechanical Work Completed	Jul-06	Oct-06	Dec-06	Jan-07	Jan-07	Feb-07	Mar-07	Apr-07	May-07
Coating Applied	Sep-06	Nov-06	Jan-07	Feb-07	Feb-07	Mar-07	Apr-07	May-07	Jun-07
Pump Put Back in Service	Oct-06	Dec-06	Mar-07	Apr-07	Mar-07	Apr-07	May-07	Jun-07	Jul-07
Filler & Top Coating									
Metal Filler	**Coating A**	**Coating B**	**Coating A**	**Coating B**	**Coating C**	**Coating C**	**Coating B**	**Coating A**	**Coating B**
Top Coating	**Coating A**	**Coating B**	**Coating A**	**Coating B**	**Coating C**	**Coating C**	**Coating B**	**Coating A**	**Coating B**

	10	11	12	13	14	15	16	17	18
Pump	***Riga No. 2***	***Beahan No. 2***	***Echo No. 3***	***Harris No. 1***	***Scribner 3***	***Shoremont No. 7***	***Scribner No. 2***	***Beahan No. 1***	***North Road No. 1***
Horsepower	60 HP	300 HP	600	75 HP	200 HP	1750 HP	200 HP	300 HP	75 HP
Manuf.	Peerless	Ingersoll-Dresser	ITT AC	Goulds	Goulds	AC	Goulds	Ingersoll-Dresser	Crane
Size	8x6x14	14x10	18x16	8x6x12	14x12x12	18x16	14x12x12	14x10	6 x 4x9
Schedule									
Removed From Service	May-07	Sep-07	Oct-07	Nov-07	Dec-07	Jan-08	Feb-08	Mar-08	Apr-08
Mechanical Work Completed	Jun-07	Nov-07	Dec-07	Dec-07	Jan-08	Mar-08	Mar-08	May-08	May-08
Coating Applied	Jul-07	Dec-07	Jan-08	Jan-08	Feb-08	Apr-08	Apr-08	Jun-08	Jun-08
Pump Put Back in Service	Aug-07	Feb-08	Mar-08	Feb-08	Mar-08	Jun-08	May-08	Aug-08	Jul-08
Filler & Top Coating									
Metal Filler	**Coating C**	**Coating C**	**Coating B**	**Coating A**	**Coating C**	**Coating C**	**Coating B**	**Coating A**	**Coating A**
Top Coating	**Coating C**	**Coating C**	**Coating B**	**Coating A**	**Coating C**	**Coating C**	**Coating B**	**Coating A**	**Coating A**

Table 3 - Range of Specific Speed and Horsepower





Pump Count	Pumps	Coating	HP	RPM	H (feet)	Q (gpm)	NS	Misc
1	Shoremont 6	B	1750	1180	460	12000	1301	
2	Shoremont 7	C	1750	1180	460	12000	1301	
3	Echo 2	A	600	1180	252	8000	1669	Bottom Suction
4	Echo 3	B	600	1180	252	8000	1669	Bottom Suction
5	Beahan 1	A	300	1765	150	6000	3190	
6	Beahan 2	C	300	1765	150	6000	3190	
7	Scribner 2	B	200	1780	105	5000	3837	
8	Scribner 3	C	200	1780	105	5000	3837	
9	North Road 1	A	75	3500	257	800	1542	
10	North Road 2	B	75	3500	257	800	1542	
11	Harris 1	A	75	1780	95	2375	2851	
12	Harris 2	C	75	1780	95	2375	2851	
13	Riga 1	B	60	1750	110	1600	2061	
14	Riga 2	C	60	1750	110	1600	2061	
15	Buffalo 1	A	30	1765	79	1125	2234	
16	Buffalo 2	B	30	1765	79	1125	2234	
17	Scottsville 1	A	20	1170	80	600	1071	
18	Scottsville 2	C	20	1170	80	600	1071	

(Experimental Design)

Appendix A

Primary Flow Signal, Inc.

Accuracy of the Flow Metering System

81 BLEACHERY COURT WARWICK RI USA 02886-1201 Ph(401)-463-9199 Fx(401)-463-3129

Customer:	Monroe County Water Authority	
Project	Venturi Meter Accuracy Analysis	
PFS Quote No:	596-2006	
Serial / Tag Number:	2190188	0
Meter Identification:	0	

Flow Transmitter:	Model No:
Foxboro	IDP10

System Range: **3 :1**

Single Flow Transmitter is Considered.

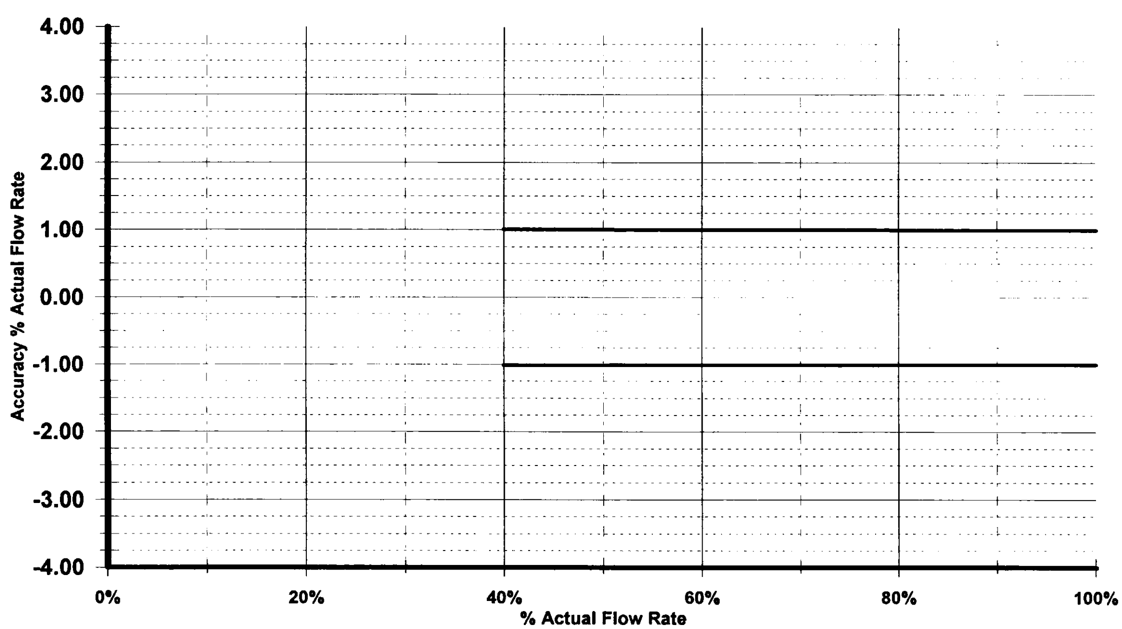
Line Size:	60.00	Max Flow:	25.00	MGD	Max. Diff:	85.95	in-wc
Beta Ratio:	0.5000	Min. Flow:	10.00	MGD	Min. Diff:	13.75	in-wc

System Accuracy Statement for Single Range.

GENERAL DATA FOR SYSTEM COMPONENTS

% Maximum Flow Rate	Actual Flow Rate	Differential	Pipe Reynolds No. (x1000)	Meter Normal Accuracy (+/-)	Installation Effect	Pipe Reynolds No. Bias Effect	Flow Transmitter Error (+/-)	System Accuracy (+)	System Accuracy (-)
100.00%	25.00	85.95	807	1.000	0.000	0.000	0.0250	1.0003	-1.0003
90.77%	22.69	70.81	733	1.000	0.000	0.000	0.0303	1.0005	-1.0005
81.54%	20.38	57.14	658	1.000	0.000	0.000	0.0376	1.0007	-1.0007
72.31%	18.08	44.94	584	1.000	0.000	0.000	0.0478	1.0011	-1.0011
63.08%	15.77	34.20	509	1.000	0.000	0.000	0.0628	1.0020	-1.0020
53.85%	13.46	24.92	435	1.000	0.000	0.000	0.0862	1.0037	-1.0037
40.00%	10.00	13.75	323	1.000	0.000	0.000	0.1561	1.0121	-1.0121

The system accuracy curve is based upon Two-Sigma (95% Confidence Level) and the secondary device performance characteristics as specified by the original equipment manufacturer.



Primary Flow Signal, Inc.

Accuracy of the Flow Metering System

117 PETTACONSETT AVENUE, CRANSTON, RI USA 02920 Ph(401)-461-6366 Fx(401)-461-4450

Customer:	Monroe County Water Authority
Project	Venturi Meter System Accuracy Check
PFS Quote No:	596-2006
Serial / Tag Number:	PFS 714
Meter Identification:	Scribner BPS

Flow Transmitter:	Model No:
FOXBORO	823

System Range: **3 :1**

Single Flow Transmitter is Considered.

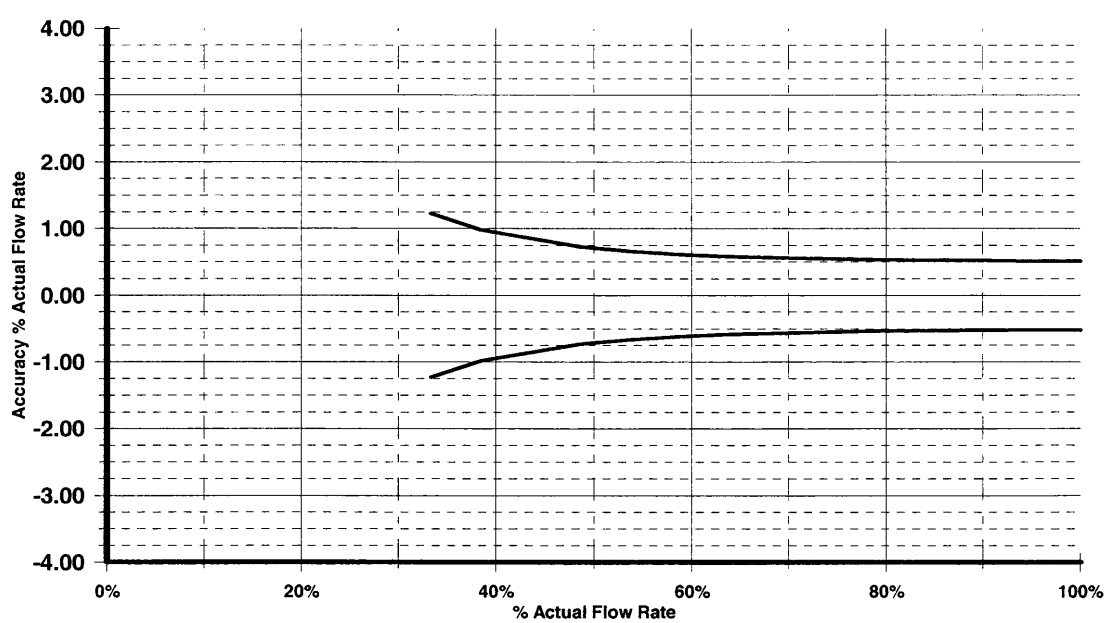
Line Size:	24.00	Max Flow:	12.00	MGD	Max. Diff:	24.83	in-wc
Beta Ratio:	0.6863	Min. Flow:	4.00	MGD	Min. Diff:	2.76	in-wc

System Accuracy Statement for Single Range.

GENERAL DATA FOR SYSTEM COMPONENTS

% Maximum Flow Rate	Actual Flow Rate	Differential	Pipe Reynolds No. (x1000)	Meter Normal Accuracy (+/-)	Installation Effect	Pipe Reynolds No. Bias Effect	Flow Transmitter Error (+/-)	System Accuracy (+)	System Accuracy (-)
100.00%	12.00	24.83	226	0.500		0.000	0.1249	0.5154	-0.5154
89.74%	10.77	20.00	203	0.500		0.000	0.1551	0.5235	-0.5235
79.49%	9.54	15.69	180	0.500		0.000	0.1976	0.5376	-0.5376
69.23%	8.31	11.90	156	0.500		0.000	0.2605	0.5638	-0.5638
58.97%	7.08	8.64	133	0.500		0.000	0.3588	0.6154	-0.6154
48.72%	5.85	5.89	110	0.500		0.000	0.5253	0.7252	-0.7252
33.33%	4.00	2.76	75	0.500		0.000	1.1187	1.2254	-1.2254

The system accuracy curve is based upon Two-Sigma (95% Confidence Level) and the secondary device performance characteristics as specified by the original equipment manufacturer.



Primary Flow Signal, Inc.

Accuracy of the Flow Metering System

117 PETTACONSETT AVENUE, CRANSTON, RI USA 02920 Ph(401)-461-6366 Fx(401)-461-4450

Customer:	Monroe County Water Authority		Flow Transmitter:	Model No:
Project	ECHO BPS11 & III		FOXBORO	823
PFS Quote No:	596-2006			
Serial / Tag Number:	90684		System Range:	2 :1
Meter Identification:	BIF REVERSE DALL TUBE			

Single Flow Transmitter is Considered.

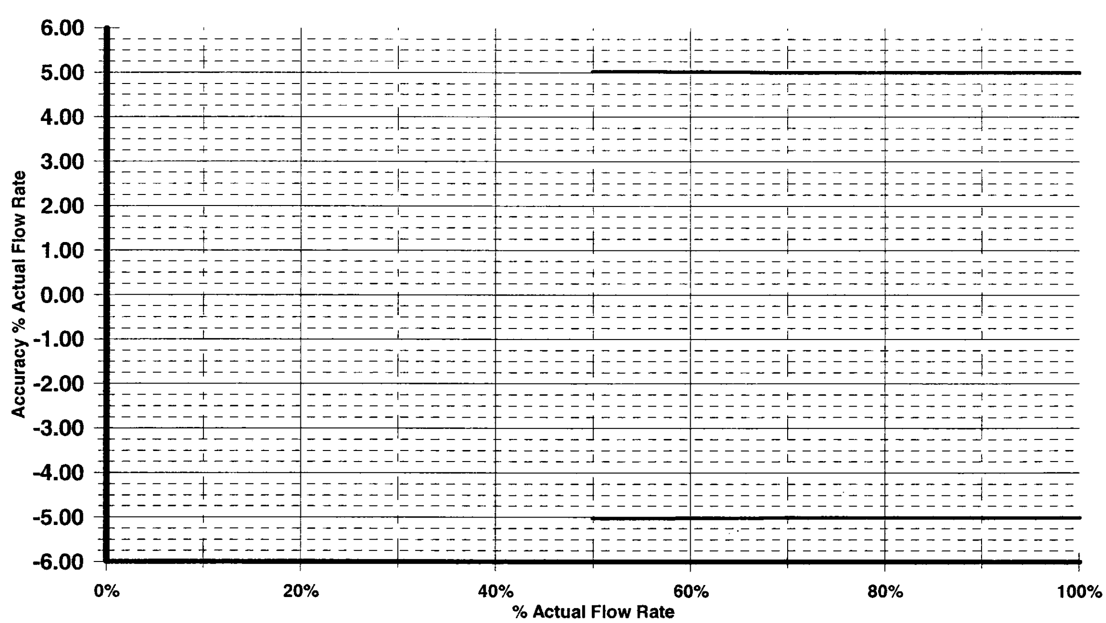
Line Size:	30.00	Max Flow:	18.00	MGD	Max. Diff:	63.84	in-wc
Beta Ratio:	0.5750	Min. Flow:	9.00	MGD	Min. Diff:	15.96	in-wc

System Accuracy Statement for Single Range.

GENERAL DATA FOR SYSTEM COMPONENTS

% Maximum Flow Rate	Actual Flow Rate	Differential	Pipe Reynolds No. (x1000)	Meter Normal Accuracy (+/-)	Installation Effect	Pipe Reynolds No. Bias Effect	Flow Transmitter Error (+/-)	System Accuracy (+)	System Accuracy (-)
100.00%	18.00	63.84	1,163	5.000		0.000	0.1249	5.0016	-5.0016
92.31%	16.62	54.40	1,074	5.000		0.000	0.1466	5.0021	-5.0021
84.62%	15.23	45.71	984	5.000		0.000	0.1744	5.0030	-5.0030
76.92%	13.85	37.78	895	5.000		0.000	0.2110	5.0045	-5.0045
69.23%	12.46	30.60	805	5.000		0.000	0.2605	5.0068	-5.0068
61.54%	11.08	24.18	716	5.000		0.000	0.3295	5.0108	-5.0108
50.00%	9.00	15.96	582	5.000		0.000	0.4988	5.0248	-5.0248

The system accuracy curve is based upon Two-Sigma (95% Confidence Level) and the secondary device performance characteristics as specified by the original equipment manufacturer.



Primary Flow Signal, Inc.

Accuracy of the Flow Metering System

117 PETTACONSETT AVENUE, CRANSTON, RI USA 02920 Ph(401)-461-6366 Fx(401)-461-4450

Customer:	**Monroe County Water Authority**
Project	**SHOREMONT WTP**
PFS Quote No:	**596-2006**
Serial / Tag Number:	
Meter Identification:	**DALL FLOW TUBE**

Flow Transmitter:	Model No:
FOXBORO	IDP10

System Range: ***3 :1***

Single Flow Transmitter is Considered.

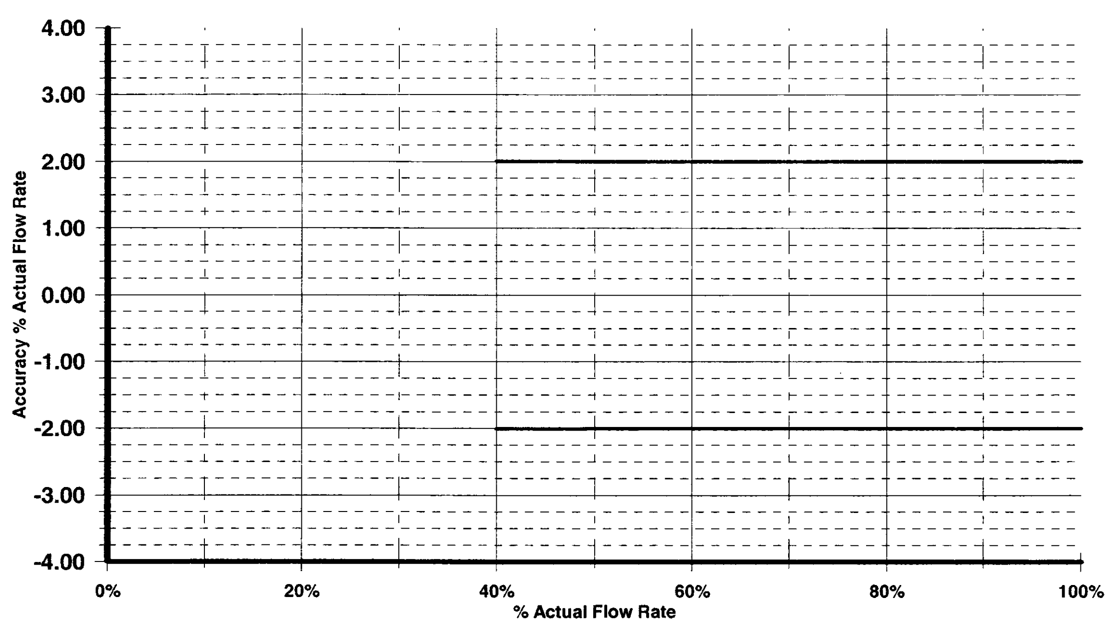
Line Size:	60.00	Max Flow:	25.00 MGD		Max. Diff:	85.95 in-wc	
Beta Ratio:	0.5333	Min. Flow:	10.00 MGD		Min. Diff:	13.75 in-wc	

System Accuracy Statement for Single Range.

GENERAL DATA FOR SYSTEM COMPONENTS

% Maximum Flow Rate	Actual Flow Rate	Differential	Pipe Reynolds No. (x1000)	Meter Normal Accuracy (+/-)	Installation Effect	Pipe Reynolds No. Bias Effect	Flow Transmitter Error (+/-)	System Accuracy (+)	System Accuracy (-)
100.00%	25.00	85.95	807	2.000		0.000	0.0300	2.0002	-2.0002
90.77%	22.69	70.81	733	2.000		0.000	0.0364	2.0003	-2.0003
81.54%	20.38	57.14	658	2.000		0.000	0.0451	2.0005	-2.0005
72.31%	18.08	44.94	584	2.000		0.000	0.0574	2.0008	-2.0008
63.08%	15.77	34.20	509	2.000		0.000	0.0754	2.0014	-2.0014
53.85%	13.46	24.92	435	2.000		0.000	0.1034	2.0027	-2.0027
40.00%	10.00	13.75	323	2.000		0.000	0.1873	2.0088	-2.0088

The system accuracy curve is based upon Two-Sigma (95% Confidence Level) and the secondary device performance characteristics as specified by the original equipment manufacturer.



Primary Flow Signal, Inc.

Accuracy of the Flow Metering System

117 PETTACONSETT AVENUE, CRANSTON, RI USA 02920 Ph(401)-461-6366 Fx(401)-461-4450

Customer:	**Monroe County Water Authority**
Project	**HARRIS BPS**
PFS Quote No:	**596-2006**
Serial / Tag Number:	
Meter Identification:	**DALL FLOW TUBE**

Flow Transmitter:	Model No:
FOXBORO	IDP10

System Range: ***4 :1***

Single Flow Transmitter is Considered.

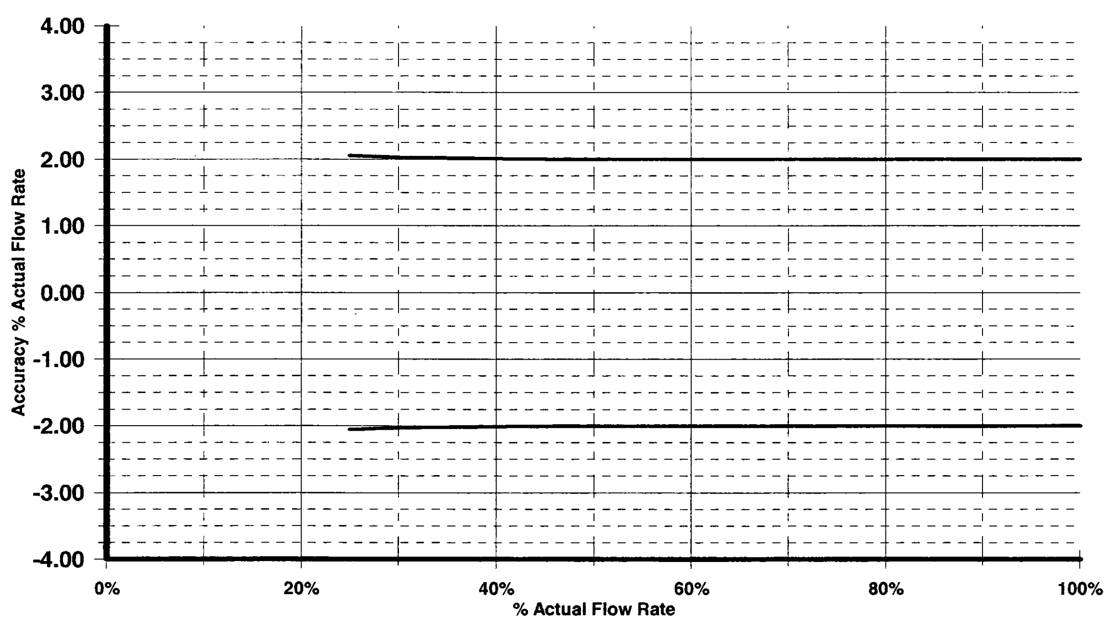
Line Size:	12.00	Max Flow:	4.00 MGD	Max. Diff:	275.41 in-wc		
Beta Ratio:	0.5315	Min. Flow:	1.00 MGD	Min. Diff:	17.21 in-wc		

System Accuracy Statement for Single Range.

GENERAL DATA FOR SYSTEM COMPONENTS

% Maximum Flow Rate	Actual Flow Rate	Differential	Pipe Reynolds No. (x1000)	Meter Normal Accuracy (+/-)	Installation Effect	Pipe Reynolds No. Bias Effect	Flow Transmitter Error (+/-)	System Accuracy (+)	System Accuracy (-)
100.00%	4.00	275.41	646	2.000		0.000	0.0300	2.0002	-2.0002
88.46%	3.54	215.52	571	2.000		0.000	0.0383	2.0004	-2.0004
76.92%	3.08	162.96	497	2.000		0.000	0.0507	2.0006	-2.0006
65.38%	2.62	117.74	422	2.000		0.000	0.0701	2.0012	-2.0012
53.85%	2.15	79.85	348	2.000		0.000	0.1034	2.0027	-2.0027
42.31%	1.69	49.30	273	2.000		0.000	0.1675	2.0070	-2.0070
25.00%	1.00	17.21	162	2.000		0.000	0.4789	2.0565	-2.0565

The system accuracy curve is based upon Two-Sigma (95% Confidence Level) and the secondary device performance characteristics as specified by the original equipment manufacturer.



Primary Flow Signal, Inc.

Accuracy of the Flow Metering System

117 PETTACONSETT AVENUE, CRANSTON, RI USA 02920 Ph(401)-461-6366 Fx(401)-461-4450

Customer:	Monroe County Water Authority
Project	RIGA BPS
PFS Quote No:	596-2006
Serial / Tag Number:	PFS 1627
Meter Identification:	HVT-PI

Flow Transmitter:	Model No:
FOXBORO	823

System Range: 4 :1

Single Flow Transmitter is Considered.

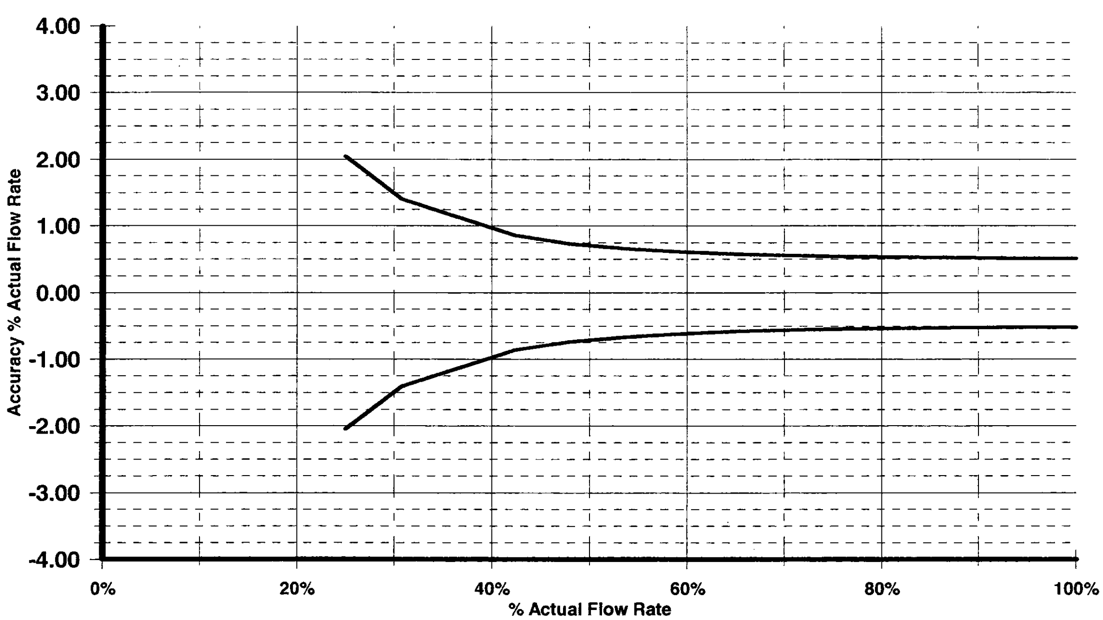
Line Size:	12.00	Max Flow:	4.00	MGD	Max. Diff:	275.41	in-wc
Beta Ratio:	0.4500	Min. Flow:	1.00	MGD	Min. Diff:	17.21	in-wc

System Accuracy Statement for Single Range.

GENERAL DATA FOR SYSTEM COMPONENTS

% Maximum Flow Rate	Actual Flow Rate	Differential	Pipe Reynolds No. (x1000)	Meter Normal Accuracy (+/-)	Installation Effect	Pipe Reynolds No. Bias Effect	Flow Transmitter Error (+/-)	System Accuracy (+)	System Accuracy (-)
100.00%	4.00	275.41	646	0.500		0.000	0.1249	0.5154	-0.5154
88.46%	3.54	215.52	571	0.500		0.000	0.1596	0.5249	-0.5249
76.92%	3.08	162.96	497	0.500		0.000	0.2110	0.5427	-0.5427
65.38%	2.62	117.74	422	0.500		0.000	0.2920	0.5790	-0.5790
53.85%	2.15	79.85	348	0.500		0.000	0.4302	0.6596	-0.6596
42.31%	1.69	49.30	273	0.500		0.000	0.6959	0.8569	-0.8569
25.00%	1.00	17.21	162	0.500		0.000	1.9804	2.0425	-2.0425

The system accuracy curve is based upon Two-Sigma (95% Confidence Level) and the secondary device performance characteristics as specified by the original equipment manufacturer.



Primary Flow Signal, Inc.

Accuracy of the Flow Metering System

117 PETTACONSETT AVENUE, CRANSTON, RI USA 02920 Ph(401)-461-6366 Fx(401)-461-4450

Customer:	Monroe County Water Authority	Flow Transmitter:	Model No:
Project	Venturi Meter System Accuracy Check	FOXBORO	823
PFS Quote No:	596-2006		
Serial / Tag Number:	PFS 2945	System Range:	3 :1
Meter Identification:	Scottsville BPS		

Single Flow Transmitter is Considered.

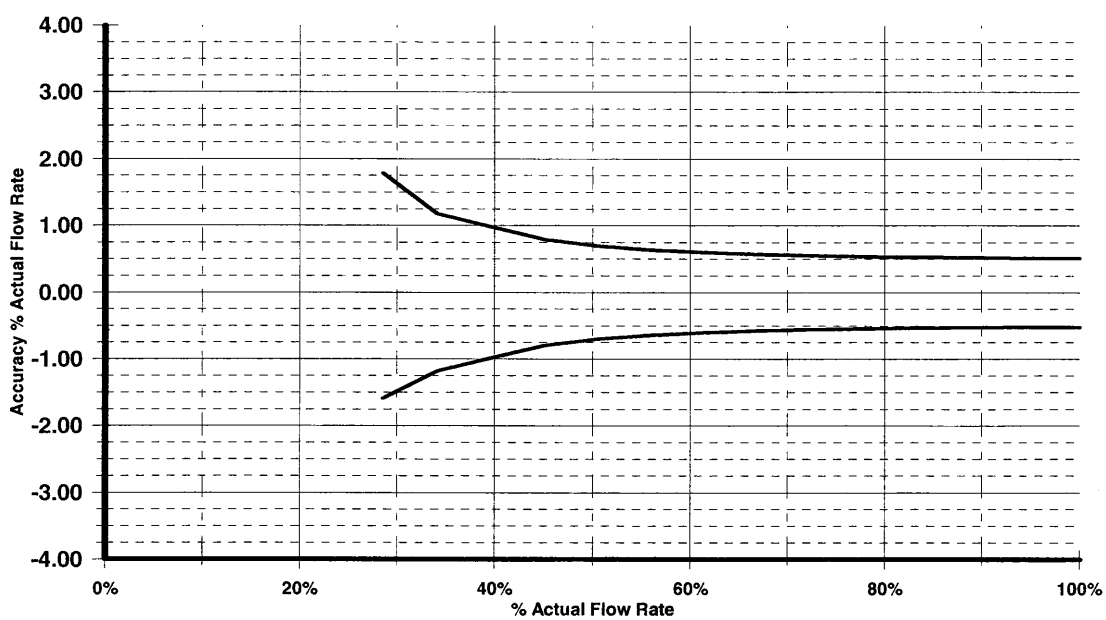
Line Size:	12.00	Max Flow:	972.00 GPM		Max. Diff:	46.54	in-wc
Beta Ratio:	0.4209	Min. Flow:	278.00 GPM		Min. Diff:	3.81	in-wc

System Accuracy Statement for Single Range.

GENERAL DATA FOR SYSTEM COMPONENTS

% Maximum Flow Rate	Actual Flow Rate	Differential	Pipe Reynolds No. (x1000)	Meter Normal Accuracy (+/-)	Installation Effect	Pipe Reynolds No. Bias Effect	Flow Transmitter Error (+/-)	System Accuracy (+)	System Accuracy (-)
100.00%	972.00	46.54	226	0.500		0.000	0.1249	0.5154	-0.5154
89.02%	865.23	36.88	201	0.500		0.000	0.1576	0.5243	-0.5243
78.03%	758.46	28.34	176	0.500		0.000	0.2051	0.5404	-0.5404
67.05%	651.69	20.92	152	0.500		0.000	0.2777	0.5719	-0.5719
56.06%	544.92	14.63	127	0.500		0.000	0.3969	0.6384	-0.6384
45.08%	438.15	9.46	102	0.500		0.000	0.6133	0.7913	-0.7913
28.60%	278.00	3.81	65	0.740		0.098	1.5166	1.7855	-1.5895

The system accuracy curve is based upon Two-Sigma (95% Confidence Level) and the secondary device performance characteristics as specified by the original equipment manufacturer.



Appendix B

Sample Calculation for determining the error in measuring change in pump efficiency

Step 1: **Error in Measuring Head, where H = Discharge Pressure - Suction Pressure**

$$Z = X - Y$$

$$\Delta Z = \sqrt{\Delta X^2 + \Delta Y^2}$$

Pressure Accuracy:	0.25% according to manufacturer			
if suction pressure is	40 psi			
error is	0.10 psi			
if discharge pressure is	100 psi			
error is	0.25 psi			
The combined error is:		0.27 psi		
converted to feet		0.62 feet		
Out of a total head of		138.6 feet	0.45% accuracy	

Step 2: **<u>Error in measuring hydraulic horsepower: (Q x H)/3960</u>**

$$Z = X * Y$$

$$\frac{\Delta Z}{Z} = \sqrt{\left(\frac{\Delta X}{X}\right)^2 + \left(\frac{\Delta Y}{Y}\right)^2}$$

Flow measurement error:	1% (will differ depending on type)	
if flow measurement is	200 gpm	
error is	2.0 gpm	
Head error (from above) is	0.62 feet	
Combined error =	1.10%	
Product calculated is	27,720 gpm.ft	
Error =	303.83 gpm.ft	
Total error of Hydraulic Horsepower is:		0.077 HP
Calculated Hydraulic Horsepower		7.00 HP

agrees

Check, using this formula

$$\Delta Z^2 = \left(\frac{\partial f(X, Y)}{\partial X}\Delta X\right)^2 + \left(\frac{\partial f(X, Y)}{\partial Y}\Delta Y\right)^2$$

Where delta Z = error in measuring Hydraulic horsepower, and x = Q, y= H

dZ^2 =	0.005887
delta Z=	0.077 HP

Step 3: **Error in Measuring KW**

Power monitor accuracy:	1%
Kw Measured	6 KW
Error	0.06 KW
Error in Measuring Electric HP	0.08 HP
Calculated Electric HP	8.0 HP

Step 4: **Error in Measuring pump Efficiency, where Eff = Hydraulic HP/Electric HP**

$$Z = \frac{X}{Y}$$

$$\frac{\Delta Z}{Z} = \sqrt{\left(\frac{\Delta X}{X}\right)^2 + \left(\frac{\Delta Y}{Y}\right)^2}$$

Combined error =	1.48%
Calculated efficiency =	87%
Efficiency error =	1.29% Efficiency points

Step 5: **Error in measuring <u>change in efficiency</u>**

$$Z = X - Y$$

$$\Delta Z = \sqrt{\Delta X^2 + \Delta Y^2}$$

Original efficiency	87%	
Efficiency error	1.29% Efficiency points	
New efficiency (for example)	95%	
Efficiency error	1.41% Efficiency points	
Error in measuring change in efficiency		1.91% Efficiency points

APPENDIX C

INDIVIDUAL PUMP PERFORMANCE DATA

Beahan Pump No 1

Energy Efficiency Cost Calculator

Note: 730 Hours & 146 Hours (20%) based on Post Mechancal and NOT Pre Mechanical Operation

Continuous Service

148.1	
5882	

Pre Mechanical

Head (ft)	148.1
Flow (gpm)	5896
Efficiency	83.4%
Hours Operation/month	706
BHP	264
kW (Assumes Motor Eff 95%)	207.6
kW Demand Charge	$2,076
kwh cost	$12,457
Total Monthly kWH	146,549
Monthly Cost	**$14,532.85**

Constants

Hours/ Month	730
kW Demand Cost	$10.00
kwh Cost	$0.085
Motor Efficiency	95.0%

Post Mechanical

Head (ft)	145.5
Flow (gpm)	5701
Efficiency	86.3%
Hours Operation/month	730
BHP	243
kW (Assumes Motor Eff 95%)	190.6
kW Demand Charge	$1,906
kwh cost	$11,827
Total Monthly kWH	139138
Monthly Cost	**$13,732.74**

Pre - Post Mechanical Comparison

Monthly Savings	**$800**
Annual Savings	**$9,601**
5 Year Savings	**$48,007**
kW Demand Reduction	**17.0**
Monthly kwh Savings	**7411**
Yearly kwh Savings	**88931**

Post Casing Coating

Head (ft)	150
Flow (gpm)	6007
Efficiency	93.1%
Hours Operation/month	693
BHP	244
kW (Assumes Motor Eff 95%)	191.9
kW Demand Charge	$1,919
kwh cost	$11,302
Total Monthly kWH	132964
Monthly Cost	**$13,221.17**

Pre - Post Internal Coating Comparison

Monthly Savings	**$512**
Annual Savings	**$6,139**
5 Year Savings	**$30,694**
kW Demand Reduction	**-1.32**
Monthly kwh Savings	**6174**
Yearly kwh Savings	**74084**

Pre Mechanical to Post Interior
Coating Comparison

Monthly Savings	**$1,312**
Annual Savings	**$15,740**
5 Year Savings	**$78,701**
kW Demand Reduction	**15.70**
Monthly kwh Savings	**13585**
Yearly kwh Savings	**163015**

Beahan Pump No 1 Cont'

20% Service Time

Pre Mechanical	
Head (ft)	148.1
Flow (gpm)	5896
Efficiency	83.4%
Hours Operation/month	141
BHP	264
kW (Assumes Motor Eff 95%)	207.6
kW Demand Charge	$2,076
kwh cost	$2,491
Total Monthly kWH	29,310
Monthly Cost	**$4,567.52**

Constants	
Hours/ Month	730
kW Demand Cost	$10.00
kwh Cost	$0.085
Motor Efficiency	95.0%

Post Mechanical	
Head (ft)	145.5
Flow (gpm)	5701
Efficiency	86.3%
Hours Operation/month	146
BHP	243
kW (Assumes Motor Eff 95%)	190.6
kW Demand Charge	$1,906
kwh cost	$2,365
Total Monthly kWH	27828
Monthly Cost	**$4,271.35**

Pre - Post Mechanical Comparison	
Monthly Savings	**$296**
Annual Savings	**$3,554**
5 Year Savings	**$17,770**
kW Demand Reduction	**17.0**
Monthly kwh Savings	**1482**
Yearly kwh Savings	**17786**

Post Casing Coating	
Head (ft)	150
Flow (gpm)	6007
Efficiency	93.1%
Hours Operation/month	139
BHP	244
kW (Assumes Motor Eff 95%)	191.9
kW Demand Charge	$1,919
kwh cost	$2,260
Total Monthly kWH	26593
Monthly Cost	**$4,179.59**

Pre - Post Internal Coating Comparison	
Monthly Savings	**$92**
Annual Savings	**$1,101**
5 Year Savings	**$5,506**
kW Demand Reduction	**-1.32**
Monthly kwh Savings	**1235**
Yearly kwh Savings	**14817**

Total Energy Savings Pre Mechanical to Post Interior Coating Comparison	
Monthly Savings	**$388**
Annual Savings	**$4,655**
5 Year Savings	**$23,276**
kW Demand Reduction	**15.70**
Monthly kwh Savings	**2717**
Yearly kwh Savings	**32603**

Total Savings (Mechanical & Coating)

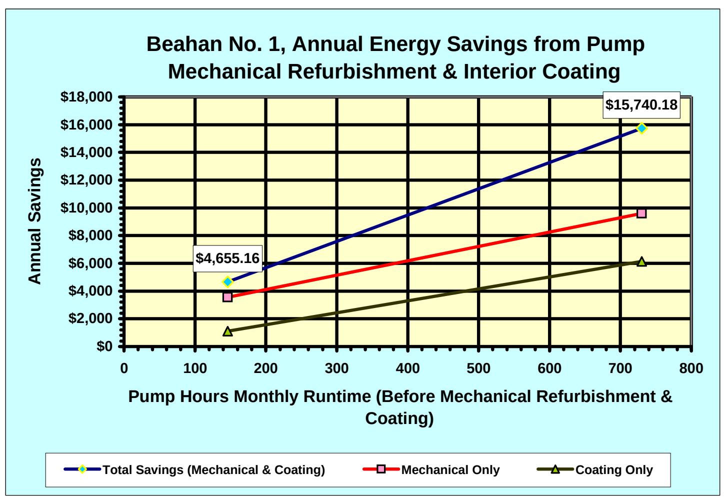
Pump Hours of Operation Before Refurbishment & Interior Coating	Annual Savings Through Refurbishment & Interior Coatings
730	$15,740.18
146	$4,655.16

Mechanical Savings Only

Pump Hours of Operation Before Refurbishment & Interior Coating	
730	$9,601.35
146	$3,554.05

Coating Savings Only

Pump Hours of Operation Before Refurbishment & Interior Coating	
730	$6,138.83
146	$1,101.10



Beahan Pump No 2
Energy Efficiency Cost Calculator

Note: 730 Hours & 146 Hours (20%) based on Post Mechancal and NOT Pre Mechanical Operation

Continuous Service

Pre Mechanical		**Constants**		
Head (ft)	149	Hours/ Month	730	148.1
Flow (gpm)	5938	kW Demand Cost	$10.00	5882
Efficiency	83.6%	kwh Cost	$0.085	
Hours Operation/month	730	Motor Efficiency	95.0%	
BHP	267			
kW (Assumes Motor Eff 95%)	209.9			
kW Demand Charge	$2,099			
kwh cost	$13,022			
Total Monthly kWH	153,202			
Monthly Cost	**$15,120.78**			

Post Coating		***Pre - Post Coating Comparison***	
Head (ft)	153.5	**Monthly Savings**	**$683**
Flow (gpm)	6222	**Annual Savings**	**$8,200**
Efficiency	90.8%	**5 Year Savings**	**$41,001**
Hours Operation/month	697	**kW Demand Reduction**	**1.3**
BHP	266	**Monthly kwh Savings**	**7888**
kW (Assumes Motor Eff 95%)	208.6	**Yearly kwh Savings**	**94658**
kW Demand Charge	$2,086		
kwh cost	$12,352		
Total Monthly kWH	145313		
Monthly Cost	**$14,437.44**		

Post Mechanical		***Pre - Post Mechanical Comparison***		**Pre Mechanical to Post Interior *Coating Comparison***	
Head (ft)	151.2	**Monthly Savings**	**$689**	**Monthly Savings**	**$1,372**
Flow (gpm)	6076	**Annual Savings**	**$8,262**	**Annual Savings**	**$16,462**
Efficiency	93.6%	**5 Year Savings**	**$41,311**	**5 Year Savings**	**$82,311**
Hours Operation/month	713	**kW Demand Reduction**	**13.95**	**kW Demand Reduction**	**15.23**
BHP	248	**Monthly kwh Savings**	**6459**	**Monthly kwh Savings**	**14347**
kW (Assumes Motor Eff 95%)	194.6	**Yearly kwh Savings**	**77510**	**Yearly kwh Savings**	**172168**
kW Demand Charge	$1,946				
kwh cost	$11,803				
Total Monthly kWH	138854				
Monthly Cost	**$13,748.93**				

Beahan Pump No 2 Cont'

20% Service Time

Pre Mechanical

Head (ft)	149
Flow (gpm)	5938
Efficiency	83.6%
Hours Operation/month	153
BHP	267
kW (Assumes Motor Eff 95%)	209.9
kW Demand Charge	$2,099
kwh cost	$2,729
Total Monthly kWH	32,106
Monthly Cost	**$4,827.64**

Constants

Hours/ Month	730
kW Demand Cost	$10.00
kwh Cost	$0.085
Motor Efficiency	95.0%

Post Coating

Head (ft)	153.5
Flow (gpm)	6222
Efficiency	90.8%
Hours Operation/month	146
BHP	266
kW (Assumes Motor Eff 95%)	208.6
kW Demand Charge	$2,086
kwh cost	$2,588
Total Monthly kWH	30453
Monthly Cost	**$4,674.28**

Pre - Post Coating Comparison

Monthly Savings	$153
Annual Savings	$1,840
5 Year Savings	$9,202
kW Demand Reduction	1.3
Monthly kwh Savings	1653
Yearly kwh Savings	19837

Post Mechanical

Head (ft)	151.2
Flow (gpm)	6076
Efficiency	93.6%
Hours Operation/month	150
BHP	248
kW (Assumes Motor Eff 95%)	194.6
kW Demand Charge	$1,946
kwh cost	$2,473
Total Monthly kWH	29099
Monthly Cost	**$4,419.74**

Pre - Post Mechanical Comparison

Monthly Savings	$255
Annual Savings	$3,054
5 Year Savings	$15,272
kW Demand Reduction	13.95
Monthly kwh Savings	1354
Yearly kwh Savings	16243

Total Energy Savings
Pre Mechanical to Post Interior Coating Comparison

Monthly Savings	$408
Annual Savings	$4,895
5 Year Savings	$24,474
kW Demand Reduction	15.23
Monthly kwh Savings	3007
Yearly kwh Savings	36080

Total Savings (Mechanical & Coating)

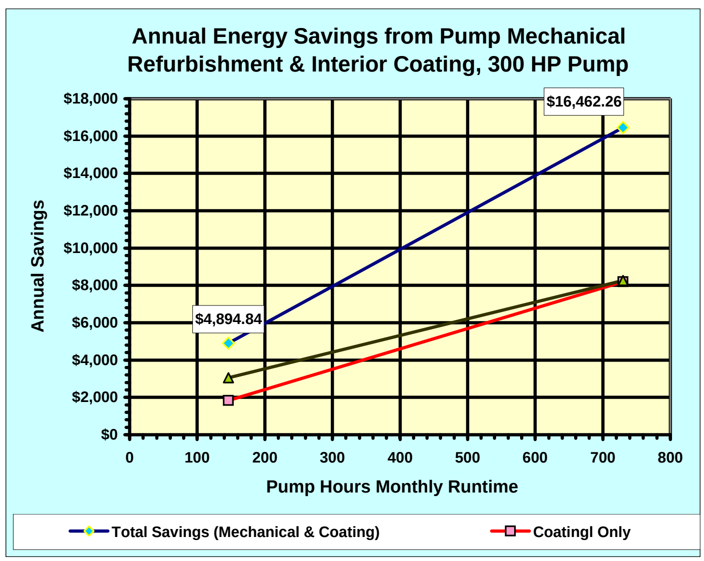
Pump Hours of Operation Before Refurbishment & Interior Coating	Annual Savings Through Refurbishment & Interior Coatings
730	$16,462.26
146	$4,894.84

Coating Savings Only

Pump Hours of Operation Before Refurbishment & Interior Coating	
730	$8,200.12
146	$1,840.36

Mechanical Savings Only

Pump Hours of Operation Before Refurbishment & Interior Coating	
730	$8,262.15
146	$3,054.48



Beahan Road BPS

Manufacturer's Pump and Motor Information

Man: Ingersoll-Dresser Pumps	Imp: 14.2	Man: Marathon	
Model: 10LR-18A	H: 150	Speed: 1785	Nom Eff: 96.5%
Speed: 1765 RPM	Q: 6000 gpm	HP: 300	Serial: MV 341480-1/4-01 & 02
Size: 14x10	Serial: A265626 4594-B	Amps: 339	

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	Ns
0	0	220				
2000	2.88	200	58%	174	137	1484
4000	5.76	175	82%	216	169	2320
6000	8.64	150	88%	258	203	3190
7000	10.08	130	85%	270	212	3836
8000	11.52	105	78%	272	214	4813

NYSERDA System Curve

Q (MGD)		H (Feet)	
50.0%	4.3	80%	120
75.0%	6.5	88%	132
BEP	8.7	100%	150
125.0%	10.8	120%	180

Pump No. 1 Field Curve 8/17/06 (95% Speed) Motor Efficiency Reduced 5% to account for VFD losses (Initial Test)

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
6360	9.16	38.79	13.26	88.28	25.98	114.3	2.73	10.48	122	81.4%	240.8	196.3	1697
5960	8.58	41.52	12.42	95.29	24.35	124.2	2.40	9.20	131	82.9%	237.9	194.0	1698
5470	7.88	32.78	11.40	91.43	22.35	135.5	2.02	7.75	141	83.5%	233.5	190.4	1698
4960	7.14	24.85	10.34	87.7	20.26	145.2	1.66	6.37	150	82.6%	227.3	185.3	1697
4560	6.57	18.4	9.50	84.43	18.63	152.5	1.40	5.39	157	82.3%	218.9	178.5	1697

(Corrected to 1765 RPM)

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM
6615	9.53	132.1	81.4%	270.9	209	1765
6195	8.92	141.6	82.9%	267.2	207	1765
5686	8.19	152.6	83.5%	262.3	203	1765
5162	7.43	162.3	82.6%	256.1	198	1766
4748	6.84	169.7	82.3%	247.2	191	1767

Pump No. 1 Field Curve 3/20/07 (95% Speed) Motor Efficiency Reduced 5% to account for VFD losses (Post Mechanical)													
Q (gpm)	**Q (mgd)**	**S**	**SV ft/sec**	**D**	**DV ft/sec**	**Pump H**	**Suc V H**	**Dis V H**	**Total H**	**Eff**	**BHP**	**KW**	**RPM**
6250	9.00	32.67	13.03	79.96	25.53	109.2	2.63	10.12	117	84.4%	218.2	177.9	1696
5806	8.36	35.32	12.10	87.36	23.72	120.2	2.27	8.73	127	85.8%	216.5	176.5	1696
5229	7.53	23.15	10.90	81.54	21.36	134.9	1.84	7.09	140	86.6%	213.6	174.2	1696
4924	7.09	17.02	10.26	78.36	20.11	141.7	1.64	6.28	146	86.7%	209.8	171.1	1696
4354	6.27	8.13	9.07	73.65	17.79	151.4	1.28	4.91	155	84.8%	201.0	163.9	1696
(Corrected to 1765 RPM)													
Q (gpm)	**Q (mgd)**	**H**	**Eff**	**BHP**	**KW**	**RPM**							
6504	9.37	126.4	84.4%	245.9	190	1765							
6042	8.70	137.2	85.8%	244.1	189	1765							
5442	7.84	151.8	86.6%	240.8	186	1765							
5124	7.38	158.5	86.7%	236.5	183	1765							
4531	6.53	167.9	84.8%	226.6	175	1765							
Pump No. 1 Field Curve 4/23/07 (95% Speed) Motor Efficiency Reduced 5% to account for VFD losses Coating)													
(Post Mechanical & Post Casing Coating)													
Q (gpm)	**Q (mgd)**	**S**	**SV ft/sec**	**D**	**DV ft/sec**	**Pump H**	**Suc V H**	**Dis V H**	**Total H**	**Eff**	**BHP**	**KW**	**RPM**
6188	8.91	33.58	12.90	85.3	25.28	119.5	2.58	9.92	127	91.1%	217.4	177.26	1696
5951	8.57	34.63	12.40	88.7	24.31	124.9	2.39	9.18	132	91.3%	216.7	176.65	1696
5757	8.29	36.36	12.00	92.27	23.52	129.2	2.24	8.59	136	91.2%	216.0	176.09	1696
5347	7.70	28.33	11.14	88.79	21.84	139.7	1.93	7.41	145	91.9%	213.3	173.94	1696
4632	6.67	14.06	9.65	81.33	18.92	155.4	1.45	5.56	160	91.1%	204.9	167.02	1696
(Corrected to 1765 RPM)													
Q (gpm)	**Q (mgd)**	**H**	**Eff**	**BHP**	**KW**	**RPM**							
6439	9.27	137.3	91.1%	245.0	189	1765							
6194	8.92	142.6	91.3%	244.2	189	1765							
5991	8.63	146.8	91.2%	243.4	188	1765							
5565	8.01	157.2	91.9%	240.5	186	1765							
4823	6.95	172.9	91.1%	231.3	179	1766							

Pump No. 1 Field Curve 5/31/07 (95% Speed) Motor Efficiency Reduced 5% to account for VFD losses Coating)

(Post Mechanical & Post Casing Coating 30 Day Test)

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
6417	9.24	33.39	13.37	83.41	26.21	115.5	2.78	10.67	123	91.7%	218.1	177.84	1696
6049	8.71	37.55	12.61	91.55	24.71	124.7	2.47	9.48	132	92.5%	217.5	177.31	1696
5681	8.18	29.45	11.84	87.78	23.21	134.7	2.18	8.36	141	93.4%	216.5	176.49	1696
5403	7.78	23.44	11.26	84.78	22.07	141.7	1.97	7.56	147	93.8%	214.3	174.70	1696
4993	7.19	15.32	10.41	80.47	20.40	150.5	1.68	6.46	155	93.5%	209.5	170.78	1696

(Corrected to 1765 RPM)

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM
6678	9.62	133.7	91.7%	245.8	190	1765
6295	9.06	142.7	92.5%	245.1	189	1765
5912	8.51	152.6	93.4%	244.0	189	1765
5623	8.10	159.5	93.8%	241.5	187	1765
5199	7.49	168.4	93.5%	236.5	183	1766

Pump No. 1 Field Curve 7/24/07 (95% Speed) Motor Efficiency Reduced 5% to account for VFD losses Coating)

(Post Mechanical & Post Casing Coating 90 Day Test)

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
6535	9.41	34.99	13.62	83.66	26.69	112.4	2.88	11.07	121	91.7%	217.0	176.89	1696
6104	8.79	38.12	12.72	91.56	24.94	123.4	2.51	9.66	131	93.0%	216.6	176.56	1696
5688	8.19	28.48	11.85	86.93	23.23	135.0	2.18	8.38	141	94.2%	215.4	175.62	1696
5299	7.63	20.27	11.04	82.89	21.65	144.7	1.89	7.28	150	94.6%	212.1	172.93	1696
5111	7.36	17.17	10.65	81.14	20.88	147.8	1.76	6.77	153	94.0%	209.7	170.96	1696

(Corrected to 1765 RPM)

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM
6801	9.79	130.6	91.7%	244.5	189	1765
6353	9.15	141.4	93.0%	244.1	189	1765
5919	8.52	152.9	94.2%	242.8	188	1765
5514	7.94	162.5	94.6%	239.1	185	1765
5322	7.66	165.6	94.0%	236.7	183	1766

Pump No. 1 Field Curve 12/4/07 (95% Speed) Motor Efficiency Reduced 5% to account for VFD losses Coating)

(Post Mechanical & Post Casing Coating 6 Month Test)

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
6326	9.11	30.86	13.19	80.97	25.84	115.8	2.70	10.37	123	91.3%	216.0	176.07	1698
5896	8.49	34.45	12.29	89.01	24.08	126.0	2.34	9.01	133	91.9%	215.0	175.26	1698
5618	8.09	27.43	11.71	85.5	22.95	134.1	2.13	8.18	140	93.0%	213.8	174.34	1698
5306	7.64	20.53	11.06	82.04	21.67	142.1	1.90	7.29	147	93.4%	211.5	172.42	1698
4951	7.13	13.87	10.32	78.53	20.23	149.4	1.65	6.35	154	91.4%	210.8	171.90	1698

(Corrected to 1765 RPM)

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM
6576	9.47	133.4	91.3%	242.5	187	1765
6128	8.83	143.4	91.9%	241.4	187	1765
5840	8.41	151.5	93.0%	240.2	186	1765
5515	7.94	159.4	93.4%	237.5	184	1765
5150	7.42	166.7	91.4%	237.2	183	1766

Pump No. 1 Field Curve 4/11/08 (95% Speed) Motor Efficiency Reduced 5% to account for VFD losses Coating)

(Post Mechanical & Post Casing Coating 1 Year Test)

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
6313	9.09	28.37	13.16	78.92	25.79	116.8	2.69	10.33	124	92.0%	215.6	175.80	1698
6104	8.79	29.6	12.72	82.39	24.94	121.9	2.51	9.66	129	92.4%	215.3	175.52	1698
5868	8.45	31.39	12.23	86.61	23.97	127.6	2.32	8.92	134	92.8%	214.3	174.71	1698
5403	7.78	20.69	11.26	81.14	22.07	139.6	1.97	7.56	145	93.7%	211.5	172.41	1698
5076	7.31	14.21	10.58	77.83	20.74	147.0	1.74	6.68	152	93.6%	208.1	169.68	1698

(Corrected to 1765 RPM)

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM
6562	9.45	134.4	92.0%	242.2	187	1765
6345	9.14	139.5	92.4%	241.8	187	1765
6100	8.78	145.0	92.8%	240.7	186	1765
5616	8.09	156.9	93.7%	237.5	184	1765
5280	7.60	164.3	93.6%	234.1	181	1766

Pump No. 1 Field Curve 10/28/08 (95% Speed) Motor Efficiency Reduced 5% to account for VFD losses Coating) 1.5 Year Test													
Q (gpm)	**Q (mgd)**	**S**	**SV ft/sec**	**D**	**DV ft/sec**	**Pump H**	**Suc V H**	**Dis V H**	**Total H**	**Eff**	**BHP**	**KW**	**RPM**
6368	9.17	37.3	13.27	87.39	26.01	115.7	2.74	10.51	123	91.5%	217.1	177.00	1697
6208	8.94	39.05	12.94	91.04	25.36	120.1	2.60	9.99	127	91.9%	217.5	177.30	1697
5993	8.63	40.61	12.49	94.82	24.48	125.2	2.42	9.31	132	92.3%	216.5	176.52	1697
5424	7.81	28.71	11.30	89.74	22.16	141.0	1.98	7.62	147	93.8%	214.1	174.58	1697
4931	7.1	20.3	10.28	85.98	20.14	151.7	1.64	6.30	156	93.5%	208.3	169.86	1698
(Corrected to 1765 RPM)													
Q (gpm)	**Q (mgd)**	**H**	**Eff**	**BHP**	**KW**	**RPM**							
6623	9.54	133.6	91.5%	244.3	189	1765							
6457	9.30	137.9	91.9%	244.7	189	1765							
6233	8.98	142.9	92.3%	243.6	188	1765							
5641	8.12	158.6	93.8%	240.9	186	1765							
5128	7.38	169.2	93.5%	234.4	181	1766							
Pump No. 1 Field Curve 5/26/09 (95% Speed) Motor Efficiency Reduced 5% to account for VFD losses Coating) 2 Year Test													
Q (gpm)	**Q (mgd)**	**S**	**SV ft/sec**	**D**	**DV ft/sec**	**Pump H**	**Suc V H**	**Dis V H**	**Total H**	**Eff**	**BHP**	**KW**	**RPM**
6243	8.99	37.32	13.01	88.31	25.50	117.8	2.63	10.10	125	91.3%	216.3	176.31	1697
6000	8.64	39.08	12.51	92.59	24.51	123.6	2.43	9.33	131	91.7%	215.7	175.85	1697
5833	8.40	40.29	12.16	95.55	23.83	127.7	2.30	8.82	134	91.9%	215.1	175.34	1697
5368	7.73	30.87	11.19	91.61	21.93	140.3	1.94	7.47	146	93.2%	212.2	172.97	1697
4854	6.99	21.57	10.12	87.04	19.83	151.2	1.59	6.11	156	92.7%	206	167.92	1698
(Corrected to 1765 RPM)													
Q (gpm)	**Q (mgd)**	**H**	**Eff**	**BHP**	**KW**	**RPM**							
6493	9.35	135.5	91.3%	243.3	188	1765							
6240	8.99	141.2	91.7%	242.7	188	1765							
6067	8.74	145.1	91.9%	242.0	187	1765							
5583	8.04	157.8	93.2%	238.7	185	1765							
5049	7.27	168.5	92.7%	231.7	179	1766							

Pump No. 1 Field Curve 7/15/10													
Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
6160	8.87	28.57	12.84	81.48	25.16	122.2	2.56	9.83	129	93.1%	216.3	176.38	1696
5972	8.60	29.92	12.45	84.72	24.40	126.6	2.41	9.24	133	93.3%	215.7	175.86	1696
5799	8.35	31.05	12.09	87.7	23.69	130.9	2.27	8.71	137	93.6%	214.8	175.16	1696
5417	7.80	23.86	11.29	84.9	22.13	141.0	1.98	7.60	147	94.3%	212.6	173.35	1696
5181	7.46	19.15	10.80	82.44	21.16	146.2	1.81	6.95	151	94.2%	210.2	171.40	1696

(Corrected to 1765 RPM)						
Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM
6410	9.23	140.2	93.1%	243.8	188	1765
6215	8.95	144.5	93.3%	243.1	188	1765
6035	8.69	148.7	93.6%	242.1	187	1765
5637	8.12	158.8	94.3%	239.6	185	1765
5394	7.77	164.1	94.2%	237.3	183	1766

Pump No. 2 Field Curve 12/4/07 (95% Speed) Motor Efficiency Reduced 5% to account for VFD losses Coating) Initial Test													
Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
6340	9.13	30.71	13.21	80.57	25.90	115.2	2.71	10.42	123	81.6%	241.1	196.58	1693
5896	8.49	34.31	12.29	88.77	24.08	125.8	2.34	9.01	132	82.9%	238.0	194.05	1693
5674	8.17	29.04	11.82	85.87	23.18	131.3	2.17	8.34	137	83.5%	235.8	192.26	1693
5257	7.57	20.4	10.96	81.2	21.48	140.4	1.86	7.16	146	84.0%	230.4	187.82	1693
4910	7.07	14.6	10.23	78.05	20.06	146.6	1.63	6.25	151	83.3%	225.1	183.50	1693

(Corrected to 1765 RPM)						
Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM
6610	9.52	133.6	81.6%	273.2	211	1765
6147	8.85	144.0	82.9%	269.7	208	1765
5915	8.52	149.4	83.5%	267.2	207	1765
5481	7.89	158.4	84.0%	261.0	202	1765
5121	7.37	164.5	83.3%	255.5	197	1766

Pump No. 2 Field Curve 1/10/08 (95% Speed) Motor Efficiency Reduced 5% to account for VFD losses Coating)													
(Post Casing Coating & Pre Mechanical Test)													
Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
6417	9.24	28.57	13.37	81.8	26.21	123.0	2.78	10.67	131	89.4%	237.1	193.29	1693
6222	8.96	30.01	12.97	85.41	25.42	128.0	2.61	10.03	135	90.1%	236.0	192.44	1693
5847	8.42	27.85	12.19	87.33	23.89	137.4	2.31	8.86	144	91.1%	233.3	190.20	1693
5486	7.9	20.27	11.43	83.16	22.41	145.3	2.03	7.80	151	91.3%	229.2	186.83	1693
5236	7.54	15.51	10.91	80.54	21.39	150.2	1.85	7.10	155	91.1%	225.8	184.08	1693
(Corrected to 1765 RPM)													
Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM							
6690	9.63	142.2	89.4%	268.6	208	1765							
6487	9.34	147.2	90.1%	267.4	207	1765							
6096	8.78	156.5	91.1%	264.3	204	1765							
5723	8.24	164.4	91.3%	260.1	201	1766							
5465	7.87	169.4	91.1%	256.7	198	1767							
Pump No. 2 Field Curve 4/11/08 (95% Speed) Motor Efficiency Reduced 5% to account for VFD losses Coating)													
(Post Casing Coating & Post Mechanical Test)													
Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
6368	9.17	28.16	13.27	79.97	26.01	119.7	2.74	10.51	127	93.1%	220.1	179.43	1693
6132	8.83	29.53	12.78	83.51	25.05	124.7	2.54	9.74	132	93.1%	219.5	178.92	1693
5910	8.51	31.15	12.32	87.46	24.14	130.1	2.36	9.05	137	93.4%	218.5	178.18	1693
5549	7.99	22.02	11.56	83.17	22.67	141.3	2.08	7.98	147	94.6%	217.9	177.64	1693
5188	7.47	14.83	10.81	79.3	21.19	148.9	1.82	6.97	154	94.2%	214.3	174.75	1693
(Corrected to 1765 RPM)													
Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM							
6639	9.56	138.5	93.1%	249.4	193	1765							
6393	9.21	143.4	93.1%	248.7	192	1765							
6161	8.87	148.7	93.4%	247.6	191	1765							
5788	8.33	160.1	94.6%	247.3	191	1766							
5414	7.80	167.8	94.2%	243.7	188	1767							

Pump No. 2 Field Curve 5/29/08 (95% Speed) Motor Efficiency Reduced 5% to account for VFD losses Coating
(Post Casing Coating & Post Mechanical Test) 30 Day Test

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
6313	9.09	33.65	13.16	86.13	25.79	121.2	2.69	10.33	129	93.4%	220.1	179.41	1693
6042	8.70	35.5	12.59	90.52	24.68	127.1	2.46	9.46	134	93.3%	219.4	178.85	1693
5826	8.39	36.96	12.14	94.23	23.80	132.3	2.29	8.80	139	93.7%	218.0	177.71	1693
5403	7.78	26.35	11.26	88.86	22.07	144.4	1.97	7.56	150	94.5%	216.6	176.61	1693
4861	7	15.77	10.13	83.02	19.86	155.3	1.59	6.12	160	93.5%	209.8	171.07	1693

(Corrected to 1765 RPM)

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM
6581	9.48	140.1	93.4%	249.3	193	1765
6299	9.07	145.7	93.3%	248.6	192	1765
6074	8.75	150.9	93.7%	247.0	191	1765
5636	8.12	163.2	94.5%	245.9	190	1766
5074	7.31	174.2	93.5%	238.6	184	1767

Pump No. 2 Field Curve 8/04/08 (95% Speed) Motor Efficiency Reduced 5% to account for VFD losses Coating
(Post Casing Coating & Post Mechanical Test) 90 Day Test

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
6507	9.37	34.53	13.56	85.2	26.58	117.0	2.86	10.97	125	93.3%	220.4	179.70	1694
6264	9.02	36.38	13.06	89.5	25.59	122.7	2.65	10.17	130	93.6%	220.2	179.52	1694
6097	8.78	37.55	12.71	92.28	24.91	126.4	2.51	9.63	134	93.6%	219.7	179.13	1694
5625	8.1	27.49	11.72	88.2	22.98	140.2	2.13	8.20	146	95.0%	218.9	178.44	1694
5174	7.45	18.45	10.78	83.31	21.13	149.8	1.81	6.94	155	94.5%	214.2	174.60	1694

(Corrected to 1765 RPM)

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM
6780	9.76	135.9	93.3%	249.3	193	1765
6526	9.40	141.4	93.6%	249.1	193	1765
6353	9.15	145.0	93.6%	248.5	192	1765
5864	8.44	159.0	95.0%	248.0	192	1766
5397	7.77	168.6	94.5%	243.1	188	1767

Pump No. 2 Field Curve 10/28/08 (95% Speed) Motor Efficiency Reduced 5% to account for VFD losses Coating, 6 Month Test													
Q (gpm)	**Q (mgd)**	**S**	**SV ft/sec**	**D**	**DV ft/sec**	**Pump H**	**Suc V H**	**Dis V H**	**Total H**	**Eff**	**BHP**	**KW**	**RPM**
6389	9.20	37.24	13.32	88.63	26.10	118.7	2.75	10.58	127	92.6%	220.4	179.70	1694
6181	8.90	38.55	12.88	92.11	25.25	123.7	2.58	9.90	131	92.9%	220.2	179.52	1694
5972	8.60	39.99	12.45	95.47	24.40	128.2	2.41	9.24	135	92.7%	219.7	179.13	1694
5479	7.89	29.08	11.42	90.74	22.38	142.4	2.02	7.78	148	93.7%	218.9	178.44	1694
4917	7.08	19.43	10.25	86.16	20.08	154.1	1.63	6.26	159	92.1%	214.2	174.60	1695
(Corrected to 1765 RPM)													
Q (gpm)	**Q (mgd)**	**H**	**Eff**	**BHP**	**KW**	**RPM**							
6657	9.59	137.4	92.6%	249.3	193	1765							
6440	9.27	142.3	92.9%	249.1	193	1765							
6223	8.96	146.5	92.7%	248.5	192	1765							
5712	8.23	161.1	93.7%	248.0	192	1766							
5126	7.38	172.6	92.1%	242.6	188	1767							

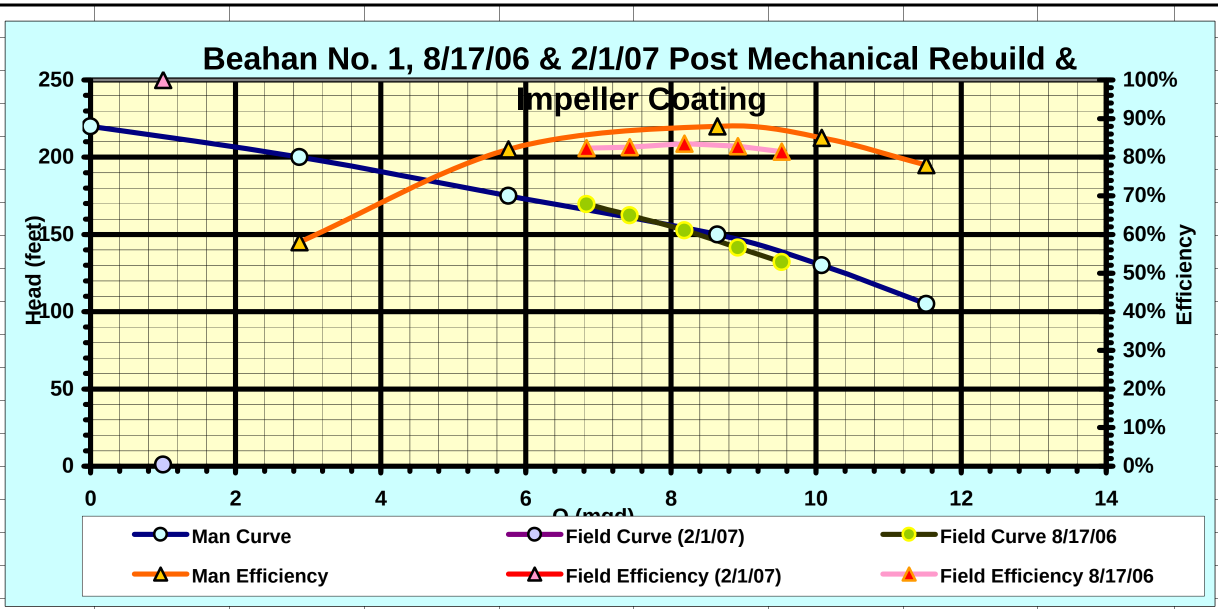
Pump No. 2 Field Curve 5/26/09 (95% Speed) Motor Efficiency Reduced 5% to account for VFD losses Coating, 1 Year Test													
Q (gpm)	**Q (mgd)**	**S**	**SV ft/sec**	**D**	**DV ft/sec**	**Pump H**	**Suc V H**	**Dis V H**	**Total H**	**Eff**	**BHP**	**KW**	**RPM**
6292	9.06	37.62	13.11	90.1	25.70	121.2	2.67	10.26	129	93.0%	220.0	179.33	1694
6083	8.76	39.01	12.68	93.47	24.85	125.8	2.50	9.59	133	93.0%	219.4	178.90	1694
5903	8.50	40.31	12.30	96.69	24.11	130.2	2.35	9.03	137	93.4%	218.6	178.21	1694
5542	7.98	32.77	11.55	93.76	22.64	140.9	2.07	7.96	147	94.3%	217.7	177.51	1694
5035	7.25	23.57	10.49	89.22	20.57	151.7	1.71	6.57	157	93.7%	212.4	173.19	1695
(Corrected to 1765 RPM)													
Q (gpm)	**Q (mgd)**	**H**	**Eff**	**BHP**	**KW**	**RPM**							
6555	9.44	139.8	93.0%	248.8	192	1765							
6338	9.13	144.3	93.0%	248.2	192	1765							
6150	8.86	148.6	93.4%	247.2	191	1765							
5777	8.32	159.5	94.3%	246.7	191	1766							
5249	7.56	170.1	93.7%	240.7	186	1767							

Pump No. 2 Field Curve 7/15/10

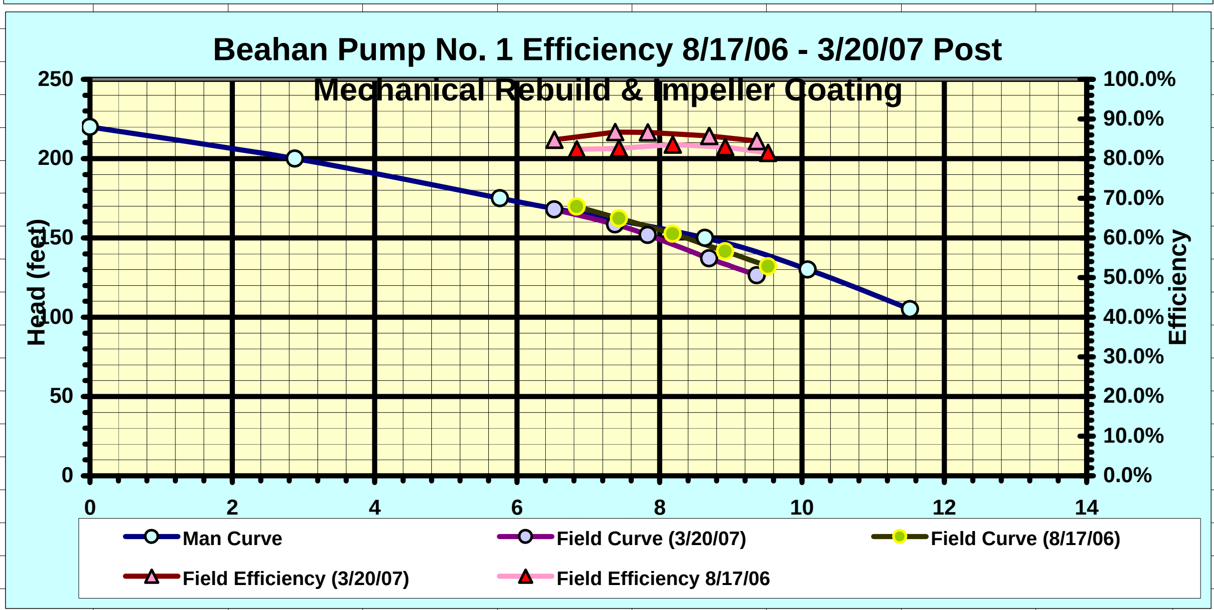
Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
6194	8.92	28.37	12.91	82.38	25.30	124.8	2.59	9.94	132	94.2%	219.5	178.95	1693
5972	8.60	29.72	12.45	85.96	24.40	129.9	2.41	9.24	137	94.3%	218.7	178.34	1693
5806	8.36	30.06	12.10	88.13	23.72	134.1	2.27	8.73	141	94.7%	217.7	177.53	1693
5563	8.01	25.06	11.59	86.38	22.72	141.6	2.09	8.02	148	95.4%	217.3	177.15	1693
5313	7.65	20.17	11.07	83.93	21.70	147.3	1.90	7.31	153	95.3%	214.9	175.22	1693

(Corrected to 1765 RPM)

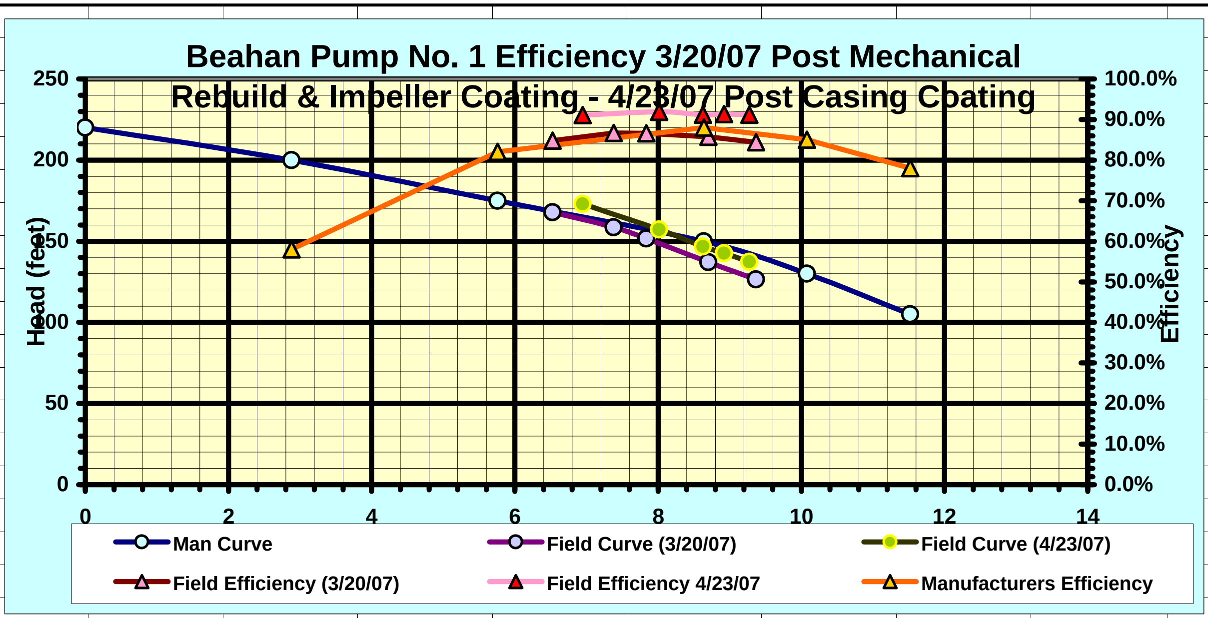
Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM
6458	9.30	143.6	94.2%	248.7	192	1765
6226	8.97	148.6	94.3%	247.9	192	1765
6052	8.72	152.8	94.7%	246.7	191	1765
5802	8.36	160.6	95.4%	246.6	191	1766
5545	7.98	166.3	95.3%	244.3	189	1767



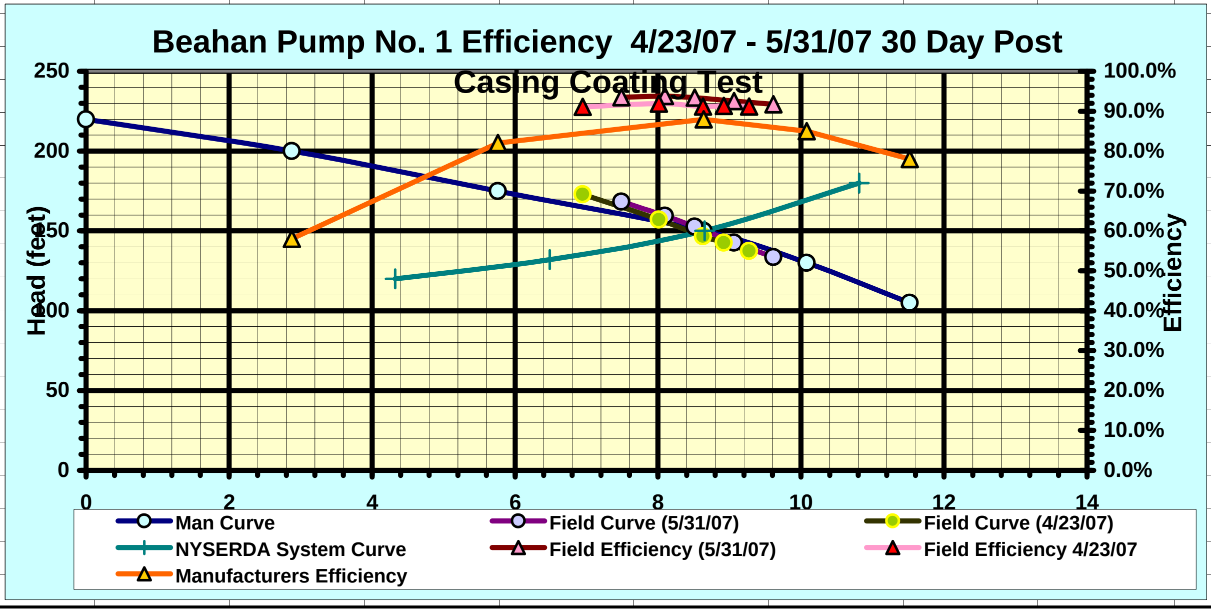
Beahan No. 1, 8/17/06 & 2/1/07 Post Mechanical Rebuild & Impeller Coating
Head (feet)
Efficiency
Q (mgd)
250
200
150
100
50
0
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0
2
4
6
8
10
12
14
Man Curve
Field Curve (2/1/07)
Field Curve 8/17/06
Man Efficiency
Field Efficiency (2/1/07)
Field Efficiency 8/17/06



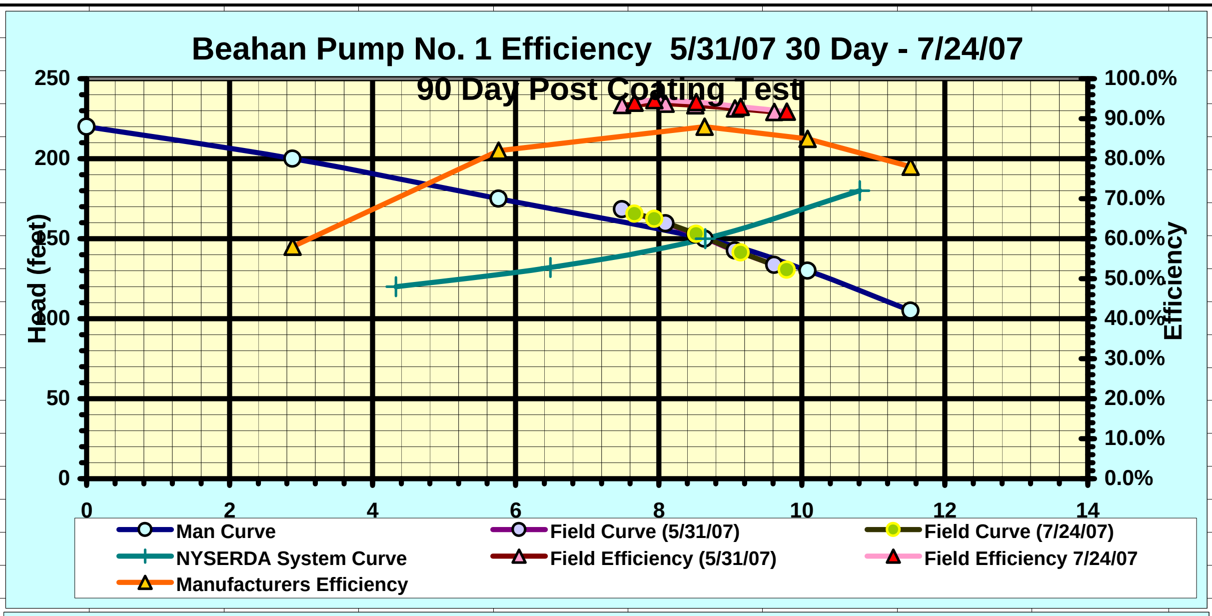
Beahan Pump No. 1 Efficiency 8/17/06 - 3/20/07 Post Mechanical Rebuild & Impeller Coating
Head (feet)
Efficiency
250
200
150
100
50
0
100.0%
90.0%
80.0%
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
0
2
4
6
8
10
12
14
Man Curve
Field Curve (3/20/07)
Field Curve (8/17/06)
Field Efficiency (3/20/07)
Field Efficiency 8/17/06

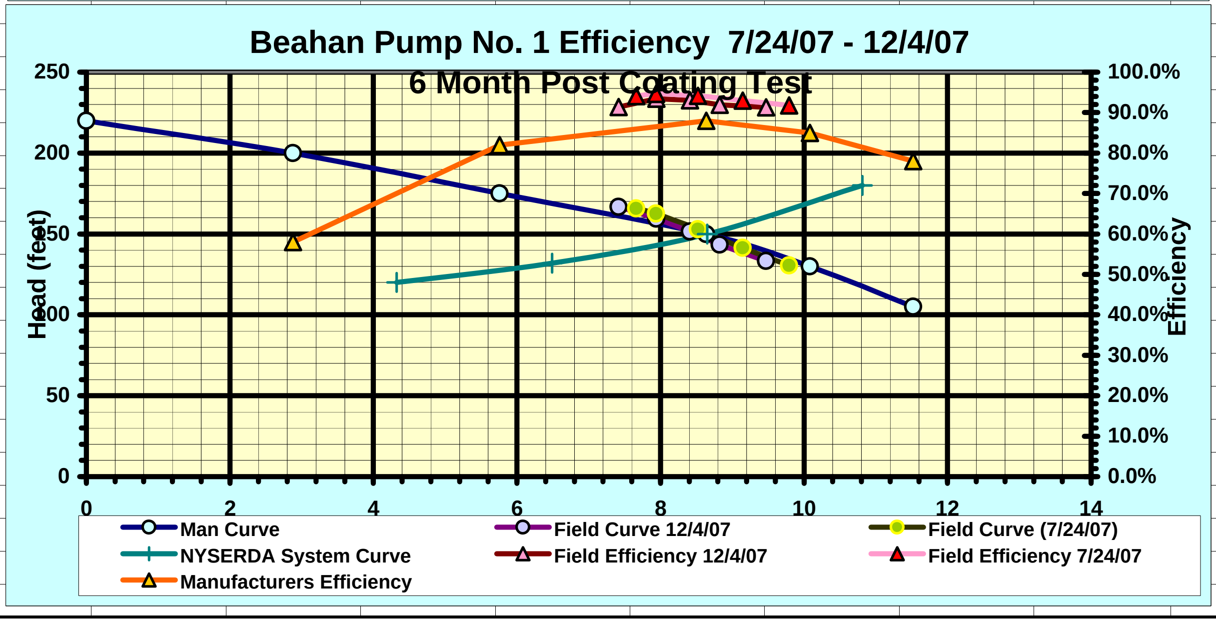


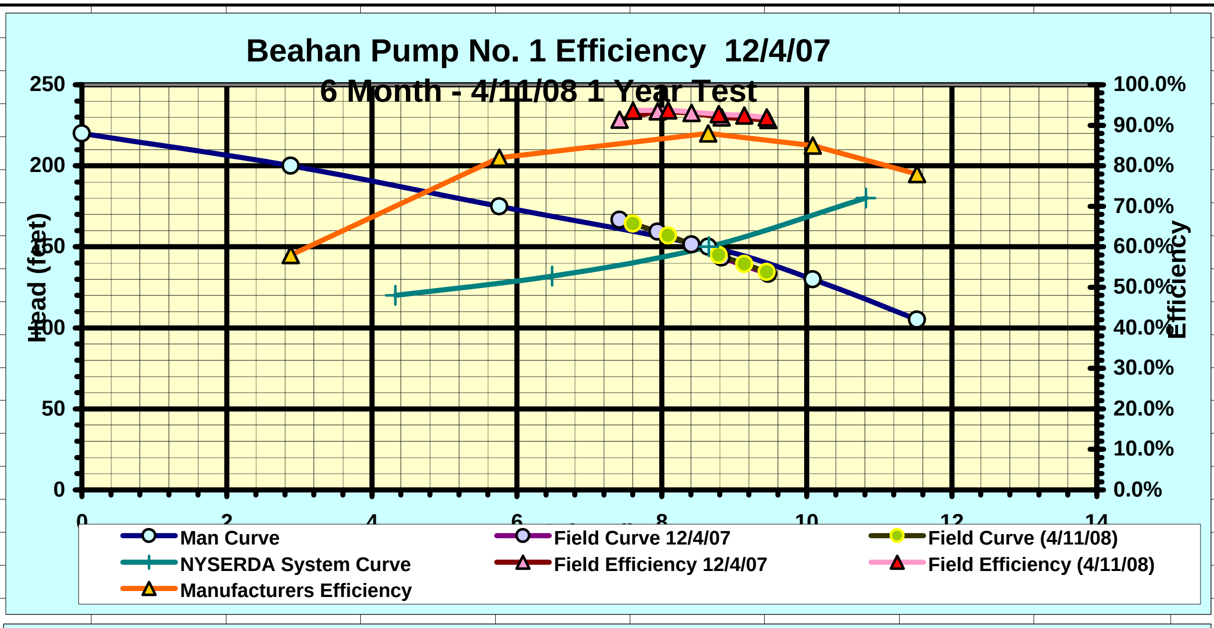
Beahan Pump No. 1 Efficiency 3/20/07 Post Mechanical Rebuild & Impeller Coating - 4/23/07 Post Casing Coating
Head (feet)
Efficiency
0
50
100
150
200
250
0.0%
10.0%
20.0%
30.0%
40.0%
50.0%
60.0%
70.0%
80.0%
90.0%
100.0%
0
2
4
6
8
10
12
14
Man Curve
Field Curve (3/20/07)
Field Curve (4/23/07)
Field Efficiency (3/20/07)
Field Efficiency 4/23/07
Manufacturers Efficiency

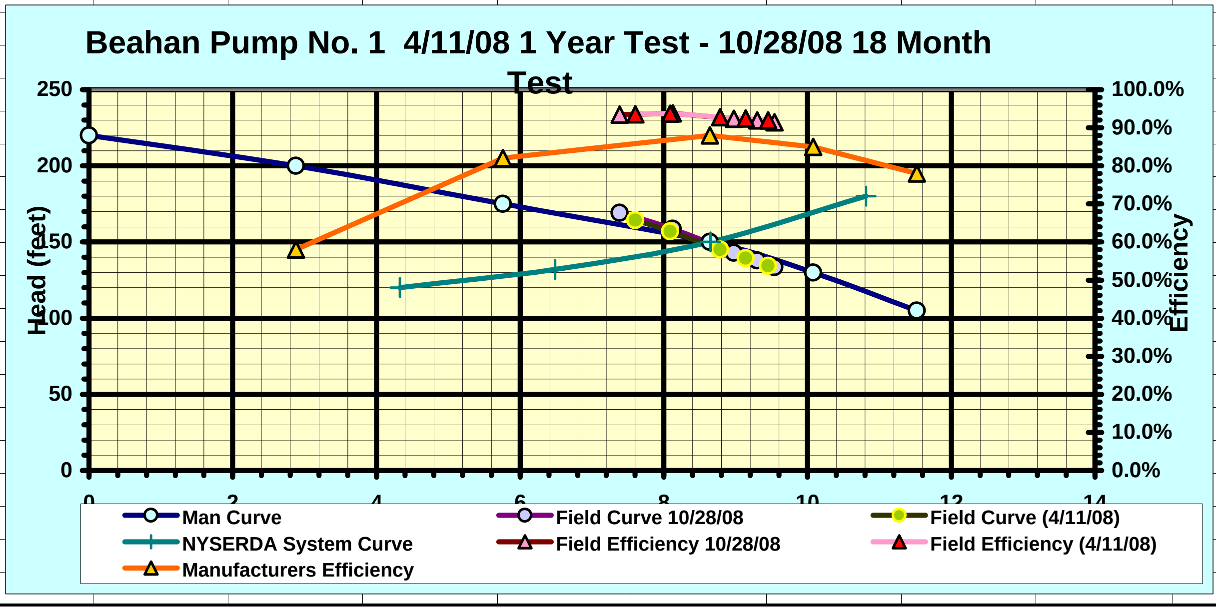


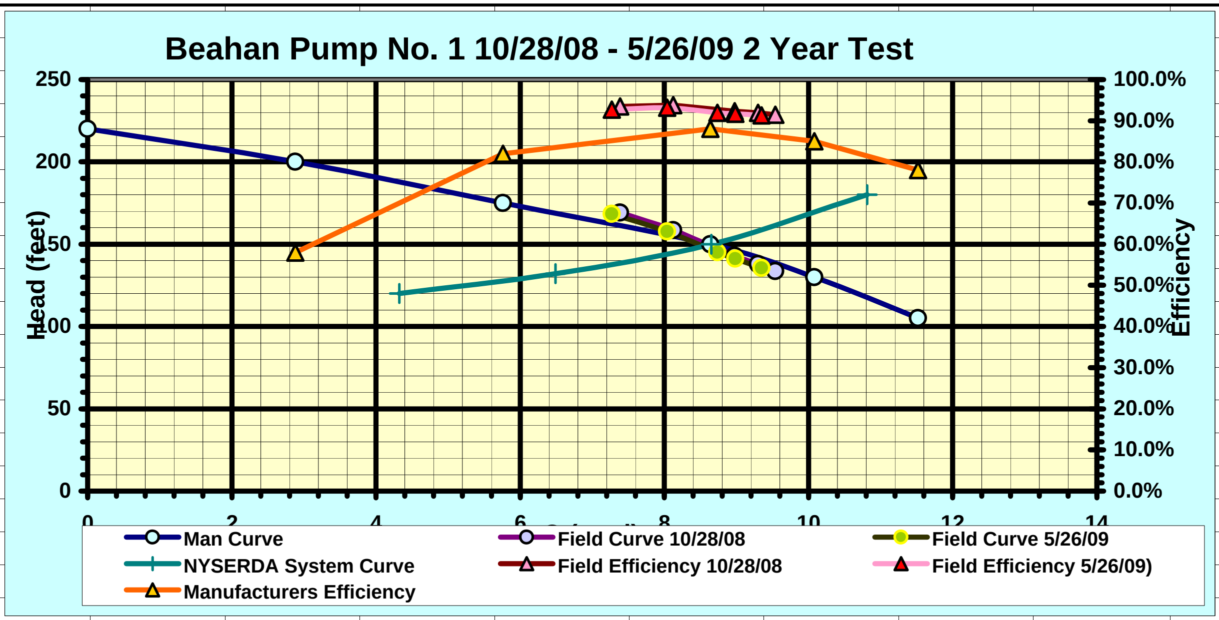
Beahan Pump No. 1 Efficiency 4/23/07 - 5/31/07 30 Day Post Casing Coating Test
Head (feet)
Efficiency
0
50
100
150
200
250
0.0%
10.0%
20.0%
30.0%
40.0%
50.0%
60.0%
70.0%
80.0%
90.0%
100.0%
0
2
4
6
8
10
12
14
Man Curve
Field Curve (5/31/07)
Field Curve (4/23/07)
NYSERDA System Curve
Field Efficiency (5/31/07)
Field Efficiency 4/23/07
Manufacturers Efficiency

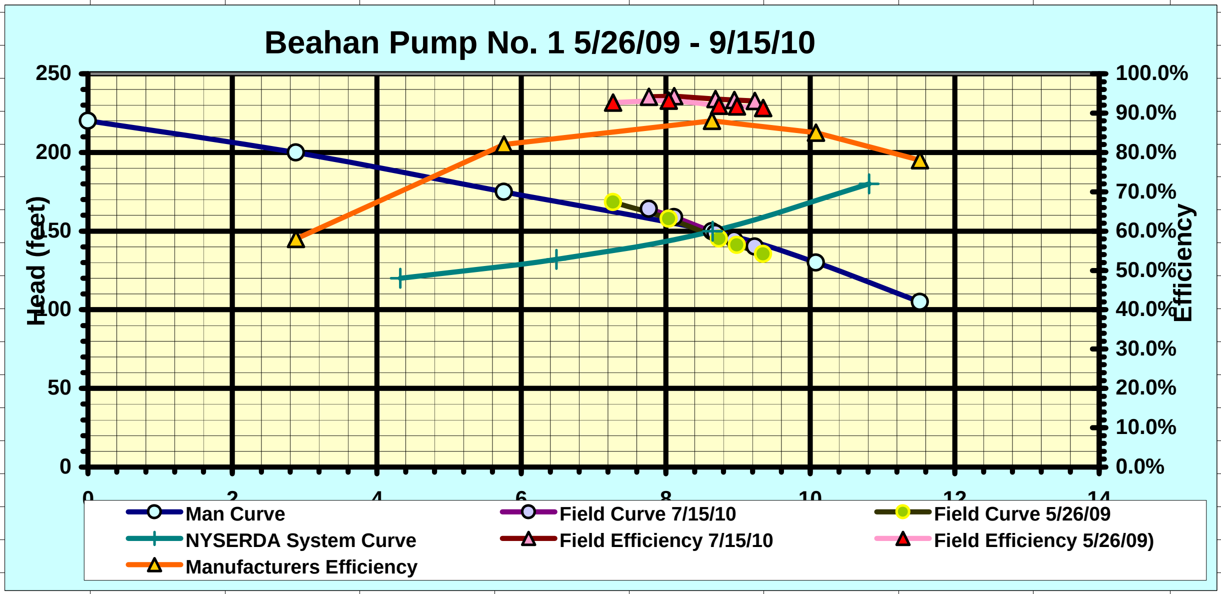

Beahan Pump No. 1 Efficiency 5/31/07 30 Day - 7/24/07
90 Day Post Coating Test
Head (feet)
Efficiency
250
200
150
100
50
0
100.0%
90.0%
80.0%
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
0
2
4
6
8
10
12
14
Man Curve
Field Curve (5/31/07)
Field Curve (7/24/07)
NYSERDA System Curve
Field Efficiency (5/31/07)
Field Efficiency 7/24/07
Manufacturers Efficiency

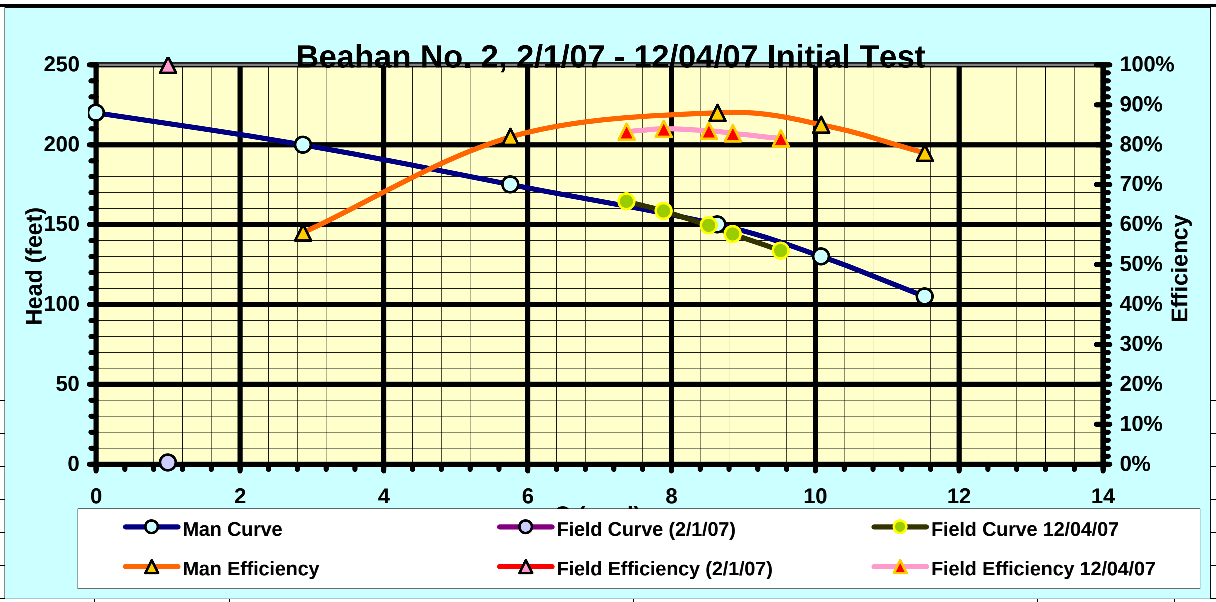

Beahan Pump No. 1 Efficiency 7/24/07 - 12/4/07
6 Month Post Coating Test
Head (feet)
Efficiency
250
200
150
100
50
0
100.0%
90.0%
80.0%
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
0
2
4
6
8
10
12
14
Man Curve
Field Curve 12/4/07
Field Curve (7/24/07)
NYSERDA System Curve
Field Efficiency 12/4/07
Field Efficiency 7/24/07
Manufacturers Efficiency

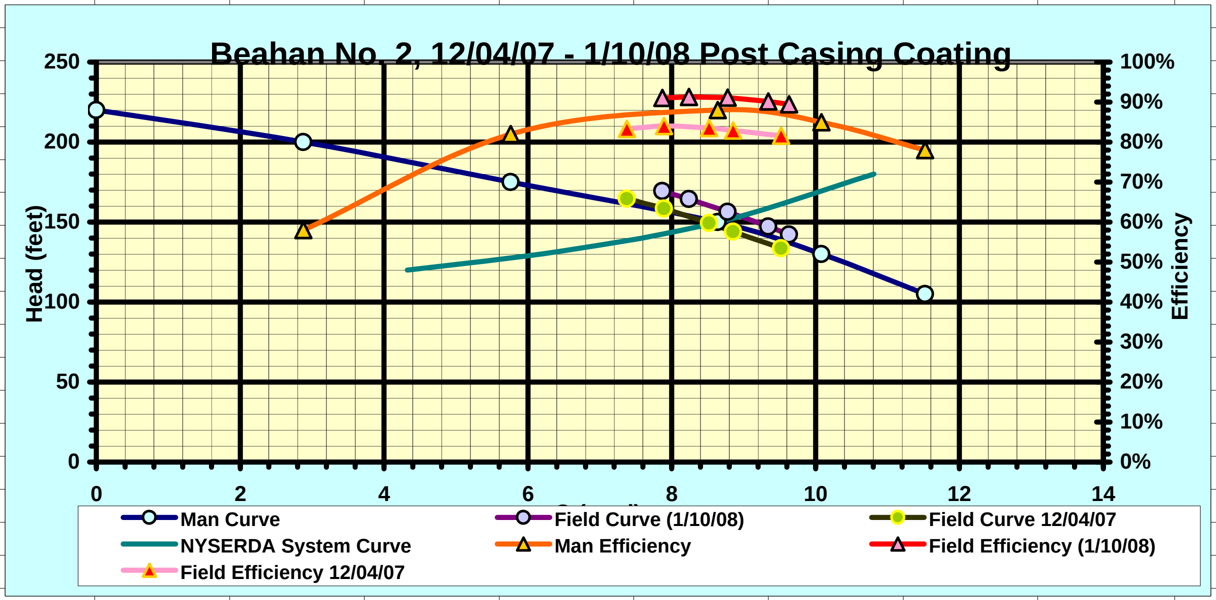

Beahan Pump No. 1 Efficiency 12/4/07
6 Month - 4/11/08 1 Year Test
Head (feet)
Efficiency
250
200
150
100
50
0
100.0%
90.0%
80.0%
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
Man Curve
NYSERDA System Curve
Manufacturers Efficiency
Field Curve 12/4/07
Field Efficiency 12/4/07
Field Curve (4/11/08)
Field Efficiency (4/11/08)

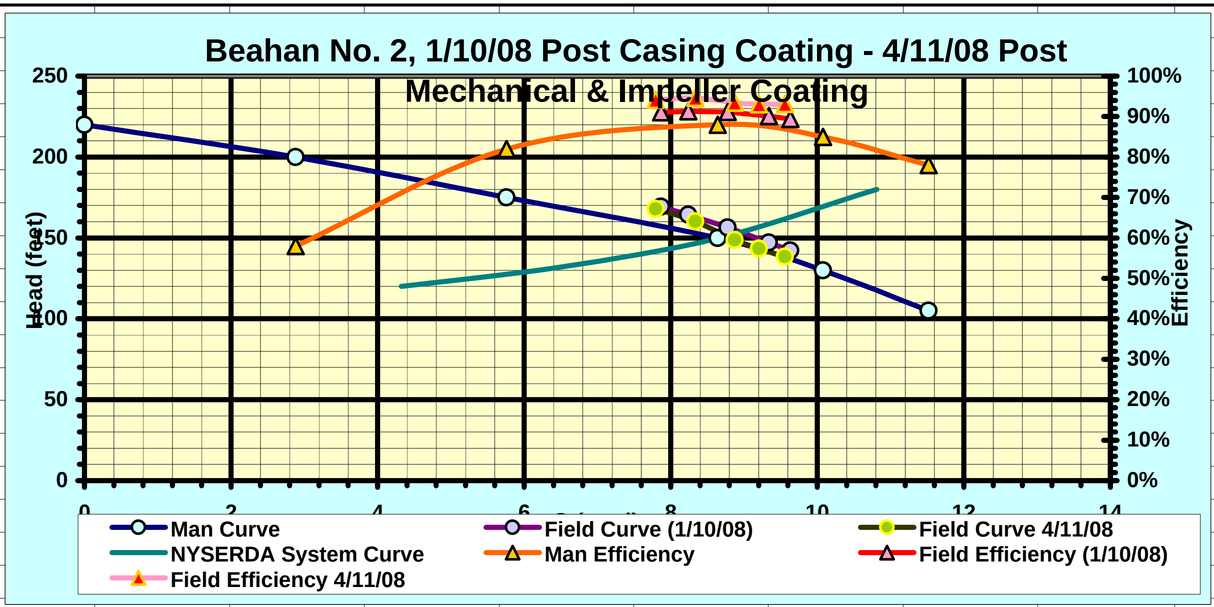

Beahan Pump No. 1 4/11/08 1 Year Test - 10/28/08 18 Month Test
Head (feet)
Efficiency
250
200
150
100
50
0
100.0%
90.0%
80.0%
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
Man Curve
NYSERDA System Curve
Manufacturers Efficiency
Field Curve 10/28/08
Field Efficiency 10/28/08
Field Curve (4/11/08)
Field Efficiency (4/11/08)

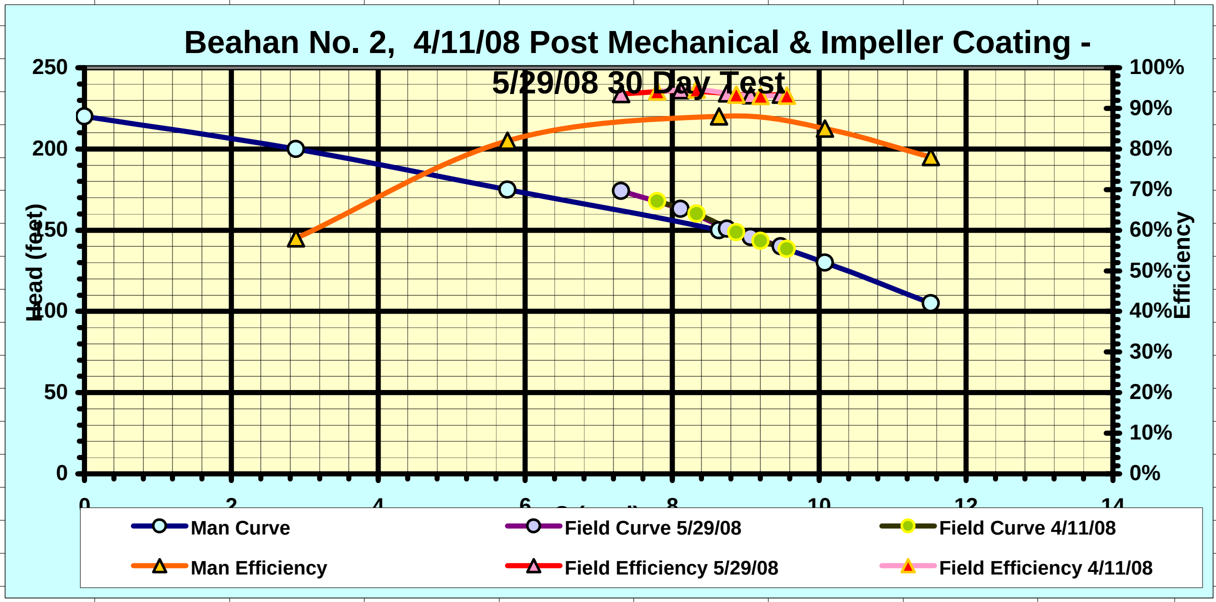

Beahan Pump No. 1 10/28/08 - 5/26/09 2 Year Test
Head (feet)
Efficiency
Man Curve
NYSERDA System Curve
Manufacturers Efficiency
Field Curve 10/28/08
Field Efficiency 10/28/08
Field Curve 5/26/09
Field Efficiency 5/26/09)

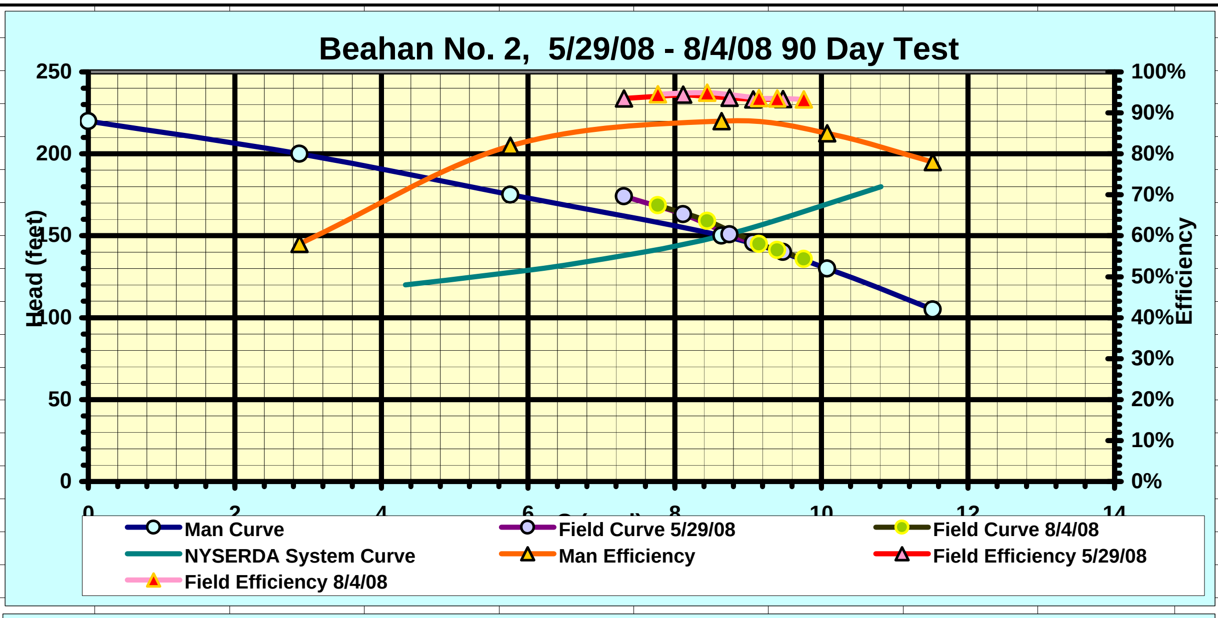

Beahan Pump No. 1 5/26/09 - 9/15/10
Head (feet)
Efficiency
Man Curve
NYSERDA System Curve
Manufacturers Efficiency
Field Curve 7/15/10
Field Efficiency 7/15/10
Field Curve 5/26/09
Field Efficiency 5/26/09)

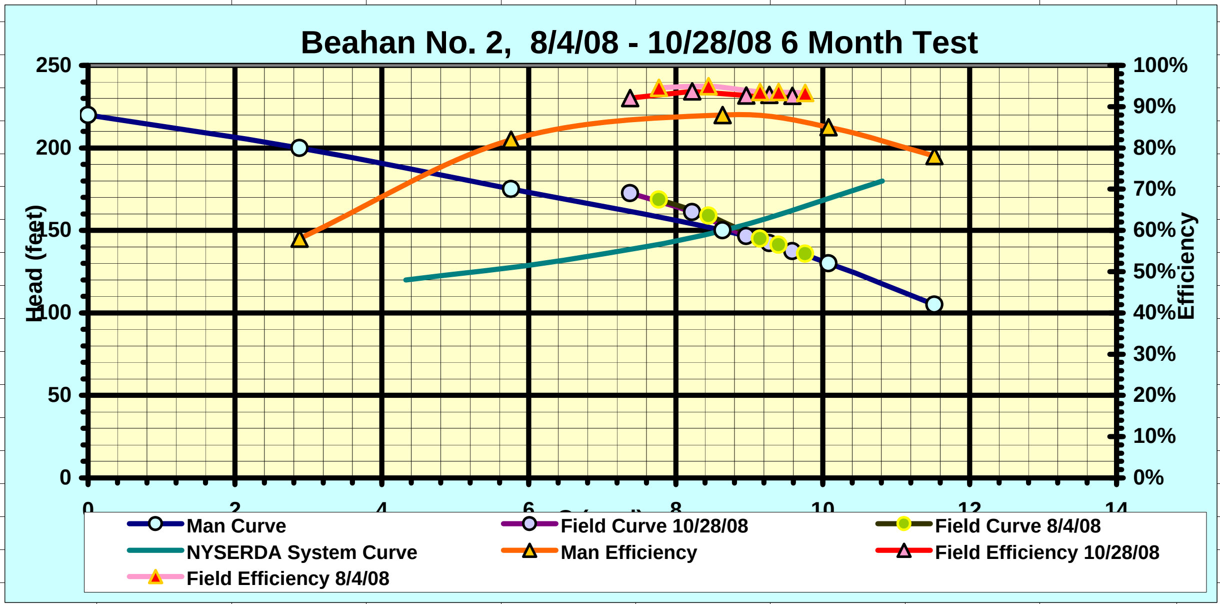

Beahan No. 2, 2/1/07 - 12/04/07 Initial Test
Head (feet)
Efficiency
0
50
100
150
200
250
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
0
2
4
6
8
10
12
14
Man Curve
Field Curve (2/1/07)
Field Curve 12/04/07
Man Efficiency
Field Efficiency (2/1/07)
Field Efficiency 12/04/07

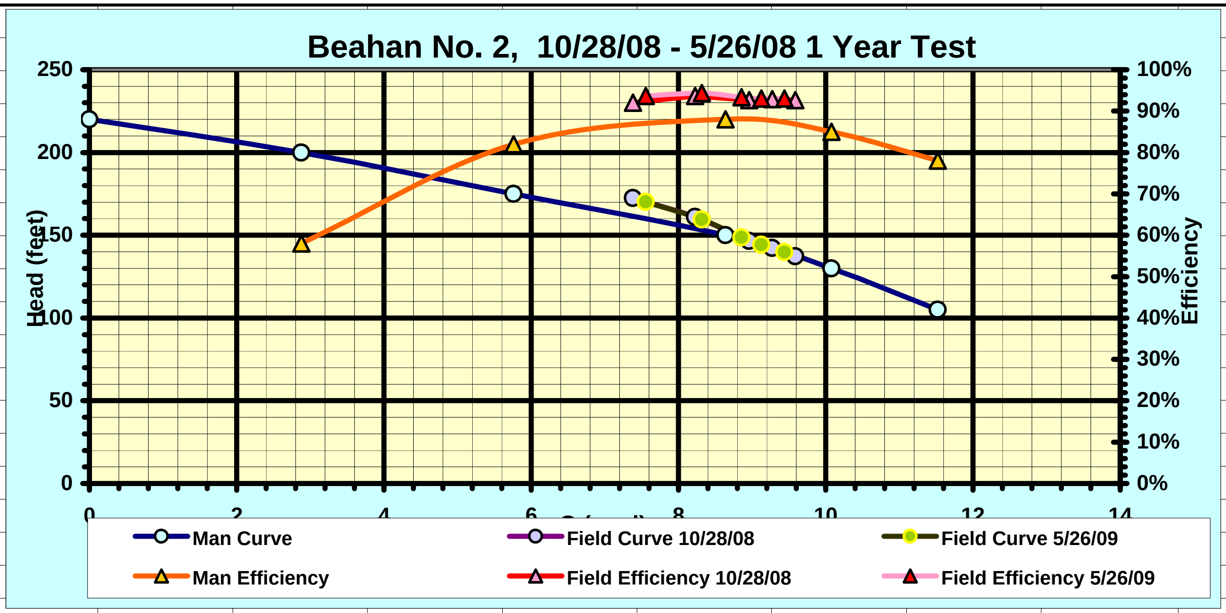

Beahan No. 2, 12/04/07 - 1/10/08 Post Casing Coating
Head (feet)
Efficiency
0
50
100
150
200
250
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
0
2
4
6
8
10
12
14
Man Curve
Field Curve (1/10/08)
Field Curve 12/04/07
NYSERDA System Curve
Man Efficiency
Field Efficiency (1/10/08)
Field Efficiency 12/04/07

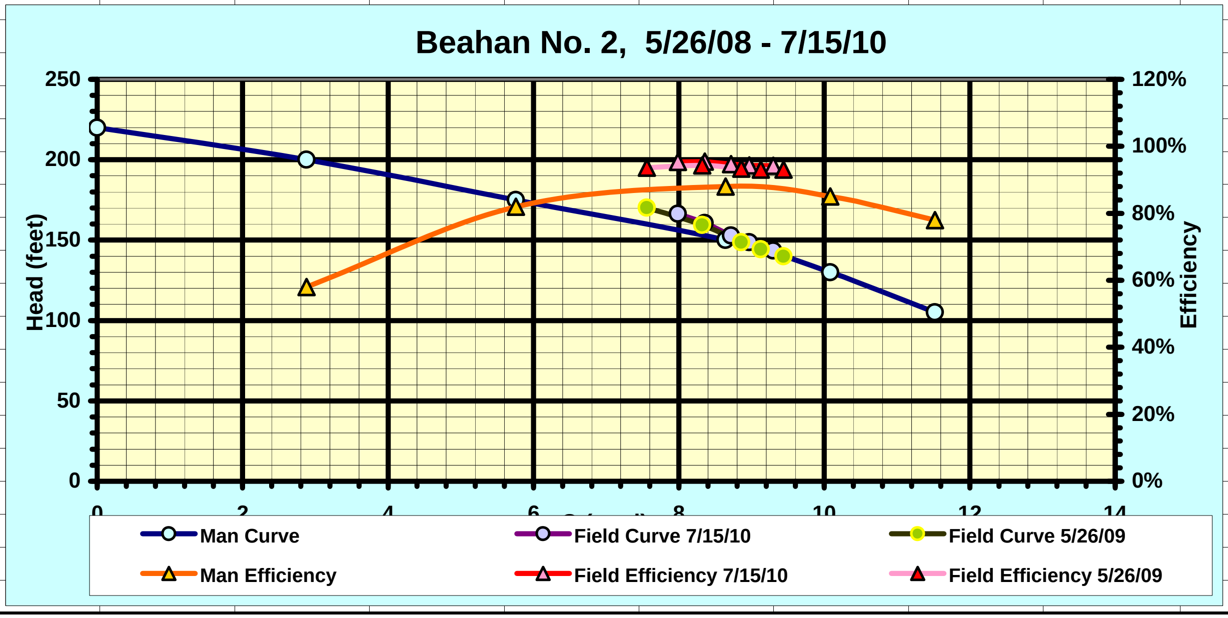

Beahan No. 2, 1/10/08 Post Casing Coating - 4/11/08 Post Mechanical & Impeller Coating
Head (feet)
Efficiency
Man Curve
Field Curve (1/10/08)
Field Curve 4/11/08
NYSERDA System Curve
Man Efficiency
Field Efficiency (1/10/08)
Field Efficiency 4/11/08


Beahan No. 2, 4/11/08 Post Mechanical & Impeller Coating - 5/29/08 30 Day Test
Head (feet)
Efficiency
Man Curve
Field Curve 5/29/08
Field Curve 4/11/08
Man Efficiency
Field Efficiency 5/29/08
Field Efficiency 4/11/08


Beahan No. 2, 5/29/08 - 8/4/08 90 Day Test
Head (feet)
Efficiency
250
200
150
100
50
0
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0
2
4
6
8
10
12
14
Man Curve
Field Curve 5/29/08
Field Curve 8/4/08
NYSERDA System Curve
Man Efficiency
Field Efficiency 5/29/08
Field Efficiency 8/4/08


Beahan No. 2, 8/4/08 - 10/28/08 6 Month Test
Head (feet)
Efficiency
250
200
150
100
50
0
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0
2
4
6
8
10
12
14
Man Curve
Field Curve 10/28/08
Field Curve 8/4/08
NYSERDA System Curve
Man Efficiency
Field Efficiency 10/28/08
Field Efficiency 8/4/08


Beahan No. 2, 10/28/08 - 5/26/08 1 Year Test
Head (feet)
Efficiency
Man Curve
Field Curve 10/28/08
Field Curve 5/26/09
Man Efficiency
Field Efficiency 10/28/08
Field Efficiency 5/26/09


Beahan No. 2, 5/26/08 - 7/15/10
Head (feet)
Efficiency
Man Curve
Field Curve 7/15/10
Field Curve 5/26/09
Man Efficiency
Field Efficiency 7/15/10
Field Efficiency 5/26/09

Buffalo Road Pump No. 1
Energy Efficiency Cost Calculator
Continuous Service

Pre Mechanical	
Head (ft)	72
Flow (gpm)	924
Efficiency	61.0%
Hours Operation/month	730
BHP	28
kW (Assumes Motor Eff 95%)	21.6
kW Demand Charge	$216
kwh cost	$1,342
Total Monthly kWH	15,788
Monthly Cost	**$1,558.22**

Constants	
Hours/ Month	730
kW Demand Cost	$10.00
kwh Cost	$0.085
Motor Efficiency	95.0%

Post Mechanical	
Head (ft)	78
Flow (gpm)	1111
Efficiency	73.9%
Hours Operation/month	607
BHP	30
kW (Assumes Motor Eff 95%)	23.3
kW Demand Charge	$233
kwh cost	$1,200
Total Monthly kWH	14118
Monthly Cost	**$1,432.54**

Pre - Post Mechanical Comparison	
Monthly Savings	**$126**
Annual Savings	**$1,508**
5 Year Savings	**$7,541**
kW Demand Reduction	**-1.6**
Monthly kwh Savings	**1670**
Yearly kwh Savings	**20039**

Post Impeller Coating	
Head (ft)	77
Flow (gpm)	1083
Efficiency	75.5%
Hours Operation/month	623
BHP	28
kW (Assumes Motor Eff 95%)	21.9
kW Demand Charge	$219
kwh cost	$1,160
Total Monthly kWH	13641
Monthly Cost	**$1,378.54**

Pre - Post Impeller Comparison	
Monthly Savings	**$54**
Annual Savings	**$648**
5 Year Savings	**$3,240**
kW Demand Reduction	**1.4**
Monthly kwh Savings	**476**
Yearly kwh Savings	**5716**

Post Casing Coating	
Head (ft)	79
Flow (gpm)	1132
Efficiency	82.0%
Hours Operation/month	596
BHP	28
kW (Assumes Motor Eff 95%)	21.6
kW Demand Charge	$216
kwh cost	$1,095
Total Monthly kWH	12886
Monthly Cost	**$1,311.60**

Pre - Post Internal Coating Comparison	
Monthly Savings	**$67**
Annual Savings	**$803**
5 Year Savings	**$4,017**
kW Demand Reduction	**1.63**
Monthly kwh Savings	**755**
Yearly kwh Savings	**9061**

Pre Mechanical to Post Interior *Coating Comparison*	
Monthly Savings	**$247**
Annual Savings	**$2,959**
5 Year Savings	**$14,797**
kW Demand Reduction	**0.00**
Monthly kwh Savings	**2901**
Yearly kwh Savings	**34816**

20% Service Time

Pre Mechanical	
Head (ft)	72
Flow (gpm)	924
Efficiency	61.0%
Hours Operation/month	146
BHP	28
kW (Assumes Motor Eff 95%)	21.6
kW Demand Charge	$216
kwh cost	$268
Total Monthly kWH	3,158
Monthly Cost	**$484.66**

Constants	
Hours/ Month	730
kW Demand Cost	$10.00
kwh Cost	$0.085
Motor Efficiency	95.0%

Buffalo Road Pump No. 1 Cont'

Post Mechanical	
Head (ft)	78
Flow (gpm)	1111
Efficiency	73.9%
Hours Operation/month	121
BHP	30
kW (Assumes Motor Eff 95%)	23.3
kW Demand Charge	$233
kwh cost	$240
Total Monthly kWH	2824
Monthly Cost	**$472.53**

Pre - Post Mechanical Comparison	
Monthly Savings	**$12**
Annual Savings	**$145**
5 Year Savings	**$727**
kW Demand Reduction	**-1.6**
Monthly kwh Savings	**334**
Yearly kwh Savings	**4008**

Post Impeller Coating	
Head (ft)	77
Flow (gpm)	1083
Efficiency	75.5%
Hours Operation/month	125
BHP	28
kW (Assumes Motor Eff 95%)	21.9
kW Demand Charge	$219
kwh cost	$232
Total Monthly kWH	2728
Monthly Cost	**$450.93**

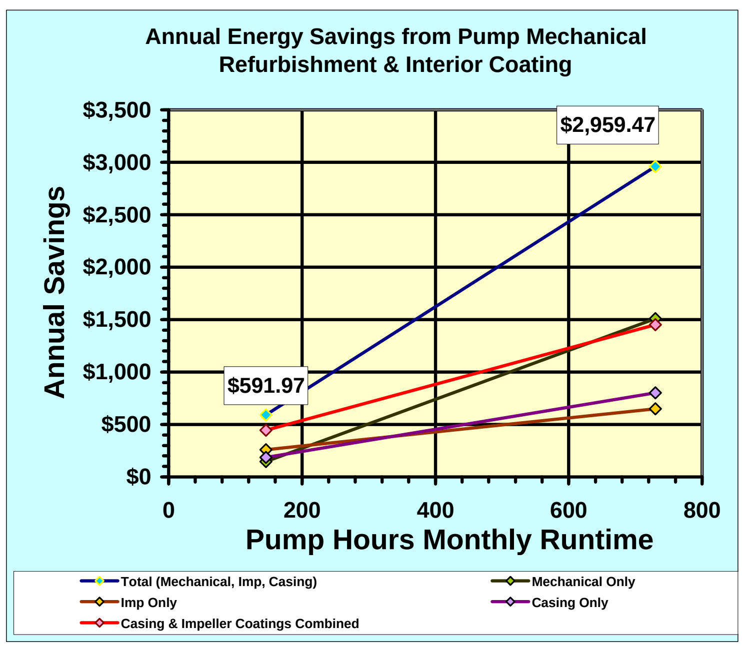
Pre - Post Impeller Comparison	
Monthly Savings	**$22**
Annual Savings	**$259**
5 Year Savings	**$1,296**
kW Demand Reduction	**1.4**
Monthly kwh Savings	**95**
Yearly kwh Savings	**1143**

Post Casing Coating	
Head (ft)	79
Flow (gpm)	1132
Efficiency	82.0%
Hours Operation/month	119
BHP	28
kW (Assumes Motor Eff 95%)	21.6
kW Demand Charge	$216
kwh cost	$219
Total Monthly kWH	2577
Monthly Cost	**$435.33**

Pre - Post Internal Coating Comparison	
Monthly Savings	**$16**
Annual Savings	**$187**
5 Year Savings	**$936**
kW Demand Reduction	**1.63**
Monthly kwh Savings	**2604**
Yearly kwh Savings	**31254**

Pre Mechanical to Post Interior *Coating Comparison*	
Monthly Savings	**$49**
Annual Savings	**$592**
5 Year Savings	**$2,960**
kW Demand Reduction	**0.00**
Monthly kwh Savings	**580**
Yearly kwh Savings	**6963**

Pump Hours of Operation Before Refurbishment & Interior Coating	**Annual Savings Through Refurbishment & Interior Coatings**
Total	
730	**$2,959.47**
146	**$591.97**
Mechanical Only	
730	**$1,508.15**
146	**$145.50**
Impeller Coating Only	
730	**$647.97**
146	**$259.28**
Casing Coating Only	
730	**$803.35**
146	**$187.19**
Casing & ImpellerCoating Only	
730	**$1,451.32**
146	**$446.47**



Buffalo Road Pump No. 2
Energy Efficiency Cost Calculator

Continuous Service

Pre Mechanical	
Head (ft)	70
Flow (gpm)	882
Effieicny	59.0%
Hours Operation/month	730
BHP	26
kW (Assumes Motor Eff 95%)	20.8
kW Demand Charge	$208
kwh cost	$1,288
Total Monthly kWH	15,148
Monthly Cost	**$1,495.09**

Constants	
Hours/ Month	730
kW Demand Cost	$10.00
kwh Cost	$0.085
Motor Efficiency	95.0%

Post Mechanical	
Head (ft)	77
Flow (gpm)	1063
Effieicny	73.5%
Hours Operation/month	606
BHP	28
kW (Assumes Motor Eff 95%)	22.1
kW Demand Charge	$221
kwh cost	$1,137
Total Monthly kWH	13376
Monthly Cost	**$1,357.76**

Pre - Post Mechanical Comparison	
Monthly Savings	**$137**
Annual Savings	**$1,648**
5 Year Savings	**$8,240**
kW Demand Reduction	**-1.3**
Monthly kwh Savings	**1772**
Yearly kwh Savings	**21269**

Post Casing Coating	
Head (ft)	79
Flow (gpm)	1125
Effieicny	82.5%
Hours Operation/month	572
BHP	27
kW (Assumes Motor Eff 95%)	21.4
kW Demand Charge	$214
kwh cost	$1,039
Total Monthly kWH	12226
Monthly Cost	**$1,252.83**

Pre - Post Internal Coating Comparison	
Monthly Savings	**$105**
Annual Savings	**$1,259**
5 Year Savings	**$6,296**
kW Demand Reduction	**0.72**
Monthly kwh Savings	**12336**
Yearly kwh Savings	**148037**

Pre Mechanical to Post Interior *Coating Comparison*	
Monthly Savings	**$242**
Annual Savings	**$2,907**
5 Year Savings	**$14,536**
kW Demand Reduction	**-0.61**
Monthly kwh Savings	**2922**
Yearly kwh Savings	**35065**

Buffalo Road Pump No. 2 Cont'

20% Service Time

Pre Mechanical

Head (ft)	70
Flow (gpm)	882
Effieicny	59.0%
Hours Operation/month	146
BHP	26
kW (Assumes Motor Eff 95%)	20.8
kW Demand Charge	$208
kwh cost	$258
Total Monthly kWH	3,030
Monthly Cost	**$465.03**

Constants

Hours/ Month	730
kW Demand Cost	$10.00
kwh Cost	$0.085
Motor Efficiency	95.0%

Post Mechanical

Head (ft)	77
Flow (gpm)	1063
Effieicny	73.5%
Hours Operation/month	121
BHP	28
kW (Assumes Motor Eff 95%)	22.1
kW Demand Charge	$221
kwh cost	$227
Total Monthly kWH	2675
Monthly Cost	**$448.22**

Pre - Post Mechanical Comparison

Monthly Savings	**$17**
Annual Savings	**$202**
5 Year Savings	**$1,009**
kW Demand Reduction	**-1.3**
Monthly kwh Savings	**354**
Yearly kwh Savings	**4254**

Post Casing Coating

Head (ft)	79
Flow (gpm)	1125
Effieicny	82.5%
Hours Operation/month	114
BHP	27
kW (Assumes Motor Eff 95%)	21.4
kW Demand Charge	$214
kwh cost	$208
Total Monthly kWH	2445
Monthly Cost	**$421.46**

Pre - Post Internal Coating Comparison

Monthly Savings	**$27**
Annual Savings	**$321**
5 Year Savings	**$1,605**
kW Demand Reduction	**0.72**
Monthly kwh Savings	**2467**
Yearly kwh Savings	**29607**

Pre Mechanical to Post Interior
Coating Comparison

Monthly Savings	**$44**
Annual Savings	**$523**
5 Year Savings	**$2,614**
kW Demand Reduction	**-0.61**
Monthly kwh Savings	**584**
Yearly kwh Savings	**7013**

Total Savings (Mechanical & Coating)

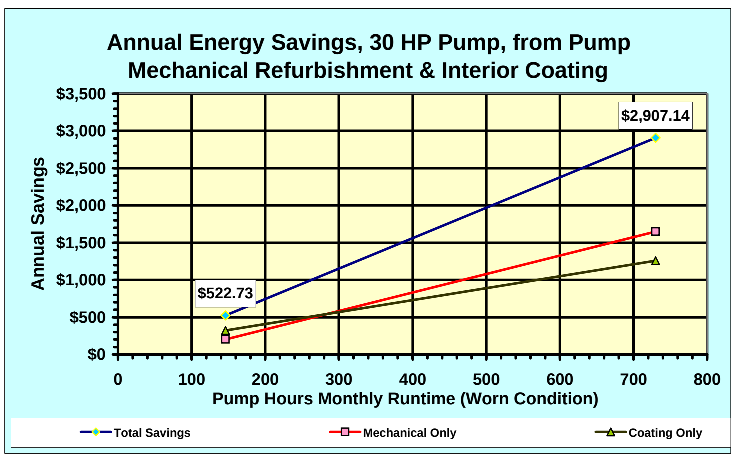
Pump Hours of Operation Before Refurbishment & Interior Coating	Annual Savings Through Refurbishment & Interior Coatings
730	$2,907.14
146	$522.73

Mechanical Savings Only

Pump Hours of Operation Before Refurbishment & Interior Coating	
730	$1,648.02
146	$201.72

Coating Savings Only

Pump Hours of Operation Before Refurbishment & Interior Coating	
730	$1,259.12
146	$321.02



Buffalo Road BPS

Manufacturer's Pump and Motor Information

Pumps 1 and 2
ITT AC Pump 8x6x12S
Model 150
1765 RPM

Motors 1 and 2
Weg
HP:30
RPM 1770

Manufacturers Curve Pump No's. 1 or 2

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	kW/mg	Ns
0	0	106					
500	0.72	102	65%	20	16	22.2	1230
1000	1.44	85	82%	26	21	14.7	1994
1125	1.62	79	83%	27	22	13.5	**2234**
1250	1.8	72	82%	28	22	12.4	2525
1500	2.16	55	72%	29	23	10.8	3385
1750	2.52	32	58%	24	20	7.8	5488

Motor Efficiency

Load %	kW	% Eff
100	15	92.4%
75	29.5	92.4%
50	44	91.0%

NYSERDA System Curve

Q (mgd)		H (feet)	
50.0%	0.81	80%	63.2
75.0%	1.22	88%	69.52
BEP	1.62	100%	79
125.0%	2.03	120%	94.8

Pump No. 1 Field Curve 4/4/06, Initial Test

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
1150	1.66	41.24	7.3	64.76	13.1	54.3	0.84	2.65	56.1	55.3%	29.5	24	1779
885	1.27	42.17	5.6	74.54	10.0	74.8	0.50	1.57	75.8	61.4%	27.6	22	1780
650	0.94	42.88	4.1	81.81	7.4	89.9	0.27	0.85	90.5	59.2%	25.1	20	1782
503	0.72	43.41	3.2	85.38	5.7	97.0	0.16	0.51	97.3	51.8%	23.8	19	1784

Corrected for Pump Rated Speed 1765 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kW/mg
1141	1.64	55.3	55.3%	28.8	23	1765	14.0
878	1.26	74.7	61.4%	27.0	21	1766	17.0
645	0.93	89.0	59.2%	24.5	19	1767	21.0
498	0.72	95.6	51.8%	23.2	18	1768	25.8

Pump No. 1 Field Curve 8/17/06 Post Mechanical Rebuild and Pre Impeller Coating & Interior Coating

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
1392	2.00	36.64	8.9	62.4	15.8	59.5	1.23	3.88	62.2	72.6%	30.1	24.0	1777
1207	1.74	34.5	7.7	65.33	13.7	71.2	0.92	2.91	73.2	75.7%	29.5	23.5	1775
1085	1.56	34.01	6.9	67.71	12.3	77.8	0.74	2.35	79.5	75.8%	28.7	22.9	1778
814	1.17	35.24	5.2	74.32	9.2	90.3	0.42	1.33	91.2	72.5%	25.8	20.6	1780
660	0.95	35.9	4.2	77.5	7.5	96.1	0.28	0.87	96.7	67.9%	23.7	18.9	1783

Corrected for Pump Rated Speed 1765 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kW/mg
1383	1.99	61.3	72.6%	29.5	24	1765	11.8
1200	1.73	72.4	75.7%	29.0	23	1765	13.4
1077	1.55	78.3	75.8%	28.1	22	1765	14.4
807	1.16	89.7	72.5%	25.2	20	1765	17.3

Pump No. 1 Field Curve 2/9/07 Post Mechanical Rebuild and Pre Impeller Coating & Interior Coating 2nd Test

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
1516	2.18	35.62	9.7	58.41	17.2	52.6	1.45	4.60	55.8	66.2%	32.3	25.7	1780
1348	1.94	33.7	8.6	61.59	15.3	64.4	1.15	3.63	66.9	71.1%	32.1	25.6	1780
1290	1.86	33.02	8.2	62.69	14.6	68.5	1.05	3.33	70.8	72.7%	31.7	25.3	1780
1025	1.48	34.54	6.5	70.5	11.6	83.1	0.66	2.10	84.5	73.3%	29.8	23.8	1780
781	1.12	35.7	5.0	75.9	8.9	92.9	0.39	1.22	93.7	68.8%	26.9	21.4	1782

Corrected for Pump Rated Speed 1765 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kW/mg
1503	2.16	54.9	66.2%	31.5	25	1765	11.6
1337	1.92	65.8	71.1%	31.3	25	1765	12.9
1279	1.84	69.6	72.7%	30.9	25	1765	13.4
1016	1.46	83.1	73.3%	29.1	23	1765	15.8
774	1.11	92.1	68.8%	26.2	21	1766	18.7

Pump No. 1 Field Curve 4/13/07 Post Impeller Coating & Pre Interior Coating

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
1307	1.88	34.07	8.3	61.98	14.8	64.5	1.08	3.42	66.8	74.2%	29.7	23.7	1779
1168	1.68	32.58	7.5	64.11	13.3	72.8	0.86	2.73	74.7	76.0%	29.0	23.1	1779
1000	1.44	31.26	6.4	66.45	11.3	81.3	0.63	2.00	82.7	75.6%	27.6	22.0	1779
800	1.15	32.28	5.1	71.56	9.1	90.7	0.40	1.28	91.6	72.3%	25.6	20.4	1780
588	0.85	33.0	3.8	75.9	6.7	99.2	0.22	0.69	99.6	65.9%	22.5	17.9	1783

Corrected for Pump Rated Speed 1765 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kW/mg
1297	1.87	65.8	74.2%	29.0	23	1765	12.4
1159	1.67	73.5	76.0%	28.3	23	1765	13.5
992	1.43	81.4	75.6%	27.0	21	1765	15.0
793	1.14	90.1	72.3%	25.0	20	1765	17.4
582	0.84	97.8	65.9%	21.8	17	1766	20.7

Pump No. 1 Field Curve 6/14/07 Post Impeller Coating & Pre Interior Coating 2nd Test

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
1375	1.98	36.74	8.8	63.21	15.6	61.1	1.20	3.78	63.7	73.6%	30.1	24.0	1780
1083	1.56	34.03	6.9	67.45	12.3	77.2	0.74	2.35	78.8	75.5%	28.6	22.8	1779
813	1.17	35.39	5.2	74.68	9.2	90.8	0.42	1.32	91.7	72.7%	25.9	20.6	1782
563	0.81	36.63	3.6	79.8	6.4	99.7	0.20	0.63	100.2	63.8%	22.3	17.8	1784

Corrected for Pump Rated Speed 1765 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kW/mg
1363	1.96	62.7	73.6%	29.3	23	1765	11.9
1075	1.55	77.6	75.5%	27.9	22	1765	14.4
805	1.16	89.9	72.7%	25.2	20	1765	17.3
557	0.80	98.0	63.8%	21.6	17	1765	21.5

Pump No. 1 Field Curve 7/16/07 POST INTERIOR CASING COATING

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
1438	2.07	38.02	9.2	63.29	16.3	58.4	1.31	4.13	61.2	75.8%	29.3	23.4	1781
1292	1.86	36.2	8.2	66.31	14.7	69.6	1.06	3.34	71.8	80.5%	29.1	23.2	1781
1146	1.65	34.74	7.3	68.81	13.0	78.7	0.83	2.63	80.5	81.7%	28.5	22.7	1781
840	1.21	36.47	5.4	77.53	9.5	94.8	0.45	1.41	95.8	80.2%	25.3	20.2	1781
653	0.94	37.14	4.2	81.38	7.4	102.2	0.27	0.85	102.8	74.9%	22.6	18.0	1785

Corrected for Pump Rated Speed 1765 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kW/mg
1425	2.05	60.1	75.8%	28.5	23	1765	11.1
1280	1.84	70.6	80.5%	28.3	23	1765	12.3
1136	1.64	79.1	81.7%	27.8	22	1765	13.5
833	1.20	94.1	80.2%	24.7	20	1765	16.4
646	0.93	100.6	74.9%	21.9	17	1766	18.8

Pump No. 1 Field Curve 9/11/07 POST INTERIOR CASING COATING 30 Day Test

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
1438	2.07	36.04	9.2	60.63	16.3	56.8	1.31	4.13	59.6	75.0%	28.9	23.0	1781
1292	1.86	34.47	8.2	63.48	14.7	67.0	1.06	3.34	69.3	79.0%	28.6	22.8	1781
1181	1.70	33.02	7.5	66.17	13.4	76.6	0.88	2.79	78.5	82.9%	28.2	22.5	1781
917	1.32	34.11	5.9	72.69	10.4	89.1	0.53	1.68	90.3	79.3%	26.3	21.0	1781
806	1.16	34.84	5.1	75.89	9.1	94.8	0.41	1.30	95.7	77.2%	25.2	20.1	1785

Corrected for Pump Rated Speed 1765 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kW/mg
1425	2.05	58.6	75.0%	28.1	22	1765	10.9
1280	1.84	68.1	79.0%	27.8	22	1765	12.0
1170	1.68	77.1	82.9%	27.5	22	1765	13.0
908	1.31	88.7	79.3%	25.6	20	1765	15.6
797	1.15	93.7	77.2%	24.4	19	1766	17.0

Pump No. 1 Field Curve 12/12/07 POST INTERIOR CASING COATING 6 Month Test

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
1219	1.76	33.87	7.8	65.62	13.8	73.3	0.94	2.97	75.4	81.0%	28.7	22.85	1780
1092	1.57	32.69	7.0	67.5	12.4	80.4	0.75	2.39	82.0	81.1%	27.9	22.25	1781
962	1.39	31.8	6.1	69.28	10.9	86.6	0.59	1.85	87.8	79.9%	26.7	21.27	1781
819	1.18	32.5	5.2	73.16	9.3	93.9	0.42	1.34	94.8	77.3%	25.4	20.21	1783
624	0.90	33.1	4.0	77.6	7.1	102.8	0.25	0.78	103.3	70.9%	22.9	18.28	1785

Corrected for Pump Rated Speed 1765 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kW/mg
1209	1.74	74.1	81.0%	28.0	22	1765	12.8
1083	1.56	80.6	81.1%	27.2	22	1765	13.9
953	1.37	86.3	79.9%	26.0	21	1765	15.1
810	1.17	92.9	77.3%	24.6	20	1765	16.8
617	0.89	101.1	70.9%	22.2	18	1766	19.9

Pump No. 1 Field Curve 7/9/08 POST INTERIOR CASING COATING 1 Year Test

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
1313	1.89	35.91	8.4	65.36	14.9	68.0	1.09	3.45	70.4	80.0%	29.2	23.24	1782
1229	1.77	35.16	7.8	66.88	14.0	73.3	0.96	3.02	75.3	80.6%	29.0	23.11	1782
1111	1.60	34.14	7.1	68.68	12.6	79.8	0.78	2.47	81.5	81.1%	28.2	22.47	1782
889	1.28	35.34	5.7	74.88	10.1	91.3	0.50	1.58	92.4	79.3%	26.2	20.85	1783
542	0.78	36.49	3.5	81.68	6.1	104.4	0.19	0.59	104.8	66.7%	21.5	17.12	1787

Corrected for Pump Rated Speed 1765 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kW/mg
1300	1.87	69.0	80.0%	28.3	23	1765	12.1
1217	1.75	73.9	80.6%	28.2	22	1765	12.8
1101	1.58	79.9	81.1%	27.4	22	1765	13.8
880	1.27	90.6	79.3%	25.4	20	1765	16.0
535	0.77	102.3	66.7%	20.7	17	1766	21.4

Pump No. 1 Field Curve 2/26/09 POST INTERIOR CASING COATING 18 month Test (Q from Mag Meter @ Station)

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
1340	1.93	33.76	8.55	61.82	15.21	64.8	1.14	3.59	67.3	77.4%	29.4	23.4	1783
1200	1.73	32.59	7.66	64.22	13.62	73.1	0.91	2.88	75.0	79.0%	28.8	22.9	1784
1080	1.56	31.62	6.89	65.99	12.26	79.4	0.74	2.33	81.0	79.2%	27.9	22.2	1784
873	1.26	32.88	5.57	72.1	9.91	90.5	0.5	1.52	91.6	77.6%	26.0	20.7	1784
685	0.99	33.59	4.37	76.27	7.77	98.6	0.30	0.94	99.2	72.0%	23.9	19.0	1785

Corrected for Pump Rated Speed 1765 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kW/mg
1326	1.91	65.9	77.4%	28.5	23	1765	11.9
1187	1.71	73.4	79.0%	27.9	22	1765	13.0
1068	1.54	79.3	79.2%	27.0	22	1765	14.0
864	1.24	89.6	77.6%	25.2	20	1765	16.1
677	0.98	97.0	72.0%	23.1	18	1765	18.8

Pump No. 1 Field Curve 8/18/09 2 Year Test (Q from Mag Meter @ Station)

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
1423	2.05	33.54	9.08	59.25	16.15	59.4	1.28	4.05	62.2	77.1%	29.0	23.1	1783
1235	1.78	31.04	7.88	62.04	14.02	71.6	0.96	3.05	73.7	79.7%	28.8	23.0	1784
1030	1.48	29.57	6.57	65.5	11.69	83.0	0.67	2.12	84.4	80.6%	27.3	21.7	1784
895	1.29	30.28	5.71	69.1	10.16	89.7	0.5	1.60	90.8	79.3%	25.9	20.6	1784

Corrected for Pump Rated Speed 1765 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kW/mg
1409	2.03	60.9	77.1%	28.1	22	1765	11.0
1222	1.76	72.1	79.7%	27.9	22	1765	12.6
1019	1.47	82.7	80.6%	26.4	21	1765	14.3
885	1.28	88.9	79.3%	25.1	20	1765	15.7

Pump No. 1 Field Curve 6/7/10

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
1493	2.15	39.89	9.53	63.06	16.95	53.5	1.41	4.46	56.6	72.5%	29.4	23.5	1780
1306	1.88	36.20	8.33	65.94	14.82	68.7	1.08	3.41	71.0	80.2%	29.2	23.3	1780
1146	1.65	34.85	7.31	68.51	13.01	77.8	0.83	2.63	79.6	81.0%	28.4	22.6	1782
979	1.41	35.58	6.25	72.9	11.11	86.2	0.61	1.92	87.5	79.7%	27.2	21.6	1782
771	1.11	37.2	4.92	78.9	8.75	96.4	0.38	1.19	97.2	75.7%	25.0	19.93	1784

Corrected for Pump Rated Speed 1765 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kW/mg
1480	2.13	55.6	72.5%	28.7	23	1765	10.7
1295	1.86	69.8	80.2%	28.5	23	1765	12.2
1135	1.63	78.0	81.0%	27.6	22	1765	13.5
970	1.40	85.8	79.7%	26.4	21	1765	15.1
763	1.10	95.2	75.7%	24.3	19	1766	17.6

Pump No. 2 Field Curve 8/17/06 Initial Test

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
1055	1.52	38.2	6.73	63	11.97	57.3	0.70	2.23	58.8	55.3%	28.4	22.6	1791
926	1.33	36.16	5.91	65.35	10.51	67.4	0.54	1.72	68.6	58.1%	27.6	22.0	1781
878	1.26	35.3	5.60	66.27	9.97	71.5	0.49	1.54	72.6	59.1%	27.2	21.7	1782
760	1.09	36.1	4.85	70.6	8.63	79.6	0.4	1.16	80.4	58.9%	26.2	20.9	1782
643	0.93	36.43	4.10	74.37	7.30	87.6	0.26	0.83	88.2	57.7%	24.8	19.8	1783

Corrected for Pump Rated Speed 1765 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kW/mg
1040	1.50	57.1	55.3%	27.1	22	1765	14.4
918	1.32	67.5	58.1%	26.9	21	1766	16.2
871	1.25	71.4	59.1%	26.5	21	1767	16.9
754	1.09	79.2	58.9%	25.6	20	1768	18.8
638	0.92	86.8	57.7%	24.3	19	1769	21.0

Pump No. 2 Field Curve 2/9/07 POST MECHANICAL REBUILD WITH IMPELLER COATING

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
1460	2.10	36.41	9.32	58.11	16.57	50.1	1.35	4.26	53.0	64.5%	30.3	24.2	1782
1348	1.94	34.89	8.60	60.34	15.30	58.8	1.15	3.63	61.3	69.8%	29.9	23.8	1782
1240	1.79	33.59	7.91	62.58	14.07	67.0	0.97	3.08	69.1	73.1%	29.6	23.6	1781
1000	1.44	34.9	6.38	69.6	11.35	80.2	0.6	2.00	81.5	73.4%	28.1	22.4	1781
904	1.30	35.47	5.77	72.37	10.26	85.2	0.52	1.63	86.4	72.9%	27.0	21.6	1782
766	1.10	36.17	4.89	75.71	8.69	91.3	0.37	1.17	92.1	70.2%	25.4	20.2	1784

Corrected for Pump Rated Speed 1765 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kW/mg
1446	2.08	52.0	64.5%	29.5	23	1765	11.3
1336	1.92	60.2	69.8%	29.1	23	1766	12.1
1230	1.77	68.0	73.1%	28.9	23	1767	13.0
993	1.43	80.3	73.4%	27.4	22	1768	15.3
897	1.29	85.1	72.9%	26.5	21	1769	16.3
760	1.09	90.7	70.2%	24.8	20	1770	18.1

Pump No. 2 Field Curve 6/14/07 POST INTERIOR CASING COATING

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
1396	2.01	36.98	8.91	62.4	15.84	58.7	1.23	3.90	61.4	76.0%	28.5	22.7	1778
1194	1.72	33.70	7.62	65.84	13.56	74.2	0.90	2.85	76.2	81.9%	28.1	22.4	1779
1111	1.60	32.05	7.09	67.56	12.61	82.0	0.78	2.47	83.7	85.2%	27.6	22.0	1780
826	1.19	34.64	5.27	76.0	9.38	95.6	0.4	1.37	96.6	81.4%	24.7	19.7	1781
611	0.88	35.82	3.90	81.2	6.94	104.8	0.24	0.75	105.3	75.3%	21.6	17.2	1784

Corrected for Pump Rated Speed 1765 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kW/mg
1386	2.00	60.5	76.0%	27.9	22	1765	11.1
1185	1.71	75.0	81.9%	27.4	22	1765	12.8
1102	1.59	82.3	85.2%	26.9	21	1765	13.5
819	1.18	94.8	81.4%	24.1	19	1765	16.3
605	0.87	103.1	75.3%	20.9	17	1765	19.1

Pump No. 2 Field Curve 7/16/07 POST INTERIOR CASING COATING 30 DAY TEST

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
1424	2.05	38.09	9.09	62.29	16.16	55.9	1.28	4.05	58.7	74.0%	28.5	22.7	1782
1139	1.64	34.88	7.27	68.34	12.93	77.3	0.82	2.59	79.1	81.8%	27.8	22.2	1782
861	1.24	36.42	5.50	77.1	9.77	93.9	0.5	1.48	94.9	82.3%	25.1	20.0	1782
590	0.85	37.33	3.77	83.5	6.70	106.7	0.22	0.70	107.1	75.8%	21.1	16.8	1784

Corrected for Pump Rated Speed 1765 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kW/mg
1410	2.03	57.6	74.0%	27.7	22	1765	10.9
1128	1.62	77.6	81.8%	27.0	22	1765	13.3
853	1.23	93.1	82.3%	24.4	19	1765	15.8
584	0.84	104.9	75.8%	20.4	16	1765	19.3

Pump No. 2 Field Curve 9/11/07 POST INTERIOR CASING COATING 90 DAY TEST

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
1451	2.09	36.28	9.26	58.89	16.47	52.2	1.33	4.21	55.1	70.3%	28.7	22.9	1782
1340	1.93	34.71	8.55	61.73	15.21	62.4	1.14	3.59	64.9	76.8%	28.6	22.8	1782
1160	1.67	32.79	7.40	65.72	13.16	76.1	0.85	2.69	77.9	81.5%	28.0	22.3	1782
1014	1.46	33.46	6.47	70.2	11.51	84.9	0.7	2.06	86.3	81.6%	27.1	21.6	1782
507	0.73	35.74	3.24	82.9	5.75	108.9	0.16	0.51	109.3	69.7%	20.1	16.0	1784

Corrected for Pump Rated Speed 1765 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kW/mg
1438	2.07	54.1	70.3%	27.9	22	1765	10.7
1327	1.91	63.6	76.8%	27.8	22	1765	11.6
1149	1.65	76.4	81.5%	27.2	22	1765	13.1
1004	1.45	84.7	81.6%	26.3	21	1765	14.5
502	0.72	107.0	69.7%	19.4	15	1765	21.5

Pump No. 2 Field Curve 12/12/07 POST INTERIOR CASING COATING 6 Month Test

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
1227	1.77	33.77	7.83	65.12	13.93	72.4	0.95	3.01	74.5	80.9%	28.5	22.8	1783
1072	1.54	32.36	6.84	67.88	12.16	82.1	0.73	2.30	83.6	81.6%	27.7	22.1	1784
992	1.43	31.71	6.33	69.14	11.26	86.5	0.62	1.97	87.8	81.4%	27.0	21.6	1784
851	1.23	32.38	5.43	73.0	9.66	93.9	0.5	1.45	94.9	80.0%	25.5	20.3	1784
670	0.97	33.01	4.28	77.3	7.61	102.3	0.28	0.90	102.9	75.2%	23.2	18.5	1785

Corrected for Pump Rated Speed 1765 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kW/mg
1215	1.75	73.0	80.9%	27.7	22	1765	12.6
1060	1.53	81.9	81.6%	26.9	21	1765	14.0
982	1.41	85.9	81.4%	26.2	21	1765	14.8
842	1.21	92.9	80.0%	24.7	20	1765	16.2
663	0.95	100.6	75.2%	22.4	18	1765	18.7

Pump No. 2 Field Curve 7/9/08 POST INTERIOR CASING COATING 1 Year Test

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
1438	2.07	38.53	9.17	60.9	16.32	51.7	1.31	4.13	54.5	70.5%	28.1	22.4	1783
1236	1.78	35.56	7.89	65.23	14.03	68.5	0.97	3.06	70.6	78.7%	28.0	22.3	1784
1097	1.58	34.18	7.00	67.85	12.45	77.8	0.76	2.41	79.4	80.1%	27.5	21.9	1784
868	1.25	35.42	5.54	74.8	9.85	90.9	0.5	1.51	91.9	78.5%	25.7	20.5	1784
632	0.91	36.28	4.03	80.52	7.17	102.2	0.25	0.80	102.7	72.7%	22.6	18.0	1785

Corrected for Pump Rated Speed 1765 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kW/mg
1423	2.05	53.4	70.5%	27.2	22	1765	10.6
1223	1.76	69.1	78.7%	27.1	22	1765	12.3
1086	1.56	77.7	80.1%	26.6	21	1765	13.6
859	1.24	90.0	78.5%	24.8	20	1765	16.0
625	0.90	100.5	72.7%	21.8	17	1765	19.3

Pump No. 2 Field Curve 2/26/09 POST INTERIOR CASING COATING 18 month Test (Q from Mag Meter @ Station)

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
1295	1.86	34.15	8.26	60.77	14.70	61.5	1.06	3.35	63.8	74.6%	28.0	22.3	1783
1164	1.68	32.78	7.43	63.31	13.21	70.5	0.86	2.71	72.4	76.9%	27.7	22.0	1784
1040	1.50	31.73	6.64	65.11	11.80	77.1	0.68	2.16	78.6	76.2%	27.1	21.6	1784
785	1.13	33.17	5.01	72.9	8.91	91.8	0.4	1.23	92.7	74.3%	24.7	19.7	1784
610	0.88	33.78	3.89	76.94	6.92	99.7	0.24	0.74	100.2	69.1%	22.3	17.8	1785

Corrected for Pump Rated Speed 1765 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kW/mg
1282	1.85	62.5	74.6%	27.1	22	1765	11.7
1152	1.66	70.8	76.9%	26.8	21	1765	12.9
1029	1.48	76.9	76.2%	26.2	21	1765	14.1
777	1.12	90.7	74.3%	23.9	19	1765	17.1
603	0.87	98.0	69.1%	21.6	17	1765	19.8

Pump No. 2 Field Curve 8/18/09 Two Year Test (Q from Mag Meter @ Station)

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
1320	1.90	33.40	8.42	58.91	14.98	58.9	1.10	3.49	61.3	74.0%	27.6	22.0	1778
1230	1.77	31.91	7.85	60.54	13.96	66.1	0.96	3.03	68.2	76.9%	27.6	22.0	1778

Corrected for Pump Rated Speed 1765 RPM

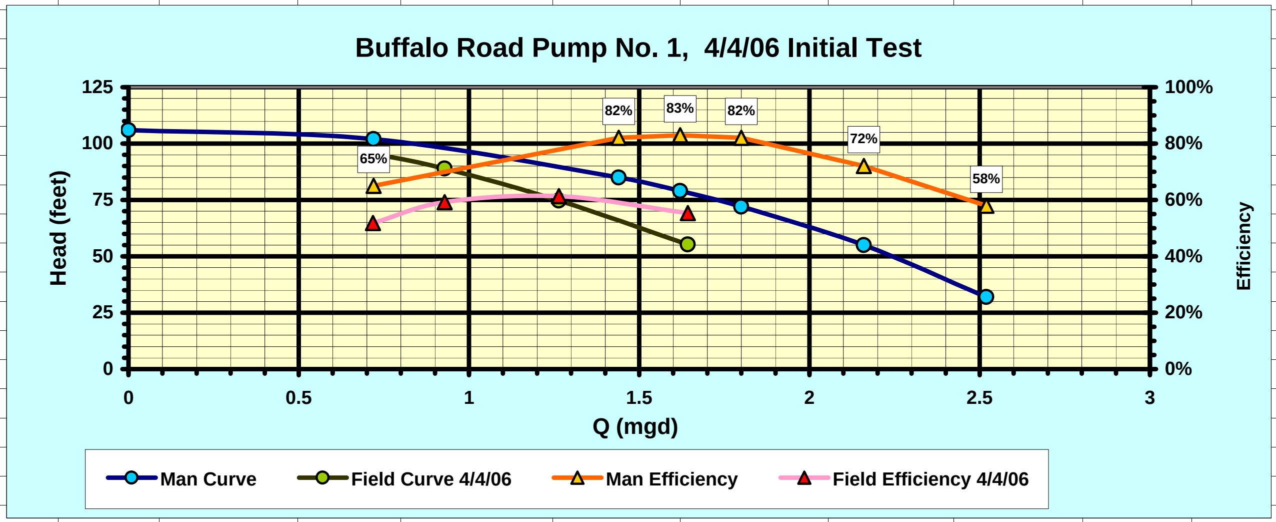
Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kW/mg
1310	1.89	60.4	74.0%	27.0	22	1765	11.4
1221	1.76	67.2	76.9%	27.0	21	1765	12.2

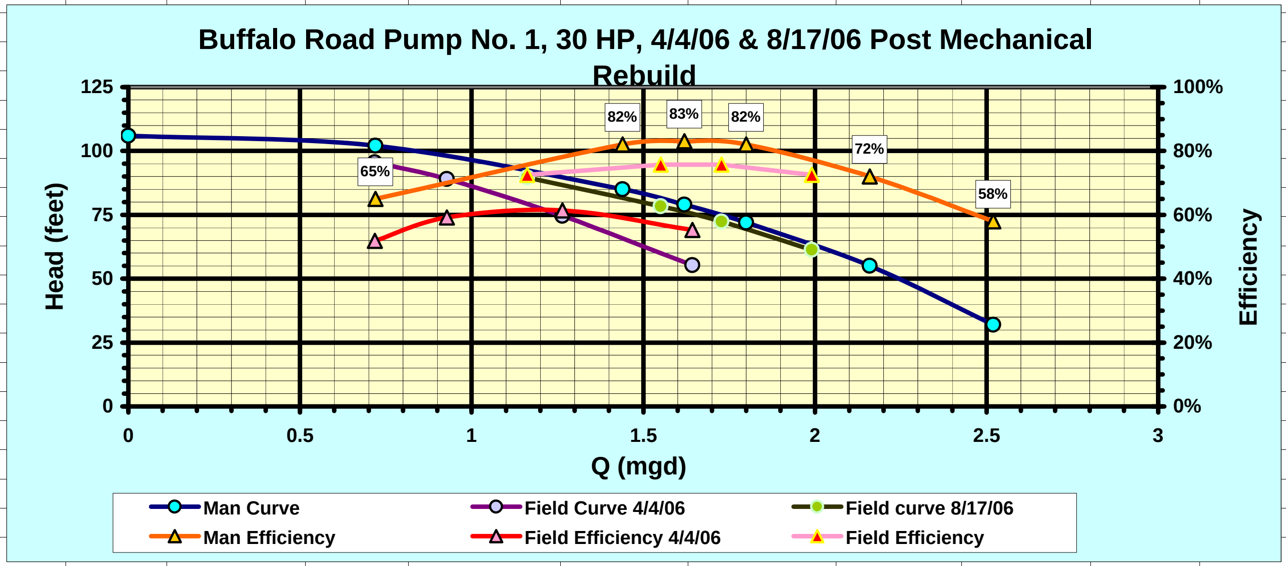
Pump No. 2 Field Curve 6/7/10

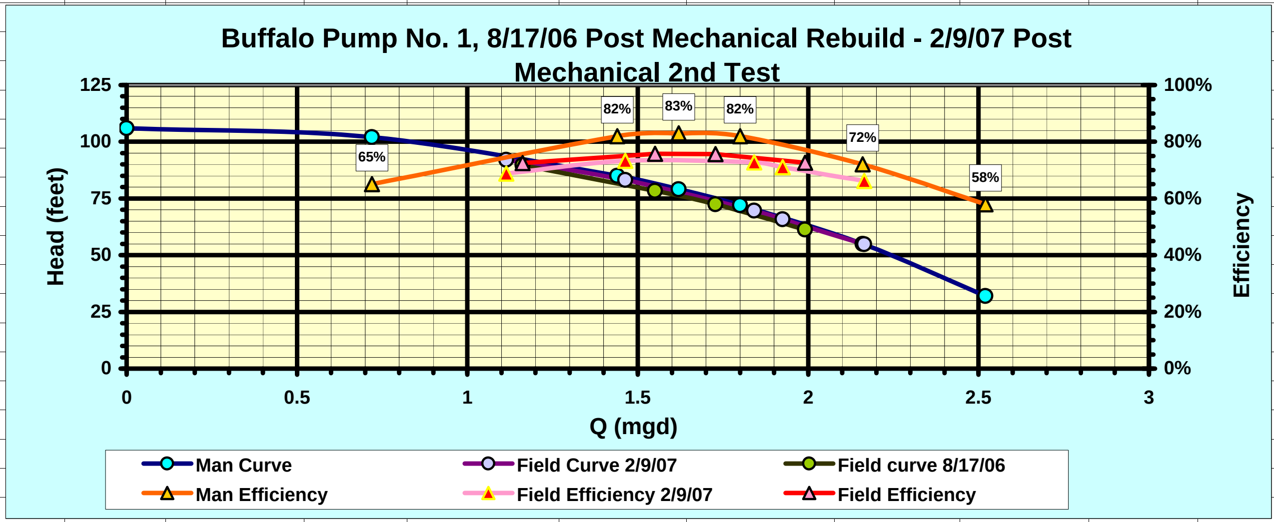
Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
1417	2.04	40.14	9.04	62.11	16.08	50.8	1.27	4.01	53.5	69.0%	27.7	22.1	1782
1250	1.80	36.73	7.98	65.28	14.19	66.0	0.99	3.13	68.1	77.5%	27.7	22.1	1782
1090	1.57	34.92	6.96	67.99	12.37	76.4	0.75	2.38	78.0	79.1%	27.1	21.6	1782

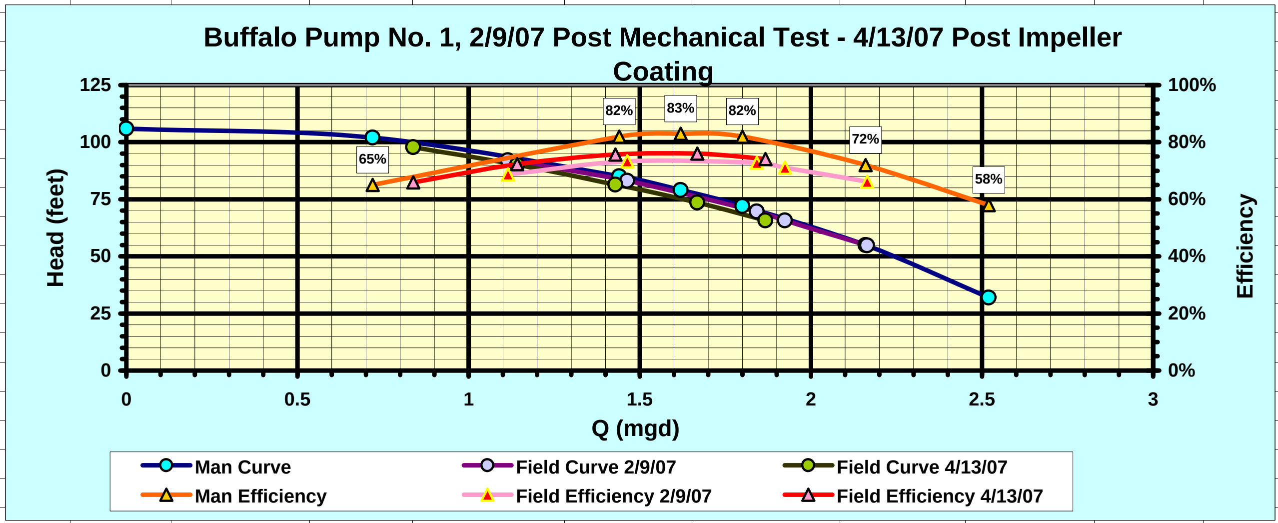
Corrected for Pump Rated Speed 1765 RPM

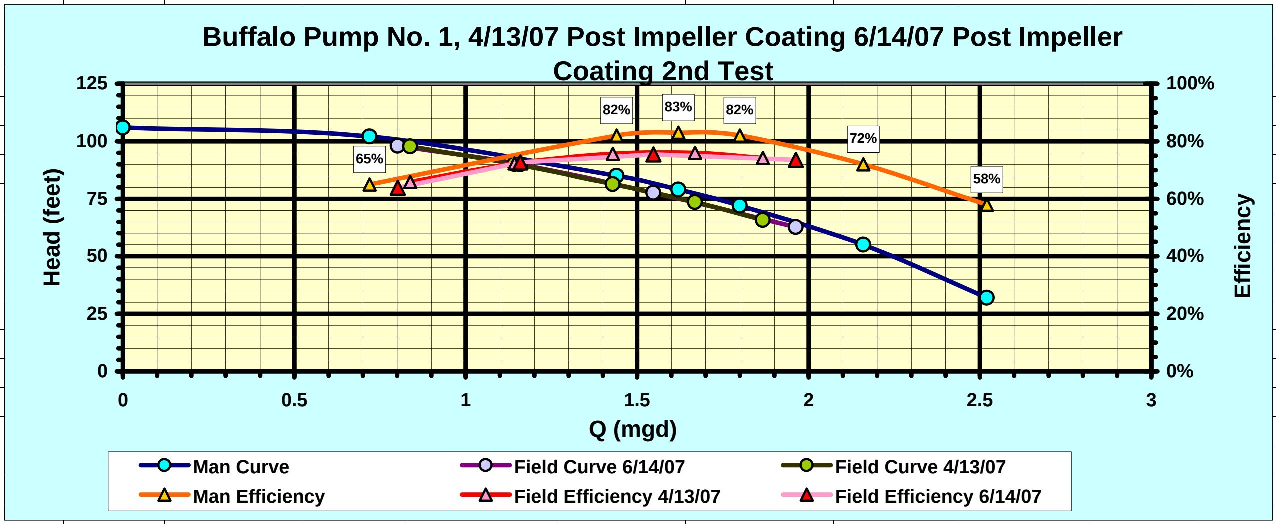
Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kW/mg
1403	2.02	52.5	69.0%	26.9	21	1765	10.6
1238	1.78	66.8	77.5%	26.9	21	1765	12.0
1080	1.56	76.5	79.1%	26.4	21	1765	13.5


Buffalo Road Pump No. 1, 4/4/06 Initial Test
Head (feet)
Efficiency
Q (mgd)
82%
83%
82%
72%
58%
65%
Man Curve
Field Curve 4/4/06
Man Efficiency
Field Efficiency 4/4/06

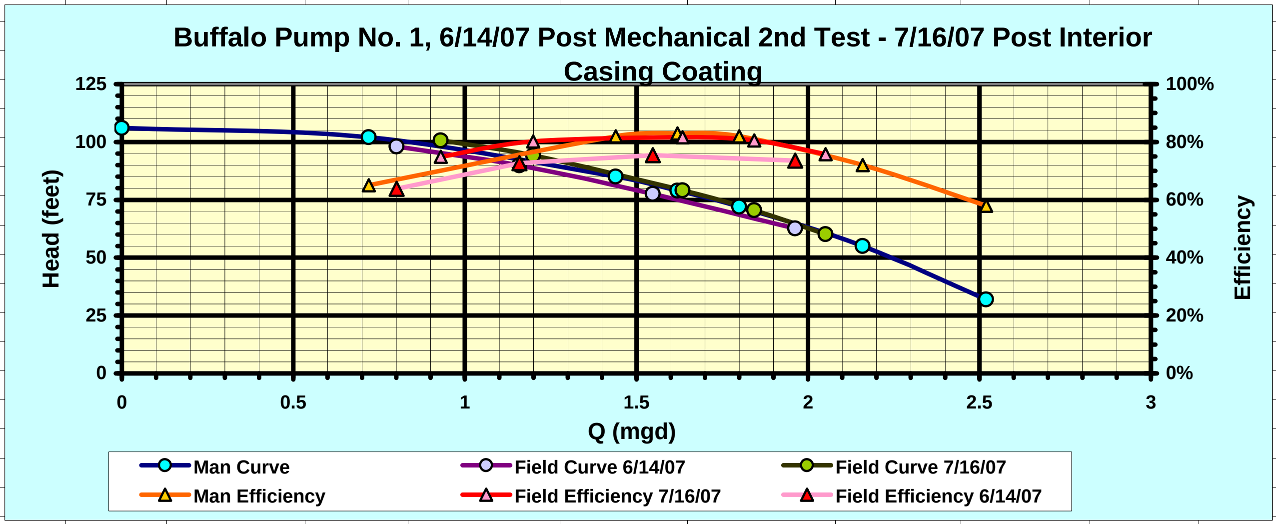

Buffalo Road Pump No. 1, 30 HP, 4/4/06 & 8/17/06 Post Mechanical Rebuild
Head (feet)
Efficiency
Q (mgd)
82%
83%
82%
72%
58%
65%
Man Curve
Field Curve 4/4/06
Field curve 8/17/06
Man Efficiency
Field Efficiency 4/4/06
Field Efficiency


Buffalo Pump No. 1, 8/17/06 Post Mechanical Rebuild - 2/9/07 Post Mechanical 2nd Test
Head (feet)
Efficiency
Q (mgd)
65%
82%
83%
82%
72%
58%
Man Curve
Field Curve 2/9/07
Field curve 8/17/06
Man Efficiency
Field Efficiency 2/9/07
Field Efficiency

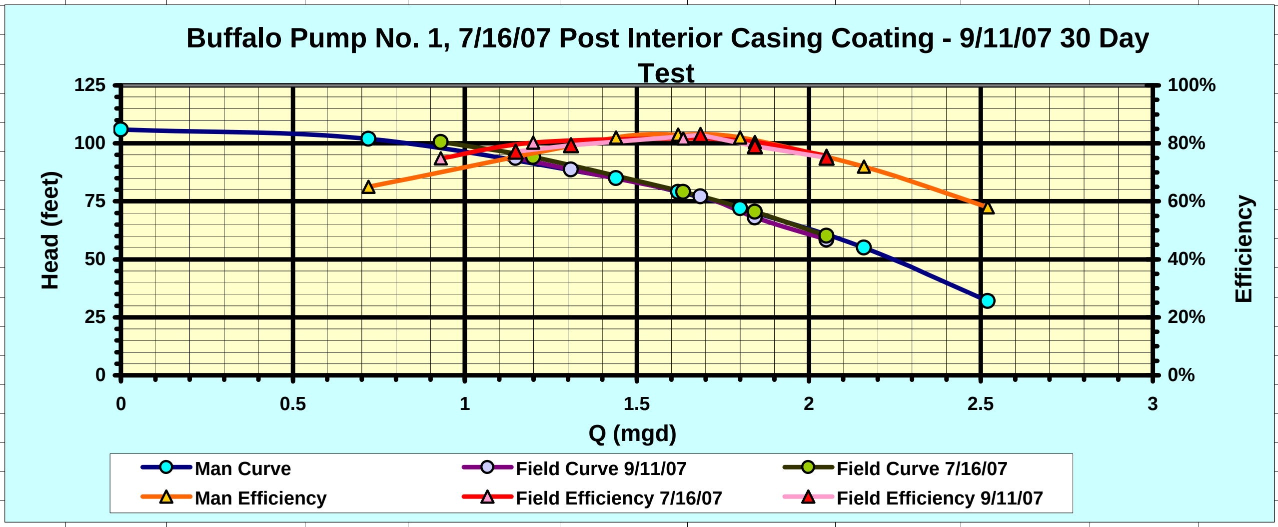

Buffalo Pump No. 1, 2/9/07 Post Mechanical Test - 4/13/07 Post Impeller Coating
Head (feet)
Efficiency
Q (mgd)
65%
82%
83%
82%
72%
58%
Man Curve
Field Curve 2/9/07
Field Curve 4/13/07
Man Efficiency
Field Efficiency 2/9/07
Field Efficiency 4/13/07



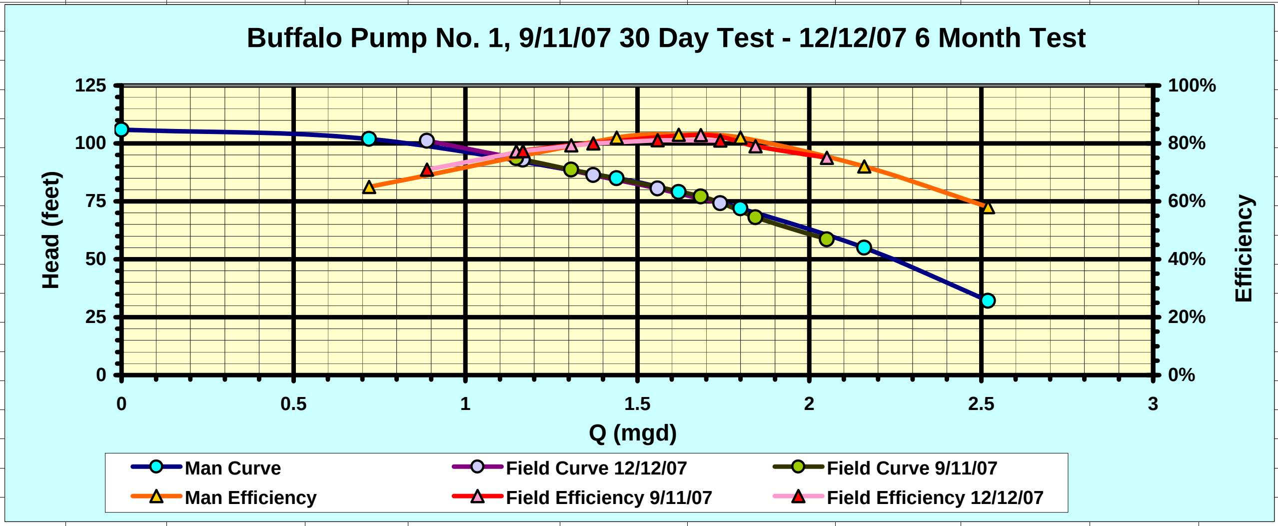
Buffalo Pump No. 1, 4/13/07 Post Impeller Coating 6/14/07 Post Impeller Coating 2nd Test
Head (feet)
Efficiency
Q (mgd)
125
100
75
50
25
0
100%
80%
60%
40%
20%
0%
0
0.5
1
1.5
2
2.5
3
65%
82%
83%
82%
72%
58%
Man Curve
Field Curve 6/14/07
Field Curve 4/13/07
Man Efficiency
Field Efficiency 4/13/07
Field Efficiency 6/14/07



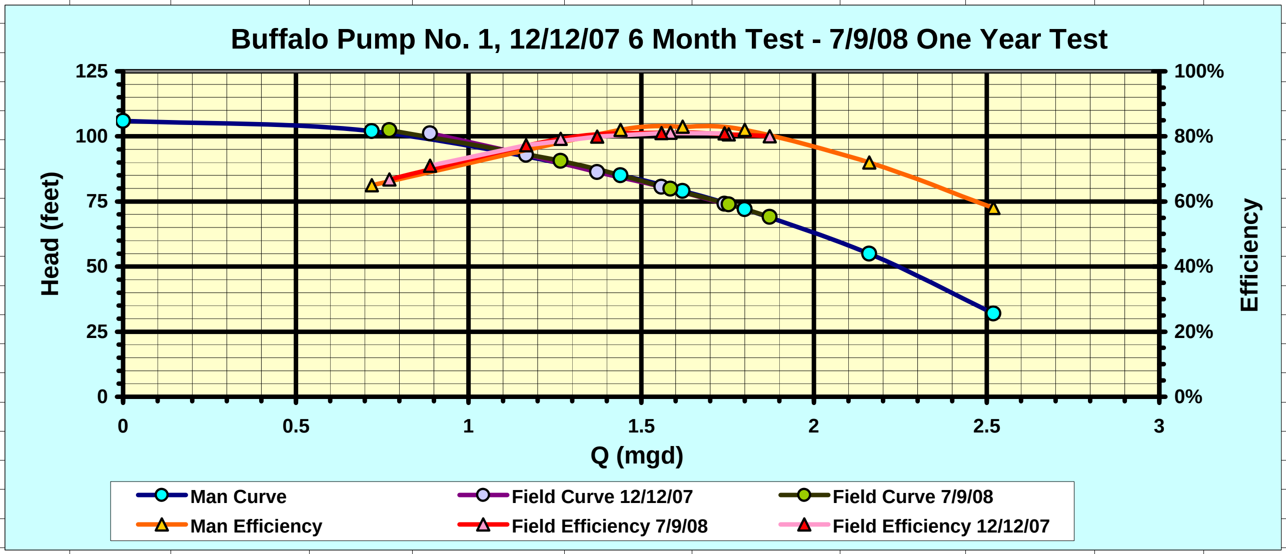
Buffalo Pump No. 1, 6/14/07 Post Mechanical 2nd Test - 7/16/07 Post Interior Casing Coating
Head (feet)
Efficiency
Q (mgd)
125
100
75
50
25
0
100%
80%
60%
40%
20%
0%
0
0.5
1
1.5
2
2.5
3
Man Curve
Field Curve 6/14/07
Field Curve 7/16/07
Man Efficiency
Field Efficiency 7/16/07
Field Efficiency 6/14/07

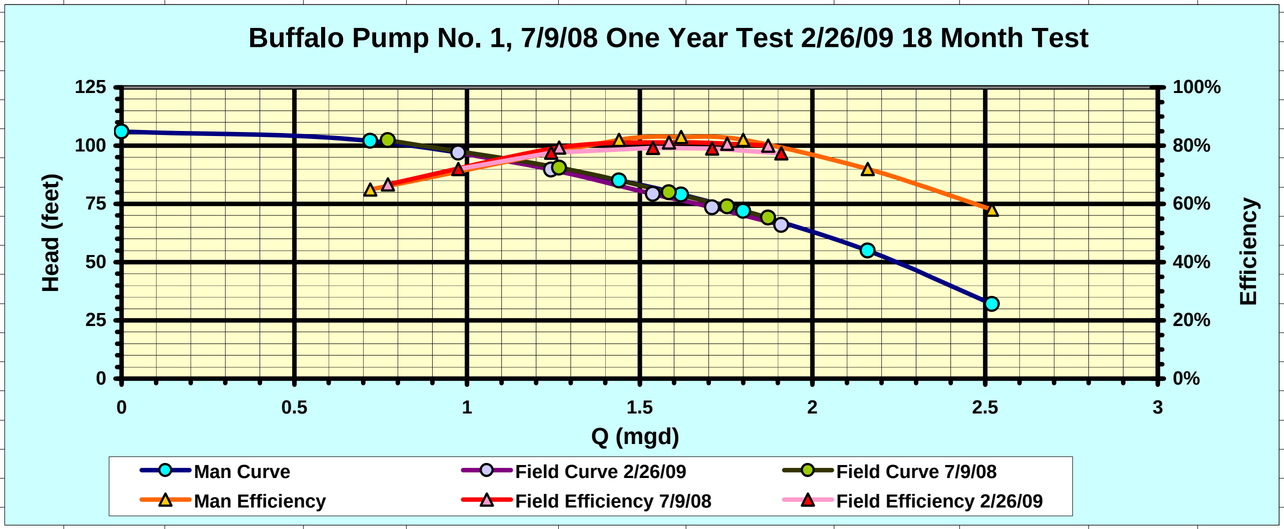


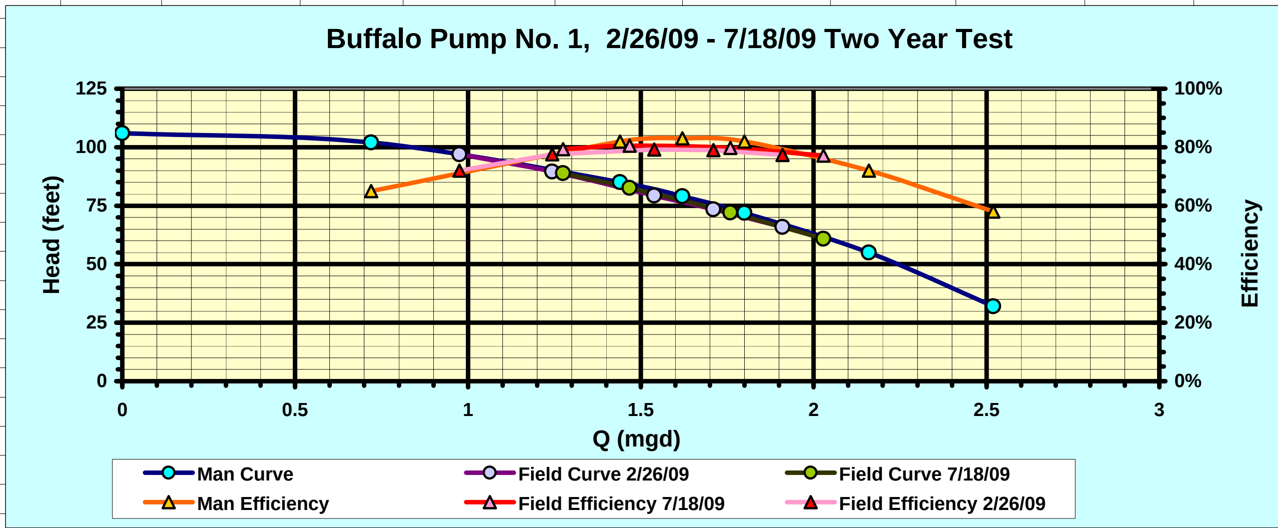
Buffalo Pump No. 1, 7/16/07 Post Interior Casing Coating - 9/11/07 30 Day Test
Head (feet)
Efficiency
Q (mgd)
125
100
75
50
25
0
100%
80%
60%
40%
20%
0%
0
0.5
1
1.5
2
2.5
3
Man Curve
Field Curve 9/11/07
Field Curve 7/16/07
Man Efficiency
Field Efficiency 7/16/07
Field Efficiency 9/11/07

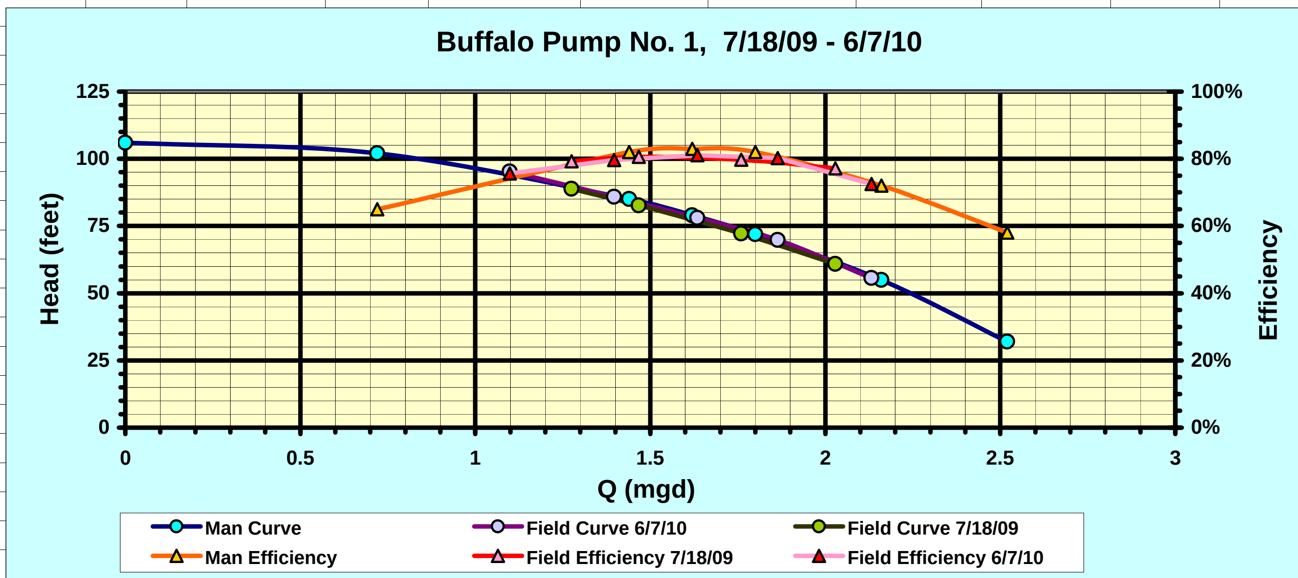


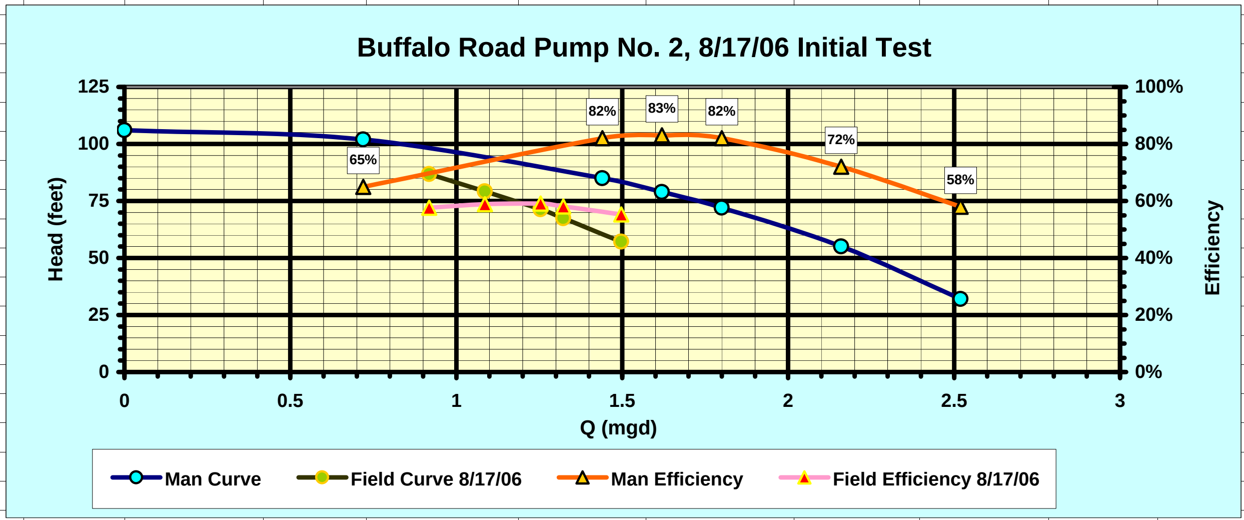
Buffalo Pump No. 1, 9/11/07 30 Day Test - 12/12/07 6 Month Test
Head (feet)
Efficiency
Q (mgd)
125
100
75
50
25
0
100%
80%
60%
40%
20%
0%
0
0.5
1
1.5
2
2.5
3
Man Curve
Field Curve 12/12/07
Field Curve 9/11/07
Man Efficiency
Field Efficiency 9/11/07
Field Efficiency 12/12/07

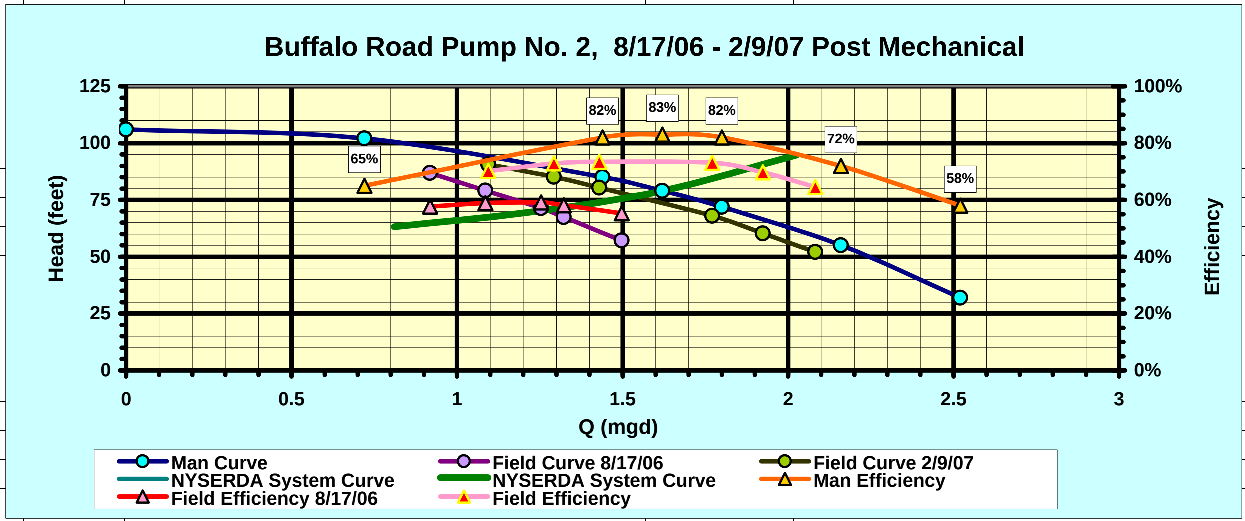

Buffalo Pump No. 1, 12/12/07 6 Month Test - 7/9/08 One Year Test
Head (feet)
Efficiency
Q (mgd)
0
25
50
75
100
125
0%
20%
40%
60%
80%
100%
0
0.5
1
1.5
2
2.5
3
Man Curve
Field Curve 12/12/07
Field Curve 7/9/08
Man Efficiency
Field Efficiency 7/9/08
Field Efficiency 12/12/07

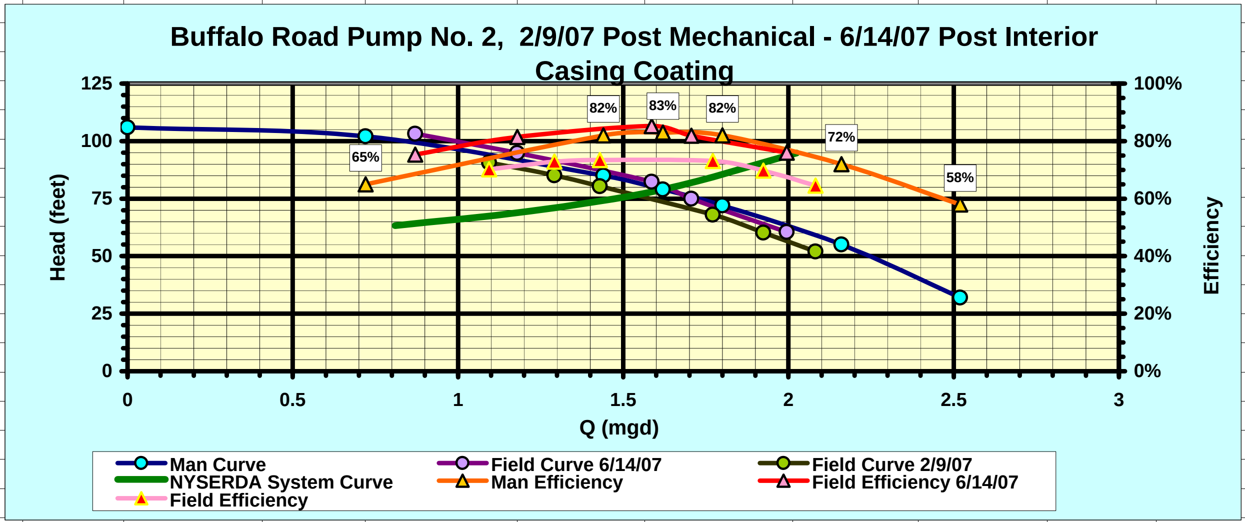

Buffalo Pump No. 1, 7/9/08 One Year Test 2/26/09 18 Month Test
Head (feet)
Efficiency
Q (mgd)
0
25
50
75
100
125
0%
20%
40%
60%
80%
100%
0
0.5
1
1.5
2
2.5
3
Man Curve
Field Curve 2/26/09
Field Curve 7/9/08
Man Efficiency
Field Efficiency 7/9/08
Field Efficiency 2/26/09

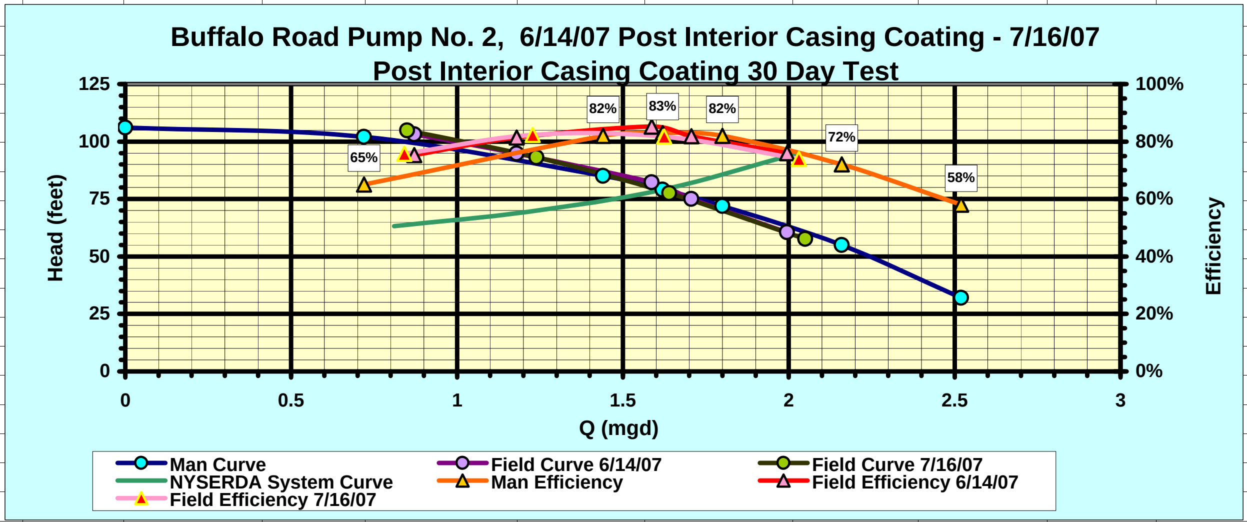

Buffalo Pump No. 1, 2/26/09 - 7/18/09 Two Year Test
Head (feet)
Efficiency
Q (mgd)
Man Curve
Field Curve 2/26/09
Field Curve 7/18/09
Man Efficiency
Field Efficiency 7/18/09
Field Efficiency 2/26/09

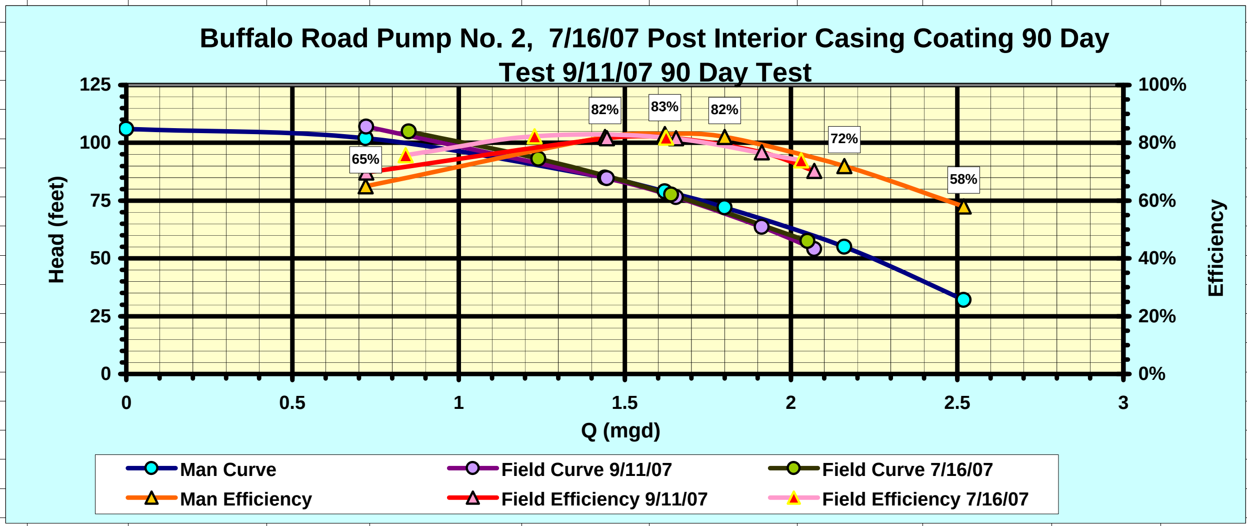

Buffalo Pump No. 1, 7/18/09 - 6/7/10
Head (feet)
Efficiency
Q (mgd)
Man Curve
Field Curve 6/7/10
Field Curve 7/18/09
Man Efficiency
Field Efficiency 7/18/09
Field Efficiency 6/7/10


Buffalo Road Pump No. 2, 8/17/06 Initial Test
Head (feet)
Efficiency
Q (mgd)
125
100
75
50
25
0
100%
80%
60%
40%
20%
0%
0
0.5
1
1.5
2
2.5
3
65%
82%
83%
82%
72%
58%
Man Curve
Field Curve 8/17/06
Man Efficiency
Field Efficiency 8/17/06

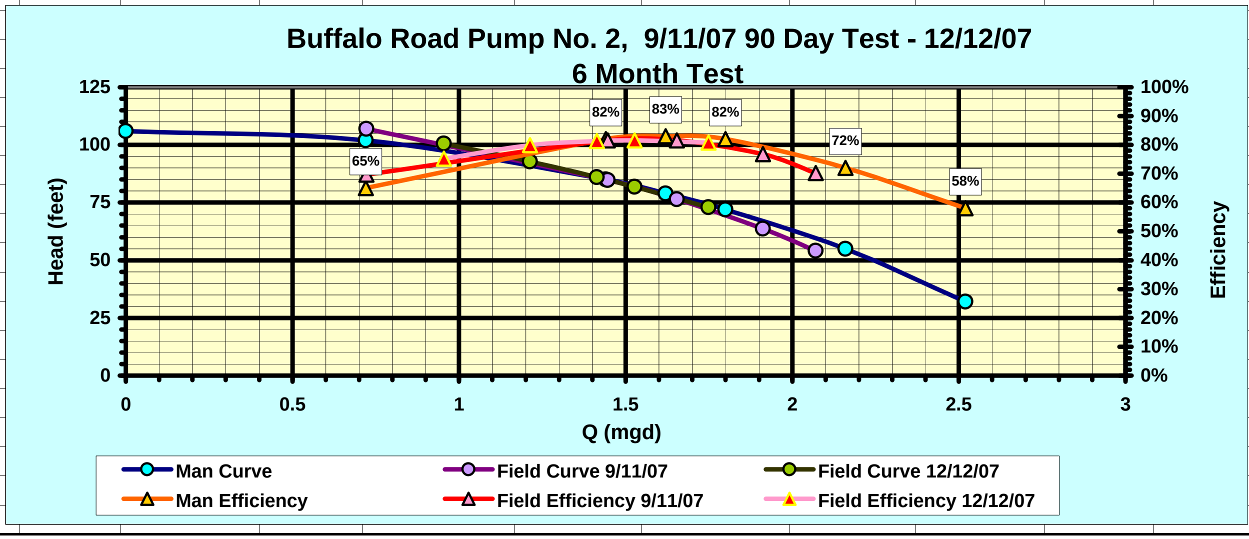

Buffalo Road Pump No. 2, 8/17/06 - 2/9/07 Post Mechanical
Head (feet)
Efficiency
Q (mgd)
125
100
75
50
25
0
100%
80%
60%
40%
20%
0%
0
0.5
1
1.5
2
2.5
3
65%
82%
83%
82%
72%
58%
Man Curve
Field Curve 8/17/06
Field Curve 2/9/07
NYSERDA System Curve
NYSERDA System Curve
Man Efficiency
Field Efficiency 8/17/06
Field Efficiency


Buffalo Road Pump No. 2, 2/9/07 Post Mechanical - 6/14/07 Post Interior Casing Coating
Head (feet)
Efficiency
Q (mgd)
125
100
75
50
25
0
100%
80%
60%
40%
20%
0%
0
0.5
1
1.5
2
2.5
3
65%
82%
83%
82%
72%
58%
Man Curve
Field Curve 6/14/07
Field Curve 2/9/07
NYSERDA System Curve
Man Efficiency
Field Efficiency 6/14/07
Field Efficiency

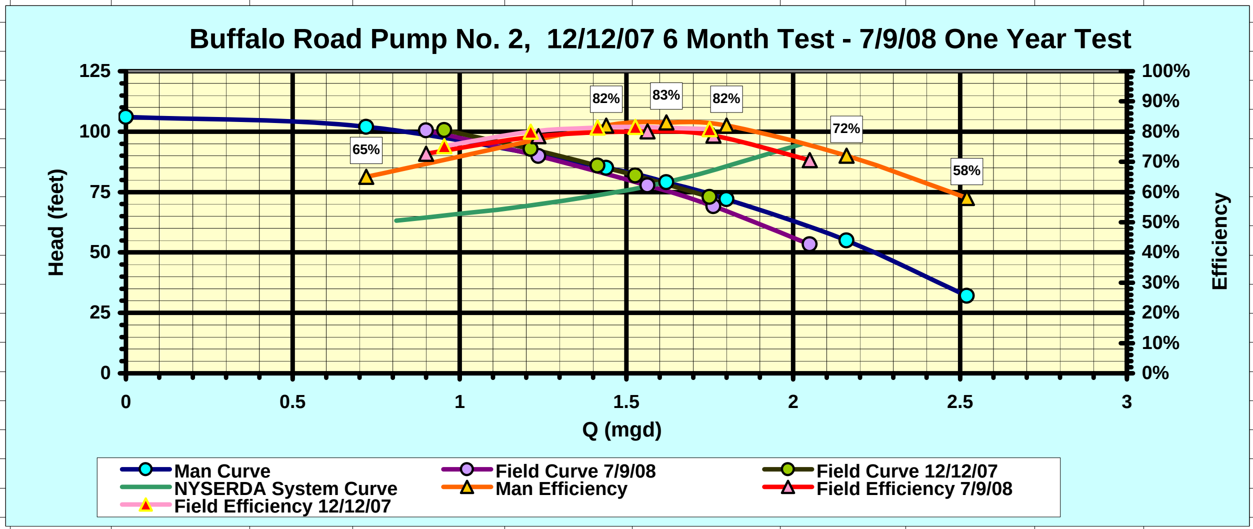

Buffalo Road Pump No. 2, 6/14/07 Post Interior Casing Coating - 7/16/07 Post Interior Casing Coating 30 Day Test
Head (feet)
Efficiency
Q (mgd)
125
100
75
50
25
0
100%
80%
60%
40%
20%
0%
0
0.5
1
1.5
2
2.5
3
65%
82%
83%
82%
72%
58%
Man Curve
Field Curve 6/14/07
Field Curve 7/16/07
NYSERDA System Curve
Man Efficiency
Field Efficiency 6/14/07
Field Efficiency 7/16/07



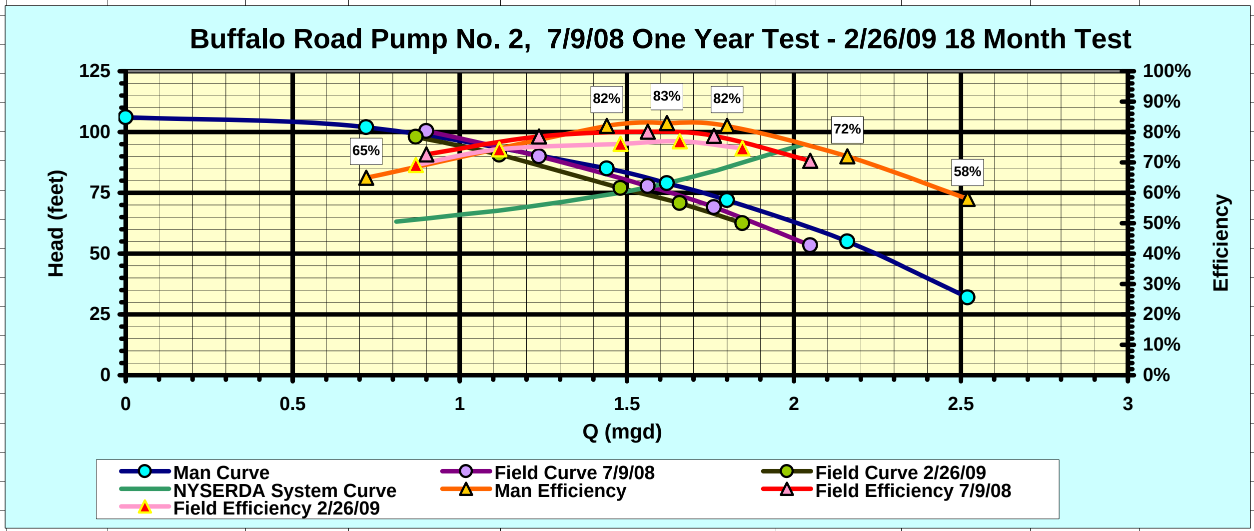
Buffalo Road Pump No. 2, 7/16/07 Post Interior Casing Coating 90 Day Test 9/11/07 90 Day Test
Head (feet)
Efficiency
Q (mgd)
125
100
75
50
25
0
100%
80%
60%
40%
20%
0%
0
0.5
1
1.5
2
2.5
3
65%
82%
83%
82%
72%
58%
Man Curve
Field Curve 9/11/07
Field Curve 7/16/07
Man Efficiency
Field Efficiency 9/11/07
Field Efficiency 7/16/07



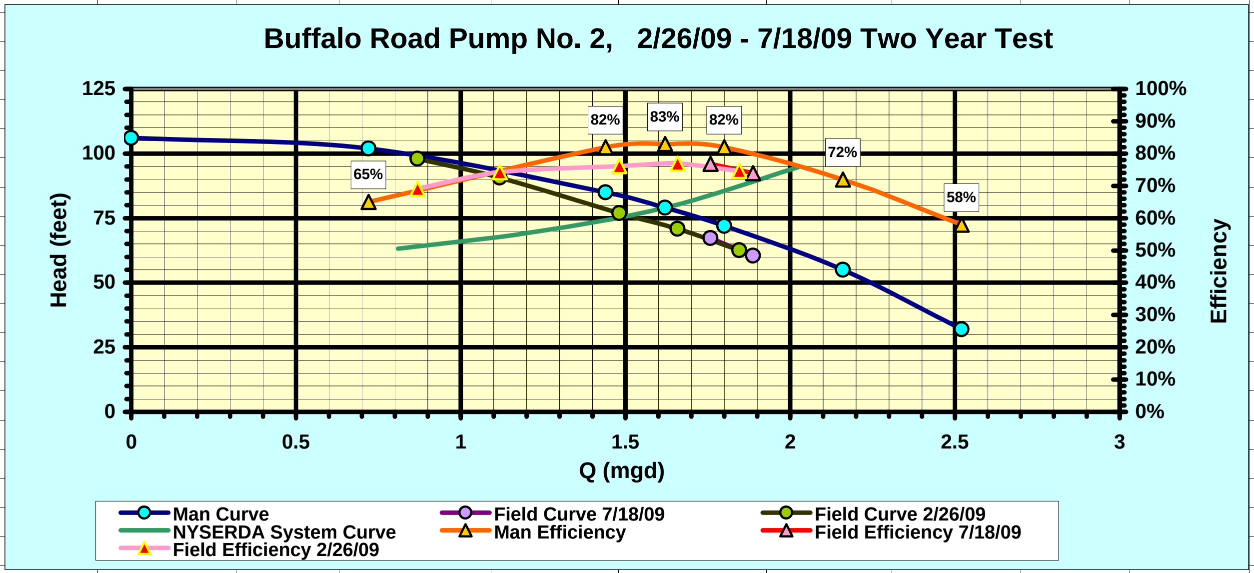
Buffalo Road Pump No. 2, 9/11/07 90 Day Test - 12/12/07 6 Month Test
Head (feet)
Efficiency
Q (mgd)
125
100
75
50
25
0
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0
0.5
1
1.5
2
2.5
3
65%
82%
83%
82%
72%
58%
Man Curve
Field Curve 9/11/07
Field Curve 12/12/07
Man Efficiency
Field Efficiency 9/11/07
Field Efficiency 12/12/07

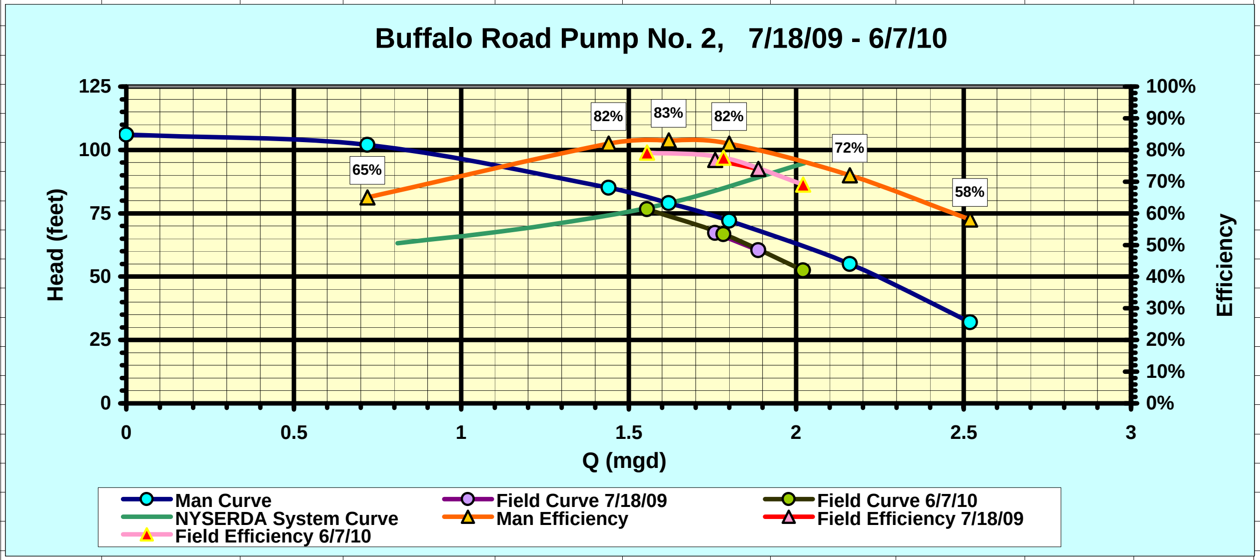


Buffalo Road Pump No. 2, 12/12/07 6 Month Test - 7/9/08 One Year Test
Head (feet)
Efficiency
Q (mgd)
125
100
75
50
25
0
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0
0.5
1
1.5
2
2.5
3
65%
82%
83%
82%
72%
58%
Man Curve
NYSERDA System Curve
Field Efficiency 12/12/07
Field Curve 7/9/08
Man Efficiency
Field Curve 12/12/07
Field Efficiency 7/9/08



Buffalo Road Pump No. 2, 7/9/08 One Year Test - 2/26/09 18 Month Test
Head (feet)
Efficiency
Q (mgd)
125
100
75
50
25
0
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0
0.5
1
1.5
2
2.5
3
65%
82%
83%
82%
72%
58%
Man Curve
NYSERDA System Curve
Field Efficiency 2/26/09
Field Curve 7/9/08
Man Efficiency
Field Curve 2/26/09
Field Efficiency 7/9/08


Buffalo Road Pump No. 2, 2/26/09 - 7/18/09 Two Year Test
Head (feet)
125
100
75
50
25
0
Efficiency
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0
0.5
1
1.5
2
2.5
3
Q (mgd)
65%
82%
83%
82%
72%
58%
Man Curve
NYSERDA System Curve
Field Efficiency 2/26/09
Field Curve 7/18/09
Man Efficiency
Field Curve 2/26/09
Field Efficiency 7/18/09


Buffalo Road Pump No. 2, 7/18/09 - 6/7/10
Head (feet)
125
100
75
50
25
0
Efficiency
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0
0.5
1
1.5
2
2.5
3
Q (mgd)
65%
82%
83%
82%
72%
58%
Man Curve
NYSERDA System Curve
Field Efficiency 6/7/10
Field Curve 7/18/09
Man Efficiency
Field Curve 6/7/10
Field Efficiency 7/18/09

Echo Pump No. 1
Energy Savings Calculation

Continuous Service

Pre Refurbishment	
Head (ft)	157.8
Flow (gpm)	9292
Efficiency	83.9%
Hours Operation/month	730
BHP	441
kW (Assumes Motor Eff 95%)	346.6
kW Demand Charge	$3,466
kwh cost	$21,504
Total Monthly kWH	252,986
Monthly Cost	**$24,969.41**

Constants	
Hours/ Month	730
kW Demand Cost	$10.00
kwh Cost	$0.085
Motor Efficiency	95.0%

Post Casing Coating	
Head (ft)	159.4
Flow (gpm)	9444
Efficiency	87.1%
Hours Operation/month	718
BHP	436
kW (Assumes Motor Eff 95%)	342.7
kW Demand Charge	$3,427
kwh cost	$20,924
Total Monthly kWH	246163
Monthly Cost	**$24,351.08**

Pre - Post Internal Coating Comparison	
Monthly Savings	**$618**
Annual Savings	**$7,420**
5 Year Savings	**$37,100**
kW Demand Reduction	**3.8**
Monthly kwh Savings	**6824**
Yearly kwh Savings	**81884**

20% Service Time

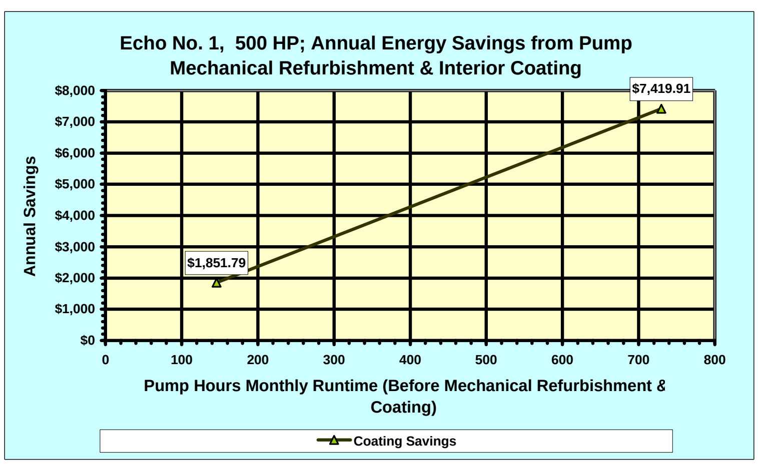
Pre Refurbishment	
Head (ft)	157.8
Flow (gpm)	9292
Efficiency	83.9%
Hours Operation/month	146
BHP	441
kW (Assumes Motor Eff 95%)	346.6
kW Demand Charge	$3,466
kwh cost	$4,301
Total Monthly kWH	50,597
Monthly Cost	**$7,766.34**

Constants	
Hours/ Month	730
kW Demand Cost	$10.00
kwh Cost	$0.085
Motor Efficiency	95.0%

Post Casing Coating	
Head (ft)	159.4
Flow (gpm)	9444
Efficiency	87.1%
Hours Operation/month	144
BHP	436
kW (Assumes Motor Eff 95%)	342.7
kW Demand Charge	$3,427
kwh cost	$4,185
Total Monthly kWH	49233
Monthly Cost	**$7,612.02**

Pre - Post Internal Coating Comparison	
Monthly Savings	**$154**
Annual Savings	**$1,852**
5 Year Savings	**$9,259**
kW Demand Reduction	**3.8**
Monthly kwh Savings	**1365**
Yearly kwh Savings	**16377**

Coating Pump Hours of Operation Before Refurbishment & Interior Coating	
730	**$7,419.91**
146	**$1,851.79**



Echo Pump No. 2
Energy Savings Calculation
NYSERDA Pump Refurbishment & Coating Project

Continuous Service

Pre Mechanical

Head (ft)	202.5
Flow (gpm)	8310
Efficiency	78.6%
Hours Operation/month	730
BHP	541
kW (Assumes Motor Eff 95%)	424.5
kW Demand Charge	$4,245
kwh cost	$26,343
Total Monthly kWH	309,918
Monthly Cost	**$30,588.45**

Constants

Hours/ Month	730
kW Demand Cost	$10.00
kwh Cost	$0.085
Motor Efficiency	95.0%

Post Mechanical

Head (ft)	203.5
Flow (gpm)	8405
Efficiency	81.9%
Hours Operation/month	722
BHP	527
kW (Assumes Motor Eff 95%)	414.1
kW Demand Charge	$4,141
kwh cost	$25,406
Total Monthly kWH	298899
Monthly Cost	**$29,547.73**

Pre - Post Mechanical Comparison

Monthly Savings	**$1,041**
Annual Savings	**$12,489**
5 Year Savings	**$62,444**
kW Demand Reduction	**10.4**
Monthly kwh Savings	**11019**
Yearly kwh Savings	**132225**

Post Casing Coating

Head (ft)	207.6
Flow (gpm)	8950
Efficiency	87.1%
Hours Operation/month	678
BHP	539
kW (Assumes Motor Eff 95%)	423.0
kW Demand Charge	$4,230
kwh cost	$24,371
Total Monthly kWH	286717
Monthly Cost	**$28,601.04**

Pre - Post Internal Coating Comparison

Monthly Savings	**$947**
Annual Savings	**$11,360**
5 Year Savings	**$56,801**
kW Demand Reduction	**-8.88**
Monthly kwh Savings	**12182**
Yearly kwh Savings	**146186**

Total Energy Savings
Pre Mechanical to Post Interior Coating Comparison

Monthly Savings	**$1,987**
Annual Savings	**$23,849**
5 Year Savings	**$119,245**
kW Demand Reduction	**1.53**
Monthly kwh Savings	**23201**
Yearly kwh Savings	**278411**

Echo Pump No. 2 Cont'

20% Service Time

Pre Mechanical	
Head (ft)	202.5
Flow (gpm)	8310
Efficiency	78.6%
Hours Operation/month	146
BHP	541
kW (Assumes Motor Eff 95%)	424.5
kW Demand Charge	$4,245
kwh cost	$5,269
Total Monthly kWH	61,984
Monthly Cost	**$9,514.05**

Constants	
Hours/ Month	730
kW Demand Cost	$10.00
kwh Cost	$0.085
Motor Efficiency	95.0%

Post Mechanical	
Head (ft)	203.5
Flow (gpm)	8405
Efficiency	81.9%
Hours Operation/month	144
BHP	527
kW (Assumes Motor Eff 95%)	414.1
kW Demand Charge	$4,141
kwh cost	$5,081
Total Monthly kWH	59780
Monthly Cost	**$9,222.60**

Pre - Post Mechanical Comparison	
Monthly Savings	$291
Annual Savings	$3,497
5 Year Savings	$17,487
kW Demand Reduction	10.4
Monthly kwh Savings	2204
Yearly kwh Savings	26445

Post Casing Coating	
Head (ft)	207.6
Flow (gpm)	8950
Efficiency	87.1%
Hours Operation/month	136
BHP	539
kW (Assumes Motor Eff 95%)	423.0
kW Demand Charge	$4,230
kwh cost	$4,874
Total Monthly kWH	57343
Monthly Cost	**$9,104.30**

Pre - Post Internal Coating Comparison	
Monthly Savings	$118
Annual Savings	$1,420
5 Year Savings	$7,098
kW Demand Reduction	-8.88
Monthly kwh Savings	2436
Yearly kwh Savings	29237

Total Energy Savings Pre Mechanical to Post Interior Coating Comparison	
Monthly Savings	$410
Annual Savings	$4,917
5 Year Savings	$24,585
kW Demand Reduction	1.53
Monthly kwh Savings	4640
Yearly kwh Savings	55682

Total Savings

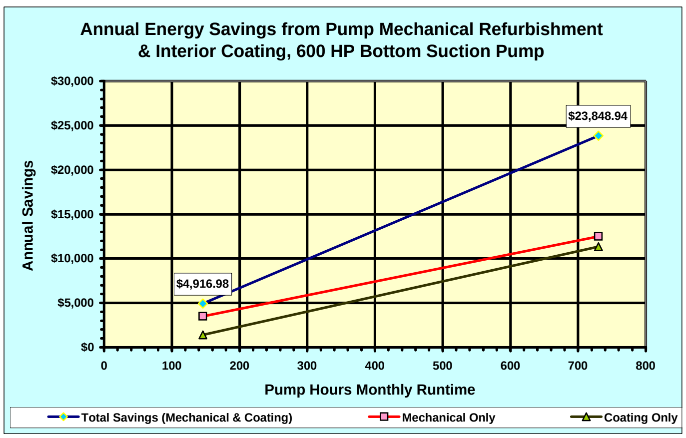
Pump Hours of Operation Before Refurbishment & Interior Coating	Annual Savings Through Refurbishment & Interior Coatings
730	$23,848.94
146	$4,916.98

Mechanical Only

Pump Hours of Operation Before Refurbishment & Interior Coating	
730	$12,488.71
146	$3,497.42

Coating Only

Pump Hours of Operation Before Refurbishment & Interior Coating	
730	$11,360
146	$1,420



Echo Pump No. 3
Energy Savings Calculation
NYSERDA Pump Refurbishment & Coating Project

Continuous Service

Pre Refurbishment	
Head (ft)	205.5
Flow (gpm)	8569
Efficiency	81.9%
Hours Operation/month	730
BHP	543
kW (Assumes Motor Eff 95%)	426.4
kW Demand Charge	$4,264
kwh cost	$26,456
Total Monthly kWH	311,244
Monthly Cost	**$30,719.35**

Constants	
Hours/ Month	730
kW Demand Cost	$10.00
kwh Cost	$0.085
Motor Efficiency	95.0%

Post Casing Coating	
Head (ft)	208.2
Flow (gpm)	8792
Efficiency	84.6%
Hours Operation/month	711
BHP	546
kW (Assumes Motor Eff 95%)	429.1
kW Demand Charge	$4,291
kwh cost	$25,948
Total Monthly kWH	305269
Monthly Cost	**$30,238.51**

Pre - Post Internal Coating Comparison	
Monthly Savings	**$481**
Annual Savings	**$5,770**
5 Year Savings	**$28,851**
kW Demand Reduction	**-2.7**
Monthly kwh Savings	**5974**
Yearly kwh Savings	**71694**

Post Mechanical	
Head (ft)	210
Flow (gpm)	8944
Efficiency	88.5%
Hours Operation/month	699
BHP	536
kW (Assumes Motor Eff 95%)	420.9
kW Demand Charge	$4,209
kwh cost	$25,019
Total Monthly kWH	294340
Monthly Cost	**$29,227.39**

Pre - Post Mechanical Comparison	
Monthly Savings	**$1,011**
Annual Savings	**$12,133**
5 Year Savings	**$60,667**
kW Demand Reduction	**8.21**
Monthly kwh Savings	**10930**
Yearly kwh Savings	**131156**

Total Energy Savings
Pre Mechanical to Post Interior

Coating Comparison	
Monthly Savings	**$1,492**
Annual Savings	**$17,904**
5 Year Savings	**$89,518**
kW Demand Reduction	**5.51**
Monthly kwh Savings	**16904**
Yearly kwh Savings	**202850**

Echo Pump No. 3 Cont'

20% Service Time

Pre Refurbishment

Head (ft)	205.5
Flow (gpm)	8569
Efficiency	81.9%
Hours Operation/month	146
BHP	543
kW (Assumes Motor Eff 95%)	426.4
kW Demand Charge	$4,264
kwh cost	$5,291
Total Monthly kWH	62,249
Monthly Cost	**$9,554.76**

Constants

Hours/ Month	730
kW Demand Cost	$10.00
kwh Cost	$0.085
Motor Efficiency	95.0%

Post Casing Coating

Head (ft)	208.2
Flow (gpm)	8792
Efficiency	84.6%
Hours Operation/month	142
BHP	546
kW (Assumes Motor Eff 95%)	429.1
kW Demand Charge	$4,291
kwh cost	$5,190
Total Monthly kWH	61054
Monthly Cost	**$9,480.18**

Pre - Post Internal Coating Comparison

Monthly Savings	**$75**
Annual Savings	**$895**
5 Year Savings	**$4,475**
kW Demand Reduction	**-2.7**
Monthly kwh Savings	**1195**
Yearly kwh Savings	**14339**

Post Mechanical

Head (ft)	210
Flow (gpm)	8944
Efficiency	88.5%
Hours Operation/month	140
BHP	536
kW (Assumes Motor Eff 95%)	420.9
kW Demand Charge	$4,209
kwh cost	$5,004
Total Monthly kWH	58868
Monthly Cost	**$9,212.28**

Pre - Post Mechanical Comparison

Monthly Savings	**$268**
Annual Savings	**$3,215**
5 Year Savings	**$16,074**
kW Demand Reduction	**8.21**
Monthly kwh Savings	**2186**
Yearly kwh Savings	**26231**

Total Energy Savings
Pre Mechanical to Post Interior
Coating Comparison

Monthly Savings	**$342**
Annual Savings	**$4,110**
5 Year Savings	**$20,549**
kW Demand Reduction	**5.51**
Monthly kwh Savings	**3381**
Yearly kwh Savings	**40570**

Total Savings

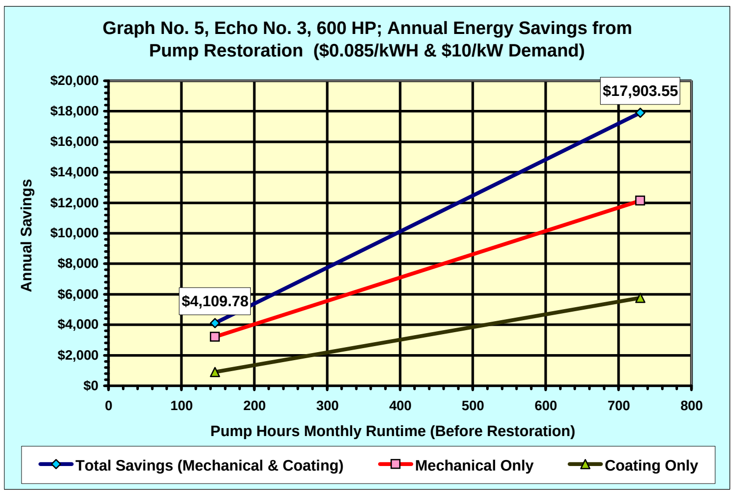
Pump Hours of Operation Before Refurbishment & Interior Coating	Annual Savings Through Refurbishment & Interior Coatings
730	$17,903.55
146	$4,109.78

Coating Only

Pump Hours of Operation Before Refurbishment & Interior Coating	
730	$5,770.17
146	$894.98

Mechanical Only

Pump Hours of Operation Before Refurbishment & Interior Coating	
730	$12,133
146	$3,215



Echo Booster Station

Pumps 2 & 3 Nameplate Information	**Motors 2 & 3 Nameplate Information**
Manufacturer: Peerless	**Manufacturer:** Westinghouse
Serial No.: 14297-2	**Model:** Worldseries
Speed: 1180	**Serial No.:** 7-5115-65376-01-1
H: 185'	**Speed:** 1188
Q: 10425 gpm	**HP:** 500
Imp Dia.: 23.5	**Amps:** 563
Size: 18 x 16S	**V:** 480
Type: WHSD	
Model: 150	

Pumps 2 & 3 Nameplate Information	**Motors 2 & 3 Nameplate Information**
Manufacturer: ITT/AC	**Manufacturer:** Siemens
Serial No.: 1-64469-01-1&2	**Model:** 110
Speed: 1180	**Serial No.:** 7-5115-65376-01-1
H: 185'	**Speed:** 1188
Q: 10425 gpm	**HP:** 600
Imp Dia.: 23.5	**Amps:** 649
Size: 18 x 16S	**V:** 480
Type: WHSD	**Type:** RG
Model: 150	

NYSERDA System Curve Pumps 2 & 3

Q		H	
50.0%	4687.5	80%	172.8
75.0%	7031.3	88%	190.08
BEP	9375.0	100%	216
125.0%	11718.8	120%	259.2

Pump No. 1

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	Ns
0	0.00	240				
6000	8.64	200	78%	388.5	305.1	1719
7000	10.08	192	83%	408.9	321.1	1914
8000	11.52	184	87%	429.7	337.5	2113
9000	12.96	170	88%	437.8	343.8	2378
10000	14.40	150	88%	430.4	338.0	2753
10400	14.98	128	82%	410.0	321.9	3162

NYSERDA System Curve Pump 1

Q		H	
50.0%	4750.0	80%	128
75.0%	7125.0	88%	140.8
BEP	9500.0	100%	160
125.0%	11875.0	120%	192

Manufacturer Curve Pumps 2 & 3

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	Ns	NPSHR
0	0.00	255					
2000	2.88	255					
4000	5.76	255	70%	368.0	288.9	1170	
6000	8.64	250	85%	445.6	349.9	1454	
8000	11.52	232	89%	526.6	413.5	1775	
10000	14.40	205	90%	575.2	451.7	2178	23
12000	17.28	165	86%	581.4	456.5	2808	25
13000	18.72	140	81%	567.4	445.6	3306	28
14000	20.16	115	73%	556.9	437.3	3976	

Pump No. 1 Field Curve 10/2/08 Initial Test

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
10313	14.85	44.69	13.00	105.77	21.49	141.1	2.63	7.17	145.6	82.5%	459.6	360.89	1194
9563	13.77	48.56	12.06	115.74	19.93	155.2	2.26	6.17	159.1	83.9%	458.0	359.67	1194
8799	12.67	52.08	11.09	124.59	18.34	167.5	1.91	5.22	170.8	84.0%	452.0	354.97	1194
8194	11.8	55.12	10.33	131.43	17.08	176.3	1.66	4.53	179.1	83.4%	444.3	348.86	1194
7674	11.05	56.46	9.68	134.69	15.99	180.7	1.45	3.97	183.2	81.0%	438.4	344.23	1194

Corrected to 1180 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM
10192	14.68	142.2	82.5%	443.6	348	1180
9450	13.61	155.4	83.9%	442.1	347	1180
8695	12.52	166.8	84.0%	436.3	343	1180
8105	11.67	175.3	83.4%	429.9	338	1181
7596	10.94	179.6	81.0%	425.3	334	1182

Pump No. 1 Field Curve 12/24/08 Post Casing Coating

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
10660	15.35	39.69	13.44	98.89	22.22	136.8	2.80	7.66	141.6	84.1%	453.3	355.96	1197
9757	14.05	44.9	12.30	112.57	20.34	156.3	2.35	6.42	160.4	86.8%	455.1	357.35	1197
8674	12.49	48.33	10.94	123.52	18.08	173.7	1.86	5.07	176.9	86.2%	449.7	353.10	1198
7639	11	54.42	9.63	136.81	15.92	190.3	1.44	3.94	192.8	85.7%	433.8	340.65	1198

Corrected to 1180 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM
10508	15.13	137.6	84.1%	434.3	341	1180
9618	13.85	155.9	86.8%	436.0	342	1180
8543	12.30	171.6	86.2%	429.7	337	1180
7524	10.83	187.1	85.7%	414.5	326	1180

Pump No. 1 Field Curve 6/23/09, 6 Month Test

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
10063	14.49	39.45	12.69	103.88	20.97	148.8	2.50	6.83	153.2	85.5%	455.2	357.48	1197
9618	13.85	45.48	12.13	115.57	20.05	161.9	2.28	6.24	165.9	88.7%	454.1	356.59	1197
8319	11.98	50.11	10.49	128.02	17.34	180.0	1.71	4.67	182.9	86.6%	444.0	348.68	1198
6785	9.77	55.87	8.55	141.11	14.14	196.9	1.14	3.10	198.9	80.9%	421.1	330.71	1198

Corrected to 1180 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM
9920	14.28	148.8	85.5%	436.1	342	1180
9481	13.65	161.2	88.7%	435.0	342	1180
8194	11.80	177.5	86.6%	424.3	333	1180
6683	9.62	192.9	80.9%	402.4	316	1180

Pump No. 1 Field Curve 1/08/10, 12 Month Test

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
9521	13.71	36.67	12.00	106.18	19.84	160.6	2.24	6.11	164.4	87.1%	454.1	356.60	1197
8097	11.66	41.89	10.21	120.6	16.88	181.8	1.62	4.42	184.6	85.6%	441.3	346.51	1197
7056	10.16	45.22	8.90	129.44	14.71	194.5	1.23	3.36	196.7	82.3%	425.8	334.38	1198

Corrected to 1180 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM
9386	13.52	159.8	87.1%	435.0	342	1180
7982	11.49	179.4	85.6%	422.7	332	1180
6950	10.01	190.8	82.3%	406.9	320	1180

Pump No. 1 Field Curve 6/8/10, 12 Month Test

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
10201	14.69	40.54	12.86	104.22	21.26	147.1	2.57	7.02	151.6	86.2%	453.1	355.83	1196
9757	14.05	43.63	12.30	112.43	20.34	158.9	2.35	6.42	163.0	88.7%	452.5	355.37	1198
8889	12.8	46.83	11.21	122.01	18.53	173.7	1.95	5.33	177.0	89.2%	445.7	350.01	1198
7833	11.28	50.57	9.88	131.66	16.33	187.3	1.51	4.14	189.9	86.5%	434.4	341.13	1198

Corrected to 1180 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM
10065	14.49	147.5	86.2%	435.2	342	1180
9610	13.84	158.1	88.7%	432.5	340	1180
8755	12.61	171.8	89.2%	425.9	334	1180
7722	11.12	184.6	86.5%	416.2	327	1181

Pump No. 2 Field Curve 8/24/06

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
11188	16.11	43.27	14.11	110.25	17.85	154.7	3.09	4.95	156.6	75.3%	587.3	459.7	1190
10903	15.7	45.03	13.75	114.5	17.40	160.5	2.93	4.70	162.2	76.1%	587.0	459.5	1189
10333	14.88	49.04	13.03	124.35	16.49	174.0	2.64	4.22	175.6	78.5%	583.3	456.6	1190
9583	13.8	52.96	12.08	134.66	15.29	188.7	2.27	3.63	190.1	80.0%	574.9	450.0	1190
9285	13.37	54.84	11.71	138.28	14.82	192.7	2.13	3.41	194.0	79.8%	569.8	446.0	1191
8306	11.96	48.52	10.47	137.66	13.25	205.9	1.70	2.73	206.9	78.6%	552.5	432.5	1190

Corrected to 1180 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM
11093	15.97	154.0	75.3%	572.6	448	1180
10820	15.58	159.8	76.1%	573.8	449	1180
10246	14.75	172.6	78.5%	568.7	445	1180
9511	13.70	187.2	80.0%	561.9	440	1181
9199	13.25	190.5	79.8%	554.1	434	1180
8236	11.86	203.5	78.6%	538.7	422	1180

Pump No. 2 Field Curve 5/10/07 (Post Mechanical & Impeller Coating)

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
10729	15.45	41.25	13.53	111.69	17.12	162.7	2.84	4.55	164.4	78.8%	565.4	442.6	1190
10125	14.58	45.06	12.77	122.28	16.16	178.4	2.53	4.05	179.9	81.8%	562.1	440.0	1190
9250	13.32	49.81	11.66	134.1	14.76	194.7	2.11	3.38	196.0	82.9%	552.2	432.2	1190
8694	12.52	52.66	10.96	140.44	13.87	202.8	1.87	2.99	203.9	82.3%	544.0	425.8	1190
7653	11.02	57.38	9.65	151.69	12.21	217.9	1.45	2.32	218.7	81.2%	520.4	407.4	1190
7222	10.4	58.7	9.11	155.89	11.52	224.5	1.29	2.06	225.3	80.9%	508.2	397.8	1190

Corrected to 1180 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM
10639	15.32	161.7	78.8%	551.2	431	1180
10040	14.46	176.9	81.8%	548.1	429	1180
9172	13.21	192.7	82.9%	538.4	421	1180
8621	12.41	200.5	82.3%	530.4	415	1180
7588	10.93	215.1	81.2%	507.4	397	1180
7162	10.31	221.5	80.9%	495.5	388	1180

Pump No. 2 Field Curve 6/4/07 (Post Interior Casing Coating)

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
11167	16.08	37.43	14.08	108.82	17.82	164.9	3.08	4.93	166.8	83.7%	562.1	440.0	1191
10375	14.94	42.34	13.08	121.92	16.55	183.8	2.66	4.26	185.4	86.8%	559.6	438.0	1191
9569	13.78	46.12	12.07	131.85	15.27	198.0	2.26	3.62	199.4	87.2%	552.5	432.5	1191
8958	12.9	48.76	11.29	138.87	14.29	208.2	1.98	3.17	209.3	87.2%	543.3	425.3	1191
8021	11.55	53.63	10.11	150.22	12.80	223.1	1.59	2.54	224.1	86.5%	525.0	410.9	1191
7063	10.17	57.42	8.90	159.31	11.27	235.4	1.23	1.97	236.1	84.1%	501.0	392.2	1191

Corrected to 1180 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM
11064	15.93	163.7	83.7%	546.7	428	1180
10279	14.80	182.0	86.8%	544.2	426	1180
9481	13.65	195.7	87.2%	537.3	421	1180
8876	12.78	205.5	87.2%	528.4	414	1180
7953	11.45	220.3	86.5%	511.8	401	1181
7009	10.09	232.6	84.1%	489.7	383	1182

Pump No. 2 Field Curve 7/6/07 (Post Interior Casing Coating 30 Day Test)

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
10743	15.47	36.28	13.55	111.39	17.14	173.5	2.85	4.56	175.2	84.6%	561.6	439.7	1191
9924	14.29	41.56	12.51	124.78	15.83	192.2	2.43	3.89	193.7	86.7%	560.2	438.5	1191
8986	12.94	45.47	11.33	135.11	14.34	207.1	1.99	3.19	208.3	86.6%	545.6	427.1	1191
8160	11.75	49.68	10.29	145.05	13.02	220.3	1.64	2.63	221.3	86.3%	528.1	413.4	1191
7514	10.82	51.09	9.47	150.3	11.99	229.2	1.39	2.23	230.0	85.0%	513.3	401.8	1191

Corrected to 1180 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM
10644	15.33	172.0	84.6%	546.2	428	1180
9832	14.16	190.1	86.7%	544.8	426	1180
8903	12.82	204.4	86.6%	530.6	415	1180
8084	11.64	217.2	86.3%	513.6	402	1180
7451	10.73	226.2	85.0%	500.5	392	1181

Pump No. 2 Field Curve 9/10/07 (Post Interior Casing Coating 90 Day Test)

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
10903	15.7	40.16	13.75	114.74	17.40	172.3	2.93	4.70	174.0	85.1%	562.9	440.66	1190
10236	14.74	45.03	12.91	126.13	16.33	187.3	2.59	4.14	188.9	87.4%	558.8	437.39	1190
9722	14	47.91	12.26	133.05	15.51	196.7	2.33	3.74	198.1	87.7%	554.4	433.96	1190
8451	12.17	53.63	10.66	147.63	13.49	217.1	1.76	2.82	218.2	87.2%	534.2	418.17	1190
7639	11	56.53	9.63	155.2	12.19	227.9	1.44	2.31	228.8	85.5%	516.2	404.05	1190

Corrected to 1180 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM
10811	15.57	171.1	85.1%	548.9	430	1180
10150	14.62	185.7	87.4%	544.8	426	1180
9641	13.88	194.8	87.7%	540.5	423	1180
8380	12.07	214.5	87.2%	520.8	408	1180
7575	10.91	225.0	85.5%	503.3	394	1180

Pump No. 2 Field Curve 12/16/07 (Post Interior Casing Coating 6 Month Test)

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
10576	15.23	33.38	13.33	107.14	16.88	170.4	2.76	4.42	172.0	81.1%	566.2	443.25	1191
10104	14.55	36.07	12.74	114.71	16.12	181.7	2.52	4.04	183.2	82.9%	564.1	441.58	1191
9243	13.31	40.57	11.65	126.84	14.75	199.3	2.11	3.38	200.6	84.2%	555.7	434.99	1191
8590	12.37	42.86	10.83	133.65	13.71	209.7	1.82	2.92	210.8	83.7%	546.2	427.53	1192
7354	10.59	47.39	9.27	146.12	11.73	228.1	1.34	2.14	228.9	81.9%	519.0	406.26	1192

Corrected to 1180 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM
10479	15.09	168.9	81.1%	550.7	431	1180
10011	14.42	179.8	82.9%	548.6	429	1180
9158	13.19	196.9	84.2%	540.4	423	1180
8504	12.25	206.6	83.7%	529.8	415	1180
7280	10.48	224.3	81.9%	503.5	394	1180

Pump No. 2 Field Curve 12/20/07 (Post Interior Casing Coating 6 Month Test - 2nd Test)

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
10840	15.61	34.46	13.67	105.88	17.30	165.0	2.90	4.65	166.7	80.8%	565.1	442.32	1191
10257	14.77	37.93	12.93	115.98	16.37	180.3	2.60	4.16	181.9	83.6%	563.2	440.89	1191
9340	13.45	42.28	11.78	127.72	14.90	197.4	2.15	3.45	198.7	84.3%	556.0	435.27	1191
8625	12.42	43.99	10.87	134.47	13.76	209.0	1.84	2.94	210.1	84.1%	544.4	426.17	1192
7944	11.44	47.16	10.02	142.55	12.68	220.4	1.56	2.50	221.3	83.9%	528.9	414.00	1192

Corrected to 1180 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM
10740	15.47	163.7	80.8%	549.5	430	1180
10162	14.63	178.5	83.6%	547.8	429	1180
9254	13.33	195.0	84.3%	540.8	423	1180
8538	12.29	205.9	84.1%	528.1	413	1180
7864	11.32	216.9	83.9%	513.1	402	1180

Pump No. 2 Field Curve 6/16/08 (One Year test)

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
11083	15.96	38.79	13.97	108.53	17.69	161.1	3.03	4.86	162.9	80.3%	568.2	444.78	1190
10660	15.35	41.05	13.44	116.36	17.01	174.0	2.80	4.49	175.7	83.1%	568.8	445.24	1191
9660	13.91	46.99	12.18	131.05	15.41	194.2	2.30	3.69	195.6	84.9%	561.7	439.71	1191
8833	12.72	50.91	11.14	140.82	14.09	207.7	1.93	3.08	208.9	84.5%	551.3	431.53	1191
8063	11.61	54.92	10.17	150.76	12.86	221.4	1.60	2.57	222.4	84.7%	534.5	418.39	1192

Corrected to 1180 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM
10990	15.83	160.2	80.3%	554.0	434	1180
10561	15.21	172.4	83.1%	553.2	433	1180
9571	13.78	192.0	84.9%	546.3	428	1180
8752	12.60	205.0	84.5%	536.1	420	1180
7981	11.49	217.9	84.7%	518.5	406	1180

Pump No. 2 Field Curve 12/24/08 (18 Month test)

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
11181	16.1	36.44	14.10	103.3	17.84	154.4	3.09	4.94	156.3	77.8%	567.4	444.19	1191
10208	14.7	41.52	12.87	119.23	16.29	179.5	2.57	4.12	181.1	82.4%	566.5	443.42	1191
9132	13.15	47.43	11.51	134.7	14.57	201.6	2.06	3.30	202.8	84.0%	556.8	435.83	1191
8250	11.88	51.34	10.40	144.44	13.16	215.1	1.68	2.69	216.1	83.0%	542.3	424.53	1191
7326	10.55	55.3	9.24	154.65	11.69	229.5	1.32	2.12	230.3	82.0%	519.8	406.86	1192

Corrected to 1180 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM
11077	15.95	153.4	77.8%	551.9	432	1180
10114	14.56	177.7	82.4%	550.9	431	1180
9048	13.03	199.1	84.0%	541.5	424	1180
8174	11.77	212.1	83.0%	527.4	413	1180
7253	10.44	225.7	82.0%	504.2	395	1180

Pump No. 2 Field Curve 1/08/10 (30 Month test)

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
10306	14.84	33.81	12.99	108.9	16.44	173.5	2.62	4.20	175.0	80.0%	569.6	445.84	1192
9618	13.85	36.78	12.13	119.09	15.35	190.1	2.28	3.66	191.5	82.4%	564.4	441.83	1191
8486	12.22	41.07	10.70	131.72	13.54	209.4	1.78	2.85	210.5	82.1%	549.2	429.92	1190
7701	11.09	43.45	9.71	139.27	12.29	221.3	1.46	2.34	222.2	81.0%	533.4	417.52	1191
6590	9.49	47.38	8.31	150.63	10.52	238.5	1.07	1.72	239.2	79.6%	500.3	391.63	1192

Corrected to 1180 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM
10202	14.69	171.5	80.0%	552.5	433	1180
9529	13.72	188.0	82.4%	548.9	430	1180
8415	12.12	206.9	82.1%	535.5	419	1180
7630	10.99	218.1	81.0%	518.7	406	1180
6524	9.39	234.4	79.6%	485.3	380	1180

Pump No. 2 Field Curve 6/8/10

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
10535	15.17	37.44	13.28	110.67	16.81	169.2	2.74	4.39	170.8	79.8%	569.2	445.55	1191
9625	13.86	41.71	12.14	124.14	15.36	190.4	2.29	3.66	191.8	82.6%	564.0	441.52	1191
8826	12.71	45.03	11.13	133.44	14.08	204.2	1.92	3.08	205.4	82.5%	554.8	434.33	1191
7729	11.13	49.25	9.75	145.18	12.33	221.6	1.47	2.36	222.5	81.4%	533.7	417.76	1191
6910	9.95	52.93	8.71	154.1	11.03	233.7	1.18	1.89	234.4	80.0%	511.2	400.20	1191

Corrected to 1180 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM
10437	15.03	167.7	79.8%	553.6	433	1180
9536	13.73	188.3	82.6%	548.5	429	1180
8745	12.59	201.6	82.5%	539.6	422	1180
7658	11.03	218.4	81.4%	519.0	406	1180
6846	9.86	230.1	80.0%	497.2	389	1180

Pump No. 3 Field Curve 12/20/07 Initial Test

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
10903	15.7	39.38	13.75	114.62	17.40	173.8	2.93	4.70	175.6	81.5%	593.0	464.2	1192
10181	14.66	42.36	12.84	123.06	16.24	186.4	2.56	4.10	188.0	82.5%	585.5	458.3	1191
9174	13.21	45.76	11.57	132.7	14.64	200.8	2.08	3.33	202.1	82.1%	569.9	446.1	1191
8035	11.57	50.16	10.13	143.9	12.82	216.5	1.59	2.55	217.5	81.5%	541.7	424.1	1191
7069	10.18	52.97	8.91	151.66	11.28	228.0	1.23	1.98	228.7	79.5%	513.7	402.1	1192

Corrected to 1180 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM
10793	15.54	172.1	81.5%	575.3	450	1180
10087	14.52	184.5	82.5%	569.4	446	1180
9089	13.09	198.4	82.1%	554.2	434	1180
7961	11.46	213.5	81.5%	526.9	412	1180
6998	10.08	224.1	79.5%	498.4	390	1180

Pump No. 3 Field Curve 3/8/08 Post Coating

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
11188	16.11	34.49	14.11	110.21	17.85	174.9	3.09	4.95	176.8	84.2%	593.1	464.3	1192
10167	14.64	40.01	12.82	122.97	16.22	191.6	2.55	4.09	193.2	84.9%	584.2	457.3	1191
9354	13.47	44.7	11.79	133.23	14.93	204.5	2.16	3.46	205.8	85.3%	570.2	446.3	1191
8479	12.21	48.33	10.69	141.81	13.53	215.9	1.77	2.84	217.0	83.9%	553.6	433.3	1191
7347	10.58	53.91	9.26	153.83	11.72	230.8	1.33	2.13	231.6	82.7%	519.6	406.7	1192

Corrected to 1180 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM
11075	15.95	173.2	84.2%	575.4	450	1180
10073	14.50	189.6	84.9%	568.2	445	1180
9268	13.35	202.0	85.3%	554.5	434	1180
8401	12.10	213.0	83.9%	538.4	421	1180
7273	10.47	227.0	82.7%	504.1	395	1180

Pump No. 3 Field Curve 12/24/08 Post Coating 2nd Test

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
11667	16.8	32.67	14.71	105.36	18.62	167.9	3.36	5.38	169.9	84.5%	592.4	463.7	1190
10764	15.5	37.65	13.57	117.11	17.18	183.6	2.86	4.58	185.3	85.7%	587.9	460.2	1190
9625	13.86	43.94	12.14	131.28	15.36	201.8	2.29	3.66	203.1	86.2%	572.7	448.3	1191
8132	11.71	51.49	10.25	147.97	12.98	222.9	1.63	2.61	223.9	85.3%	539.1	422.0	1191
7278	10.48	55.15	9.18	156.09	11.61	233.2	1.31	2.09	234.0	83.9%	512.4	401.1	1192

Corrected to 1180 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM
11569	16.66	167.1	84.5%	577.6	452	1180
10673	15.37	182.2	85.7%	573.2	449	1180
9536	13.73	199.4	86.2%	556.9	436	1180
8057	11.60	219.7	85.3%	524.3	410	1180
7205	10.37	229.3	83.9%	497.1	389	1180

Pump No. 3 Field Curve 2/27/09 Post Mechanical & Impeller Coating

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
11000	15.84	34.92	13.87	112.55	17.55	179.3	2.99	4.78	181.1	87.4%	575.4	450.44	1191
10083	14.52	39.28	12.71	123.42	16.09	194.4	2.51	4.02	195.9	88.0%	567.0	443.81	1190
9229	13.29	43.4	11.64	133.99	14.73	209.3	2.10	3.37	210.5	88.6%	553.9	433.57	1190
8243	11.87	47.42	10.39	144.2	13.15	223.6	1.68	2.69	224.6	87.8%	532.2	416.63	1191
7424	10.69	50.64	9.36	152.04	11.85	234.2	1.36	2.18	235.1	86.5%	509.6	398.94	1191

Corrected to 1180 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM
10898	15.69	177.8	87.4%	559.6	438	1180
9999	14.40	192.6	88.0%	552.8	433	1180
9152	13.18	207.0	88.6%	540.0	423	1180
8167	11.76	220.4	87.8%	517.6	405	1180
7355	10.59	230.7	86.5%	495.6	388	1180

Pump No. 3 Field Curve 6/23/09, 90 Day Test

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
10993	15.83	35.67	13.86	112.67	17.54	177.9	2.98	4.78	179.7	86.9%	574.1	449.42	1191
10021	14.43	41.51	12.63	126.09	15.99	195.4	2.48	3.97	196.9	88.5%	562.8	440.56	1191
8931	12.86	46.3	11.26	138.29	14.25	212.5	1.97	3.15	213.7	88.3%	545.8	427.23	1191
8243	11.87	49.69	10.39	145.81	13.15	222.0	1.68	2.69	223.0	87.5%	530.6	415.34	1191
7500	10.8	53.16	9.46	153.4	11.97	231.6	1.39	2.22	232.4	86.4%	509.7	398.96	1191

Corrected to 1180 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM
10892	15.68	176.4	86.9%	558.4	437	1180
9928	14.30	193.3	88.5%	547.4	428	1180
8848	12.74	209.8	88.3%	530.8	416	1180
8167	11.76	218.9	87.5%	516.0	404	1180
7431	10.70	228.1	86.4%	495.7	388	1180

Pump No. 3 Field Curve 1/08/2010, 9 Month Test

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
11007	15.85	30.13	13.88	107.25	17.56	178.1	2.99	4.79	179.9	87.1%	574.0	449.29	1191
9792	14.1	34.76	12.35	120.52	15.62	198.1	2.37	3.79	199.5	87.9%	561.2	439.34	1191
8174	11.77	40.85	10.31	137.21	13.04	222.6	1.65	2.64	223.6	87.1%	529.8	414.76	1191
6646	9.57	46.43	8.38	151.25	10.60	242.1	1.09	1.75	242.8	84.4%	482.7	377.86	1191

Corrected to 1180 RPM

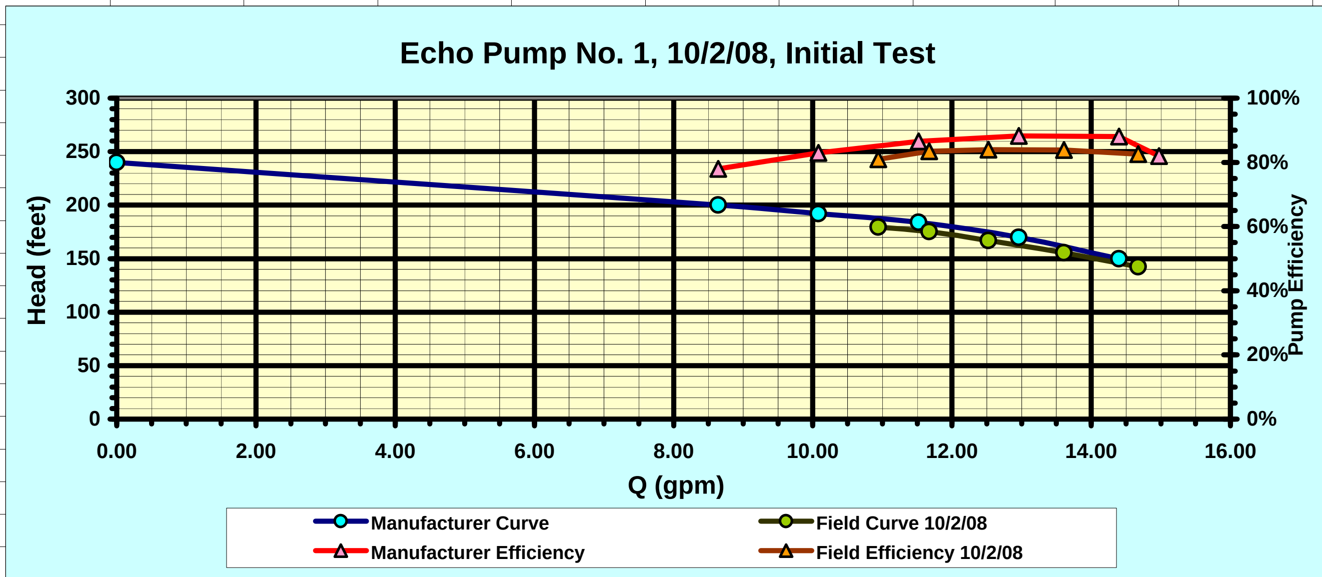
Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM
10905	15.70	176.6	87.1%	558.2	437	1180
9701	13.97	195.9	87.9%	545.8	427	1180
8098	11.66	219.5	87.1%	515.3	403	1180
6584	9.48	238.3	84.4%	469.5	367	1180

Pump No. 3 Field Curve 6/8/10

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
11042	15.9	35.63	13.92	112.86	17.62	178.4	3.01	4.82	180.2	87.8%	572.0	447.78	1191
9910	14.27	40.35	12.49	125.02	15.81	195.6	2.42	3.88	197.0	87.7%	562.2	440.10	1191
9076	13.07	44.1	11.44	135.06	14.48	210.1	2.03	3.26	211.3	88.4%	547.8	428.79	1191
8167	11.76	47.54	10.30	144.1	13.03	223.1	1.65	2.64	224.0	87.2%	530.0	414.89	1191
7375	10.62	51.19	9.30	152.34	11.77	233.7	1.34	2.15	234.5	86.1%	507.1	397	1191

Corrected to 1180 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM
10940	15.75	176.9	87.8%	556.3	435	1180
9818	14.14	193.4	87.7%	546.8	428	1180
8993	12.95	207.5	88.4%	532.7	417	1180
8091	11.65	219.9	87.2%	515.5	404	1180
7307	10.52	230.2	86.1%	493.2	386	1180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Head (feet)
Pump Efficiency
Q (gpm)
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250
200
150
100
50
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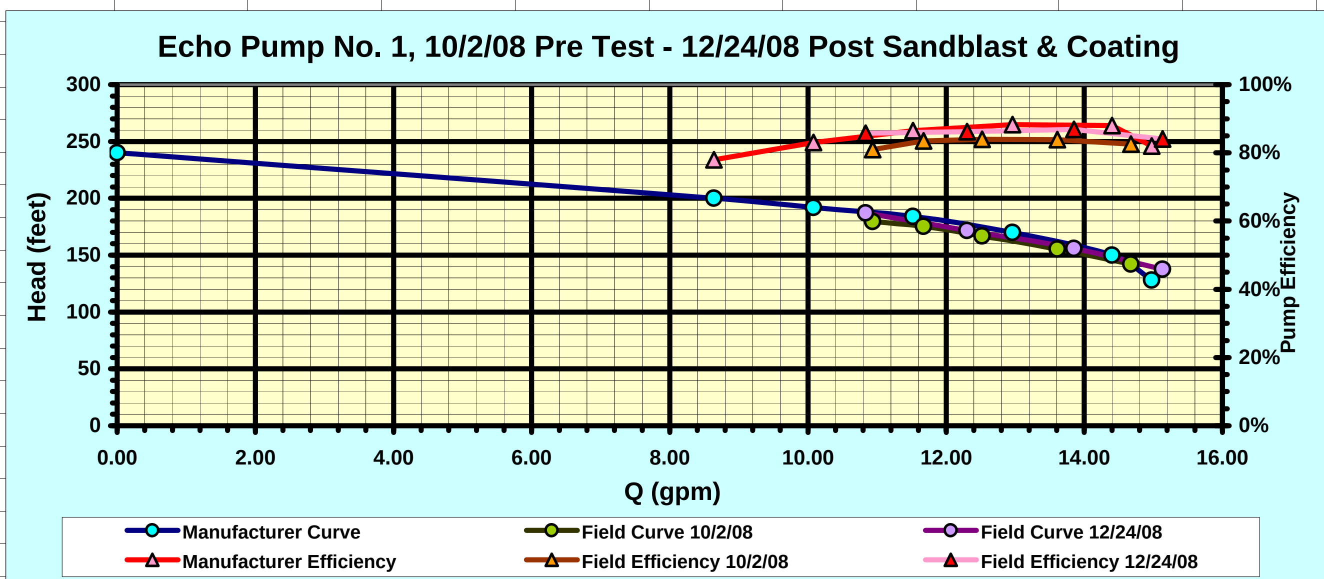
100%
80%
60%
40%
20%
0%
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
Manufacturer Curve
Field Curve 10/2/08
Manufacturer Efficiency
Field Efficiency 10/2/08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Head (feet)
Pump Efficiency
Q (gpm)
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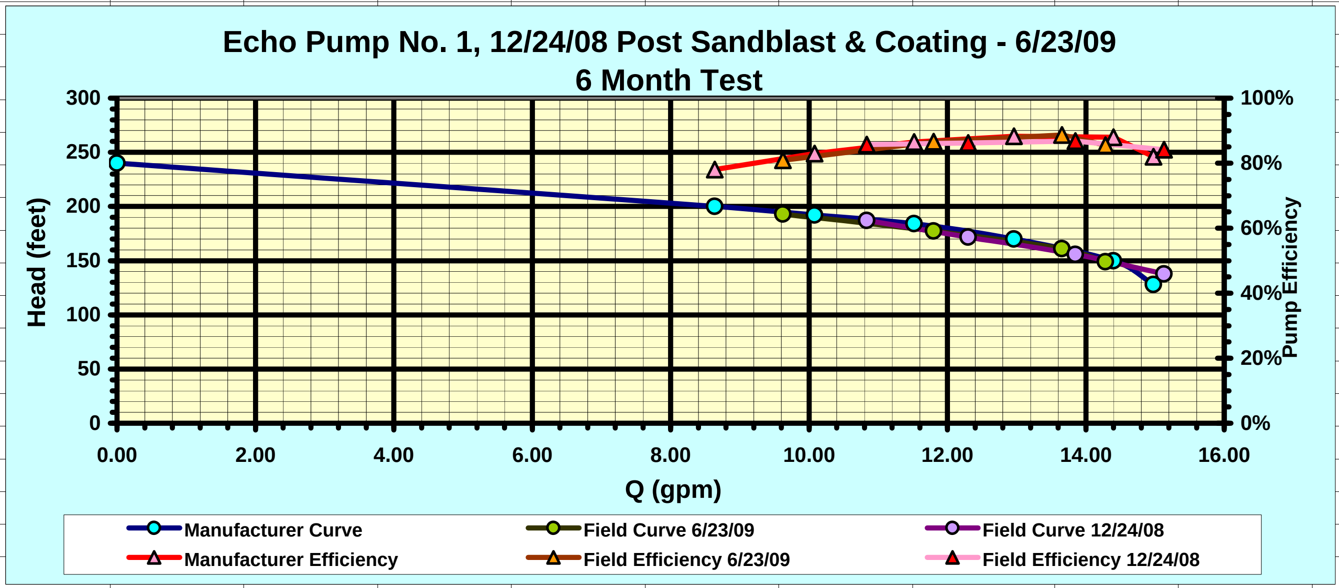
250
200
150
100
50
0
100%
80%
60%
40%
20%
0%
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
Manufacturer Curve
Field Curve 10/2/08
Field Curve 12/24/08
Manufacturer Efficiency
Field Efficiency 10/2/08
Field Efficiency 12/24/08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6 Month Test
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250
200
150
100
50
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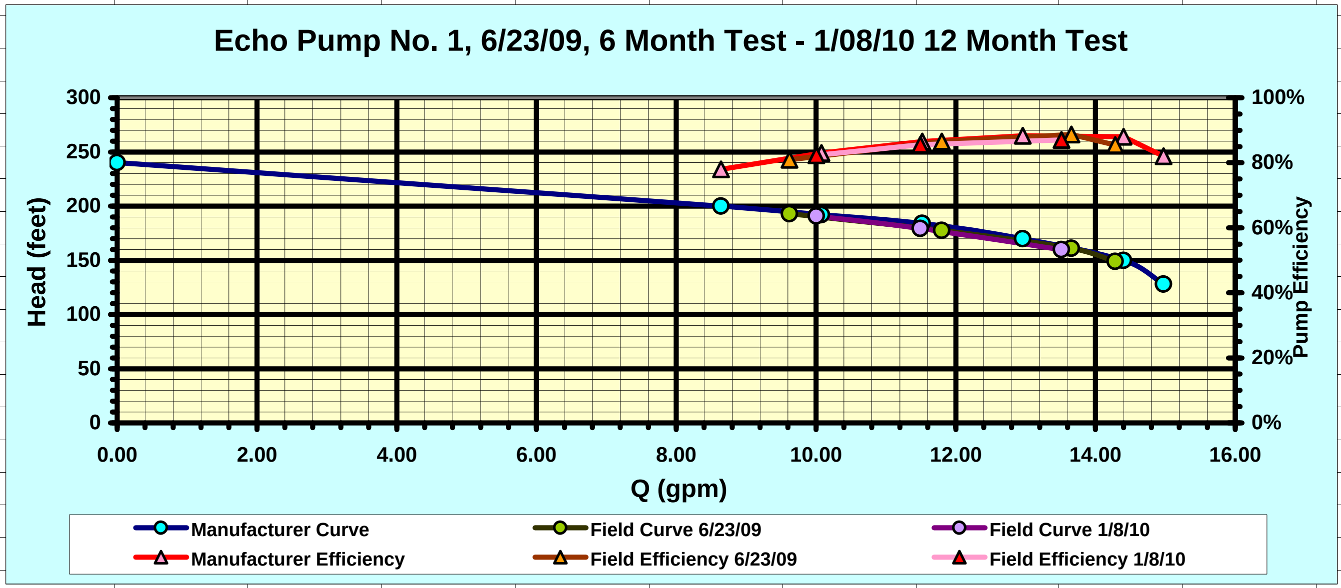
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
Q (gpm)
100%
80%
60%
40%
20%
0%
Pump Efficiency
Manufacturer Curve
Field Curve 6/23/09
Field Curve 12/24/08
Manufacturer Efficiency
Field Efficiency 6/23/09
Field Efficiency 12/24/08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Head (feet)
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250
200
150
100
50
0
0.00
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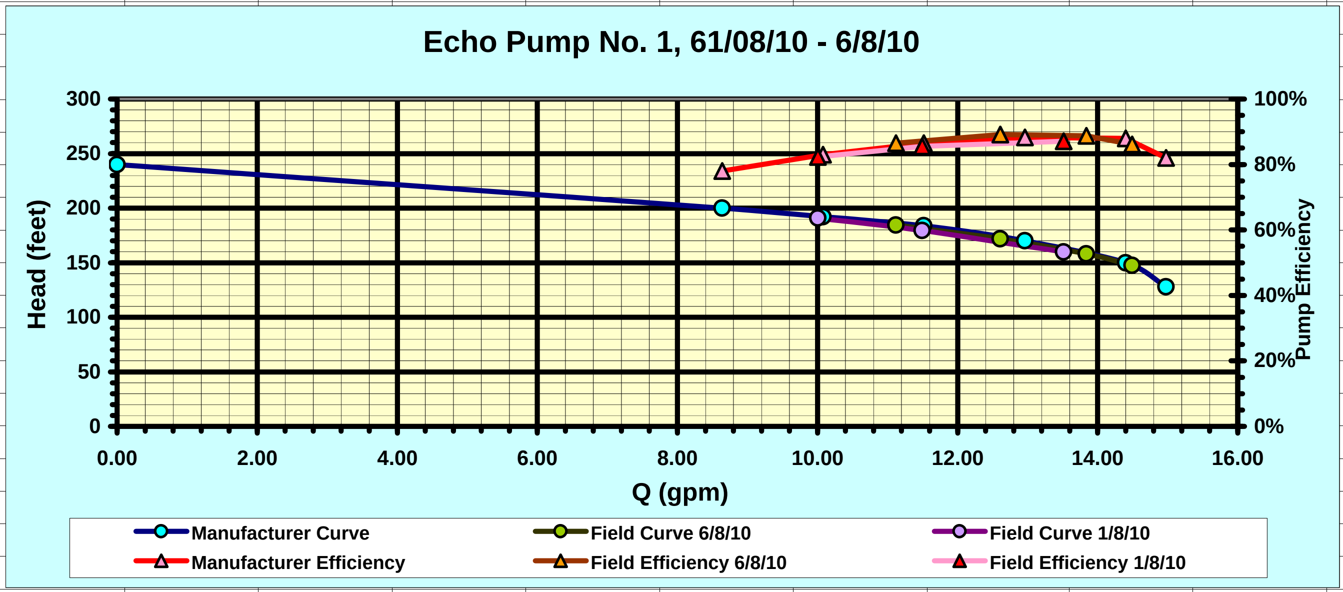
4.00
6.00
8.00
10.00
12.00
14.00
16.00
Q (gpm)
100%
80%
60%
40%
20%
0%
Pump Efficiency
Manufacturer Curve
Field Curve 6/23/09
Field Curve 1/8/10
Manufacturer Efficiency
Field Efficiency 6/23/09
Field Efficiency 1/8/10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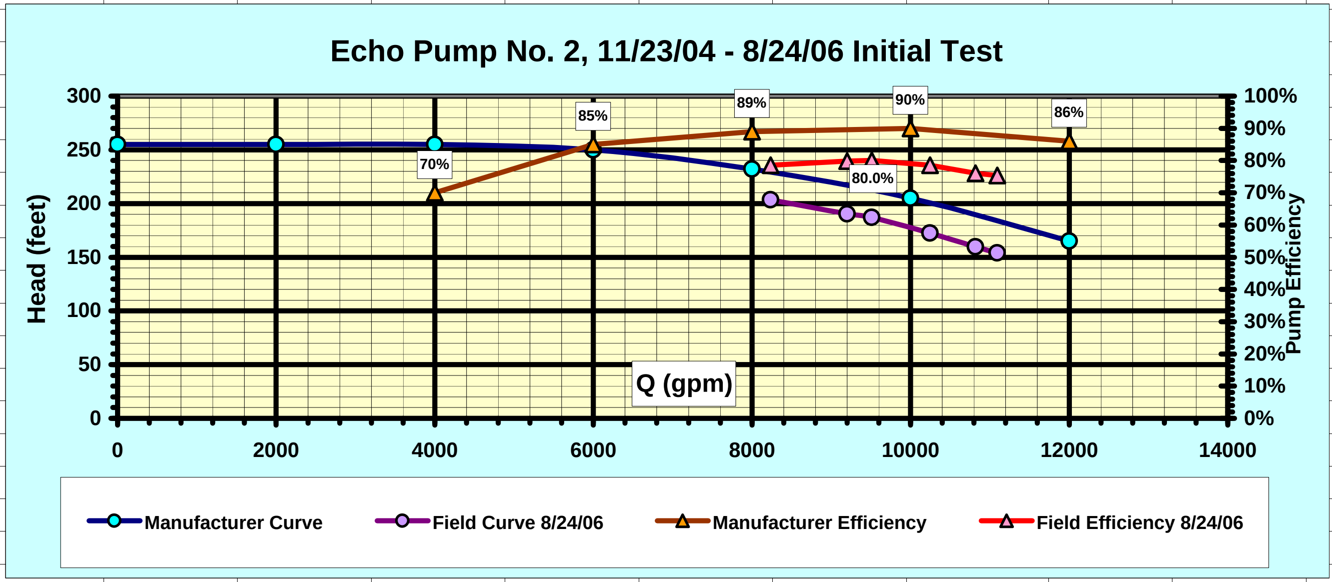
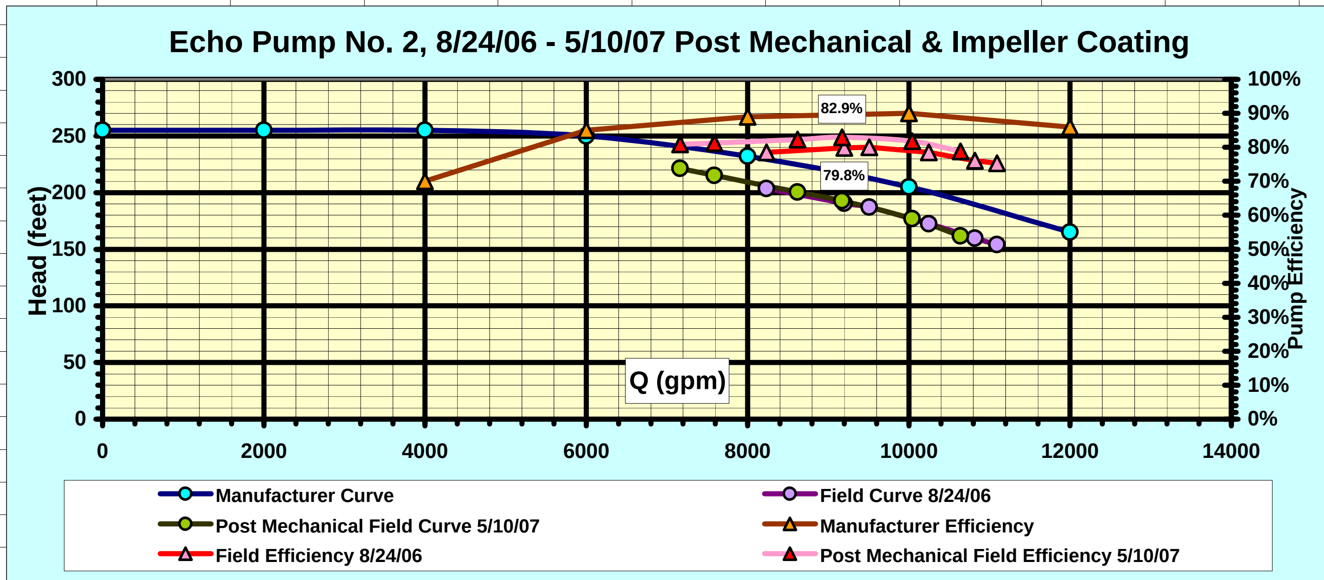
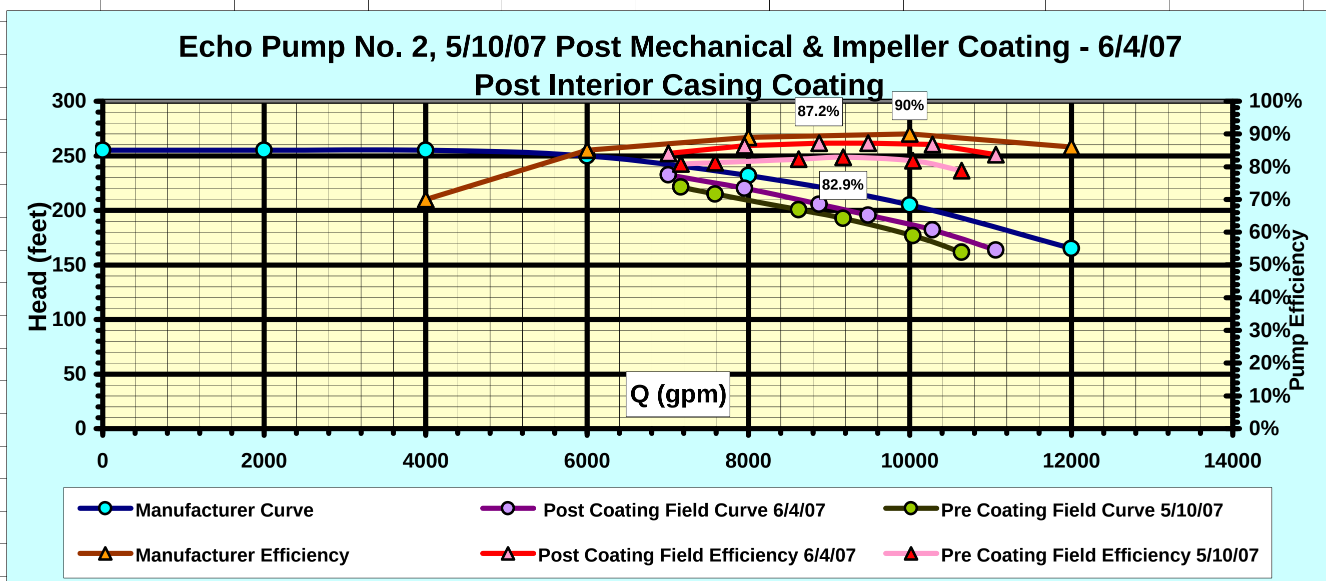
Head (feet)
Pump Efficiency
Q (gpm)
Manufacturer Curve
Field Curve 6/8/10
Field Curve 1/8/10
Manufacturer Efficiency
Field Efficiency 6/8/10
Field Efficiency 1/8/10

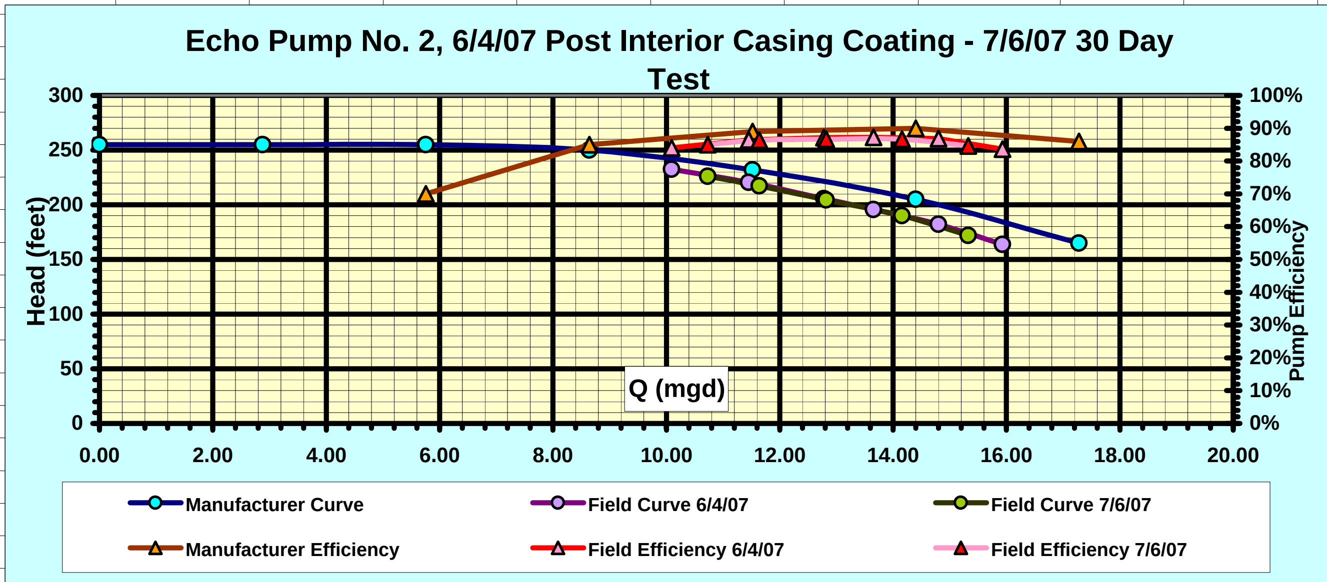

Echo Pump No. 2, 11/23/04 - 8/24/06 Initial Test
Head (feet)
Pump Efficiency
Q (gpm)
70%
85%
89%
90%
86%
80.0%
Manufacturer Curve
Field Curve 8/24/06
Manufacturer Efficiency
Field Efficiency 8/24/06



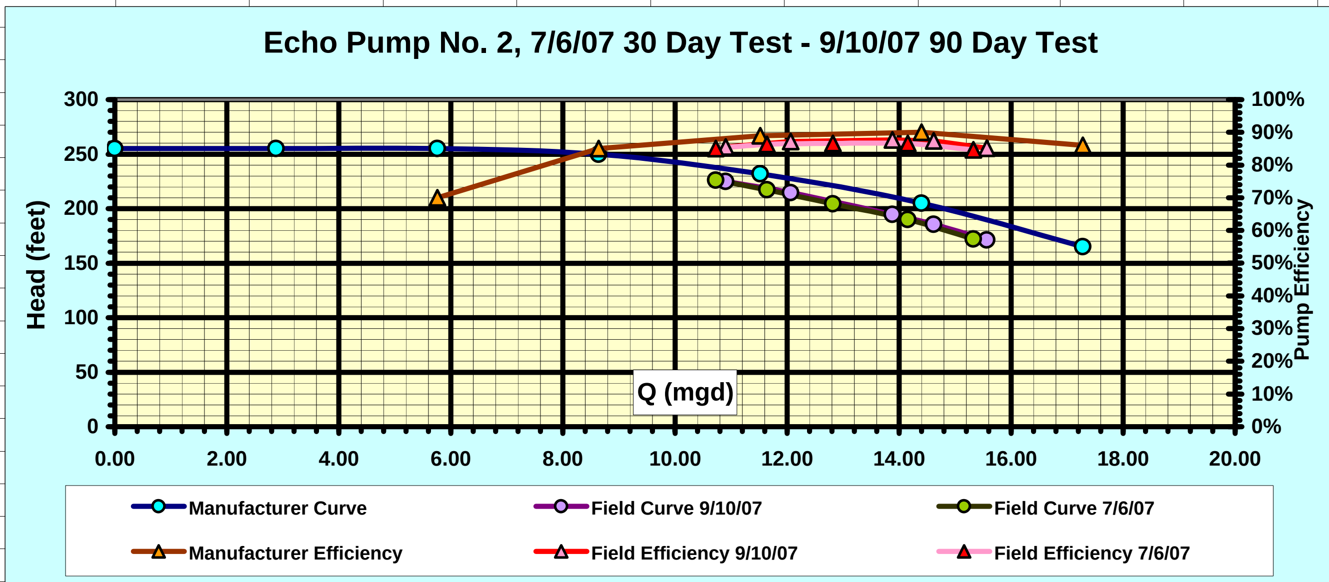
Echo Pump No. 2, 8/24/06 - 5/10/07 Post Mechanical & Impeller Coating
Head (feet)
Pump Efficiency
Q (gpm)
82.9%
79.8%
0 50 100 150 200 250 300
0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
0 2000 4000 6000 8000 10000 12000 14000
Manufacturer Curve
Field Curve 8/24/06
Post Mechanical Field Curve 5/10/07
Manufacturer Efficiency
Field Efficiency 8/24/06
Post Mechanical Field Efficiency 5/10/07



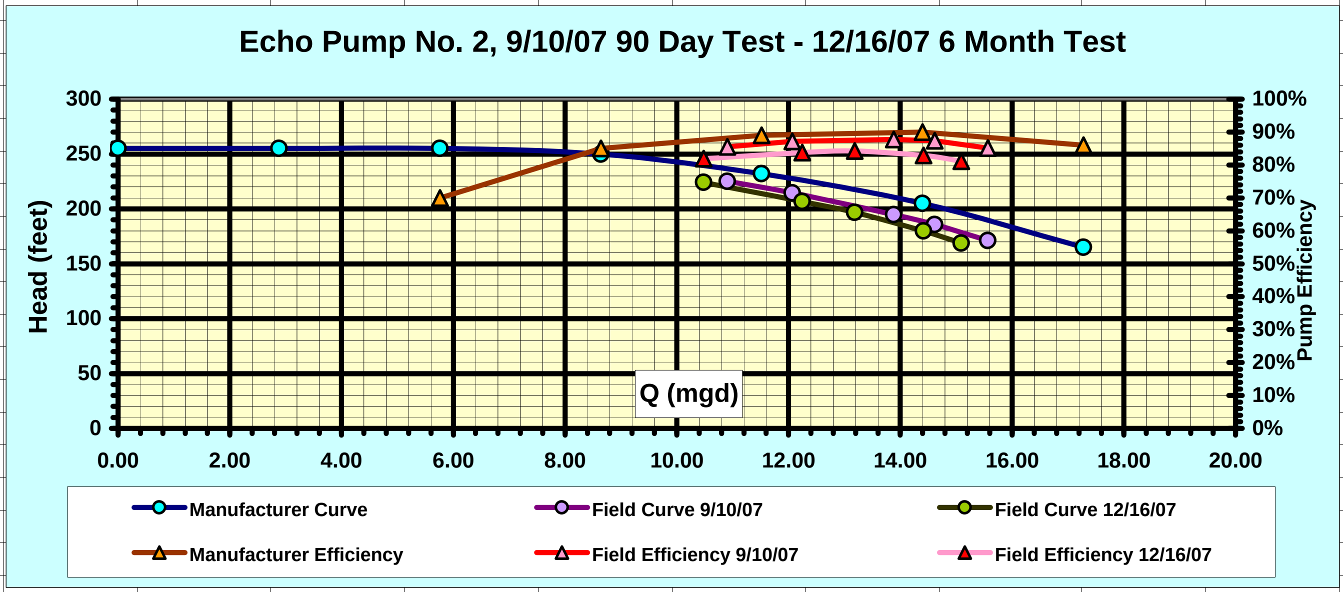
Echo Pump No. 2, 5/10/07 Post Mechanical & Impeller Coating - 6/4/07
Post Interior Casing Coating
Head (feet)
Pump Efficiency
Q (gpm)
87.2%
90%
82.9%
0 50 100 150 200 250 300
0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
0 2000 4000 6000 8000 10000 12000 14000
Manufacturer Curve
Post Coating Field Curve 6/4/07
Pre Coating Field Curve 5/10/07
Manufacturer Efficiency
Post Coating Field Efficiency 6/4/07
Pre Coating Field Efficiency 5/10/07

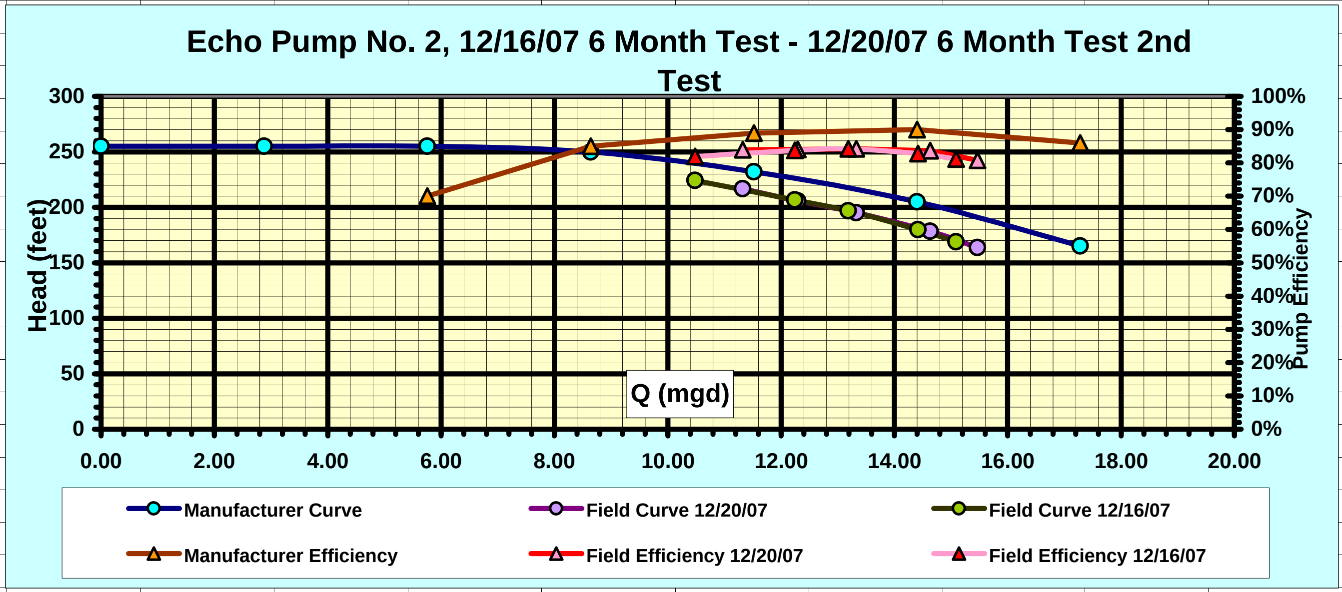


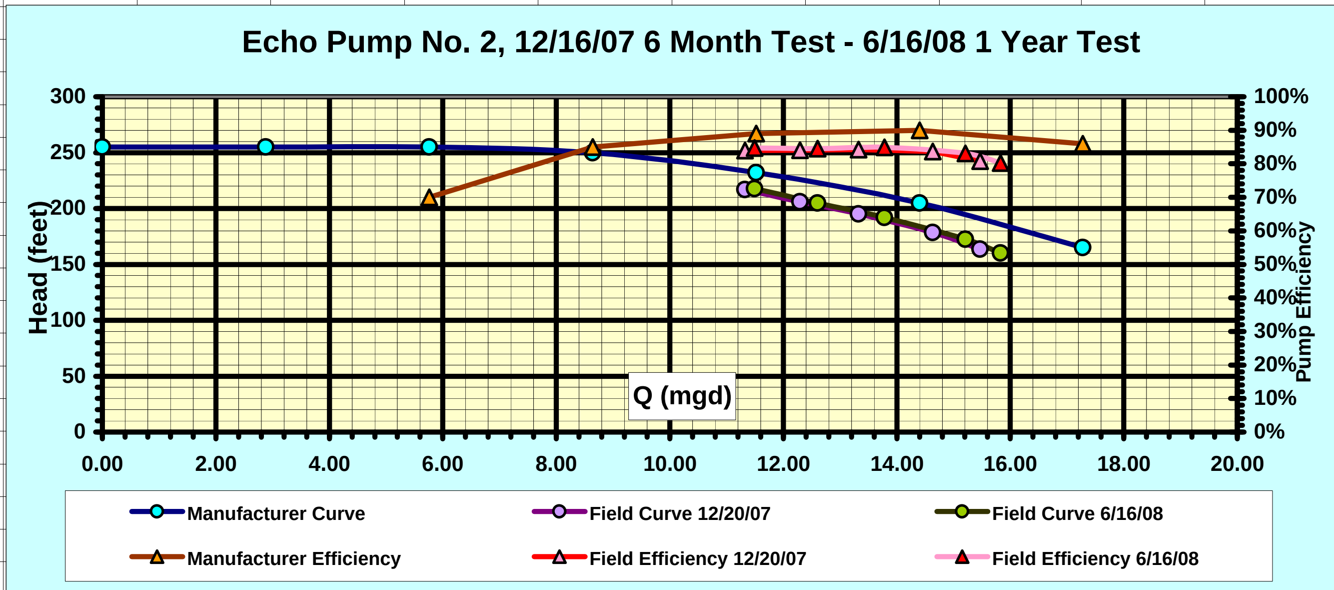
Echo Pump No. 2, 6/4/07 Post Interior Casing Coating - 7/6/07 30 Day Test
Head (feet)
300
250
200
150
100
50
0
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Pump Efficiency
Q (mgd)
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
20.00
Manufacturer Curve
Field Curve 6/4/07
Field Curve 7/6/07
Manufacturer Efficiency
Field Efficiency 6/4/07
Field Efficiency 7/6/07

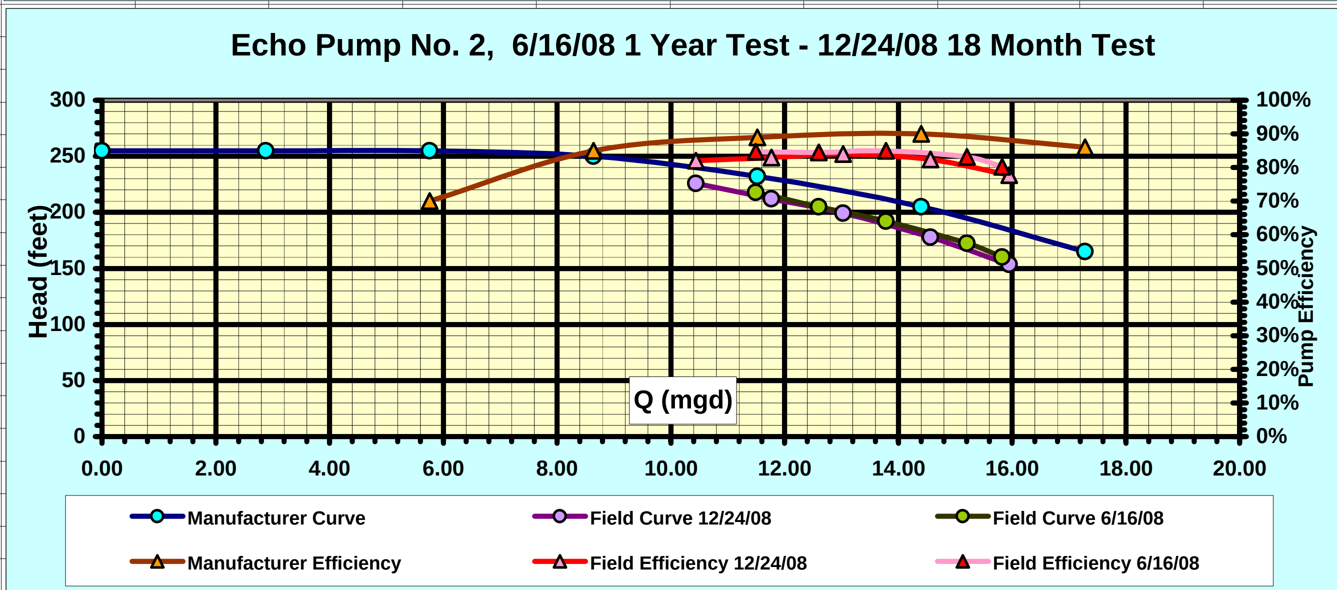


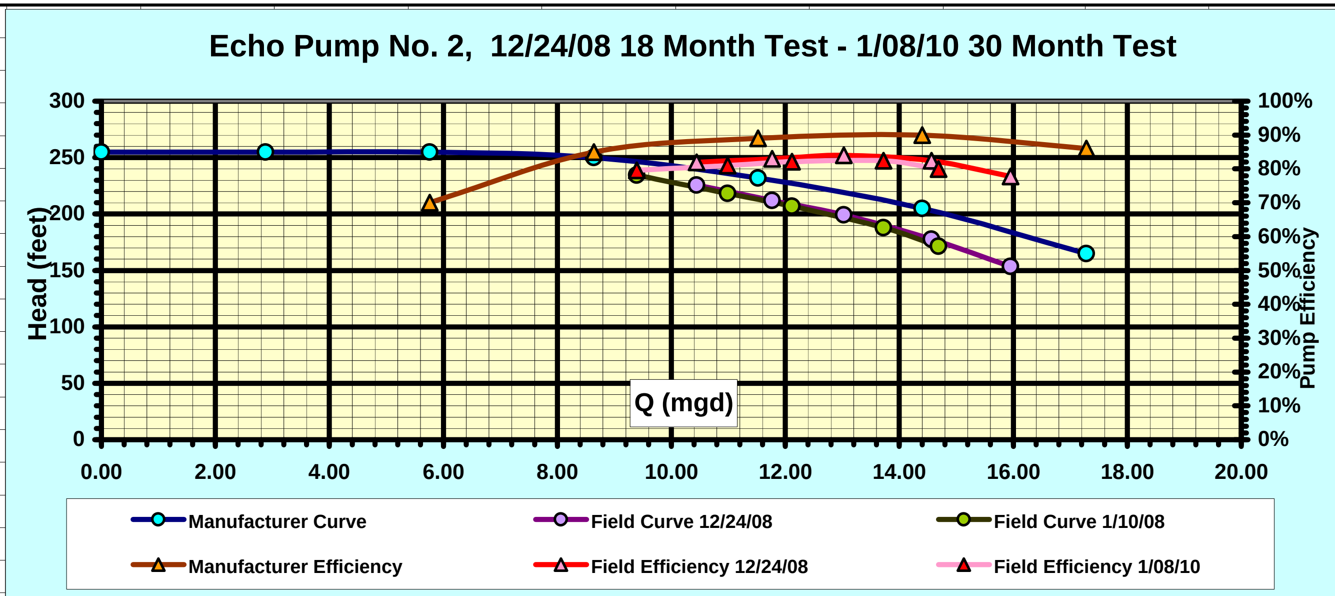
Echo Pump No. 2, 7/6/07 30 Day Test - 9/10/07 90 Day Test
Head (feet)
300
250
200
150
100
50
0
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Pump Efficiency
Q (mgd)
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
20.00
Manufacturer Curve
Field Curve 9/10/07
Field Curve 7/6/07
Manufacturer Efficiency
Field Efficiency 9/10/07
Field Efficiency 7/6/07


Echo Pump No. 2, 9/10/07 90 Day Test - 12/16/07 6 Month Test
Head (feet)
Pump Efficiency
Q (mgd)
300
250
200
150
100
50
0
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
20.00
Manufacturer Curve
Field Curve 9/10/07
Field Curve 12/16/07
Manufacturer Efficiency
Field Efficiency 9/10/07
Field Efficiency 12/16/07

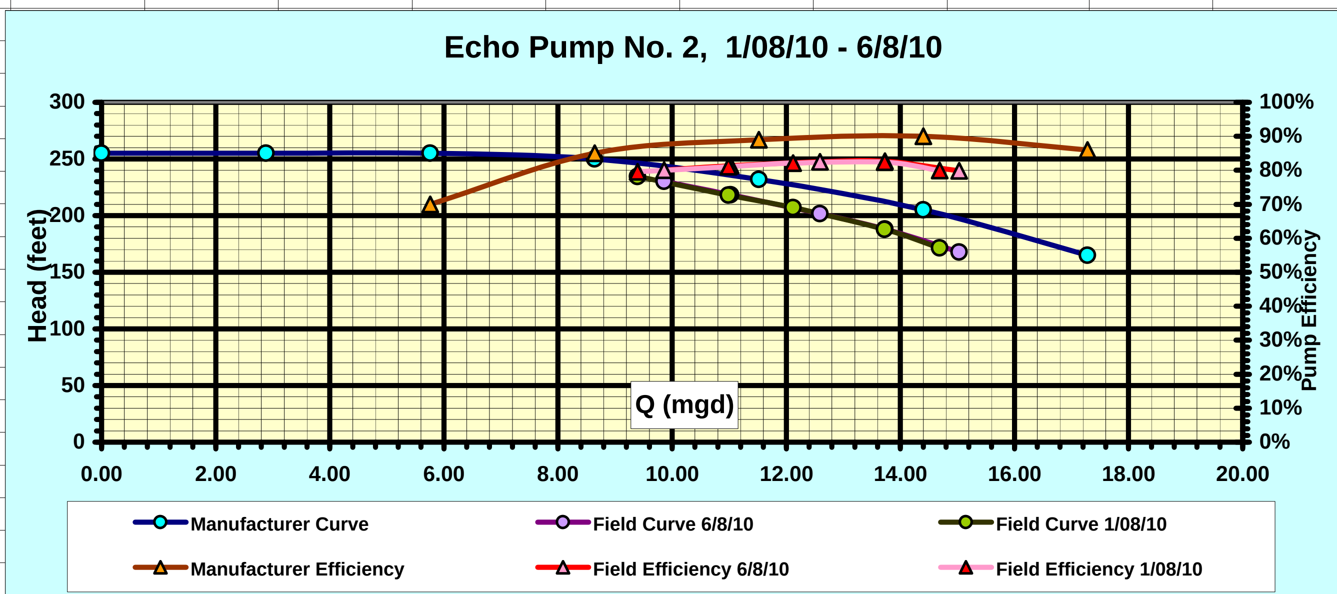

Echo Pump No. 2, 12/16/07 6 Month Test - 12/20/07 6 Month Test 2nd Test
Head (feet)
Pump Efficiency
Q (mgd)
300
250
200
150
100
50
0
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
20.00
Manufacturer Curve
Field Curve 12/20/07
Field Curve 12/16/07
Manufacturer Efficiency
Field Efficiency 12/20/07
Field Efficiency 12/16/07


Echo Pump No. 2, 12/16/07 6 Month Test - 6/16/08 1 Year Test
Head (feet)
Pump Efficiency
Q (mgd)
300
250
200
150
100
50
0
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
20.00
Manufacturer Curve
Field Curve 12/20/07
Field Curve 6/16/08
Manufacturer Efficiency
Field Efficiency 12/20/07
Field Efficiency 6/16/08

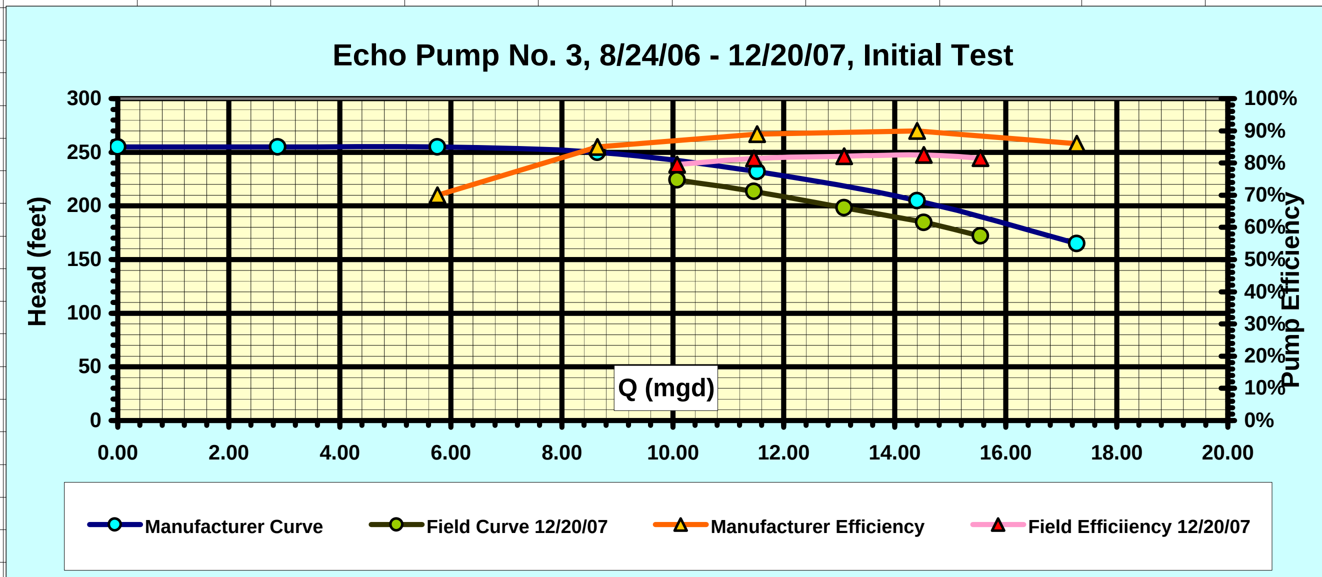

Echo Pump No. 2, 6/16/08 1 Year Test - 12/24/08 18 Month Test
Head (feet)
Pump Efficiency
Q (mgd)
300
250
200
150
100
50
0
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
20.00
Manufacturer Curve
Field Curve 12/24/08
Field Curve 6/16/08
Manufacturer Efficiency
Field Efficiency 12/24/08
Field Efficiency 6/16/08

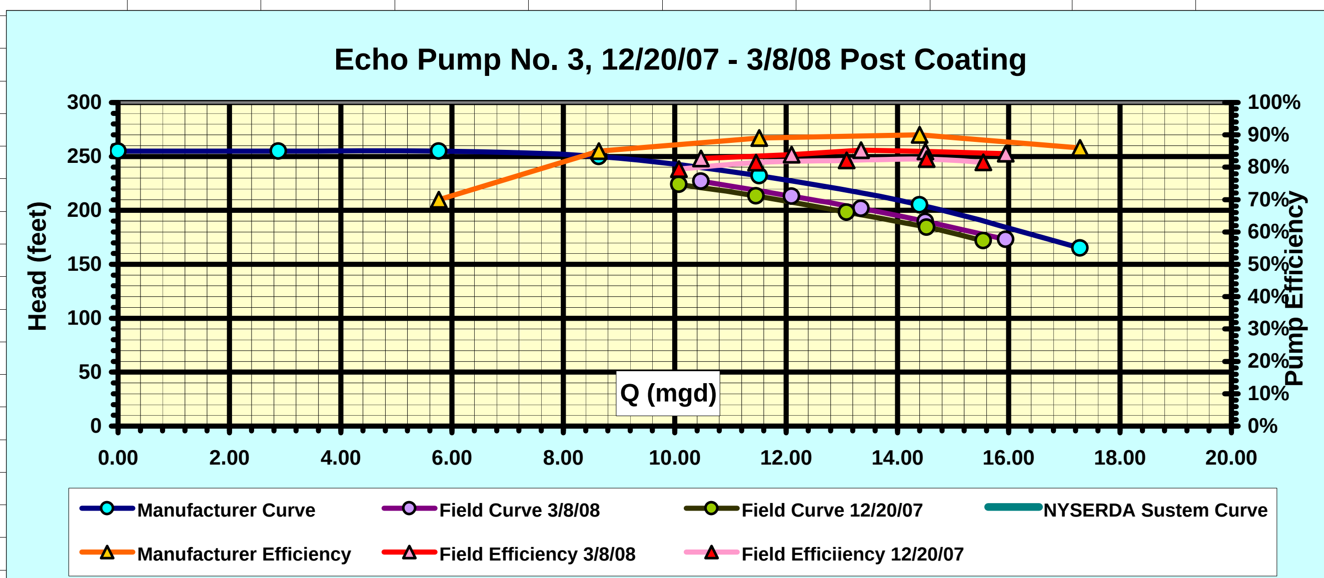


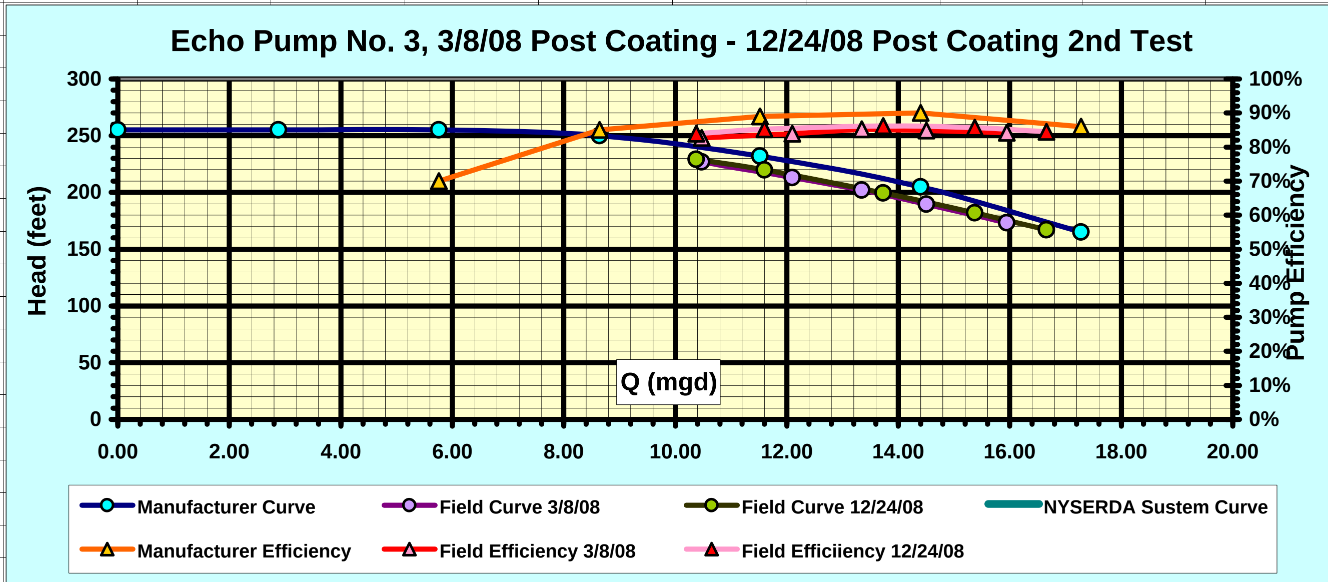
Echo Pump No. 2, 12/24/08 18 Month Test - 1/08/10 30 Month Test
Head (feet)
Pump Efficiency
Q (mgd)
300
250
200
150
100
50
0
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
20.00
Manufacturer Curve
Field Curve 12/24/08
Field Curve 1/10/08
Manufacturer Efficiency
Field Efficiency 12/24/08
Field Efficiency 1/08/10

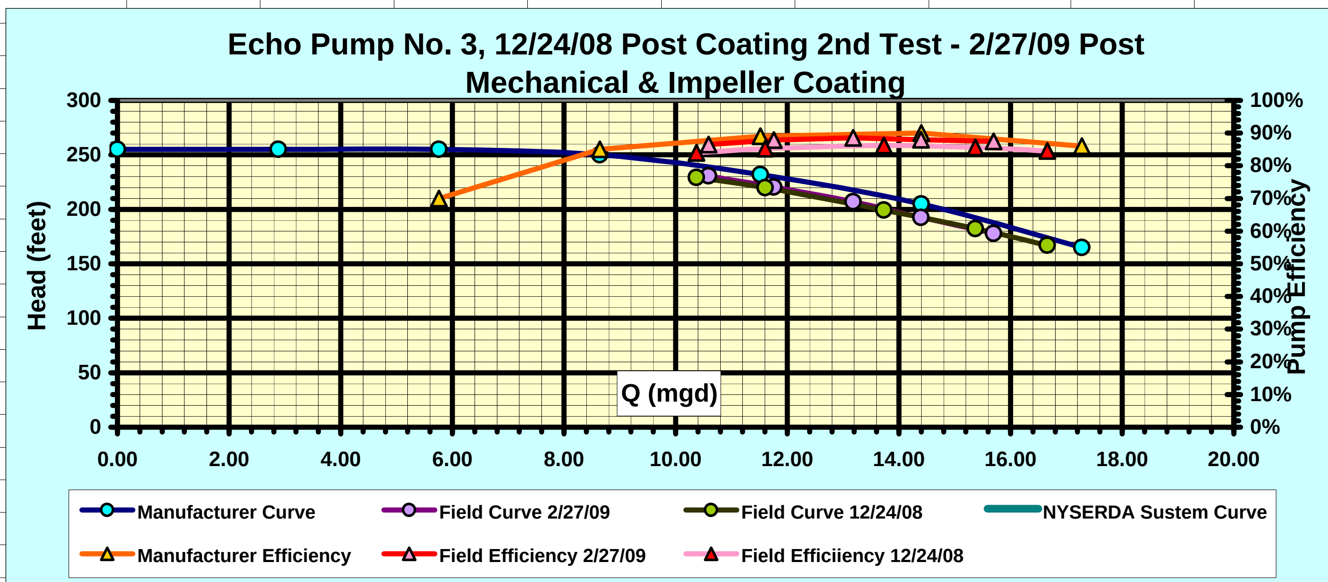


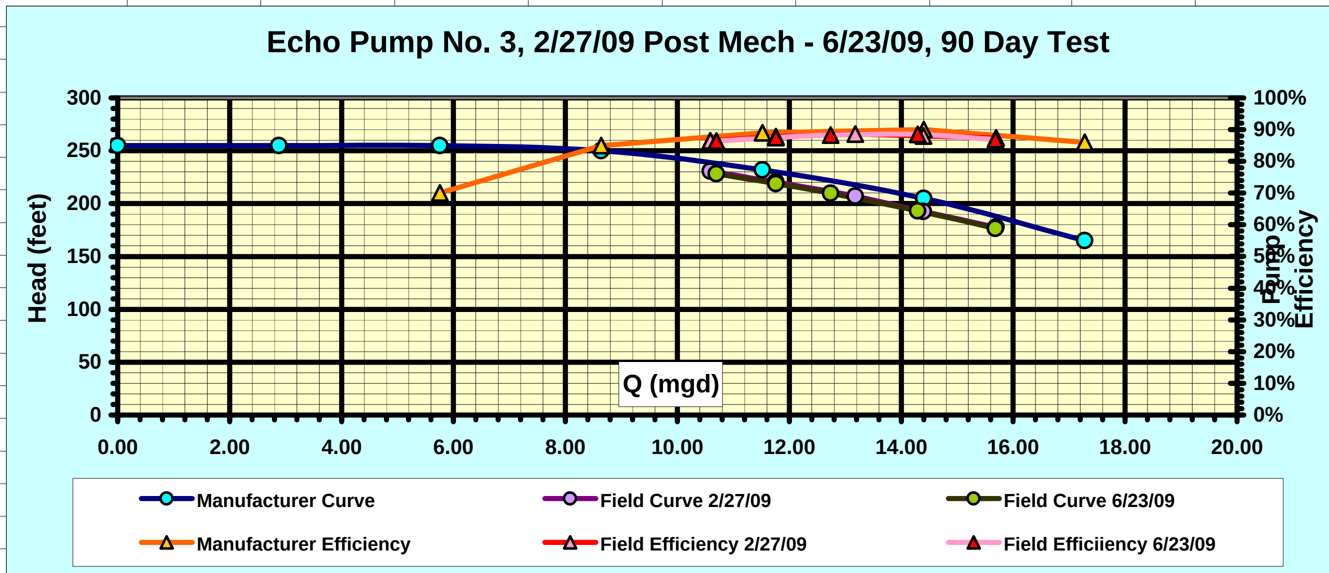
Echo Pump No. 2, 1/08/10 - 6/8/10
Head (feet)
Pump Efficiency
Q (mgd)
300
250
200
150
100
50
0
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
20.00
Manufacturer Curve
Field Curve 6/8/10
Field Curve 1/08/10
Manufacturer Efficiency
Field Efficiency 6/8/10
Field Efficiency 1/08/10

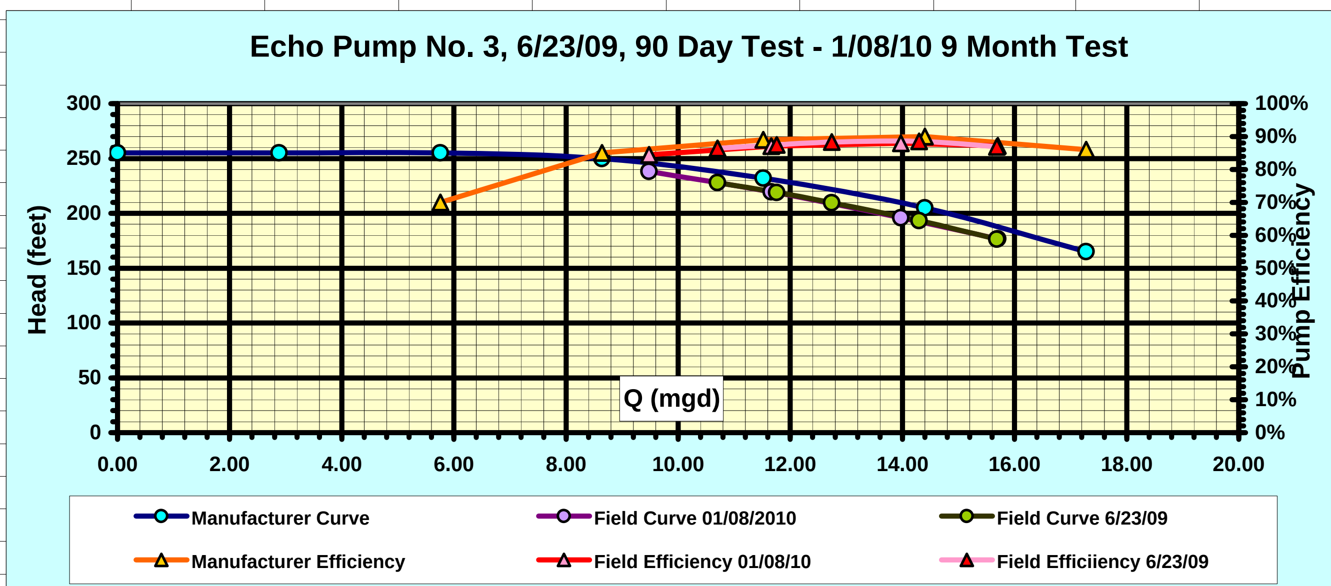

Echo Pump No. 3, 8/24/06 - 12/20/07, Initial Test
Head (feet)
Pump Efficiency
Q (mgd)
300
250
200
150
100
50
0
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
20.00
Manufacturer Curve
Field Curve 12/20/07
Manufacturer Efficiency
Field Efficiiency 12/20/07

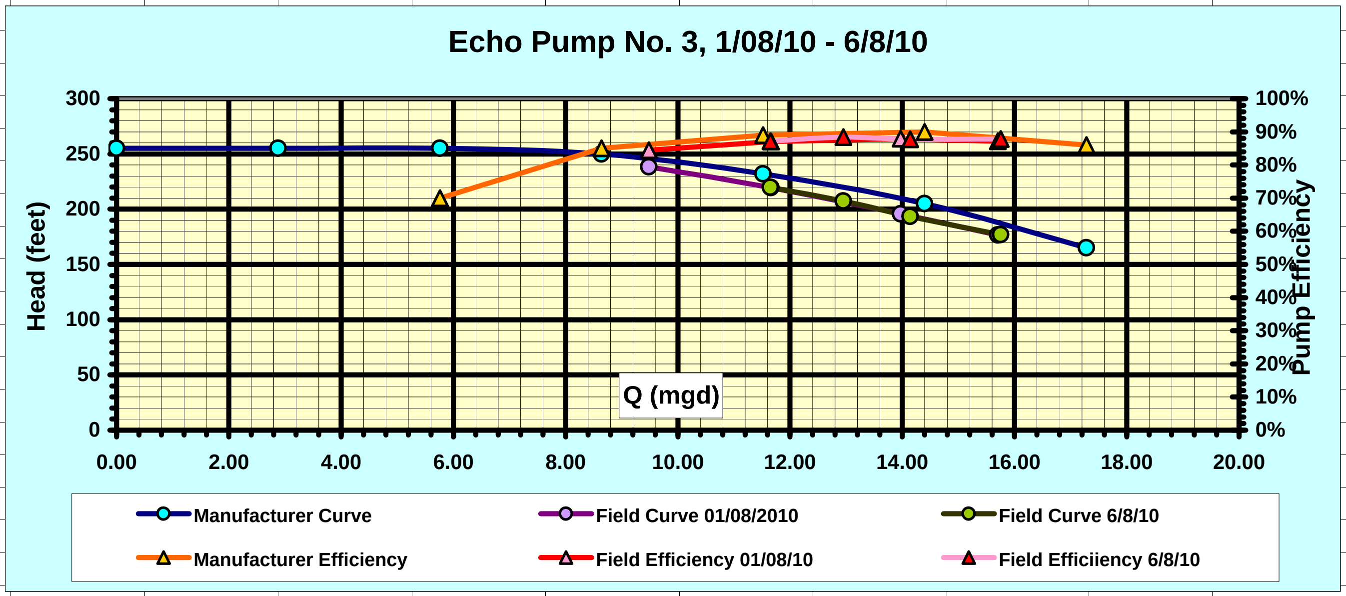

Echo Pump No. 3, 12/20/07 - 3/8/08 Post Coating
Head (feet)
Pump Efficiency
Q (mgd)
300
250
200
150
100
50
0
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
20.00
Manufacturer Curve
Field Curve 3/8/08
Field Curve 12/20/07
NYSERDA Sustem Curve
Manufacturer Efficiency
Field Efficiency 3/8/08
Field Efficiiency 12/20/07


Echo Pump No. 3, 3/8/08 Post Coating - 12/24/08 Post Coating 2nd Test
Head (feet)
Pump Efficiency
Q (mgd)
Manufacturer Curve
Field Curve 3/8/08
Field Curve 12/24/08
NYSERDA Sustem Curve
Manufacturer Efficiency
Field Efficiency 3/8/08
Field Efficiiency 12/24/08


Echo Pump No. 3, 12/24/08 Post Coating 2nd Test - 2/27/09 Post Mechanical & Impeller Coating
Head (feet)
Pump Efficiency
Q (mgd)
Manufacturer Curve
Field Curve 2/27/09
Field Curve 12/24/08
NYSERDA Sustem Curve
Manufacturer Efficiency
Field Efficiency 2/27/09
Field Efficiiency 12/24/08


Echo Pump No. 3, 2/27/09 Post Mech - 6/23/09, 90 Day Test
Head (feet)
Pump Efficiency
Q (mgd)
300
250
200
150
100
50
0
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
20.00
Manufacturer Curve
Field Curve 2/27/09
Field Curve 6/23/09
Manufacturer Efficiency
Field Efficiency 2/27/09
Field Efficiiency 6/23/09


Echo Pump No. 3, 6/23/09, 90 Day Test - 1/08/10 9 Month Test
Head (feet)
Pump Efficiency
Q (mgd)
300
250
200
150
100
50
0
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
20.00
Manufacturer Curve
Field Curve 01/08/2010
Field Curve 6/23/09
Manufacturer Efficiency
Field Efficiency 01/08/10
Field Efficiiency 6/23/09



Echo Pump No. 3, 1/08/10 - 6/8/10
Head (feet)
Pump Efficiency
Q (mgd)
300
250
200
150
100
50
0
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
20.00
Manufacturer Curve
Field Curve 01/08/2010
Field Curve 6/8/10
Manufacturer Efficiency
Field Efficiency 01/08/10
Field Efficiiency 6/8/10

Echo BPS Pump & VFD Operation

Heavy Demand System Curve

Q	S	D	H
15	83	94	25.41
20	62	119	131.67
24	38	141	237.93

Manufacturer Curve Pumps 2 & 3

Q (gpm)	Q (mgd)	Q (2 Pumps)	H	Eff	BHP	KW	Ns	NPSHR
0	0.00	0	255					
2000	2.88	5.76	255					
4000	5.76	11.52	255	70%	368.0	288.9	1170	
6000	8.64	17.28	250	85%	445.6	349.9	1454	
8000	11.52	23.04	232	89%	526.6	413.5	1775	
10000	14.40	28.8	205	90%	575.2	451.7	2178	23
12000	17.28	34.56	165	86%	581.4	456.5	2808	25
14000	20.16	40.32	115	73%	556.9	437.3	3976	

Average System Curve

	Q		H
50.0%	**8.5**	**80%**	**128**
75.0%	**12.8**	**88%**	**140.8**
BEP	**17.0**	**100%**	**160**
110.0%	**18.7**	**110%**	**176**
130.0%	**24.3**	**130%**	**228.8**

Pump No. 1 Field Curve 12/24/08 Post Casing Coating

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
10660	15.35	39.69	13.44	98.89	22.22	136.8	2.80	7.66	141.6	84.1%	453.3	355.96	1197
9806	14.12	44.9	12.36	112.57	20.44	156.3	2.37	6.49	160.4	87.3%	455.0	357.33	1197
8674	12.49	48.33	10.94	123.52	18.08	173.7	1.86	5.07	176.9	86.2%	449.7	353.11	1198
7639	11	54.42	9.63	136.81	15.92	190.3	1.44	3.94	192.8	85.8%	433.7	340.57	1198
6000	8.64		7.56		12.51		0.89	2.43	205.0				1198
2778	4		3.50		5.79		0.19	0.52	225.0				1199
0	0		0.00		0.00		0.00	0.00	245.0				1200

Corrected to 1180 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM
10508	15.13	137.6	84.1%	434.3	341	1180
9666	13.92	155.9	87.3%	435.9	342	1180
8543	12.30	171.6	86.2%	429.7	337	1180
7524	10.83	187.1	85.8%	414.4	325	1180

95% Speed 1137 rpm

Q (gpm)	Q (mgd)	H	Eff	BHP	RPM
10125	14.58	127.8	84.1%	388.5	1137
9314	13.41	144.7	87.3%	390.0	1137
8239	11.86	159.6	86.2%	385.4	1137
7256	10.45	174.0	85.8%	371.7	1137
	8.21	185.0			1137
	3.80	203.0			1137
0	0.00	221.1			1137

90% Speed 1077 rpm

Q (gpm)	Q (mgd)	H	Eff	BHP	RPM
9591	13.81	114.6	84.1%	330.2	1077
8823	12.70	129.9	87.3%	331.5	1077
7804	11.24	143.2	86.2%	327.5	1077
6873	9.90	156.1	85.8%	315.9	1077
	7.77	166.0			1077
	3.60	182.1			1077
0	0.00	198.3			1077

85% Speed 1077 rpm

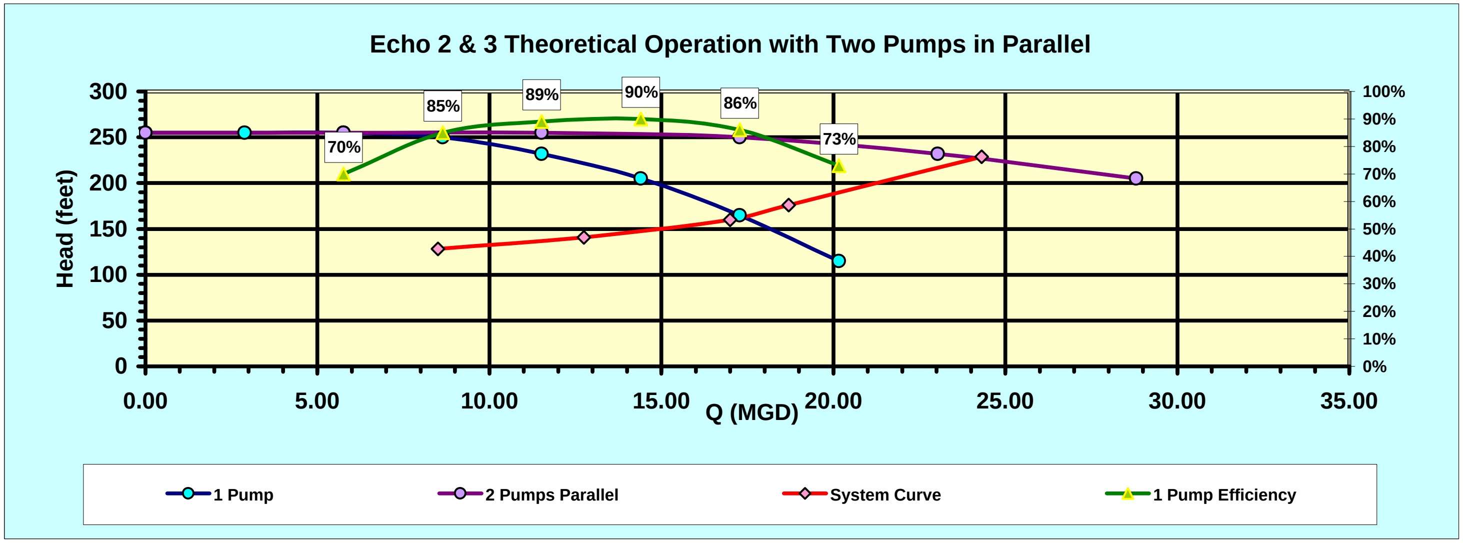
Q (gpm)	Q (mgd)	H	Eff	BHP	RPM
9057	13.04	102.2	84.1%	278.0	1017
8331	12.00	115.8	87.3%	279.1	1017
7369	10.61	127.7	86.2%	275.8	1017
6490	9.35	139.2	85.8%	266.0	1017
	7.34	148.0			1017
	3.40	162.4			1017
0	0.00	176.9		0.0	1017

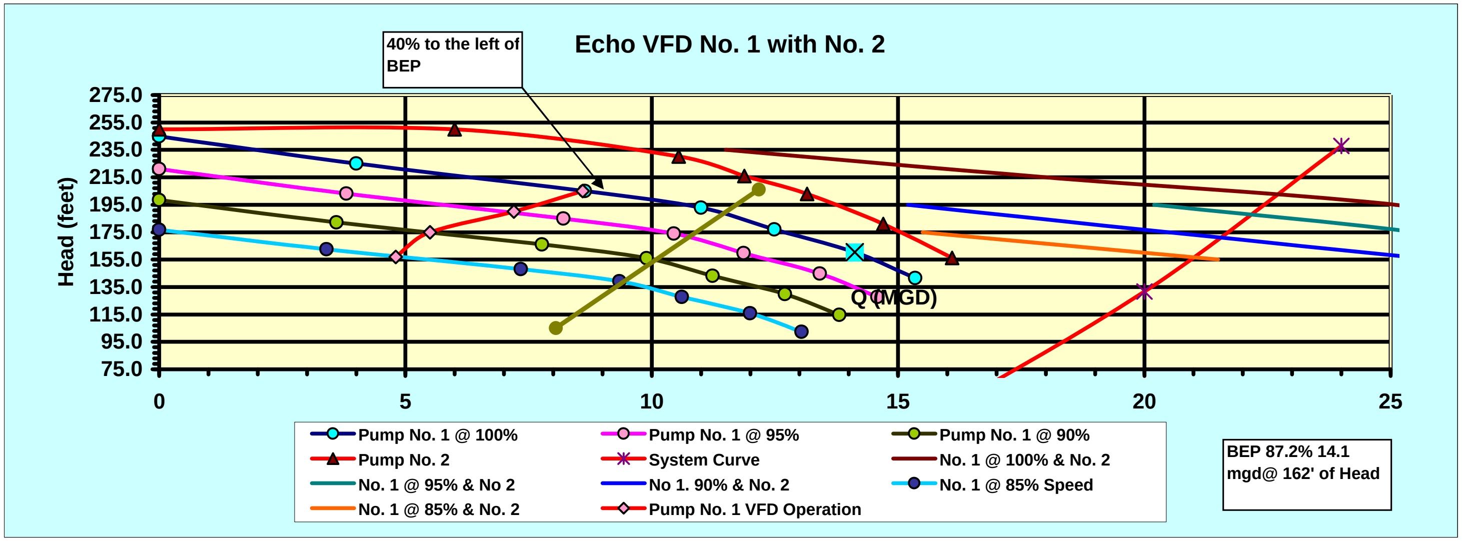
Pump No. 2 Field Curve 12/24/08 (18 Month test)

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
11181	16.1	36.44	14.10	103.3	17.84	154.4	3.09	4.94	156.3	77.8%	567.4	444.19	1191
10208	14.7	41.52	12.87	119.23	16.29	179.5	2.57	4.12	181.1	82.4%	566.5	443.42	1191
9132	13.15	47.43	11.51	134.7	14.57	201.6	2.06	3.30	202.8	84.0%	556.8	435.83	1191
8250	11.88	51.34	10.40	144.44	13.16	215.1	1.68	2.69	216.1	83.0%	542.3	424.53	1191
7326	10.55	55.3	9.24	154.65	11.69	229.5	1.32	2.12	230.3	82.0%	519.8	406.86	1192
4167	6		5.25		6.65		0.43	0.69	250.0				
0	0.00								250.0				

Corrected to 1180 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM
11077	15.95	153.4	77.8%	551.9	432	1180
10114	14.56	177.7	82.4%	550.9	431	1180
9048	13.03	199.1	84.0%	541.5	424	1180
8174	11.77	212.1	83.0%	527.4	413	1180
7253	10.44	225.7	82.0%	504.2	395	1180





Pump No. 1 100% with Pump no. 2

H	Q
155	30.6
175	27.6
195	25.1
215	18
235	11.5

Pump No. 1 @ 90% with Pump no. 2

H	Q
155	25.9
175	20.5
195	15.2

Condition	Q2	Q1	Total	Head	% BEP
1 @ 100%	13.1	8.6	21.7	205	36%
1 @ 95%	14.1	7.2	21.3	190	47%
1 @ 90%	15.1	5.5	20.6	175	59%
1@ 85%	16	4.8	20.8	157	64%

Pump No. 1 @ 95% with Pump no. 2

H	Q
155	28.3
175	25.5
195	20.2

Pump No. 1 @ 85% with Pump no. 2

H	Q
155	21.5
175	15.5

Pump No. 3 Field Curve 2/27/09 Post Mechanical & Impeller Coating

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
11000	15.84	34.92	13.87	112.55	17.55	179.3	2.99	4.78	181.1	87.4%	575.4	450.44	1191
10083	14.52	39.28	12.71	123.42	16.09	194.4	2.51	4.02	195.9	88.0%	567.0	443.81	1191
9229	13.29	43.4	11.64	133.99	14.73	209.3	2.10	3.37	210.5	88.6%	553.9	433.57	1191
8243	11.87	47.42	10.39	144.2	13.15	223.6	1.68	2.69	224.6	87.8%	532.2	416.63	1191
7424	10.69	50.64	9.36	152.04	11.85	234.2	1.36	2.18	235.1	86.5%	509.6	398.94	1191
4167	6		5.25		6.65		0.43	0.69	250.0				
0	0		0.00		0.00		0.00	0.00	250.0				

Corrected to 1180 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM
10898	15.69	177.8	87.4%	559.6	438	1180
9990	14.39	192.3	88.0%	551.4	432	1180
9144	13.17	206.7	88.6%	538.7	422	1180
8167	11.76	220.4	87.8%	517.6	405	1180
7355	10.59	230.7	86.5%	495.6	388	1180

95% Speed 1137 rpm

Q (gpm)	Q (mgd)	H	Eff	BHP	RPM
10446	15.04	163.3	87.4%	492.8	1131
9575	13.79	176.6	88.0%	485.5	1131
8764	12.62	189.9	88.6%	474.3	1131
7828	11.27	202.5	87.8%	455.8	1131
7050	10.15	212.0	86.5%	436.4	1131
	5.70	225.4			1131
	0.00	225.4			1131

90% Speed 1077 rpm

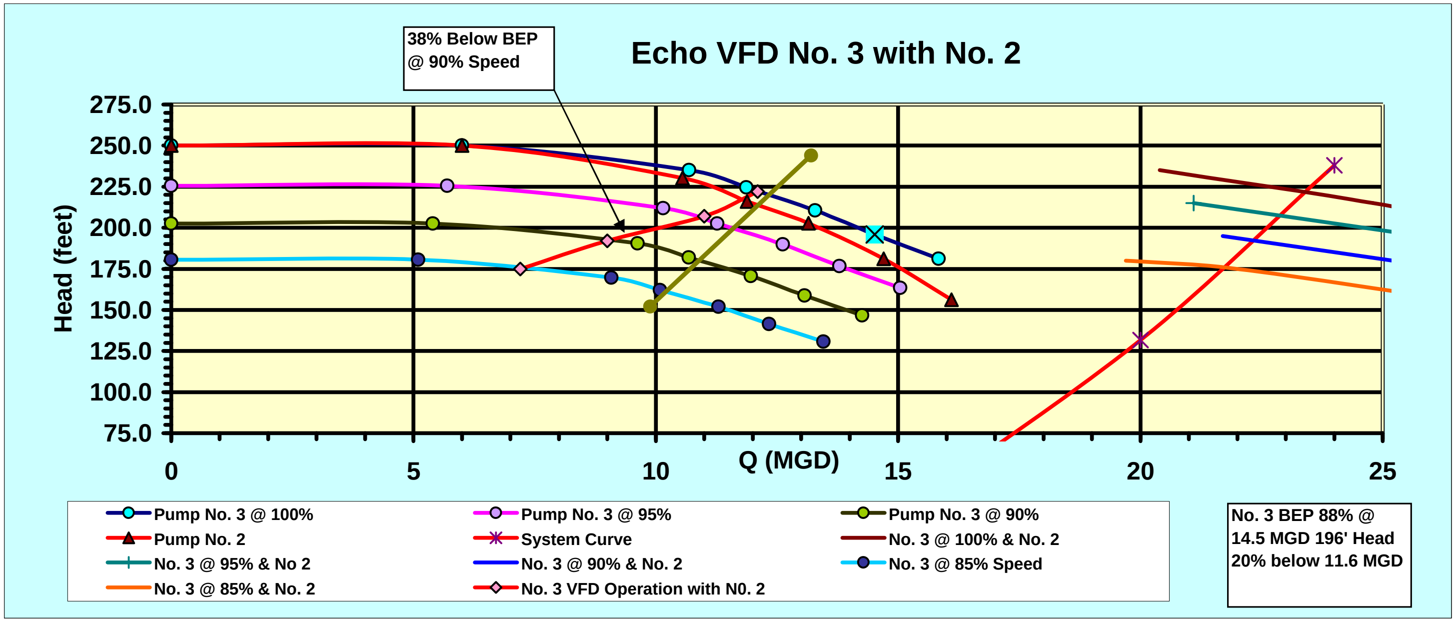
Q (gpm)	Q (mgd)	H	Eff	BHP	RPM
9901	14.26	146.7	87.4%	419.6	1072
9076	13.07	158.7	88.0%	413.4	1072
8307	11.96	170.6	88.6%	403.9	1072
7419	10.68	181.9	87.8%	388.1	1072
6682	9.62	190.4	86.5%	371.6	1072
3750	5.40	202.5			1072
	0.00	202.5			1072

85% Speed 1012 rpm

Q (gpm)	Q (mgd)	H	Eff	BHP	RPM
9347	13.46	130.8	87.4%	353.0	1012
8568	12.34	141.4	88.0%	347.8	1012
7842	11.29	152.0	88.6%	339.8	1012
7004	10.09	162.1	87.8%	326.5	1012
6308	9.08	169.7	86.5%	312.7	1012
3540	5.10	180.5			1012
	0.00	180.5			1012

80% Speed 1014 rpm

Q (gpm)	Q (mgd)	H	Eff	BHP	RPM
8802	12.67	116.0	87.4%	294.8	953
8068	11.62	125.4	88.0%	290.5	953
7385	10.63	134.8	88.6%	283.8	953
6596	9.50	143.8	87.8%	272.7	953
5940	8.55	150.5	86.5%	261.1	953
3334	4.80	160.1			953
	0.00	160.1			953



Pump No. 3 100% with Pump no. 2

H	Q
195	28.25
215	24.8
235	20.4

Pump No. 3 @ 90% with Pump no. 2

H	Q
175	26.4
195	21.7

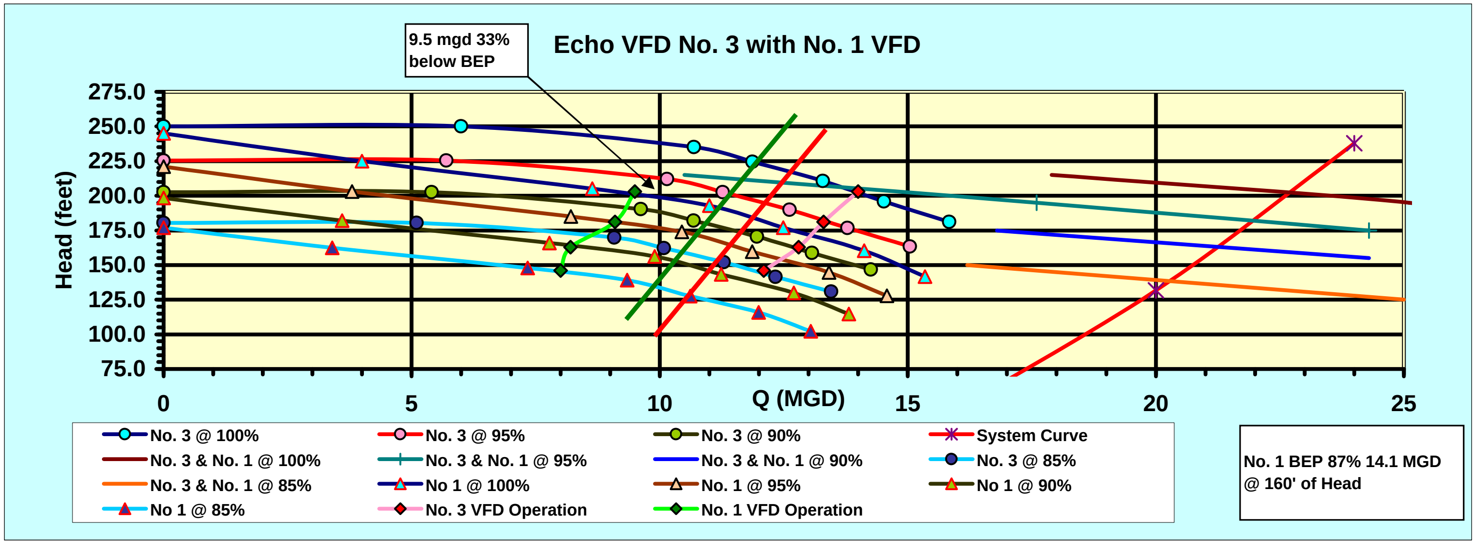
Condition	Q 3	Q 2	Total	H
3 @ 100%	12.1	11.4	23.5	222
3 @ 95%	11	13	24	207
3 @ 90%	9	14	23	192
3 @ 85%	7.2	15	22.2	175

Pump No. 3 @ 95% with Pump no. 2

H	Q
175	28.8
195	25.8
215	21.1

Pump No. 3 @ 85% with Pump no. 2

H	Q
155	26.7
175	22
180	19.7



Pump No. 3 & No. 1 @ 100%

H	Q
175	28.9
195	25.1
215	17.9

Pump No. 3 & No. 1 @ 90%

H	Q
155	24.3
175	16.8

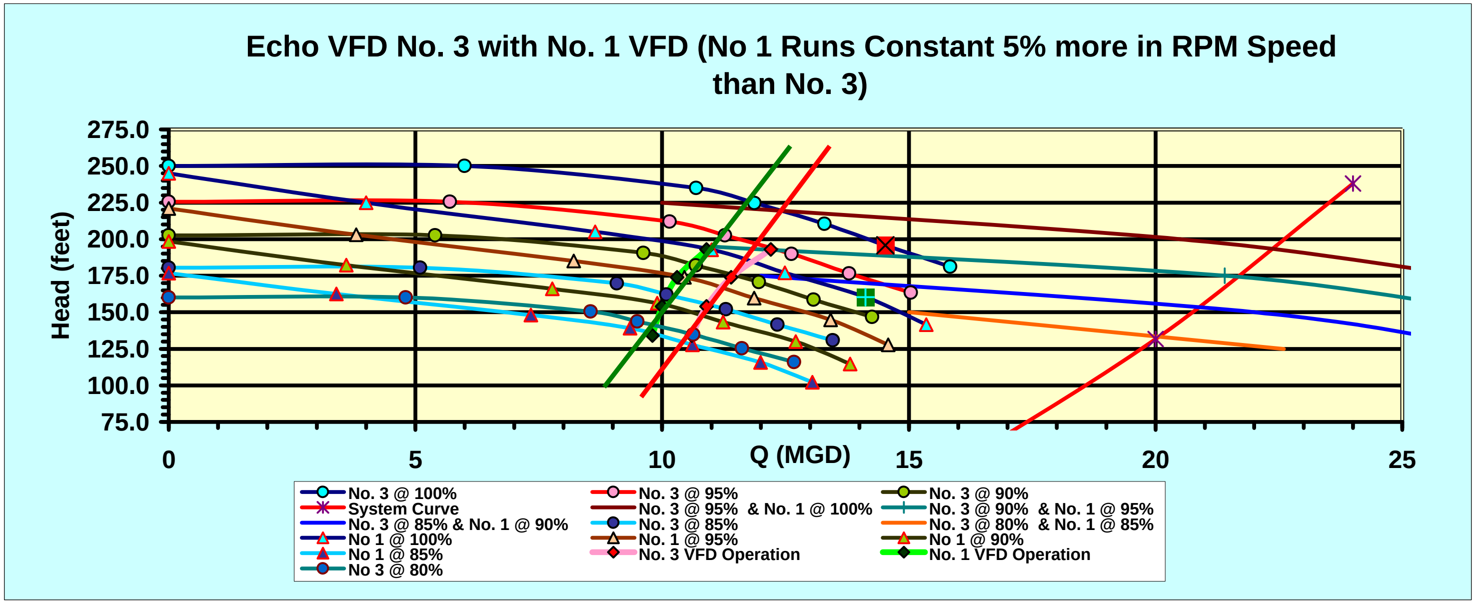
Condition	Q 3	Q 1	Total	H
3 @ 100%	14	9.5	23.5	203
3 @ 95%	13.3	9.1	22.4	181
3 @ 90%	12.8	8.2	21	163
3 @ 85%	12.1	8	20.1	146

Pump No. 3 & No. 1 @ 95%

H	Q
175	24.3
195	17.6
215	10.5

Pump No. 3 & No. 1 @ 85%

H	Q
125	25
150	16.2



Pump No. 3 @ 95% & No. 1 @ 100%

H	Q
175	26.3
200	20.5
225	10

Pump No. 3 @ 85% & No. 1 @ 90%

H	Q
125	27
150	22
175	12

Condition	Q 3	Q 1	Total	H
3 @ 95% 1 @100%	12.2	10.9	23.1	193
3 @ 90% 1 @ 95%	11.4	10.3	21.7	174
3 @ 85% 1 @ 90%	10.9	10	20.9	154
3 @ 80% 1 @ 85%	10.6	9.8	20.4	134

Pump No. 3 @ 90% & No. 1 @ 95%

H	Q
150	27
175	21.4
195	11

Pump No. 3 @ 80% & No. 1 @ 85%

H	Q
125	22.6
150	15

Harris Road Pump No. 1
Energy Efficiency Cost Calculator

Continuous Service

Pre Mechanical	
Head (ft)	95
Flow (gpm)	2285
Effieicny	79.4%
Hours Operation/month	710
BHP	69
kW (Assumes Motor Eff 95%)	54.2
kW Demand Charge	$542
kwh cost	$3,271
Total Monthly kWH	38,485
Monthly Cost	**$3,813.35**

Constants	
Hours/ Month	730
kW Demand Cost	$10.00
kwh Cost	$0.085
Motor Efficiency	95.0%

Post Mechanical	
Head (ft)	94.5
Flow (gpm)	2222
Effieicny	80.8%
Hours Operation/month	730
BHP	66
kW (Assumes Motor Eff 95%)	51.5
kW Demand Charge	$515
kwh cost	$3,198
Total Monthly kWH	37619
Monthly Cost	**$3,712.95**

Pre - Post Mechanical Comparison	
Monthly Savings	**$100**
Annual Savings	**$1,205**
5 Year Savings	**$6,024**
kW Demand Reduction	**2.7**
Monthly kwh Savings	**866**
Yearly kwh Savings	**10390**

Post Casing Coating	
Head (ft)	95.3
Flow (gpm)	2326
Effieicny	85.5%
Hours Operation/month	697
BHP	65
kW (Assumes Motor Eff 95%)	51.4
kW Demand Charge	$514
kwh cost	$3,047
Total Monthly kWH	35852
Monthly Cost	**$3,561.53**

Pre - Post Internal Coating Comparison	
Monthly Savings	**$151**
Annual Savings	**$1,817**
5 Year Savings	**$9,085**
kW Demand Reduction	**0.12**
Monthly kwh Savings	**34572**
Yearly kwh Savings	**414859**

Pre Mechanical to Post Interior Coating Comparison	
Monthly Savings	**$252**
Annual Savings	**$3,022**
5 Year Savings	**$15,109**
kW Demand Reduction	**2.80**
Monthly kwh Savings	**2633**
Yearly kwh Savings	**31594**

Harris Road Pump No. 1 Cont'

20% Service Time

Pre Mechanical

Head (ft)	95
Flow (gpm)	2285
Effieicny	79.4%
Hours Operation/month	146
BHP	69
kW (Assumes Motor Eff 95%)	54.2
kW Demand Charge	$542
kwh cost	$673
Total Monthly kWH	7,915
Monthly Cost	**$1,214.93**

Constants

Hours/ Month	730
kW Demand Cost	$10.00
kwh Cost	$0.085
Motor Efficiency	95.0%

Post Mechanical

Head (ft)	94.5
Flow (gpm)	2222
Effieicny	80.8%
Hours Operation/month	150
BHP	66
kW (Assumes Motor Eff 95%)	51.5
kW Demand Charge	$515
kwh cost	$658
Total Monthly kWH	7737
Monthly Cost	**$1,172.98**

Pre - Post Mechanical Comparison

Monthly Savings	$42
Annual Savings	$503
5 Year Savings	$2,517
kW Demand Reduction	2.7
Monthly kwh Savings	178
Yearly kwh Savings	2137

Post Casing Coating

Head (ft)	95.3
Flow (gpm)	2326
Effieicny	85.5%
Hours Operation/month	143
BHP	65
kW (Assumes Motor Eff 95%)	51.4
kW Demand Charge	$514
kwh cost	$627
Total Monthly kWH	7374
Monthly Cost	**$1,140.88**

Pre - Post Internal Coating Comparison

Monthly Savings	$32
Annual Savings	$385
5 Year Savings	$1,927
kW Demand Reduction	0.12
Monthly kwh Savings	7110
Yearly kwh Savings	85324

Pre Mechanical to Post Interior Coating Comparison

Monthly Savings	$74
Annual Savings	$889
5 Year Savings	$4,443
kW Demand Reduction	2.80
Monthly kwh Savings	541
Yearly kwh Savings	6498

Total Savings (Mechanical & Coating)

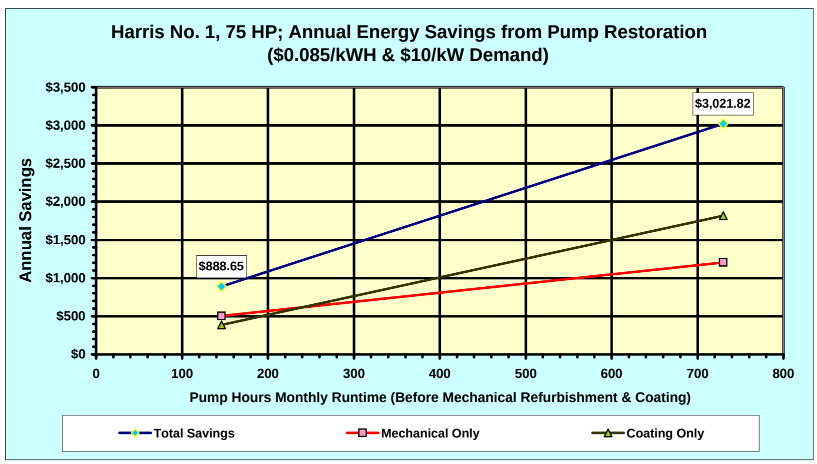
Pump Hours of Operation Before Refurbishment & Interior Coating	Annual Savings Through Refurbishment & Interior Coatings
730	$3,021.82
146	$888.65

Mechanical Savings Only

Pump Hours of Operation Before Refurbishment & Interior Coating	
730	$1,204.88
146	$503.34

Coating Savings Only

Pump Hours of Operation Before Refurbishment & Interior Coating	
730	$1,816.94
146	$385.31



Harris Pump No. 2
Energy Efficiency Cost Calculator
Continuous Service

Pre Mechanical	
Head (ft)	94.2
Flow (gpm)	2278
Efficiency	78.7%
Hours Operation/month	730
BHP	69
kW (Assumes Motor Eff 95%)	54.1
kW Demand Charge	$541
kwh cost	$3,355
Total Monthly kWH	39,471
Monthly Cost	**$3,895.69**

Constants	
Hours/ Month	730
kW Demand Cost	$10.00
kwh Cost	$0.085
Motor Efficiency	95.0%

Post Casing Coating	
Head (ft)	96.2
Flow (gpm)	2347
Efficiency	83.4%
Hours Operation/month	709
BHP	68
kW (Assumes Motor Eff 95%)	53.7
kW Demand Charge	$537
kwh cost	$3,233
Total Monthly kWH	38037
Monthly Cost	**$3,769.98**

Pre - Post Mechanical Comparison	
Monthly Savings	**$126**
Annual Savings	**$1,509**
5 Year Savings	**$7,543**
kW Demand Reduction	**0.4**
Monthly kwh Savings	**1434**
Yearly kwh Savings	**17203**

Post Mechanical	
Head (ft)	96.1
Flow (gpm)	2340
Efficiency	83.6%
Hours Operation/month	711
BHP	68
kW (Assumes Motor Eff 95%)	53.4
kW Demand Charge	$534
kwh cost	$3,223
Total Monthly kWH	37916
Monthly Cost	**$3,756.35**

Pre - Post Impeller Comparison	
Monthly Savings	**$14**
Annual Savings	**$164**
5 Year Savings	**$818**
kW Demand Reduction	**0.3**
Monthly kwh Savings	**121**
Yearly kwh Savings	**1456**

Post Impeller Coating	
Head (ft)	95.5
Flow (gpm)	2319
Efficiency	85.6%
Hours Operation/month	717
BHP	65
kW (Assumes Motor Eff 95%)	51.3
kW Demand Charge	$513
kwh cost	$3,127
Total Monthly kWH	36790
Monthly Cost	**$3,640.16**

Pre - Post Internal Coating Comparison	
Monthly Savings	**$116**
Annual Savings	**$1,394**
5 Year Savings	**$6,971**
kW Demand Reduction	**2.38**
Monthly kwh Savings	**1126**
Yearly kwh Savings	**13511**

Pre Mechanical to Post Interior Coating Comparison	
Monthly Savings	**$256**
Annual Savings	**$3,066**
5 Year Savings	**$15,331**
kW Demand Reduction	**2.77**
Monthly kwh Savings	**2681**
Yearly kwh Savings	**32170**

Harris Pump No. 2 Cont'
20% Service Time

Pre Mechanical	
Head (ft)	94.5
Flow (gpm)	2278
Efficiency	78.7%
Hours Operation/month	146
BHP	69
kW (Assumes Motor Eff 95%)	54.2
kW Demand Charge	$542
kwh cost	$673
Total Monthly kWH	7,919
Monthly Cost	**$1,215.55**

Constants	
Hours/ Month	730
kW Demand Cost	$10.00
kwh Cost	$0.085
Motor Efficiency	95.0%

Post Casing Coating	
Head (ft)	96.2
Flow (gpm)	2347
Efficiency	83.2%
Hours Operation/month	142
BHP	69
kW (Assumes Motor Eff 95%)	53.8
kW Demand Charge	$538
kwh cost	$648
Total Monthly kWH	7626
Monthly Cost	**$1,186.31**

Pre - Post Internal Coating Comparison	
Monthly Savings	$29
Annual Savings	$351
5 Year Savings	$1,754
kW Demand Reduction	0.4
Monthly kwh Savings	294
Yearly kwh Savings	3523

Post Mechanical	
Head (ft)	96.1
Flow (gpm)	2340
Efficiency	83.6%
Hours Operation/month	142
BHP	68
kW (Assumes Motor Eff 95%)	53.4
kW Demand Charge	$534
kwh cost	$645
Total Monthly kWH	7583
Monthly Cost	**$1,178.09**

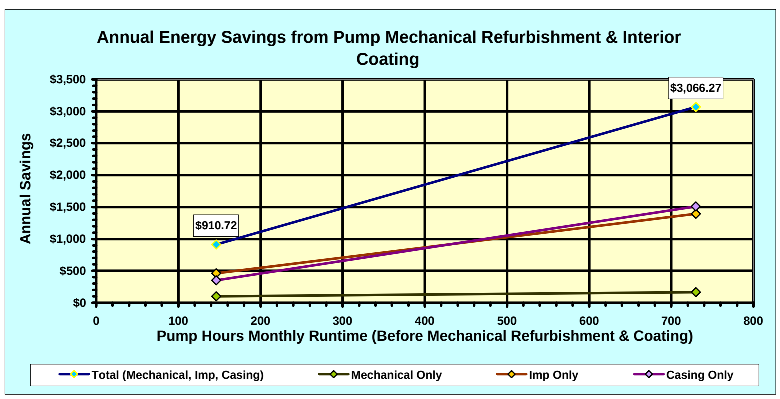
Pre - Post Mechanical Comparison	
Monthly Savings	$8
Annual Savings	$99
5 Year Savings	$493
kW Demand Reduction	0.5
Monthly kwh Savings	43
Yearly kwh Savings	511

Post Impeller Coating	
Head (ft)	95.6
Flow (gpm)	2319
Efficiency	85.6%
Hours Operation/month	143
BHP	65
kW (Assumes Motor Eff 95%)	51.4
kW Demand Charge	$514
kwh cost	$626
Total Monthly kWH	7366
Monthly Cost	**$1,139.66**

Pre - Post Impeller Comparison	
Monthly Savings	$38
Annual Savings	$461
5 Year Savings	$2,306
kW Demand Reduction	2.46
Monthly kwh Savings	7000
Yearly kwh Savings	83995

Pre Mechanical to Post Interior Coating Comparison	
Monthly Savings	$76
Annual Savings	$911
5 Year Savings	$4,554
kW Demand Reduction	2.88
Monthly kwh Savings	554
Yearly kwh Savings	6643

Pump Hours of Operation Before Refurbishment & Interior Coating	Annual Savings Through Refurbishment & Interior Coatings
Total	
730	$3,066.27
146	$910.72
Casing Coating Only	
730	$1,508.50
146	$350.88
Mechanical Only	
730	$163.51
146	$98.61
Impeller Coating Only	
730	$1,394.26
146	$461.24



Harris Road BPS

Manufacturer's Pump and Motor Information

Pumps 1 and 2

ITT AC Pump 10x8x12S — **Serial: 230840-01-02**
Type 8100 — **Size: 10x8x12S**
1780 RPM — **IMP: 11.5**
Installed 8/19/97
Manufacturers Curve Pump No's. 1 or 2

Motors 1 and 2

Marathon Electric
Model: 365TSTFS6026BP
HP:75
Installed 8/19/97
Nema Nom Eff: 94.5%

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	kW/mg	Ns
0	0	135					
1000	1.44	127	62%	52	41	28.2	1488
1500	2.16	120	75%	61	48	22.0	1901
2250	3.24	100	84%	68	53	16.4	2670
2375	3.42	95	85%	67	53	15.5	2851
2500	3.6	90	84%	68	53	14.8	3046
3000	4.32	65	77%	64	50	11.6	4259

Motor Efficiency

Amps	kW	% Eff
37	15	91.7%
50	29.5	94.1%
68	44	95.0%
86	59	95.0%
100	68	94.5%
110	74	94.1%

NYSERDA System Curve

Q		H	
50.0%	1.69	80%	77
75.0%	2.54	88%	84.7
BEP	3.38	100%	96.25
125.0%	4.23	120%	115.5

Pump No. 1 Field Curve 10/17/07 Initial Test													
Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
2319	3.34	42.95	9.48	83.12	14.80	92.8	1.39	3.40	94.8	79.3%	70.01	55.27	1786
2167	3.12	44.12	8.85	87.11	13.83	99.3	1.22	2.97	101.1	79.9%	69.18	54.61	1786
1861	2.68	45.69	7.60	92.5	11.88	108.1	0.90	2.19	109.4	76.8%	66.94	52.84	1786
1549	2.23	47.23	6.33	97.77	9.88	116.7	0.62	1.52	117.6	73.6%	62.51	49.35	1786
Corrected to 1780													
Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kW/mg						
2312	3.33	94.2	79.3%	69.3	55	1780.0	16.4						
2159	3.11	100.4	79.9%	68.5	54	1780.0	17.4						
1855	2.67	108.7	76.8%	66.3	52	1780.0	19.6						
1544	2.22	117.0	73.6%	62.0	49	1781.0	22.0						
Pump No. 1 Field Curve 4/28/08 Post Mechanical													
Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
2528	3.64	52.35	10.33	87.76	16.13	81.8	1.66	4.04	84.2	82.1%	65.48	51.69	1787
2306	3.32	53.89	9.42	92.88	14.71	90.1	1.38	3.36	92.1	81.3%	65.88	52.01	1787
2049	2.95	55.66	8.37	98.46	13.07	98.9	1.09	2.65	100.4	79.5%	65.39	51.62	1787
1639	2.36	58.06	6.69	106.33	10.46	111.5	0.70	1.70	112.5	75.1%	61.98	48.93	1787
1375	1.98	59.36	5.62	109.34	8.78	115.5	0.49	1.20	116.2	69.8%	57.81	45.64	1788
Corrected to 1780													
Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kW/mg						
2518	3.63	83.5	82.1%	64.7	51	1780.0	14.1						
2297	3.31	91.3	81.3%	65.1	51	1780.0	15.5						
2041	2.94	99.6	79.5%	64.6	51	1780.0	17.4						
1632	2.35	111.6	75.1%	61.3	48	1780.0	20.6						
1369	1.97	115.1	69.8%	57.0	45	1780.0	22.8						

Pump No. 1 Field Curve 6/4/08 Post Casing Coating

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
2569	3.7	49.64	10.50	85.5	16.40	82.8	1.71	4.18	85.3	85.5%	64.77	51.13	1788
2368	3.41	51.62	9.67	91.13	15.11	91.3	1.45	3.55	93.4	85.6%	65.20	51.47	1787
2125	3.06	53.31	8.68	97.29	13.56	101.6	1.17	2.86	103.3	85.2%	65.07	51.37	1788
1660	2.39	55.65	6.78	106.7	10.59	117.9	0.71	1.74	119.0	80.9%	61.63	48.65	1788
1222	1.76	57.49	4.99	112.87	7.80	127.9	0.39	0.94	128.5	72.3%	54.83	43.28	1789

Corrected to 1780

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kW/mg
2558	3.68	84.5	85.5%	63.9	50	1780.0	13.7
2359	3.40	92.6	85.6%	64.4	51	1780.0	15.0
2115	3.05	102.4	85.2%	64.2	51	1780.0	16.6
1652	2.38	117.9	80.9%	60.8	48	1780.0	20.2
1216	1.75	127.2	72.3%	54.0	43	1780.0	24.3

Pump No. 1 Field Curve 8/7/08 30 & 60 Day Test

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
2569	3.7	49.16	10.50	84.65	16.40	82.0	1.71	4.18	84.4	85.4%	64.12	50.62	1787
2375	3.42	50.6	9.70	89.88	15.16	90.7	1.46	3.57	92.8	86.1%	64.64	51.03	1786
2125	3.06	52.04	8.68	95.96	13.56	101.5	1.17	2.86	103.1	86.0%	64.35	50.80	1787
1611	2.32	54.14	6.58	105.85	10.28	119.5	0.67	1.64	120.4	81.6%	60.07	47.42	1788
1340	1.93	56.17	5.48	110.84	8.55	126.3	0.47	1.14	127.0	77.0%	55.81	44.06	1788

Corrected to 1780

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kW/mg
2559	3.69	83.8	85.4%	63.4	50	1780.0	13.6
2367	3.41	92.2	86.1%	64.0	51	1780.0	14.8
2117	3.05	102.3	86.0%	63.6	50	1780.0	16.5
1604	2.31	119.3	81.6%	59.3	47	1780.0	20.3
1334	1.92	125.8	77.0%	55.1	43	1780.0	22.6

Pump No. 1 Field Curve 10/31/08 6 Month

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
2563	3.69	49.3	10.47	85.4	16.35	83.4	1.70	4.15	85.8	86.6%	64.14	50.63	1785
2375	3.42	50.81	9.70	90.44	15.16	91.5	1.46	3.57	93.7	87.0%	64.55	50.96	1787
2111	3.04	52.38	8.62	96.68	13.47	102.3	1.15	2.82	104.0	86.4%	64.20	50.68	1789
1757	2.53	54.55	7.18	104.38	11.21	115.1	0.80	1.95	116.3	83.8%	61.55	48.59	1788
1479	2.13	55.76	6.04	109.14	9.44	123.3	0.57	1.38	124.1	80.2%	57.78	45.61	1787

Corrected to 1780

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kW/mg
2555	3.68	85.4	86.6%	63.6	50	1780.0	13.6
2366	3.41	92.9	87.0%	63.8	50	1780.0	14.8
2100	3.02	103.0	86.4%	63.2	50	1780.0	16.5
1749	2.52	115.2	83.8%	60.7	48	1780.0	19.0
1473	2.12	123.2	80.2%	57.1	45	1780.0	21.2

Pump No. 1 Field Curve 3/14/09 1 Year Test

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
2486	3.58	45.06	10.16	82.35	15.87	86.1	1.60	3.91	88.4	85.8%	64.74	51.11	1787
2319	3.34	46	9.48	86.3	14.80	93.1	1.39	3.40	95.1	85.8%	64.93	51.26	1787
2063	2.97	48.33	8.43	93.01	13.16	103.2	1.10	2.69	104.8	84.9%	64.33	50.78	1787
1660	2.39	50.62	6.78	101.54	10.59	117.6	0.71	1.74	118.7	81.8%	60.82	48.01	1788
1472	2.12	51.42	6.01	104.54	9.40	122.7	0.56	1.37	123.5	79.1%	58.07	45.84	1788

Corrected to 1780

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kW/mg
2476	3.57	87.8	85.8%	64.0	51	1780.0	14.2
2310	3.33	94.4	85.8%	64.2	51	1780.0	15.2
2054	2.96	104.0	84.9%	63.6	50	1780.0	17.0
1652	2.38	117.6	81.8%	60.0	47	1780.0	19.9
1466	2.11	122.4	79.1%	57.3	45	1780.0	21.4

Pump No. 1 Field Curve 7/6/10

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
2292	3.3	42.41	9.36	80.33	14.63	87.6	1.36	3.32	89.6	80.9%	64.03	50.55	1787
2083	3	42.28	8.51	84.46	13.30	97.4	1.12	2.75	99.1	81.7%	63.82	50.38	1787
1896	2.73	44.5	7.74	89.94	12.10	105.0	0.93	2.27	106.3	80.9%	62.89	49.65	1787
1639	2.36	46.1	6.69	95.71	10.46	114.6	0.70	1.70	115.6	80.5%	59.46	46.94	1788
1347	1.94	47.01	5.50	100.37	8.60	123.3	0.47	1.15	123.9	74.4%	56.64	44.71	1788

Corrected to 1780

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kW/mg
2283	3.29	88.9	80.9%	63.3	50	1780.0	15.2
2075	2.99	98.3	81.7%	63.1	50	1780.0	16.7
1888	2.72	105.5	80.9%	62.2	49	1780.0	18.0
1632	2.35	114.6	80.5%	58.7	46	1780.0	19.7
1341	1.93	122.8	74.4%	55.9	44	1780.0	22.8

Pump No. 1 Field Curve 7/15/10

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
2417	3.48	49.02	9.87	82.36	15.42	77.0	1.51	3.69	79.2	76.8%	62.96	49.70	1787
2188	3.15	50.46	8.94	88.68	13.96	88.3	1.24	3.03	90.1	78.7%	63.22	49.91	1787
2014	2.9	51.73	8.23	93.4	12.85	96.3	1.05	2.57	97.8	79.0%	62.92	49.67	1787
1819	2.62	52.97	7.43	98.28	11.61	104.7	0.86	2.09	105.9	78.9%	61.67	48.68	1788
1535	2.21	54	6.27	103.9	9.79	115.3	0.61	1.49	116.1	76.4%	58.90	46.50	1788

Corrected to 1780

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kW/mg
2407	3.47	78.6	76.8%	62.2	49	1780.0	14.2
2179	3.14	89.4	78.7%	62.5	49	1780.0	15.7
2006	2.89	97.0	79.0%	62.2	49	1780.0	17.0
1811	2.61	105.0	78.9%	60.8	48	1780.0	18.4
1528	2.20	115.1	76.4%	58.1	46	1780.0	20.9

Pump No. 2 Field Curve 10/17/07 Initial Test

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
2285	3.29	43.06	9.33	83.38	14.58	93.1	1.35	3.30	95.1	78.7%	69.68	55.01	1786
2014	2.9	44.62	8.23	88.88	12.85	102.2	1.05	2.57	103.8	77.5%	68.11	53.77	1786
1819	2.62	45.49	7.43	92.46	11.61	108.5	0.86	2.09	109.7	76.3%	66.06	52.15	1786
1382	1.99	47.86	5.65	99.39	8.82	119.0	0.49	1.21	119.7	70.0%	59.73	47.15	1786

Corrected to 1780

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kW/mg
2277	3.28	94.5	78.7%	69.0	54	1780.0	16.6
2007	2.89	103.1	77.5%	67.4	53	1780.0	18.4
1813	2.61	109.0	76.3%	65.4	52	1780.0	19.8
1378	1.98	119.1	70.0%	59.2	47	1781.0	23.6

Pump No. 2 Field Curve 1/3/08 Post Coating Pre Mechanical Test

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
2479	3.57	47.14	10.13	86.02	15.82	89.8	1.59	3.89	92.1	83.0%	69.46	54.83	1786
2271	3.27	48.45	9.28	90.95	14.49	98.2	1.34	3.26	100.1	83.3%	68.87	54.37	1786
2007	2.89	49.72	8.20	96.6	12.81	108.3	1.04	2.55	109.8	83.0%	67.02	52.91	1786
1667	2.4	51.46	6.81	103.19	10.64	119.5	0.72	1.76	120.5	80.4%	63.07	49.79	1786
1194	1.72	53.75	4.88	109.7	7.62	129.2	0.37	0.90	129.8	69.8%	56.04	44.24	1789

Corrected to 1780

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kW/mg
2471	3.56	91.5	83.0%	68.8	54	1780.0	15.3
2263	3.26	99.4	83.3%	68.2	54	1780.0	16.5
2000	2.88	109.1	83.0%	66.4	52	1780.0	18.2
1662	2.39	119.9	80.4%	62.5	49	1781.0	20.6
1190	1.71	128.8	69.8%	55.4	44	1782.0	25.5

Pump No. 2 Field Curve 1/18/08 Post Coating & Mechanical, Pre Impeller Coating

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
2486	3.58	47.19	10.16	86.15	15.87	90.0	1.60	3.91	92.3	82.6%	70.14	55.37	1786
2354	3.39	48.63	9.62	90.59	15.02	96.9	1.44	3.51	99.0	85.1%	69.18	54.61	1786
1993	2.87	50.17	8.14	96.82	12.72	107.8	1.03	2.51	109.2	81.7%	67.33	53.15	1786
1785	2.57	51.46	7.29	101.45	11.39	115.5	0.83	2.01	116.7	80.8%	65.11	51.40	1787
1611	2.32	52.1	6.58	104.76	10.28	121.6	0.67	1.64	122.6	79.0%	63.11	49.82	1787
1403	2.02	53.3	5.73	108.24	8.95	126.9	0.51	1.24	127.6	75.7%	59.74	47.16	1788

Corrected to 1780

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kW/mg
2478	3.57	91.7	82.6%	69.4	55	1780.0	15.4
2346	3.38	98.3	85.1%	68.5	54	1780.0	16.0
1986	2.86	108.5	81.7%	66.7	53	1780.0	18.4
1778	2.56	115.8	80.8%	64.3	51	1780.0	19.8
1605	2.31	121.7	79.0%	62.4	49	1780.0	21.3
1397	2.01	126.5	75.7%	58.9	47	1780.0	23.1

Pump No. 2 Field Curve 1/22/08 Post Coating & Mechanical, Pre Impeller Coating (2nd Test)

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
2486	3.58	47.66	10.16	86.12	15.87	88.8	1.60	3.91	91.2	83.3%	68.67	54.21	1785
2319	3.34	49.48	9.48	90.89	14.80	95.7	1.39	3.40	97.7	83.6%	68.42	54.01	1785
2028	2.92	50.84	8.28	97.02	12.94	106.7	1.07	2.60	108.2	83.0%	66.78	52.72	1786
1694	2.44	52.71	6.92	103.69	10.81	117.8	0.74	1.82	118.8	80.2%	63.43	50.07	1786
1340	1.93	54.17	5.48	108.91	8.55	126.4	0.47	1.14	127.1	73.2%	58.82	46.43	1787

Corrected to 1780

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kW/mg
2479	3.57	90.6	83.3%	68.1	54	1780.0	15.1
2313	3.33	97.1	83.6%	67.8	54	1780.0	16.1
2021	2.91	107.5	83.0%	66.1	52	1780.0	17.9
1689	2.43	118.0	80.2%	62.8	50	1780.0	20.4
1335	1.92	126.1	73.2%	58.1	46	1780.0	23.9

Pump No. 2 Field Curve 3/18/08 Post Impeller Coating

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
2417	3.48	47.44	9.87	86.52	15.42	90.3	1.51	3.69	92.5	85.5%	65.97	52.08	1786
2201	3.17	49.19	8.99	92.12	14.05	99.2	1.26	3.07	101.0	85.6%	65.59	51.78	1785
1965	2.83	50.52	8.03	97.43	12.54	108.4	1.00	2.44	109.8	84.7%	64.33	50.78	1785
1611	2.32	52.12	6.58	104.2	10.28	120.3	0.67	1.64	121.3	81.7%	60.42	47.70	1786
1326	1.91	53.78	5.42	108.66	8.47	126.8	0.46	1.11	127.4	76.2%	56.03	44.23	1787

Corrected to 1780

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kW/mg
2409	3.47	91.8	85.5%	65.3	52	1780.0	14.9
2195	3.16	100.4	85.6%	65.0	51	1780.0	16.2
1960	2.82	109.2	84.7%	63.8	50	1780.0	17.8
1606	2.31	120.5	81.7%	59.8	47	1780.0	20.4
1321	1.90	126.4	76.2%	55.4	44	1780.0	23.0

Pump No. 2 Field Curve 4/28/08 30 Day Test

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
2535	3.65	52.35	10.35	89.1	16.18	84.9	1.66	4.06	87.3	86.0%	65.00	51.31	1786
2319	3.34	54.15	9.48	94.82	14.80	93.9	1.39	3.40	96.0	86.3%	65.11	51.40	1785
2076	2.99	55.9	8.48	100.71	13.25	103.5	1.12	2.73	105.1	85.4%	64.52	50.93	1785
1785	2.57	57.57	7.29	107.41	11.39	115.1	0.83	2.01	116.3	84.9%	61.75	48.75	1786
1444	2.08	59.76	5.90	113.56	9.22	124.3	0.54	1.32	125.1	79.8%	57.18	45.14	1787

Corrected to 1780

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kW/mg
2526	3.64	86.7	86.0%	64.3	51	1780.0	14.0
2313	3.33	95.4	86.3%	64.6	51	1780.0	15.3
2071	2.98	104.5	85.4%	64.0	51	1780.0	16.9
1779	2.56	115.5	84.9%	61.1	48	1780.0	18.8
1439	2.07	124.1	79.8%	56.5	45	1780.0	21.5

Pump No. 2 Field Curve 6/4/08 90 Day Test

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
2576	3.71	50.05	10.52	85.98	16.44	83.0	1.72	4.20	85.5	86.0%	64.69	51.07	1787
2375	3.42	51.65	9.70	91.41	15.16	91.8	1.46	3.57	94.0	86.7%	65.02	51.33	1786
2125	3.06	53.33	8.68	97.51	13.56	102.1	1.17	2.86	103.7	86.3%	64.52	50.93	1787
1743	2.51	55.95	7.12	106.38	11.12	116.5	0.79	1.92	117.6	84.6%	61.22	48.33	1788
1229	1.77	58.09	5.02	113.89	7.84	128.9	0.39	0.96	129.5	75.8%	53.00	41.84	1790

Corrected to 1780

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kW/mg
2566	3.70	84.8	86.0%	63.9	50	1780.0	13.7
2367	3.41	93.3	86.7%	64.4	51	1780.0	14.9
2117	3.05	102.9	86.3%	63.8	50	1780.0	16.5
1735	2.50	116.6	84.6%	60.4	48	1780.0	19.1
1222	1.76	128.0	75.8%	52.1	41	1780.0	23.4

Pump No. 2 Field Curve 8/7/08 6-Month Test

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
2563	3.69	49.41	10.47	85.36	16.35	83.0	1.70	4.15	85.5	85.9%	64.41	50.85	1787
2347	3.38	50.93	9.59	91.02	14.98	92.6	1.43	3.48	94.7	86.7%	64.73	51.10	1786
2104	3.03	52.12	8.60	96.58	13.43	102.7	1.15	2.80	104.4	86.6%	64.05	50.56	1787
1757	2.53	54.52	7.18	104.64	11.21	115.8	0.80	1.95	116.9	84.9%	61.11	48.24	1788
1444	2.08	55.9	5.90	110.01	9.22	125.0	0.54	1.32	125.8	81.2%	56.51	44.61	1790

Corrected to 1780

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kW/mg
2552	3.68	84.8	85.9%	63.7	50	1780.0	13.7
2339	3.37	94.0	86.7%	64.1	51	1780.0	15.0
2096	3.02	103.5	86.6%	63.3	50	1780.0	16.6
1749	2.52	115.9	84.9%	60.3	48	1780.0	18.9
1436	2.07	124.4	81.2%	55.6	44	1780.0	21.2

Pump No. 2 Field Curve 3/14/09 1 Year Test

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
2486	3.58	45.83	10.16	83.41	15.87	86.8	1.60	3.91	89.1	86.0%	65.02	51.33	1787
2333	3.36	47.12	9.53	87.71	14.89	93.8	1.41	3.44	95.8	86.6%	65.15	51.43	1787
2069	2.98	48.44	8.45	93.57	13.21	104.3	1.11	2.71	105.8	86.2%	64.19	50.67	1787
1722	2.48	50.32	7.04	100.81	10.99	116.6	0.77	1.88	117.7	84.0%	60.97	48.13	1788
1375	1.98	51.77	5.62	106.15	8.78	125.6	0.49	1.20	126.3	78.6%	55.84	44.08	1789

Corrected to 1780

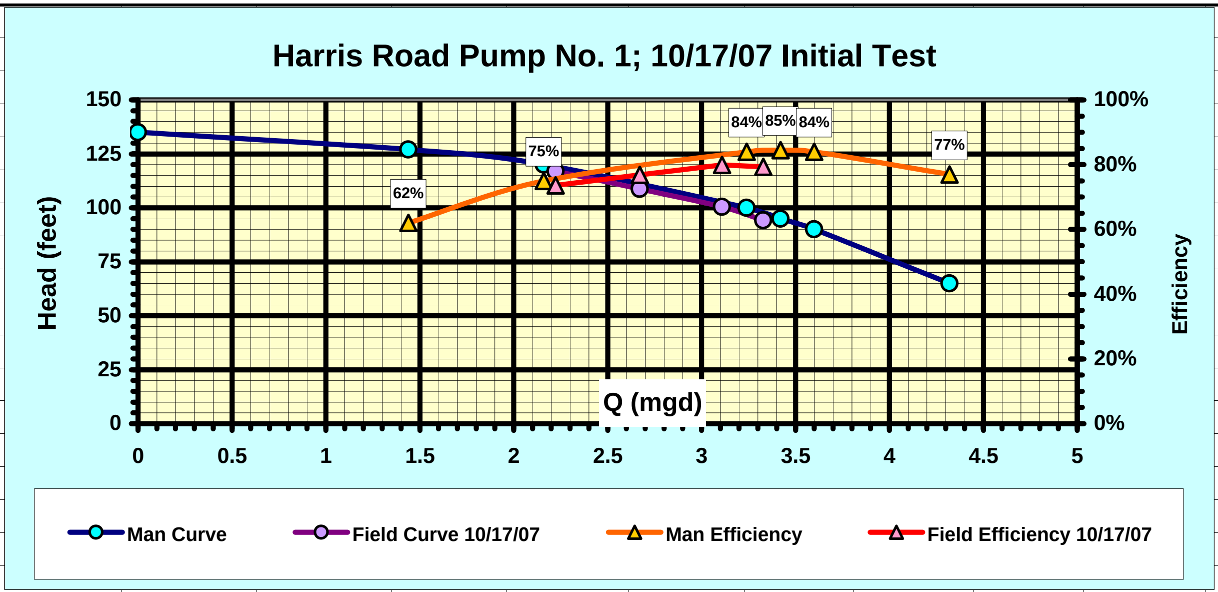
Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kW/mg
2476	3.57	88.4	86.0%	64.3	51	1780.0	14.2
2324	3.35	95.0	86.6%	64.4	51	1780.0	15.2
2061	2.97	105.0	86.2%	63.4	50	1780.0	16.9
1715	2.47	116.7	84.0%	60.2	47	1780.0	19.2
1368	1.97	125.1	78.6%	55.0	43	1780.0	22.0

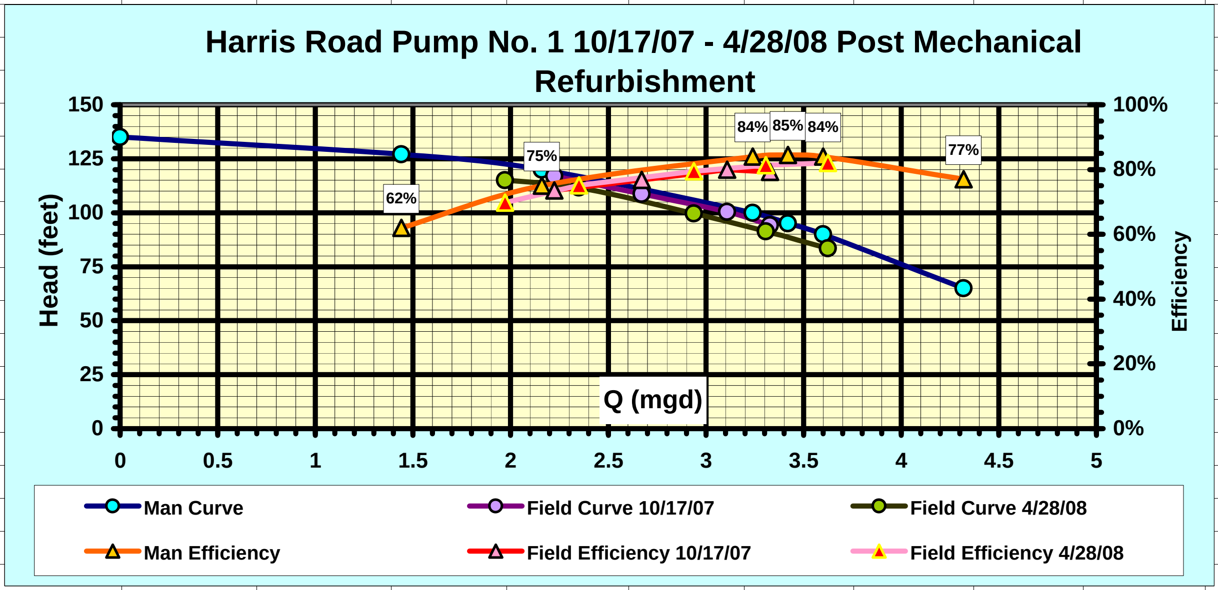
Pump No. 2 Field Curve 7/6/10

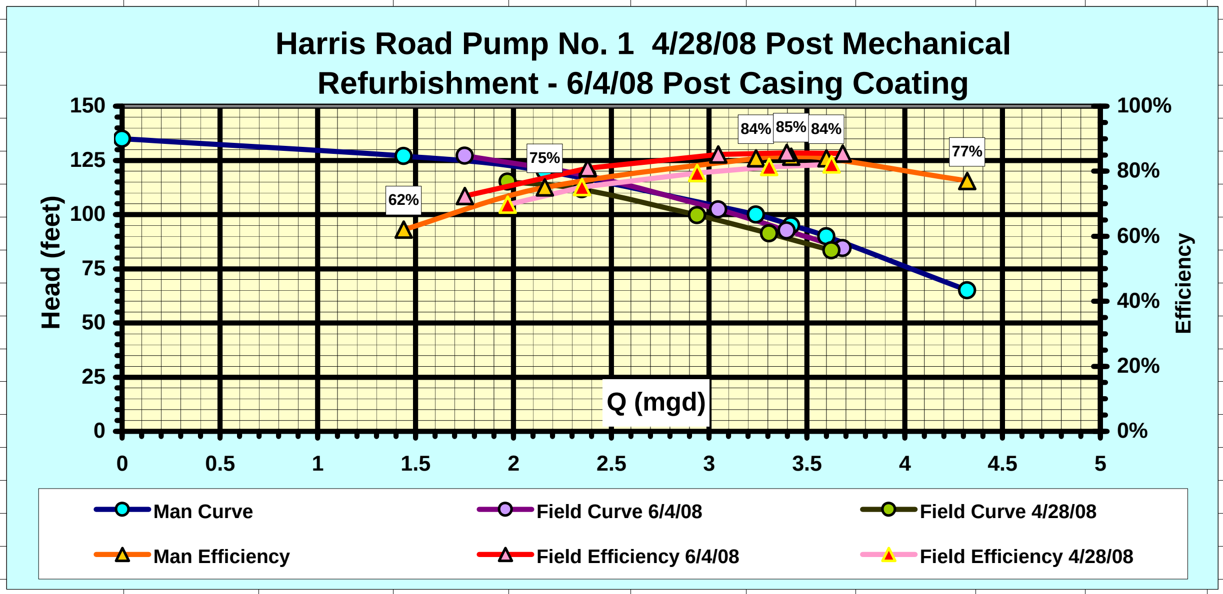
Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
2361	3.4	41.71	9.65	82.15	15.07	93.4	1.44	3.53	95.5	87.1%	65.36	51.60	1787
2111	3.04	42.91	8.62	87.66	13.47	103.4	1.15	2.82	105.0	86.8%	64.50	50.92	1787
1924	2.77	43.4	7.86	91.26	12.28	110.6	0.96	2.34	111.9	85.9%	63.27	49.95	1787
1569	2.26	45.46	6.41	98.31	10.02	122.1	0.64	1.56	123.0	84.0%	58.07	45.84	1788
1271	1.83	46.29	5.19	102.1	8.11	128.9	0.42	1.02	129.5	78.7%	52.85	41.72	1789

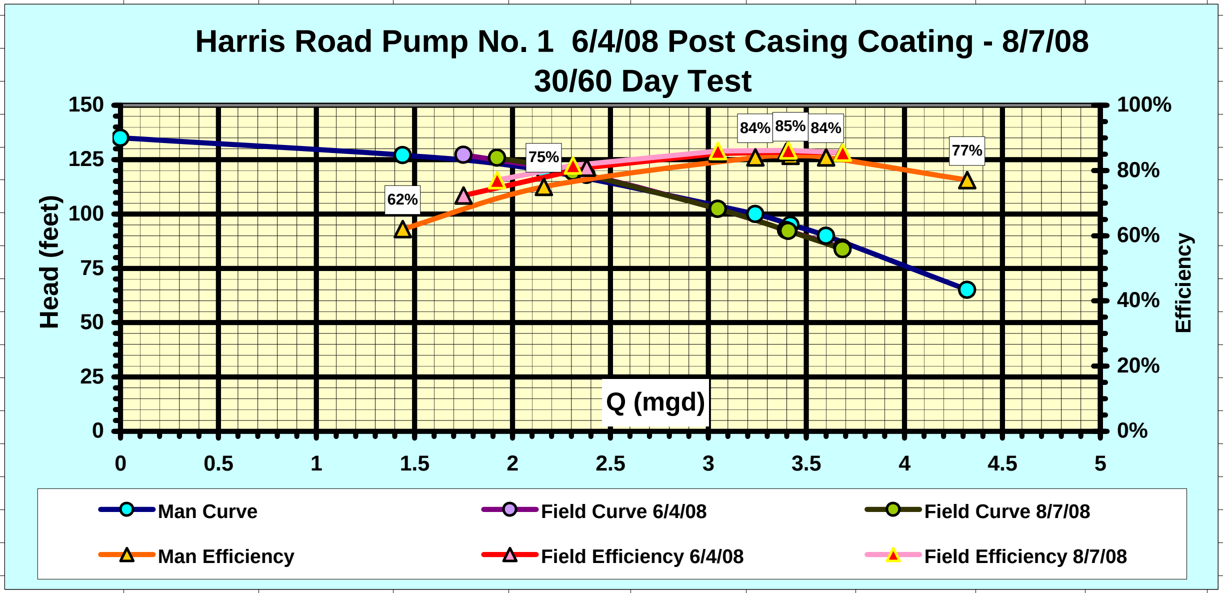
Corrected to 1780

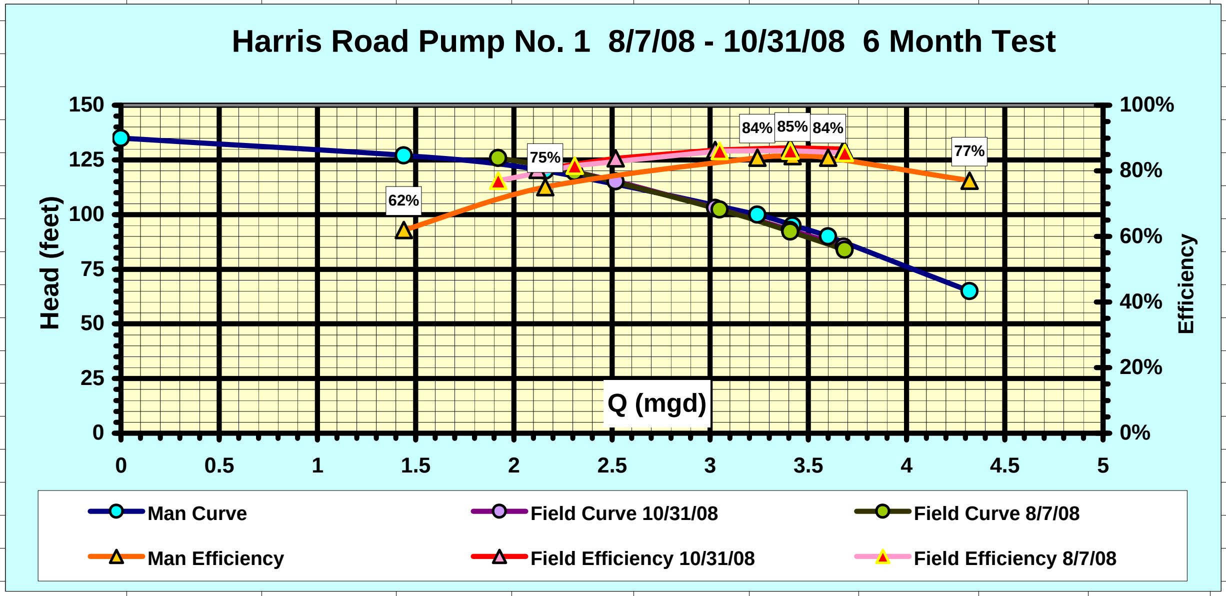
Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kW/mg
2352	3.39	94.8	87.1%	64.6	51	1780.0	15.1
2103	3.03	104.2	86.8%	63.7	50	1780.0	16.6
1916	2.76	111.1	85.9%	62.5	49	1780.0	17.9
1562	2.25	121.9	84.0%	57.3	45	1780.0	20.1
1264	1.82	128.2	78.7%	52.1	41	1780.0	22.6

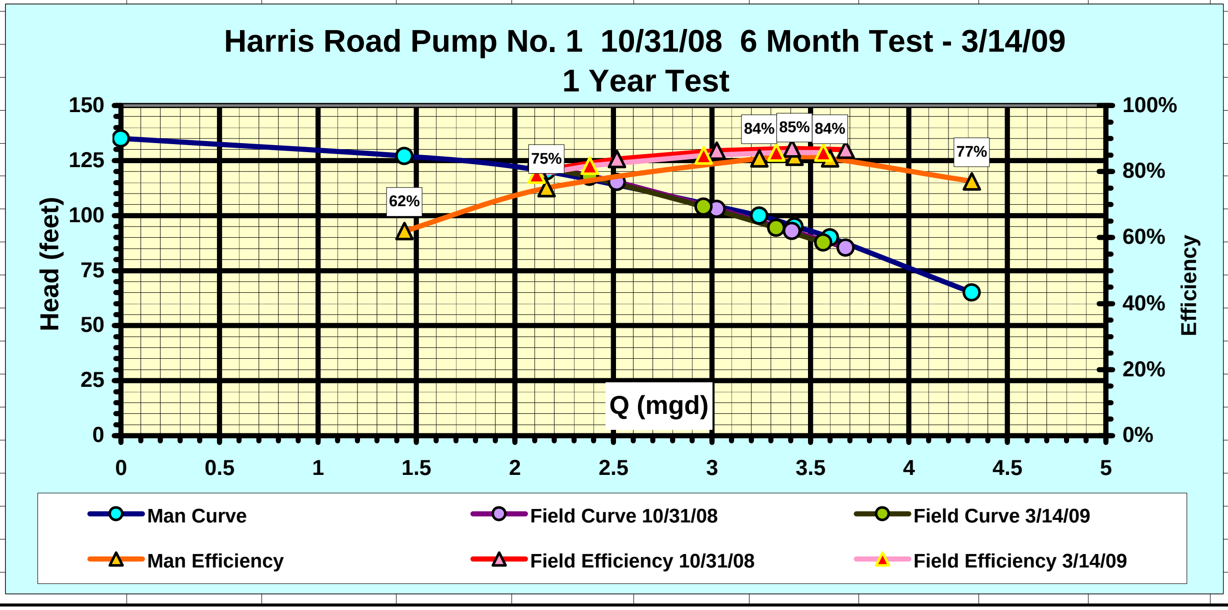

Harris Road Pump No. 1; 10/17/07 Initial Test
Head (feet)
Efficiency
Q (mgd)
150
125
100
75
50
25
0
100%
80%
60%
40%
20%
0%
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
62%
75%
84%
85%
84%
77%
Man Curve
Field Curve 10/17/07
Man Efficiency
Field Efficiency 10/17/07

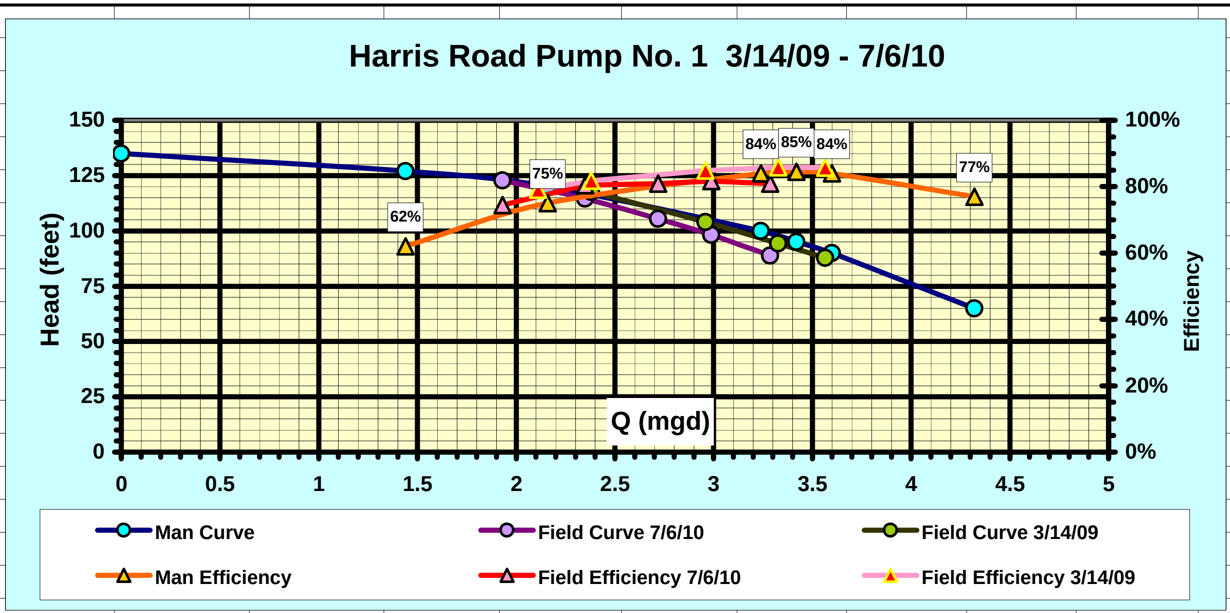

Harris Road Pump No. 1 10/17/07 - 4/28/08 Post Mechanical Refurbishment
Head (feet)
Efficiency
Q (mgd)
150
125
100
75
50
25
0
100%
80%
60%
40%
20%
0%
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
62%
75%
84%
85%
84%
77%
Man Curve
Field Curve 10/17/07
Field Curve 4/28/08
Man Efficiency
Field Efficiency 10/17/07
Field Efficiency 4/28/08


Harris Road Pump No. 1 4/28/08 Post Mechanical Refurbishment - 6/4/08 Post Casing Coating
Head (feet)
Efficiency
Q (mgd)
62%
75%
84%
85%
84%
77%
Man Curve
Field Curve 6/4/08
Field Curve 4/28/08
Man Efficiency
Field Efficiency 6/4/08
Field Efficiency 4/28/08

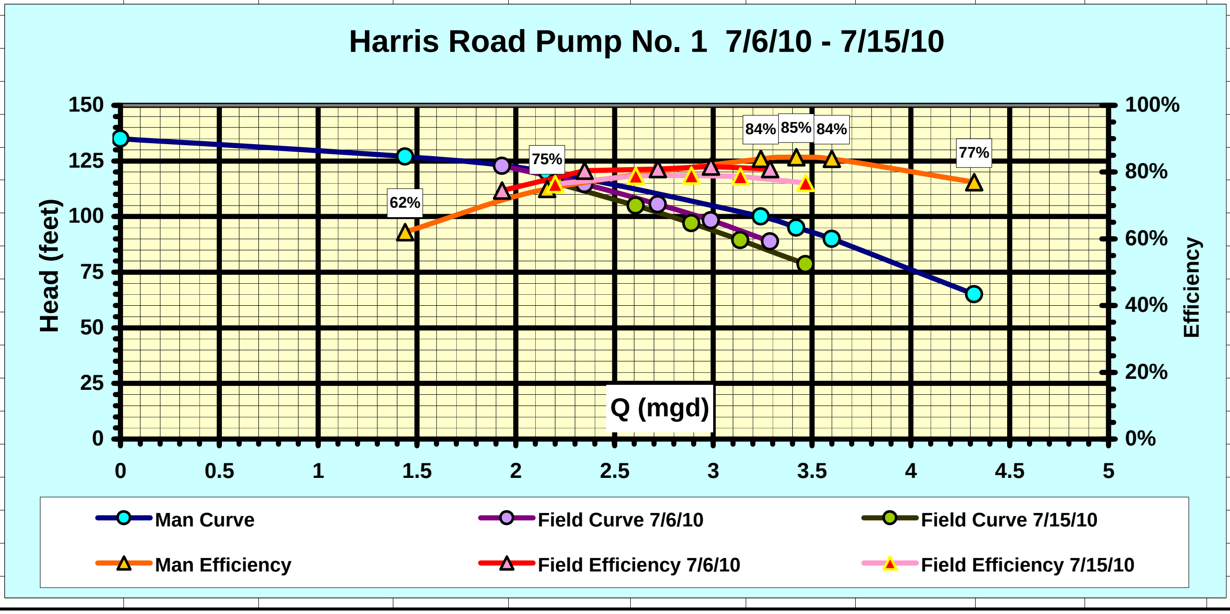

Harris Road Pump No. 1 6/4/08 Post Casing Coating - 8/7/08 30/60 Day Test
Head (feet)
Efficiency
Q (mgd)
62%
75%
84%
85%
84%
77%
Man Curve
Field Curve 6/4/08
Field Curve 8/7/08
Man Efficiency
Field Efficiency 6/4/08
Field Efficiency 8/7/08


Harris Road Pump No. 1 8/7/08 - 10/31/08 6 Month Test
Head (feet)
Efficiency
Q (mgd)
150
125
100
75
50
25
0
100%
80%
60%
40%
20%
0%
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
62%
75%
84%
85%
84%
77%
Man Curve
Field Curve 10/31/08
Field Curve 8/7/08
Man Efficiency
Field Efficiency 10/31/08
Field Efficiency 8/7/08

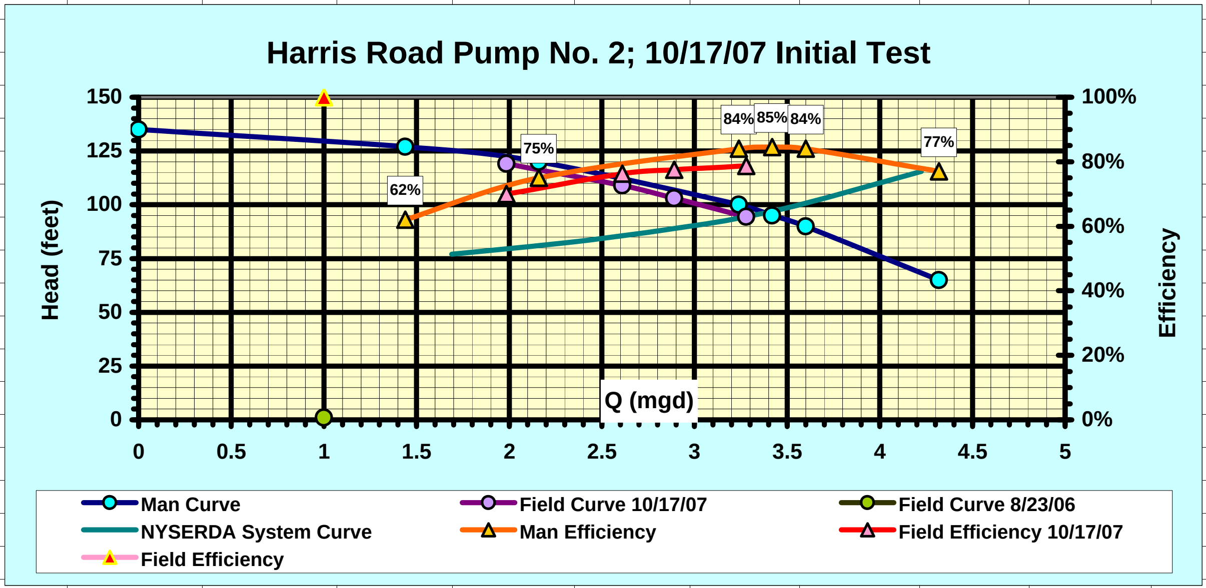

Harris Road Pump No. 1 10/31/08 6 Month Test - 3/14/09
1 Year Test
Head (feet)
Efficiency
Q (mgd)
150
125
100
75
50
25
0
100%
80%
60%
40%
20%
0%
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
62%
75%
84%
85%
84%
77%
Man Curve
Field Curve 10/31/08
Field Curve 3/14/09
Man Efficiency
Field Efficiency 10/31/08
Field Efficiency 3/14/09

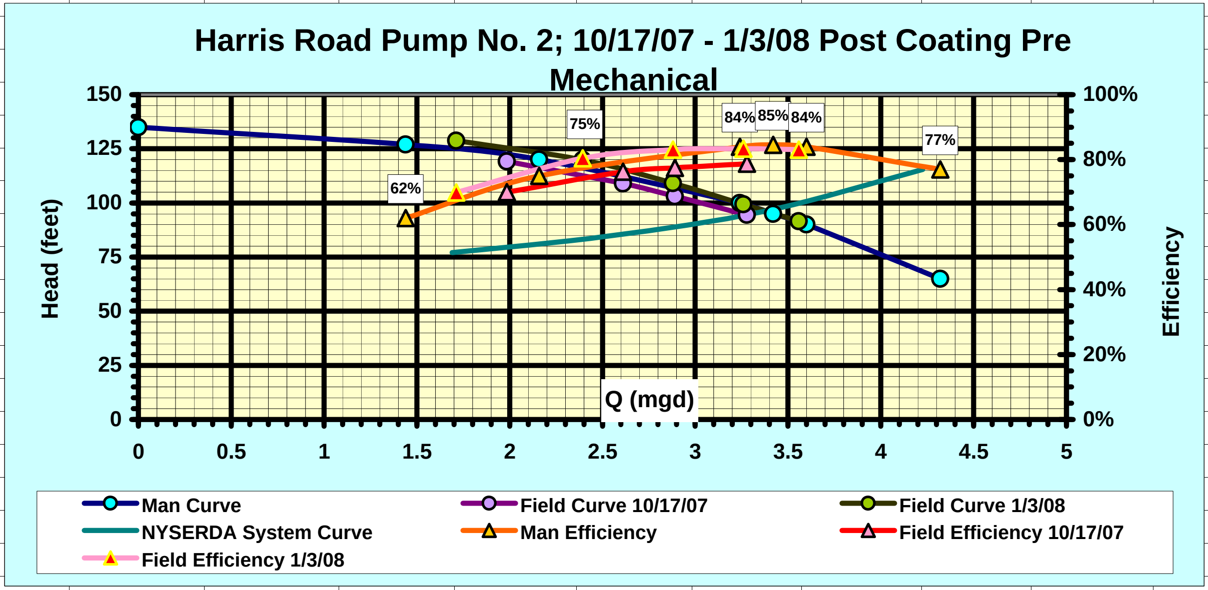


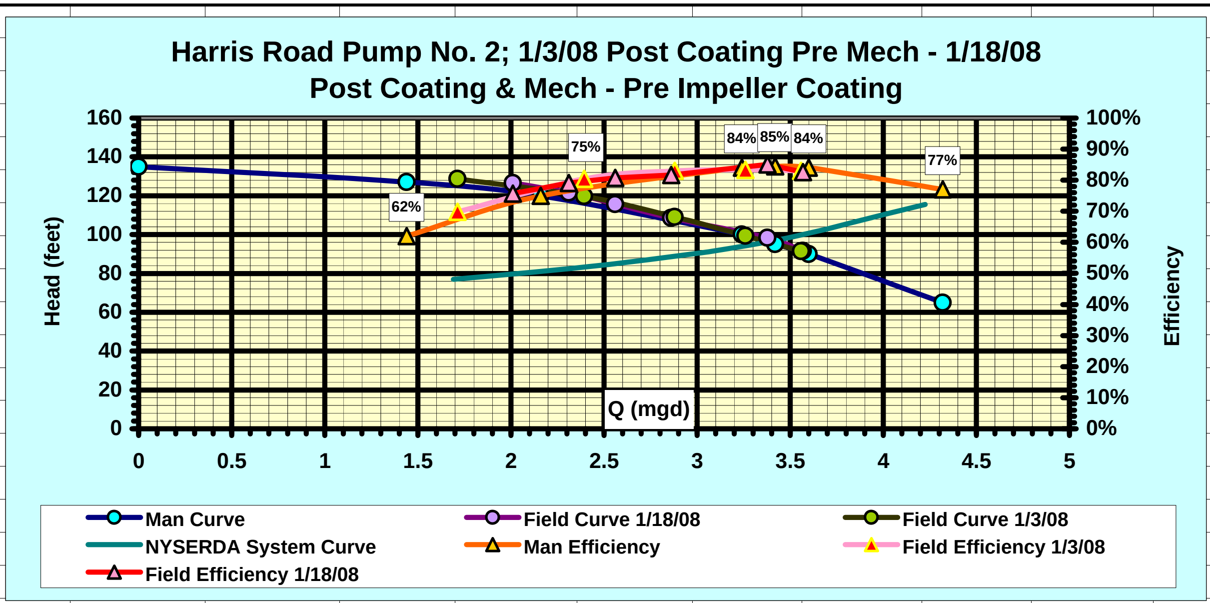
Harris Road Pump No. 1 3/14/09 - 7/6/10
Head (feet)
Efficiency
Q (mgd)
150
125
100
75
50
25
0
100%
80%
60%
40%
20%
0%
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
62%
75%
84%
85%
84%
77%
Man Curve
Field Curve 7/6/10
Field Curve 3/14/09
Man Efficiency
Field Efficiency 7/6/10
Field Efficiency 3/14/09



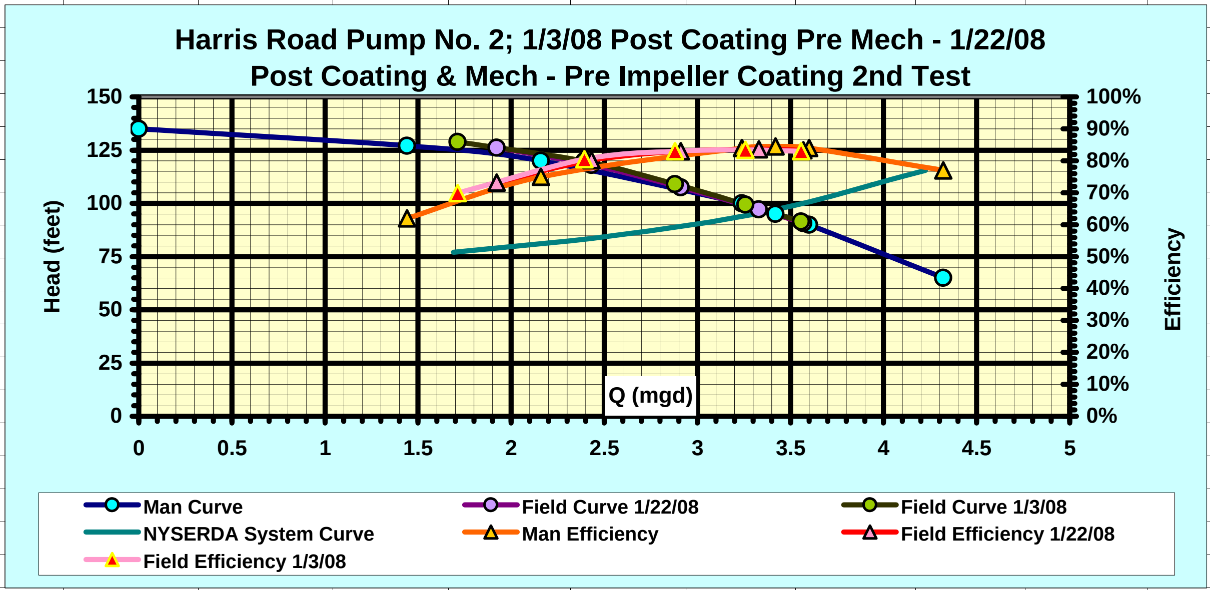
Harris Road Pump No. 1 7/6/10 - 7/15/10
Head (feet)
Efficiency
Q (mgd)
150
125
100
75
50
25
0
100%
80%
60%
40%
20%
0%
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
62%
75%
84%
85%
84%
77%
Man Curve
Field Curve 7/6/10
Field Curve 7/15/10
Man Efficiency
Field Efficiency 7/6/10
Field Efficiency 7/15/10


Harris Road Pump No. 2; 10/17/07 Initial Test
Head (feet)
Efficiency
Q (mgd)
62%
75%
84%
85%
84%
77%
Man Curve
Field Curve 10/17/07
Field Curve 8/23/06
NYSERDA System Curve
Man Efficiency
Field Efficiency 10/17/07
Field Efficiency

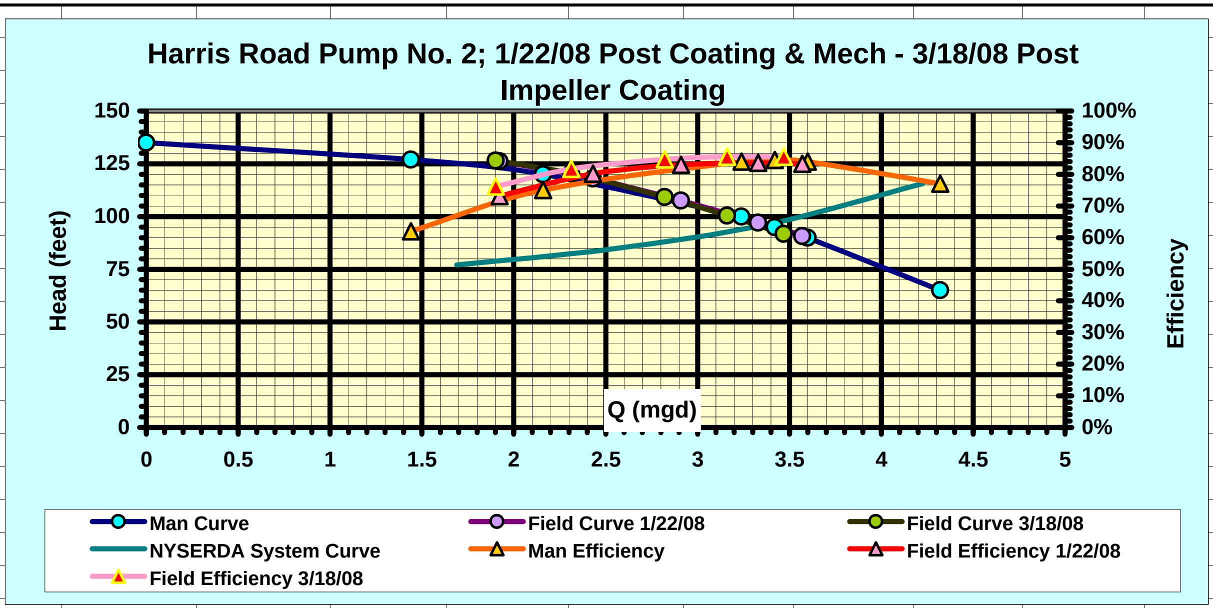

Harris Road Pump No. 2; 10/17/07 - 1/3/08 Post Coating Pre Mechanical
Head (feet)
Efficiency
Q (mgd)
62%
75%
84%
85%
84%
77%
Man Curve
Field Curve 10/17/07
Field Curve 1/3/08
NYSERDA System Curve
Man Efficiency
Field Efficiency 10/17/07
Field Efficiency 1/3/08

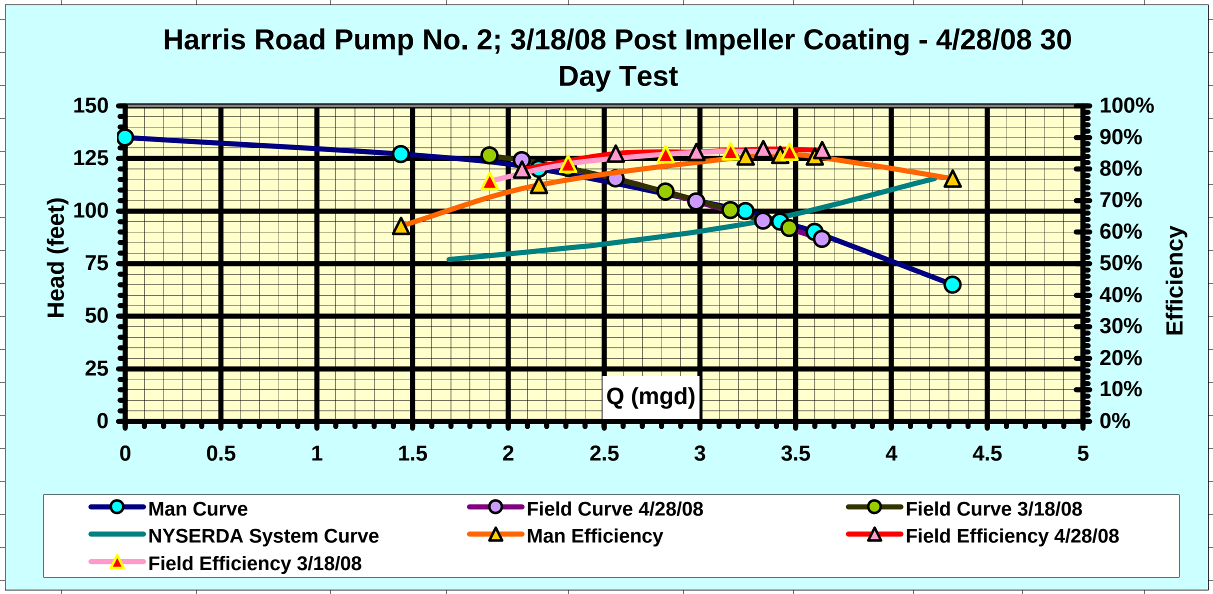


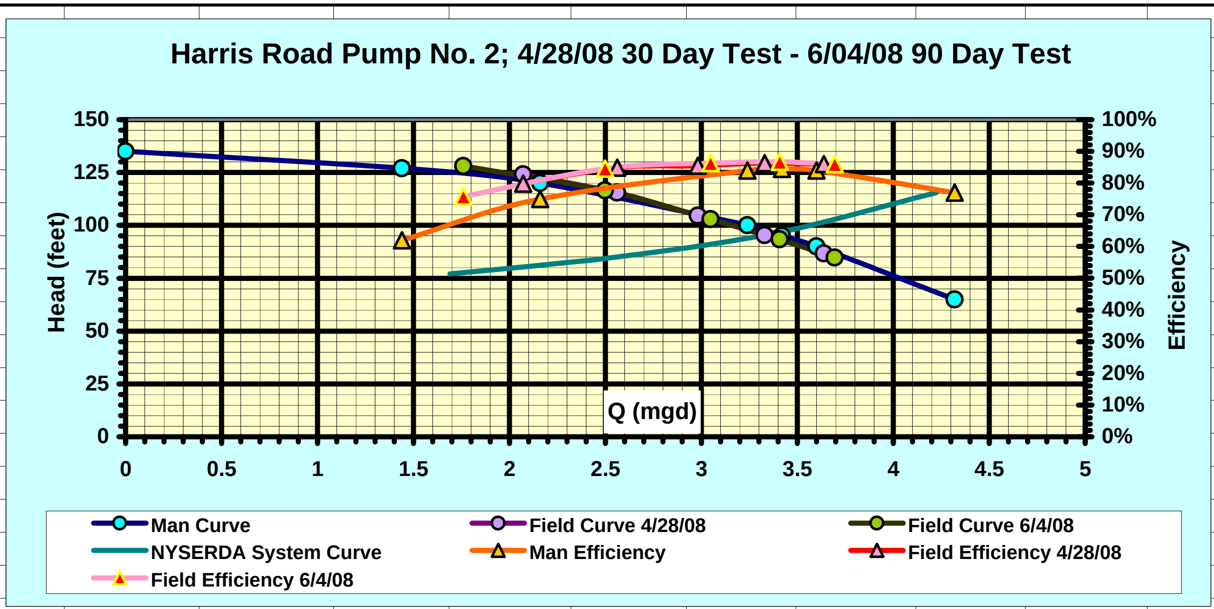
Harris Road Pump No. 2; 1/3/08 Post Coating Pre Mech - 1/18/08
Post Coating & Mech - Pre Impeller Coating
Head (feet)
Efficiency
Q (mgd)
62%
75%
84%
85%
84%
77%
Man Curve
Field Curve 1/18/08
Field Curve 1/3/08
NYSERDA System Curve
Man Efficiency
Field Efficiency 1/3/08
Field Efficiency 1/18/08

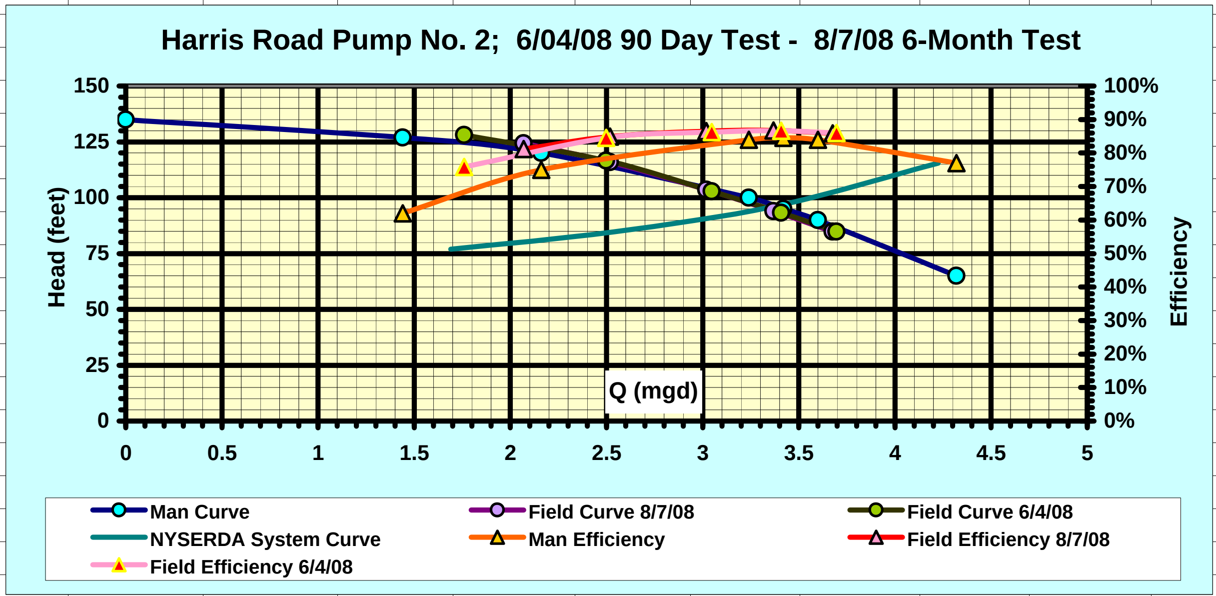


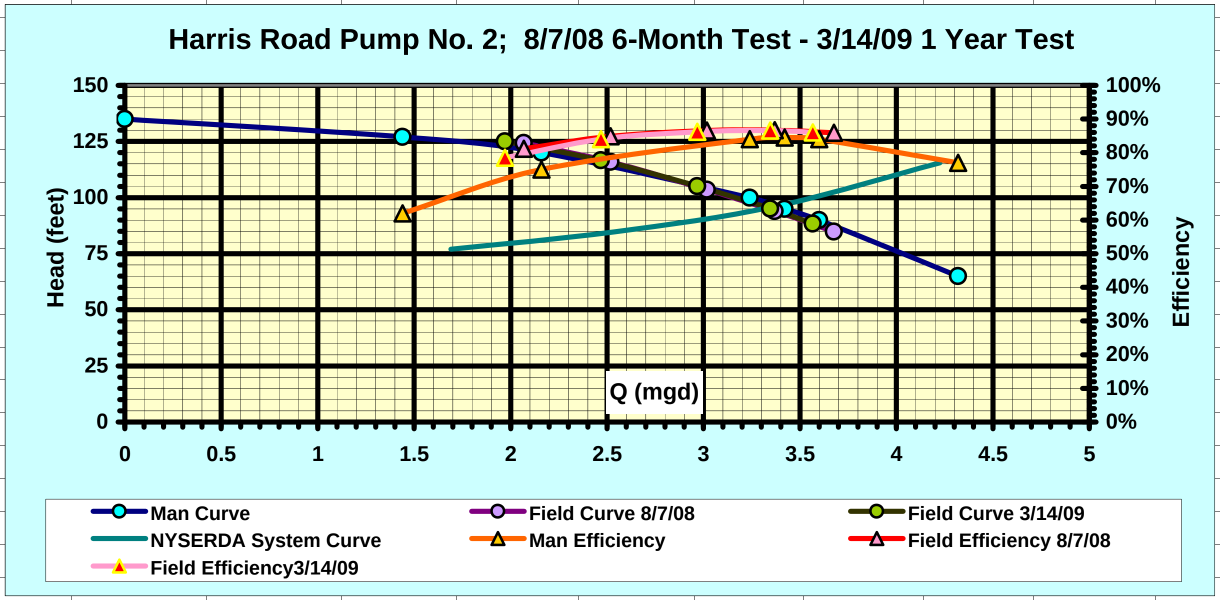
Harris Road Pump No. 2; 1/3/08 Post Coating Pre Mech - 1/22/08
Post Coating & Mech - Pre Impeller Coating 2nd Test
Head (feet)
Efficiency
Q (mgd)
Man Curve
Field Curve 1/22/08
Field Curve 1/3/08
NYSERDA System Curve
Man Efficiency
Field Efficiency 1/22/08
Field Efficiency 1/3/08

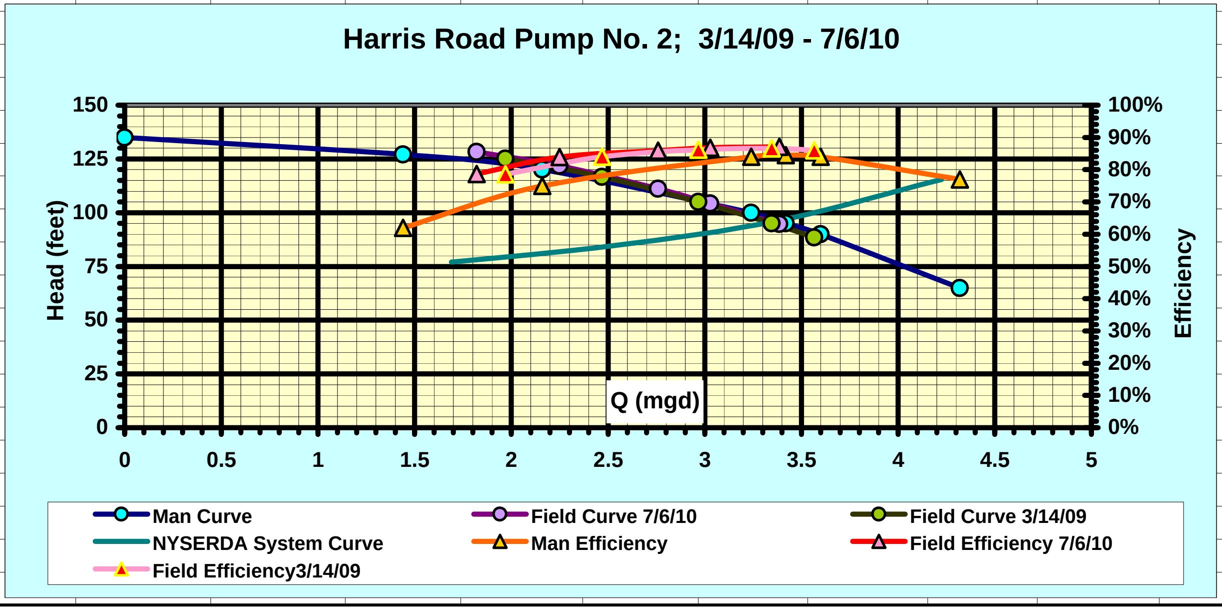

Harris Road Pump No. 2; 1/22/08 Post Coating & Mech - 3/18/08 Post Impeller Coating
Head (feet)
Efficiency
Q (mgd)
150
125
100
75
50
25
0
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Man Curve
Field Curve 1/22/08
Field Curve 3/18/08
NYSERDA System Curve
Man Efficiency
Field Efficiency 1/22/08
Field Efficiency 3/18/08


Harris Road Pump No. 2; 3/18/08 Post Impeller Coating - 4/28/08 30 Day Test
Head (feet)
Efficiency
Q (mgd)
150
125
100
75
50
25
0
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Man Curve
Field Curve 4/28/08
Field Curve 3/18/08
NYSERDA System Curve
Man Efficiency
Field Efficiency 4/28/08
Field Efficiency 3/18/08


Harris Road Pump No. 2; 4/28/08 30 Day Test - 6/04/08 90 Day Test
Head (feet)
Efficiency
Q (mgd)
150
125
100
75
50
25
0
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Man Curve
Field Curve 4/28/08
Field Curve 6/4/08
NYSERDA System Curve
Man Efficiency
Field Efficiency 4/28/08
Field Efficiency 6/4/08


Harris Road Pump No. 2; 6/04/08 90 Day Test - 8/7/08 6-Month Test
Head (feet)
Efficiency
Q (mgd)
150
125
100
75
50
25
0
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Man Curve
Field Curve 8/7/08
Field Curve 6/4/08
NYSERDA System Curve
Man Efficiency
Field Efficiency 8/7/08
Field Efficiency 6/4/08


Harris Road Pump No. 2; 8/7/08 6-Month Test - 3/14/09 1 Year Test
Head (feet)
Efficiency
Q (mgd)
150
125
100
75
50
25
0
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Man Curve
Field Curve 8/7/08
Field Curve 3/14/09
NYSERDA System Curve
Man Efficiency
Field Efficiency 8/7/08
Field Efficiency3/14/09


Harris Road Pump No. 2; 3/14/09 - 7/6/10
Head (feet)
Efficiency
Q (mgd)
150
125
100
75
50
25
0
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Man Curve
Field Curve 7/6/10
Field Curve 3/14/09
NYSERDA System Curve
Man Efficiency
Field Efficiency 7/6/10
Field Efficiency3/14/09

High Lift No. 6
Energy Efficiency Cost Calculator
Continuous Service

Pre Mechanical

Head (ft)	431
Flow (gpm)	11542
Efficiency	83.4%
Hours Operation/month	717
BHP	1506
kW (Assumes Motor Eff 95%)	1182.8
kW Demand Charge	$11,828
kwh cost	$72,108
Total Monthly kWH	848,335
Monthly Cost	**$83,936.47**

Constants

Hours/ Month	730
kW Demand Cost	$10.00
kwh Cost	$0.085
Motor Efficiency	95.0%

Post Coating

Head (ft)	430
Flow (gpm)	11500
Efficiency	82.3%
Hours Operation/month	727
BHP	1517
kW (Assumes Motor Eff 95%)	1191.5
kW Demand Charge	$11,915
kwh cost	$73,662
Total Monthly kWH	866615
Monthly Cost	**$85,577.06**

Pre - Post Mechanical Comparison

Monthly Savings	**-$1,641**
Annual Savings	**-$19,687**
5 Year Savings	**-$98,435**
kW Demand Reduction	**-8.7**
Monthly kwh Savings	**-18280**
Yearly kwh Savings	**-219363**

Post Impeller Coating

Head (ft)	426
Flow (gpm)	11340
Efficiency	80.9%
Hours Operation/month	730
BHP	1508
kW (Assumes Motor Eff 95%)	1184.1
kW Demand Charge	$11,841
kwh cost	$73,474
Total Monthly kWH	864405
Monthly Cost	**$85,315.54**

Pre - Post Impeller Comparison

Monthly Savings	**$262**
Annual Savings	**$3,138**
5 Year Savings	**$15,691**
kW Demand Reduction	**7.4**
Monthly kwh Savings	**2210**
Yearly kwh Savings	**26524**

Pre Mechanical to Post Interior

Monthly Savings	**-$1,379**
Annual Savings	**-$16,549**
5 Year Savings	**-$82,745**
kW Demand Reduction	**-1.3**
Monthly kwh Savings	**-16070**
Yearly kwh Savings	**-192839**

20% Service Time

Pre Mechanical

Head (ft)	431
Flow (gpm)	11542
Efficiency	83.4%
Hours Operation/month	143
BHP	1506
kW (Assumes Motor Eff 95%)	1182.8
kW Demand Charge	$11,828
kwh cost	$14,422
Total Monthly kWH	169,667
Monthly Cost	**$26,249.72**

Constants

Hours/ Month	730
kW Demand Cost	$10.00
kwh Cost	$0.085
Motor Efficiency	95.0%

Post Casing Coating

Head (ft)	430
Flow (gpm)	11500
Efficiency	82.3%
Hours Operation/month	144
BHP	1517
kW (Assumes Motor Eff 95%)	1191.5
kW Demand Charge	$11,915
kwh cost	$14,581
Total Monthly kWH	171536
Monthly Cost	**$26,495.33**

Pre - Post Mechanical Comparison

Monthly Savings	**-$246**
Annual Savings	**-$2,947**
5 Year Savings	**-$14,737**
kW Demand Reduction	**-8.7**
Monthly kwh Savings	**-1869**
Yearly kwh Savings	**-22426**

Post Impeller Coating

Head (ft)	426
Flow (gpm)	11340
Efficiency	80.9%
Hours Operation/month	146
BHP	1508
kW (Assumes Motor Eff 95%)	1184.1
kW Demand Charge	$11,841
kwh cost	$14,695
Total Monthly kWH	172881
Monthly Cost	**$26,536.03**

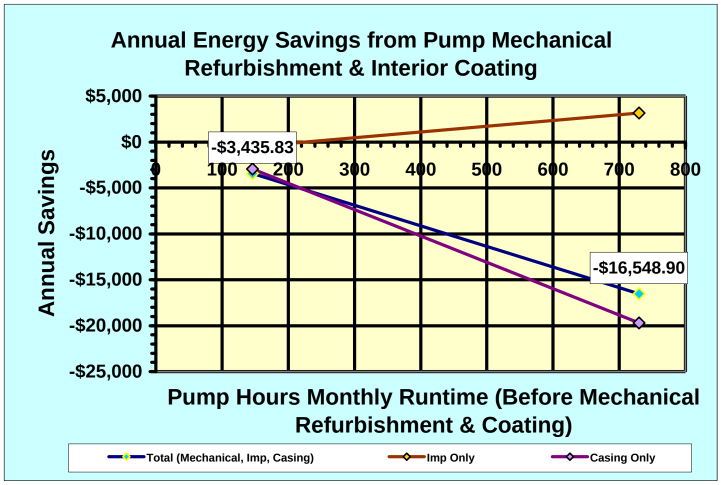
Pre - Post Impeller Comparison

Monthly Savings	**-$41**
Annual Savings	**-$488**
5 Year Savings	**-$2,442**
kW Demand Reduction	**7.4**
Monthly kwh Savings	**-1345**
Yearly kwh Savings	**-16142**

Pre Mechanical to Post Interior

Monthly Savings	**-$286**
Annual Savings	**-$3,436**
5 Year Savings	**-$17,179**
kW Demand Reduction	**-1.3**
Monthly kwh Savings	**-3214**
Yearly kwh Savings	**-38568**

Pump Hours of Operation Before Refurbishment & Interior Coating	Annual Savings Through Refurbishment & Interior Coatings
Total	
730	-$16,548.90
146	-$3,435.83
Casing Coating Only	
730	-$19,687.06
146	-$2,947.36
Impeller Coating Only	
730	$3,138.16
146	-$488.47



High Lift No. 6

Manufacturer's Pump and Motor Information

NYSERDA System Curve

Q		H	
50.0%	8.0	80%	336
75.0%	12.0	88%	370
BEP	16.0	100%	420
125.0%	20.0	120%	504

Pumps 2, 4, 6 & 7

Allis Chalmers

18x16

13500 gpm @ 415 feet of head

1180 rpm

Motors 2, 4, 6 & 7

Pump No. 1 or 3

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	Ns
0	0	595				
5000	7.2	570	66.0%			
8000	11.52	540	82.0%	1330	943	942
10000	14.4	510	85.5%	1506	1068	1100
12000	17.28	460	87.0%	1602	1135	1301
14000	20.16	400	85.0%	1664	1179	1561
16000	23.04	330	77.5%	1720	1219	1928

Motor Efficiency 6 & 7

% Load	Nominal % Eff	Guar % Eff
100		96.1%
75		96.3%
50		96.1%

Pump No. 6 Field Curve 12/28/07

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
16097	23.18	1.92	20.30	135.58	25.69	308.8	6.40	10.24	312.6	74.5%	1705.0	1334.67	1195
15257	21.97	2.29	19.24	147.98	24.34	336.5	5.75	9.20	340.0	77.3%	1693.9	1325.97	1195
13688	19.71	2.95	17.26	170	21.84	385.9	4.62	7.41	388.7	81.4%	1649.7	1291.35	1194
12049	17.35	3.53	15.19	190.13	19.23	431.0	3.58	5.74	433.2	83.3%	1582.7	1238.92	1195
9708	13.98	4.37	12.24	215.76	15.49	488.3	2.33	3.73	489.7	83.4%	1439.5	1126.86	1196

Corrected to 1180 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM
15895	22.89	304.8	74.5%	1641.6	1285	1180
15065	21.69	331.5	77.3%	1630.9	1277	1180
13527	19.48	379.6	81.4%	1592.3	1246	1180
11897	17.13	422.4	83.3%	1523.8	1193	1180
9587	13.80	477.5	83.4%	1386.1	1085	1181

Pump No. 6 Field Curve 5/22/08 Post Casing Coating Test No. 1

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
15785	22.73	1.27	19.90	136.31	25.19	311.9	6.15	9.85	315.6	74.0%	1700.3	1331.01	1195
14035	20.21	2.03	17.70	163.21	22.39	372.3	4.86	7.79	375.3	79.6%	1670.3	1307.46	1195
12569	18.1	2.69	15.85	182.15	20.06	414.6	3.90	6.25	416.9	81.7%	1618.9	1267.27	1195
10896	15.69	3.4	13.74	201.75	17.39	458.2	2.93	4.69	460.0	82.4%	1536.0	1202.37	1195
9104	13.11	4.14	11.48	220.58	14.53	500.0	2.05	3.28	501.2	81.4%	1416.1	1108.52	1196

Corrected to 1180 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM
15587	22.44	307.8	74.0%	1637.1	1282	1180
13859	19.96	365.9	79.6%	1608.1	1259	1180
12412	17.87	406.5	81.7%	1558.7	1220	1180
10759	15.49	448.5	82.4%	1478.9	1158	1180
8982	12.93	487.9	81.4%	1360.0	1065	1180

Pump No. 6 Field Curve 5/22/08 Post Casing Coating Test No. 2

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
15931	22.94	1.32	20.09	133.56	25.42	305.5	6.26	10.03	309.2	73.0%	1704.5	1334.24	1195
13847	19.94	2.35	17.46	165.68	22.10	377.3	4.73	7.58	380.1	79.9%	1663.5	1302.18	1195
12424	17.89	2.92	15.66	183.68	19.82	417.6	3.81	6.10	419.8	81.7%	1611.3	1261.28	1195
10486	15.10	3.73	13.22	205.82	16.73	466.8	2.71	4.35	468.5	82.0%	1512.9	1184.32	1195
8278	11.92	4.56	10.44	227.92	13.21	516.0	1.69	2.71	517.0	80.0%	1351.4	1057.83	1196

Corrected to 1180 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM
15731	22.65	301.5	73.0%	1641.1	1285	1180
13673	19.69	370.7	79.9%	1601.6	1254	1180
12268	17.67	409.4	81.7%	1551.3	1214	1180
10354	14.91	456.8	82.0%	1456.7	1140	1180
8167	11.76	503.2	80.0%	1297.8	1016	1180

Pump No. 6 Field Curve 6/16/08 Post Impeller Coating

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
15639	22.52	2.05	19.72	136.36	24.95	310.3	6.04	9.67	313.9	74.5%	1663.8	1302.38	1195
12292	17.7	3.41	15.50	181.63	19.61	411.7	3.73	5.97	413.9	80.8%	1589.6	1244.36	1195
10201	14.69	4.25	12.86	206.01	16.28	466.1	2.57	4.11	467.6	81.2%	1484.3	1161.86	1195
7333	10.56	5	9.25	232.57	11.70	525.7	1.33	2.13	526.5	75.6%	1289.1	1009.08	1196

Corrected to 1180 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM
15443	22.24	306.1	74.5%	1601.9	1254	1180
12137	17.48	403.6	80.8%	1530.5	1198	1180
10073	14.51	455.9	81.2%	1429.1	1119	1180
7235	10.42	512.5	75.6%	1238.0	969	1180

Pump No. 6 Field Curve 10/28/08

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
15590	22.45	1.22	19.66	134.02	24.88	306.8	6.00	9.61	310.4	73.4%	1664.2	1302.71	1195
14653	21.1	1.7	18.47	148.94	23.38	340.1	5.30	8.49	343.3	76.8%	1653.6	1294.40	1195
13014	18.74	2.54	16.41	171.99	20.77	391.4	4.18	6.70	393.9	80.3%	1611.7	1261.63	1195
10972	15.80	3.5	13.83	197.51	17.51	448.2	2.97	4.76	450.0	81.7%	1525.8	1194.38	1195
9292	13.38	4.1	11.72	216.17	14.83	489.9	2.13	3.41	491.2	81.1%	1420.9	1112.28	1195

Corrected to 1180 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM
15395	22.17	302.6	73.4%	1602.3	1254	1180
14469	20.84	334.7	76.8%	1592.1	1246	1180
12851	18.50	384.1	80.3%	1551.8	1215	1180
10834	15.60	438.7	81.7%	1469.1	1150	1180
9183	13.22	479.7	81.1%	1371.6	1074	1181

Pump No. 6 Field Curve 11/20/08 (Pre Flow Transmitter Change)

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
15361	22.12	1.48	19.37	138.34	24.51	316.1	5.82	9.33	319.7	74.5%	1664.0	1302.57	1195
13819	19.9	2.35	17.42	162.13	22.05	369.1	4.71	7.55	371.9	79.3%	1636.7	1281.17	1195
12042	17.34	3.15	15.18	185.22	19.21	420.6	3.58	5.73	422.7	81.5%	1577.8	1235.08	1195
10549	15.19	3.91	13.30	203.18	16.83	460.3	2.75	4.40	462.0	81.9%	1502.4	1176.10	1196
8292	11.94	4.74	10.45	226.84	13.23	513.1	1.70	2.72	514.1	80.3%	1340.1	1048.98	1196

Corrected to 1180 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM
15168	21.84	311.7	74.5%	1602.1	1254	1180
13646	19.65	362.6	79.3%	1575.8	1234	1180
11891	17.12	412.2	81.5%	1519.1	1189	1180
10407	14.99	449.7	81.9%	1442.9	1130	1180
8181	11.78	500.4	80.3%	1287.0	1007	1180

Pump No. 6 Field Curve 12/08/08 (Post Flow Transmitter Change)

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
16014	23.06	0.7	20.19	129.77	25.55	298.2	6.33	10.14	302.0	73.1%	1670.9	1308.00	1195
14625	21.06	1.39	18.44	152.18	23.34	348.3	5.28	8.46	351.5	78.5%	1653.3	1294.19	1195
12618	18.17	2.35	15.91	179.89	20.13	410.1	3.93	6.29	412.5	82.4%	1595.1	1248.65	1195
10944	15.76	3.09	13.80	200.49	17.46	456.0	2.96	4.74	457.8	83.6%	1514.0	1185.11	1196
9076	13.07	4.11	11.44	221.07	14.48	501.2	2.03	3.26	502.4	83.0%	1387.6	1086.22	1196

Corrected to 1180 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM
15813	22.77	294.4	73.1%	1608.8	1259	1180
14441	20.80	342.7	78.5%	1591.8	1246	1180
12460	17.94	402.2	82.4%	1535.8	1202	1180
10798	15.55	445.6	83.6%	1454.0	1138	1180
8955	12.90	489.0	83.0%	1332.7	1043	1180

Pump No. 6 Field Curve 7/28/09

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
15389	22.16	1.54	19.40	134.44	24.56	307.0	5.85	9.36	310.5	72.5%	1663.7	1302.35	1195
14493	20.87	2.03	18.27	149.14	23.13	339.8	5.18	8.30	342.9	75.9%	1654.6	1295.18	1195
12771	18.39	2.95	16.10	172.62	20.38	391.9	4.03	6.45	394.4	79.0%	1610.7	1260.86	1195
10986	15.82	3.69	13.85	194.55	17.53	440.9	2.98	4.77	442.7	79.8%	1539.6	1205.15	1196
9424	13.57	4.37	11.88	211.98	15.04	479.6	2.19	3.51	480.9	79.1%	1446.9	1132.59	1196

Corrected to 1180 RPM

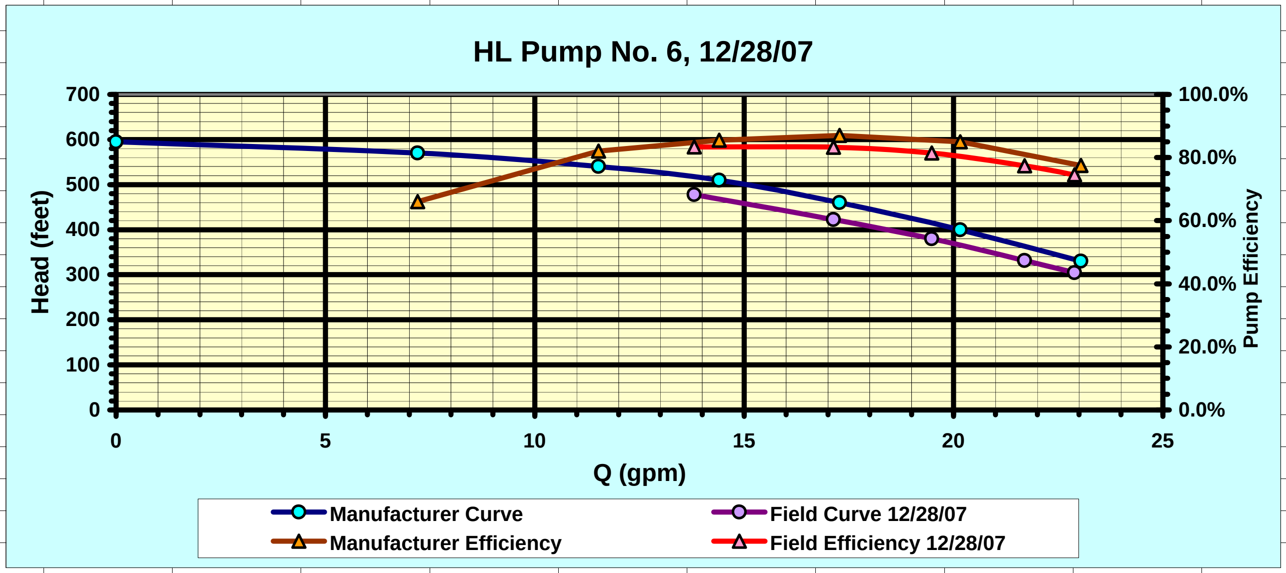
Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM
15196	21.88	302.8	72.5%	1601.9	1254	1180
14311	20.61	334.4	75.9%	1593.0	1247	1180
12611	18.16	384.5	79.0%	1550.8	1214	1180
10839	15.61	430.9	79.8%	1478.6	1157	1180
9298	13.39	468.1	79.1%	1389.6	1088	1180

Pump No. 6 Field Curve 3/1/10

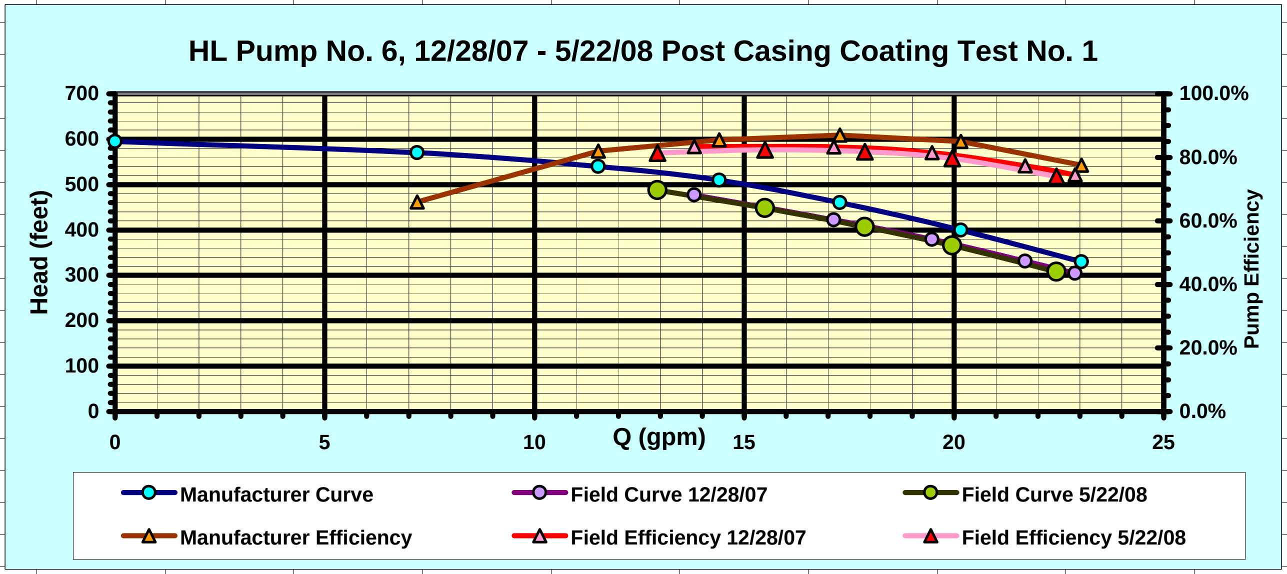
Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
15417	22.2	1.59	19.44	136.54	24.60	311.7	5.87	9.40	315.3	73.5%	1670.6	1307.72	1195
13819	19.9	2.45	17.42	160.71	22.05	365.6	4.71	7.55	368.4	78.2%	1643.8	1286.73	1195
12479	17.97	3.19	15.73	179.87	19.91	408.1	3.84	6.16	410.4	80.9%	1598.7	1251.44	1195
10521	15.15	4.04	13.26	204.06	16.79	462.0	2.73	4.38	463.7	82.2%	1498.8	1173.21	1196

Corrected to 1180 RPM

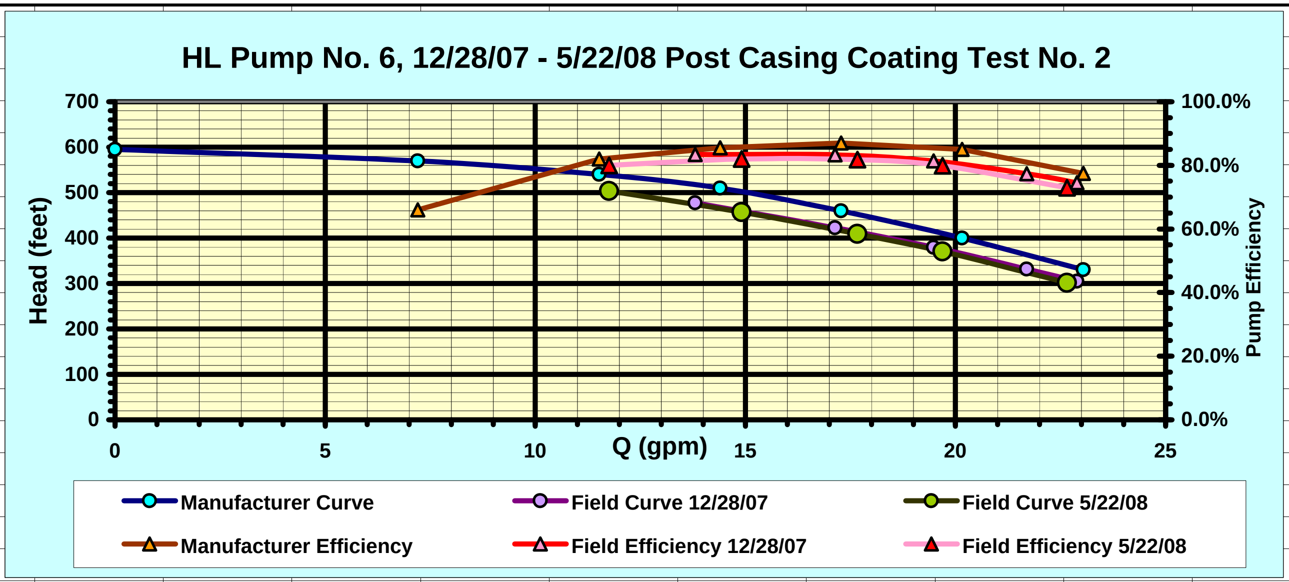
Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM
15223	21.92	307.4	73.5%	1608.5	1259	1180
13646	19.65	359.2	78.2%	1582.6	1239	1180
12323	17.74	400.2	80.9%	1539.2	1205	1180
10380	14.95	451.4	82.2%	1439.4	1127	1180

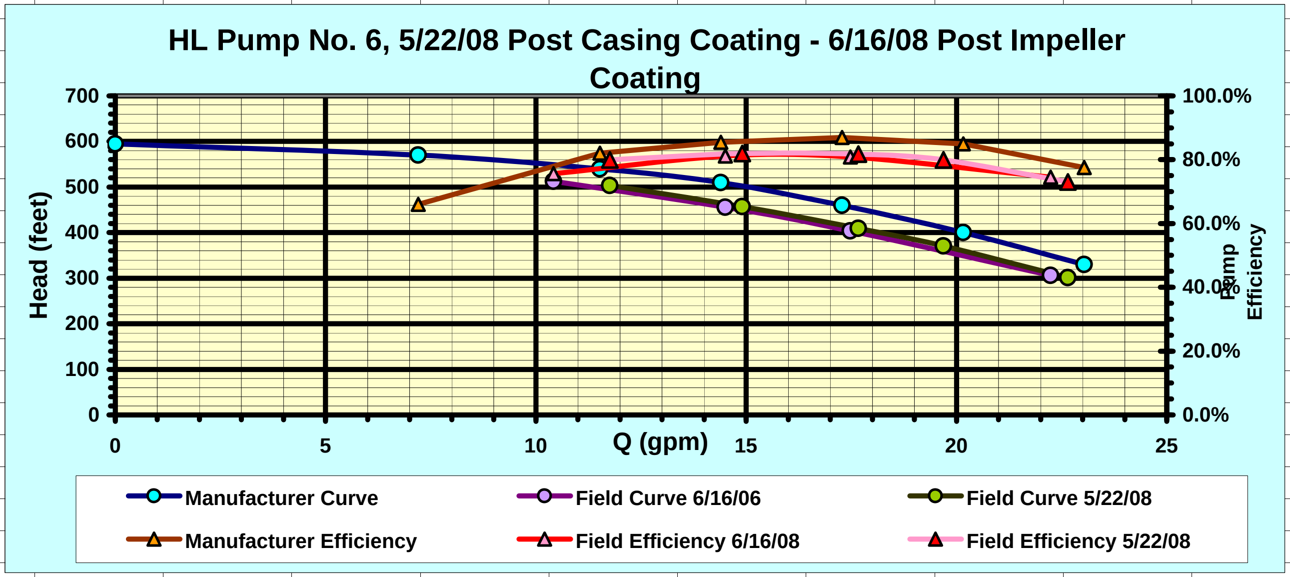


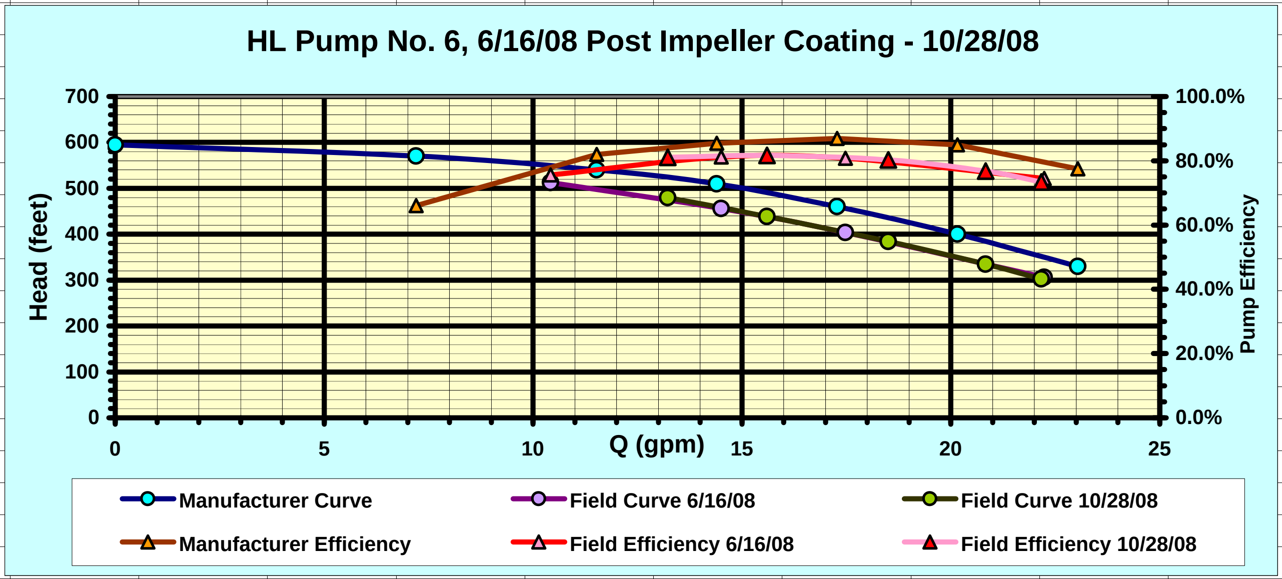
HL Pump No. 6, 12/28/07
Head (feet)
Pump Efficiency
Q (gpm)
Manufacturer Curve
Field Curve 12/28/07
Manufacturer Efficiency
Field Efficiency 12/28/07

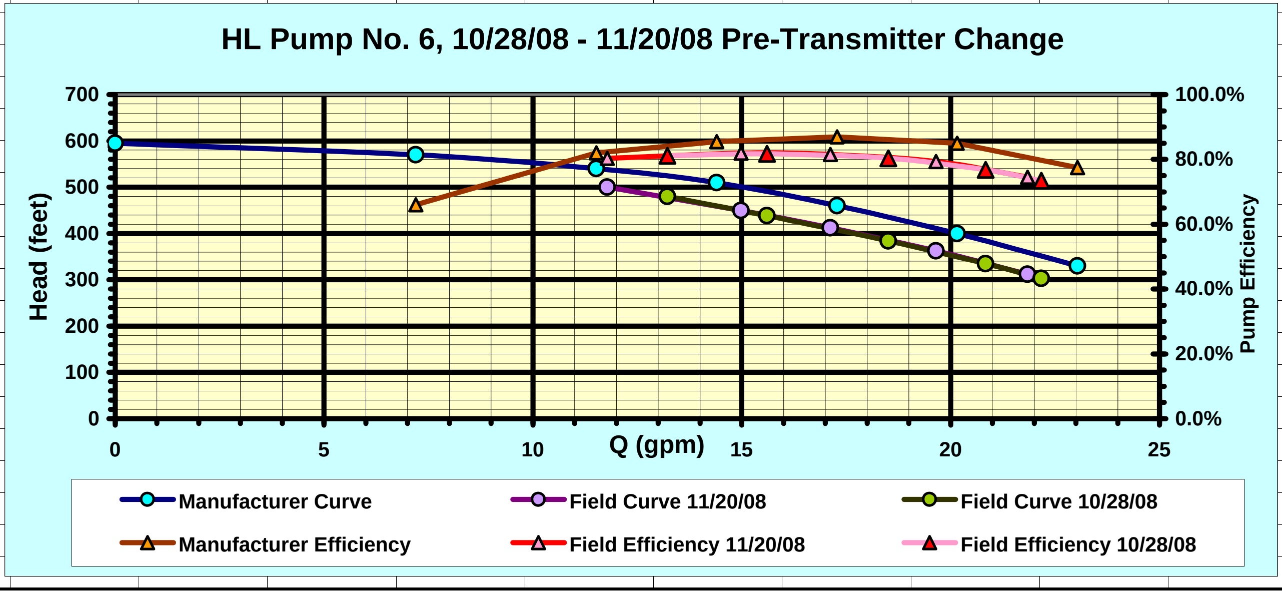


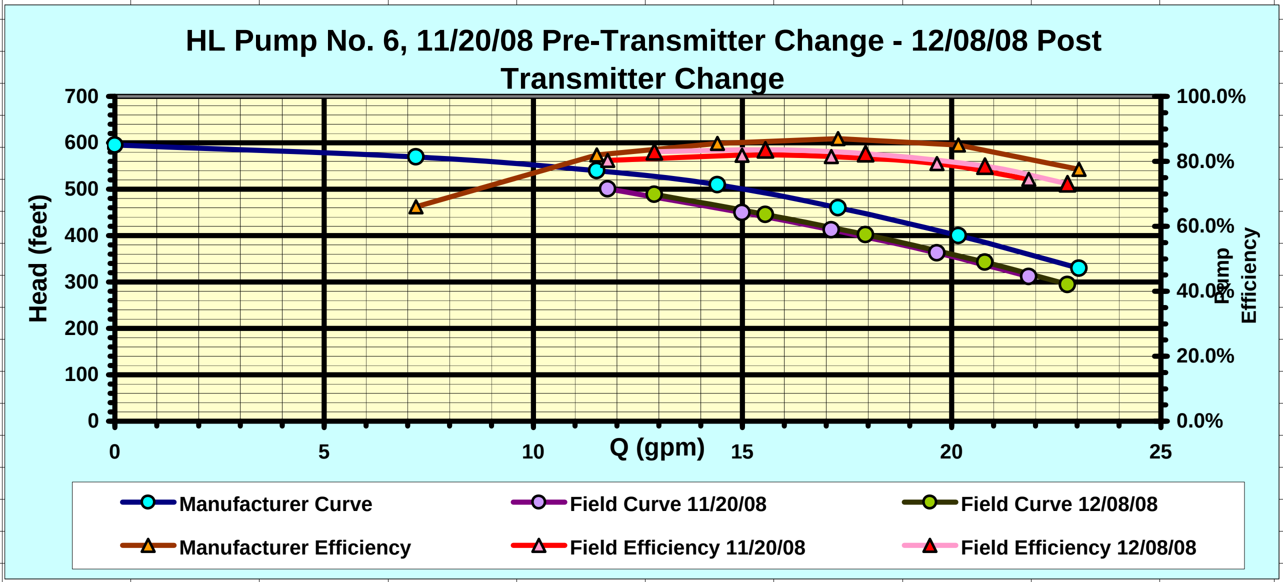
HL Pump No. 6, 12/28/07 - 5/22/08 Post Casing Coating Test No. 1
Head (feet)
Pump Efficiency
Q (gpm)
Manufacturer Curve
Field Curve 12/28/07
Field Curve 5/22/08
Manufacturer Efficiency
Field Efficiency 12/28/07
Field Efficiency 5/22/08


HL Pump No. 6, 12/28/07 - 5/22/08 Post Casing Coating Test No. 2
Head (feet)
Pump Efficiency
Q (gpm)
0
100
200
300
400
500
600
700
0.0%
20.0%
40.0%
60.0%
80.0%
100.0%
0
5
10
15
20
25
Manufacturer Curve
Field Curve 12/28/07
Field Curve 5/22/08
Manufacturer Efficiency
Field Efficiency 12/28/07
Field Efficiency 5/22/08

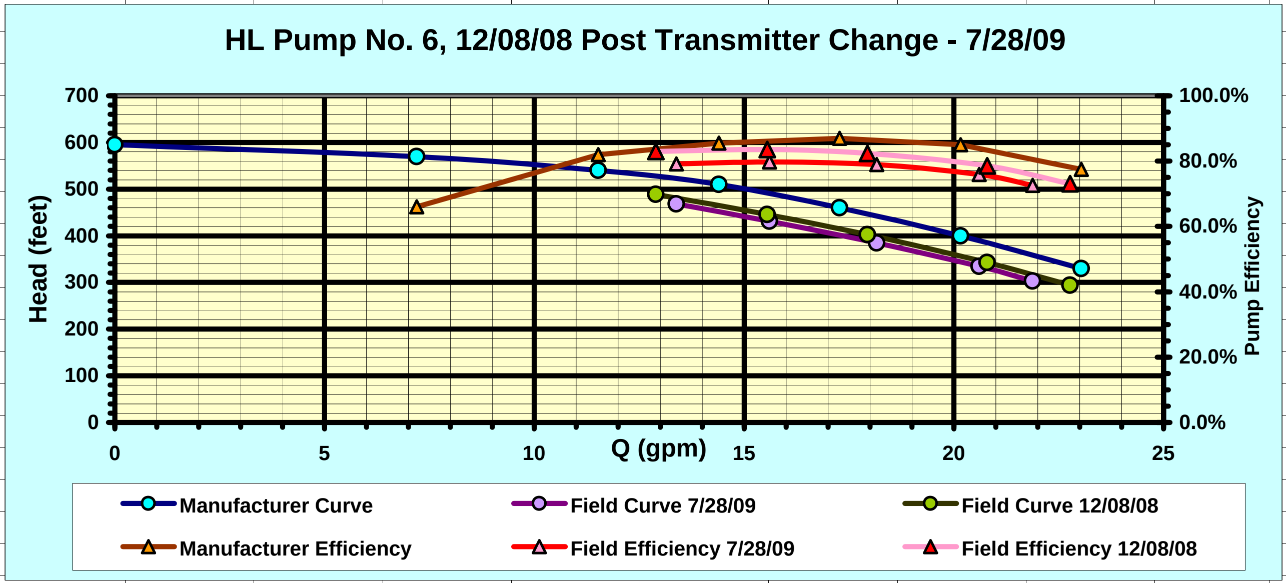

HL Pump No. 6, 5/22/08 Post Casing Coating - 6/16/08 Post Impeller Coating
Head (feet)
Pump Efficiency
Q (gpm)
0
100
200
300
400
500
600
700
0.0%
20.0%
40.0%
60.0%
80.0%
100.0%
0
5
10
15
20
25
Manufacturer Curve
Field Curve 6/16/06
Field Curve 5/22/08
Manufacturer Efficiency
Field Efficiency 6/16/08
Field Efficiency 5/22/08


HL Pump No. 6, 6/16/08 Post Impeller Coating - 10/28/08
Head (feet)
Pump Efficiency
Q (gpm)
700
600
500
400
300
200
100
0
100.0%
80.0%
60.0%
40.0%
20.0%
0.0%
0
5
10
15
20
25
Manufacturer Curve
Field Curve 6/16/08
Field Curve 10/28/08
Manufacturer Efficiency
Field Efficiency 6/16/08
Field Efficiency 10/28/08

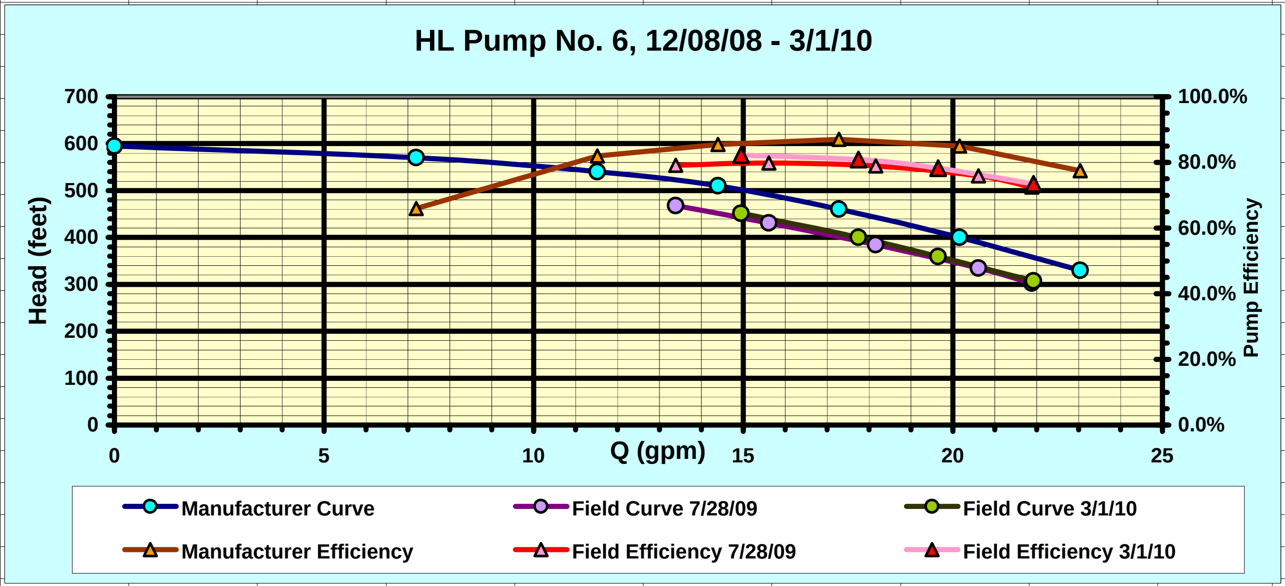

HL Pump No. 6, 10/28/08 - 11/20/08 Pre-Transmitter Change
Head (feet)
Pump Efficiency
Q (gpm)
700
600
500
400
300
200
100
0
100.0%
80.0%
60.0%
40.0%
20.0%
0.0%
0
5
10
15
20
25
Manufacturer Curve
Field Curve 11/20/08
Field Curve 10/28/08
Manufacturer Efficiency
Field Efficiency 11/20/08
Field Efficiency 10/28/08



HL Pump No. 6, 11/20/08 Pre-Transmitter Change - 12/08/08 Post Transmitter Change
Head (feet)
700
600
500
400
300
200
100
0
0
5
10
15
20
25
Q (gpm)
100.0%
80.0%
60.0%
40.0%
20.0%
0.0%
Pump Efficiency
Manufacturer Curve
Field Curve 11/20/08
Field Curve 12/08/08
Manufacturer Efficiency
Field Efficiency 11/20/08
Field Efficiency 12/08/08



HL Pump No. 6, 12/08/08 Post Transmitter Change - 7/28/09
Head (feet)
700
600
500
400
300
200
100
0
0
5
10
15
20
25
Q (gpm)
100.0%
80.0%
60.0%
40.0%
20.0%
0.0%
Pump Efficiency
Manufacturer Curve
Field Curve 7/28/09
Field Curve 12/08/08
Manufacturer Efficiency
Field Efficiency 7/28/09
Field Efficiency 12/08/08



HL Pump No. 6, 12/08/08 - 3/1/10
Head (feet)
0
100
200
300
400
500
600
700
Pump Efficiency
0.0%
20.0%
40.0%
60.0%
80.0%
100.0%
Q (gpm)
0
5
10
15
20
25
Manufacturer Curve
Field Curve 7/28/09
Field Curve 3/1/10
Manufacturer Efficiency
Field Efficiency 7/28/09
Field Efficiency 3/1/10

High Lift No. 7
Energy Savings Calculation
NYSERDA Pump Refurbishment & Coating Project
Note: Pump was rebuilt in 2006 and not refurbished for NYSERDA project
Note 2: Energy savings based on 730 Hours after coating application

Continuous Service

Pre Coating	
Head (ft)	431
Flow (gpm)	11528
Efficiency	81.60%
Hours Operation/month	728
BHP	1538
kW (Assumes Motor Eff 95%)	1207.4
kW Demand Charge	$12,074
kwh cost	$74,693
Total Monthly kWH	878,746
Monthly Cost	**$86,767.70**

Constants	
Hours/ Month	730
kW Demand Cost	$10.00
kwh Cost	$0.085
Motor Efficiency	95.0%

Post Coating	
Head (ft)	430
Flow (gpm)	11493
Efficiency	84.75%
Hours Operation/month	730
BHP	1473
kW (Assumes Motor Eff 95%)	1156.3
kW Demand Charge	$11,563
kwh cost	$71,750
Total Monthly kWH	844122
Monthly Cost	**$83,313.65**

Post Coating Comparison	
Monthly Savings	**$3,454**
Annual Savings	**$41,449**
5 Year Savings	**$207,243**
kW Demand Reduction	**51.1**
Monthly kwh Savings	**34624**
Yearly kwh Savings	**415493**

20% Service Time

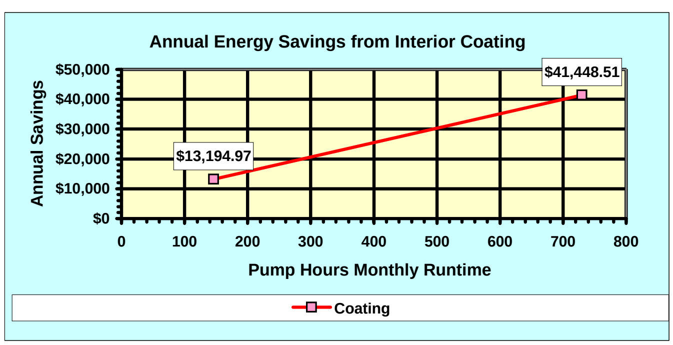
Pre Coating	
Head (ft)	431
Flow (gpm)	11528
Efficiency	81.60%
Hours Operation/month	146
BHP	1538
kW (Assumes Motor Eff 95%)	1207.4
kW Demand Charge	$12,074
kwh cost	$14,939
Total Monthly kWH	175,749
Monthly Cost	**$27,012.96**

Constants	
Hours/ Month	730
kW Demand Cost	$10.00
kwh Cost	$0.085
Motor Efficiency	95.0%

Post Coating	
Head (ft)	430
Flow (gpm)	11493
Efficiency	84.75%
Hours Operation/month	146
BHP	1473
kW (Assumes Motor Eff 95%)	1156.3
kW Demand Charge	$11,563
kwh cost	$14,350
Total Monthly kWH	168824
Monthly Cost	**$25,913.38**

Pre-Post Coating Comparison	
Monthly Savings	**$1,100**
Annual Savings	**$13,195**
5 Year Savings	**$65,975**
kW Demand Reduction	**51.1**
Monthly kwh Savings	**6925**
Yearly kwh Savings	**83099**

Interior Coating **Pump Hours of Operation Before Refurbishment & Interior Coating**	
730	**$41,448.51**
146	**$13,194.97**



High Lift No. 7

Manufacturer's Pump and Motor Information

NYSERDA System Curve			
Q		H	
50.0%	8.0	80%	336
75.0%	12.0	88%	370
BEP	16.0	100%	420
125.0%	20.0	120%	504

Pumps 2, 4, 6 & 7
Allis Chalmers
18x16
13500 gpm @ 415 feet of head
1180 rpm

Motors 2, 4, 6 & 7

Pump No. 1 or 3

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	Ns
0	0	595				
5000	7.2	570	66.0%			
8000	11.52	540	82.0%	1330	943	942
10000	14.4	510	85.5%	1506	1068	1100
12000	17.28	460	87.0%	1602	1135	1301
14000	20.16	400	85.0%	1664	1179	1561
16000	23.04	330	77.5%	1720	1219	1928

Motor Efficiency 6 & 7			Motor Efficiency 2 & 4		
	Nominal	Guar		Nominal	Guar
% Load	% Eff	% Eff	% Load	% Eff	% Eff
100		96.1%	100		
75		96.3%	75		
50		96.1%	50		

Pump 8
Allis Chalmers
18x16
13500 gpm @ 415 feet of head
1180 rpm

Motor 8

Pump No. 1 or 3

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	Ns
0	0	600				
5000	7.2	580	69.5%			
7500	10.8	550	81.0%	1468	1040	900
10000	14.4	500	86.0%	1614	1144	1116
12500	18	450	88.0%	1614	1144	1350
15000	21.6	380	84.0%	1714	1214	1679
17500	25.2	300	75.0%	1768	1253	2166

Motor Efficiency

Amps	kW	% Eff

Pump No. 7 Field Curve 2/8/07 Morning

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
16382	23.59	2.52	20.65	132.95	26.14	301.3	6.62	10.61	305.3	72.7%	1737.1	1359.76	1194
14993	21.59	3.22	18.90	152.81	23.92	345.6	5.55	8.89	348.9	77.0%	1716.1	1343.38	1194
12229	17.61	4.02	15.42	179.18	19.51	404.6	3.69	5.91	406.8	76.0%	1653.4	1294.24	1194
11208	16.14	4.48	14.13	197.76	17.88	446.5	3.10	4.97	448.3	80.2%	1582.7	1238.96	1195
9500	13.68	4.98	11.98	215.93	15.16	487.3	2.23	3.57	488.6	79.4%	1475.9	1155.29	1195
7215	10.39	5.62	9.10	236.74	11.51	533.9	1.29	2.06	534.7	74.7%	1303.4	1020.27	1196

Corrected to 1180 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM
16190	23.31	298.2	72.7%	1676.7	1312	1180
14817	21.34	340.8	77.0%	1656.5	1297	1180
12086	17.40	397.4	76.0%	1595.9	1249	1180
11068	15.94	437.2	80.2%	1523.9	1193	1180
9389	13.52	477.3	79.4%	1424.6	1115	1181
7131	10.27	522.2	74.7%	1258.1	985	1182

Pump No. 7 Field Curve 2/8/07 Afternoon

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
16389	23.6	2.54	20.66	132.51	26.15	300.2	6.63	10.62	304.2	72.4%	1737.9	1360.41	1194
14465	20.83	3.28	18.24	159	23.08	359.7	5.17	8.27	362.8	77.7%	1706.5	1335.81	1194
13472	19.4	3.66	16.99	173.32	21.50	391.9	4.48	7.18	394.6	80.1%	1675.0	1311.18	1194
11931	17.18	4.38	15.04	191.86	19.04	433.1	3.51	5.63	435.2	81.5%	1608.8	1259.35	1195
9924	14.29	4.91	12.51	214.25	15.83	483.6	2.43	3.89	485.0	81.5%	1491.3	1167.39	1195
7181	10.34	5.52	9.05	237.00	11.46	534.7	1.27	2.04	535.5	75.1%	1293.0	1012.12	1196

Corrected to 1180 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM
16197	23.32	297.1	72.4%	1677.5	1313	1180
14296	20.59	354.4	77.7%	1647.1	1289	1180
13314	19.17	385.4	80.1%	1616.8	1266	1180
11781	16.96	424.3	81.5%	1549.0	1213	1180
9807	14.12	473.7	81.5%	1439.5	1127	1181
7097	10.22	523.0	75.1%	1248.1	977	1182

Pump No. 7 Field Curve 7/5/07 (1st Test)

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
16146	23.25	1.39	20.36	133.66	25.76	305.5	6.43	10.31	309.4	76.6%	1647.4	1289.59	1194
13965	20.11	2.41	17.61	153.87	22.28	349.9	4.81	7.71	352.8	76.2%	1632.3	1277.76	1194
12563	18.09	3.17	15.84	180.82	20.05	410.4	3.90	6.24	412.7	83.1%	1576.5	1234.05	1195
11076	15.95	3.99	13.97	199.09	17.67	450.7	3.03	4.85	452.5	84.0%	1506.1	1179.00	1195
8743	12.59	4.52	11.02	224.56	13.95	508.3	1.89	3.02	509.4	83.6%	1345.8	1053.49	1195

Corrected to 1180 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM
15957	22.98	302.2	76.6%	1590.2	1245	1180
13802	19.87	344.5	76.2%	1575.6	1233	1180
12405	17.86	402.4	83.1%	1517.9	1188	1180
10937	15.75	441.2	84.0%	1450.1	1135	1180
8641	12.44	497.6	83.6%	1299.1	1017	1181

Pump No. 7 Field Curve 7/5/07 (2nd Test)

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
16299	23.47	1.68	20.55	131.72	26.01	300.4	6.56	10.50	304.3	76.1%	1647.1	1289.31	1194
15090	21.73	2.24	19.03	150.74	24.08	343.0	5.62	9.00	346.4	80.5%	1639.8	1283.59	1194
13326	19.19	2.89	16.80	173.48	21.26	394.1	4.38	7.02	396.7	83.7%	1595.6	1249.00	1195
11521	16.59	3.59	14.53	194.92	18.38	442.0	3.28	5.25	443.9	84.8%	1523.4	1192.52	1195
10306	14.84	4.02	12.99	209.04	16.44	473.6	2.62	4.20	475.2	85.1%	1453.7	1137.94	1195
8500	12.24	4.77	10.72	226.61	13.56	512.5	1.78	2.86	513.5	83.0%	1328.7	1040.08	1195

Corrected to 1180 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM
16108	23.19	297.2	76.1%	1589.8	1244	1180
14913	21.48	338.3	80.5%	1582.8	1239	1180
13159	18.95	386.8	83.7%	1536.2	1203	1180
11376	16.38	432.9	84.8%	1466.8	1148	1180
10176	14.65	463.3	85.1%	1399.6	1096	1180
8393	12.09	500.7	83.0%	1279.3	1001	1180

Pump No. 7 Field Curve 8/8/07 (30 Day Test)

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
15688	22.59	1.78	19.78	138.18	25.03	315.1	6.07	9.73	318.7	76.6%	1647.7	1289.83	1194
14222	20.48	2.34	17.93	160.48	22.69	365.3	4.99	8.00	368.3	81.4%	1624.8	1271.84	1194
12688	18.27	3.02	16.00	180.63	20.24	410.3	3.97	6.36	412.7	83.9%	1576.7	1234.24	1195
11257	16.21	3.55	14.19	198.12	17.96	449.5	3.13	5.01	451.3	85.0%	1510.2	1182.21	1195
9236	13.30	4.11	11.65	219.45	14.74	497.4	2.11	3.37	498.7	84.1%	1383.2	1082.77	1195

Corrected to 1180 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM
15504	22.33	311.3	76.6%	1590.4	1245	1180
14055	20.24	359.7	81.4%	1568.3	1228	1180
12528	18.04	402.4	83.9%	1518.1	1188	1180
11116	16.01	440.1	85.0%	1454.1	1138	1180
9120	13.13	486.3	84.1%	1331.8	1043	1180

Pump No. 7 Field Curve 2/7/08 (6 Month Test)

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
16028	23.08	2.47	20.21	137.74	25.57	312.5	6.34	10.16	316.3	77.2%	1659.2	1298.77	1195
14375	20.7	3.1	18.12	160.69	22.94	364.0	5.10	8.17	367.1	81.5%	1635.7	1280.44	1195
12583	18.12	3.72	15.87	183.3	20.08	414.8	3.91	6.26	417.2	84.1%	1577.1	1234.51	1196
10465	15.07	4.51	13.19	208.22	16.70	470.6	2.70	4.33	472.2	84.8%	1471.7	1152.00	1196
8361	12.04	4.9	10.54	228.99	13.34	517.6	1.73	2.76	518.7	83.1%	1317.8	1031.60	1196

Corrected to 1180 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM
15827	22.79	308.4	77.2%	1597.5	1250	1180
14195	20.44	357.9	81.5%	1574.9	1233	1180
12415	17.88	406.1	84.1%	1514.6	1186	1180
10325	14.87	459.6	84.8%	1413.4	1106	1180
8249	11.88	504.9	83.1%	1265.7	991	1180

Pump No. 7 Field Curve 5/22/08

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
15903	22.9	2.04	20.05	135.84	25.38	309.1	6.24	10.00	312.8	75.9%	1654.4	1295.08	1195
13938	20.07	2.86	17.57	164.63	22.24	373.7	4.80	7.68	376.6	81.6%	1625.1	1272.09	1195
12681	18.26	3.28	15.99	179.82	20.23	407.8	3.97	6.36	410.2	82.9%	1584.1	1239.99	1196
10944	15.76	3.93	13.80	201.08	17.46	455.4	2.96	4.74	457.2	84.0%	1503.5	1176.91	1196
9250	13.32	4.41	11.66	219.29	14.76	496.4	2.11	3.38	497.6	83.5%	1392.9	1090.32	1196

Corrected to 1180 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM
15703	22.61	305.0	75.9%	1592.9	1247	1180
13763	19.82	367.2	81.6%	1564.6	1225	1180
12511	18.02	399.3	82.9%	1521.3	1191	1180
10798	15.55	445.0	84.0%	1443.9	1130	1180
9126	13.14	484.4	83.5%	1337.7	1047	1180

Pump No. 7 Field Curve 8/22/08 (1 Year Test)

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
15882	22.87	2.26	20.02	133.21	25.34	302.5	6.23	9.97	306.2	74.4%	1650.5	1292.00	1195
14542	20.94	2.78	18.33	153.52	23.20	348.2	5.22	8.36	351.3	78.9%	1636.2	1280.77	1195
12417	17.88	3.67	15.66	181.03	19.81	409.7	3.81	6.10	412.0	82.0%	1575.8	1233.51	1195
10361	14.92	4.32	13.06	205.60	16.53	465.0	2.65	4.24	466.6	82.9%	1473.1	1153.16	1196
6403	9.22	5.29	8.07	242.77	10.22	548.6	1.01	1.62	549.2	74.4%	1193.2	933.99	1196

Corrected to 1180 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM
15683	22.58	298.6	74.4%	1589.1	1244	1180
14359	20.68	342.6	78.9%	1575.3	1233	1180
12261	17.66	401.7	82.0%	1517.2	1188	1180
10223	14.72	454.2	82.9%	1414.8	1107	1180
6317	9.10	534.6	74.4%	1145.9	897	1180

Pump No. 7 Field Curve 11/20/08 (Pre Flow Transmitter Change)

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
15507	22.33	2.39	19.55	137.62	24.74	312.4	5.94	9.51	316.0	74.8%	1653.1	1294.06	1194
14278	20.56	2.87	18.00	156.21	22.78	354.2	5.03	8.06	357.2	78.6%	1638.6	1282.68	1195
12368	17.81	3.64	15.59	182.26	19.74	412.6	3.78	6.05	414.9	82.2%	1575.6	1233.40	1195
10632	15.31	4.24	13.40	203.70	16.96	460.8	2.79	4.47	462.4	83.4%	1489.5	1165.93	1195
9028	13.00	4.53	11.38	220.87	14.41	499.7	2.01	3.22	501.0	82.8%	1379.3	1079.71	1195

Corrected to 1180 RPM

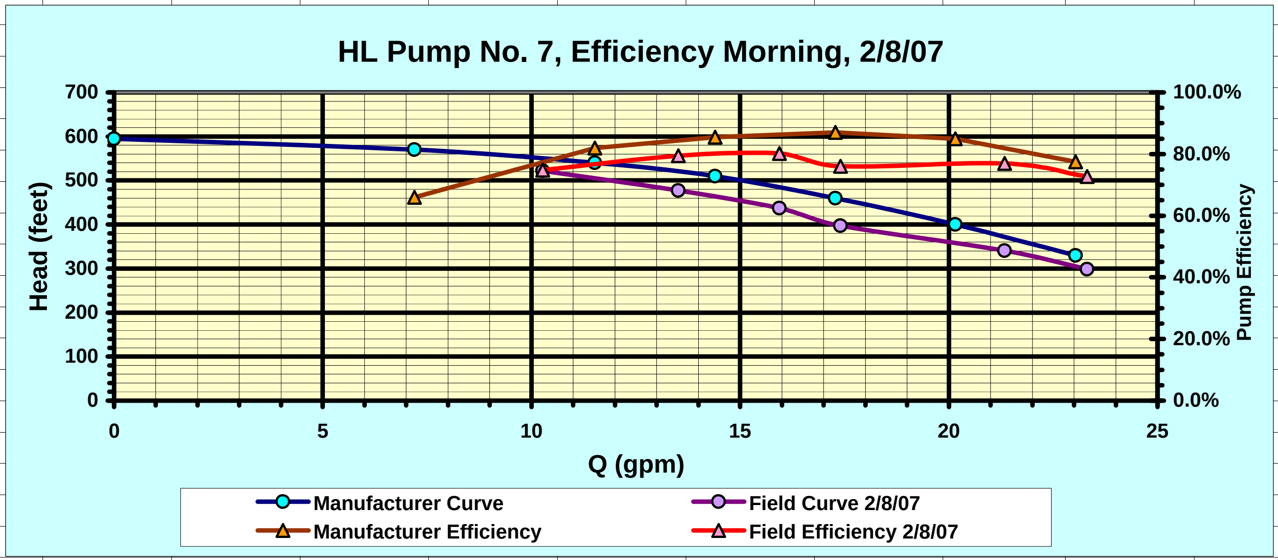
Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM
15325	22.07	308.6	74.8%	1595.7	1249	1180
14099	20.30	348.3	78.6%	1577.7	1235	1180
12213	17.59	404.5	82.2%	1517.1	1188	1180
10498	15.12	450.9	83.4%	1434.1	1123	1180
8914	12.84	488.5	82.8%	1328.0	1040	1180

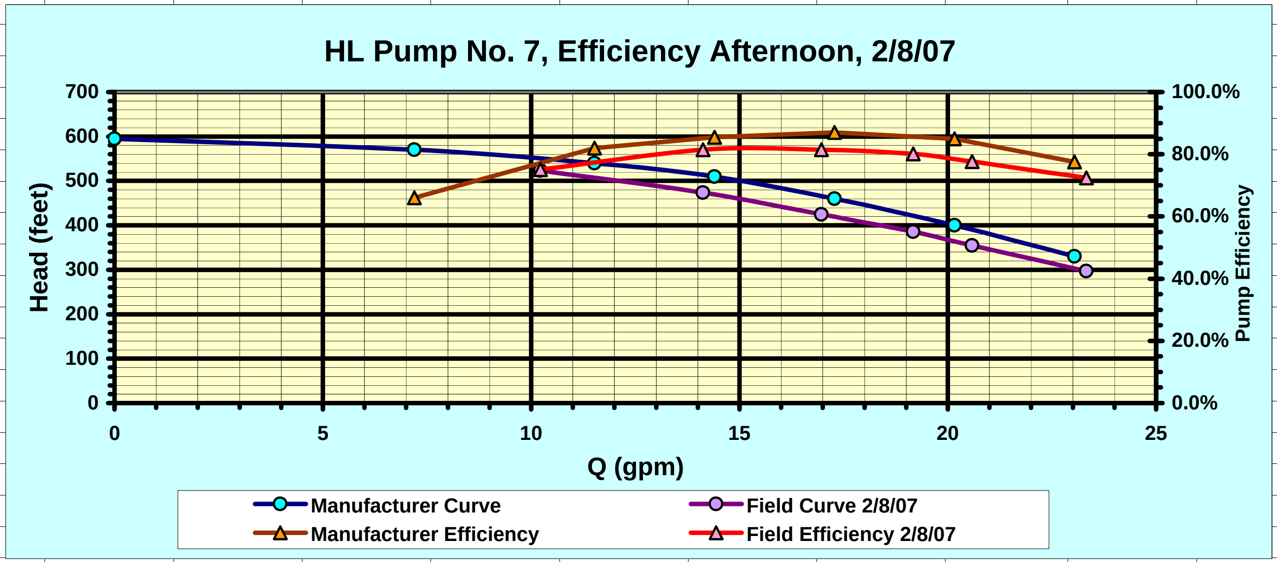
Pump No. 7 Field Curve 7/28/09

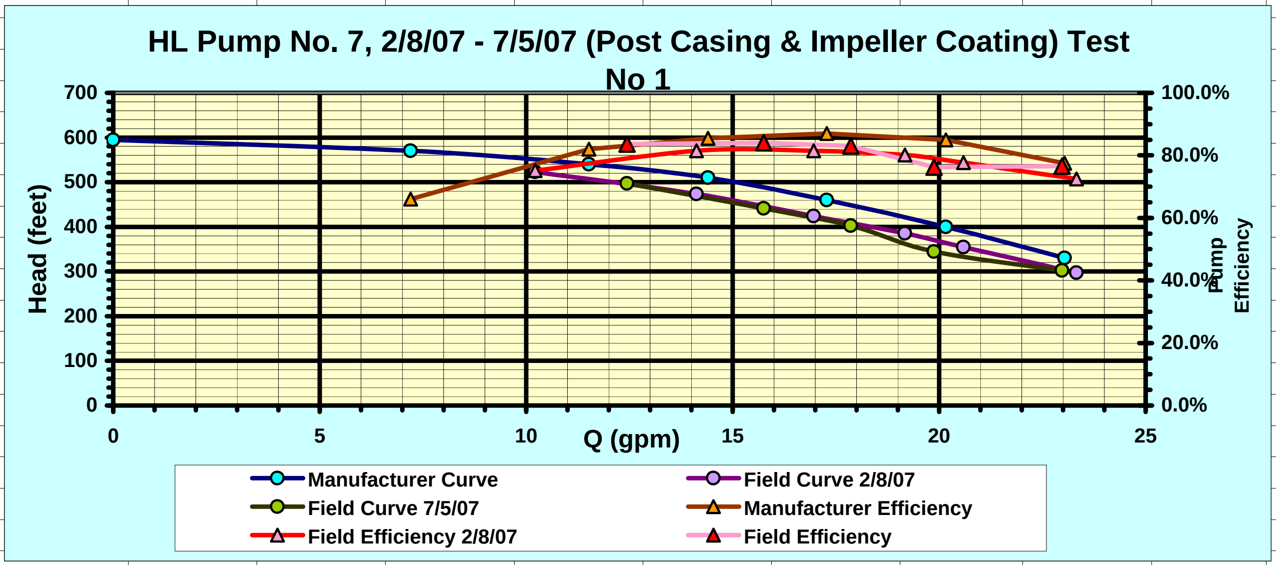
Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
15563	22.41	2.62	19.62	134.74	24.83	305.2	5.98	9.58	308.8	73.5%	1651.4	1292.69	1195
14736	21.22	2.95	18.58	147.5	23.51	333.9	5.36	8.59	337.1	76.3%	1643.8	1286.74	1195
13056	18.8	3.62	16.46	170.29	20.83	385.0	4.21	6.74	387.5	79.5%	1606.2	1257.34	1195
11229	16.17	4.24	14.16	192.59	17.92	435.1	3.11	4.99	437.0	80.6%	1538.0	1203.93	1195
9597	13.82	4.83	12.10	211.65	15.31	477.8	2.27	3.64	479.1	80.4%	1443.5	1129.98	1195

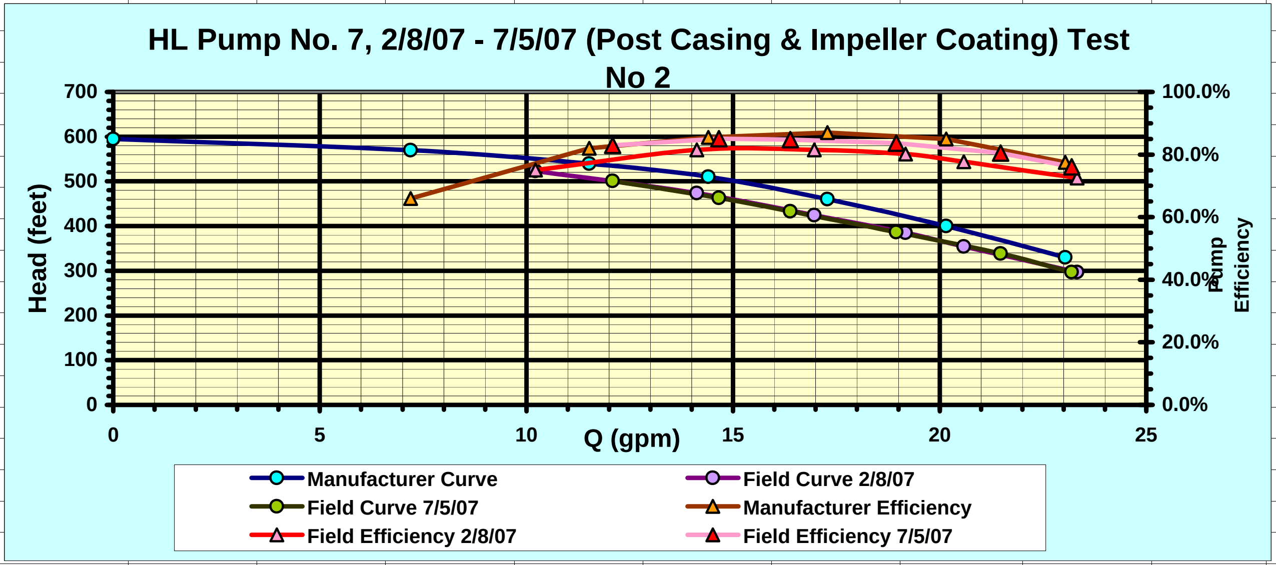
Corrected to 1180 RPM

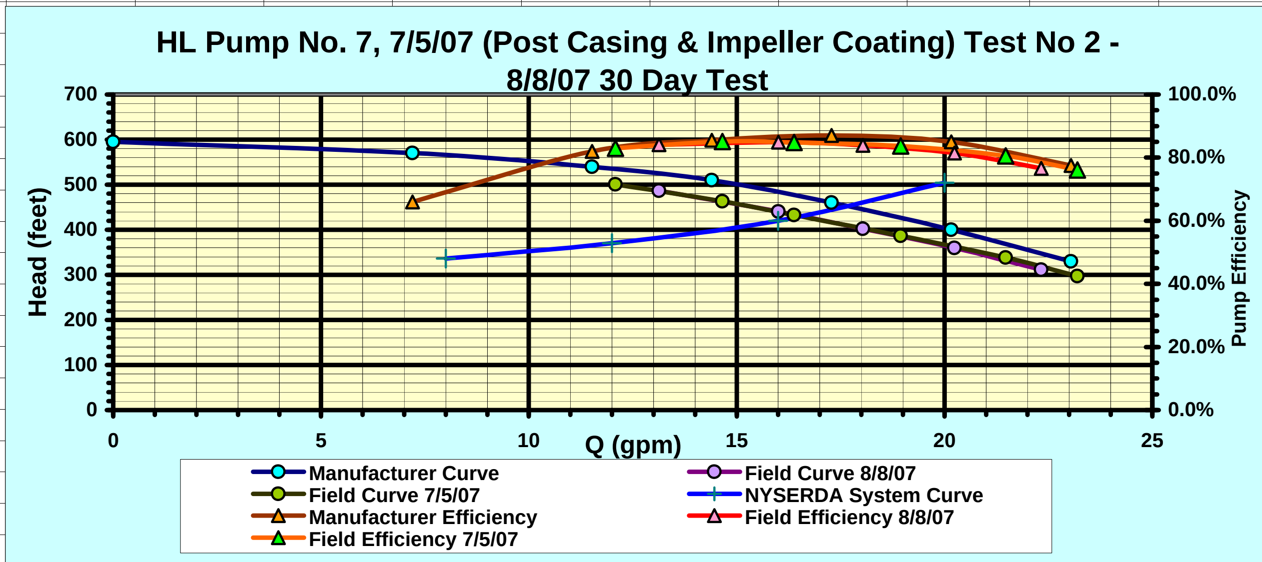
Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM
15367	22.13	301.1	73.5%	1590.0	1245	1180
14551	20.95	328.7	76.3%	1582.7	1239	1180
12892	18.56	377.9	79.5%	1546.5	1211	1180
11088	15.97	426.1	80.6%	1480.8	1159	1180
9477	13.65	467.2	80.4%	1389.8	1088	1180


HL Pump No. 7, Efficiency Morning, 2/8/07
Head (feet)
700
600
500
400
300
200
100
0
100.0%
80.0%
60.0%
40.0%
20.0%
0.0%
Pump Efficiency
0
5
10
15
20
25
Q (gpm)
Manufacturer Curve
Field Curve 2/8/07
Manufacturer Efficiency
Field Efficiency 2/8/07

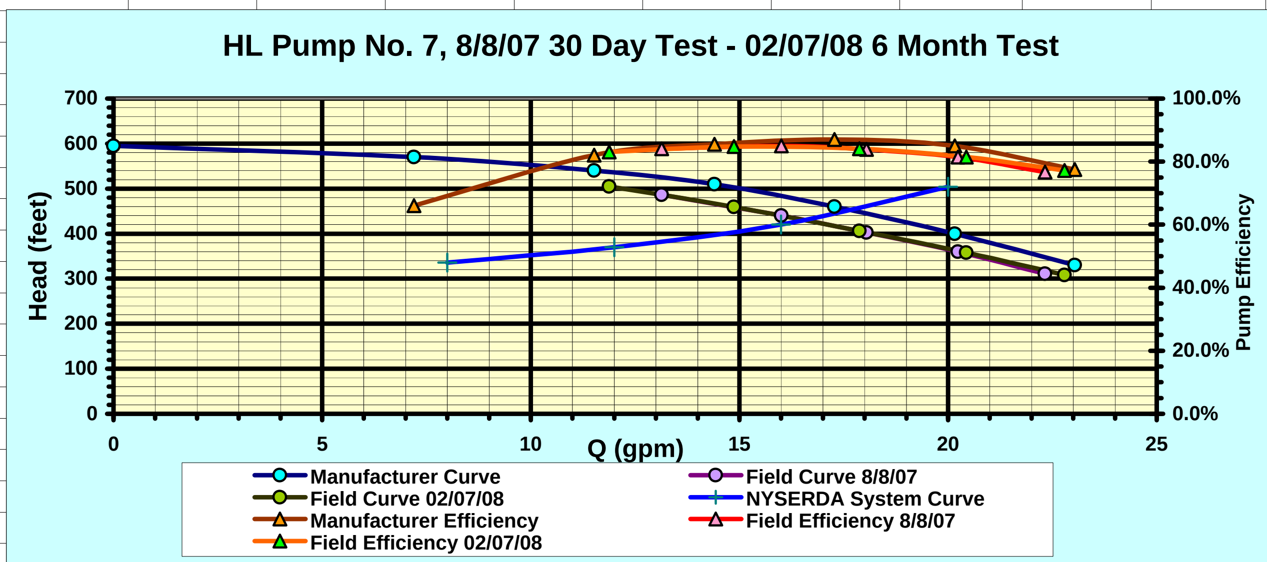

HL Pump No. 7, Efficiency Afternoon, 2/8/07
Head (feet)
700
600
500
400
300
200
100
0
100.0%
80.0%
60.0%
40.0%
20.0%
0.0%
Pump Efficiency
0
5
10
15
20
25
Q (gpm)
Manufacturer Curve
Field Curve 2/8/07
Manufacturer Efficiency
Field Efficiency 2/8/07


HL Pump No. 7, 2/8/07 - 7/5/07 (Post Casing & Impeller Coating) Test No 1
Head (feet)
Pump Efficiency
Q (gpm)
0
100
200
300
400
500
600
700
0.0%
20.0%
40.0%
60.0%
80.0%
100.0%
0
5
10
15
20
25
Manufacturer Curve
Field Curve 2/8/07
Field Curve 7/5/07
Manufacturer Efficiency
Field Efficiency 2/8/07
Field Efficiency

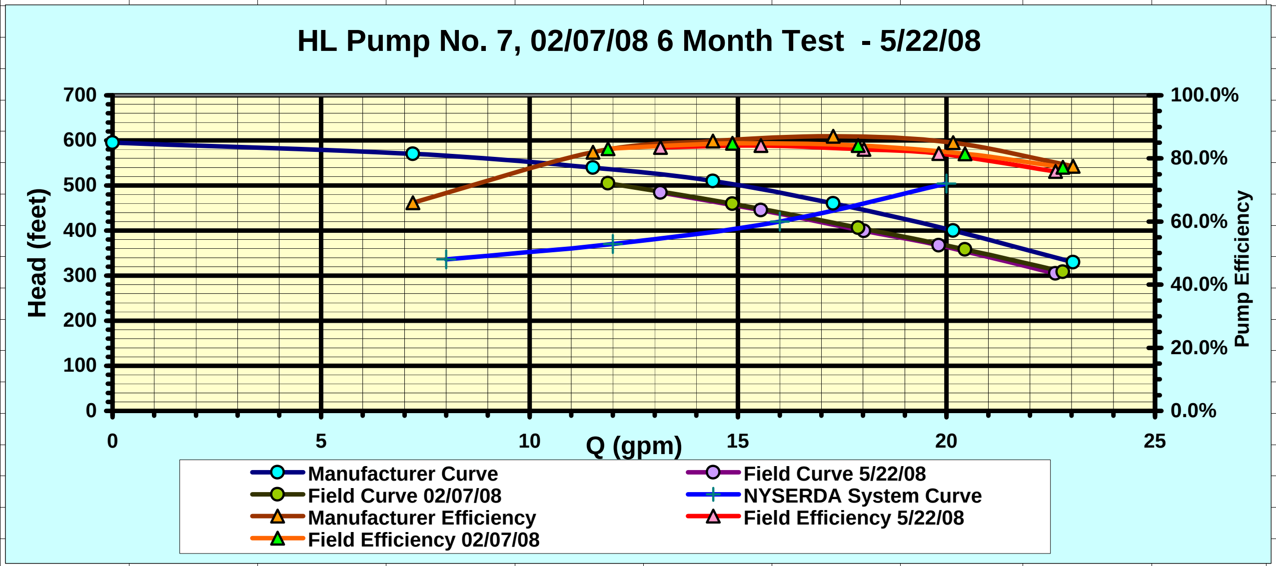

HL Pump No. 7, 2/8/07 - 7/5/07 (Post Casing & Impeller Coating) Test No 2
Head (feet)
Pump Efficiency
Q (gpm)
0
100
200
300
400
500
600
700
0.0%
20.0%
40.0%
60.0%
80.0%
100.0%
0
5
10
15
20
25
Manufacturer Curve
Field Curve 2/8/07
Field Curve 7/5/07
Manufacturer Efficiency
Field Efficiency 2/8/07
Field Efficiency 7/5/07

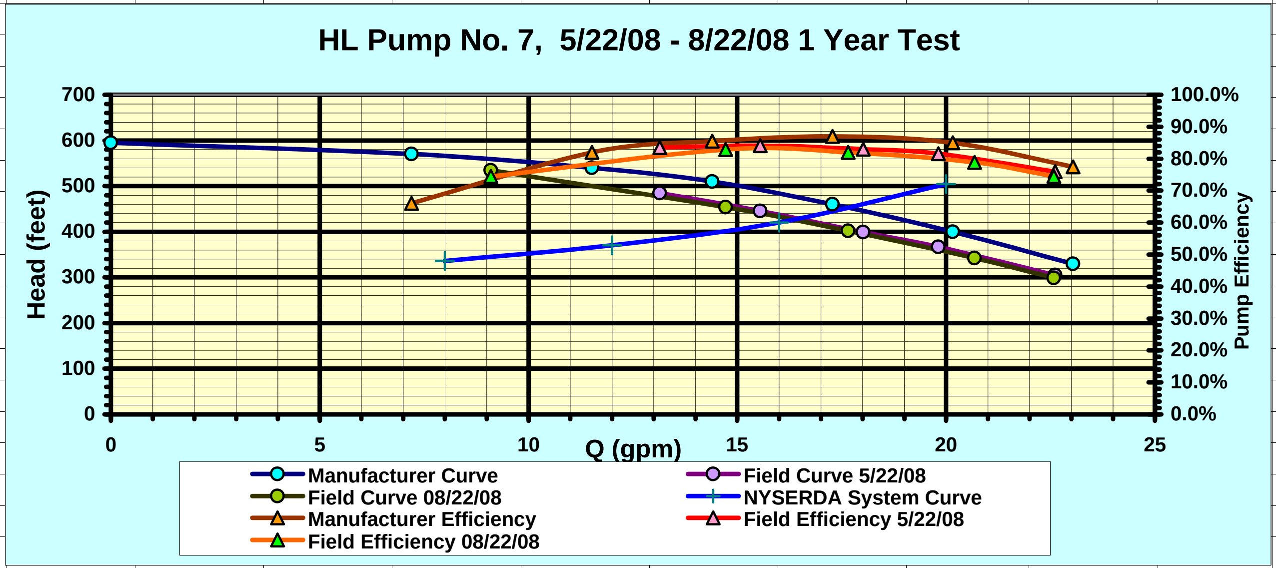


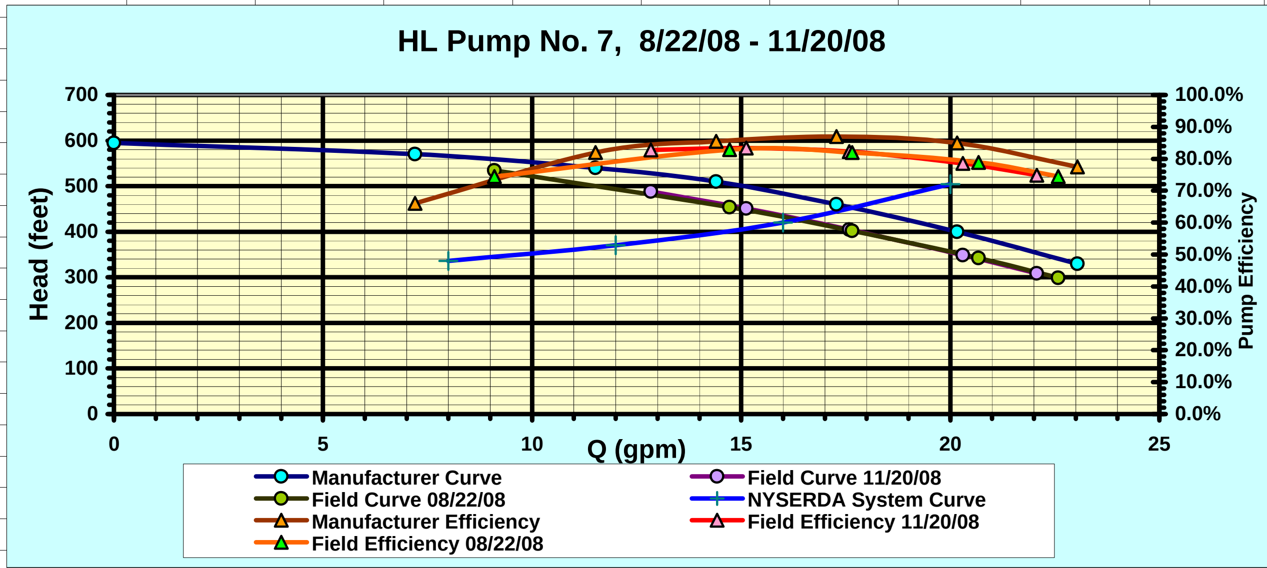
HL Pump No. 7, 7/5/07 (Post Casing & Impeller Coating) Test No 2 - 8/8/07 30 Day Test
Head (feet)
700
600
500
400
300
200
100
0
0
5
10
15
20
25
Q (gpm)
100.0%
80.0%
60.0%
40.0%
20.0%
0.0%
Pump Efficiency
Manufacturer Curve
Field Curve 7/5/07
Manufacturer Efficiency
Field Efficiency 7/5/07
Field Curve 8/8/07
NYSERDA System Curve
Field Efficiency 8/8/07

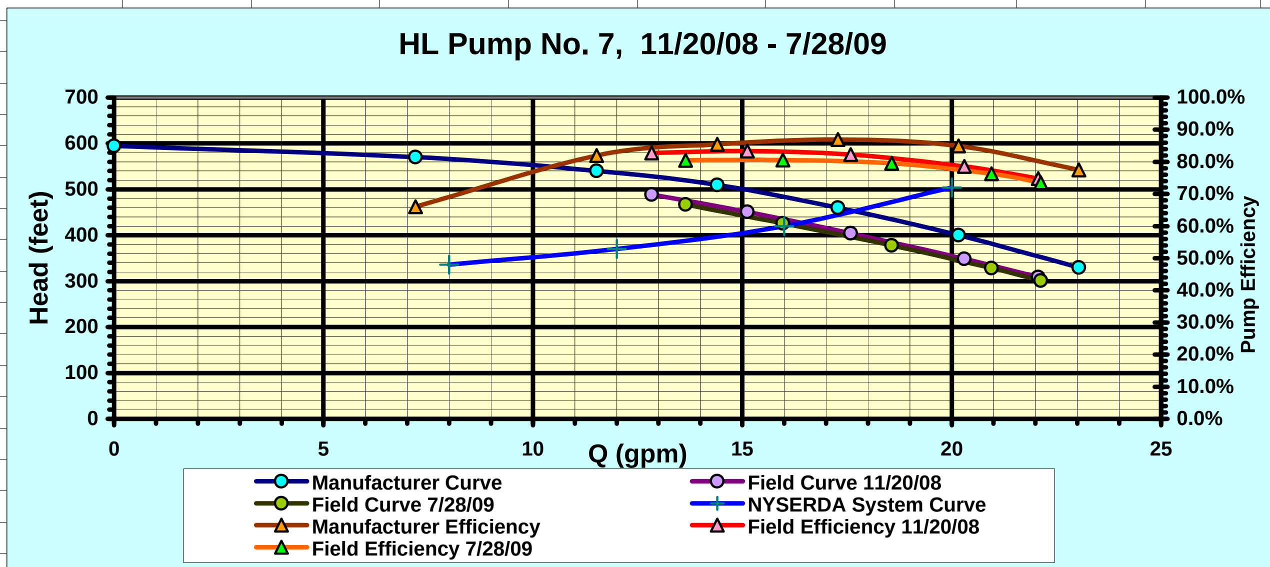


HL Pump No. 7, 8/8/07 30 Day Test - 02/07/08 6 Month Test
Head (feet)
700
600
500
400
300
200
100
0
0
5
10
15
20
25
Q (gpm)
100.0%
80.0%
60.0%
40.0%
20.0%
0.0%
Pump Efficiency
Manufacturer Curve
Field Curve 02/07/08
Manufacturer Efficiency
Field Efficiency 02/07/08
Field Curve 8/8/07
NYSERDA System Curve
Field Efficiency 8/8/07


HL Pump No. 7, 02/07/08 6 Month Test - 5/22/08
Head (feet)
Pump Efficiency
Q (gpm)
Manufacturer Curve
Field Curve 02/07/08
Manufacturer Efficiency
Field Efficiency 02/07/08
Field Curve 5/22/08
NYSERDA System Curve
Field Efficiency 5/22/08


HL Pump No. 7, 5/22/08 - 8/22/08 1 Year Test
Head (feet)
Pump Efficiency
Q (gpm)
Manufacturer Curve
Field Curve 08/22/08
Manufacturer Efficiency
Field Efficiency 08/22/08
Field Curve 5/22/08
NYSERDA System Curve
Field Efficiency 5/22/08


HL Pump No. 7, 8/22/08 - 11/20/08
Head (feet)
Pump Efficiency
Q (gpm)
0
100
200
300
400
500
600
700
0.0%
10.0%
20.0%
30.0%
40.0%
50.0%
60.0%
70.0%
80.0%
90.0%
100.0%
0
5
10
15
20
25
Manufacturer Curve
Field Curve 08/22/08
Manufacturer Efficiency
Field Efficiency 08/22/08
Field Curve 11/20/08
NYSERDA System Curve
Field Efficiency 11/20/08


HL Pump No. 7, 11/20/08 - 7/28/09
Head (feet)
Pump Efficiency
Q (gpm)
0
100
200
300
400
500
600
700
0.0%
10.0%
20.0%
30.0%
40.0%
50.0%
60.0%
70.0%
80.0%
90.0%
100.0%
0
5
10
15
20
25
Manufacturer Curve
Field Curve 7/28/09
Manufacturer Efficiency
Field Efficiency 7/28/09
Field Curve 11/20/08
NYSERDA System Curve
Field Efficiency 11/20/08

Morgan Pump No. 1
Energy Efficiency Cost Calculator

Continuous Service

Pre Mechanical	
Head (ft)	99
Flow (gpm)	2410
Efficiency	80.0%
Hours Operation/month	730
BHP	75
kW (Assumes Motor Eff 95%)	59.1
kW Demand Charge	$591
kwh cost	$3,670
Total Monthly kWH	43,172
Monthly Cost	**$4,261.05**

Constants	
Hours/ Month	730
kW Demand Cost	$10.00
kwh Cost	$0.085
Motor Efficiency	95.0%

Post Casing Coating	
Head (ft)	100.5
Flow (gpm)	2486
Efficiency	84.0%
Hours Operation/month	708
BHP	75
kW (Assumes Motor Eff 95%)	59.0
kW Demand Charge	$590
kwh cost	$3,548
Total Monthly kWH	41739
Monthly Cost	**$4,137.66**

Pre - Post Coating Comparison	
Monthly Savings	**$123**
Annual Savings	**$1,481**
5 Year Savings	**$7,403**
kW Demand Reduction	**0.2**
Monthly kwh Savings	**1433**
Yearly kwh Savings	**17194**

Post Mechanical	
Head (ft)	102
Flow (gpm)	2542
Efficiency	85.7%
Hours Operation/month	692
BHP	76
kW (Assumes Motor Eff 95%)	60.0
kW Demand Charge	$600
kwh cost	$3,529
Total Monthly kWH	41522
Monthly Cost	**$4,129.33**

Pre - Post Mechanical Comparison	
Monthly Savings	**$8**
Annual Savings	**$100**
5 Year Savings	**$500**
kW Demand Reduction	**-1.01**
Monthly kwh Savings	**217**
Yearly kwh Savings	**2608**

Post Impeller Coating	
Head (ft)	100.6
Flow (gpm)	2486
Efficiency	86.7%
Hours Operation/month	708
BHP	73
kW (Assumes Motor Eff 95%)	57.2
kW Demand Charge	$572
kwh cost	$3,441
Total Monthly kWH	40480
Monthly Cost	**$4,012.79**

Pre - Post Impeller Coating	
Monthly Savings	**$117**
Annual Savings	**$1,398**
5 Year Savings	**$6,992**
kW Demand Reduction	**2.79**
Monthly kwh Savings	**1042**
Yearly kwh Savings	**12507**

Pre Coating to Post Impeller coating	
Monthly Savings	**$248**
Annual Savings	**$2,979**
5 Year Savings	**$14,895**
kW Demand Reduction	**1.94**
Monthly kwh Savings	**2692**
Yearly kwh Savings	**32309**

Morgan No. 1 Cont'
20% Service Time

Pre Mechanical

Head (ft)	99
Flow (gpm)	2410
Efficiency	80.0%
Hours Operation/month	146
BHP	75
kW (Assumes Motor Eff 95%)	59.1
kW Demand Charge	$591
kwh cost	$734
Total Monthly kWH	8,634
Monthly Cost	**$1,325.33**

Constants

Hours/ Month	730
kW Demand Cost	$10.00
kwh Cost	$0.085
Motor Efficiency	95.0%

Post Casing Coating

Head (ft)	100.5
Flow (gpm)	2486
Efficiency	84.0%
Hours Operation/month	142
BHP	75
kW (Assumes Motor Eff 95%)	59.0
kW Demand Charge	$590
kwh cost	$710
Total Monthly kWH	8348
Monthly Cost	**$1,299.37**

Pre - Post Coating Comparison

Monthly Savings	$26
Annual Savings	$311
5 Year Savings	$1,557
kW Demand Reduction	0.2
Monthly kwh Savings	287
Yearly kwh Savings	3439

Post Mechanical

Head (ft)	102
Flow (gpm)	2542
Efficiency	85.7%
Hours Operation/month	138
BHP	76
kW (Assumes Motor Eff 95%)	60.0
kW Demand Charge	$600
kwh cost	$706
Total Monthly kWH	8304
Monthly Cost	**$1,305.83**

Pre - Post Mechanical Comparison

Monthly Savings	-$6
Annual Savings	-$77
5 Year Savings	-$387
kW Demand Reduction	-1.01
Monthly kwh Savings	7642
Yearly kwh Savings	91704

Post Impeller Coating`

Head (ft)	100.6
Flow (gpm)	2486
Efficiency	86.7%
Hours Operation/month	142
BHP	73
kW (Assumes Motor Eff 95%)	57.2
kW Demand Charge	$572
kwh cost	$688
Total Monthly kWH	8096
Monthly Cost	**$1,260.16**

Pre - Post Internal Coating Comparison

Monthly Savings	$46
Annual Savings	$548
5 Year Savings	$2,740
kW Demand Reduction	2.79
Monthly kwh Savings	7616
Yearly kwh Savings	91395

Pre Mechanical to Post Interior Coating Comparison

Monthly Savings	$20
Annual Savings	$234
5 Year Savings	$1,170
kW Demand Reduction	-0.85
Monthly kwh Savings	330
Yearly kwh Savings	3960

Total Savings (Mechanical & Coating)

Pump Hours of Operation Before Refurbishment & Interior Coating	Annual Savings Through Refurbishment & Interior Coatings
730	$2,979.05
146	$234.06

Coating Savings Only

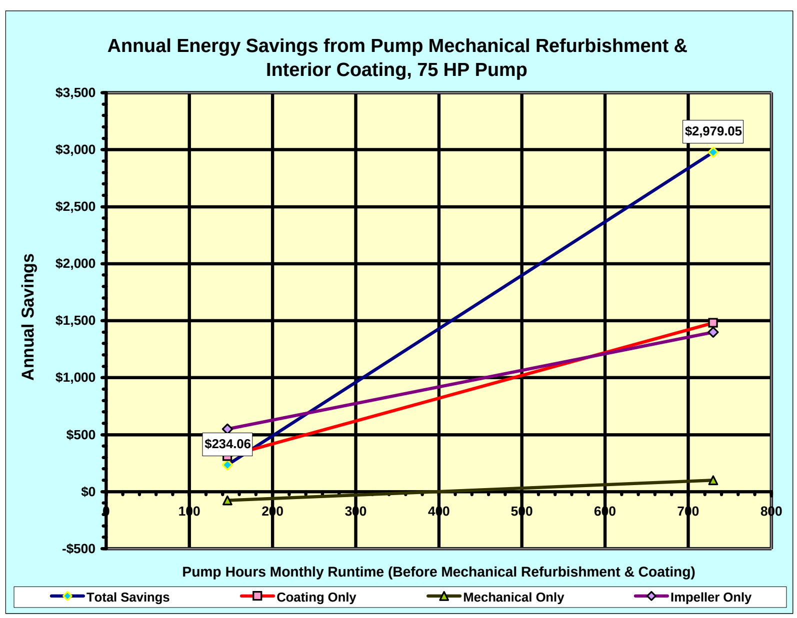
Pump Hours of Operation Before Refurbishment & Interior Coating	
730	$1,480.67
146	$311.46

Mechanical Savings Only

Pump Hours of Operation Before Refurbishment & Interior Coating	
730	$99.95
146	-$77.41

Impeller Savings Only

Pump Hours of Operation Before Refurbishment & Interior Coating	
730	$1,398.43
146	$547.95



Morgan No. 2
Energy Efficiency Cost Calculator
Continuous Service

Pre Mechanical

Head (ft)	98
Flow (gpm)	2368
Efficiency	73.6%
Hours Operation/month	730
BHP	80
kW (Assumes Motor Eff 95%)	62.5
kW Demand Charge	$625
kwh cost	$3,880
Total Monthly kWH	45,643
Monthly Cost	**$4,504.89**

Constants

Hours/ Month	730
kW Demand Cost	$10.00
kwh Cost	$0.085
Motor Efficiency	95.0%

Post Casing Coating

Head (ft)	98.5
Flow (gpm)	2396
Efficiency	79.8%
Hours Operation/month	721
BHP	75
kW (Assumes Motor Eff 95%)	58.6
kW Demand Charge	$586
kwh cost	$3,596
Total Monthly kWH	42311
Monthly Cost	**$4,182.94**

Pre - Post Mechanical Comparison

Monthly Savings	**$322**
Annual Savings	**$3,863**
5 Year Savings	**$19,317**
kW Demand Reduction	**3.9**
Monthly kwh Savings	**3331**
Yearly kwh Savings	**39977**

Post Mechanical

Head (ft)	99.5
Flow (gpm)	2444
Efficiency	86.6%
Hours Operation/month	707
BHP	71
kW (Assumes Motor Eff 95%)	55.7
kW Demand Charge	$557
kwh cost	$3,348
Total Monthly kWH	39385
Monthly Cost	**$3,904.55**

Pre - Post Impeller Comparison

Monthly Savings	**$278**
Annual Savings	**$3,341**
5 Year Savings	**$16,703**
kW Demand Reduction	**3.0**
Monthly kwh Savings	**2927**
Yearly kwh Savings	**35119**

Pre Mechanical to Post Interior *Coating Comparison*

Monthly Savings	**$600**
Annual Savings	**$7,204**
5 Year Savings	**$36,020**
kW Demand Reduction	**6.84**
Monthly kwh Savings	**6258**
Yearly kwh Savings	**75095**

Morgan No. 2 Cont'
20% Service Time

Pre Mechanical	
Head (ft)	98
Flow (gpm)	2368
Efficiency	73.6%
Hours Operation/month	146
BHP	80
kW (Assumes Motor Eff 95%)	62.5
kW Demand Charge	$625
kwh cost	$776
Total Monthly kWH	9,129
Monthly Cost	**$1,401.17**

Constants	
Hours/ Month	730
kW Demand Cost	$10.00
kwh Cost	$0.085
Motor Efficiency	95.0%

Post Casing Coating	
Head (ft)	98.5
Flow (gpm)	2396
Efficiency	79.8%
Hours Operation/month	144
BHP	75
kW (Assumes Motor Eff 95%)	58.6
kW Demand Charge	$586
kwh cost	$719
Total Monthly kWH	8462
Monthly Cost	**$1,305.76**

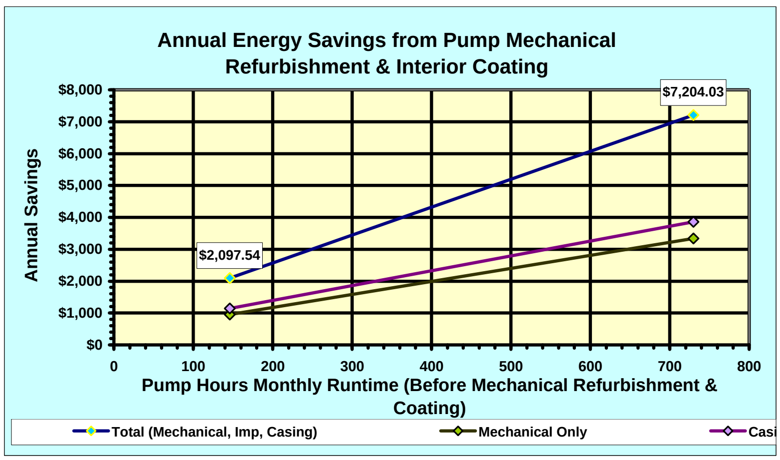
Pre - Post Internal Coating Comparison	
Monthly Savings	$95
Annual Savings	$1,145
5 Year Savings	$5,725
kW Demand Reduction	3.9
Monthly kwh Savings	666
Yearly kwh Savings	7995

Post Mechanical	
Head (ft)	99.5
Flow (gpm)	2444
Efficiency	86.6%
Hours Operation/month	141
BHP	71
kW (Assumes Motor Eff 95%)	55.7
kW Demand Charge	$557
kwh cost	$670
Total Monthly kWH	7877
Monthly Cost	**$1,226.38**

Pre - Post Mechanical Comparison	
Monthly Savings	$79
Annual Savings	$953
5 Year Savings	$4,763
kW Demand Reduction	3.0
Monthly kwh Savings	585
Yearly kwh Savings	7024

Pre Mechanical to Post Interior *Coating Comparison*	
Monthly Savings	$175
Annual Savings	$2,098
5 Year Savings	$10,488
kW Demand Reduction	6.84
Monthly kwh Savings	1252
Yearly kwh Savings	15019

Pump Hours of Operation Before Refurbishment & Interior Coating	Annual Savings Through Refurbishment & Interior Coatings
Total	
730	$7,204.03
146	$2,097.54
Casing Coating Only	
730	$3,863.42
146	$1,144.99
Mechanical Only	
730	$3,340.61
146	$952.55



Morgan Road BPS

Manufacturer's Pump and Motor Information

Man: ITT AC	Size: 10x8x12S	Siemens	RPM 1775
Type: 8100	Date: 1995	1LA03654SE42	Nom Eff: 94.5%
Model: 150	Imp: 11.9	HP:75	Type: RGZE3D
Speed: 1780 RPM	Serial: 1-7567-01-1 & 2	Date: 1995	

NYSERDA System Curve

Q (mgd)		H (feet)	
50.0%	1.8	80%	80.8
75.0%	2.7	88%	88.88
BEP	3.6	100%	101
125.0%	4.5	120%	121.2

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	kw/mg	Ns
0	0	143					
1000	1.44	135	60%	57	45	31.0	1421
1500	2.16	127	74%	65	51	23.6	1822
1750	2.52	123	79%	69	54	21.4	2016
2000	2.88	117	82%	72	57	19.6	2238
2250	3.24	110	84%	74	58	18.0	2486
2500	3.6	101	85%	75	59	16.4	2794
2750	3.96	90	84%	74	58	14.8	3195
3000	4.32	78	80%	74	58	13.4	3715

Pump No. 1 Field Curve 7/2/08 Initial Test

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
3021	4.35	25.57	12.34	56.81	19.28	72.2	2.36	5.77	75.6	77.2%	74.6	58.93	1785
2896	4.17	25.48	11.83	59.32	18.48	78.2	2.17	5.30	81.3	79.0%	75.3	59.41	1784
2472	3.56	25.23	10.10	66.36	15.78	95.0	1.58	3.87	97.3	80.0%	75.9	59.95	1783
1951	2.81	26.42	7.97	75.63	12.45	113.7	0.99	2.41	115.1	77.5%	73.2	57.77	1783
1139	1.64	27.86	4.65	84.5	7.27	130.8	0.34	0.82	131.3	61.1%	61.8	48.78	1786

Corrected to 1780 rpm

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mg
3012	4.34	75.1	77.2%	74.0	58	1780.0	13.4
2889	4.16	80.9	79.0%	74.8	59	1780.0	14.1
2468	3.55	97.0	80.0%	75.6	59	1780.0	16.7
1948	2.81	114.7	77.5%	72.8	57	1780.0	20.4
1135	1.63	130.4	61.1%	61.2	48	1780.0	29.4

Pump No. 1 Field Curve 9/2/08 2nd Initial Test

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
3007	4.33	23.97	12.28	55.17	19.19	72.1	2.34	5.72	75.4	76.9%	74.5	58.79	1781
2611	3.76	24.16	10.67	62.78	16.66	89.2	1.77	4.31	91.8	79.9%	75.7	59.76	1781
2389	3.44	24.16	9.76	66.52	15.25	97.9	1.48	3.61	100.0	79.8%	75.6	59.67	1782
2090	3.01	24.74	8.54	71.78	13.34	108.7	1.13	2.76	110.3	78.4%	74.2	58.60	1782
1694	2.44	25.29	6.92	77.37	10.81	120.3	0.74	1.82	121.4	74.1%	70.1	55.33	1784

Corrected to 1780 rpm

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mg
3005	4.33	75.4	76.9%	74.3	58	1780.0	13.5
2610	3.76	91.7	79.9%	75.6	59	1780.0	15.8
2386	3.44	99.8	79.8%	75.3	59	1780.0	17.2
2088	3.01	110.0	78.4%	74.0	58	1780.0	19.3
1691	2.43	120.8	74.1%	69.6	55	1780.0	22.5

Pump No. 1 Field Curve 9/19/08 Post Coating

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
3049	4.39	24.69	12.45	56.57	19.46	73.6	2.41	5.88	77.1	79.9%	74.3	58.65	1781
2674	3.85	24.89	10.92	64.32	17.06	91.1	1.85	4.52	93.8	83.8%	75.5	59.60	1781
2451	3.53	24.93	10.01	68.26	15.65	100.1	1.56	3.80	102.3	84.0%	75.4	59.51	1782
2139	3.08	25.51	8.74	73.98	13.65	112.0	1.19	2.89	113.7	83.0%	74.0	58.43	1782
1472	2.12	26.34	6.01	82.66	9.40	130.1	0.56	1.37	130.9	73.8%	66.0	52.09	1784

Corrected to 1780 rpm

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mg
3047	4.39	77.0	79.9%	74.2	58	1780.0	13.3
2672	3.85	93.6	83.8%	75.4	59	1780.0	15.4
2449	3.53	102.1	84.0%	75.1	59	1780.0	16.7
2136	3.08	113.4	83.0%	73.8	58	1780.0	18.8
1469	2.12	130.3	73.8%	65.5	51	1780.0	24.3

Pump No. 1 Field Curve 11/25/08 Post Coating & Mechanical (Pre Impeller Coating)

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
3125	4.5	23.46	12.77	54.7	19.94	72.2	2.53	6.18	75.8	79.0%	75.7	59.75	1783
2792	4.02	23.16	11.40	62.07	17.82	89.9	2.02	4.93	92.8	85.0%	77.0	60.78	1784
2542	3.66	22.96	10.38	66.42	16.22	100.4	1.67	4.09	102.8	85.7%	77.0	60.76	1783
2167	3.12	24	8.85	73.82	13.83	115.1	1.22	2.97	116.8	85.2%	75.0	59.23	1784
1368	1.97	25.58	5.59	84.01	8.73	135.0	0.48	1.18	135.7	71.9%	65.2	51.48	1786

Corrected to 1780 rpm

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mg
3120	4.49	75.6	79.0%	75.3	59	1780.0	13.2
2785	4.01	92.4	85.0%	76.5	60	1780.0	15.0
2537	3.65	102.5	85.7%	76.6	60	1780.0	16.5
2162	3.11	116.3	85.2%	74.5	59	1780.0	18.8
1363	1.96	134.8	71.9%	64.6	51	1780.0	25.8

Pump No. 1 Field Curve 1/27/09 Post Impeller Coating

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
3118	4.49	23.03	12.74	52.73	19.90	68.6	2.52	6.15	72.2	80.4%	70.7	55.85	1783
2771	3.99	22.72	11.32	60.1	17.68	86.3	1.99	4.86	89.2	85.7%	72.9	57.52	1784
2493	3.59	22.55	10.18	65.23	15.91	98.6	1.61	3.93	100.9	86.7%	73.3	57.87	1783
2146	3.09	23.41	8.77	72.11	13.69	112.5	1.19	2.91	114.2	85.9%	72.0	56.87	1784
1417	2.04	24.83	5.79	82.36	9.04	132.9	0.52	1.27	133.6	75.8%	63.0	49.76	1786

Corrected to 1780 rpm

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mg
3113	4.48	72.0	80.4%	70.4	55	1780.0	12.3
2765	3.98	88.8	85.7%	72.4	57	1780.0	14.3
2489	3.58	100.6	86.7%	72.9	57	1780.0	16.0
2141	3.08	113.7	85.9%	71.6	56	1780.0	18.2
1412	2.03	132.7	75.8%	62.4	49	1780.0	24.1

Pump No. 1 Field Curve 3/14/09 30 Day Test

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
2944	4.24	22.84	12.03	57.09	18.79	79.1	2.25	5.48	82.4	84.4%	72.6	57.29	1786
2563	3.69	22.74	10.47	64.64	16.35	96.8	1.70	4.15	99.2	86.8%	74.0	58.38	1786
2493	3.59	22.73	10.18	65.87	15.91	99.7	1.61	3.93	102.0	86.9%	73.9	58.35	1785
2167	3.12	23.39	8.85	72.12	13.83	112.6	1.22	2.97	114.3	86.0%	72.7	57.40	1785
1451	2.09	24.64	5.93	82.19	9.26	132.9	0.55	1.33	133.7	77.0%	63.7	50.28	1786

Corrected to 1780 rpm

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mg
2935	4.23	81.8	84.4%	71.8	56	1780.0	13.4
2554	3.68	98.6	86.8%	73.2	57	1780.0	15.6
2486	3.58	101.4	86.9%	73.3	58	1780.0	16.1
2161	3.11	113.7	86.0%	72.1	57	1780.0	18.2
1447	2.08	132.8	77.0%	63.1	50	1780.0	23.8

Pump No. 1 Field Curve 5/27/09 90 Day Test

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
3049	4.39	25.02	12.45	56.19	19.46	72.0	2.41	5.88	75.5	82.0%	70.9	55.96	1785
2729	3.93	24.71	11.15	63.03	17.42	88.5	1.93	4.71	91.3	86.5%	72.8	57.45	1785
2479	3.57	24.58	10.13	67.54	15.82	99.2	1.59	3.89	101.5	86.8%	73.2	57.80	1784
2153	3.1	25.39	8.79	74.01	13.74	112.3	1.20	2.93	114.0	86.1%	72.0	56.81	1784
1757	2.53	26.28	7.18	80.83	11.21	126.0	0.80	1.95	127.2	83.1%	67.9	53.62	1783

Corrected to 1780 rpm

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mg
3040	4.38	75.1	82.0%	70.3	55	1780.0	12.6
2722	3.92	90.8	86.5%	72.2	57	1780.0	14.5
2474	3.56	101.1	86.8%	72.7	57	1780.0	16.0
2148	3.09	113.5	86.1%	71.5	56	1780.0	18.1
1754	2.53	126.7	83.1%	67.6	53	1780.0	21.0

Pump No. 1 Field Curve 7/28/09 6 Month Test

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
2875	4.14	22.69	11.74	57.31	18.35	80.0	2.14	5.23	83.1	83.3%	72.4	57.16	1785
2583	3.72	22.54	10.55	63.07	16.49	93.6	1.73	4.22	96.1	85.6%	73.3	57.85	1785
2340	3.37	22.34	9.56	67.18	14.94	103.6	1.42	3.46	105.6	85.4%	73.1	57.73	1784
1931	2.78	23.26	7.89	75.11	12.32	119.8	0.97	2.36	121.2	84.0%	70.3	55.53	1784

Corrected to 1780 rpm

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mg
2867	4.13	82.6	83.3%	71.8	56	1780.0	13.7
2576	3.71	95.6	85.6%	72.7	57	1780.0	15.4
2335	3.36	105.2	85.4%	72.6	57	1780.0	17.0
1926	2.77	120.6	84.0%	69.9	55	1780.0	19.8

Pump No. 1 Field Curve 6/14/10

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
2979	4.29	25.11	12.17	57.02	19.01	73.7	2.30	5.61	77.0	81.0%	71.5	56.46	1784
2646	3.81	24.95	10.81	63.88	16.89	89.9	1.81	4.43	92.5	84.9%	72.9	57.51	1784
2118	3.05	25.63	8.65	74.1	13.52	112.0	1.16	2.84	113.6	84.3%	72.1	56.90	1784
1611	2.32	26.53	6.58	82.3	10.28	128.8	0.67	1.64	129.7	79.2%	66.6	52.60	1784

Corrected to 1780 rpm

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mg
2972	4.28	76.7	81.0%	71.0	56	1780.0	13.0
2640	3.80	92.1	84.9%	72.4	57	1780.0	14.9
2113	3.04	113.1	84.3%	71.6	56	1780.0	18.5
1608	2.32	129.3	79.2%	66.3	52	1781.0	22.5

Pump No. 2 Field Curve 7/2/08 Initial Test

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
3007	4.33	25.94	12.28	55.33	19.19	67.9	2.34	5.72	71.3	69.2%	78.2	61.74	1782
2750	3.96	25.79	11.23	60.67	17.55	80.6	1.96	4.78	83.4	72.9%	79.5	62.72	1780
2403	3.46	25.37	9.82	66.2	15.33	94.3	1.50	3.65	96.5	73.6%	79.5	62.78	1780
1931	2.78	26.79	7.89	74.85	12.32	111.0	0.97	2.36	112.4	71.5%	76.7	60.54	1780
1139	1.64	28.04	4.65	83.91	7.27	129.1	0.34	0.82	129.5	56.6%	65.8	51.96	1784

Corrected to 1780 rpm

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mg
3004	4.33	71.1	69.2%	77.9	61	1780.0	14.2
2750	3.96	83.4	72.9%	79.5	62	1780.0	15.8
2403	3.46	96.5	73.6%	79.5	62	1780.0	18.0
1931	2.78	112.4	71.5%	76.7	60	1780.0	21.7
1136	1.64	129.0	56.6%	65.4	51	1780.0	31.4

Pump No. 2 Field Curve 9/2/08 Post Casing Coating

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
2951	4.25	24.41	12.06	55.22	18.84	71.2	2.26	5.51	74.4	75.0%	73.9	58.37	1781
2583	3.72	24.48	10.55	62.8	16.49	88.5	1.73	4.22	91.0	79.2%	75.0	59.18	1780
2375	3.42	24.46	9.70	66.51	15.16	97.1	1.46	3.57	99.2	79.8%	74.6	58.86	1779
2049	2.95	25.05	8.37	72.8	13.07	110.3	1.09	2.65	111.9	79.2%	73.1	57.67	1778
1569	2.26	25.5	6.41	79.75	10.02	125.3	0.64	1.56	126.2	74.0%	67.6	53.40	1779

Corrected to 1780 rpm

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mg
2950	4.25	74.3	75.0%	73.8	58	1780.0	13.6
2583	3.72	91.0	79.2%	75.0	59	1780.0	15.8
2376	3.42	99.4	79.8%	74.7	59	1780.0	17.1
2051	2.95	112.1	79.2%	73.3	58	1780.0	19.5
1570	2.26	126.4	74.0%	67.8	53	1780.0	23.5

Pump No. 2 Field Curve 11/25/08 Post Casing Coating & Mechanical Work

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
3049	4.39	23.86	12.45	54.2	19.46	70.1	2.41	5.88	73.6	81.8%	69.3	54.68	1785
2708	3.9	23.49	11.06	61.07	17.28	86.8	1.90	4.64	89.5	85.8%	71.4	56.38	1784
2465	3.55	23.33	10.07	65.43	15.73	97.3	1.57	3.84	99.5	86.6%	71.6	56.49	1784
2021	2.91	24.31	8.26	74.01	12.90	114.8	1.06	2.58	116.3	85.2%	69.7	55.00	1785
1396	2.01	25.47	5.70	82.66	8.91	132.1	0.50	1.23	132.8	75.6%	61.9	48.89	1786

Corrected to 1780 rpm

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mg
3040	4.38	73.1	81.8%	68.7	54	1780.0	12.3
2702	3.89	89.1	85.8%	70.9	56	1780.0	14.3
2460	3.54	99.1	86.6%	71.1	56	1780.0	15.8
2015	2.90	115.7	85.2%	69.1	54	1780.0	18.7
1391	2.00	131.9	75.6%	61.3	48	1780.0	24.0

Pump No. 2 Field Curve 1/27/09 30 Day Test

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
3076	4.43	22.98	12.57	52.71	19.63	68.7	2.45	5.99	72.2	81.0%	69.2	54.65	1785
2736	3.94	22.38	11.18	59.92	17.46	86.7	1.94	4.73	89.5	86.6%	71.4	56.39	1784
2431	3.5	21.92	9.93	64.59	15.51	98.6	1.53	3.74	100.8	86.3%	71.7	56.61	1784
2153	3.1	22.6	8.79	70.07	13.74	109.7	1.20	2.93	111.4	85.5%	70.8	55.90	1785
1604	2.31	23.73	6.55	78.94	10.24	127.5	0.67	1.63	128.5	80.1%	65.0	51.28	1786

Corrected to 1780 rpm

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mg
3068	4.42	71.8	81.0%	68.6	54	1780.0	12.2
2730	3.93	89.1	86.6%	71.0	56	1780.0	14.2
2425	3.49	100.3	86.3%	71.2	56	1780.0	16.0
2147	3.09	110.8	85.5%	70.2	55	1780.0	17.8
1599	2.30	127.6	80.1%	64.3	50	1780.0	21.9

Pump No. 2 Field Curve 3/14/09 90 Day Test

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
2986	4.3	23.14	12.20	55.17	19.06	74.0	2.31	5.64	77.3	83.1%	70.1	55.36	1786
2764	3.98	23.12	11.29	59.9	17.64	85.0	1.98	4.83	87.8	85.8%	71.5	56.41	1786
2444	3.52	22.96	9.99	65.78	15.60	98.9	1.55	3.78	101.1	86.9%	71.9	56.75	1786
2181	3.14	23.58	8.91	70.95	13.92	109.4	1.23	3.01	111.2	86.4%	70.9	55.94	1785
1549	2.23	24.53	6.33	80.78	9.88	129.9	0.62	1.52	130.8	79.9%	64.0	50.56	1787

Corrected to 1780 rpm

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mg
2976	4.29	76.8	83.1%	69.4	55	1780.0	12.7
2755	3.97	87.2	85.8%	70.7	56	1780.0	14.0
2436	3.51	100.5	86.9%	71.2	56	1780.0	15.9
2174	3.13	110.6	86.4%	70.3	55	1780.0	17.6
1543	2.22	129.8	79.9%	63.3	50	1780.0	22.4

Pump No. 2 Field Curve 5/27/09 6 Month Test

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
2986	4.3	25.18	12.20	56.91	19.06	73.3	2.31	5.64	76.6	83.1%	69.6	54.91	1784
2674	3.85	24.87	10.92	63.09	17.06	88.3	1.85	4.52	91.0	86.2%	71.2	56.23	1783
2438	3.51	24.69	9.96	67.25	15.56	98.3	1.54	3.76	100.5	86.6%	71.4	56.38	1783
2111	3.04	25.46	8.62	73.66	13.47	111.3	1.15	2.82	113.0	85.9%	70.1	55.36	1783
1563	2.25	26.53	6.38	82.39	9.97	129.0	0.63	1.54	129.9	80.3%	63.8	50.39	1785

Corrected to 1780 rpm

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mg
2979	4.29	76.3	83.1%	69.1	54	1780.0	12.6
2669	3.84	90.7	86.2%	70.9	56	1780.0	14.5
2433	3.50	100.2	86.6%	71.1	56	1780.0	15.9
2108	3.03	112.6	85.9%	69.8	55	1780.0	18.1
1558	2.24	129.2	80.3%	63.3	50	1780.0	22.2

Pump No. 2 Field Curve 7/28/09 6 Month Test (2nd Test)

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
2833	4.08	23.02	11.57	58.17	18.08	81.2	2.08	5.08	84.2	84.4%	71.4	56.35	1781
2403	3.46	22.73	9.82	65.9	15.33	99.7	1.50	3.65	101.9	86.7%	71.3	56.28	1781
2326	3.35	22.65	9.50	67.05	14.85	102.6	1.40	3.42	104.6	86.4%	71.1	56.12	1781
1701	2.45	23.96	6.95	78.31	10.86	125.5	0.75	1.83	126.6	82.4%	66.0	52.10	1783

Corrected to 1780 rpm

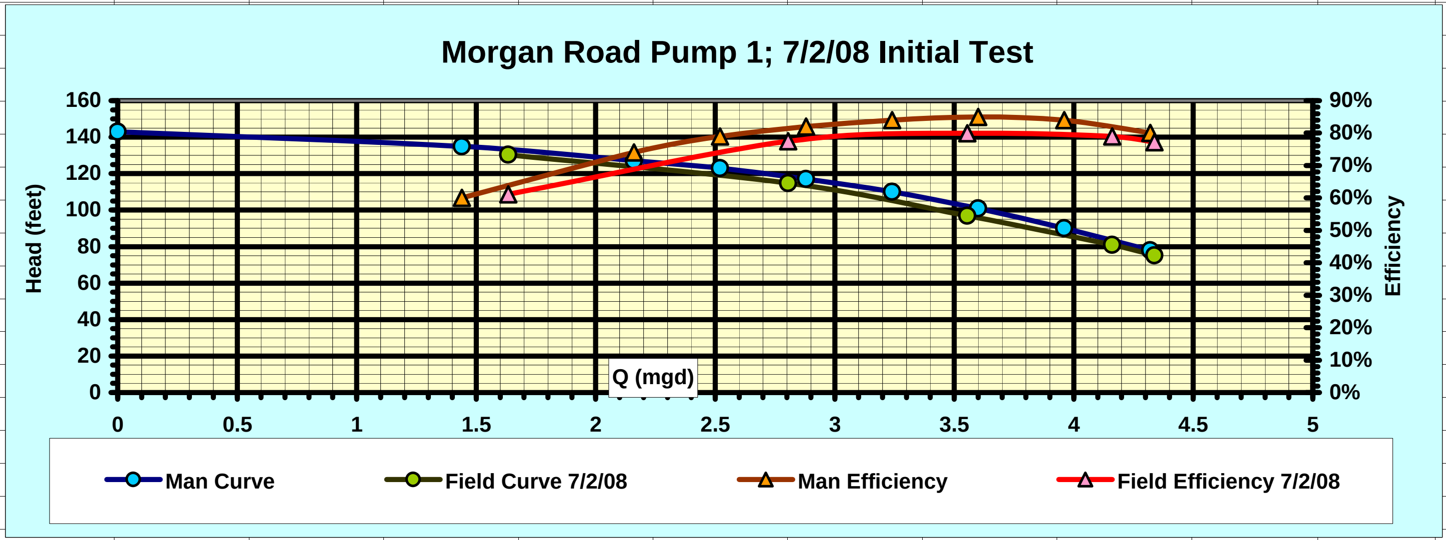
Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mg
2832	4.08	84.1	84.4%	71.3	56	1780.0	13.7
2401	3.46	101.8	86.7%	71.2	56	1780.0	16.2
2325	3.35	104.5	86.4%	71.0	56	1780.0	16.6
1699	2.45	126.2	82.4%	65.7	52	1780.0	21.1

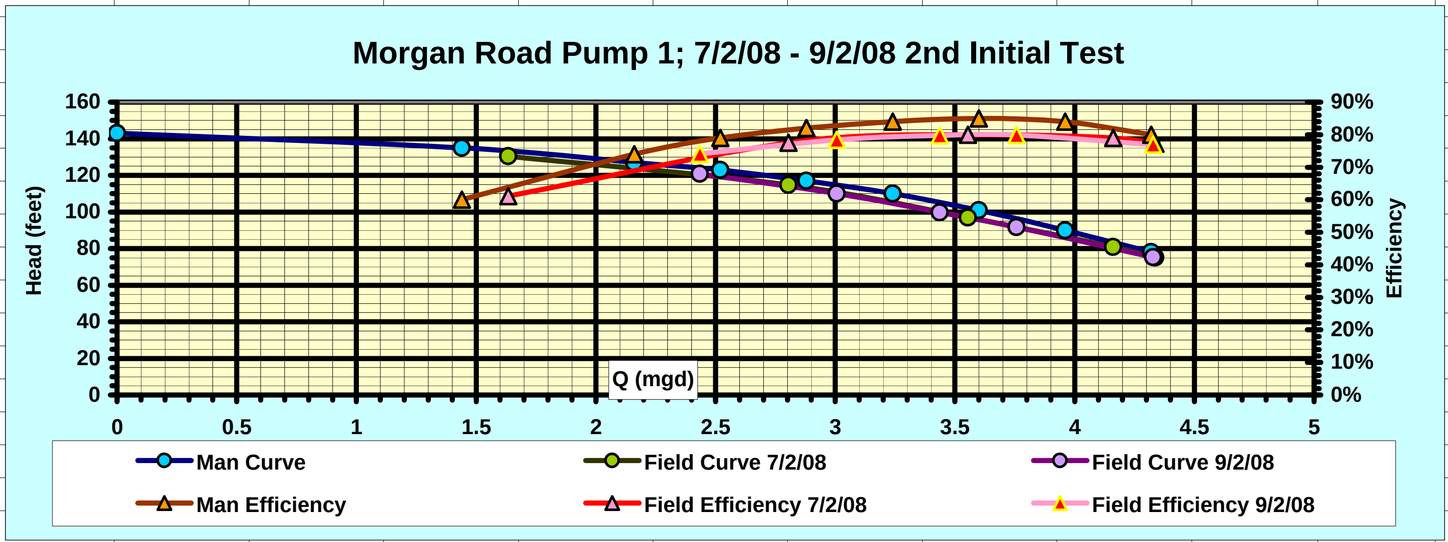
Pump No. 2 Field Curve 6/14/10

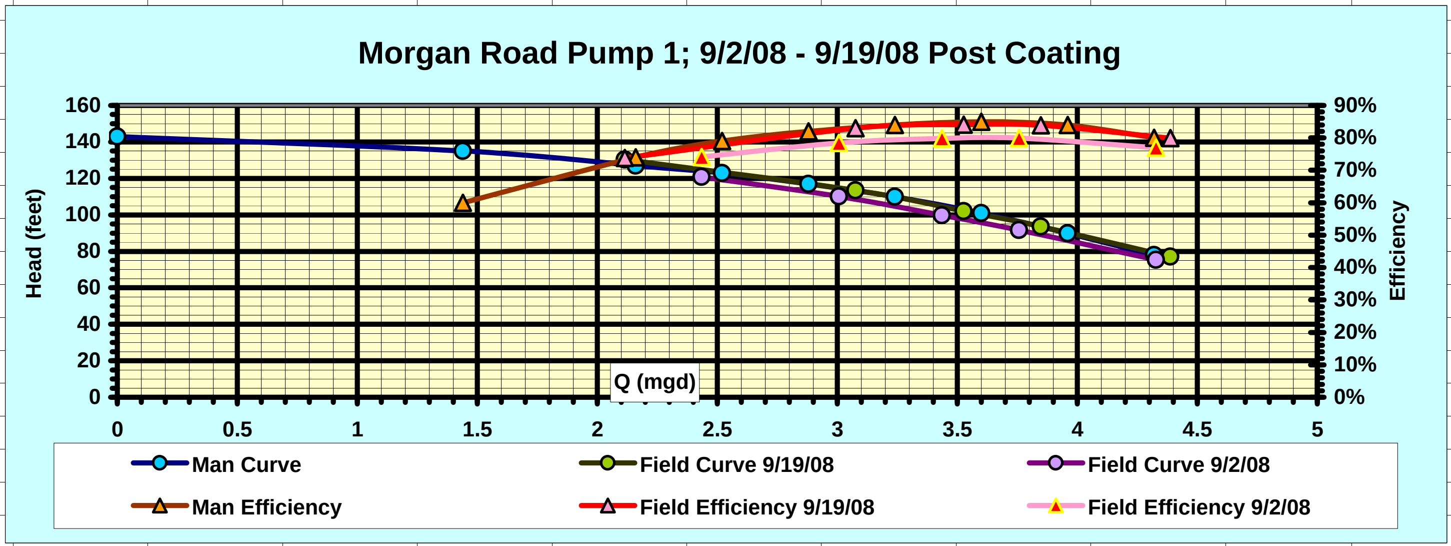
Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
2972	4.28	25.21	12.14	57.05	18.97	73.6	2.29	5.59	76.8	81.3%	71.0	56.04	1782
2625	3.78	24.99	10.72	63.89	16.75	89.9	1.79	4.36	92.4	85.7%	71.5	56.45	1782
2458	3.54	24.87	10.04	66.83	15.69	96.9	1.57	3.82	99.2	85.9%	71.6	56.56	1782
2097	3.02	25.64	8.57	73.81	13.38	111.3	1.14	2.78	112.9	84.9%	70.4	55.61	1781
1861	2.68	26.08	7.60	77.9	11.88	119.8	0.90	2.19	121.1	0.8	68.4	54.03	1781

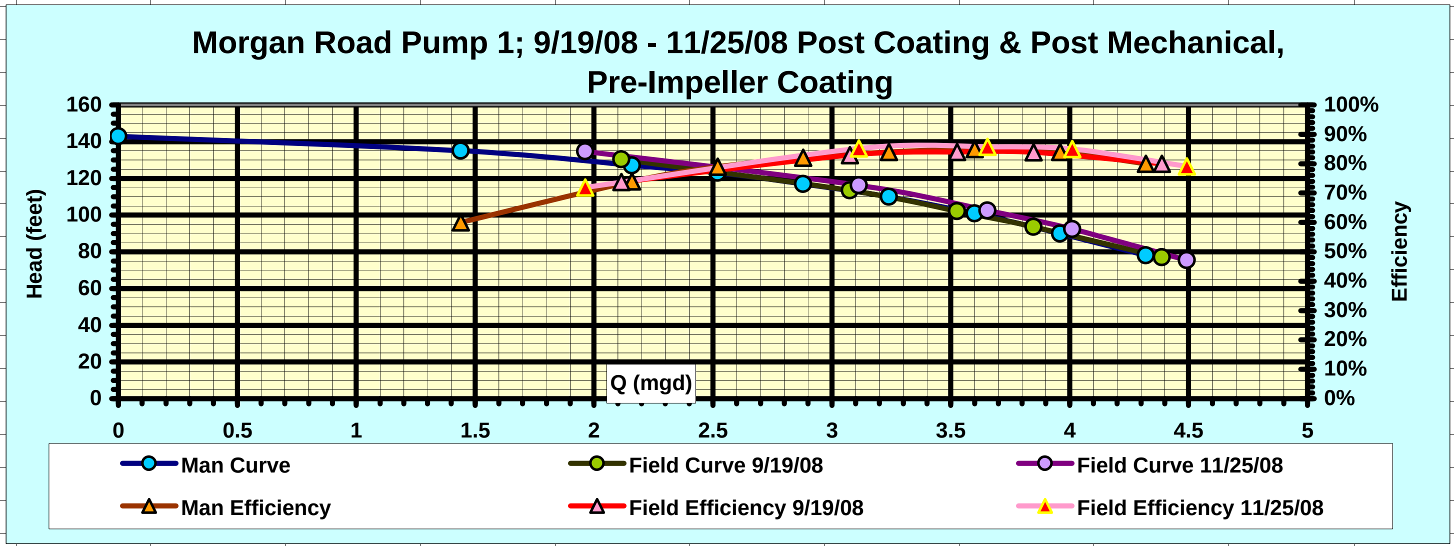
Corrected to 1780 rpm

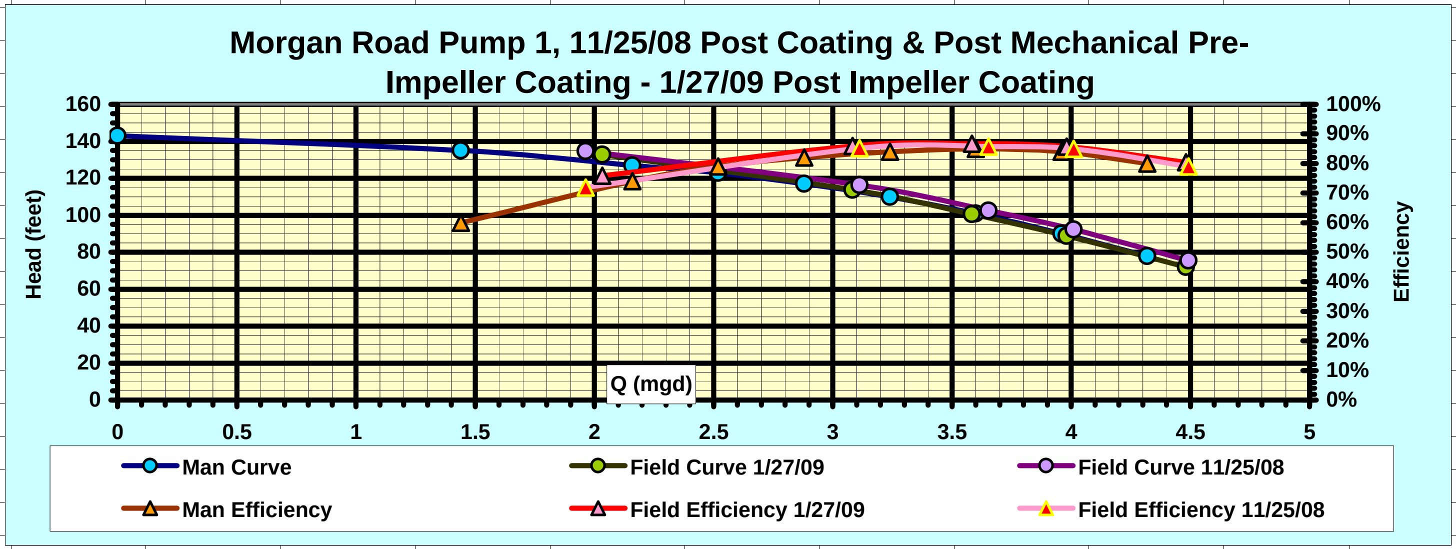
Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mg
2969	4.28	76.7	81.3%	70.8	56	1780.0	13.0
2624	3.78	92.3	85.7%	71.4	56	1781.0	14.8
2458	3.54	99.2	85.9%	71.6	56	1782.0	15.9
2100	3.02	113.2	84.9%	70.7	56	1783.0	18.4
1864	2.68	121.5	83.1%	68.8	54	1784.0	20.1


Morgan Road Pump 1; 7/2/08 Initial Test
Head (feet)
Efficiency
Q (mgd)
160
140
120
100
80
60
40
20
0
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Man Curve
Field Curve 7/2/08
Man Efficiency
Field Efficiency 7/2/08

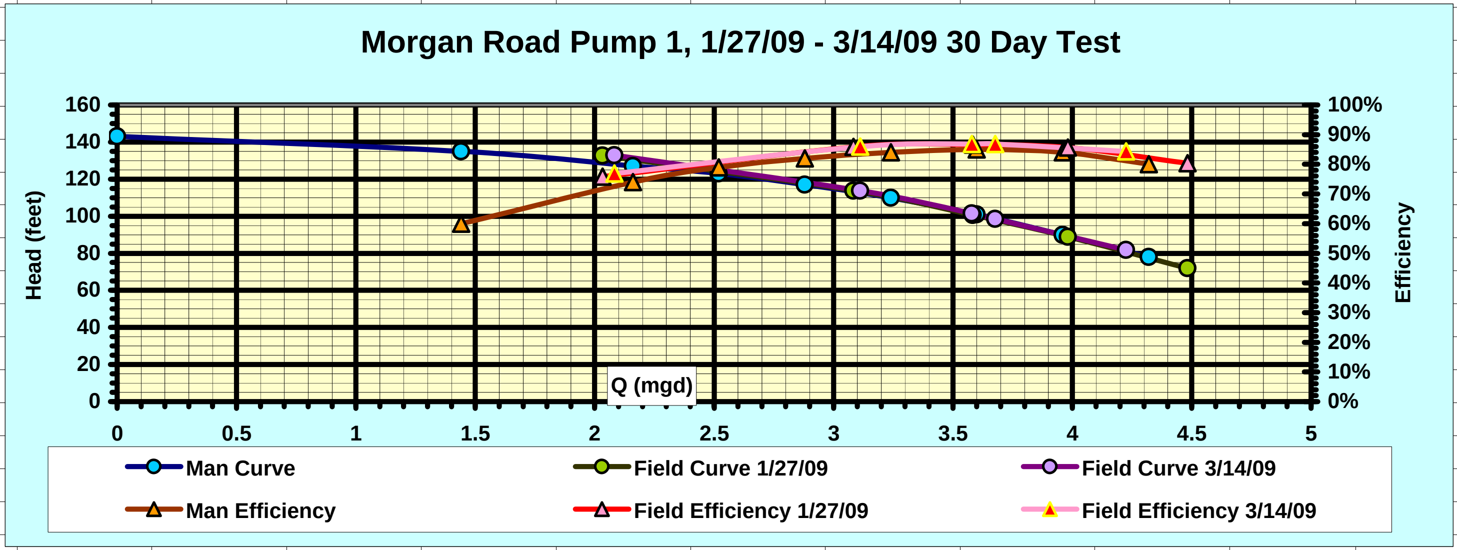

Morgan Road Pump 1; 7/2/08 - 9/2/08 2nd Initial Test
Head (feet)
Efficiency
Q (mgd)
160
140
120
100
80
60
40
20
0
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Man Curve
Field Curve 7/2/08
Field Curve 9/2/08
Man Efficiency
Field Efficiency 7/2/08
Field Efficiency 9/2/08


Morgan Road Pump 1; 9/2/08 - 9/19/08 Post Coating
Head (feet)
Efficiency
Q (mgd)
160
140
120
100
80
60
40
20
0
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Man Curve
Field Curve 9/19/08
Field Curve 9/2/08
Man Efficiency
Field Efficiency 9/19/08
Field Efficiency 9/2/08

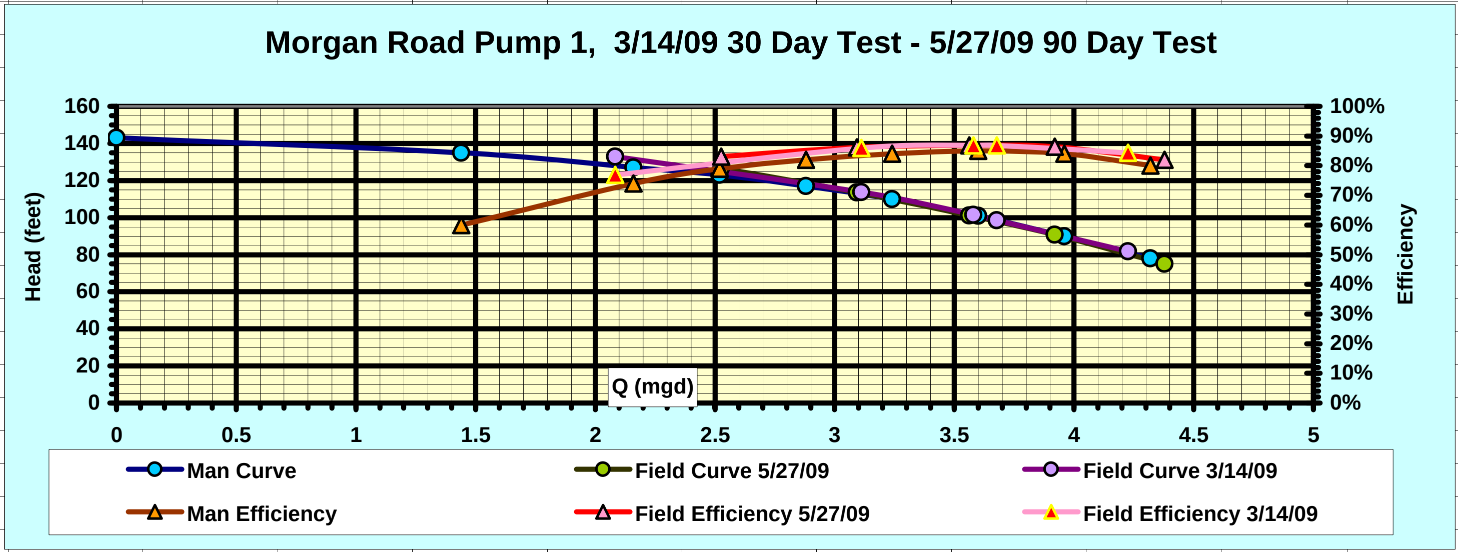

Morgan Road Pump 1; 9/19/08 - 11/25/08 Post Coating & Post Mechanical, Pre-Impeller Coating
Head (feet)
Efficiency
Q (mgd)
160
140
120
100
80
60
40
20
0
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Man Curve
Field Curve 9/19/08
Field Curve 11/25/08
Man Efficiency
Field Efficiency 9/19/08
Field Efficiency 11/25/08



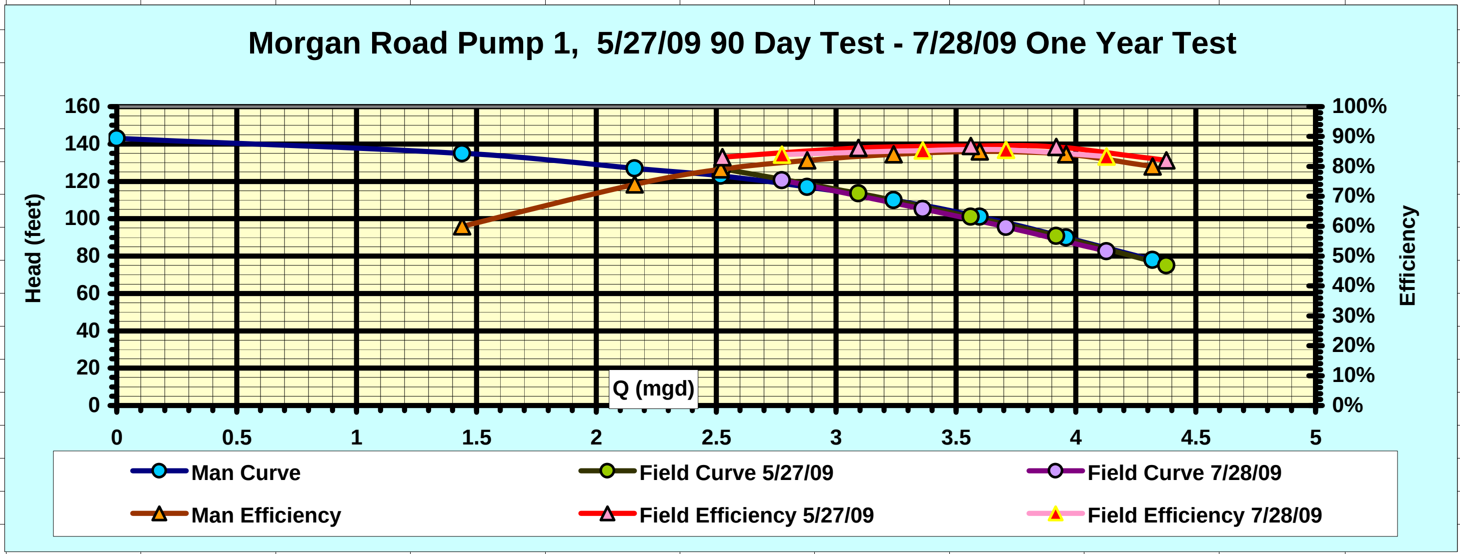
Morgan Road Pump 1, 11/25/08 Post Coating & Post Mechanical Pre-Impeller Coating - 1/27/09 Post Impeller Coating
Head (feet)
Efficiency
Q (mgd)
160
140
120
100
80
60
40
20
0
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Man Curve
Field Curve 1/27/09
Field Curve 11/25/08
Man Efficiency
Field Efficiency 1/27/09
Field Efficiency 11/25/08



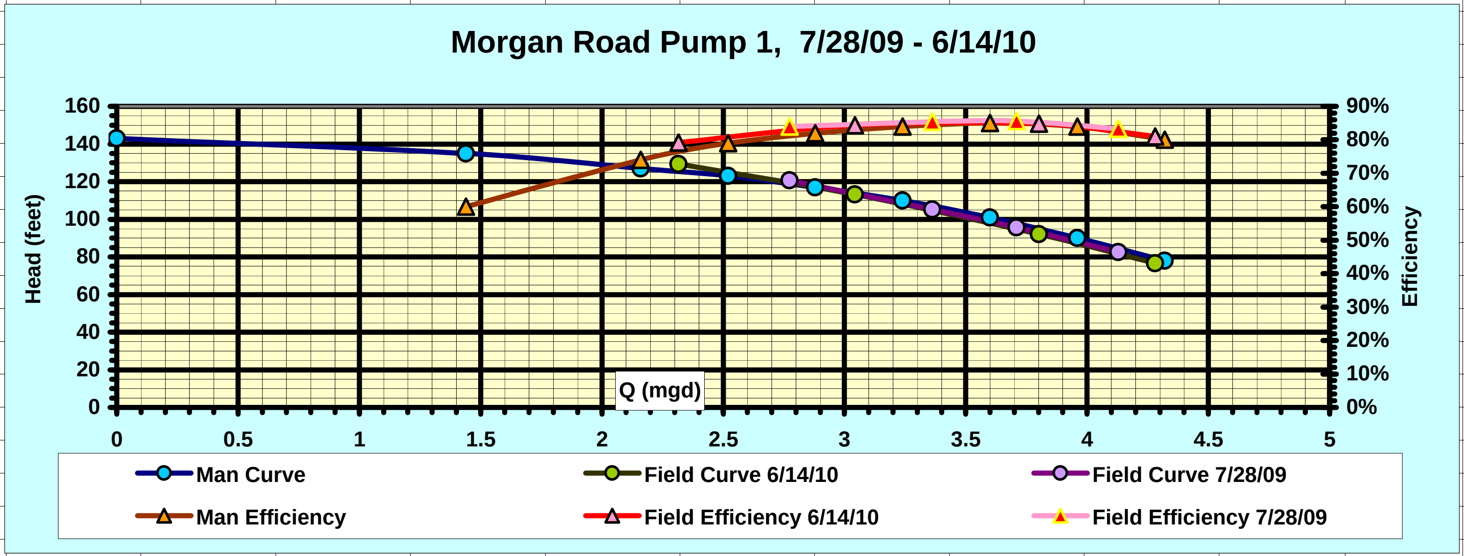
Morgan Road Pump 1, 1/27/09 - 3/14/09 30 Day Test
Head (feet)
Efficiency
Q (mgd)
160
140
120
100
80
60
40
20
0
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Man Curve
Field Curve 1/27/09
Field Curve 3/14/09
Man Efficiency
Field Efficiency 1/27/09
Field Efficiency 3/14/09



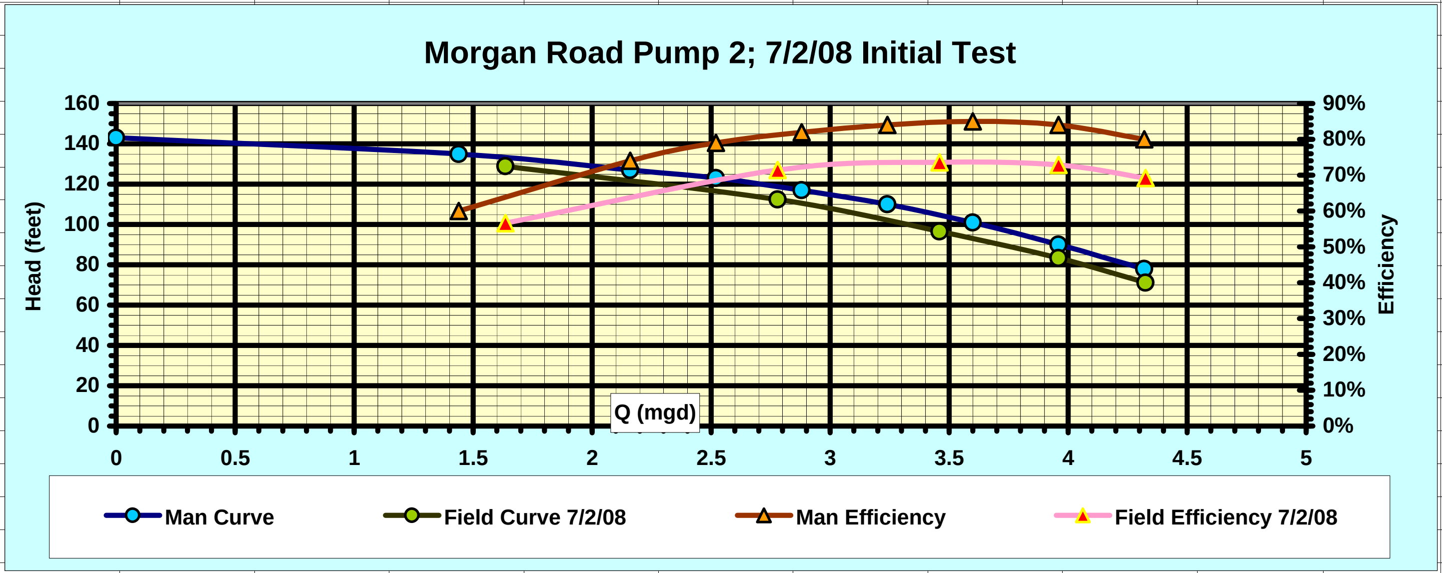
Morgan Road Pump 1, 3/14/09 30 Day Test - 5/27/09 90 Day Test
Head (feet)
Efficiency
Q (mgd)
Man Curve
Field Curve 5/27/09
Field Curve 3/14/09
Man Efficiency
Field Efficiency 5/27/09
Field Efficiency 3/14/09



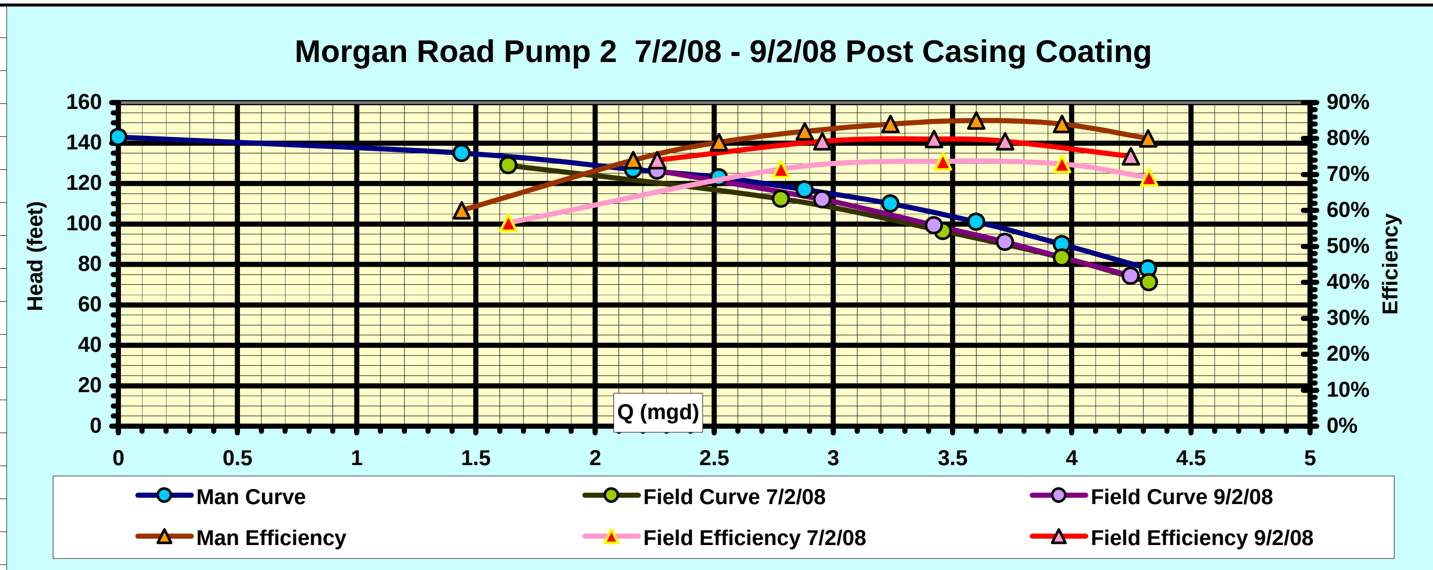
Morgan Road Pump 1, 5/27/09 90 Day Test - 7/28/09 One Year Test
Head (feet)
Efficiency
Q (mgd)
Man Curve
Field Curve 5/27/09
Field Curve 7/28/09
Man Efficiency
Field Efficiency 5/27/09
Field Efficiency 7/28/09

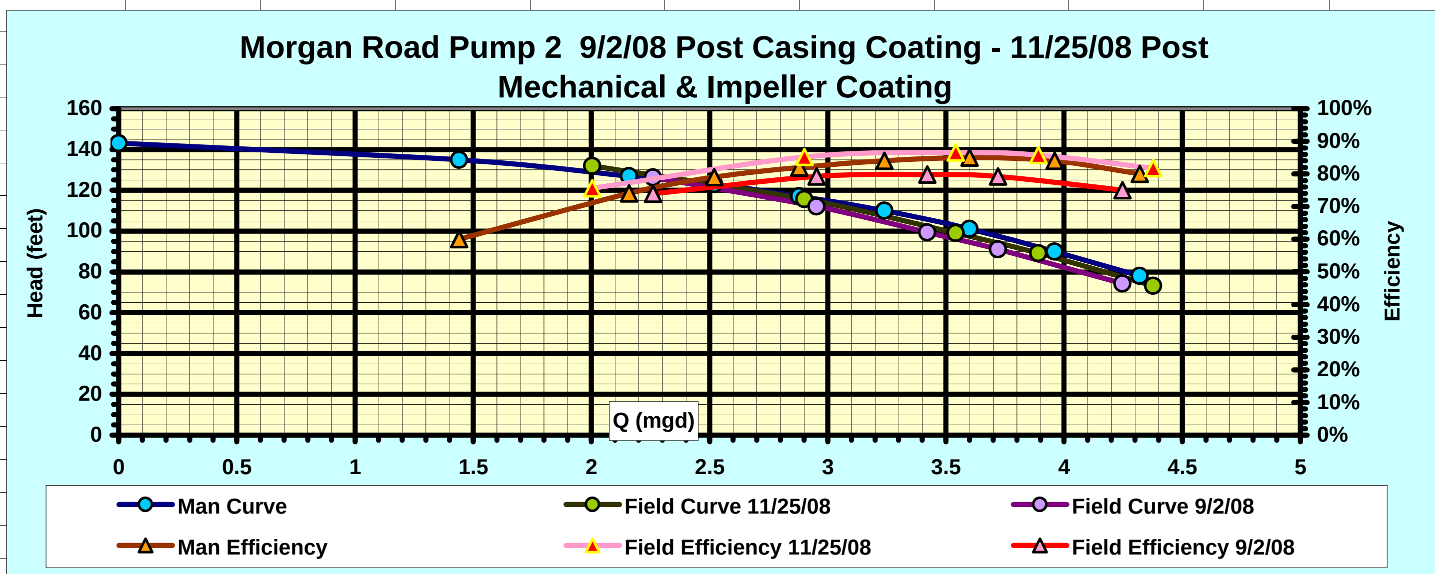


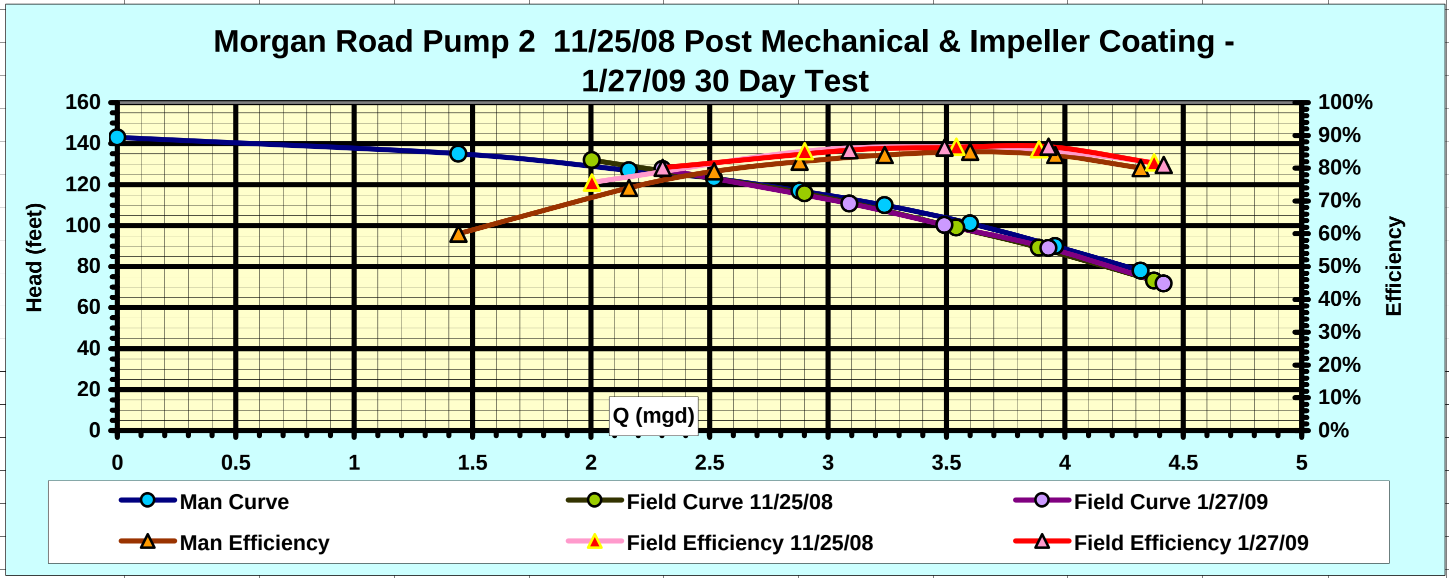
Morgan Road Pump 1, 7/28/09 - 6/14/10
Head (feet)
Efficiency
Q (mgd)
160
140
120
100
80
60
40
20
0
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Man Curve
Field Curve 6/14/10
Field Curve 7/28/09
Man Efficiency
Field Efficiency 6/14/10
Field Efficiency 7/28/09

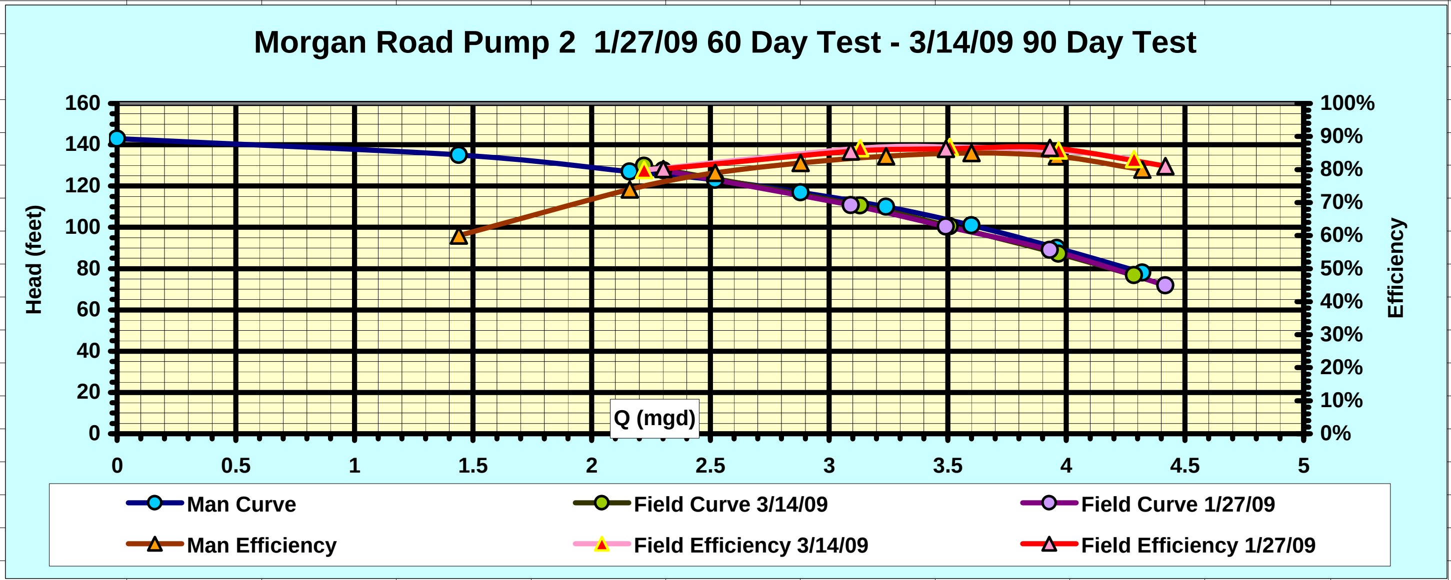


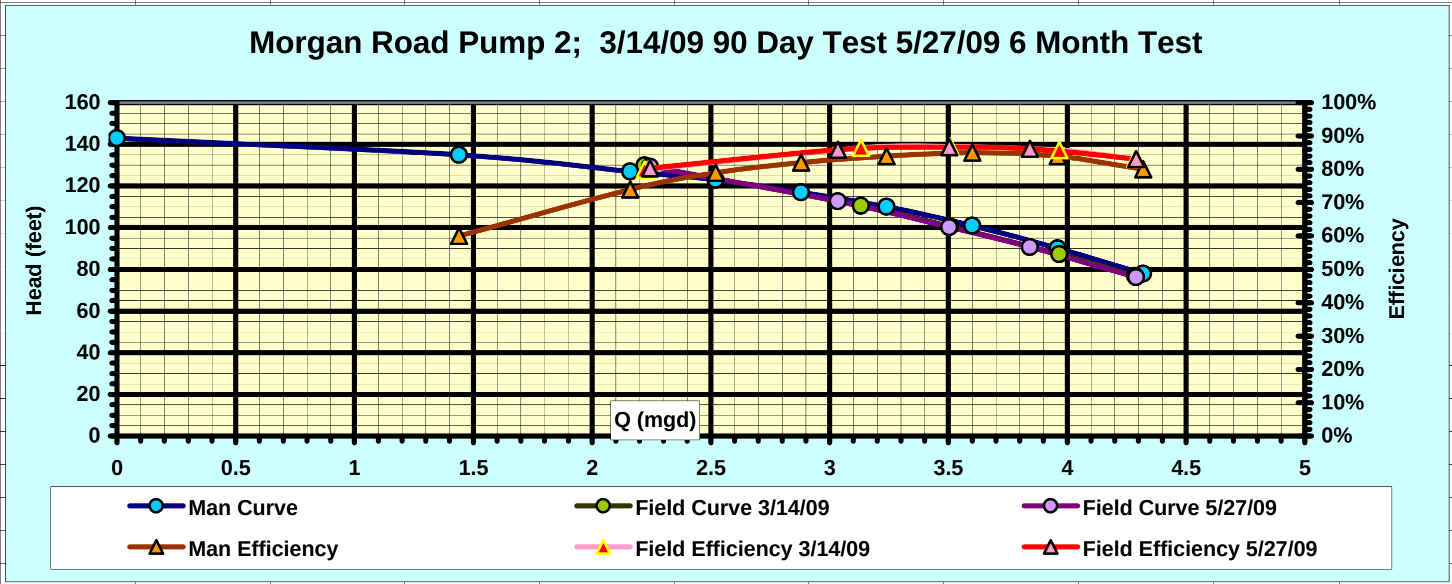
Morgan Road Pump 2; 7/2/08 Initial Test
Head (feet)
Efficiency
Q (mgd)
160
140
120
100
80
60
40
20
0
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Man Curve
Field Curve 7/2/08
Man Efficiency
Field Efficiency 7/2/08


Morgan Road Pump 2 7/2/08 - 9/2/08 Post Casing Coating
Head (feet)
Efficiency
Q (mgd)
160
140
120
100
80
60
40
20
0
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Man Curve
Field Curve 7/2/08
Field Curve 9/2/08
Man Efficiency
Field Efficiency 7/2/08
Field Efficiency 9/2/08

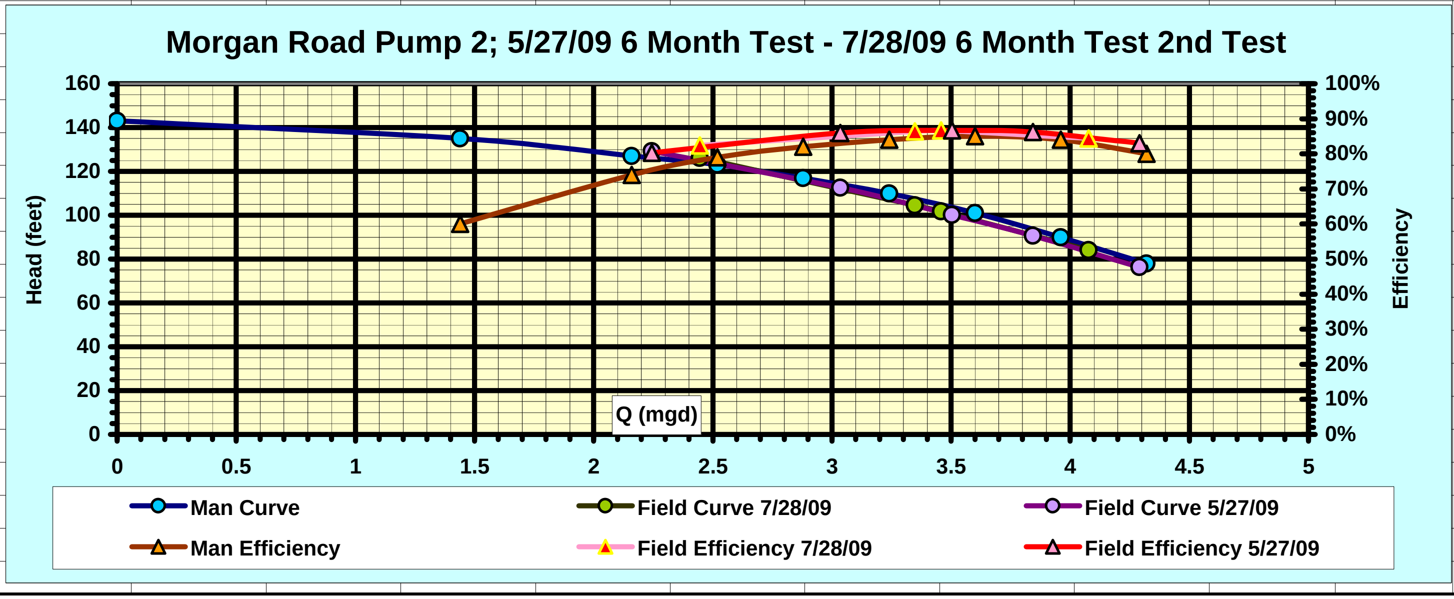

Morgan Road Pump 2 9/2/08 Post Casing Coating - 11/25/08 Post Mechanical & Impeller Coating
Head (feet)
Efficiency
Q (mgd)
160
140
120
100
80
60
40
20
0
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Man Curve
Field Curve 11/25/08
Field Curve 9/2/08
Man Efficiency
Field Efficiency 11/25/08
Field Efficiency 9/2/08


Morgan Road Pump 2 11/25/08 Post Mechanical & Impeller Coating - 1/27/09 30 Day Test
Head (feet)
Efficiency
Q (mgd)
0
20
40
60
80
100
120
140
160
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Man Curve
Field Curve 11/25/08
Field Curve 1/27/09
Man Efficiency
Field Efficiency 11/25/08
Field Efficiency 1/27/09

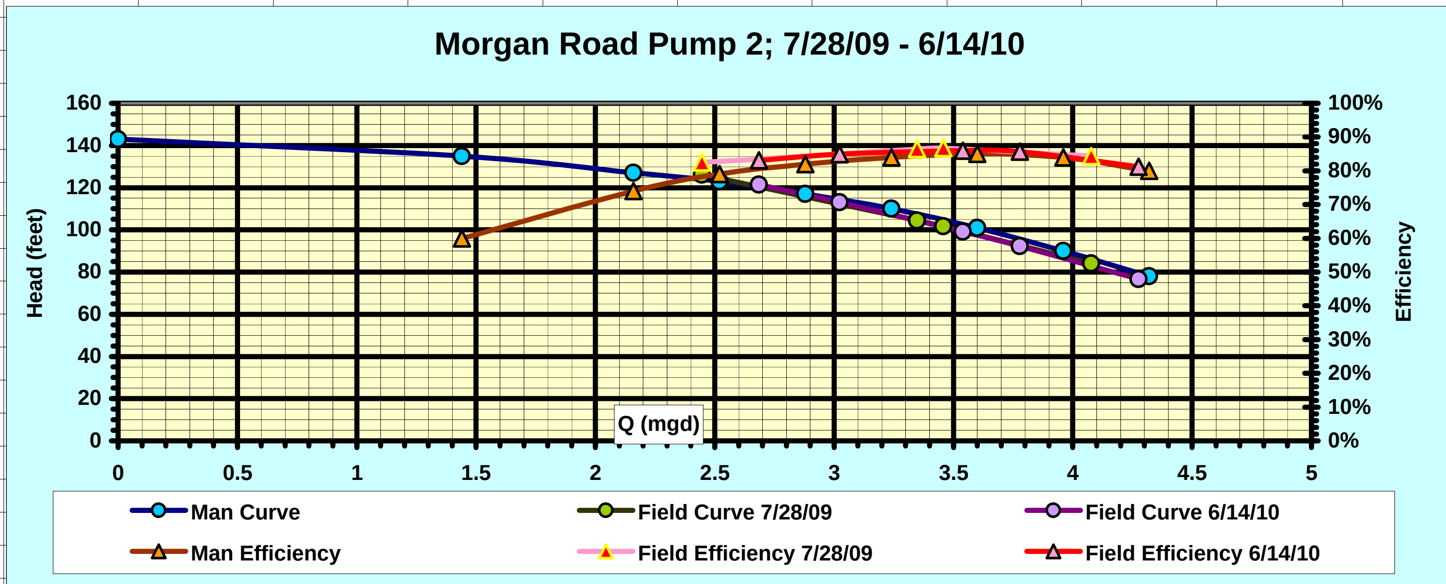

Morgan Road Pump 2 1/27/09 60 Day Test - 3/14/09 90 Day Test
Head (feet)
Efficiency
Q (mgd)
0
20
40
60
80
100
120
140
160
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Man Curve
Field Curve 3/14/09
Field Curve 1/27/09
Man Efficiency
Field Efficiency 3/14/09
Field Efficiency 1/27/09



Morgan Road Pump 2; 3/14/09 90 Day Test 5/27/09 6 Month Test
Head (feet)
Efficiency
Q (mgd)
160
140
120
100
80
60
40
20
0
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Man Curve
Field Curve 3/14/09
Field Curve 5/27/09
Man Efficiency
Field Efficiency 3/14/09
Field Efficiency 5/27/09



Morgan Road Pump 2; 5/27/09 6 Month Test - 7/28/09 6 Month Test 2nd Test
Head (feet)
Efficiency
Q (mgd)
160
140
120
100
80
60
40
20
0
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Man Curve
Field Curve 7/28/09
Field Curve 5/27/09
Man Efficiency
Field Efficiency 7/28/09
Field Efficiency 5/27/09



Morgan Road Pump 2; 7/28/09 - 6/14/10
Head (feet)
Efficiency
Q (mgd)
160
140
120
100
80
60
40
20
0
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Man Curve
Field Curve 7/28/09
Field Curve 6/14/10
Man Efficiency
Field Efficiency 7/28/09
Field Efficiency 6/14/10

Riga Pump No. 1
Energy Efficiency Cost Calculator

Continuous Service

Pre Mechanical

Head (ft)	108.6
Flow (gpm)	1567
Effieicny	75.4%
Hours Operation/month	730
BHP	57
kW (Assumes Motor Eff 95%)	44.8
kW Demand Charge	$448
kwh cost	$2,777
Total Monthly kWH	32,672
Monthly Cost	**$3,224.64**

Constants

Hours/ Month	730
kW Demand Cost	$10.00
kwh Cost	$0.085
Motor Efficiency	95.0%

Post Sandblasting

Head (ft)	110.3
Flow (gpm)	1606
Effieicny	77.8%
Hours Operation/month	712
BHP	57
kW (Assumes Motor Eff 95%)	45.2
kW Demand Charge	$452
kwh cost	$2,734
Total Monthly kWH	32159
Monthly Cost	**$3,185.05**

Pre - Post Sandblasting Comparison

Monthly Savings	$40
Annual Savings	$475
5 Year Savings	$2,375
kW Demand Reduction	-0.4
Monthly kwh Savings	512
Yearly kwh Savings	6146

Post Mechanical

Head (ft)	113
Flow (gpm)	1613
Effieicny	78.9%
Hours Operation/month	709
BHP	58
kW (Assumes Motor Eff 95%)	45.8
kW Demand Charge	$458
kwh cost	$2,761
Total Monthly kWH	32487
Monthly Cost	**$3,219.51**

Pre - Post Mechanical Comparison

Monthly Savings	-$34
Annual Savings	-$414
5 Year Savings	-$2,068
kW Demand Reduction	-0.66
Monthly kwh Savings	29398
Yearly kwh Savings	352776

Pre Refurbishment to Post Mechanical & Interior Sandblasting Comparison

Monthly Savings	$5
Annual Savings	$62
5 Year Savings	$308
kW Demand Reduction	-1.05
Monthly kwh Savings	184
Yearly kwh Savings	2212

20% Service Time

Pre Mechanical

Head (ft)	108.6
Flow (gpm)	1567
Effieicny	75.4%
Hours Operation/month	146
BHP	57
kW (Assumes Motor Eff 95%)	44.8
kW Demand Charge	$448
kwh cost	$555
Total Monthly kWH	6,534
Monthly Cost	**$1,002.97**

Constants

Hours/ Month	730
kW Demand Cost	$10.00
kwh Cost	$0.085
Motor Efficiency	95.0%

Post Sandblasting

Head (ft)	110.3
Flow (gpm)	1606
Effieicny	77.8%
Hours Operation/month	142
BHP	57
kW (Assumes Motor Eff 95%)	45.2
kW Demand Charge	$452
kwh cost	$547
Total Monthly kWH	6432
Monthly Cost	**$998.21**

Pre - Post Sandblasting Comparison

Monthly Savings	$5
Annual Savings	$57
5 Year Savings	$286
kW Demand Reduction	-0.4
Monthly kwh Savings	102
Yearly kwh Savings	1229

Post Mechanical

Head (ft)	113
Flow (gpm)	1613
Effieicny	78.9%
Hours Operation/month	142
BHP	58
kW (Assumes Motor Eff 95%)	45.8
kW Demand Charge	$458
kwh cost	$552
Total Monthly kWH	6497
Monthly Cost	**$1,010.38**

Pre - Post Mechanical Comparison

Monthly Savings	-$12
Annual Savings	-$146
5 Year Savings	-$730
kW Demand Reduction	-0.66
Monthly kwh Savings	5880
Yearly kwh Savings	70555

Pre Refurbishment to Post Mechanical & Interior Sandblasting Comparison

Monthly Savings	-$7
Annual Savings	-$89
5 Year Savings	-$444
kW Demand Reduction	-1.05
Monthly kwh Savings	37
Yearly kwh Savings	442

Total Savings (Mechanical & Coating)

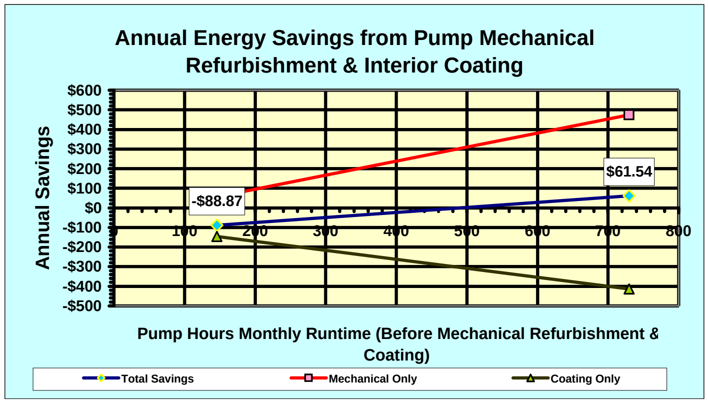
Pump Hours of Operation Before Refurbishment & Interior Coating	Annual Savings Through Refurbishment & Interior Coatings
730	$61.54
146	-$88.87

Coating Savings Only

Pump Hours of Operation Before Refurbishment & Interior Coating	
730	$475.08
146	$57.12

Mechanical Savings Only

Pump Hours of Operation Before Refurbishment & Interior Coating	
730	-$413.54
146	-$145.99



Riga Pump No. 2
Energy Efficiency Cost Calculator

Continuous Service

Pre Mechanical	
Head (ft)	107
Flow (gpm)	1537
Effieicny	72.6%
Hours Operation/month	730
BHP	57
kW (Assumes Motor Eff 95%)	44.9
kW Demand Charge	$449
kwh cost	$2,787
Total Monthly kWH	32,792
Monthly Cost	**$3,236.50**

Constants	
Hours/ Month	730
kW Demand Cost	$10.00
kwh Cost	$0.085
Motor Efficiency	95.0%

Post Mechanical	
Head (ft)	109
Flow (gpm)	1592
Effieicny	77.2%
Hours Operation/month	705
BHP	57
kW (Assumes Motor Eff 95%)	44.6
kW Demand Charge	$446
kwh cost	$2,670
Total Monthly kWH	31414
Monthly Cost	**$3,115.94**

Pre - Post Mechanical Comparison	
Monthly Savings	**$121**
Annual Savings	**$1,447**
5 Year Savings	**$7,234**
kW Demand Reduction	**0.3**
Monthly kwh Savings	**1378**
Yearly kwh Savings	**16530**

Post Casing Coating	
Head (ft)	112
Flow (gpm)	1644
Effieicny	82.2%
Hours Operation/month	682
BHP	57
kW (Assumes Motor Eff 95%)	44.4
kW Demand Charge	$444
kwh cost	$2,577
Total Monthly kWH	30315
Monthly Cost	**$3,021.00**

Pre - Post Internal Coating Comparison	
Monthly Savings	**$95**
Annual Savings	**$1,139**
5 Year Savings	**$5,696**
kW Demand Reduction	**0.15**
Monthly kwh Savings	**28837**
Yearly kwh Savings	**346049**

Pre Mechanical to Post Interior *Coating Comparison*	
Monthly Savings	**$215**
Annual Savings	**$2,586**
5 Year Savings	**$12,930**
kW Demand Reduction	**0.50**
Monthly kwh Savings	**2476**
Yearly kwh Savings	**29716**

20% Service Time

Pre Mechanical	
Head (ft)	107
Flow (gpm)	1537
Effieicny	72.6%
Hours Operation/month	146
BHP	57
kW (Assumes Motor Eff 95%)	44.9
kW Demand Charge	$449
kwh cost	$557
Total Monthly kWH	6,558
Monthly Cost	**$1,006.66**

Constants	
Hours/ Month	730
kW Demand Cost	$10.00
kwh Cost	$0.085
Motor Efficiency	95.0%

Post Mechanical	
Head (ft)	109
Flow (gpm)	1592
Effieicny	77.2%
Hours Operation/month	141
BHP	57
kW (Assumes Motor Eff 95%)	44.6
kW Demand Charge	$446
kwh cost	$534
Total Monthly kWH	6283
Monthly Cost	**$979.77**

Pre - Post Mechanical Comparison	
Monthly Savings	**$27**
Annual Savings	**$323**
5 Year Savings	**$1,613**
kW Demand Reduction	**0.3**
Monthly kwh Savings	**276**
Yearly kwh Savings	**3306**

Post Casing Coating

Head (ft)	112
Flow (gpm)	1644
Effieicny	82.2%
Hours Operation/month	136
BHP	57
kW (Assumes Motor Eff 95%)	44.4
kW Demand Charge	$444
kwh cost	$515
Total Monthly kWH	6063
Monthly Cost	**$959.55**

Pre - Post Internal Coating Comparison

Monthly Savings	$20
Annual Savings	$243
5 Year Savings	$1,213
kW Demand Reduction	0.15
Monthly kwh Savings	5767
Yearly kwh Savings	69210

Pre Mechanical to Post Interior Coating Comparison

Monthly Savings	$47
Annual Savings	$565
5 Year Savings	$2,827
kW Demand Reduction	0.50
Monthly kwh Savings	495
Yearly kwh Savings	5943

Total Savings (Mechanical & Coating)

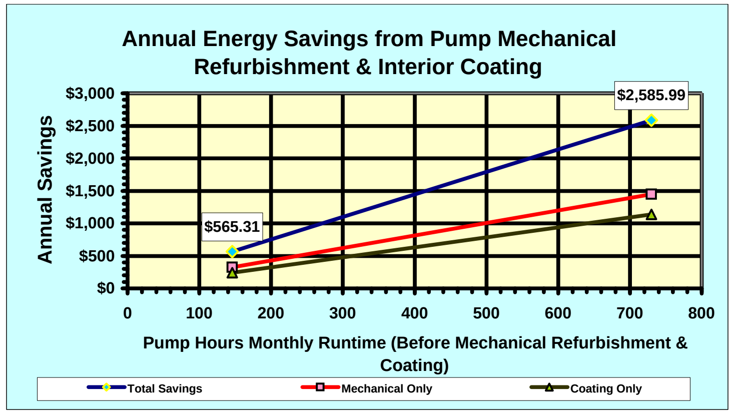
Pump Hours of Operation Before Refurbishment & Interior Coating	Annual Savings Through Refurbishment & Interior Coatings
730	$2,585.99
146	$565.31

Mechanical Savings Only

Pump Hours of Operation Before Refurbishment & Interior Coating	
730	$1,446.70
146	$322.66

Coating Savings Only

Pump Hours of Operation Before Refurbishment & Interior Coating	
730	$1,139.29
146	$242.65



Riga Pump Station

Manufacturer Curve Pump No. 1 or 2

Q	H	Eff	BHP	KW	Ns
0	151	1%	0	0	
400	151	50%	31	25	813
800	145	76%	39	32	1185
1200	131	85%	47	39	1566
1600	110	87%	51	42	2061
2000	81	83%	49	41	2899

Pump Name Plate Information

Manufacturer: Peerless

Model No.: 6AE14

Size 8x6

Motor Name Plate Information

Manufacturer: US Motors

Serial: A409A/VO9V178R022R-2 & 022R-4

Speed: 1780

HP: 60

Amps: 70

Nom Eff %: 94.5

NYSERDA System Curve

Q		H	
50.0%	800.00	80%	88
75.0%	1200.00	88%	96.8
BEP	1600.00	100%	110
125.0%	2000.00	120%	132

Pump No. 1 Field Curve 10/23/07 Initial Test (Sandblast Only Pump)													
Q (gpm)	**Q (mgd)**	**S**	**SV ft/sec**	**D**	**DV ft/sec**	**Pump H**	**Suc V H**	**Dis V H**	**Total H**	**Eff**	**BHP**	**KW**	**RPM**
1868	2.69	9.5	11.92	46.88	21.20	86.35	2.2	7.0	91.12	70.8%	60.7	47.91	1785
1743	2.51	9.53	11.12	52.36	19.78	98.94	1.9	6.1	103.09	74.5%	60.9	48.06	1786
1569	2.26	9.65	10.02	57.93	17.81	111.53	1.6	4.9	114.90	75.6%	60.2	47.55	1785
1319	1.9	9.85	8.42	65.6	14.98	128.78	1.1	3.5	131.16	75.5%	57.9	45.72	1786
965	1.39	10.28	6.16	73.86	10.96	146.87	0.6	1.9	148.14	69.8%	51.7	40.82	1787

Corrected to 1750 RPM

Q (gpm)	**Q (mgd)**	**H**	**Eff**	**BHP**	**KW**	**RPM**	**kw/mgd**
1831	2.64	88	70.8%	57.2	44.9	1750	17.0
1708	2.46	99	74.5%	57.3	45.0	1750	18.3
1539	2.22	110	75.6%	56.8	44.6	1750	20.1
1293	1.86	126	75.5%	54.5	42.8	1750	23.0
945	1.36	142	69.8%	48.6	38.1	1750	28.0

Pump No. 1 Field Curve 12/19/07 Post Sandblasting													
Q (gpm)	**Q (mgd)**	**S**	**SV ft/sec**	**D**	**DV ft/sec**	**Pump H**	**Suc V H**	**Dis V H**	**Total H**	**Eff**	**BHP**	**KW**	**RPM**
1826	2.63	7.78	11.66	49.83	20.73	97.14	2.1	6.7	101.70	76.0%	61.7	48.73	1788
1681	2.42	7.97	10.73	54.95	19.07	108.52	1.8	5.6	112.39	77.5%	61.6	48.59	1788
1507	2.17	8.25	9.62	60.58	17.10	120.88	1.4	4.5	123.99	78.1%	60.4	47.70	1788
1250	1.8	8.75	7.98	67.98	14.19	136.82	1.0	3.1	138.96	76.7%	57.2	45.16	1788
1069	1.54	9.25	6.83	72.49	12.14	146.08	0.7	2.3	147.65	73.5%	54.2	42.80	1789

Corrected to 1750 RPM

Q (gpm)	**Q (mgd)**	**H**	**Eff**	**BHP**	**KW**	**RPM**	**kw/mgd**
1788	2.57	97	76.0%	57.9	45.4	1750	17.7
1645	2.37	108	77.5%	57.7	45.3	1750	19.1
1475	2.12	119	78.1%	56.7	44.5	1750	20.9
1223	1.76	133	76.7%	53.6	42.1	1750	23.9
1046	1.51	141	73.5%	50.7	39.9	1750	26.5

Pump No. 1 Field Curve 3/7/08 Post Sandblasting & Mechanical Refurbishment

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
1917	2.76	4.75	12.23	43.22	21.75	88.87	2.3	7.3	93.89	74.4%	61.1	48.24	1788
1819	2.62	4.8	11.61	47.32	20.65	98.22	2.1	6.6	102.75	77.4%	61.0	48.15	1787
1632	2.35	5.06	10.42	53.85	18.52	112.70	1.7	5.3	116.35	78.9%	60.7	47.95	1787
1382	1.99	5.43	8.82	61.56	15.69	129.66	1.2	3.8	132.27	78.5%	58.8	46.41	1787
1097	1.58	5.89	7.00	68.85	12.45	145.44	0.8	2.4	147.08	74.5%	54.7	43.19	1789

Corrected to 1750 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mgd
1876	2.70	90	74.4%	57.3	45.0	1750	16.7
1782	2.57	99	77.4%	57.3	45.0	1750	17.5
1598	2.30	112	78.9%	57.0	44.8	1750	19.5
1353	1.95	127	78.5%	55.2	43.4	1750	22.2
1073	1.55	141	74.5%	51.2	40.2	1750	26.0

Pump No. 1 Field Curve 5/5/08 30 Day Test

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
1604	2.31	0.08	10.24	49.53	18.21	114.23	1.6	5.1	117.75	76.2%	62.6	49.44	1788
1493	2.15	1.7	9.53	54.79	16.95	122.64	1.4	4.5	125.69	76.7%	61.8	48.77	1788
1313	1.89	4.69	8.38	62.57	14.90	133.70	1.1	3.4	136.06	75.5%	59.7	47.15	1788
1021	1.47	8.51	6.52	72.9	11.59	148.74	0.7	2.1	150.17	70.9%	54.6	43.12	1789

Corrected to 1750 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mgd
1570	2.26	113	76.2%	58.7	46.1	1750	20.4
1461	2.10	120	76.7%	57.9	45.5	1750	21.6
1285	1.85	130	75.5%	56.0	44.0	1750	23.8
999	1.44	144	70.9%	51.1	40.1	1750	27.9

Pump No. 1 Field Curve 6/11/08 90 Day Test

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
2021	2.91	11.88	12.90	44.48	22.94	75.31	2.6	8.2	80.89	66.2%	62.3	49.20	1788
1875	2.7	11.95	11.97	50.68	21.28	89.47	2.2	7.0	94.28	71.2%	62.7	49.50	1786
1722	2.48	12.02	10.99	56.67	19.55	103.14	1.9	5.9	107.20	74.2%	62.9	49.63	1787
1438	2.07	12.34	9.17	66.07	16.32	124.12	1.3	4.1	126.94	75.7%	60.9	48.04	1787
1188	1.71	12.6	7.58	72.97	13.48	139.45	0.9	2.8	141.38	73.5%	57.7	45.54	1788

Corrected to 1750 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mgd
1978	2.85	77	66.2%	58.4	45.9	1750	16.1
1837	2.65	91	71.2%	59.0	46.3	1750	17.5
1687	2.43	103	74.2%	59.0	46.4	1750	19.1
1408	2.03	122	75.7%	57.2	44.9	1750	22.1
1163	1.67	136	73.5%	54.2	42.5	1751	25.4

Pump No. 1 Field Curve 10/29/08 6 Month Test

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
1826	2.63	10.33	11.66	44.9	20.73	79.86	2.1	6.7	84.42	65.3%	59.7	47.10	1788
1757	2.53	10.55	11.21	48.26	19.94	87.11	2.0	6.2	91.33	67.8%	59.8	47.18	1788
1597	2.3	11.58	10.19	55.52	18.13	101.50	1.6	5.1	104.99	70.8%	59.8	47.19	1788
1368	1.97	12.79	8.73	64.23	15.53	118.83	1.2	3.7	121.39	71.9%	58.3	46.05	1788
1028	1.48	14.01	6.56	74.27	11.67	139.20	0.7	2.1	140.65	69.1%	52.8	41.72	1788

Corrected to 1750 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mgd
1788	2.57	81	65.3%	55.9	43.9	1750	17.1
1720	2.48	87	67.8%	56.0	44.0	1750	17.8
1563	2.25	101	70.8%	56.0	44.0	1750	19.6
1339	1.93	116	71.9%	54.7	42.9	1750	22.3
1006	1.45	135	69.1%	49.6	38.9	1750	26.9

Pump No. 1 Field Curve 11/03/08 6 Month Test 2nd Test

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
1875	2.7	13.87	11.97	46.8	21.28	76.07	2.2	7.0	80.88	64.3%	59.6	47.01	1787
1771	2.55	14	11.30	51.81	20.10	87.34	2.0	6.3	91.63	68.4%	59.9	47.29	1787
1611	2.32	14.21	10.28	58.05	18.29	101.27	1.6	5.2	104.82	71.2%	59.9	47.28	1787
1493	2.15	14.32	9.53	62.12	16.95	110.42	1.4	4.5	113.47	72.2%	59.3	46.80	1787
1271	1.83	14.94	8.11	69.53	14.42	126.10	1.0	3.2	128.31	72.0%	57.2	45.13	1788
1069	1.54	15.97	6.83	75.38	12.14	137.24	0.7	2.3	138.80	69.9%	53.6	42.31	1789

Corrected to 1750 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mgd
1836	2.64	78	64.3%	55.9	43.9	1750	16.6
1734	2.50	88	68.4%	56.3	44.2	1750	17.7
1578	2.27	101	71.2%	56.2	44.2	1750	19.4
1462	2.11	109	72.2%	55.7	43.7	1750	20.8
1244	1.79	123	72.0%	53.6	42.1	1750	23.5
1047	1.51	133	69.9%	50.3	39.5	1751	26.2

Pump No. 1 Field Curve 12/17/08 Post Impeller Debris Removal, 6 Month Test

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
1924	2.77	11.76	12.28	47.2	21.83	81.87	2.3	7.4	86.93	69.5%	60.8	47.97	1787
1840	2.65	11.87	11.74	51.16	20.89	90.76	2.1	6.8	95.39	72.6%	61.0	48.18	1787
1632	2.35	12.13	10.42	58.44	18.52	106.98	1.7	5.3	110.62	74.9%	60.9	48.07	1787
1458	2.1	12.36	9.31	63.93	16.55	119.13	1.3	4.3	122.04	75.2%	59.8	47.20	1787
1188	1.71	13.56	7.58	72.29	13.48	135.67	0.9	2.8	137.60	72.7%	56.7	44.79	1788

Corrected to 1750 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mgd
1884	2.71	83	69.5%	57.1	44.8	1750	16.5
1802	2.60	91	72.6%	57.3	45.0	1750	17.3
1598	2.30	106	74.9%	57.2	44.9	1750	19.5
1428	2.06	117	75.2%	56.2	44.1	1750	21.4
1162	1.67	132	72.7%	53.2	41.8	1750	25.0

Pump No. 1 Field Curve 4/20/09 One Year Test

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
1979	2.85	12.99	12.63	46	22.46	76.25	2.5	7.8	81.61	67.5%	60.4	47.67	1788
1861	2.68	13.15	11.88	51.49	21.12	88.57	2.2	6.9	93.30	71.9%	61.0	48.15	1788
1681	2.42	13.4	10.73	58.16	19.07	103.40	1.8	5.6	107.26	74.6%	61.1	48.20	1788
1368	1.97	13.87	8.73	67.94	15.53	124.90	1.2	3.7	127.46	75.0%	58.7	46.37	1788
1132	1.63	14.62	7.22	74.28	12.85	137.81	0.8	2.6	139.57	71.7%	55.6	43.90	1788

Corrected to 1750 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mgd
1937	2.79	78	67.5%	56.6	44.5	1750	15.9
1822	2.62	89	71.9%	57.2	44.9	1750	17.1
1645	2.37	103	74.6%	57.2	45.0	1750	19.0
1339	1.93	122	75.0%	55.1	43.2	1750	22.4
1108	1.60	134	71.7%	52.1	40.9	1750	25.7

Pump No. 1 Field Curve 6/14/10

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
1854	2.67	8.54	11.83	47.33	21.04	89.60	2.2	6.9	94.31	72.5%	60.9	48.11	1788
1715	2.47	8.85	10.95	52.56	19.47	100.97	1.9	5.9	104.99	74.6%	60.9	48.11	1788
1590	2.29	9.73	10.15	57.22	18.05	109.70	1.6	5.1	113.16	75.1%	60.5	47.75	1788
1188	1.71	11.98	7.58	70.2	13.48	134.49	0.9	2.8	136.42	73.2%	55.9	44.13	1788

Corrected to 1750 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mgd
1815	2.61	90	72.5%	57.1	44.9	1750	17.2
1679	2.42	101	74.6%	57.1	44.9	1750	18.6
1556	2.24	108	75.1%	56.7	44.5	1750	19.9
1162	1.67	131	73.2%	52.4	41.2	1750	24.6

Pump No. 2 Field Curve 8/10/06 Initial Test

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
1819	2.62	12.17	11.61	50.9	20.65	89.47	2.1	6.6	93.99	70.9%	60.9	48.1	1783
1569	2.26	12.49	10.02	59.35	17.81	108.25	1.6	4.9	111.62	72.6%	60.9	48.1	1785
1319	1.9	12.96	8.42	66.5	14.98	123.68	1.1	3.5	126.06	70.2%	59.8	47.2	1784
1139	1.64	13.13	7.27	71.49	12.93	134.81	0.8	2.6	136.59	68.2%	57.6	45.5	1787
910	1.31	13.7	5.81	77.1	10.33	146.38	0.5	1.7	147.52	63.1%	53.7	42.4	1786

Corrected to 1750 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mgd
1786	2.57	91	70.9%	57.6	45.2	1750	17.6
1539	2.22	107	72.6%	57.4	45.1	1750	20.3
1294	1.86	121	70.2%	56.4	44.3	1750	23.8
1115	1.61	131	68.2%	54.1	42.5	1750	26.5
891	1.28	142	63.1%	50.5	39.7	1750	30.9

Pump No. 2 Field Curve 10/23/07 Post Mechanical Refurbishment

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
1917	2.76	9.71	12.23	47.41	21.75	87.09	2.3	7.3	92.11	72.9%	61.2	48.29	1786
1757	2.53	9.8	11.21	53.87	19.94	101.80	2.0	6.2	106.02	76.7%	61.3	48.42	1787
1604	2.31	9.93	10.24	58.61	18.21	112.45	1.6	5.1	115.97	77.2%	60.9	48.05	1788
1313	1.89	10.26	8.38	67.06	14.90	131.21	1.1	3.4	133.56	76.6%	57.8	45.63	1787
792	1.14	11.0	5.05	77.5	8.99	153.50	0.4	1.3	154.36	65.7%	47.0	37.09	1791

Corrected to 1750 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mgd
1878	2.70	88	72.9%	57.5	45.2	1750	16.7
1721	2.48	102	76.7%	57.6	45.2	1750	18.3
1570	2.26	111	77.2%	57.1	44.8	1750	19.8
1285	1.85	128	76.6%	54.3	42.6	1750	23.0
774	1.11	147	65.7%	43.8	34.4	1750	30.9

Pump No. 2 Field Curve 12/4/07 Post Interior Casing Coating

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
1944	2.8	10.58	12.41	49.78	22.07	90.55	2.4	7.6	95.72	78.0%	60.3	47.60	1786
1806	2.6	10.71	11.52	55.14	20.49	102.63	2.1	6.5	107.09	80.7%	60.5	47.75	1786
1632	2.35	10.91	10.42	61.25	18.52	116.29	1.7	5.3	119.93	82.2%	60.1	47.45	1786
1444	2.08	11.27	9.22	67.18	16.39	129.15	1.3	4.2	132.01	81.7%	58.9	46.52	1789
1160	1.67	11.7	7.40	75.5	13.16	147.47	0.9	2.7	149.31	80.1%	54.6	43.07	1787

Corrected to 1750 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mgd
1905	2.74	92	78.0%	56.7	44.5	1750	16.2
1769	2.55	103	80.7%	56.9	44.7	1750	17.5
1599	2.30	115	82.2%	56.5	44.4	1750	19.3
1413	2.03	126	81.7%	55.2	43.3	1750	21.3
1136	1.64	143	80.1%	51.2	40.2	1750	24.6

Pump No. 2 Field Curve 12/19/07 Post Interior Casing Coating (30 Day Test)

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
1854	2.67	7.98	11.83	50.51	21.04	98.24	2.2	6.9	102.95	78.7%	61.3	48.36	1786
1722	2.48	8.12	10.99	55.46	19.55	109.36	1.9	5.9	113.41	80.9%	61.0	48.14	1786
1549	2.23	8.4	9.88	61.3	17.58	122.20	1.5	4.8	125.48	81.8%	60.0	47.38	1786
1368	1.97	8.67	8.73	66.58	15.53	133.77	1.2	3.7	136.33	81.1%	58.1	45.85	1789
1090	1.57	9.3	6.96	74.6	12.37	150.73	0.8	2.4	152.35	78.4%	53.5	42.25	1787

Corrected to 1750 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mgd
1817	2.62	99	78.7%	57.6	45.3	1750	17.3
1688	2.43	109	80.9%	57.4	45.0	1750	18.5
1517	2.19	120	81.8%	56.5	44.3	1750	20.3
1338	1.93	130	81.1%	54.4	42.7	1750	22.2
1068	1.54	146	78.4%	50.3	39.5	1750	25.7

Pump No. 2 Field Curve 3/7/08, 90 Day Test

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
1931	2.78	4.45	12.32	44	21.91	91.36	2.4	7.5	96.46	77.3%	60.9	48.05	1786
1771	2.55	4.66	11.30	50.32	20.10	105.47	2.0	6.3	109.76	80.8%	60.7	47.93	1786
1653	2.38	4.78	10.55	54.58	18.76	115.04	1.7	5.5	118.77	82.1%	60.4	47.68	1786
1417	2.04	5.15	9.04	61.96	16.08	131.23	1.3	4.0	133.98	82.0%	58.4	46.13	1789
1118	1.61	5.6	7.14	70.2	12.69	149.32	0.8	2.5	151.03	78.2%	54.5	43.02	1787

Corrected to 1750 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mgd
1892	2.72	93	77.3%	57.3	45.0	1750	16.5
1735	2.50	105	80.8%	57.1	44.9	1750	18.0
1619	2.33	114	82.1%	56.8	44.6	1750	19.1
1386	2.00	128	82.0%	54.7	43.0	1750	21.5
1095	1.58	145	78.2%	51.2	40.2	1750	25.5

Pump No. 2 Field Curve 6/11/08, 6 Month Test

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
2028	2.92	10.72	12.94	46.26	23.02	82.10	2.6	8.2	87.72	74.7%	60.1	47.47	1786
1917	2.76	10.73	12.23	51.21	21.75	93.51	2.3	7.3	98.53	78.6%	60.7	47.89	1786
1736	2.5	10.88	11.08	58.16	19.70	109.22	1.9	6.0	113.34	81.8%	60.7	47.93	1786
1472	2.12	11.22	9.40	66.46	16.71	127.60	1.4	4.3	130.57	82.3%	59.0	46.57	1789
1222	1.76	11.5	7.80	73.4	13.87	143.08	0.9	3.0	145.12	80.4%	55.7	43.97	1787

Corrected to 1750 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mgd
1987	2.86	84	74.7%	56.6	44.4	1750	15.5
1878	2.70	95	78.6%	57.1	44.8	1750	16.6
1701	2.45	109	81.8%	57.1	44.9	1750	18.3
1440	2.07	125	82.3%	55.2	43.4	1750	20.9
1197	1.72	139	80.4%	52.3	41.1	1750	23.8

Pump No. 2 Field Curve 10/29/08 1 Year Test

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
1972	2.84	10.05	12.59	47.47	22.38	86.44	2.5	7.8	91.76	76.1%	60.1	47.43	1785
1861	2.68	10.15	11.88	52.06	21.12	96.81	2.2	6.9	101.55	78.9%	60.5	47.76	1785
1694	2.44	10.63	10.81	58.58	19.23	110.76	1.8	5.7	114.69	81.2%	60.4	47.71	1785
1549	2.23	11.48	9.88	63.83	17.58	120.93	1.5	4.8	124.21	81.4%	59.7	47.09	1785
1215	1.75	13.2	7.76	74.9	13.79	142.46	0.9	3.0	144.48	79.7%	55.6	43.92	1785

Corrected to 1750 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mgd
1934	2.78	88	76.1%	56.6	44.5	1750	16.0
1825	2.63	98	78.9%	57.0	44.8	1750	17.0
1661	2.39	110	81.2%	57.0	44.7	1750	18.7
1518	2.19	119	81.4%	56.2	44.1	1750	20.2
1191	1.72	139	79.7%	52.4	41.2	1750	24.0

Pump No. 2 Field Curve 4/20/09 1 Year Test

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
2014	2.9	12.66	12.85	47.74	22.86	81.03	2.6	8.1	86.58	73.9%	59.6	47.06	1787
1903	2.74	12.73	12.14	52.66	21.60	92.24	2.3	7.2	97.19	77.6%	60.2	47.53	1787
1715	2.47	12.97	10.95	59.86	19.47	108.32	1.9	5.9	112.34	80.8%	60.3	47.57	1787
1535	2.21	13.21	9.79	65.71	17.42	121.28	1.5	4.7	124.50	81.4%	59.3	46.81	1787
1257	1.81	14.1	8.02	74.3	14.27	138.95	1.0	3.2	141.11	79.7%	56.2	44.39	1788

Corrected to 1750 RPM

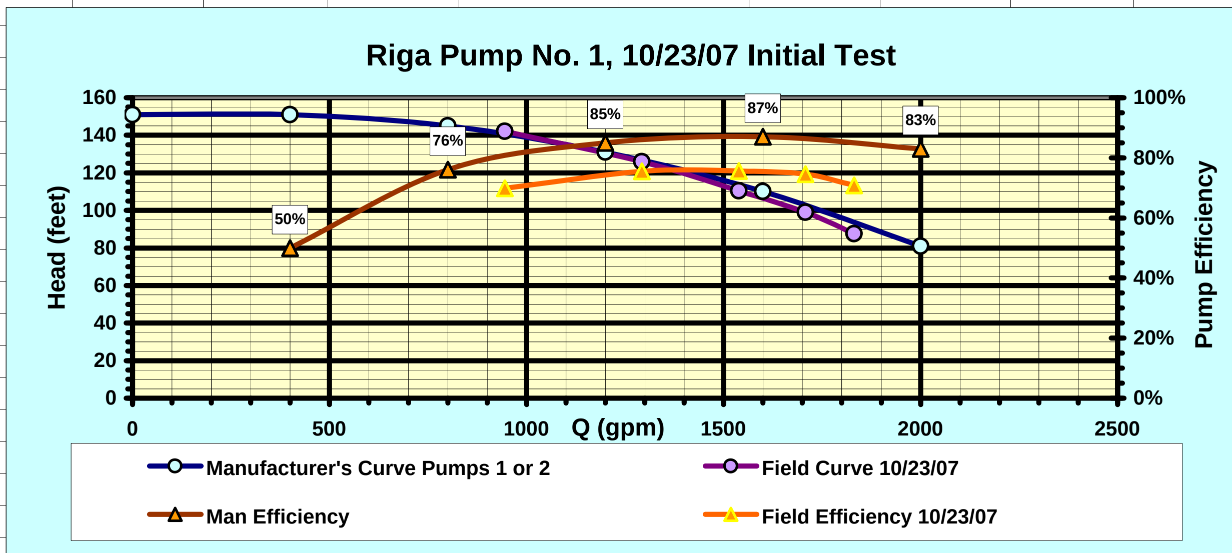
Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mgd
1972	2.84	83	73.9%	56.0	44.0	1750	15.5
1863	2.68	93	77.6%	56.5	44.4	1750	16.5
1680	2.42	108	80.8%	56.6	44.4	1750	18.4
1503	2.16	119	81.4%	55.7	43.7	1750	20.2
1230	1.77	135	79.7%	52.7	41.4	1750	23.4

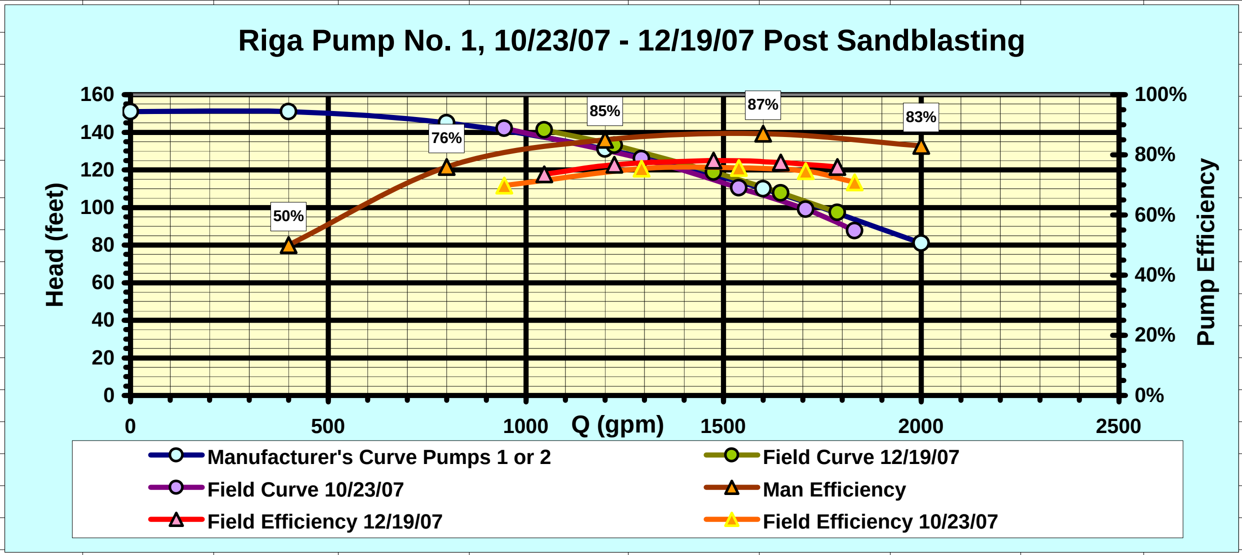
Pump No. 2 Field Curve 6/14/10

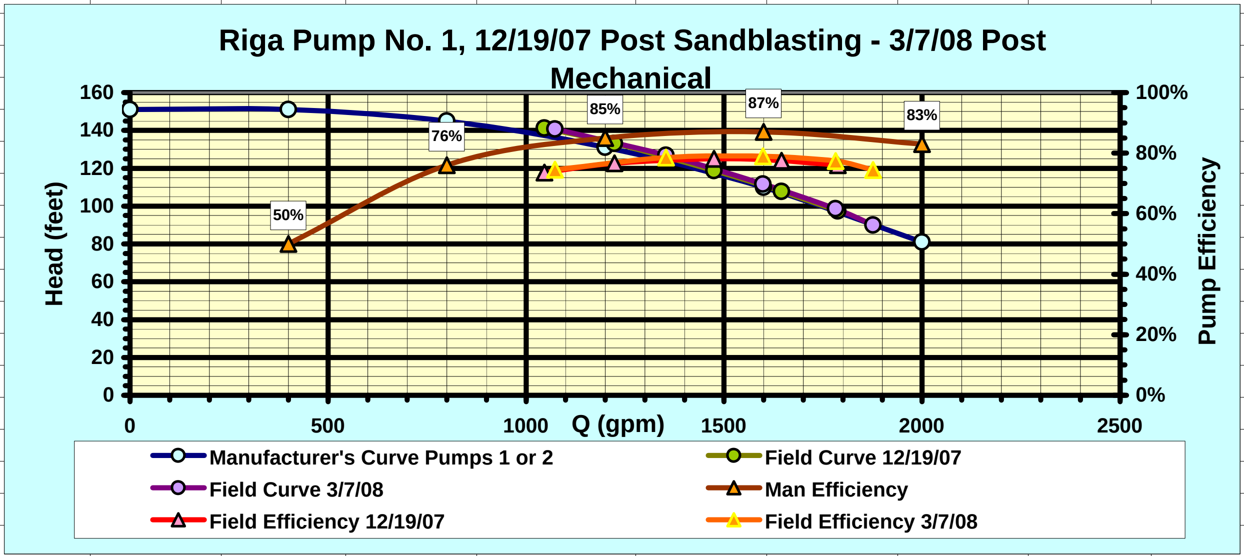
Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
1924	2.77	8.46	12.28	48.37	21.83	92.19	2.3	7.4	97.25	78.9%	59.9	47.29	1784
1792	2.58	8.64	11.43	53.12	20.34	102.75	2.0	6.4	107.14	80.6%	60.2	47.49	1784
1646	2.37	9.39	10.50	58.84	18.68	114.23	1.7	5.4	117.93	82.1%	59.7	47.13	1784
1222	1.76	11.83	7.80	73.53	13.87	142.53	0.9	3.0	144.57	80.5%	55.4	43.75	1785

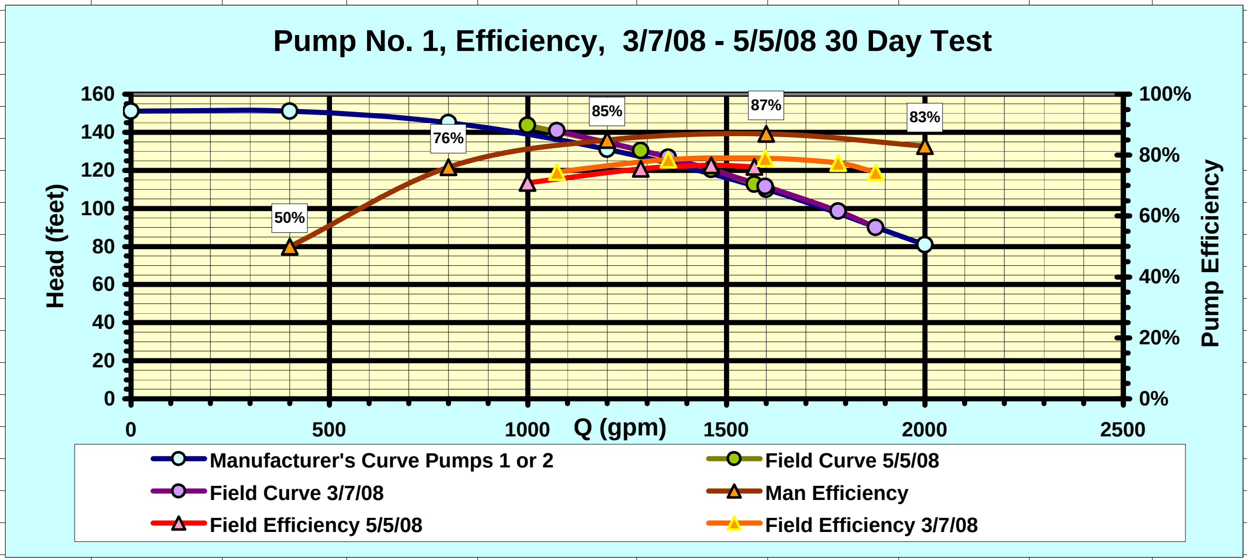
Corrected to 1750 RPM

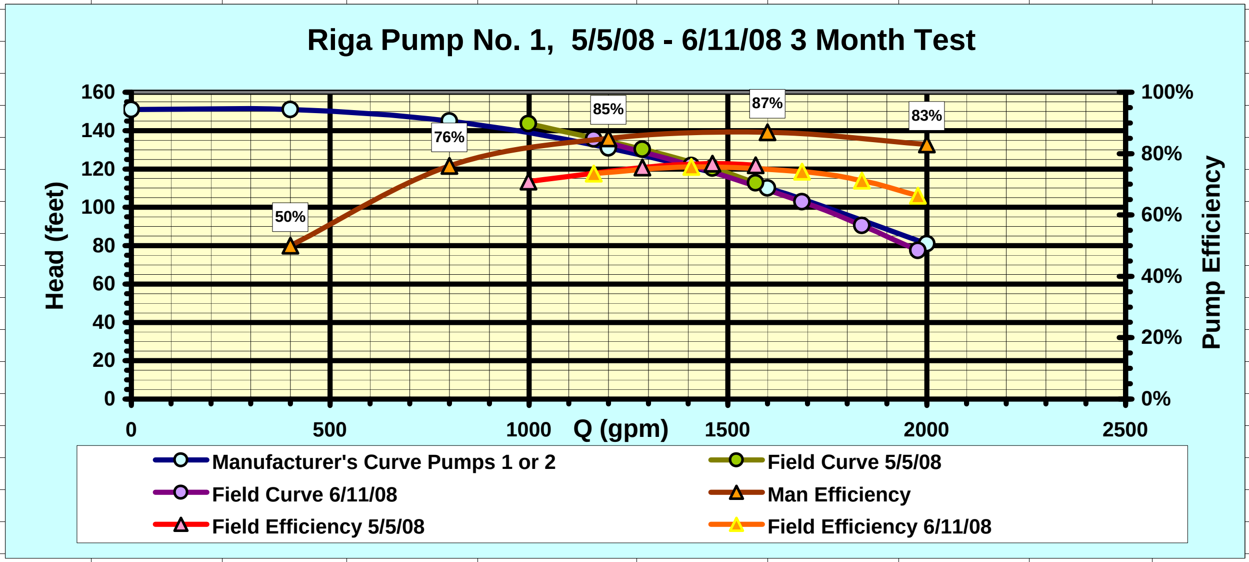
Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mgd
1887	2.72	94	78.9%	56.5	44.4	1750	16.3
1758	2.53	103	80.6%	56.8	44.6	1750	17.6
1614	2.32	113	82.1%	56.4	44.3	1750	19.0
1198	1.73	139	80.5%	52.2	41.0	1750	23.8

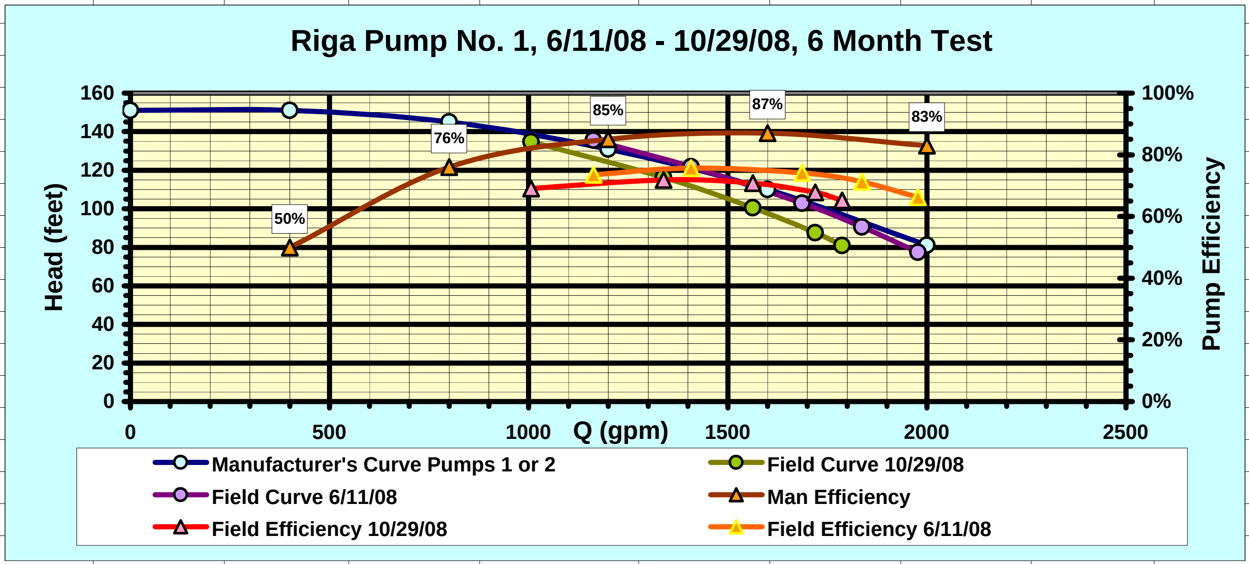



Riga Pump No. 1, 10/23/07 - 12/19/07 Post Sandblasting
Head (feet)
Pump Efficiency
Q (gpm)
160
140
120
100
80
60
40
20
0
100%
80%
60%
40%
20%
0%
0
500
1000
1500
2000
2500
50%
76%
85%
87%
83%
Manufacturer's Curve Pumps 1 or 2
Field Curve 12/19/07
Field Curve 10/23/07
Man Efficiency
Field Efficiency 12/19/07
Field Efficiency 10/23/07

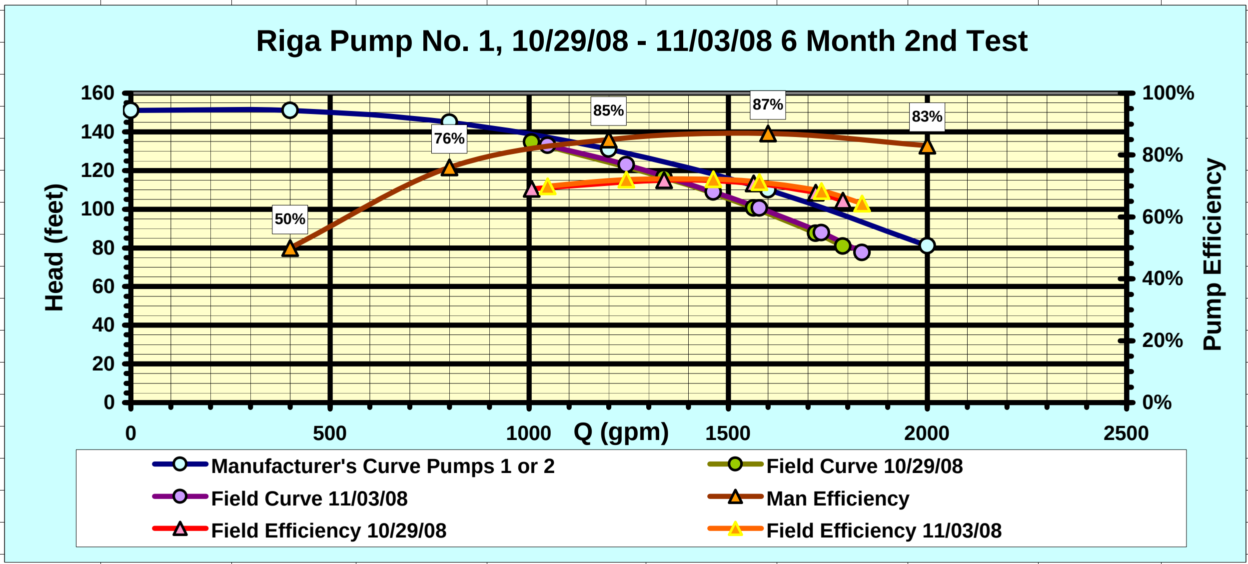

Riga Pump No. 1, 12/19/07 Post Sandblasting - 3/7/08 Post Mechanical
Head (feet)
Pump Efficiency
Q (gpm)
160
140
120
100
80
60
40
20
0
100%
80%
60%
40%
20%
0%
0
500
1000
1500
2000
2500
50%
76%
85%
87%
83%
Manufacturer's Curve Pumps 1 or 2
Field Curve 12/19/07
Field Curve 3/7/08
Man Efficiency
Field Efficiency 12/19/07
Field Efficiency 3/7/08


Pump No. 1, Efficiency, 3/7/08 - 5/5/08 30 Day Test
Head (feet)
Pump Efficiency
Q (gpm)
160
140
120
100
80
60
40
20
0
100%
80%
60%
40%
20%
0%
0
500
1000
1500
2000
2500
50%
76%
85%
87%
83%
Manufacturer's Curve Pumps 1 or 2
Field Curve 5/5/08
Field Curve 3/7/08
Man Efficiency
Field Efficiency 5/5/08
Field Efficiency 3/7/08

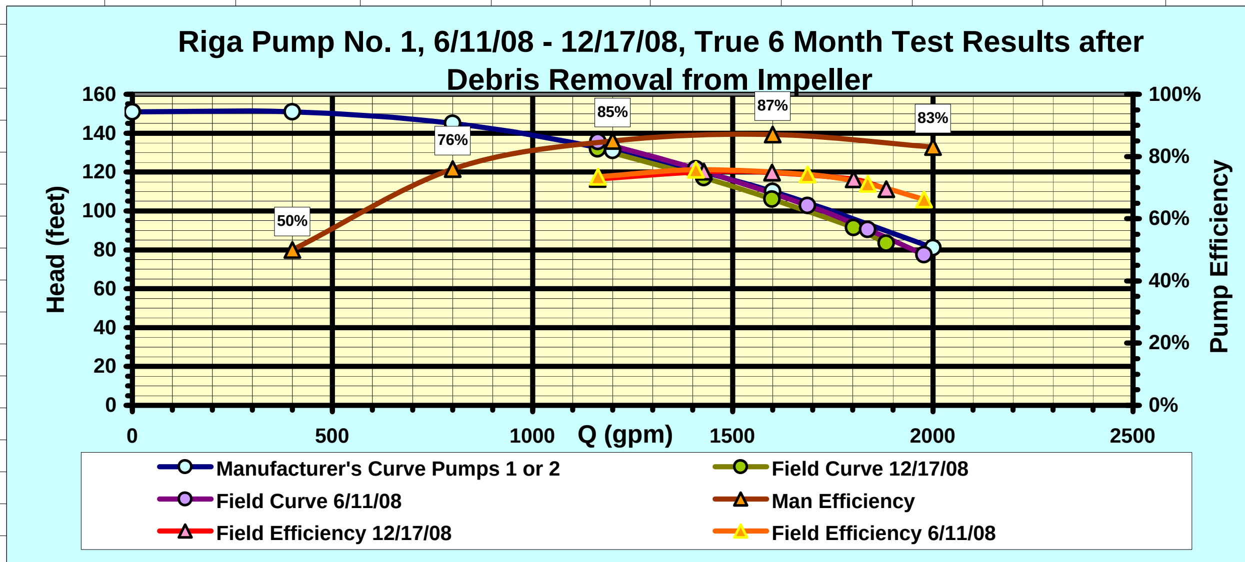

Riga Pump No. 1, 5/5/08 - 6/11/08 3 Month Test
Head (feet)
Pump Efficiency
Q (gpm)
160
140
120
100
80
60
40
20
0
100%
80%
60%
40%
20%
0%
0
500
1000
1500
2000
2500
50%
76%
85%
87%
83%
Manufacturer's Curve Pumps 1 or 2
Field Curve 5/5/08
Field Curve 6/11/08
Man Efficiency
Field Efficiency 5/5/08
Field Efficiency 6/11/08

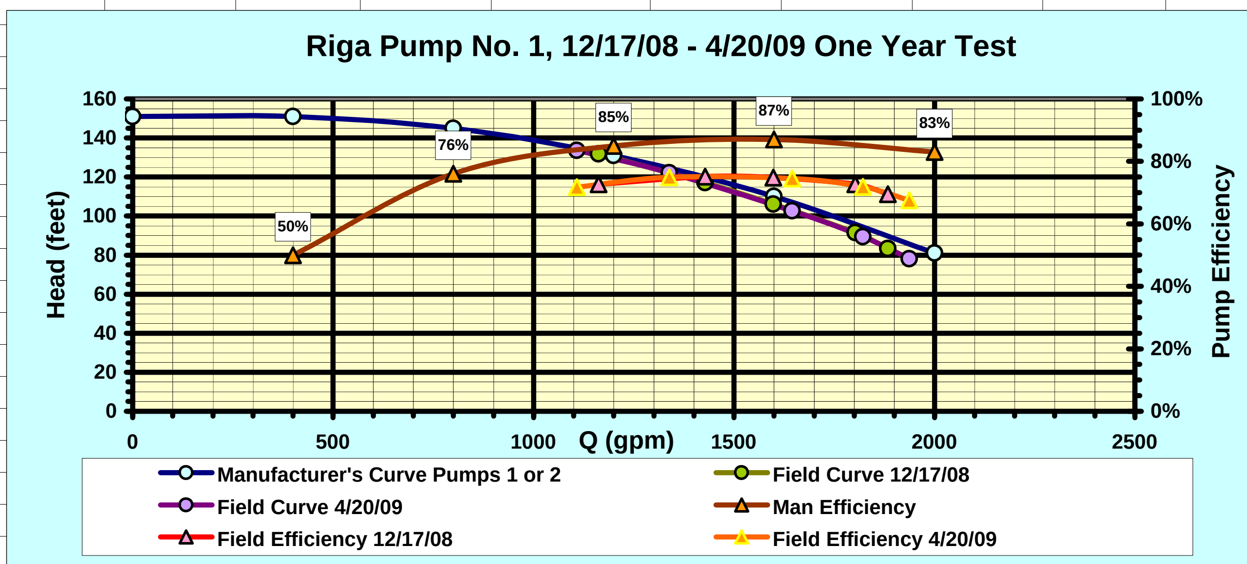


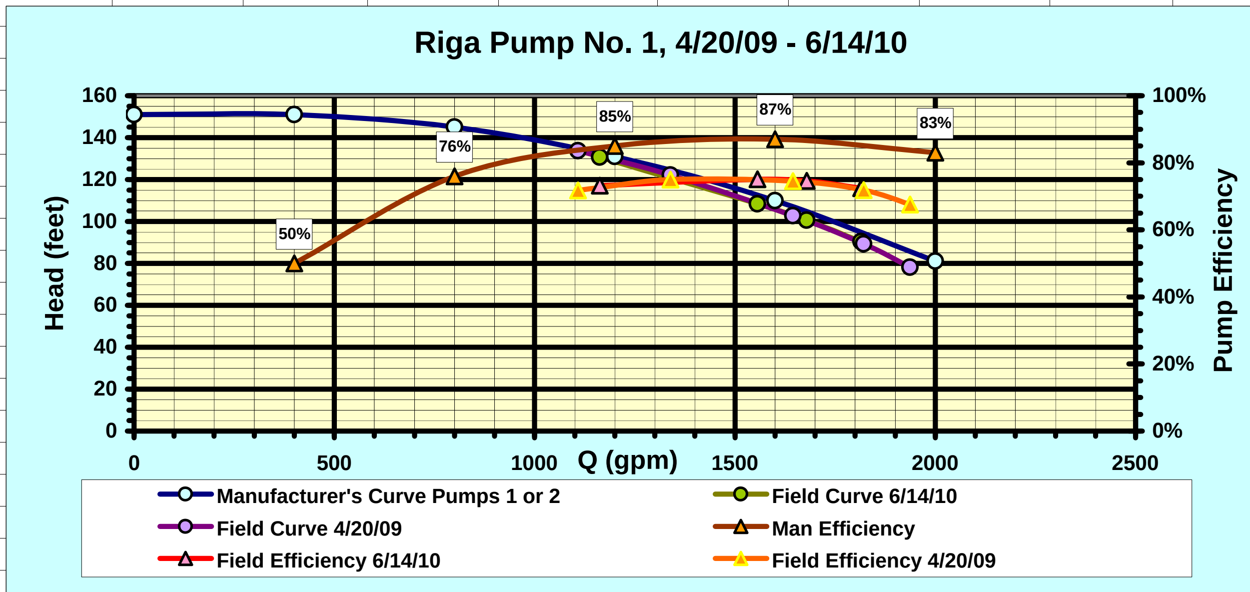
Riga Pump No. 1, 6/11/08 - 10/29/08, 6 Month Test
Head (feet)
Pump Efficiency
Q (gpm)
0
20
40
60
80
100
120
140
160
0%
20%
40%
60%
80%
100%
0
500
1000
1500
2000
2500
50%
76%
85%
87%
83%
Manufacturer's Curve Pumps 1 or 2
Field Curve 10/29/08
Field Curve 6/11/08
Man Efficiency
Field Efficiency 10/29/08
Field Efficiency 6/11/08

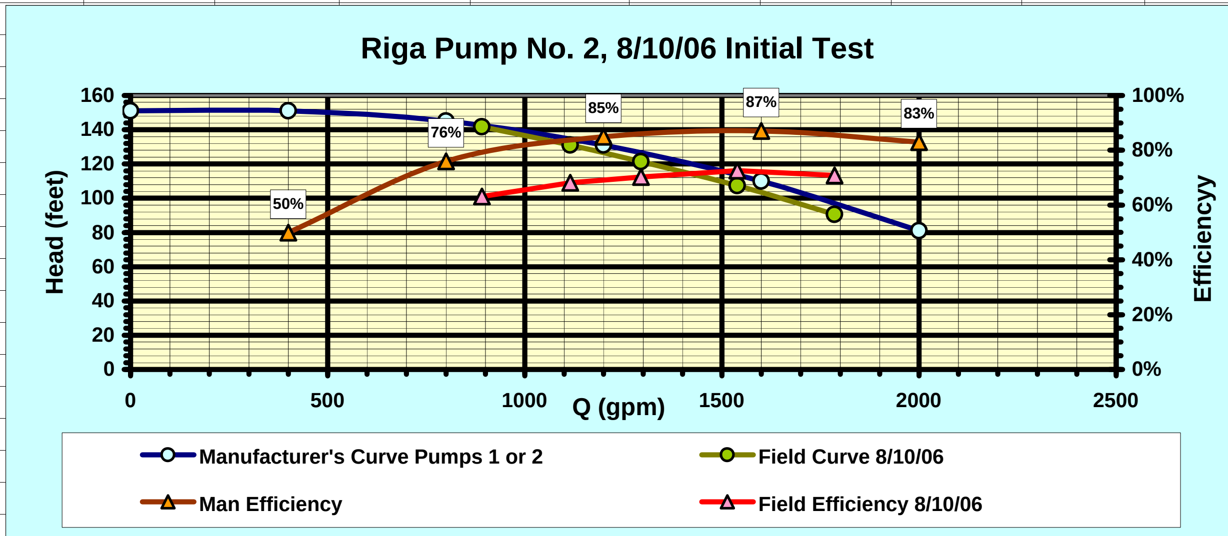


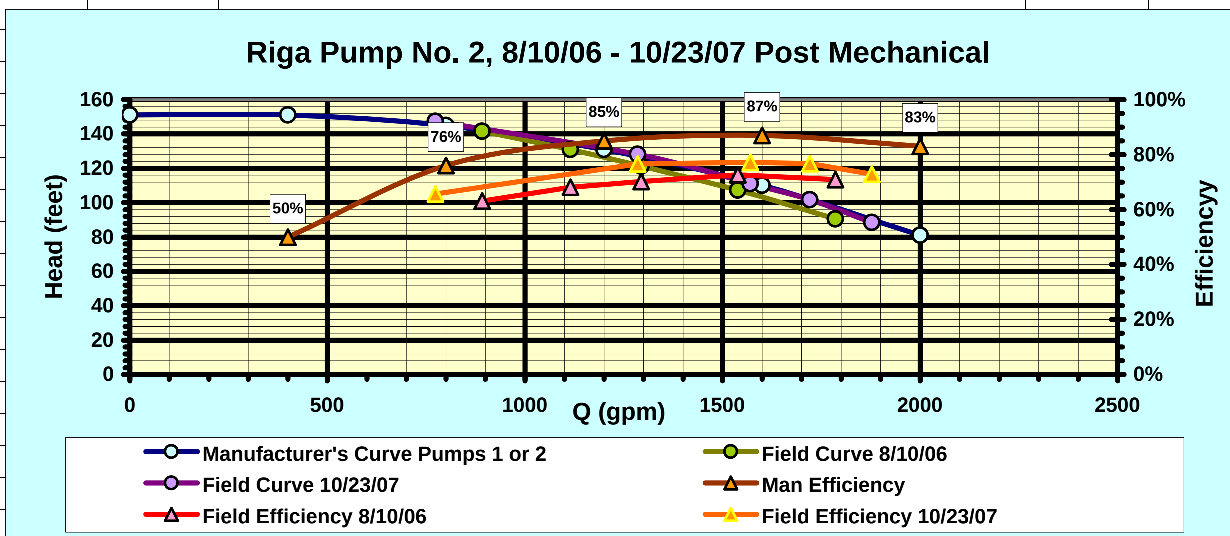
Riga Pump No. 1, 10/29/08 - 11/03/08 6 Month 2nd Test
Head (feet)
Pump Efficiency
Q (gpm)
0
20
40
60
80
100
120
140
160
0%
20%
40%
60%
80%
100%
0
500
1000
1500
2000
2500
50%
76%
85%
87%
83%
Manufacturer's Curve Pumps 1 or 2
Field Curve 10/29/08
Field Curve 11/03/08
Man Efficiency
Field Efficiency 10/29/08
Field Efficiency 11/03/08

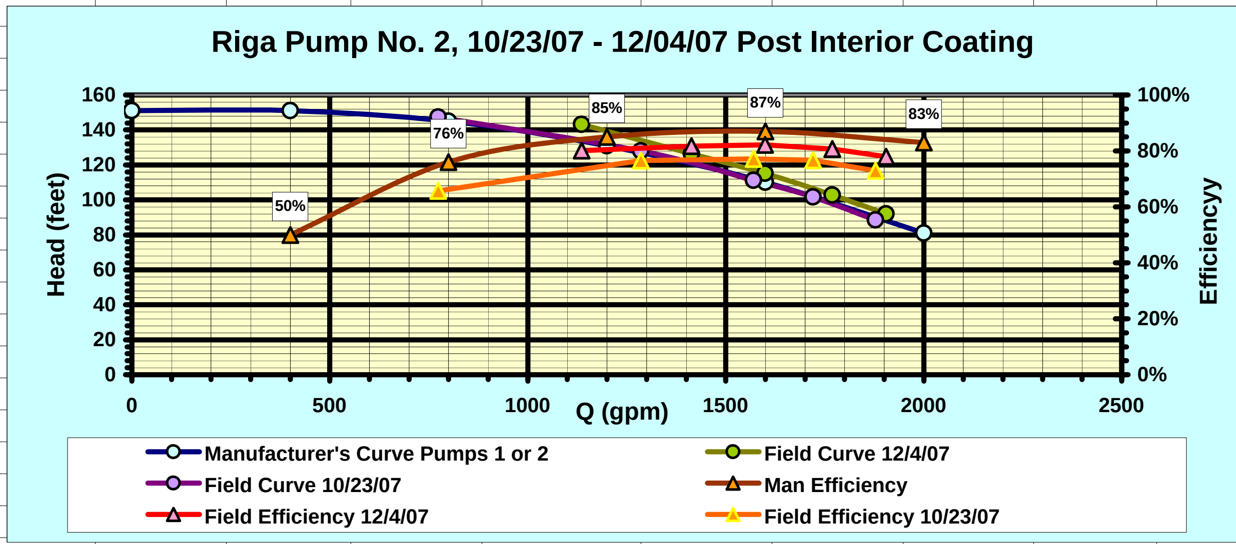

Riga Pump No. 1, 6/11/08 - 12/17/08, True 6 Month Test Results after Debris Removal from Impeller
Head (feet)
Pump Efficiency
Q (gpm)
50%
76%
85%
87%
83%
Manufacturer's Curve Pumps 1 or 2
Field Curve 12/17/08
Field Curve 6/11/08
Man Efficiency
Field Efficiency 12/17/08
Field Efficiency 6/11/08

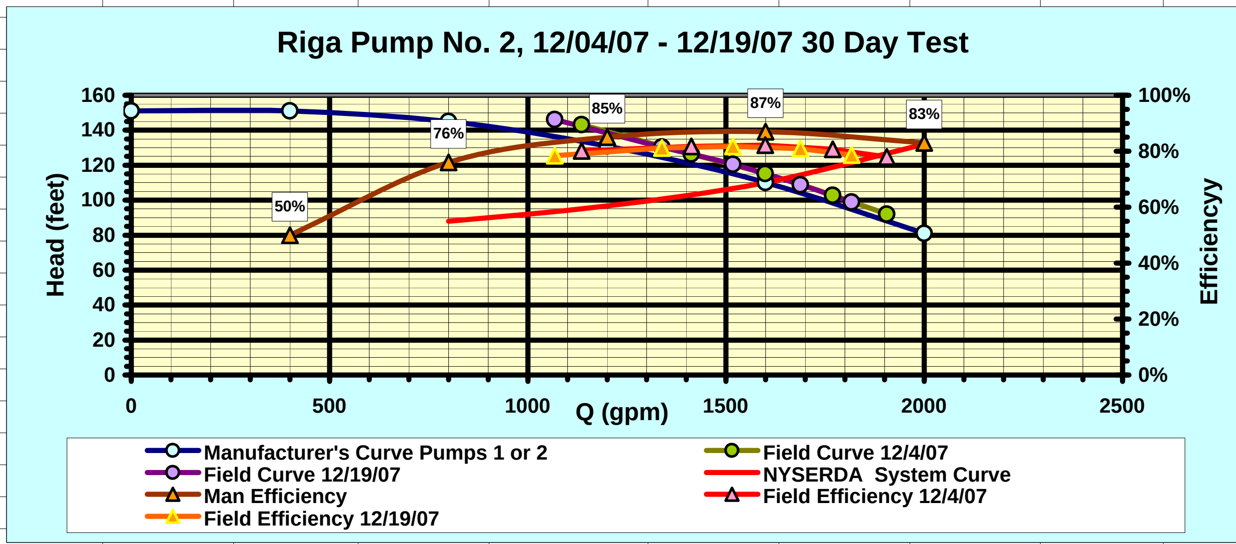

Riga Pump No. 1, 12/17/08 - 4/20/09 One Year Test
Head (feet)
Pump Efficiency
Q (gpm)
50%
76%
85%
87%
83%
Manufacturer's Curve Pumps 1 or 2
Field Curve 12/17/08
Field Curve 4/20/09
Man Efficiency
Field Efficiency 12/17/08
Field Efficiency 4/20/09

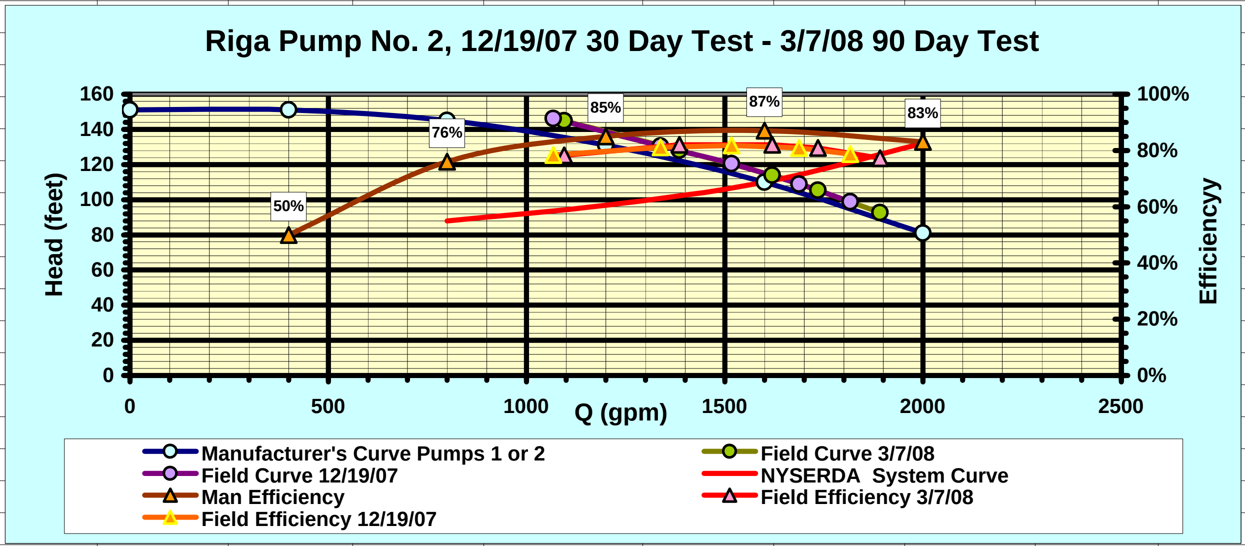

Riga Pump No. 1, 4/20/09 - 6/14/10
Head (feet)
Pump Efficiency
Q (gpm)
0
20
40
60
80
100
120
140
160
0
500
1000
1500
2000
2500
0%
20%
40%
60%
80%
100%
50%
76%
85%
87%
83%
Manufacturer's Curve Pumps 1 or 2
Field Curve 6/14/10
Field Curve 4/20/09
Man Efficiency
Field Efficiency 6/14/10
Field Efficiency 4/20/09


Riga Pump No. 2, 8/10/06 Initial Test
Head (feet)
160
140
120
100
80
60
40
20
0
100%
80%
60%
40%
20%
0%
Efficiencyy
0
500
1000
1500
2000
2500
Q (gpm)
50%
76%
85%
87%
83%
Manufacturer's Curve Pumps 1 or 2
Field Curve 8/10/06
Man Efficiency
Field Efficiency 8/10/06

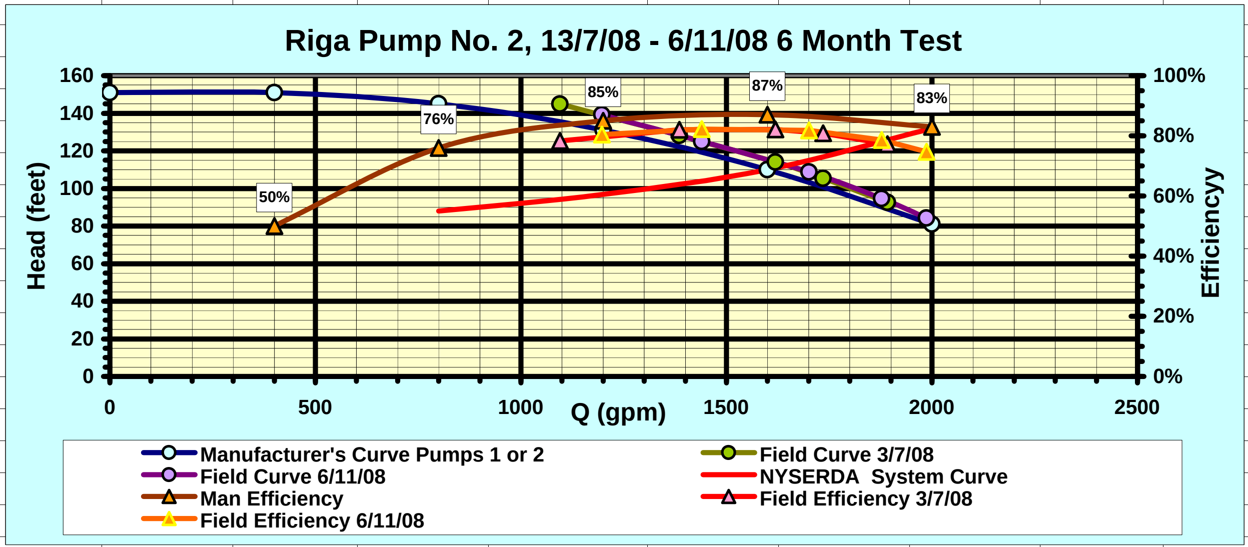

Riga Pump No. 2, 8/10/06 - 10/23/07 Post Mechanical
Head (feet)
160
140
120
100
80
60
40
20
0
100%
80%
60%
40%
20%
0%
Efficiencyy
0
500
1000
1500
2000
2500
Q (gpm)
50%
76%
85%
87%
83%
Manufacturer's Curve Pumps 1 or 2
Field Curve 8/10/06
Field Curve 10/23/07
Man Efficiency
Field Efficiency 8/10/06
Field Efficiency 10/23/07


Riga Pump No. 2, 10/23/07 - 12/04/07 Post Interior Coating
Head (feet)
Efficiencyy
Q (gpm)
50%
76%
85%
87%
83%
0
20
40
60
80
100
120
140
160
0%
20%
40%
60%
80%
100%
0
500
1000
1500
2000
2500
Manufacturer's Curve Pumps 1 or 2
Field Curve 10/23/07
Field Efficiency 12/4/07
Field Curve 12/4/07
Man Efficiency
Field Efficiency 10/23/07

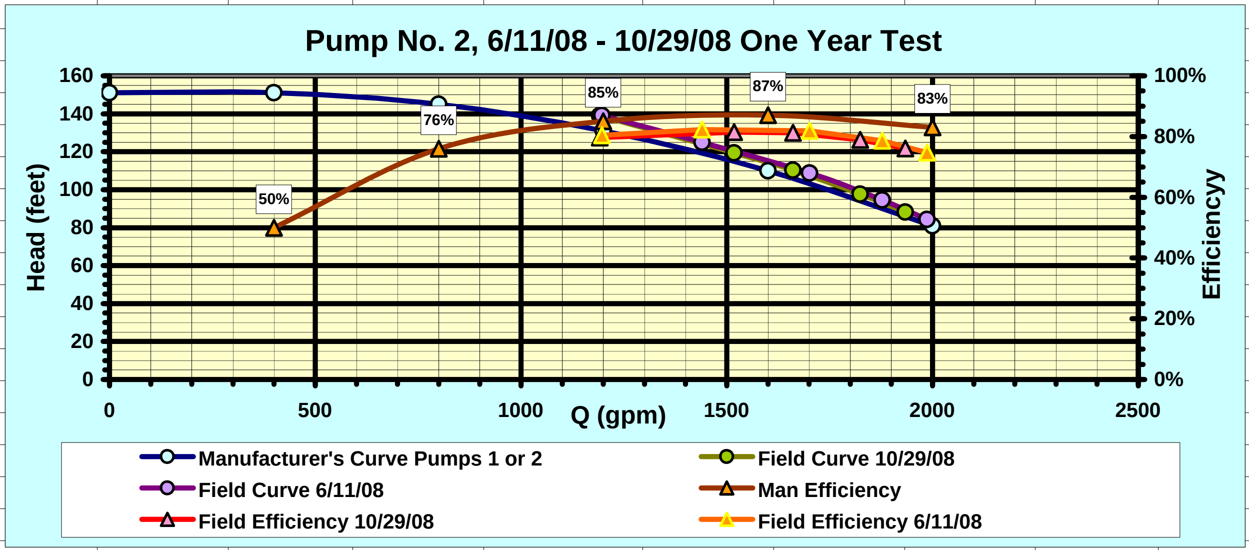

Riga Pump No. 2, 12/04/07 - 12/19/07 30 Day Test
Head (feet)
Efficiencyy
Q (gpm)
50%
76%
85%
87%
83%
0
20
40
60
80
100
120
140
160
0%
20%
40%
60%
80%
100%
0
500
1000
1500
2000
2500
Manufacturer's Curve Pumps 1 or 2
Field Curve 12/19/07
Man Efficiency
Field Efficiency 12/19/07
Field Curve 12/4/07
NYSERDA System Curve
Field Efficiency 12/4/07



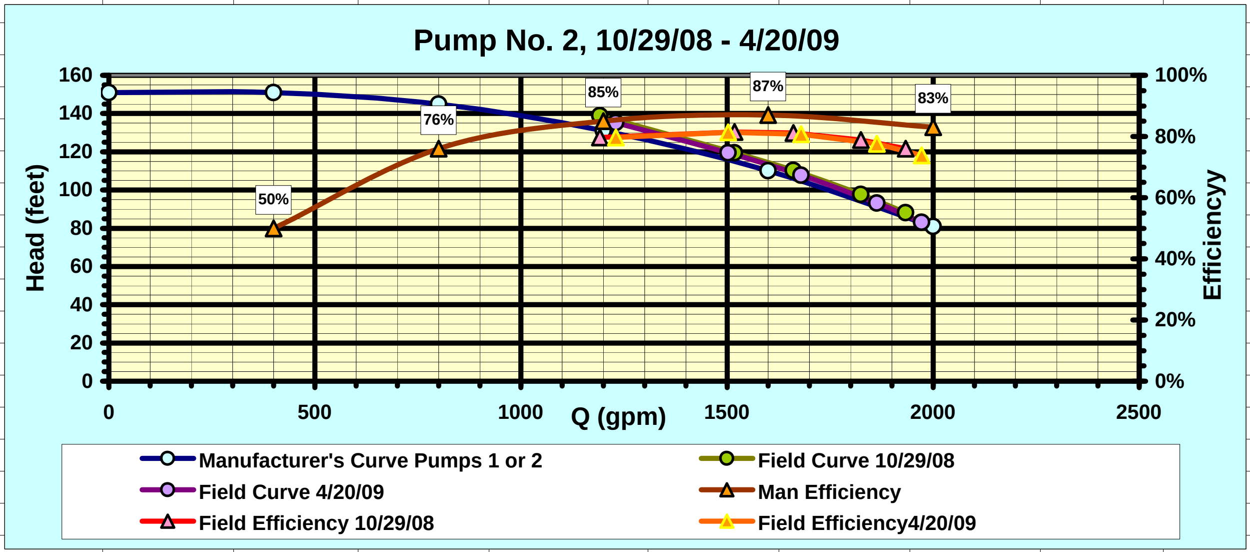
Riga Pump No. 2, 12/19/07 30 Day Test - 3/7/08 90 Day Test
Head (feet)
Efficiencyy
Q (gpm)
0
20
40
60
80
100
120
140
160
0%
20%
40%
60%
80%
100%
0
500
1000
1500
2000
2500
50%
76%
85%
87%
83%
Manufacturer's Curve Pumps 1 or 2
Field Curve 12/19/07
Man Efficiency
Field Efficiency 12/19/07
Field Curve 3/7/08
NYSERDA System Curve
Field Efficiency 3/7/08



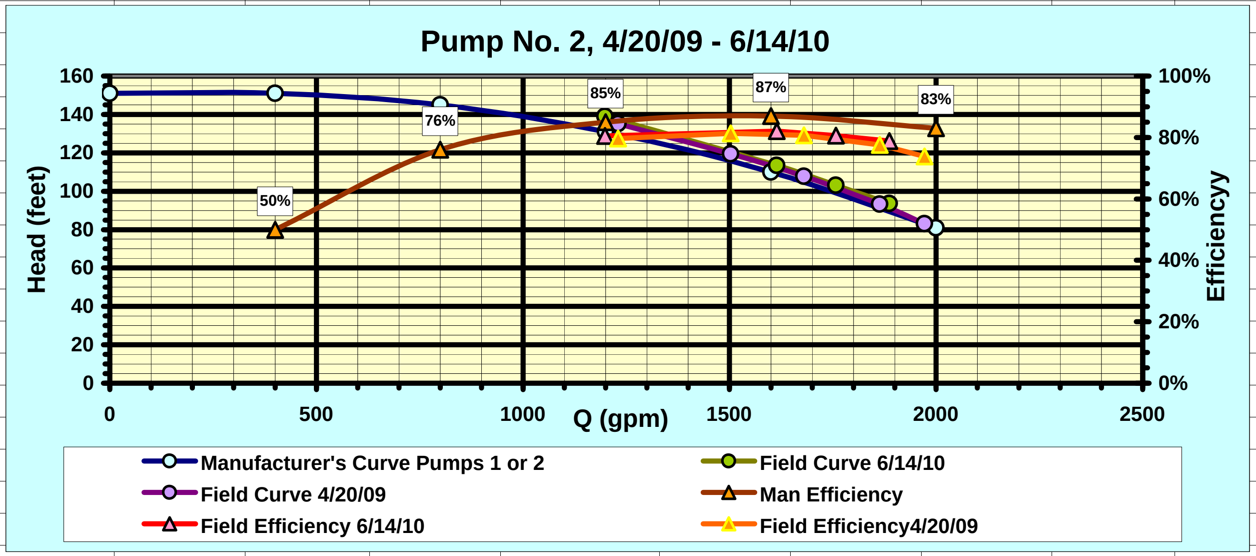
Riga Pump No. 2, 13/7/08 - 6/11/08 6 Month Test
Head (feet)
Efficiencyy
Q (gpm)
0
20
40
60
80
100
120
140
160
0%
20%
40%
60%
80%
100%
0
500
1000
1500
2000
2500
50%
76%
85%
87%
83%
Manufacturer's Curve Pumps 1 or 2
Field Curve 6/11/08
Man Efficiency
Field Efficiency 6/11/08
Field Curve 3/7/08
NYSERDA System Curve
Field Efficiency 3/7/08



Pump No. 2, 6/11/08 - 10/29/08 One Year Test
Head (feet)
Efficiencyy
Q (gpm)
0
500
1000
1500
2000
2500
0
20
40
60
80
100
120
140
160
0%
20%
40%
60%
80%
100%
50%
76%
85%
87%
83%
Manufacturer's Curve Pumps 1 or 2
Field Curve 10/29/08
Field Curve 6/11/08
Man Efficiency
Field Efficiency 10/29/08
Field Efficiency 6/11/08

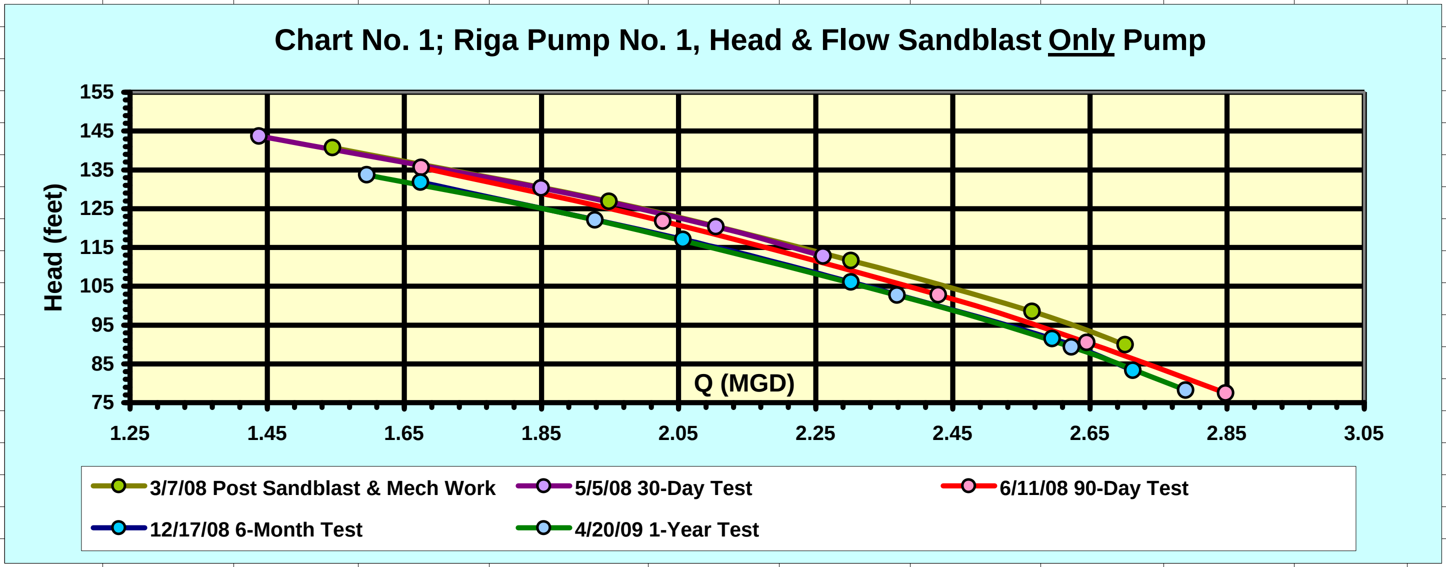


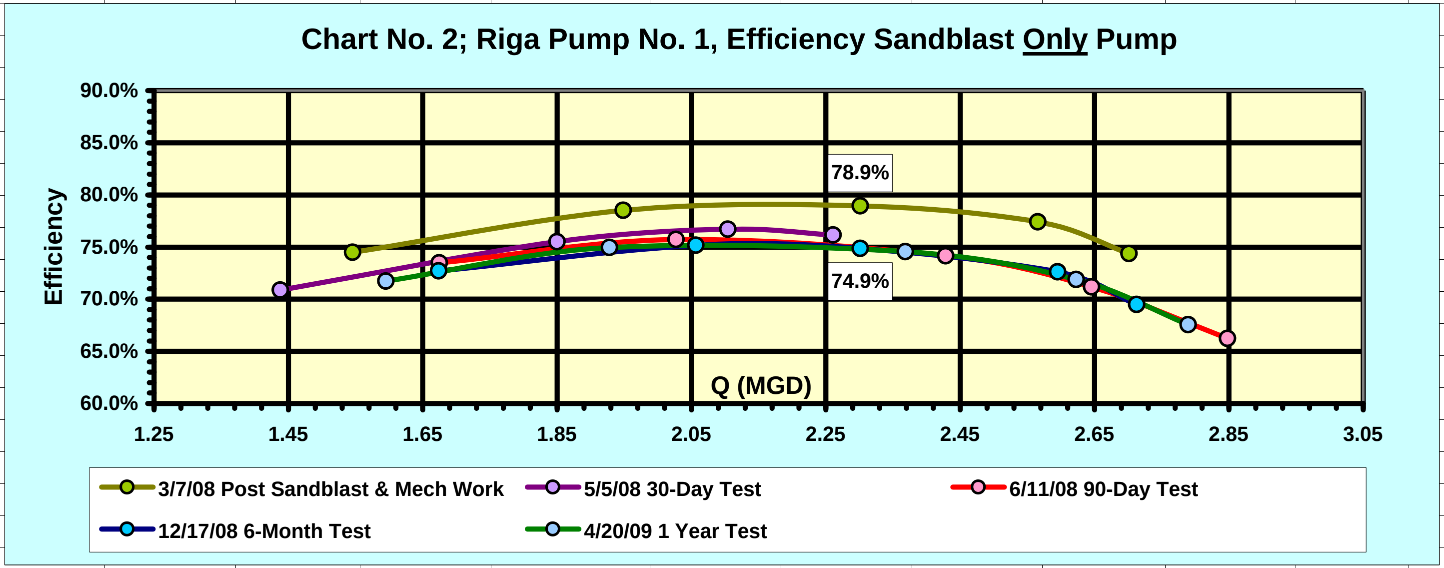
Pump No. 2, 10/29/08 - 4/20/09
Head (feet)
Efficiencyy
Q (gpm)
0
500
1000
1500
2000
2500
0
20
40
60
80
100
120
140
160
0%
20%
40%
60%
80%
100%
50%
76%
85%
87%
83%
Manufacturer's Curve Pumps 1 or 2
Field Curve 10/29/08
Field Curve 4/20/09
Man Efficiency
Field Efficiency 10/29/08
Field Efficiency4/20/09



Pump No. 2, 4/20/09 - 6/14/10
160
140
120
100
80
60
40
20
0
Head (feet)
100%
80%
60%
40%
20%
0%
Efficiencyy
0
500
1000
1500
2000
2500
Q (gpm)
50%
76%
85%
87%
83%
Manufacturer's Curve Pumps 1 or 2
Field Curve 4/20/09
Field Efficiency 6/14/10
Field Curve 6/14/10
Man Efficiency
Field Efficiency4/20/09

Sandblast vs. Sandblast & Coating Comparison





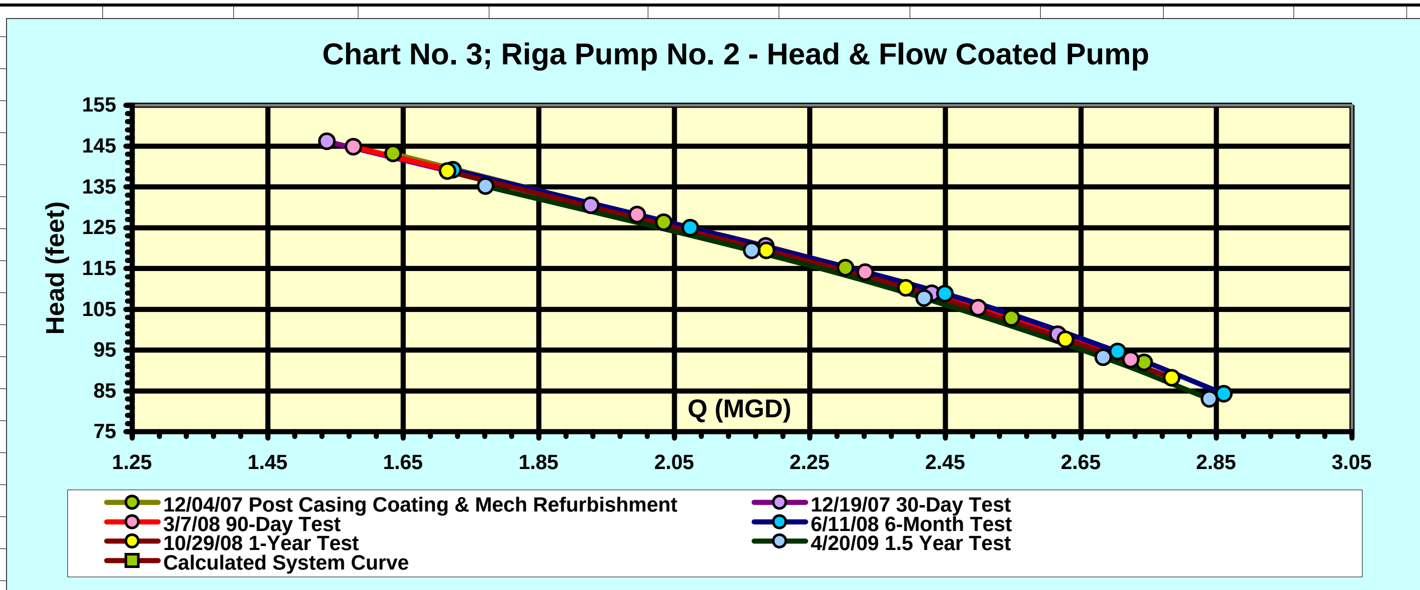


Chart No. 3; Riga Pump No. 2 - Head & Flow Coated Pump
Head (feet)
155
145
135
125
115
105
95
85
75
Q (MGD)
1.25
1.45
1.65
1.85
2.05
2.25
2.45
2.65
2.85
3.05
12/04/07 Post Casing Coating & Mech Refurbishment
12/19/07 30-Day Test
3/7/08 90-Day Test
6/11/08 6-Month Test
10/29/08 1-Year Test
4/20/09 1.5 Year Test
Calculated System Curve

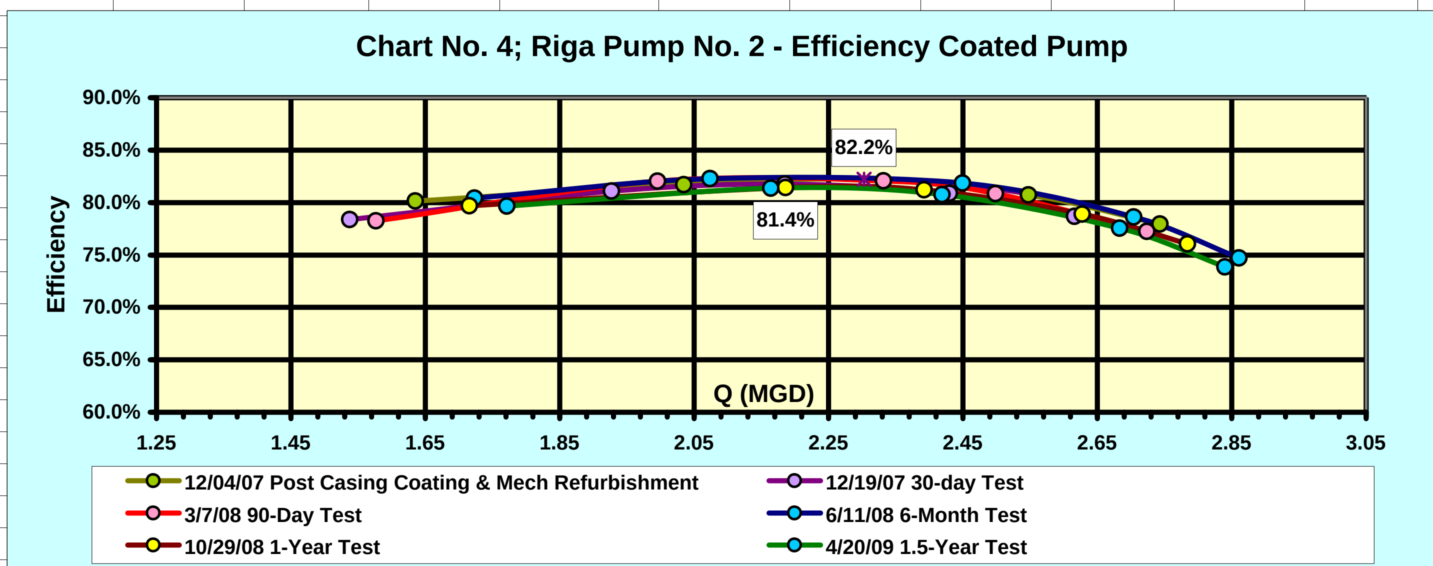


Chart No. 4; Riga Pump No. 2 - Efficiency Coated Pump
Efficiency
90.0%
85.0%
80.0%
75.0%
70.0%
65.0%
60.0%
82.2%
81.4%
Q (MGD)
1.25
1.45
1.65
1.85
2.05
2.25
2.45
2.65
2.85
3.05
12/04/07 Post Casing Coating & Mech Refurbishment
12/19/07 30-day Test
3/7/08 90-Day Test
6/11/08 6-Month Test
10/29/08 1-Year Test
4/20/09 1.5-Year Test

Scottsville No. 1
Energy Efficiency Cost Calculator
Continuous Service

Pre Mechanical & Coating	
Head (ft)	70.5
Flow (gpm)	622.9
Efficiency	63.7%
Hours Operation/month	730
BHP	17
kW (Assumes Motor Eff 95%)	13.7
kW Demand Charge	$137
kwh cost	$848
Total Monthly kWH	9,980
Monthly Cost	**$984.97**

Constants	
Hours/ Month	730
kW Demand Cost	$10.00
kwh Cost	$0.085
Motor Efficiency	95.0%

Post Mechanical	
Head (ft)	71.5
Flow (gpm)	639
Efficiency	66.2%
Hours Operation/month	712
BHP	17
kW (Assumes Motor Eff 95%)	13.7
kW Demand Charge	$137
kwh cost	$828
Total Monthly kWH	9739
Monthly Cost	**$964.66**

Pre - Post Mechanical Comparison	
Monthly Savings	**$20**
Annual Savings	**$244**
5 Year Savings	**$1,218**
kW Demand Reduction	**-0.02**
Monthly kwh Savings	**241**
Yearly kwh Savings	**2888**

Post Sandblasting (only)	
Head (ft)	75
Flow (gpm)	694
Efficiency	76.2%
Hours Operation/month	655
BHP	17
kW (Assumes Motor Eff 95%)	13.5
kW Demand Charge	$135
kwh cost	$754
Total Monthly kWH	8875
Monthly Cost	**$889.83**

Pre - Post Sandblast Comparison	
Monthly Savings	**$75**
Annual Savings	**$898**
5 Year Savings	**$4,490**
kW Demand Reduction	**0.14**
Monthly kwh Savings	**864**
Yearly kwh Savings	**10367**

Post Impeller Coating	
Head (ft)	75
Flow (gpm)	694
Efficiency	76.2%
Hours Operation/month	655
BHP	17
kW (Assumes Motor Eff 95%)	13.5
kW Demand Charge	$135
kwh cost	$754
Total Monthly kWH	8875
Monthly Cost	**$889.83**

Pre - Post Impeller Coating Comparison	
Monthly Savings	**$0**
Annual Savings	**$0**
5 Year Savings	**$0**
kW Demand Reduction	**0.14**
Monthly kwh Savings	**0**
Yearly kwh Savings	**0**

Pre Mechanical to Post Interior *Sandblasting Comparison*	
Monthly Savings	**$95**
Annual Savings	**$1,142**
5 Year Savings	**$5,709**
kW Demand Reduction	**0.13**
Monthly kwh Savings	**1105**
Yearly kwh Savings	**13255**

20% Service Time

Pre Mechanical & Coating	
Head (ft)	70.5
Flow (gpm)	622.9
Efficiency	63.7%
Hours Operation/month	146
BHP	17
kW (Assumes Motor Eff 95%)	13.7
kW Demand Charge	$137
kwh cost	$170
Total Monthly kWH	1,996
Monthly Cost	**$306.36**

Constants	
Hours/ Month	730
kW Demand Cost	$10.00
kwh Cost	$0.085
Motor Efficiency	95.0%

Scottsville No. 1 Cont'

Post Mechanical

Head (ft)	71.5
Flow (gpm)	639
Efficiency	66.2%
Hours Operation/month	142
BHP	17
kW (Assumes Motor Eff 95%)	13.7
kW Demand Charge	$137
kwh cost	$166
Total Monthly kWH	1948
Monthly Cost	**$302.42**

Pre - Post Mechanical Comparison

Monthly Savings	$4
Annual Savings	$47
5 Year Savings	$236
kW Demand Reduction	0.0
Monthly kwh Savings	48
Yearly kwh Savings	578

Post Sandblasting (only)

Head (ft)	75
Flow (gpm)	694
Efficiency	76.2%
Hours Operation/month	131
BHP	17
kW (Assumes Motor Eff 95%)	13.5
kW Demand Charge	$135
kwh cost	$151
Total Monthly kWH	1775
Monthly Cost	**$286.33**

Pre - Post Sandblast Comparison

Monthly Savings	$16
Annual Savings	$193
5 Year Savings	$966
kW Demand Reduction	0.1
Monthly kwh Savings	173
Yearly kwh Savings	2073

Post Impeller Coating

Head (ft)	75
Flow (gpm)	694
Efficiency	76.2%
Hours Operation/month	131
BHP	17
kW (Assumes Motor Eff 95%)	13.5
kW Demand Charge	$135
kwh cost	$151
Total Monthly kWH	1775
Monthly Cost	**$286.33**

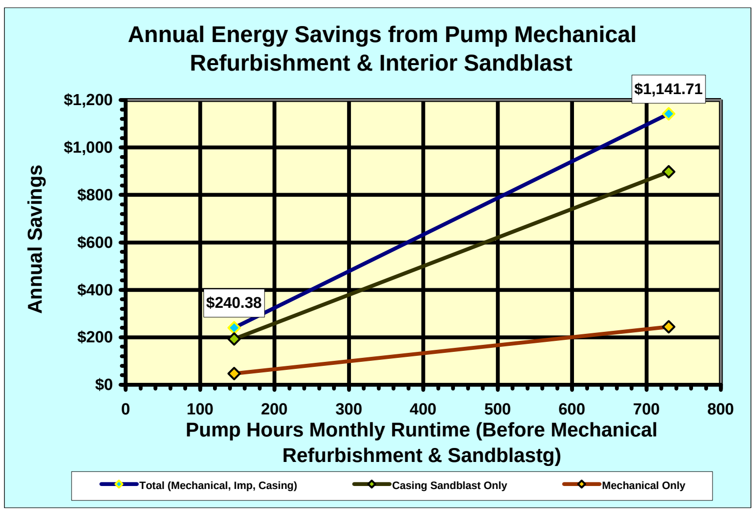
Pre - Post Impeller Coating Comparison

Monthly Savings	$0
Annual Savings	$0
5 Year Savings	$0
kW Demand Reduction	0.14
Monthly kwh Savings	1797
Yearly kwh Savings	21563

Pre Mechanical to Post Interior Sandblast Comparison

Monthly Savings	$20
Annual Savings	$240
5 Year Savings	$1,202
kW Demand Reduction	0.13
Monthly kwh Savings	221
Yearly kwh Savings	2651

Pump Hours of Operation Before Refurbishment & Interior Coating	Annual Savings Through Refurbishment & Interior Coatings
Total	
730	$1,141.71
146	$240.38
Mechanical Only	
730	$243.66
146	$47.28
Casing Sandblast Only	
730	$898.05
146	$193.10
Impeller Coating Only	
730	$0.00
146	$0.00



Scottsville No. 2
Energy Efficiency Cost Calculator
Continuous Service

Pre Mechanical & Coating

Head (ft)	69.8
Flow (gpm)	602.8
Efficiency	65.0%
Hours Operation/month	730
BHP	16
kW (Assumes Motor Eff 95%)	12.8
kW Demand Charge	$128
kwh cost	$796
Total Monthly kWH	9,370
Monthly Cost	**$924.85**

Constants

Hours/ Month	730
kW Demand Cost	$10.00
kwh Cost	$0.085
Motor Efficiency	95.0%

Post Casing Coating

Head (ft)	75
Flow (gpm)	694.4
Efficiency	78.5%
Hours Operation/month	634
BHP	17
kW (Assumes Motor Eff 95%)	13.2
kW Demand Charge	$132
kwh cost	$709
Total Monthly kWH	8337
Monthly Cost	**$840.20**

Pre - Post Casing Coating Comparison

Monthly Savings	**$85**
Annual Savings	**$1,016**
5 Year Savings	**$5,079**
kW Demand Reduction	**-0.3**
Monthly kwh Savings	**1033**
Yearly kwh Savings	**12401**

Post Mechanical

Head (ft)	76.2
Flow (gpm)	711.8
Efficiency	81.2%
Hours Operation/month	618
BHP	17
kW (Assumes Motor Eff 95%)	13.2
kW Demand Charge	$132
kwh cost	$696
Total Monthly kWH	8189
Monthly Cost	**$828.50**

Pre - Post Mechanical Comparison

Monthly Savings	**$12**
Annual Savings	**$140**
5 Year Savings	**$702**
kW Demand Reduction	**-0.1**
Monthly kwh Savings	**148**
Yearly kwh Savings	**1779**

Post Impeller Coating

Head (ft)	74.2
Flow (gpm)	681
Efficiency	79.7%
Hours Operation/month	646
BHP	16
kW (Assumes Motor Eff 95%)	12.6
kW Demand Charge	$126
kwh cost	$691
Total Monthly kWH	8124
Monthly Cost	**$816.25**

Pre - Post Impeller Coating Comparison

Monthly Savings	**$12**
Annual Savings	**$147**
5 Year Savings	**$735**
kW Demand Reduction	**0.58**
Monthly kwh Savings	**65**
Yearly kwh Savings	**778**

Pre Mechanical to Post Interior
Coating Comparison

Monthly Savings	**$109**
Annual Savings	**$1,303**
5 Year Savings	**$6,516**
kW Demand Reduction	**0.26**
Monthly kwh Savings	**1247**
Yearly kwh Savings	**14959**

Scottsville No. 2 Cont'
20% Service Time

Constants

Hours/ Month	730
kW Demand Cost	$10.00
kwh Cost	$0.085
Motor Efficiency	95.0%

Pre Mechanical & Coating

Head (ft)	69.8
Flow (gpm)	602.8
Efficiency	65.0%
Hours Operation/month	146
BHP	16
kW (Assumes Motor Eff 95%)	12.8
kW Demand Charge	$128
kwh cost	$159
Total Monthly kWH	1,874
Monthly Cost	**$287.66**

Post Casing Coating

Head (ft)	75
Flow (gpm)	694.4
Efficiency	78.5%
Hours Operation/month	127
BHP	17
kW (Assumes Motor Eff 95%)	13.2
kW Demand Charge	$132
kwh cost	$142
Total Monthly kWH	1667
Monthly Cost	**$273.29**

Pre - Post Mechanical Comparison

Monthly Savings	**$14**
Annual Savings	**$172**
5 Year Savings	**$862**
kW Demand Reduction	**-0.3**
Monthly kwh Savings	**207**
Yearly kwh Savings	**2480**

Post Mechanical

Head (ft)	76.2
Flow (gpm)	711.8
Efficiency	81.2%
Hours Operation/month	124
BHP	17
kW (Assumes Motor Eff 95%)	13.2
kW Demand Charge	$132
kwh cost	$139
Total Monthly kWH	1638
Monthly Cost	**$271.67**

Pre - Post Impeller Comparison

Monthly Savings	**$2**
Annual Savings	**$19**
5 Year Savings	**$97**
kW Demand Reduction	**-0.1**
Monthly kwh Savings	**30**
Yearly kwh Savings	**356**

Post Impeller Coating

Head (ft)	74.2
Flow (gpm)	681
Efficiency	79.7%
Hours Operation/month	129
BHP	16
kW (Assumes Motor Eff 95%)	12.6
kW Demand Charge	$126
kwh cost	$138
Total Monthly kWH	1625
Monthly Cost	**$263.83**

Pre - Post Internal Coating Comparison

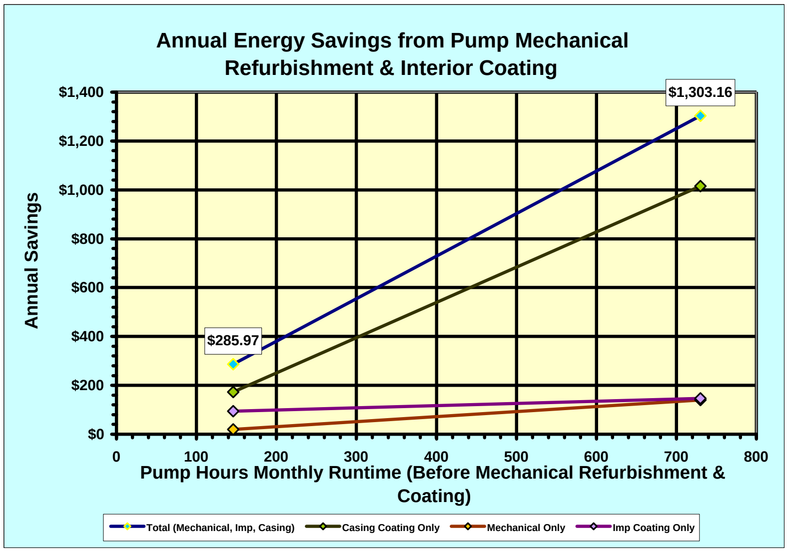
Monthly Savings	**$8**
Annual Savings	**$94**
5 Year Savings	**$470**
kW Demand Reduction	**0.58**
Monthly kwh Savings	**1529**
Yearly kwh Savings	**18351**

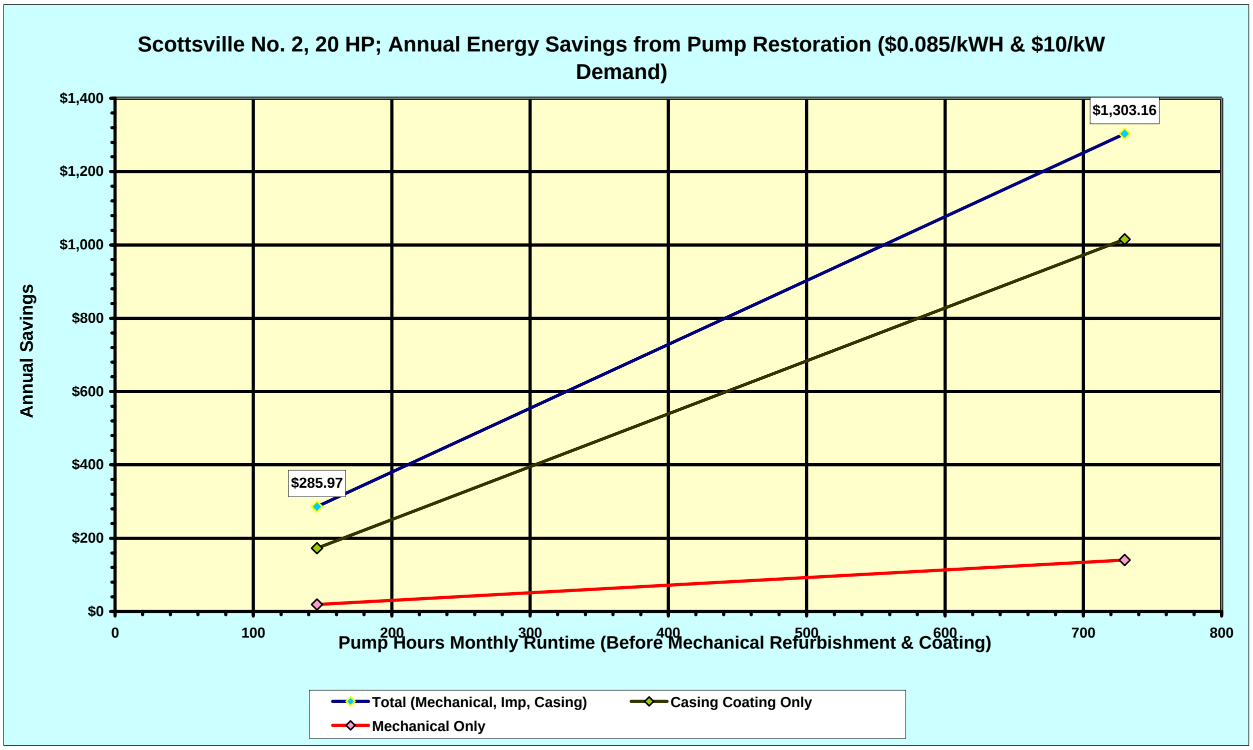
Pre Mechanical to Post Interior *Coating Comparison*

Monthly Savings	**$24**
Annual Savings	**$286**
5 Year Savings	**$1,430**
kW Demand Reduction	**0.26**
Monthly kwh Savings	**249**
Yearly kwh Savings	**2992**

Scottsville No. 2 Cont'

Pump Hours of Operation Before Refurbishment & Interior Coating	Annual Savings Through Refurbishment & Interior Coatings
Total	
730	$1,303.16
146	$285.97
Casing Coating Only	
730	$1,015.74
146	$172.45
Mechanical Only	
730	$140.44
146	$19.46
Impeller Coating Only	
730	$146.98
146	$94.05





Scottsville BPS

Manufacturer Pump No. 1 or 2

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	Ns
0	0	84				
200	0.288	84	51.0%	8	7	596
400	0.576	83	73.0%	11	9	851
600	0.864	80	80.0%	15	12	1071
800	1.152	66	78.0%	17	14	1429
1000	1.44	47	63.0%	19	15	2061

NYSERDA System Curve

Q		H	
50.0%	0.50	80%	60
75.0%	0.75	88%	66
BEP	1.00	100%	75
125.0%	1.25	120%	90

Pump Nameplate Information

Man:	ITT/AC
Serial:	1-75467-01-01 & 02
Speed	1170
Model:	8100, 150
Size:	6x4x12

Motor Nameplate Information

Man:	Siemens
Model:	RGZESD
Speed:	1175
HP:	20
Amps:	26
Nom Eff%	91.70%

Pump No. 1 Field Curve 8/16/06 Initial Test

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
931	1.34	51.74	10.56	69.42	23.75	40.8	1.73	8.76	48	54.5%	20.7	17	1180
833	1.2	52.74	9.46	75.44	21.27	52.4	1.39	7.02	58	61.0%	20.0	16	1179
653	0.94	54.66	7.41	83.51	16.66	66.6	0.85	4.31	70	63.5%	18.2	15	1181
563	0.81	55.52	6.38	86.6	14.36	71.8	0.63	3.20	74	62.3%	17.0	14	1182
361	0.52	57.63	4.10	92.48	9.22	80.5	0.26	1.32	82	53.5%	13.9	11	1185

Corrected to 1170 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mgd
923	1.33	47.1	54.5%	20.1	16	1170	12.3
827	1.19	57.2	61.0%	19.6	16	1170	13.4
647	0.93	68.8	63.5%	17.7	14	1170	15.5
557	0.80	72.9	62.3%	16.5	13	1170	16.7
357	0.51	79.5	53.5%	13.4	11	1170	21.2

Pump No. 1 Field Curve 10/2/06 Post Mechanical Rebuild

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
840	1.21	46.23	9.54	69.64	21.44	54.1	1.41	7.14	60	61.8%	20.5	17	1181
792	1.14	46.4	8.99	71.88	20.20	58.9	1.25	6.34	64	64.2%	19.9	16	1182
694	1	48.03	7.88	77.13	17.72	67.2	0.96	4.88	71	66.8%	18.7	15	1184
542	0.78	49.19	6.15	81.68	13.82	75.1	0.59	2.97	77	63.4%	16.7	14	1184
340	0.49	51.53	3.86	87.21	8.68	82.4	0.23	1.17	83	54.0%	13.3	11	1187

Corrected to 1170 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mgd
832	1.20	58.7	61.8%	20.0	16	1170	13.5
784	1.13	62.7	64.2%	19.3	16	1170	13.9
686	0.99	69.5	66.8%	18.0	15	1170	14.8
535	0.77	75.6	63.4%	16.1	13	1170	17.0
335	0.48	81.0	54.0%	12.7	10	1170	21.4

Pump No. 1 Field Curve 11/03/06 Post Sandblasting

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
917	1.32	32.57	10.40	55.64	23.39	53.3	1.68	8.50	60	70.3%	19.8	16.1	1181
757	1.09	35.65	8.59	65.49	19.32	68.9	1.15	5.79	74	76.3%	18.4	15.0	1182
660	0.95	37.48	7.49	69.91	16.84	74.9	0.87	4.40	78	75.4%	17.3	14.1	1184
458	0.66	40.69	5.20	76.85	11.70	83.5	0.42	2.12	85	69.2%	14.3	11.6	1187
278	0.4	43.28	3.15	80.75	7.09	86.6	0.15	0.78	87	55.3%	11.1	9.0	1189

Corrected to 1170 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mgd
908	1.31	59.0	70.3%	19.2	16	1170	12.0
749	1.08	72.1	76.3%	17.9	15	1170	13.5
652	0.94	76.6	75.4%	16.7	14	1170	14.5
452	0.65	82.8	69.2%	13.7	11	1170	17.1
273	0.39	84.4	55.3%	10.5	9	1170	21.8

Pump No. 1 Field Curve 12/14/06, 30 Day Test

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
715	1.03	35.91	8.12	66.63	18.25	71.0	1.02	5.17	75	76.6%	17.7	14.4	1181
646	0.93	37.29	7.33	70.17	16.48	76.0	0.83	4.22	79	76.3%	17.0	13.8	1182
528	0.76	38.65	5.99	73.65	13.47	80.9	0.56	2.82	83	72.7%	15.2	12.4	1184
424	0.61	39.74	4.81	76.29	10.81	84.4	0.36	1.81	86	67.3%	13.6	11.1	1187
306	0.44	40.72	3.47	77.86	7.80	85.8	0.19	0.94	87	54.9%	12.2	9.9	1189

Corrected to 1170 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mgd
709	1.02	73.7	76.6%	17.2	14	1170	13.7
639	0.92	77.7	76.3%	16.5	13	1170	14.5
522	0.75	81.2	72.7%	14.7	12	1170	15.9
418	0.60	83.4	67.3%	13.1	11	1170	17.7
301	0.43	83.8	54.9%	11.6	9	1170	21.8

Pump No. 1 Field Curve 2/1/07, 90 Day Test

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
917	1.32	47.52	10.40	70.4	23.39	52.9	1.68	8.50	60	69.1%	20.0	16.3	1181
868	1.25	47.86	9.85	73.59	22.15	59.4	1.51	7.62	66	73.8%	19.5	15.9	1182
757	1.09	49.14	8.59	79.24	19.32	69.5	1.15	5.79	74	77.2%	18.4	15.0	1184
563	0.81	51.28	6.38	86.02	14.36	80.2	0.63	3.20	83	74.5%	15.8	12.9	1184
375	0.54	53.3	4.26	90.6	9.57	86.2	0.28	1.42	87	64.4%	12.8	10.5	1188

Corrected to 1170 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mgd
908	1.31	58.6	69.1%	19.4	16	1170	12.1
859	1.24	64.2	73.8%	18.9	15	1170	12.4
748	1.08	72.4	77.2%	17.7	14	1170	13.4
556	0.80	80.9	74.5%	15.2	12	1170	15.5
369	0.53	84.7	64.4%	12.3	10	1170	18.8

Pump No. 1 Field Curve 5/11/07, 6 Month Test

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
944	1.36	41.29	10.72	62.49	24.10	49.0	1.78	9.02	56	67.1%	20.0	16.3	1181
813	1.17	44.63	9.22	71.97	20.74	63.2	1.32	6.68	69	74.4%	18.9	15.4	1182
688	0.99	47.04	7.80	78.63	17.55	73.0	0.95	4.78	77	76.2%	17.5	14.2	1182
535	0.77	49.65	6.07	84.73	13.65	81.0	0.57	2.89	83	73.0%	15.4	12.5	1185
396	0.57	51.86	4.49	88.75	10.10	85.2	0.31	1.58	86	66.4%	13.0	10.6	1187

Corrected to 1170 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mgd
936	1.35	55.2	67.1%	19.4	16	1170	11.7
804	1.16	67.1	74.4%	18.3	15	1170	12.9
681	0.98	75.3	76.2%	17.0	14	1170	14.1
528	0.76	81.3	73.0%	14.8	12	1170	15.9
390	0.56	84.0	66.4%	12.5	10	1170	18.1

Pump No. 1 Field Curve 11/19/07, One Year Test

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
931	1.34	36.63	10.56	58.87	23.75	51.4	1.73	8.76	58	69.4%	19.8	16.09	1182
688	0.99	40.38	7.80	71.82	17.55	72.6	0.95	4.78	76	76.4%	17.4	14.14	1184
500	0.72	42.96	5.67	78.51	12.76	82.1	0.50	2.53	84	71.8%	14.8	12.04	1187
250	0.36	45.24	2.84	82.53	6.38	86.1	0.13	0.63	87	52.5%	10.4	8.47	1190

Corrected to 1170 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mgd
921	1.33	57.2	69.4%	19.2	16	1170	11.8
679	0.98	74.7	76.4%	16.8	14	1170	13.9
493	0.71	81.8	71.8%	14.2	12	1170	16.2
246	0.35	83.8	52.5%	9.9	8	1170	22.7

Pump No. 1 Field Curve 4/10/08, 18 Month Test

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
792	1.14	38.43	8.99	66.65	20.20	65.2	1.25	6.34	70	75.6%	18.6	15.11	1183
715	1.03	39.78	8.12	70.34	18.25	70.6	1.02	5.17	75	76.0%	17.8	14.45	1184
646	0.93	41.01	7.33	73.34	16.48	74.7	0.83	4.22	78	75.4%	16.9	13.74	1184
486	0.7	43.49	5.52	79.03	12.41	82.1	0.47	2.39	84	71.3%	14.5	11.77	1187
285	0.41	45.67	3.23	82.69	7.27	85.5	0.16	0.82	86	56.7%	10.9	8.89	1190

Corrected to 1170 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mgd
783	1.13	68.7	75.6%	18.0	15	1170	13.0
707	1.02	73.0	76.0%	17.1	14	1170	13.7
638	0.92	76.2	75.4%	16.3	13	1170	14.4
479	0.69	81.6	71.3%	13.9	11	1170	16.3
280	0.40	83.4	56.7%	10.4	8	1171	21.0

Pump No. 1 Field Curve 10/29/08, Two Year Test

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
972	1.4	40.91	11.03	59.87	24.81	43.8	1.89	9.56	51	63.1%	20.0	16.28	1178
833	1.2	44.09	9.46	70.33	21.27	60.6	1.39	7.02	66	74.0%	18.8	15.33	1179
569	0.82	49.21	6.46	82.96	14.53	78.0	0.65	3.28	81	73.9%	15.7	12.76	1183
424	0.61	51.85	4.81	87.51	10.81	82.4	0.36	1.81	84	66.3%	13.5	11.01	1186
229	0.33	54.21	2.60	91.2	5.85	85.4	0.11	0.53	86	49.5%	10.0	8.17	1190

Corrected to 1170 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mgd
966	1.39	50.8	63.1%	19.6	16	1170	11.5
827	1.19	65.2	74.0%	18.4	15	1170	12.6
563	0.81	78.8	73.9%	15.2	12	1170	15.2
418	0.60	81.6	66.3%	13.0	11	1170	17.6
226	0.32	83.2	49.5%	9.6	8	1171	24.0

Pump No. 1 Field Curve 4/20/09, 2.5 Year Test

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
826	1.19	40	9.38	66.9	21.09	62.1	1.37	6.91	68	74.5%	19.0	15.43	1182
757	1.09	40.94	8.59	70.23	19.32	67.7	1.15	5.79	72	75.6%	18.3	14.88	1183
681	0.98	42.48	7.72	73.95	17.37	72.7	0.93	4.68	76	76.2%	17.2	14.03	1183
472	0.68	45.66	5.36	81.46	12.05	82.7	0.45	2.26	85	70.6%	14.3	11.61	1187
208	0.3	48.56	2.36	85.88	5.32	86.2	0.09	0.44	87	47.2%	9.6	7.85	1191

Corrected to 1170 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mgd
818	1.18	66.3	74.5%	18.4	15	1170	12.7
749	1.08	70.7	75.6%	17.7	14	1170	13.4
673	0.97	74.8	76.2%	16.7	14	1170	14.0
465	0.67	82.1	70.6%	13.7	11	1170	16.6
205	0.29	83.7	47.2%	9.2	7	1171	25.3

Pump No. 1 Field Curve 3/29/10 (Post Sandblasting 3.5 Year Test)

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
799	1.15	41.12	9.06	68.89	20.38	64.1	1.28	6.45	69	74.2%	18.8	15.33	1182
708	1.02	42.72	8.04	73.48	18.08	71.1	1.00	5.07	75	75.4%	17.8	14.49	1183
646	0.93	43.72	7.33	76.22	16.48	75.1	0.83	4.22	78	75.1%	17.0	13.86	1183
597	0.86	44.6	6.78	78.02	15.24	77.2	0.71	3.61	80	74.0%	16.3	13.28	1186
465	0.67	46.64	5.28	82.67	11.87	83.2	0.43	2.19	85	70.0%	14.3	11.60	1184

Corrected to 1170 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mgd
791	1.14	67.9	74.2%	18.3	15	1170	13.1
701	1.01	73.5	75.4%	17.2	14	1170	13.9
639	0.92	76.7	75.1%	16.5	13	1170	14.6
589	0.85	77.9	74.0%	15.7	13	1170	15.0
460	0.66	83.1	70.0%	13.8	11	1171	16.9

Pump No. 1 Field Curve 6/7/10 (Post Sandblasting 3.75 Year Test)

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
826	1.19	41.78	9.38	68.38	21.09	61.4	1.37	6.91	67	73.6%	19.0	15.46	1182
771	1.11	42.96	8.75	71.82	19.67	66.7	1.19	6.01	71	75.6%	18.4	14.97	1182
694	1	44.09	7.88	74.97	17.72	71.3	0.96	4.88	75	75.3%	17.5	14.25	1183
583	0.84	45.73	6.62	79.4	14.89	77.8	0.68	3.44	81	73.7%	16.1	13.09	1184
361	0.52	48.35	4.10	85.38	9.22	85.5	0.26	1.32	87	63.7%	12.4	10.08	1187

Corrected to 1170 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mgd
818	1.18	65.6	73.6%	18.4	15	1170	12.6
763	1.10	70.0	75.6%	17.8	14	1170	12.8
687	0.99	73.6	75.3%	16.9	13	1170	13.6
576	0.83	78.6	73.7%	15.5	13	1170	15.4
356	0.51	84.3	63.7%	11.9	11	1171	21.9

Pump No. 2 Field Curve 9/11/07 Initial Test

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
743	1.07	44.63	8.43	70.01	18.96	58.6	1.10	5.58	63	64.0%	18.5	15.1	1182
618	0.89	47.07	7.01	76.34	15.77	67.6	0.76	3.86	71	65.2%	16.9	13.8	1182
451	0.65	49.47	5.12	81.82	11.52	74.7	0.41	2.06	76	59.0%	14.8	12.0	1184
313	0.45	52.18	3.55	87.01	7.98	80.5	0.20	0.99	81	51.6%	12.4	10.1	1187

Corrected to 1170 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mgd
736	1.06	61.8	64.0%	17.9	15	1170	13.8
612	0.88	69.3	65.2%	16.4	13	1170	15.2
446	0.64	74.6	59.0%	14.2	12	1170	18.0
308	0.44	78.9	51.6%	11.9	10	1170	21.8

Pump No. 2 Field Curve (10/12/07) Post Coating - Pre Mechanical & Imp Coating

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
882	1.27	34.35	10.01	59.78	22.51	58.7	1.56	7.87	65	75.2%	19.3	15.7	1183
632	0.91	38.16	7.17	71.4	16.13	76.8	0.80	4.04	80	77.4%	16.5	13.4	1184
424	0.61	41.06	4.81	78.09	10.81	85.5	0.36	1.81	87	68.8%	13.5	11.0	1187
271	0.39	42.57	3.07	80.79	6.91	88.3	0.15	0.74	89	55.6%	10.9	8.9	1188

Corrected to 1170 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mgd
872	1.26	63.6	75.2%	18.6	15	1170	12.1
624	0.90	78.1	77.4%	15.9	13	1170	14.4
418	0.60	84.5	68.8%	13.0	11	1170	17.5
267	0.38	86.2	55.6%	10.5	9	1170	22.1

Pump No. 2 Field Curve (10/19/07) Post Coating - Pre Mechanical & Imp Coating (2nd Test)

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
924	1.33	33.71	10.48	57.92	23.57	55.9	1.71	8.63	63	74.9%	19.6	15.9	1182
736	1.06	37.05	8.35	67.68	18.79	70.8	1.08	5.48	75	78.9%	17.7	14.4	1184
486	0.7	41.01	5.52	77.36	12.41	84.0	0.47	2.39	86	72.7%	14.5	11.8	1187
340	0.49	42.5	3.86	80.18	8.68	87.0	0.23	1.17	88	62.1%	12.2	9.9	1188

Corrected to 1170 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mgd
914	1.32	61.6	74.9%	19.0	15	1170	11.7
727	1.05	73.4	78.9%	17.1	14	1170	13.3
479	0.69	83.4	72.7%	13.9	11	1170	16.4
335	0.48	85.3	62.1%	11.6	9	1170	19.6

Pump No. 2 Field Curve (11/16/07) Post Coating & Mechanical - Pre Impeller Coating

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
924	1.33	33.27	10.48	58.03	23.57	57.2	1.71	8.63	64	76.1%	19.7	15.99	1180
778	1.12	36.27	8.83	66.57	19.85	70.0	1.21	6.12	75	80.9%	18.2	14.79	1182
625	0.9	39.09	7.09	73.32	15.95	79.1	0.78	3.95	82	80.0%	16.2	13.20	1186
500	0.72	40.68	5.67	77.17	12.76	84.3	0.50	2.53	86	75.9%	14.4	11.68	1184
299	0.43	43.4	3.39	81.81	7.62	88.7	0.18	0.90	89	62.4%	10.8	8.8	1187

Corrected to 1170 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mgd
916	1.32	63.0	76.1%	19.2	16	1170	11.8
770	1.11	73.4	80.9%	17.6	14	1170	12.9
617	0.89	80.0	80.0%	15.6	13	1170	14.3
494	0.71	84.3	75.9%	13.9	11	1170	15.8
294	0.42	86.9	62.4%	10.4	8	1170	19.9

Pump No. 2 Field Curve (1/18/08) Post Coating & Mechanical - Pre Impeller Coating (2nd Test)

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
972	1.4	32.09	11.03	55.23	24.81	53.5	1.89	9.56	61	74.9%	20.0	16.30	1181
764	1.1	36.13	8.67	66.99	19.50	71.3	1.17	5.90	76	81.3%	18.0	14.67	1184
542	0.78	39.66	6.15	75.46	13.82	82.7	0.59	2.97	85	77.9%	14.9	12.16	1187
306	0.44	43.04	3.47	81.58	7.80	89.0	0.19	0.94	90	63.1%	11.0	8.93	1190

Corrected to 1170 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mgd
963	1.39	60.0	74.9%	19.5	16	1170	11.4
755	1.09	74.2	81.3%	17.4	14	1170	13.0
534	0.77	82.7	77.9%	14.3	12	1170	15.1
300	0.43	86.8	63.1%	10.4	8	1170	19.6

Pump No. 2 Field Curve (04/10/08) Post Impeller Coating

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
785	1.13	38.16	8.91	66.49	20.03	65.4	1.23	6.23	70	79.5%	17.6	14.28	1184
701	1.01	39.51	7.96	70.4	17.90	71.4	0.98	4.98	75	79.9%	16.7	13.59	1184
549	0.79	42.59	6.23	77.23	14.00	80.0	0.60	3.04	82	77.1%	14.8	12.05	1186
333	0.48	45.76	3.78	83.22	8.51	86.5	0.22	1.12	87	64.0%	11.5	9.35	1190

Corrected to 1170 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mgd
775	1.12	68.8	79.5%	16.9	14	1170	12.3
693	1.00	73.6	79.9%	16.1	13	1170	13.1
541	0.78	80.3	77.1%	14.2	12	1170	14.8
328	0.47	84.7	64.0%	11.0	9	1171	18.9

Pump No. 2 Field Curve 05/27/08 30 Day Test

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
813	1.17	38.89	9.22	66.23	20.74	63.2	1.32	6.68	69	79.2%	17.7	14.44	1184
757	1.09	40	8.59	69.02	19.32	67.0	1.15	5.79	72	79.6%	17.2	14.01	1184
674	0.97	41.71	7.65	73.14	17.19	72.6	0.91	4.59	76	79.4%	16.3	13.29	1185
542	0.78	43.95	6.15	78.58	13.82	80.0	0.59	2.97	82	77.2%	14.6	11.87	1186
375	0.54	46.37	4.26	83.66	9.57	86.1	0.28	1.42	87	68.5%	12.1	9.81	1188

Corrected to 1170 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mgd
803	1.16	66.9	79.2%	17.1	14	1170	12.1
748	1.08	70.0	79.6%	16.6	14	1170	12.6
665	0.96	74.4	79.4%	15.7	13	1170	13.4
534	0.77	80.2	77.2%	14.0	11	1170	14.8
370	0.53	84.8	68.5%	11.5	9	1171	17.7

Pump No. 2 Field Curve 05/29/08 30 Day Test (2nd Test)

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
833	1.2	43.23	9.46	69.5	21.27	60.7	1.39	7.02	66	77.6%	18.0	14.64	1183
750	1.08	45.44	8.51	74.78	19.14	67.8	1.13	5.69	72	80.0%	17.1	13.93	1184
625	0.9	48.17	7.09	81.06	15.95	76.0	0.78	3.95	79	79.8%	15.7	12.74	1185
424	0.61	52.74	4.81	89.26	10.81	84.4	0.36	1.81	86	70.5%	13.0	10.59	1188

Corrected to 1170 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mgd
824	1.19	64.9	77.6%	17.4	14	1170	11.9
741	1.07	70.6	80.0%	16.5	13	1170	12.6
617	0.89	77.2	79.8%	15.1	12	1170	13.8
418	0.60	83.4	70.5%	12.5	10	1171	16.9

Pump No. 2 Field Curve 8/4/08

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
847	1.22	43.73	9.62	69.85	21.62	60.3	1.44	7.26	66	79.1%	17.9	14.56	1179
771	1.11	45.21	8.75	73.85	19.67	66.2	1.19	6.01	71	80.1%	17.3	14.04	1180
701	1.01	46.4	7.96	77.14	17.90	71.0	0.98	4.98	75	80.4%	16.5	13.44	1180
521	0.75	49.64	5.91	84.7	13.29	81.0	0.54	2.74	83	76.8%	14.2	11.59	1184
326	0.47	52.14	3.70	89.82	8.33	87.0	0.21	1.08	88	64.4%	11.2	9.15	1188

Corrected to 1170 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mgd
841	1.21	65.2	79.1%	17.5	14	1170	11.8
764	1.10	69.8	80.1%	16.8	14	1170	12.4
695	1.00	73.7	80.4%	16.1	13	1170	13.1
515	0.74	81.2	76.8%	13.7	11	1170	15.1
321	0.46	85.3	64.4%	10.7	9	1170	18.9

Pump No. 2 Field Curve 10/29/08 (6 Month Test)

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
972	1.4	40.56	11.03	61.23	24.81	47.7	1.89	9.56	55	72.3%	18.8	15.31	1183
792	1.14	44.99	8.99	73.07	20.20	64.9	1.25	6.34	70	79.8%	17.5	14.25	1184
569	0.82	49.1	6.46	83.06	14.53	78.4	0.65	3.28	81	77.7%	15.0	12.20	1186
410	0.59	51.67	4.65	88.31	10.46	84.6	0.34	1.70	86	69.8%	12.7	10.37	1188
229	0.33	53.83	2.60	91.74	5.85	87.6	0.11	0.53	88	52.5%	9.7	7.89	1190

Corrected to 1170 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mgd
962	1.38	54.2	72.3%	18.2	15	1170	10.7
782	1.13	68.3	79.8%	16.9	14	1170	12.2
562	0.81	78.9	77.7%	14.4	12	1170	14.5
404	0.58	83.4	69.8%	12.2	10	1170	17.0
225	0.32	85.1	52.5%	9.2	7	1170	23.1

Pump No. 2 Field Curve 4/20/09 (1 Year Test)

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
826	1.19	39.74	9.38	66.58	21.09	62.0	1.37	6.91	68	78.3%	18.0	14.64	1184
764	1.1	40.94	8.67	69.87	19.50	66.8	1.17	5.90	72	79.8%	17.3	14.07	1184
681	0.98	42.41	7.72	73.9	17.37	72.7	0.93	4.68	76	79.9%	16.4	13.38	1184
583	0.84	44.04	6.62	78.18	14.89	78.9	0.68	3.44	82	78.5%	15.3	12.46	1186
340	0.49	47.22	3.86	84.88	8.68	87.0	0.23	1.17	88	65.1%	11.6	9.44	1189

Corrected to 1170 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mgd
817	1.18	66.0	78.3%	17.4	14	1170	12.0
755	1.09	69.9	79.8%	16.7	14	1170	12.5
673	0.97	74.7	79.9%	15.9	13	1170	13.3
575	0.83	79.4	78.5%	14.7	12	1170	14.4
335	0.48	85.1	65.1%	11.1	9	1170	18.7

Pump No. 2 Field Curve 3/29/10 (2 Year Test)

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
792	1.14	41.25	8.99	69.11	20.20	64.4	1.25	6.34	69	78.8%	17.6	14.33	1185
708	1.02	42.87	8.04	73.34	18.08	70.4	1.00	5.07	74	79.8%	16.7	13.58	1185
639	0.92	44.02	7.25	76.33	16.31	74.6	0.82	4.13	78	79.1%	15.9	12.93	1186
583	0.84	44.82	6.62	78.49	14.89	77.8	0.68	3.44	81	77.8%	15.3	12.41	1186
417	0.6	47.46	4.73	84.18	10.63	84.8	0.35	1.76	86	70.6%	12.9	10.46	1186

Corrected to 1170 RPM

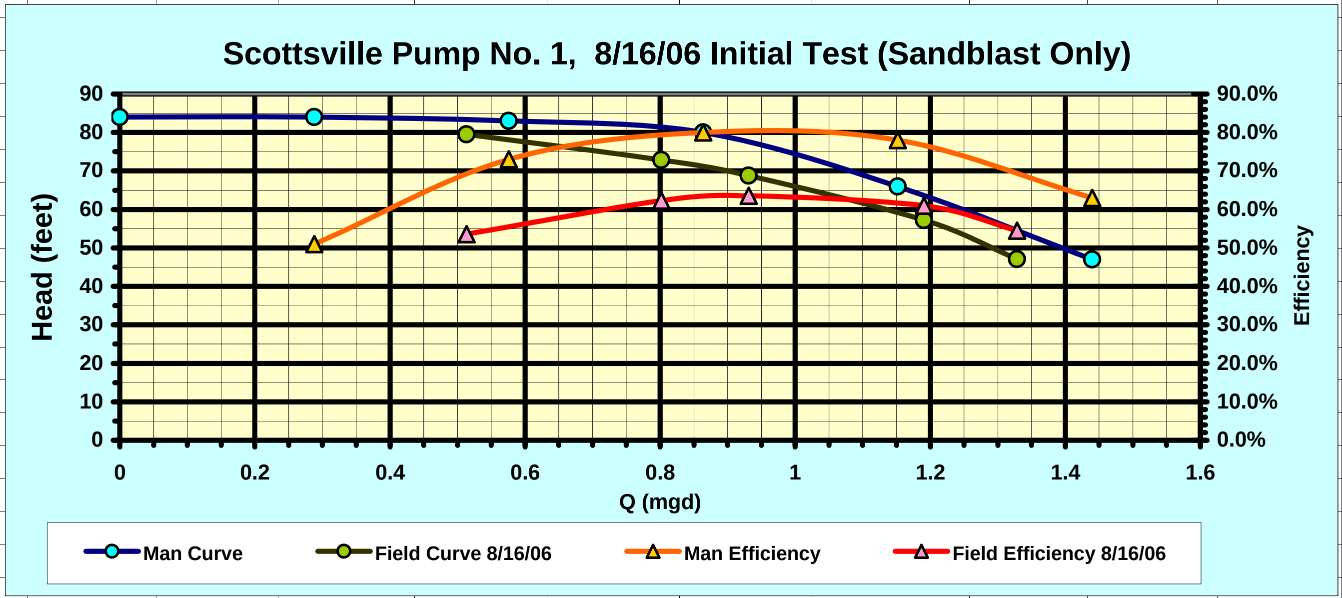
Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mgd
782	1.13	67.7	78.8%	17.0	14	1170	12.3
699	1.01	72.6	79.8%	16.1	13	1170	13.0
630	0.91	75.9	79.1%	15.3	12	1170	13.7
575	0.83	78.4	77.8%	14.6	12	1170	14.4
411	0.59	83.9	70.6%	12.3	10	1170	17.0

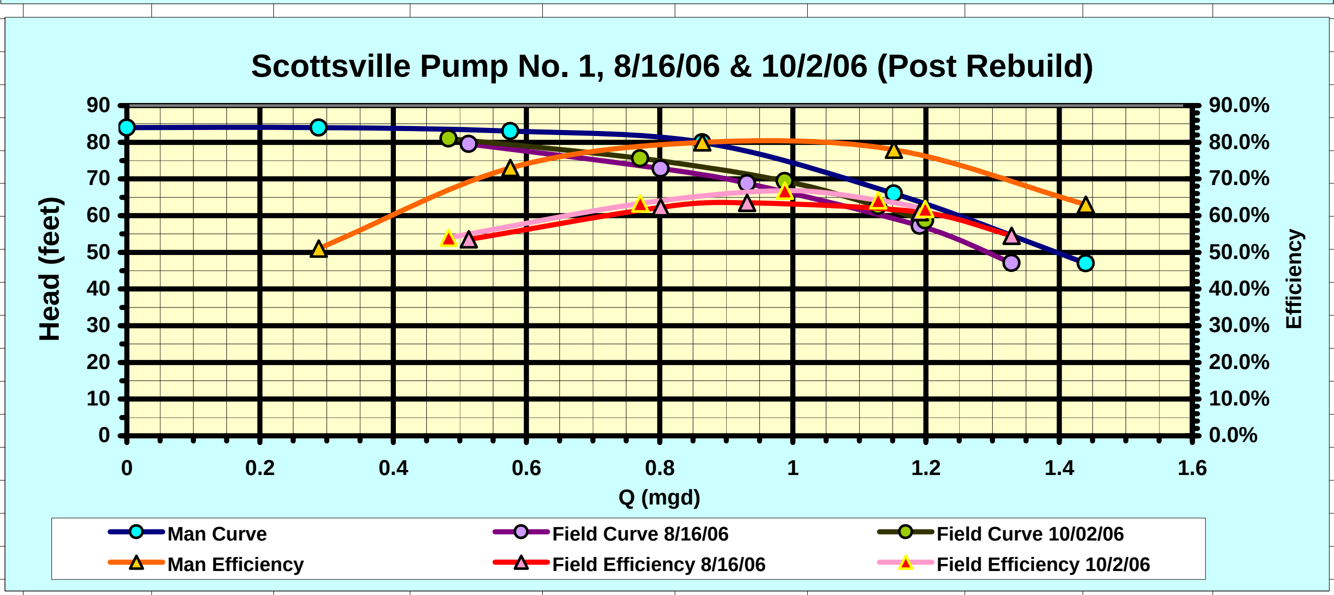
Pump No. 2 Field Curve 6/7/10 (2.25 Year Test)

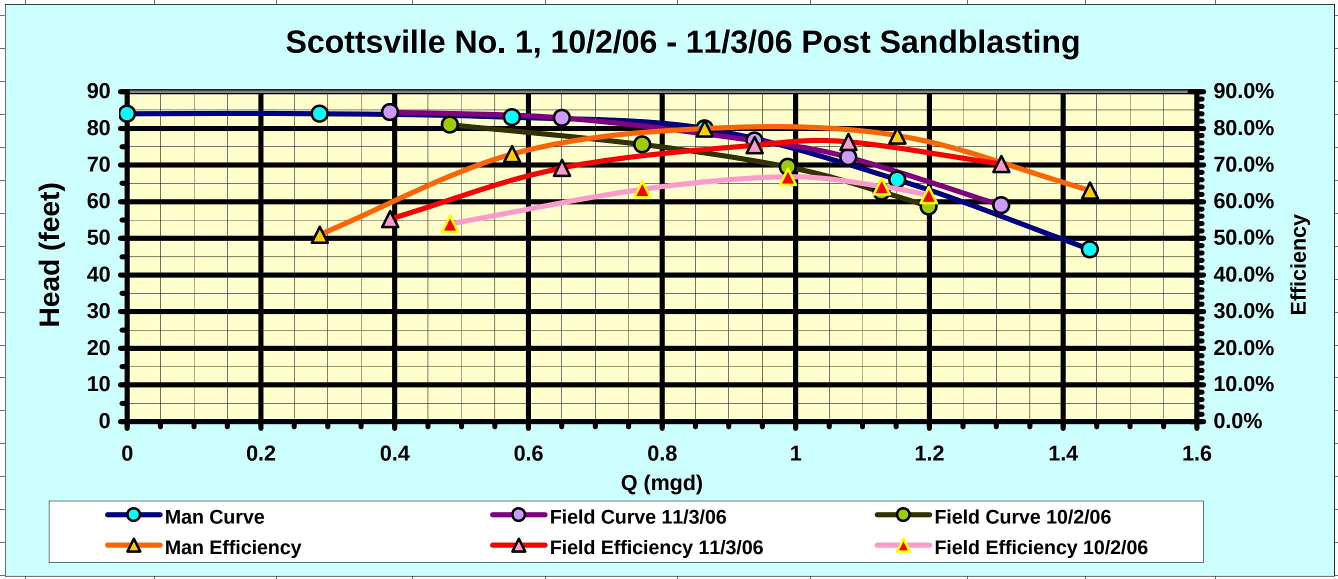
Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
813	1.17	41.48	9.22	68.6	20.74	62.6	1.32	6.68	68	78.4%	17.8	14.48	1183
757	1.09	42.77	8.59	71.67	19.32	66.8	1.15	5.79	71	79.3%	17.2	14.01	1184
688	0.99	43.99	7.80	75.05	17.55	71.7	0.95	4.78	76	79.5%	16.5	13.42	1184
618	0.89	45.06	7.01	77.9	15.77	75.9	0.76	3.86	79	78.5%	15.7	12.77	1187
396	0.57	47.96	4.49	84.71	10.10	84.9	0.31	1.58	86	68.4%	12.6	10.25	1187

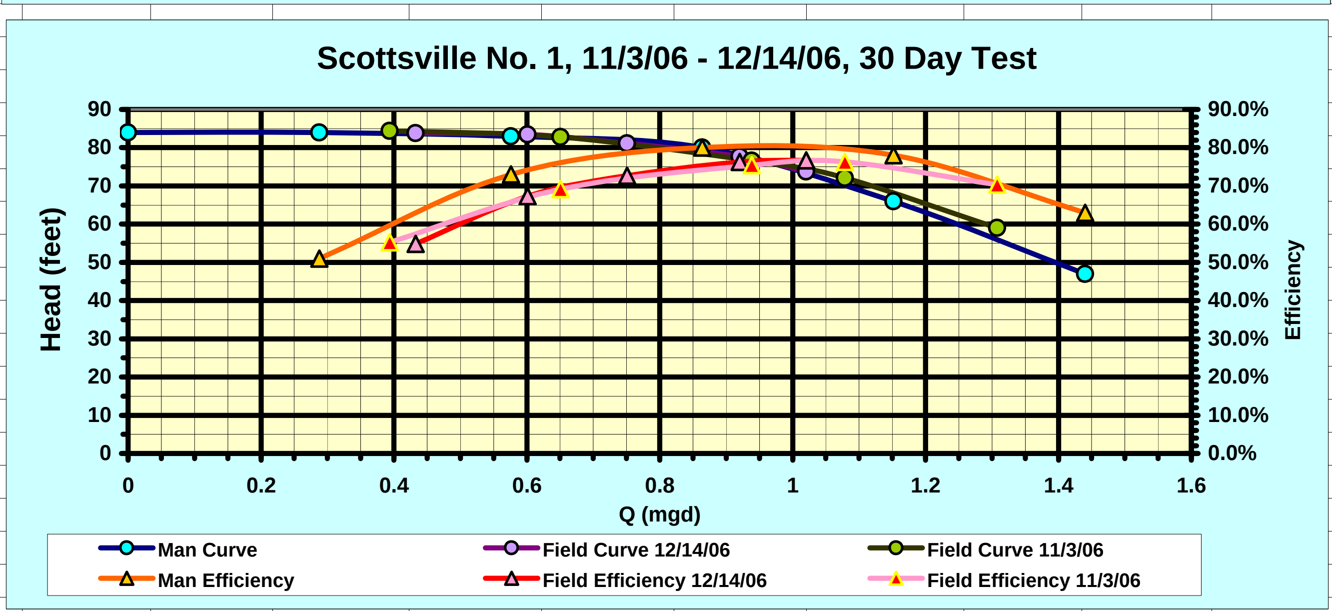
Corrected to 1170 RPM

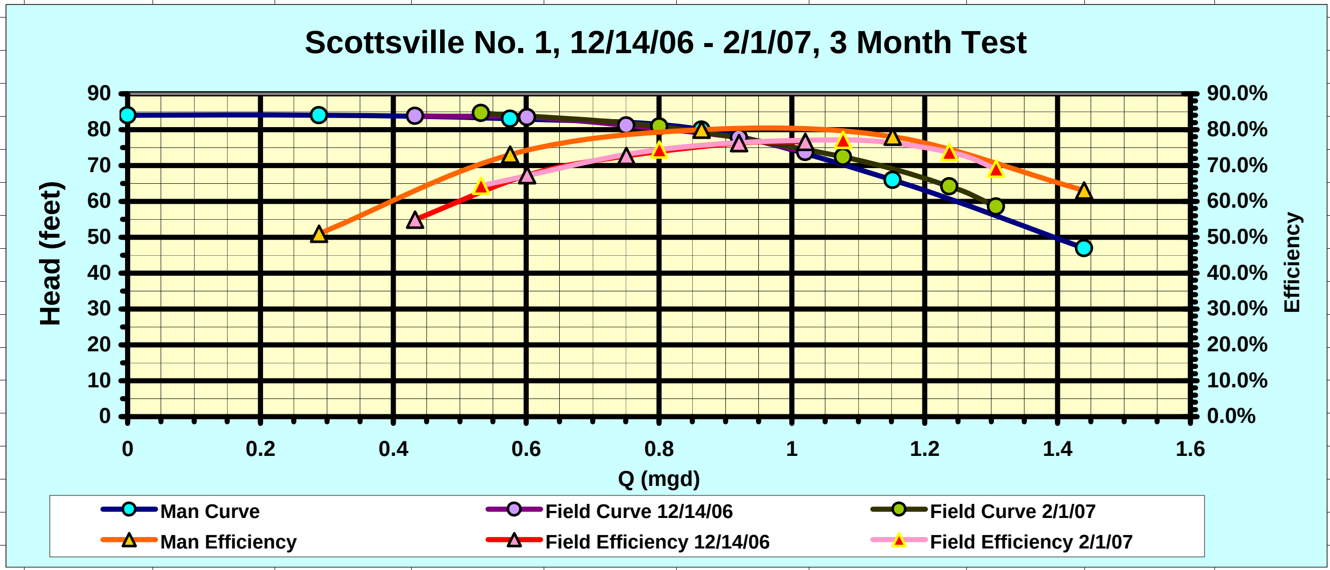
Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mgd
804	1.16	66.5	78.4%	17.2	14	1170	12.1
748	1.08	69.7	79.3%	16.6	14	1170	12.6
679	0.98	73.8	79.5%	15.9	13	1170	13.2
609	0.88	76.7	78.5%	15.0	12	1170	13.9
390	0.56	83.7	68.4%	12.1	10	1170	17.5

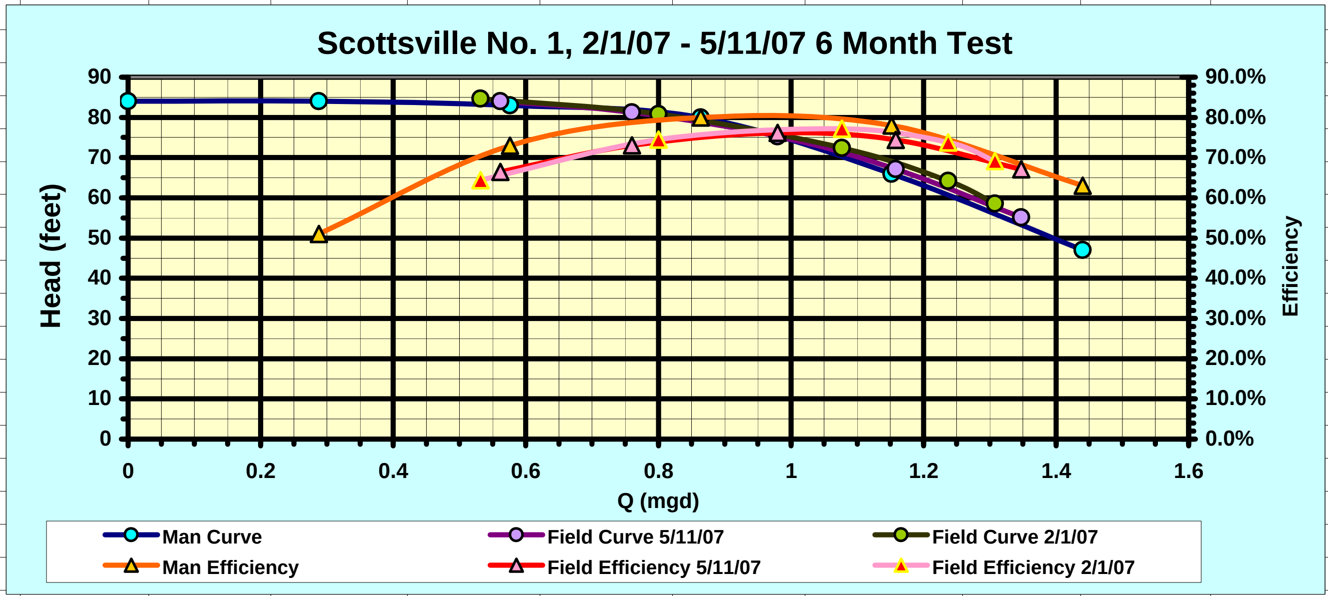

Scottsville Pump No. 1, 8/16/06 Initial Test (Sandblast Only)
Head (feet)
Efficiency
Q (mgd)
Man Curve
Field Curve 8/16/06
Man Efficiency
Field Efficiency 8/16/06

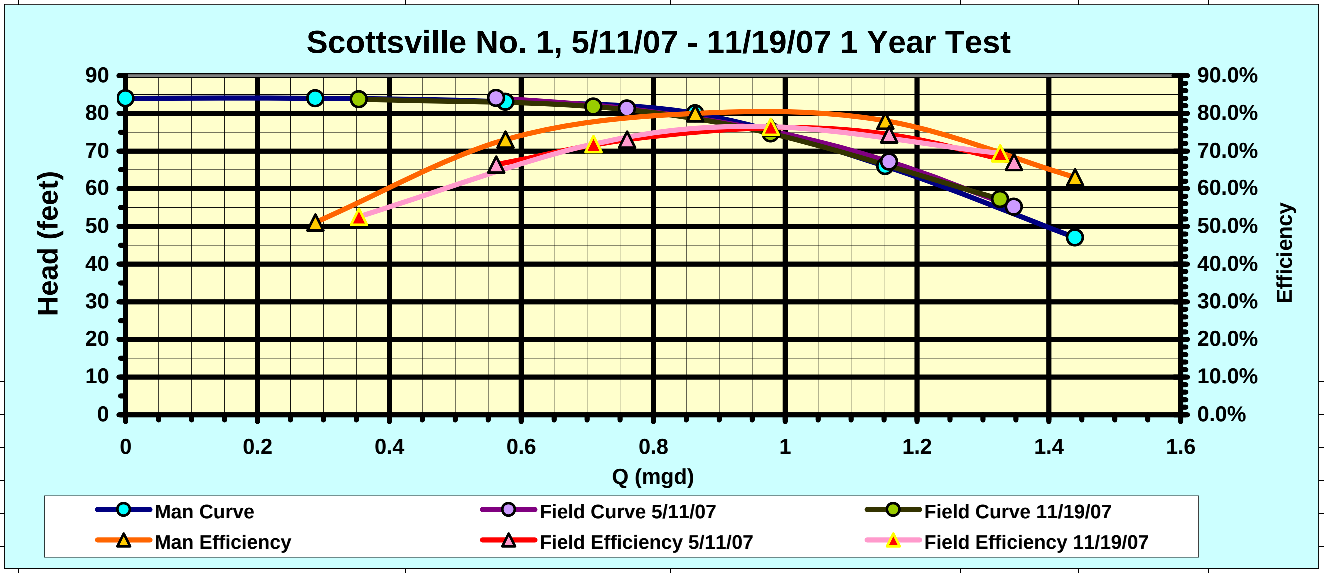

Scottsville Pump No. 1, 8/16/06 & 10/2/06 (Post Rebuild)
Head (feet)
Efficiency
Q (mgd)
Man Curve
Field Curve 8/16/06
Field Curve 10/02/06
Man Efficiency
Field Efficiency 8/16/06
Field Efficiency 10/2/06


Scottsville No. 1, 10/2/06 - 11/3/06 Post Sandblasting
Head (feet)
Efficiency
Q (mgd)
0
10
20
30
40
50
60
70
80
90
0.0%
10.0%
20.0%
30.0%
40.0%
50.0%
60.0%
70.0%
80.0%
90.0%
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
Man Curve
Field Curve 11/3/06
Field Curve 10/2/06
Man Efficiency
Field Efficiency 11/3/06
Field Efficiency 10/2/06

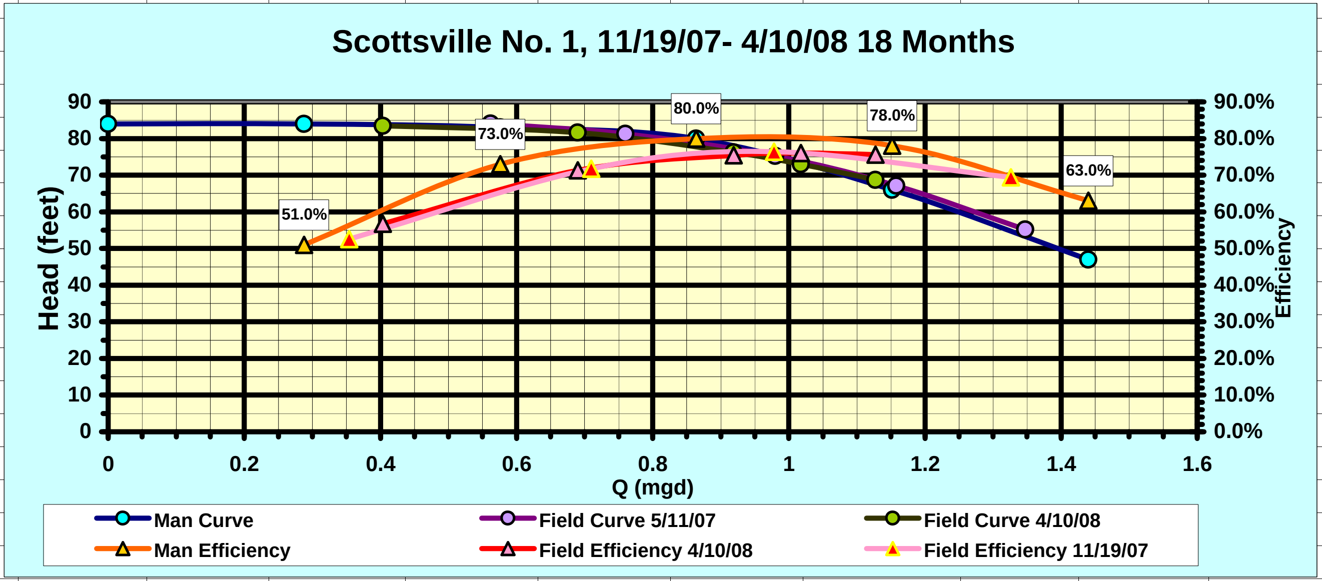

Scottsville No. 1, 11/3/06 - 12/14/06, 30 Day Test
Head (feet)
Efficiency
Q (mgd)
0
10
20
30
40
50
60
70
80
90
0.0%
10.0%
20.0%
30.0%
40.0%
50.0%
60.0%
70.0%
80.0%
90.0%
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
Man Curve
Field Curve 12/14/06
Field Curve 11/3/06
Man Efficiency
Field Efficiency 12/14/06
Field Efficiency 11/3/06


Scottsville No. 1, 12/14/06 - 2/1/07, 3 Month Test
Head (feet)
Efficiency
Q (mgd)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
0
10
20
30
40
50
60
70
80
90
0.0%
10.0%
20.0%
30.0%
40.0%
50.0%
60.0%
70.0%
80.0%
90.0%
Man Curve
Field Curve 12/14/06
Field Curve 2/1/07
Man Efficiency
Field Efficiency 12/14/06
Field Efficiency 2/1/07

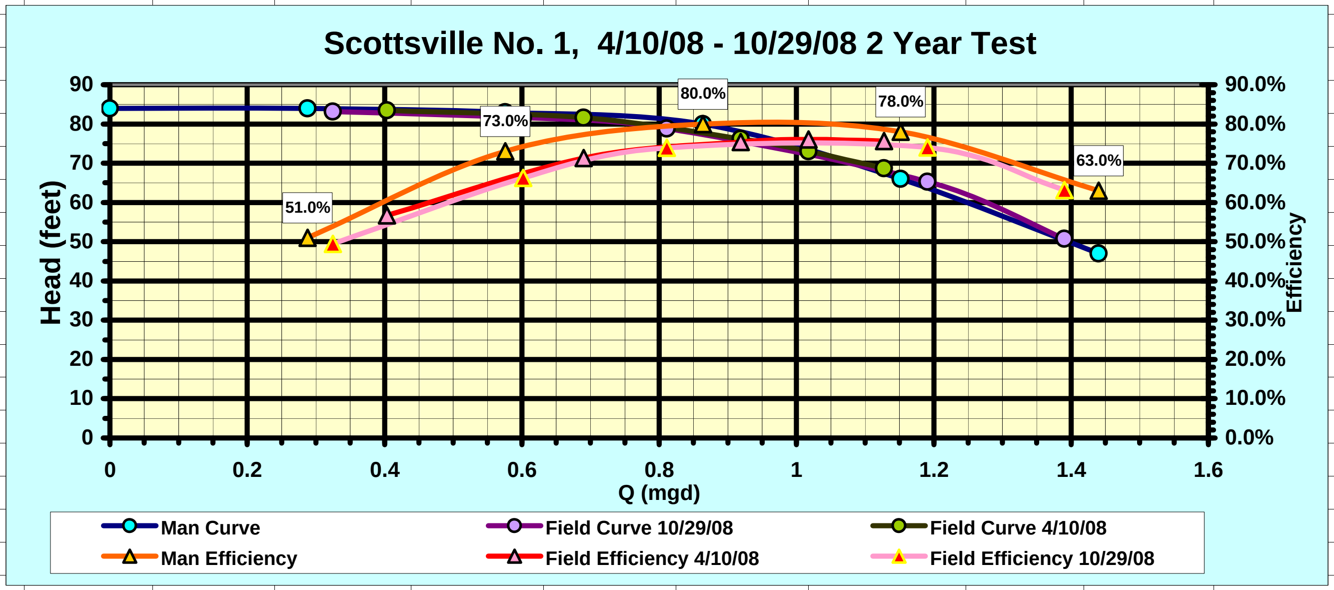

Scottsville No. 1, 2/1/07 - 5/11/07 6 Month Test
Head (feet)
Efficiency
Q (mgd)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
0
10
20
30
40
50
60
70
80
90
0.0%
10.0%
20.0%
30.0%
40.0%
50.0%
60.0%
70.0%
80.0%
90.0%
Man Curve
Field Curve 5/11/07
Field Curve 2/1/07
Man Efficiency
Field Efficiency 5/11/07
Field Efficiency 2/1/07



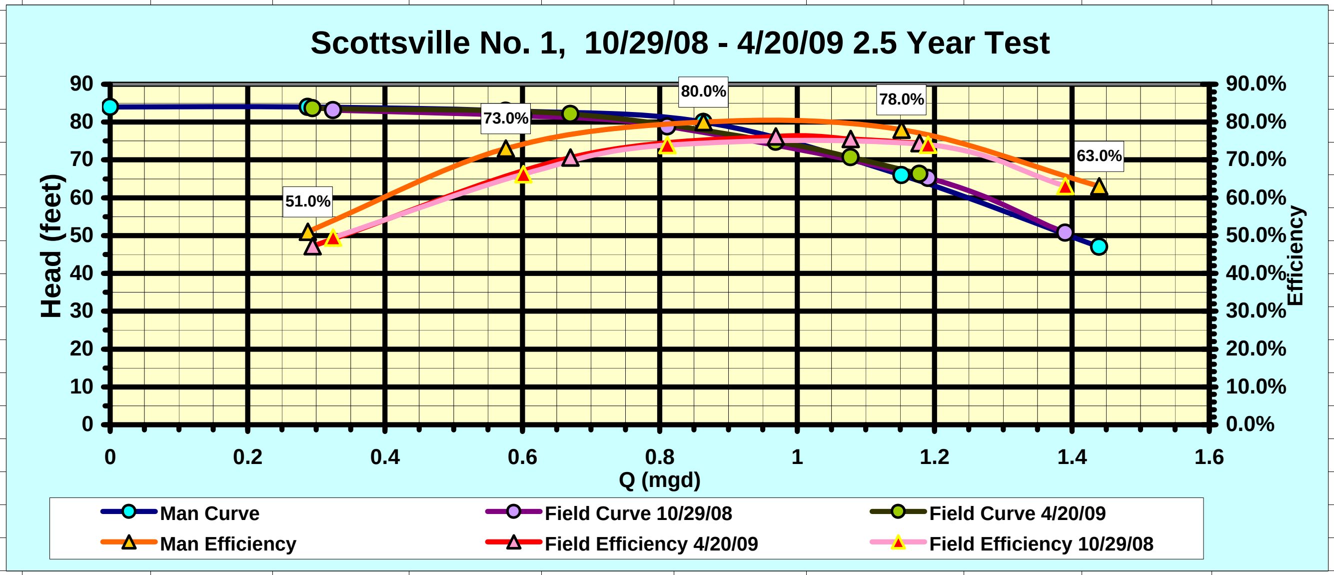
Scottsville No. 1, 5/11/07 - 11/19/07 1 Year Test
Head (feet)
Efficiency
Q (mgd)
Man Curve
Field Curve 5/11/07
Field Curve 11/19/07
Man Efficiency
Field Efficiency 5/11/07
Field Efficiency 11/19/07



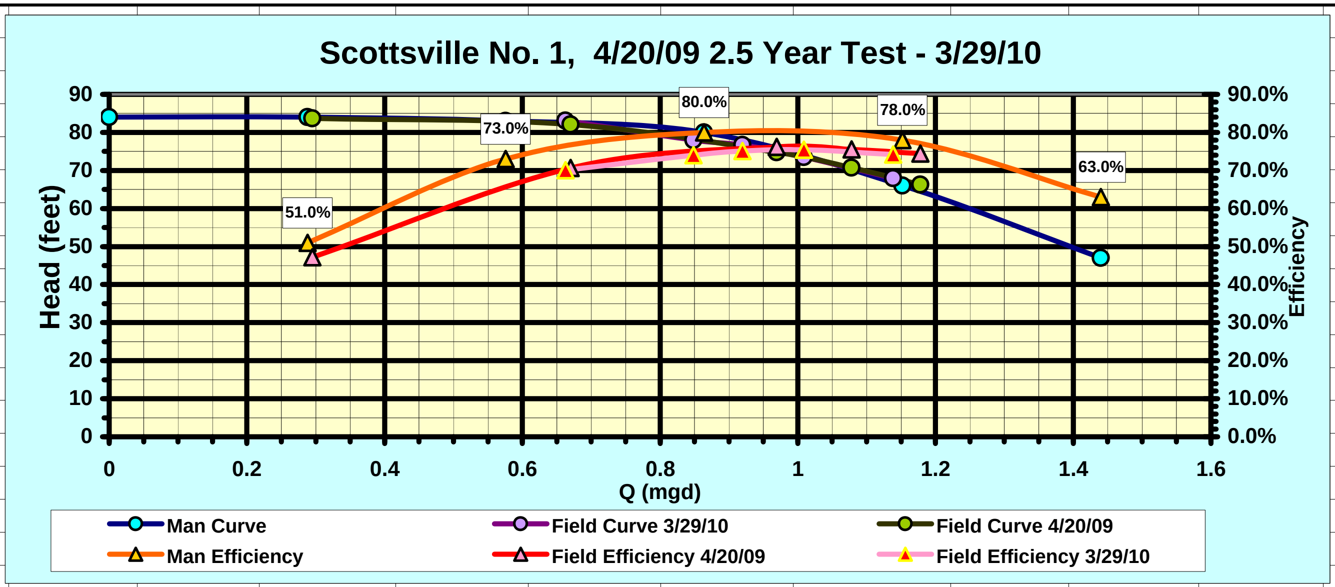
Scottsville No. 1, 11/19/07- 4/10/08 18 Months
Head (feet)
Efficiency
Q (mgd)
51.0%
73.0%
80.0%
78.0%
63.0%
Man Curve
Field Curve 5/11/07
Field Curve 4/10/08
Man Efficiency
Field Efficiency 4/10/08
Field Efficiency 11/19/07

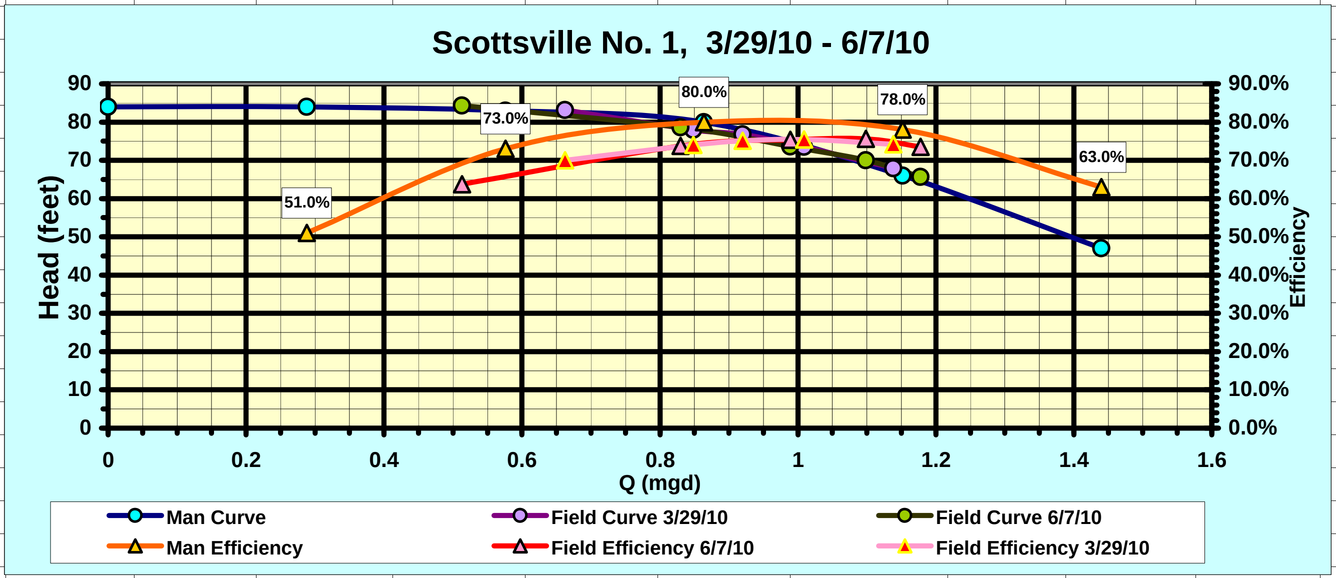


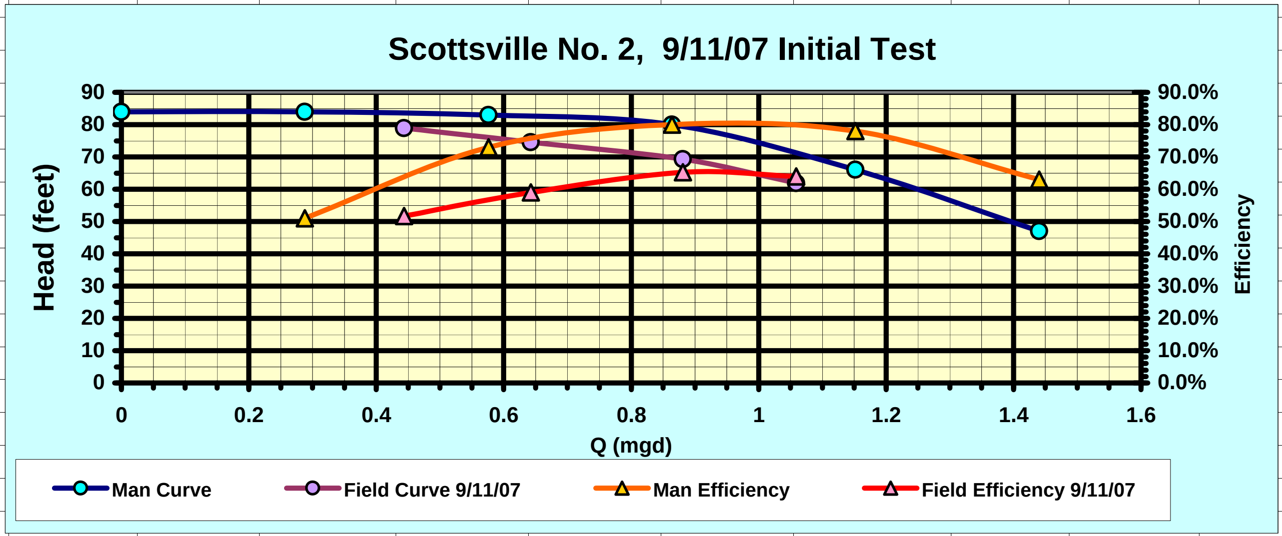
Scottsville No. 1, 4/10/08 - 10/29/08 2 Year Test
Head (feet)
Efficiency
Q (mgd)
90
80
70
60
50
40
30
20
10
0
90.0%
80.0%
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
51.0%
73.0%
80.0%
78.0%
63.0%
Man Curve
Field Curve 10/29/08
Field Curve 4/10/08
Man Efficiency
Field Efficiency 4/10/08
Field Efficiency 10/29/08



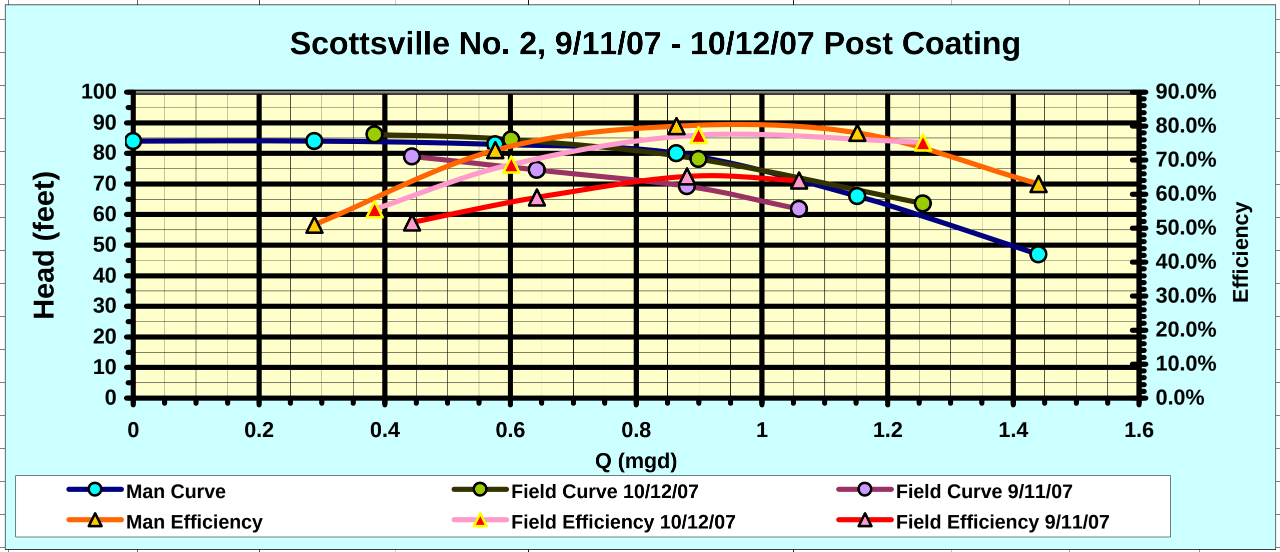
Scottsville No. 1, 10/29/08 - 4/20/09 2.5 Year Test
Head (feet)
Efficiency
Q (mgd)
90
80
70
60
50
40
30
20
10
0
90.0%
80.0%
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
51.0%
73.0%
80.0%
78.0%
63.0%
Man Curve
Field Curve 10/29/08
Field Curve 4/20/09
Man Efficiency
Field Efficiency 4/20/09
Field Efficiency 10/29/08


Scottsville No. 1, 4/20/09 2.5 Year Test - 3/29/10
Head (feet)
Efficiency
Q (mgd)
90
80
70
60
50
40
30
20
10
0
90.0%
80.0%
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
80.0%
78.0%
73.0%
63.0%
51.0%
Man Curve
Field Curve 3/29/10
Field Curve 4/20/09
Man Efficiency
Field Efficiency 4/20/09
Field Efficiency 3/29/10

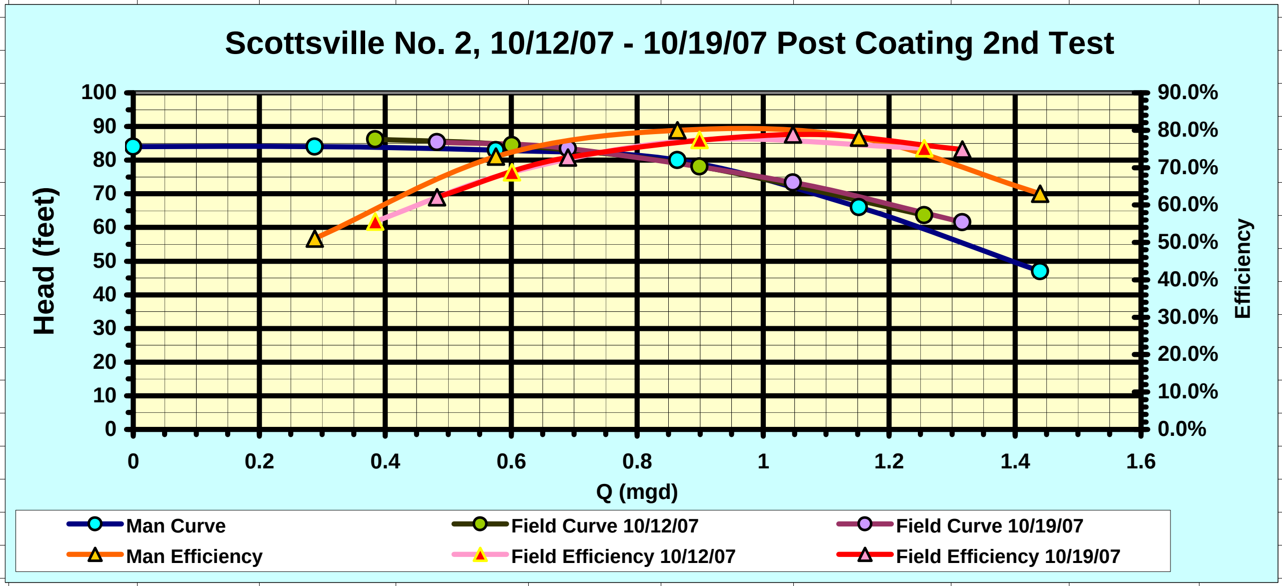

Scottsville No. 1, 3/29/10 - 6/7/10
Head (feet)
Efficiency
Q (mgd)
90
80
70
60
50
40
30
20
10
0
90.0%
80.0%
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
80.0%
78.0%
73.0%
63.0%
51.0%
Man Curve
Field Curve 3/29/10
Field Curve 6/7/10
Man Efficiency
Field Efficiency 6/7/10
Field Efficiency 3/29/10



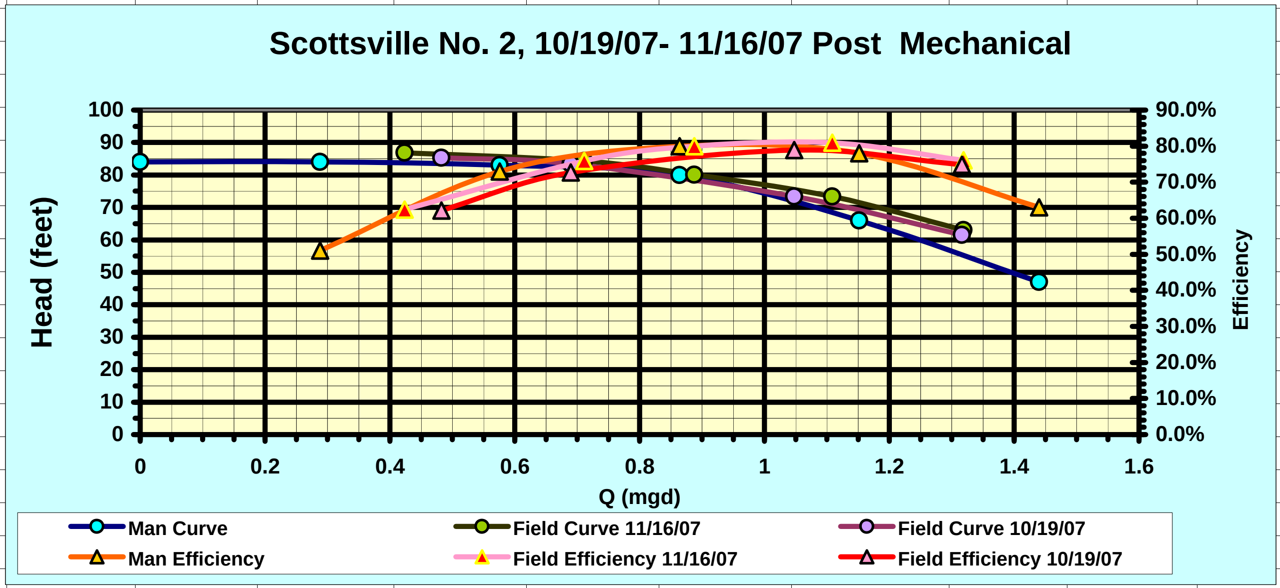
Scottsville No. 2, 9/11/07 Initial Test
Head (feet)
Efficiency
Q (mgd)
Man Curve
Field Curve 9/11/07
Man Efficiency
Field Efficiency 9/11/07



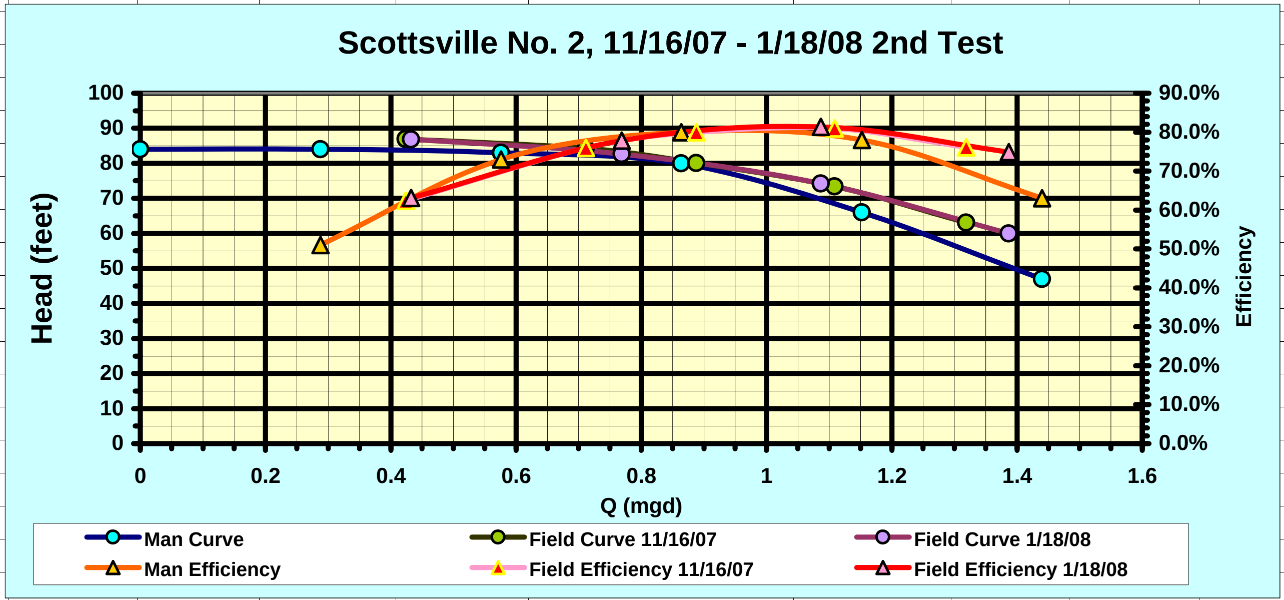
Scottsville No. 2, 9/11/07 - 10/12/07 Post Coating
Head (feet)
Efficiency
Q (mgd)
Man Curve
Field Curve 10/12/07
Field Curve 9/11/07
Man Efficiency
Field Efficiency 10/12/07
Field Efficiency 9/11/07

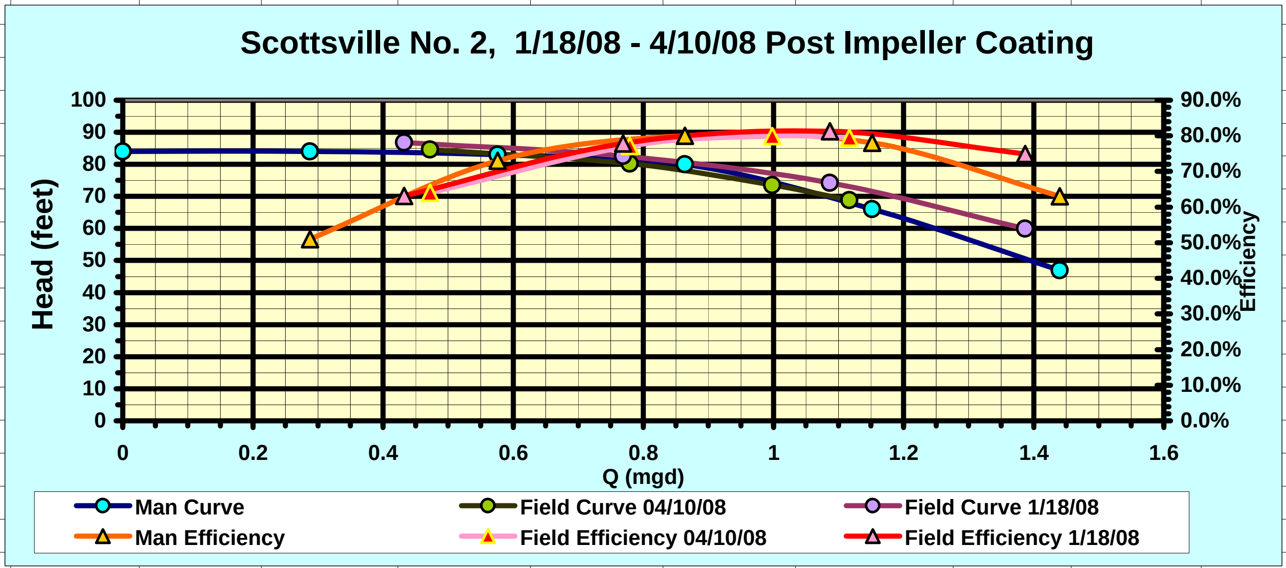


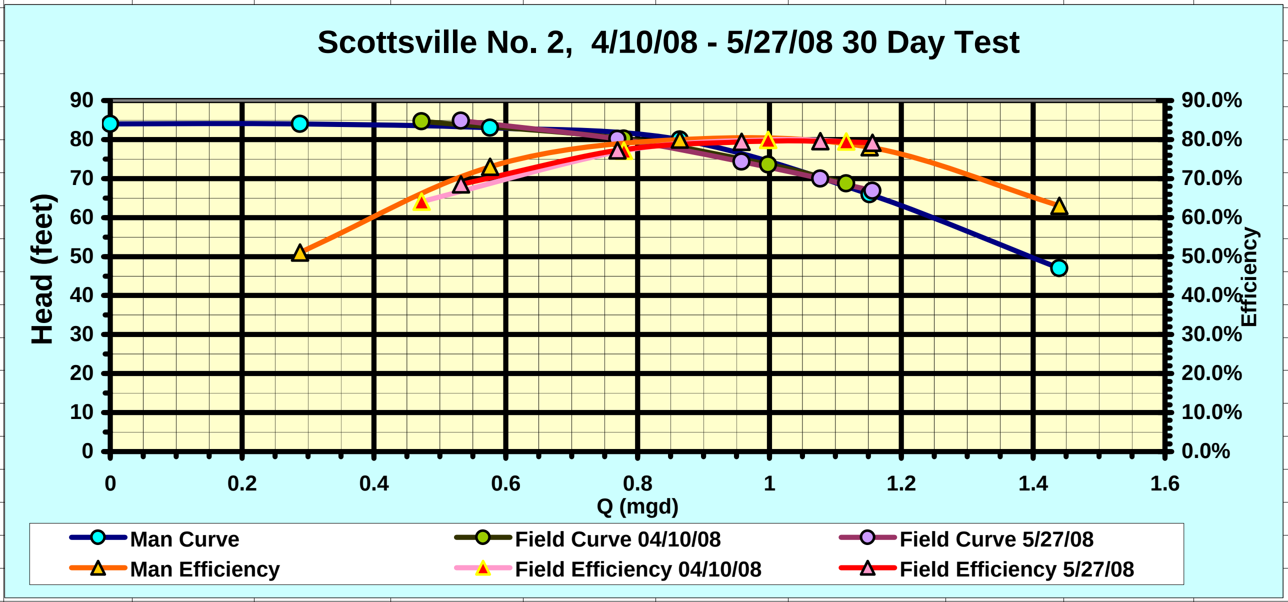
Scottsville No. 2, 10/12/07 - 10/19/07 Post Coating 2nd Test
Head (feet)
Efficiency
Q (mgd)
Man Curve
Field Curve 10/12/07
Field Curve 10/19/07
Man Efficiency
Field Efficiency 10/12/07
Field Efficiency 10/19/07

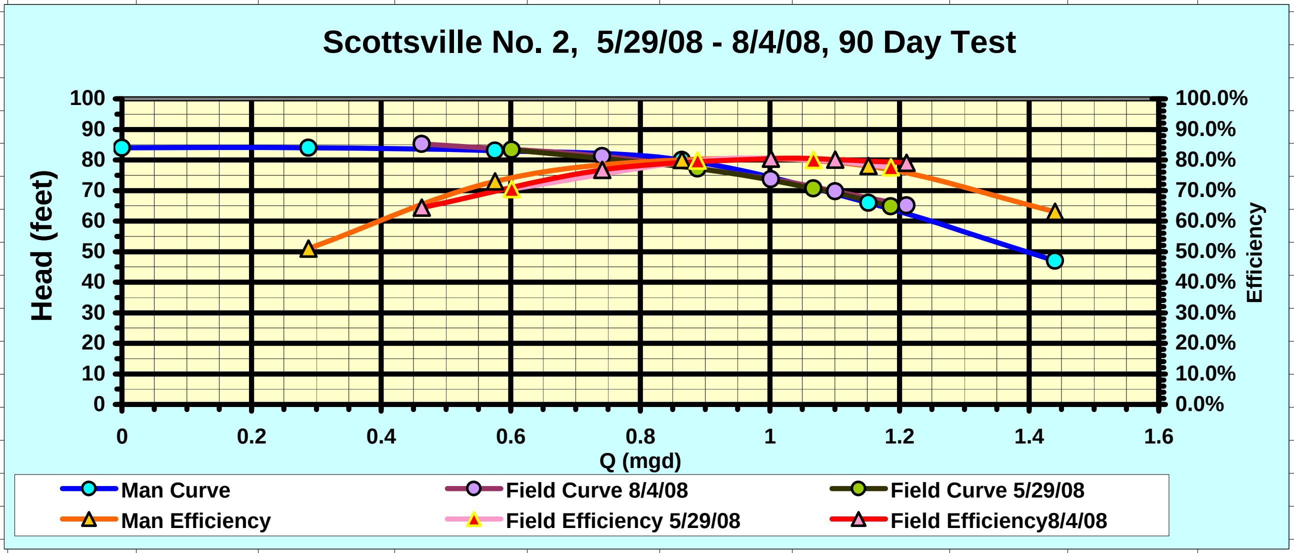


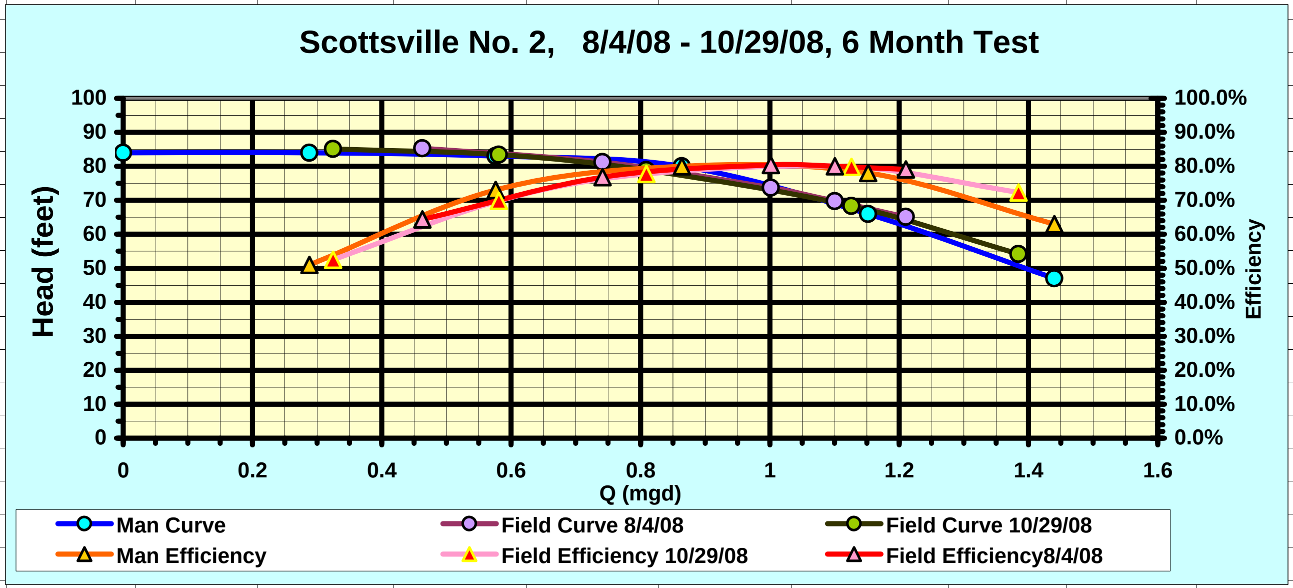
Scottsville No. 2, 10/19/07- 11/16/07 Post Mechanical
Head (feet)
Efficiency
Q (mgd)
Man Curve
Field Curve 11/16/07
Field Curve 10/19/07
Man Efficiency
Field Efficiency 11/16/07
Field Efficiency 10/19/07


Scottsville No. 2, 11/16/07 - 1/18/08 2nd Test
Head (feet)
Efficiency
Q (mgd)
Man Curve
Field Curve 11/16/07
Field Curve 1/18/08
Man Efficiency
Field Efficiency 11/16/07
Field Efficiency 1/18/08

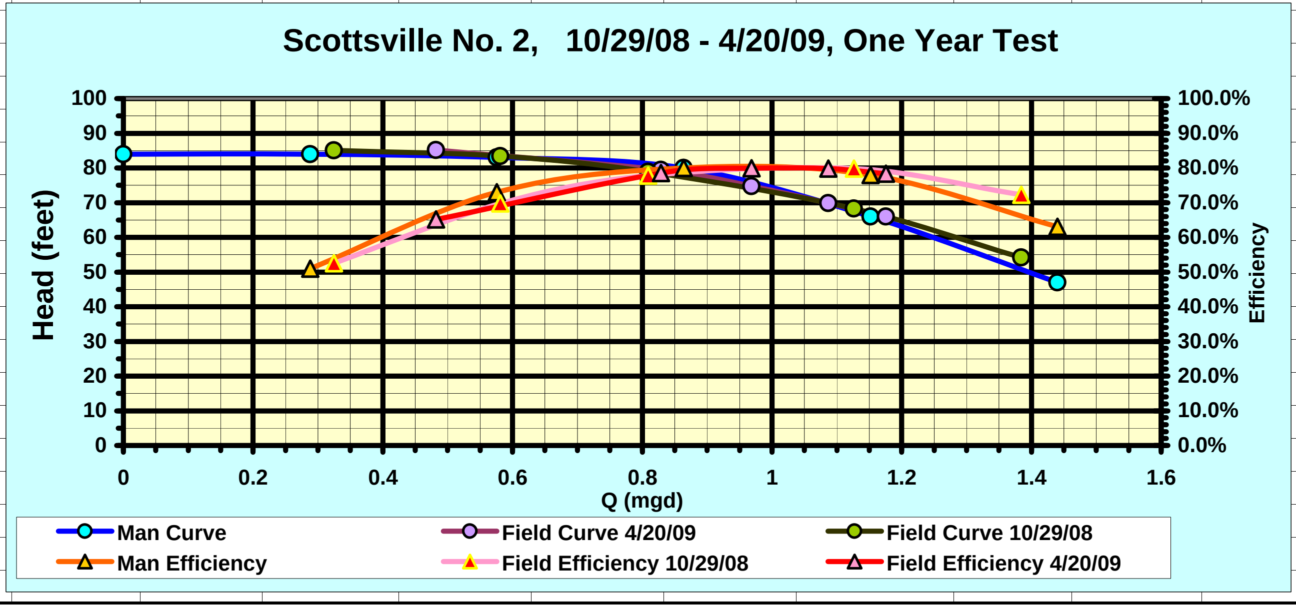

Scottsville No. 2, 1/18/08 - 4/10/08 Post Impeller Coating
Head (feet)
Efficiency
Q (mgd)
Man Curve
Field Curve 04/10/08
Field Curve 1/18/08
Man Efficiency
Field Efficiency 04/10/08
Field Efficiency 1/18/08


Scottsville No. 2, 4/10/08 - 5/27/08 30 Day Test
Head (feet)
Efficiency
Q (mgd)
Man Curve
Field Curve 04/10/08
Field Curve 5/27/08
Man Efficiency
Field Efficiency 04/10/08
Field Efficiency 5/27/08

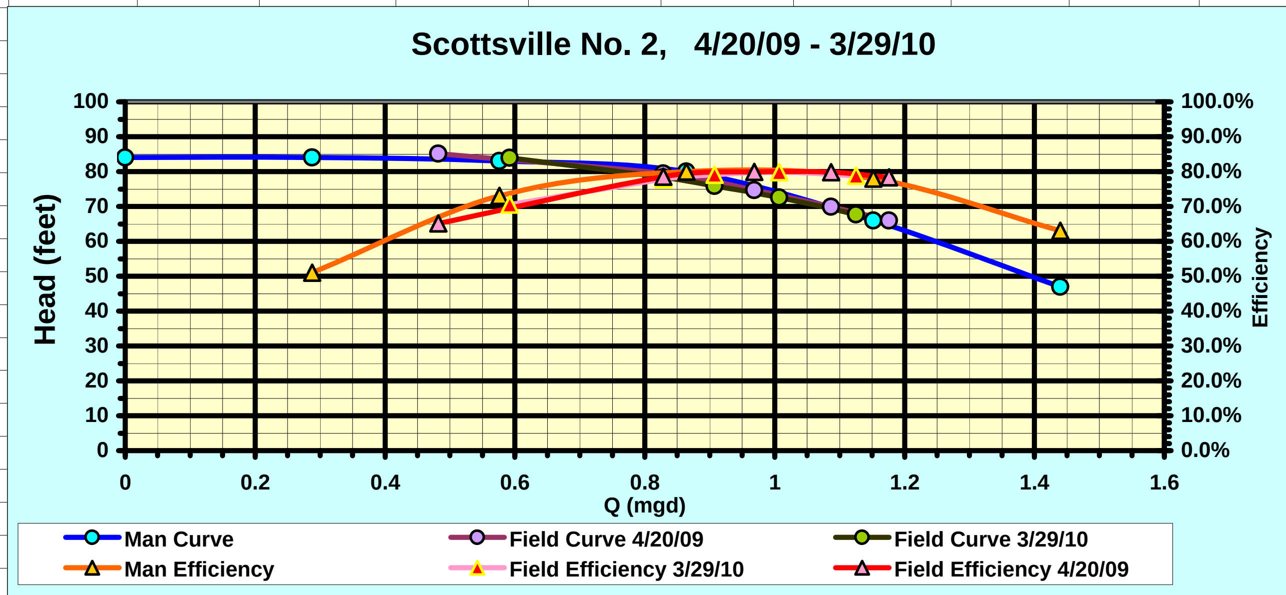

Scottsville No. 2, 5/29/08 - 8/4/08, 90 Day Test
Head (feet)
Efficiency
Q (mgd)
Man Curve
Field Curve 8/4/08
Field Curve 5/29/08
Man Efficiency
Field Efficiency 5/29/08
Field Efficiency8/4/08



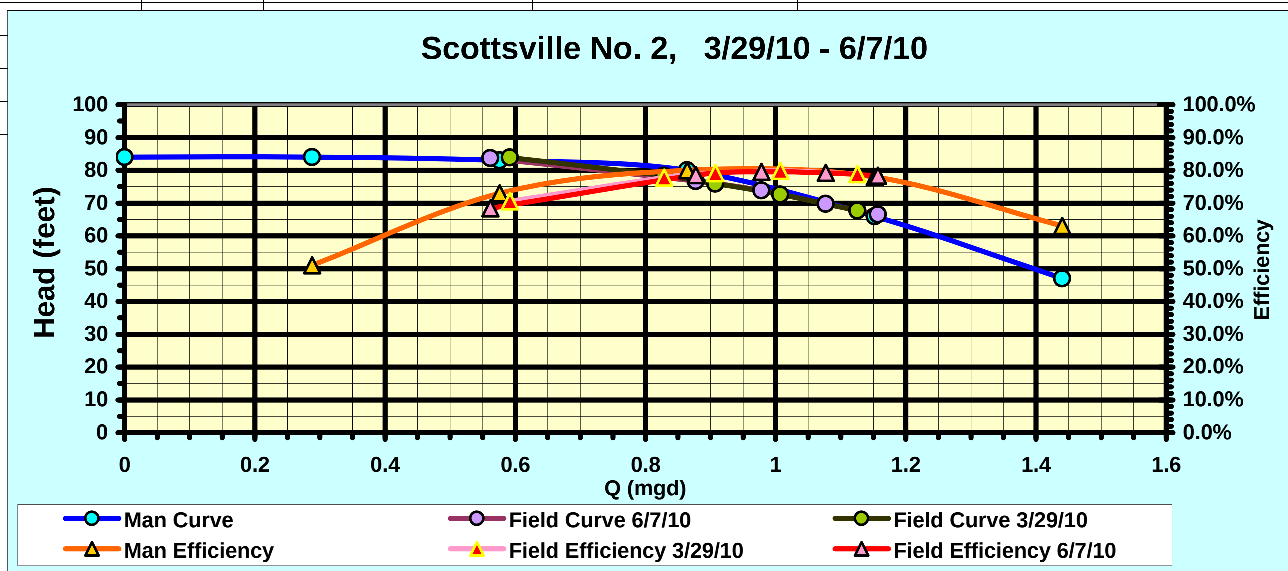
Scottsville No. 2, 8/4/08 - 10/29/08, 6 Month Test
Head (feet)
Efficiency
Q (mgd)
Man Curve
Field Curve 8/4/08
Field Curve 10/29/08
Man Efficiency
Field Efficiency 10/29/08
Field Efficiency8/4/08



Scottsville No. 2, 10/29/08 - 4/20/09, One Year Test
Head (feet)
Efficiency
Q (mgd)
Man Curve
Field Curve 4/20/09
Field Curve 10/29/08
Man Efficiency
Field Efficiency 10/29/08
Field Efficiency 4/20/09



Scottsville No. 2, 4/20/09 - 3/29/10
Head (feet)
Efficiency
Q (mgd)
0
10
20
30
40
50
60
70
80
90
100
0.0%
10.0%
20.0%
30.0%
40.0%
50.0%
60.0%
70.0%
80.0%
90.0%
100.0%
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
Man Curve
Field Curve 4/20/09
Field Curve 3/29/10
Man Efficiency
Field Efficiency 3/29/10
Field Efficiency 4/20/09



Scottsville No. 2, 3/29/10 - 6/7/10
Head (feet)
Efficiency
Q (mgd)
0
10
20
30
40
50
60
70
80
90
100
0.0%
10.0%
20.0%
30.0%
40.0%
50.0%
60.0%
70.0%
80.0%
90.0%
100.0%
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
Man Curve
Field Curve 6/7/10
Field Curve 3/29/10
Man Efficiency
Field Efficiency 3/29/10
Field Efficiency 6/7/10

Scribner No. 2
Energy Efficiency Cost Calculator
Continuous Service

Pre Mechanical

Head (ft)	99
Flow (gpm)	5138
Efficiency	81.6%
Hours Operation/month	730
BHP	157
kW (Assumes Motor Eff 95%)	123.6
kW Demand Charge	$1,236
kwh cost	$7,670
Total Monthly kWH	90,236
Monthly Cost	**$8,906.21**

Constants

Hours/ Month	730
kW Demand Cost	$10.00
kwh Cost	$0.085
Motor Efficiency	95.0%

Post Mechanical

Head (ft)	101
Flow (gpm)	5528
Efficiency	83.4%
Hours Operation/month	678
BHP	169
kW (Assumes Motor Eff 95%)	132.8
kW Demand Charge	$1,328
kwh cost	$7,656
Total Monthly kWH	90073
Monthly Cost	**$8,983.69**

Pre - Post Mechanical Comparison

Monthly Savings	**-$77**
Annual Savings	**-$930**
5 Year Savings	**-$4,649**
kW Demand Reduction	**-9.1**
Monthly kwh Savings	**164**
Yearly kwh Savings	**1967**

Post Impeller Coating

Head (ft)	100
Flow (gpm)	5458
Efficiency	84.6%
Hours Operation/month	687
BHP	163
kW (Assumes Motor Eff 95%)	127.9
kW Demand Charge	$1,279
kwh cost	$7,473
Total Monthly kWH	87916
Monthly Cost	**$8,752.17**

Pre - Post Impeller Comparison

Monthly Savings	**$232**
Annual Savings	**$2,778**
5 Year Savings	**$13,891**
kW Demand Reduction	**4.8**
Monthly kwh Savings	**2157**
Yearly kwh Savings	**25881**

Post Casing Coating

Head (ft)	101
Flow (gpm)	5556
Efficiency	86.6%
Hours Operation/month	675
BHP	164
kW (Assumes Motor Eff 95%)	128.5
kW Demand Charge	$1,285
kwh cost	$7,373
Total Monthly kWH	86744
Monthly Cost	**$8,658.21**

Pre - Post Internal Coating Comparison

Monthly Savings	**$94**
Annual Savings	**$1,128**
5 Year Savings	**$5,638**
kW Demand Reduction	**4.26**
Monthly kwh Savings	**1172**
Yearly kwh Savings	**14058**

Pre Mechanical to Post Interior Coating Comparison

Monthly Savings	**$248**
Annual Savings	**$2,976**
5 Year Savings	**$14,881**
kW Demand Reduction	**-4.88**
Monthly kwh Savings	**3492**
Yearly kwh Savings	**41907**

Scribner No. 2 Cont'
20% Service Time

Pre Mechanical

Head (ft)	99
Flow (gpm)	5138
Efficiency	81.6%
Hours Operation/month	146
BHP	157
kW (Assumes Motor Eff 95%)	123.6
kW Demand Charge	$1,236
kwh cost	$1,534
Total Monthly kWH	18,047
Monthly Cost	**$2,770.14**

Constants

Hours/ Month	730
kW Demand Cost	$10.00
kwh Cost	$0.085
Motor Efficiency	95.0%

Post Mechanical

Head (ft)	101
Flow (gpm)	5528
Efficiency	83.4%
Hours Operation/month	136
BHP	169
kW (Assumes Motor Eff 95%)	132.8
kW Demand Charge	$1,328
kwh cost	$1,531
Total Monthly kWH	18015
Monthly Cost	**$2,858.76**

Pre - Post Mechanical Comparison

Monthly Savings	-$89
Annual Savings	-$1,063
5 Year Savings	-$5,317
kW Demand Reduction	-9.1
Monthly kwh Savings	33
Yearly kwh Savings	393

Post Impeller Coating

Head (ft)	100
Flow (gpm)	5458
Efficiency	84.6%
Hours Operation/month	137
BHP	163
kW (Assumes Motor Eff 95%)	127.9
kW Demand Charge	$1,279
kwh cost	$1,495
Total Monthly kWH	17583
Monthly Cost	**$2,773.90**

Pre - Post Impeller Comparison

Monthly Savings	$85
Annual Savings	$1,018
5 Year Savings	$5,092
kW Demand Reduction	4.8
Monthly kwh Savings	431
Yearly kwh Savings	5176

Post Casing Coating

Head (ft)	101
Flow (gpm)	5556
Efficiency	86.6%
Hours Operation/month	135
BHP	164
kW (Assumes Motor Eff 95%)	128.5
kW Demand Charge	$1,285
kwh cost	$1,475
Total Monthly kWH	17349
Monthly Cost	**$2,759.60**

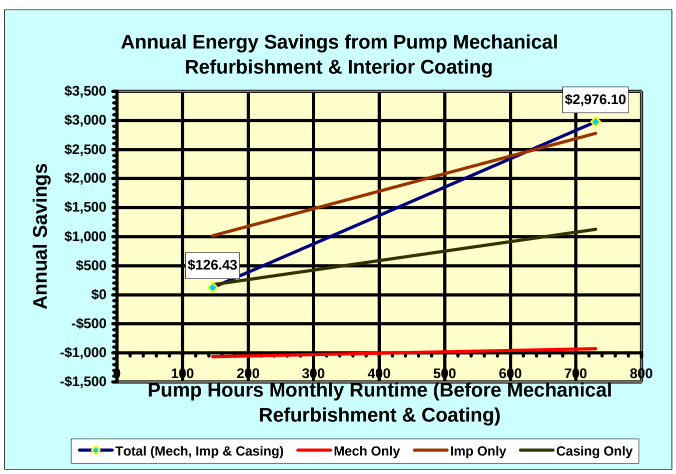
Pre - Post Internal Coating Comparison

Monthly Savings	$14
Annual Savings	$172
5 Year Savings	$858
kW Demand Reduction	4.26
Monthly kwh Savings	16540
Yearly kwh Savings	198478

Pre Mechanical to Post Interior Coating Comparison

Monthly Savings	$11
Annual Savings	$126
5 Year Savings	$632
kW Demand Reduction	-4.88
Monthly kwh Savings	698
Yearly kwh Savings	8381

Pump Hours of Operation Before Refurbishment & Interior Coating	Annual Savings Through Refurbishment & Interior Coatings
Total (Mechanical, Imp & Casing)	
730	$2,976.10
146	$126.43
Mechanical Only	
730	-$929.72
146	-$1,063.49
Imp Coating Only	
730	$2,778.26
146	$1,018.33
Casing Coating Only	
730	$1,127.56
146	$171.59



Scribner No. 3
Energy Efficiency Cost Calculator
Continuous Service

Pre Mechanical	
Head (ft)	98.2
Flow (gpm)	5292
Efficiency	80.4%
Hours Operation/month	730
BHP	163
kW (Assumes Motor Eff 95%)	128.2
kW Demand Charge	$1,282
kwh cost	$7,953
Total Monthly kWH	93,566
Monthly Cost	**$9,234.84**

Constants	
Hours/ Month	730
kW Demand Cost	$10.00
kwh Cost	$0.085
Motor Efficiency	95.0%

Post Casing coating	
Head (ft)	99.5
Flow (gpm)	5403
Efficiency	82.8%
Hours Operation/month	715
BHP	164
kW (Assumes Motor Eff 95%)	128.8
kW Demand Charge	$1,288
kwh cost	$7,825
Total Monthly kWH	92057
Monthly Cost	**$9,112.32**

Post Casing Coating	
Monthly Savings	**$123**
Annual Savings	**$1,470**
5 Year Savings	**$7,351**
kW Demand Reduction	**-0.6**
Monthly kwh Savings	**1509**
Yearly kwh Savings	**18112**

Post Mechanical Refurbishment	
Head (ft)	102.8
Flow (gpm)	5666
Efficiency	88.1%
Hours Operation/month	682
BHP	167
kW (Assumes Motor Eff 95%)	131.1
kW Demand Charge	$1,311
kwh cost	$7,598
Total Monthly kWH	89388
Monthly Cost	**$8,909.03**

Post Mechanical Refurbishment	
Monthly Savings	**$203**
Annual Savings	**$2,440**
5 Year Savings	**$12,198**
kW Demand Reduction	**-2.4**
Monthly kwh Savings	**2669**
Yearly kwh Savings	**32023**

Pre Mechanical to Post Interior *Coating Comparison*	
Monthly Savings	**$326**
Annual Savings	**$3,910**
5 Year Savings	**$19,549**
kW Demand Reduction	**-2.93**
Monthly kwh Savings	**4178**
Yearly kwh Savings	**50135**

Scribner No. 3 Cont'
20% Service Time

Pre Mechanical	
Head (ft)	98.2
Flow (gpm)	5299
Efficiency	80.2%
Hours Operation/month	146
BHP	164
kW (Assumes Motor Eff 95%)	128.7
kW Demand Charge	$1,287
kwh cost	$1,597
Total Monthly kWH	18,785
Monthly Cost	**$2,883.32**

Constants	
Hours/ Month	730
kW Demand Cost	$10.00
kwh Cost	$0.085
Motor Efficiency	95.0%

Post Casing Coating	
Head (ft)	99.5
Flow (gpm)	5403
Efficiency	82.8%
Hours Operation/month	143
BHP	164
kW (Assumes Motor Eff 95%)	128.8
kW Demand Charge	$1,288
kwh cost	$1,567
Total Monthly kWH	18436
Monthly Cost	**$2,854.54**

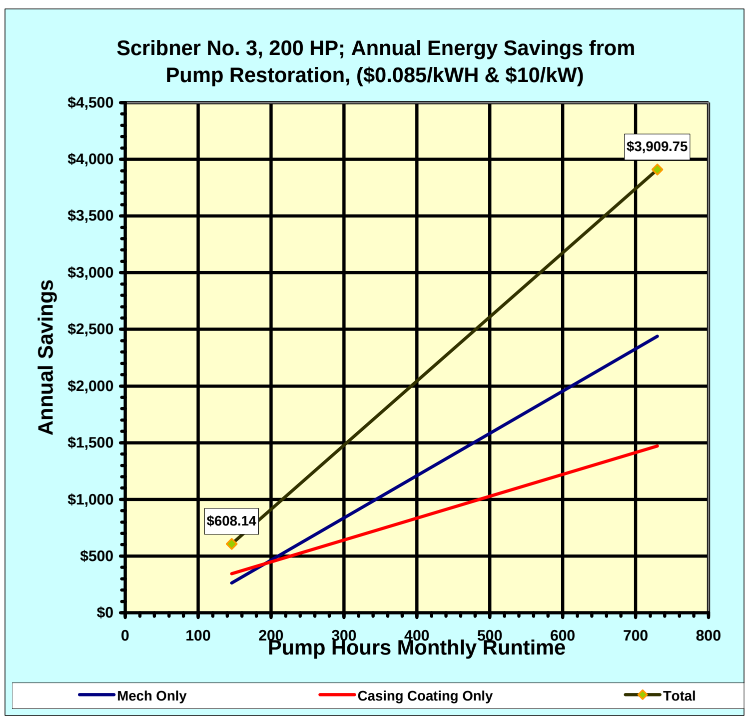
Post Casing Coating	
Monthly Savings	**$29**
Annual Savings	**$345**
5 Year Savings	**$1,727**
kW Demand Reduction	**-0.1**
Monthly kwh Savings	**349**
Yearly kwh Savings	**4188**

Post Mechanical Refurbishment	
Head (ft)	102.8
Flow (gpm)	5666
Efficiency	88.1%
Hours Operation/month	137
BHP	167
kW (Assumes Motor Eff 95%)	131.1
kW Demand Charge	$1,311
kwh cost	$1,522
Total Monthly kWH	17901
Monthly Cost	**$2,832.64**

Post Mechanical Refurbishment	
Monthly Savings	**$22**
Annual Savings	**$263**
5 Year Savings	**$1,314**
kW Demand Reduction	**-2.4**
Monthly kwh Savings	**534**
Yearly kwh Savings	**6413**

Pre Mechanical to Post Interior *Coating Comparison*	
Monthly Savings	**$51**
Annual Savings	**$608**
5 Year Savings	**$3,041**
kW Demand Reduction	**-2.44**
Monthly kwh Savings	**883**
Yearly kwh Savings	**10601**

Pump Hours of Operation Before Refurbishment & Interior Coating	**Annual Savings Through Refurbishment & Interior Coatings**
Total (Mechanical, Imp & Casing)	
730	**$3,909.75**
146	**$608.14**
Casing Coating Only	
730	**$1,470.19**
146	**$345.42**
Mechanical Only	
730	**$2,439.55**
146	**$262.72**



Scribner Booster Station

Manufacturer's Pump and Motor Information

Pumps 2 and 3

Goulds 12 x 14 x 12DV
Model 3405
1780 RPM
Serial No: 2368726
Pump No. 2 or 3

Motors 2 and 3

GE **RPM 1785**
Model: 5KS445AL208C
Serial: PH6122015
HP:200
Nom Eff: 96.2%

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	Ns	Amps	kW	% Eff
0	0	155							
2000	2.88	145	53%	138	108	1905.061			
4000	5.76	122	82%	150	117	3066.762			
5000	7.2	105	86%	154	120	3837.188			
6000	8.64	83	82%	153	120	5014.032			
6550	9.432	68	76%	148	115	6083.576			
7300	10.512	40	65%	113	88	9561.729			

NYSERDA System Curve

Q (mgd)		H (feet)	
50.0%	5.0	80%	84
75.0%	6.8	88%	92.4
BEP	8.4	100%	105
125.0%	10.4	120%	126

Pump No. 2 Field Curve 12/19/06 Initial Test

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
6479	9.33	50.71	13.50	78.4	18.38	64.0	2.83	5.25	66.4	67.4%	161.2	125.0	1791
6201	8.93	54.46	12.92	87.25	17.59	75.7	2.59	4.81	78.0	73.6%	165.8	128.6	1791
5625	8.10	59.91	11.72	100.08	15.96	92.8	2.13	3.95	94.6	80.0%	168.0	130.3	1791
4958	7.14	65.67	10.33	112.57	14.07	108.3	1.66	3.07	109.8	82.9%	165.7	128.5	1790
4458	6.42	70.8	9.29	121.7	12.65	117.6	1.34	2.48	118.7	82.2%	162.6	126.1	1791

Corrected to 1780 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mgd
6439	9.27	65.6	67.4%	158	123	1780.0	13
6163	8.88	77.0	73.6%	163	126	1780.0	14
5590	8.05	93.5	80.0%	165	128	1780.0	16
4931	7.10	108.5	82.9%	163	126	1780.0	18
4433	6.38	117.4	82.2%	160	124	1781.0	19

Pump No. 2 Field Curve 2/26/07, Post Mechanical Rebuild

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
6389	9.2	47.26	13.32	78.81	18.12	72.9	2.75	5.10	75.2	71.9%	168.7	130.9	1791
6014	8.66	51.08	12.53	89.09	17.06	87.8	2.44	4.52	89.9	79.3%	172.2	133.6	1791
5083	7.32	58.16	10.59	106.68	14.42	112.1	1.74	3.23	113.6	84.9%	171.8	133.2	1791
4396	6.33	63.87	9.16	117.86	12.47	124.7	1.30	2.41	125.8	83.8%	166.8	129.3	1790
3708	5.34	69.1	7.73	129.0	10.52	138.2	0.93	1.72	139.0	79.3%	164.1	127.3	1791

Corrected to 1780 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mgd
6350	9.14	74.3	71.9%	166	128	1780.0	14
5977	8.61	88.8	79.3%	169	131	1780.0	15
5052	7.28	112.2	84.9%	169	131	1780.0	18
4371	6.29	124.4	83.8%	164	127	1780.0	20
3688	5.31	137.5	79.3%	161	125	1781.0	24

Pump No. 2 Field Curve 4/27/07, Post Impeller Coating

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
6472	9.32	43.32	13.49	72.83	18.36	68.2	2.83	5.23	70.6	72.4%	159.4	123.6	1792
5792	8.34	50.60	12.07	90.12	16.43	91.3	2.26	4.19	93.2	82.4%	165.4	128.3	1792
5319	7.66	52.39	11.09	97.62	15.09	104.5	1.91	3.54	106.1	85.6%	166.6	129.2	1792
5083	7.32	55.22	10.59	103.45	14.42	111.4	1.74	3.23	112.9	87.2%	166.3	129.0	1792
4604	6.63	58.05	9.60	111.17	13.06	122.7	1.43	2.65	123.9	88.3%	163.1	126.5	1791

Corrected to 1780 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mgd
6429	9.26	69.6	72.4%	156	121	1780.0	13
5753	8.28	92.0	82.4%	162	126	1780.0	15
5284	7.61	104.7	85.6%	163	127	1780.0	17
5049	7.27	111.4	87.2%	163	126	1780.0	17
4578	6.59	122.5	88.3%	160	124	1781.0	19

Pump No. 2 Field Curve 5/21/07, Post Casing Coating

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
6861	9.88	52.36	14.30	77.94	19.46	59.1	3.18	5.88	61.8	69.0%	155.2	120.3	1792
6438	9.27	58.14	13.42	91.78	18.26	77.7	2.80	5.18	80.1	80.2%	162.4	125.9	1792
6049	8.71	62.31	12.61	100.81	17.16	88.9	2.47	4.57	91.0	83.9%	165.7	128.5	1792
5611	8.08	64.87	11.69	108.30	15.92	100.3	2.12	3.93	102.1	86.5%	167.3	129.8	1792
5243	7.55	69.14	10.93	116.83	14.87	110.2	1.85	3.44	111.7	88.3%	167.5	129.9	1791

Corrected to 1780 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mgd
6815	9.81	61.0	69.0%	152	118	1780.0	12
6394	9.21	79.0	80.2%	159	123	1780.0	13
6008	8.65	89.8	83.9%	162	126	1780.0	15
5574	8.03	100.8	86.5%	164	127	1780.0	16
5214	7.51	110.5	88.3%	165	128	1781.0	17

Pump No. 2 Field Curve 7/6/07, 30 Day Test

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
6347	9.14	41.80	13.23	75.72	18.01	78.4	2.72	5.03	80.7	78.4%	164.9	127.9	1792
5861	8.44	47.43	12.22	89.42	16.63	97.0	2.32	4.29	99.0	86.6%	169.1	131.2	1792
5201	7.49	53.01	10.84	102.04	14.76	113.3	1.82	3.38	114.8	88.9%	169.7	131.6	1792
4764	6.86	57.15	9.93	110.36	13.51	122.9	1.53	2.84	124.2	89.1%	167.8	130.1	1792
4174	6.01	62.70	8.70	120.24	11.84	132.9	1.17	2.18	133.9	87.2%	161.9	125.5	1791

Corrected to 1780 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mgd
6305	9.08	79.6	78.4%	162	125	1780.0	14
5822	8.38	97.7	86.6%	166	129	1780.0	15
5167	7.44	113.3	88.9%	166	129	1780.0	17
4732	6.81	122.6	89.1%	164	128	1780.0	19
4150	5.98	132.4	87.2%	159	123	1781.0	21

Pump No. 2 Field Curve 9/10/07, 90 Day Test

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
6750	9.72	54.11	14.07	80.83	19.15	61.7	3.07	5.69	64.3	68.6%	160.0	124.1	1791
6465	9.31	56.13	13.47	88.00	18.34	73.6	2.82	5.22	76.0	75.2%	165.0	127.9	1792
6069	8.74	60.88	12.65	99.09	17.22	88.3	2.48	4.60	90.4	82.2%	168.6	130.7	1792
5604	8.07	64.81	11.68	107.54	15.90	98.7	2.12	3.92	100.5	83.6%	170.1	131.9	1792
5063	7.29	69.86	10.55	118.55	14.36	112.5	1.73	3.20	113.9	85.7%	170.0	131.9	1790

Corrected to 1780 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mgd
6709	9.66	63.6	68.6%	157	122	1780.0	13
6422	9.25	75.0	75.2%	162	125	1780.0	14
6029	8.68	89.2	82.2%	165	128	1780.0	15
5567	8.02	99.2	83.6%	167	129	1780.0	16
5037	7.25	112.8	85.7%	167	130	1781.0	18

Pump No. 2 Field Curve 1/22/08, Post Interior Coating 6 Month Test & After Impeller Re-Coating Repair

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
6951	10.01	56.69	14.49	79.46	19.72	52.6	3.26	6.04	55.4	64.8%	150.1	116.4	1792
6618	9.53	60.37	13.79	89.06	18.77	66.3	2.95	5.47	68.8	73.5%	156.5	121.4	1792
6257	9.01	62.92	13.04	96.89	17.75	78.5	2.64	4.89	80.7	79.1%	161.3	125.1	1791
5979	8.61	66.54	12.46	105.31	16.96	89.6	2.41	4.47	91.6	84.3%	164.1	127.3	1791
5486	7.90	69.88	11.43	113.83	15.56	101.5	2.03	3.76	103.3	86.2%	165.9	128.7	1791

Corrected to 1780 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mgd
6905	9.94	54.6	64.8%	147	114	1780.0	11
6574	9.47	67.9	73.5%	153	119	1780.0	13
6219	8.95	79.7	79.1%	158	123	1780.0	14
5942	8.56	90.5	84.3%	161	125	1780.0	15
5455	7.86	102.1	86.2%	163	127	1781.0	16

Pump No. 2 Field Curve 5/6/08, One Year Test

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
6528	9.4	48.63	13.61	78.19	18.52	68.3	2.87	5.32	70.7	74.1%	157.4	122.0	1792
6160	8.87	53.37	12.84	89.64	17.47	83.8	2.56	4.74	86.0	82.2%	162.6	126.1	1792
5826	8.39	56.20	12.14	96.75	16.53	93.7	2.29	4.24	95.6	85.3%	165.0	127.9	1792
5313	7.65	60.34	11.07	106.44	15.07	106.5	1.90	3.53	108.1	87.2%	166.3	128.9	1792
4917	7.08	63.85	10.25	114.57	13.95	117.2	1.63	3.02	118.6	89.0%	165.3	128.2	1792

Corrected to 1780 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mgd
6484	9.34	69.8	74.1%	154	120	1780.0	13
6118	8.81	84.8	82.2%	159	124	1780.0	14
5787	8.33	94.3	85.3%	162	125	1780.0	15
5277	7.60	106.7	87.2%	163	126	1780.0	17
4886	7.04	117.1	89.0%	162	126	1781.0	18

Pump No. 2 Field Curve 1/6/09, 18 Month Test

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
6806	9.8	52.07	14.18	77.11	19.31	57.8	3.12	5.79	60.5	68.3%	152.3	118.1	1791
6396	9.21	56.98	13.33	89.28	18.14	74.6	2.76	5.11	77.0	78.1%	159.3	123.5	1791
5861	8.44	61.00	12.22	100.48	16.63	91.2	2.32	4.29	93.2	84.3%	163.5	126.8	1791
5451	7.85	63.64	11.36	107.45	15.46	101.2	2.00	3.71	102.9	86.0%	164.8	127.8	1791
5000	7.20	66.72	10.42	115.84	14.18	113.5	1.69	3.12	114.9	88.2%	164.4	127.5	1791

Corrected to 1780 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mgd
6764	9.74	59.8	68.3%	149	116	1780.0	12
6357	9.15	76.0	78.1%	156	121	1780.0	13
5825	8.39	92.0	84.3%	161	124	1780.0	15
5418	7.80	101.6	86.0%	162	125	1780.0	16
4972	7.16	113.6	88.2%	162	125	1781.0	18

Pump No. 2 Field Curve 6/23/09, Two Year Test

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
6875	9.9	54.92	14.33	78.46	19.50	54.4	3.19	5.91	57.1	65.8%	150.5	116.7	1792
6528	9.4	57.15	13.61	86.46	18.52	67.7	2.87	5.32	70.2	74.0%	156.4	121.3	1792
5764	8.30	62.14	12.01	101.18	16.35	90.2	2.24	4.15	92.1	82.2%	163.0	126.4	1791
5278	7.6	65.35	11.00	110.12	14.97	103.4	1.88	3.48	105.0	85.3%	164.2	127.3	1791

Corrected to 1780 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mgd
6829	9.83	56.3	65.8%	148	114	1780.0	12
6484	9.34	69.2	74.0%	153	119	1780.0	13
5728	8.25	91.0	82.2%	160	124	1780.0	15
5245	7.55	103.7	85.3%	161	125	1780.0	17

Pump No. 2 Field Curve 1/5/10, 30 Month Test

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
6535	9.41	51.02	13.62	79.47	18.54	65.7	2.88	5.34	68.2	72.0%	156.4	121.3	1791
6028	8.68	56.20	12.56	93.45	17.10	86.0	2.45	4.54	88.1	82.3%	163.1	126.5	1791
5576	8.03	59.45	11.62	102.20	15.82	98.8	2.10	3.89	100.5	85.7%	165.2	128.1	1792
5069	7.3	63.43	10.57	111.53	14.38	111.1	1.73	3.21	112.6	87.3%	165.2	128.1	1792
4674	6.73	66.3	9.74	118.6	13.26	120.6513	1.5	2.73	121.9	88.4%	162.7	126.2	1792

Corrected to 1780 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mgd
6495	9.35	67.3	72.0%	153	119	1780.0	13
5991	8.63	87.1	82.3%	160	124	1780.0	14
5539	7.98	99.2	85.7%	162	126	1780.0	16
5035	7.25	111.1	87.3%	162	126	1780.0	17
4645	6.69	120.4	88.4%	160	124	1781.0	19

Pump No. 2 Field Curve 6/8/10

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
6674	9.61	52.13	13.91	79.21	18.93	62.6	3.00	5.57	65.1	70.6%	155.5	120.6	1791
6076	8.75	57.71	12.66	94.46	17.24	84.9	2.49	4.61	87.0	81.9%	163.0	126.4	1791
5424	7.81	63.23	11.30	108.01	15.39	103.4	1.98	3.68	105.1	86.9%	165.6	128.4	1791
4639	6.68	68.29	9.67	120.48	13.16	120.6	1.45	2.69	121.8	88.3%	161.6	125.4	1791

Corrected to 1780 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mgd
6633	9.55	64.3	70.6%	153	118	1780.0	12
6039	8.70	86.0	81.9%	160	124	1780.0	14
5390	7.76	103.8	86.9%	163	126	1780.0	16
4610	6.64	120.3	88.3%	159	123	1780.0	19

Pump No. 3 Field Curve 1/18/08, Initial Test													
Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
6646	9.57	54.76	13.85	78	18.85	53.7	2.98	5.52	56.2	59.6%	158.3	122.8	1792
6306	9.08	60.83	13.14	91.73	17.89	71.4	2.68	4.97	73.7	71.3%	164.4	127.5	1792
5931	8.54	64.26	12.36	99.93	16.82	82.4	2.37	4.39	84.4	75.9%	166.5	129.1	1791
5444	7.84	67.81	11.35	108.78	15.44	94.6	2.00	3.70	96.3	79.5%	166.7	129.3	1791
5278	7.60	69.3	11.00	112.3	14.97	99.2	1.88	3.48	100.8	80.8%	166.2	128.9	1791

Corrected to 1780 RPM							
Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mgd
6601	9.51	55.5	59.6%	155	120	1780.0	13
6263	9.02	72.7	71.3%	161	125	1780.0	14
5894	8.49	83.4	75.9%	163	127	1780.0	15
5411	7.79	95.2	79.5%	164	127	1780.0	16
5245	7.55	99.6	80.8%	163	127	1780.0	17

Pump No. 3 Field Curve 5/6/08 (Post Casing Coating)													
Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
6458	9.3	49.04	13.46	78.42	18.32	67.9	2.81	5.21	70.3	70.9%	161.6	125.3	1792
6111	8.8	53.95	12.74	89.05	17.34	81.1	2.52	4.67	83.2	77.6%	165.5	128.3	1791
5847	8.42	56.5	12.19	94.96	16.59	88.8	2.31	4.27	90.8	80.2%	167.1	129.6	1791
5306	7.64	61.87	11.06	106.14	15.05	102.3	1.90	3.52	103.9	83.5%	166.7	129.2	1792
4951	7.13	64.8	10.32	111.8	14.05	108.8	1.65	3.06	110.2	83.8%	164.4	127.5	1791

Corrected to 1780 RPM							
Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mgd
6415	9.24	69.3	70.9%	158	123	1780.0	13
6074	8.75	82.2	77.6%	162	126	1780.0	14
5811	8.37	89.7	80.2%	164	127	1780.0	15
5270	7.59	102.5	83.5%	163	127	1780.0	17
4921	7.09	108.8	83.8%	161	125	1780.0	18

Pump No. 3 Field Curve 5/21/08 (Post Mechanical & Impeller Coating)

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
6361	9.16	43.03	13.26	77.58	18.05	79.8	2.73	5.06	82.1	80.1%	164.8	127.76	1792
5965	8.59	47.68	12.43	88.42	16.92	94.1	2.40	4.45	96.2	86.0%	168.4	130.58	1791
5625	8.10	51.19	11.72	96.34	15.96	104.3	2.13	3.95	106.1	88.9%	169.6	131.53	1791
4986	7.18	56.53	10.39	108.15	14.14	119.2	1.68	3.11	120.7	90.3%	168.2	130.46	1791
4458	6.42	60.82	9.29	115.73	12.65	126.8	1.34	2.48	128.0	88.2%	163.3	126.63	1792
3958	5.70	63.50	8.25	121.67	11.23	134.4	1.06	1.96	135.3	85.3%	158.5	122.89	1791

Corrected to 1780 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mgd
6319	9.10	81.0	80.1%	161	125	1780.0	14
5929	8.54	95.0	86.0%	165	128	1780.0	15
5590	8.05	104.8	88.9%	167	129	1780.0	16
4955	7.14	119.2	90.3%	165	128	1780.0	18
4428	6.38	126.3	88.2%	160	124	1780.0	19
3936	5.67	133.8	85.3%	156	121	1781.0	21

Pump No. 3 Field Curve 7/11/08 (30 Day Test)

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
6951	10.01	49.31	14.49	75.96	19.72	61.6	3.26	6.04	64.3	72.5%	155.7	120.74	1792
6535	9.41	54.21	13.62	87.68	18.54	77.3	2.88	5.34	79.8	81.0%	162.5	125.98	1791
5965	8.59	60.08	12.43	101.25	16.92	95.1	2.40	4.45	97.1	87.5%	167.3	129.73	1791
5451	7.85	64.35	11.36	111.53	15.46	109.0	2.00	3.71	110.7	90.5%	168.4	130.62	1791
5222	7.52	66.87	10.88	116.42	14.81	114.5	1.84	3.41	116.0	91.2%	167.8	130.10	1792

Corrected to 1780 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mgd
6905	9.94	63.5	72.5%	153	118	1780.0	12
6495	9.35	78.8	81.0%	159	124	1780.0	13
5929	8.54	96.0	87.5%	164	127	1780.0	15
5418	7.80	109.3	90.5%	165	128	1780.0	16
5187	7.47	114.5	91.2%	164	128	1780.0	17

Pump No. 3 Field Curve 8/8/08 (90 Day Test)

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
7132	10.27	56.86	14.86	80.59	20.23	54.8	3.43	6.36	57.7	68.7%	151.4	117.43	1793
6632	9.55	63.00	13.82	94.59	18.81	73.0	2.97	5.50	75.5	78.7%	160.6	124.55	1793
6264	9.02	66.22	13.06	102.95	17.77	84.8	2.65	4.90	87.1	83.8%	164.5	127.55	1792
5743	8.27	70.58	11.97	113.82	16.29	99.9	2.22	4.12	101.8	88.2%	167.4	129.82	1790

Corrected to 1780 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mgd
7080	10.20	56.9	68.7%	148	115	1780.0	11
6584	9.48	74.4	78.7%	157	122	1780.0	13
6222	8.96	85.9	83.8%	161	125	1780.0	14
5711	8.22	100.6	88.2%	165	128	1780.0	16

Pump No. 3 Field Curve 1/6/09 (6 Month Test)

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
6889	9.92	51.97	14.36	78.36	19.54	61.0	3.20	5.93	63.7	73.2%	151.4	117.43	1791
6597	9.5	55.97	13.75	88.12	18.71	74.3	2.94	5.44	76.8	79.6%	160.6	124.55	1791
6215	8.95	58.78	12.95	96.20	17.63	86.4	2.61	4.83	88.7	84.6%	164.5	127.55	1791
5729	8.25	62.62	11.94	106.27	16.25	100.8	2.21	4.10	102.7	88.0%	168.9	131.01	1791
5285	7.61	65.31	11.01	113.99	14.99	112.5	1.88	3.49	114.1	90.0%	169.2	131.19	1791

Corrected to 1780 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mgd
6847	9.86	62.9	73.2%	149	115	1780.0	12
6557	9.44	75.8	79.6%	158	122	1780.0	13
6177	8.90	87.6	84.6%	161	125	1780.0	14
5694	8.20	101.5	88.0%	166	129	1780.0	16
5252	7.56	112.7	90.0%	166	129	1780.0	17

Pump No. 3 Field Curve 6/23/09

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
7000	10.08	51.88	14.59	76.72	19.86	57.4	3.31	6.12	60.2	69.3%	153.5	119.07	1791
6646	9.57	55.75	13.85	87.12	18.85	72.5	2.98	5.52	75.0	78.1%	161.1	124.93	1791
6194	8.92	59.84	12.91	97.58	17.57	87.2	2.59	4.79	89.4	84.5%	165.5	128.33	1791
5618	8.09	63.91	11.71	108.99	15.94	104.1	2.13	3.94	105.9	89.3%	168.4	130.58	1791

Corrected to 1780 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mgd
6957	10.02	59.5	69.3%	151	117	1780.0	12
6605	9.51	74.1	78.1%	158	123	1780.0	13
6156	8.87	88.3	84.5%	162	126	1780.0	14
5584	8.04	104.7	89.3%	165	128	1780.0	16

Pump No. 3 Field Curve 1/5/10

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
6583	9.48	50.87	13.72	81.56	18.68	70.9	2.92	5.42	73.4	75.5%	161.7	125.38	1791
6174	8.89	55.25	12.87	92.66	17.51	86.4	2.57	4.76	88.6	82.9%	166.6	129.22	1791
5708	8.22	59.01	11.90	102.89	16.19	101.4	2.20	4.07	103.2	88.0%	169.2	131.19	1791
5215	7.51	62.81	10.87	111.97	14.79	113.6	1.83	3.40	115.1	89.8%	168.9	130.95	1792
4785	6.89	65.69	9.97	118.50	13.57	122.0	1.54	2.86	123.3	89.6%	166.2	128.91	1792

Corrected to 1780 RPM

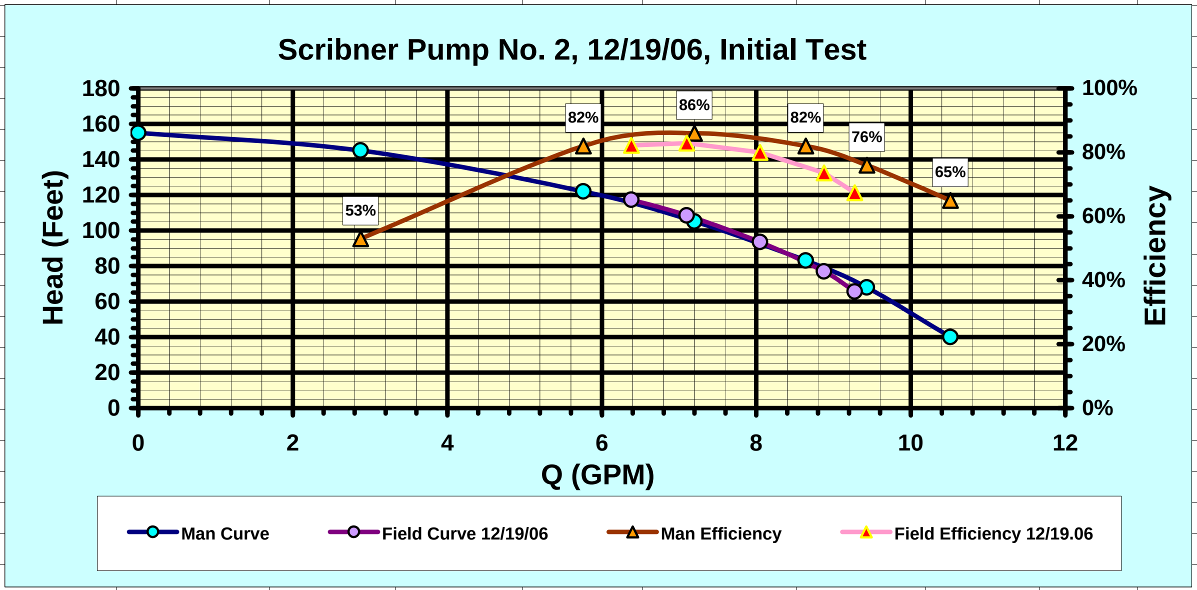
Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mgd
6543	9.42	72.5	75.5%	159	123	1780.0	13
6136	8.84	87.5	82.9%	164	127	1780.0	14
5673	8.17	102.0	88.0%	166	129	1780.0	16
5180	7.46	113.6	89.8%	165	128	1780.0	17
4755	6.85	121.8	89.6%	163	127	1781.0	18

Pump No. 3 Field Curve 6/8/10

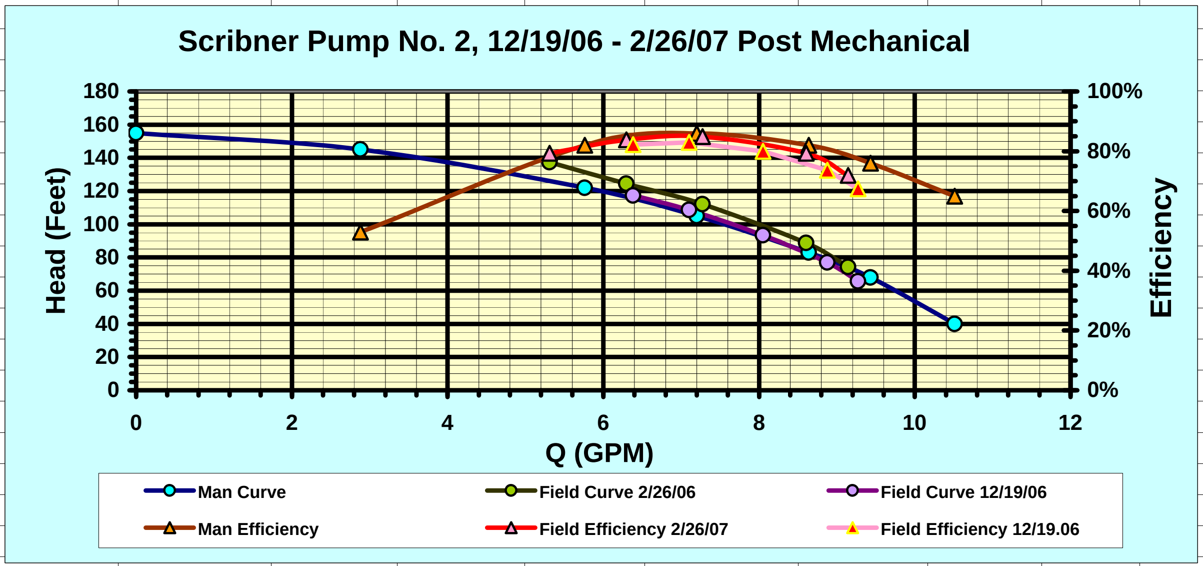
Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
6708	9.66	52.08	13.98	81.13	19.03	67.1	3.04	5.62	69.7	74.3%	159.0	123.27	1790
6313	9.09	56.00	13.16	91.52	17.91	82.1	2.69	4.98	84.3	81.8%	164.4	127.48	1790
5889	8.48	60.16	12.27	101.42	16.71	95.3	2.34	4.33	97.3	86.4%	167.5	129.89	1790
5299	7.63	64.05	11.04	112.01	15.03	110.8	1.89	3.51	112.4	89.5%	168.1	130.33	1791
5028	7.24	66.13	10.48	116.59	14.26	116.6	1.71	3.16	118.0	89.8%	166.8	129.34	1791

Corrected to 1780 RPM

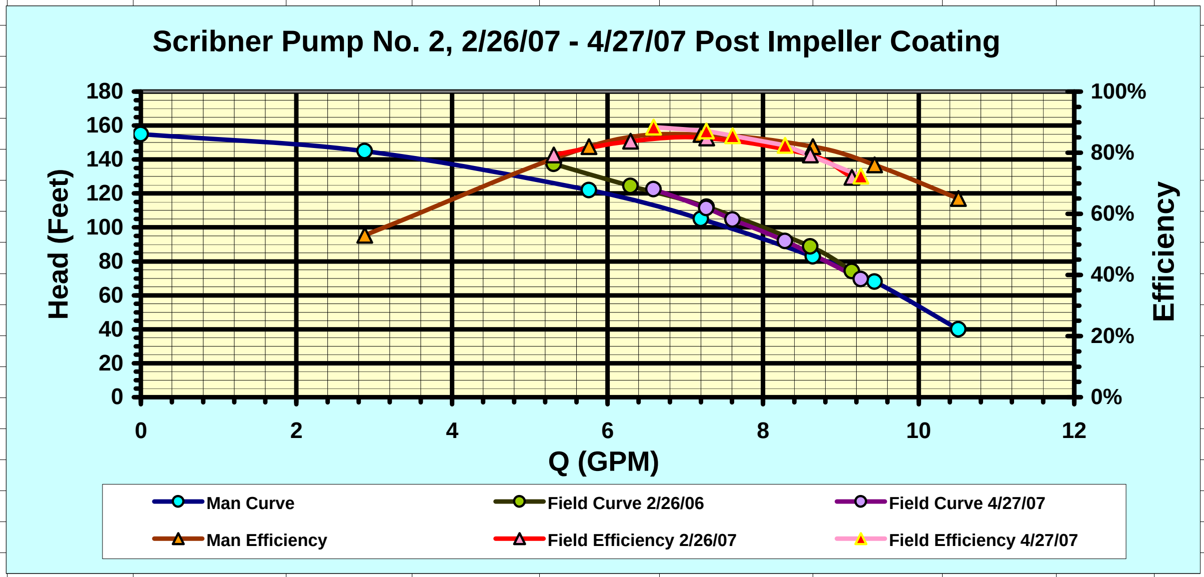
Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mgd
6671	9.61	68.9	74.3%	156	121	1780.0	13
6277	9.04	83.4	81.8%	162	125	1780.0	14
5856	8.43	96.2	86.4%	165	128	1780.0	15
5266	7.58	111.0	89.5%	165	128	1780.0	17
5000	7.20	116.7	89.8%	164	127	1781.0	18



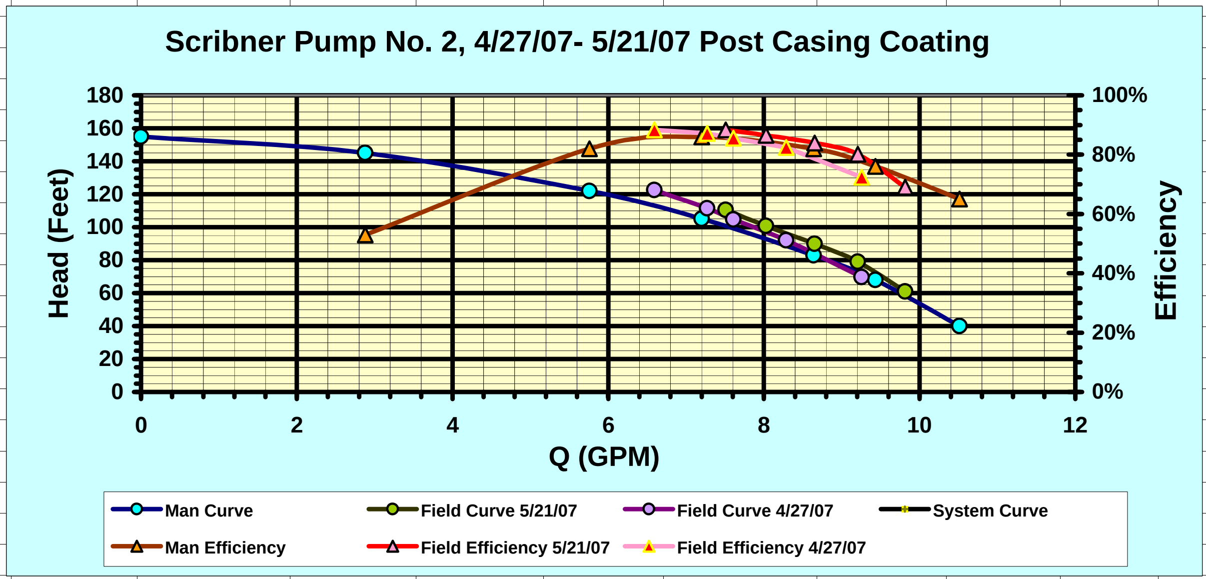
Scribner Pump No. 2, 12/19/06, Initial Test
Head (Feet)
Efficiency
Q (GPM)
180
160
140
120
100
80
60
40
20
0
100%
80%
60%
40%
20%
0%
0
2
4
6
8
10
12
53%
82%
86%
82%
76%
65%
Man Curve
Field Curve 12/19/06
Man Efficiency
Field Efficiency 12/19.06



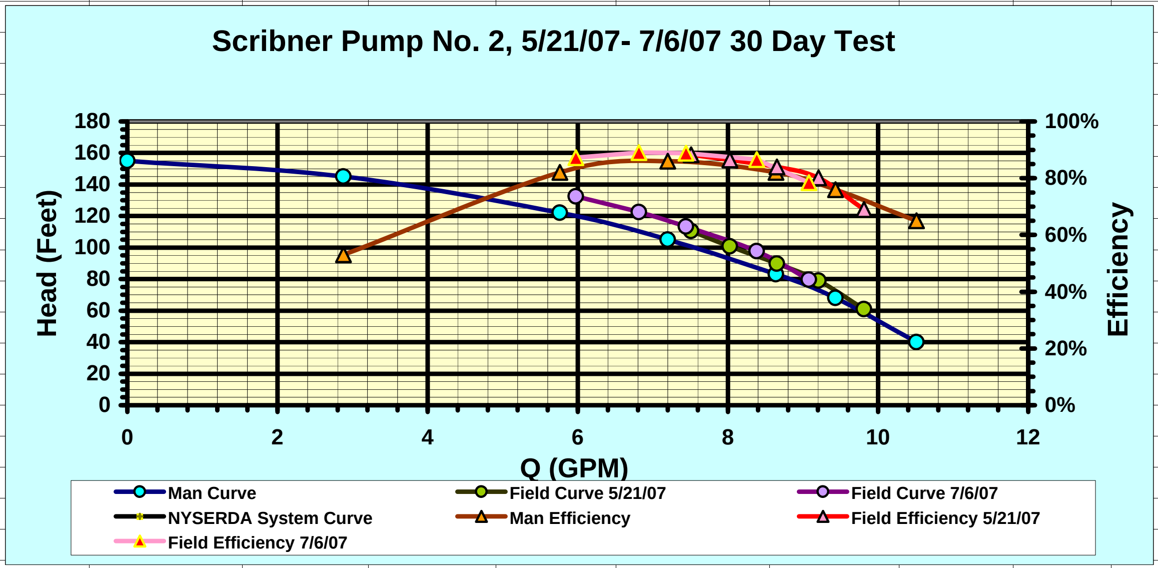
Scribner Pump No. 2, 12/19/06 - 2/26/07 Post Mechanical
Head (Feet)
Efficiency
Q (GPM)
180
160
140
120
100
80
60
40
20
0
100%
80%
60%
40%
20%
0%
0
2
4
6
8
10
12
Man Curve
Field Curve 2/26/06
Field Curve 12/19/06
Man Efficiency
Field Efficiency 2/26/07
Field Efficiency 12/19.06

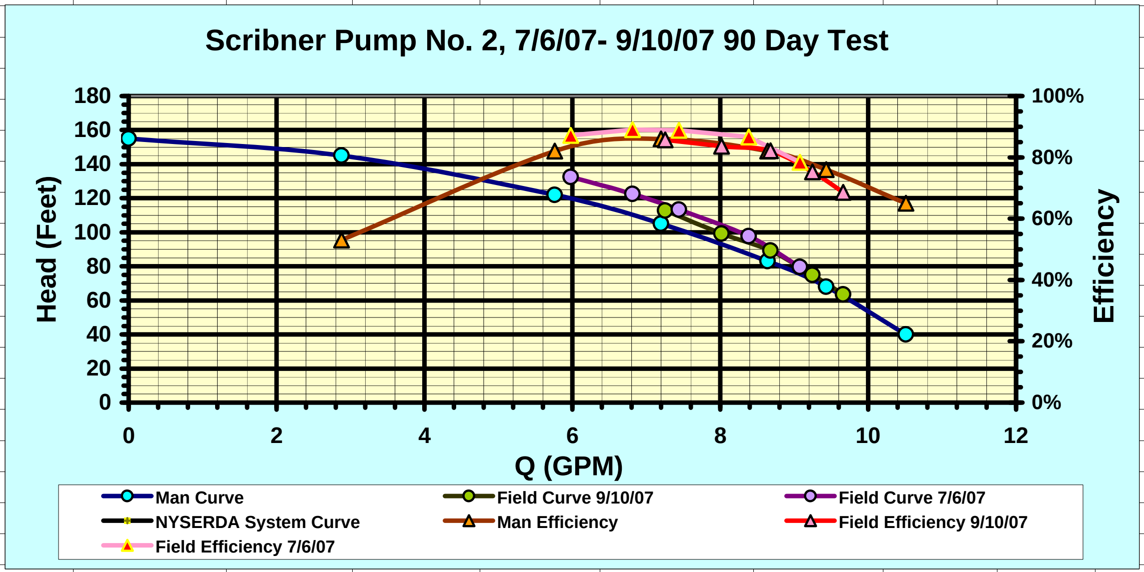


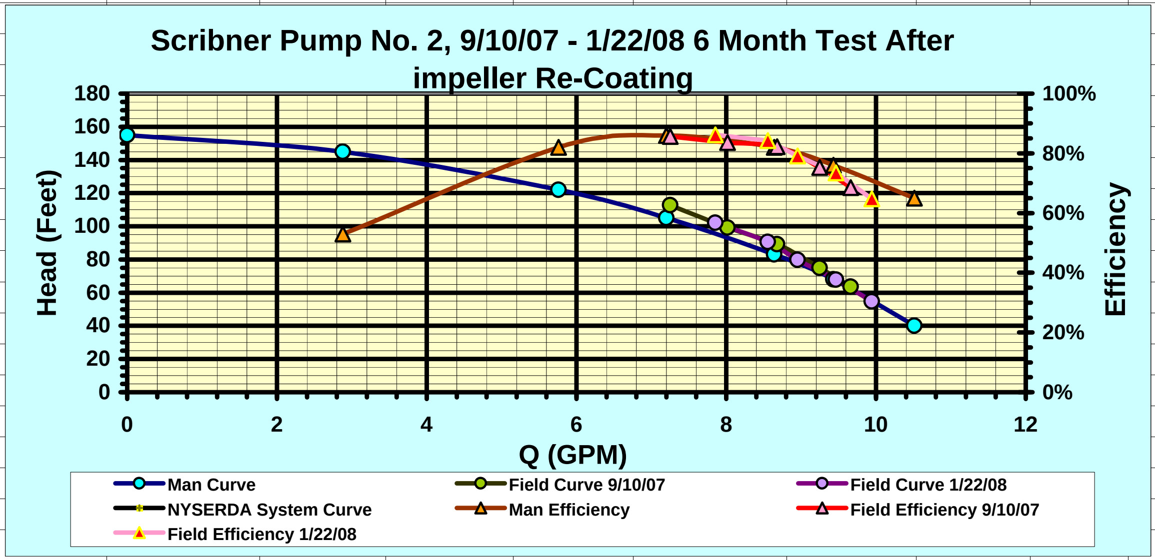
Scribner Pump No. 2, 2/26/07 - 4/27/07 Post Impeller Coating
Head (Feet)
Efficiency
Q (GPM)
180
160
140
120
100
80
60
40
20
0
100%
80%
60%
40%
20%
0%
0
2
4
6
8
10
12
Man Curve
Field Curve 2/26/06
Field Curve 4/27/07
Man Efficiency
Field Efficiency 2/26/07
Field Efficiency 4/27/07

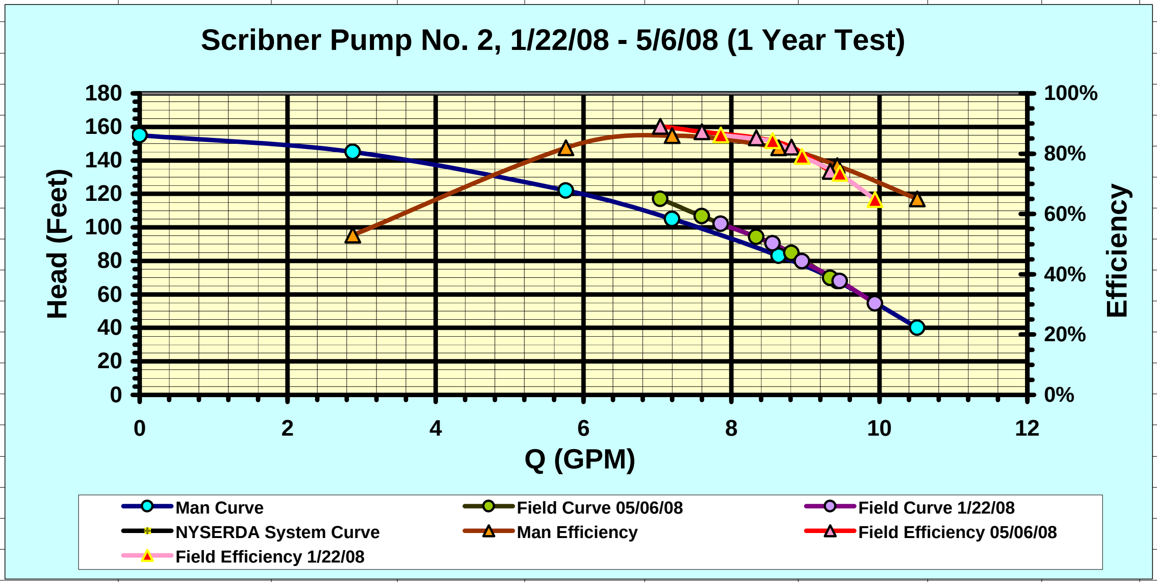


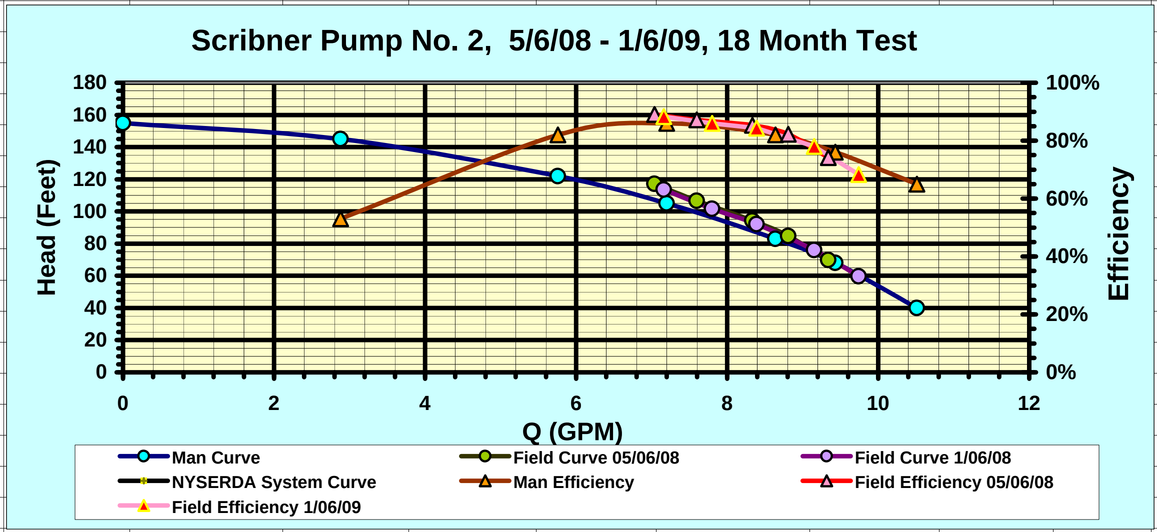
Scribner Pump No. 2, 4/27/07- 5/21/07 Post Casing Coating
Head (Feet)
Efficiency
Q (GPM)
180
160
140
120
100
80
60
40
20
0
100%
80%
60%
40%
20%
0%
0
2
4
6
8
10
12
Man Curve
Field Curve 5/21/07
Field Curve 4/27/07
System Curve
Man Efficiency
Field Efficiency 5/21/07
Field Efficiency 4/27/07

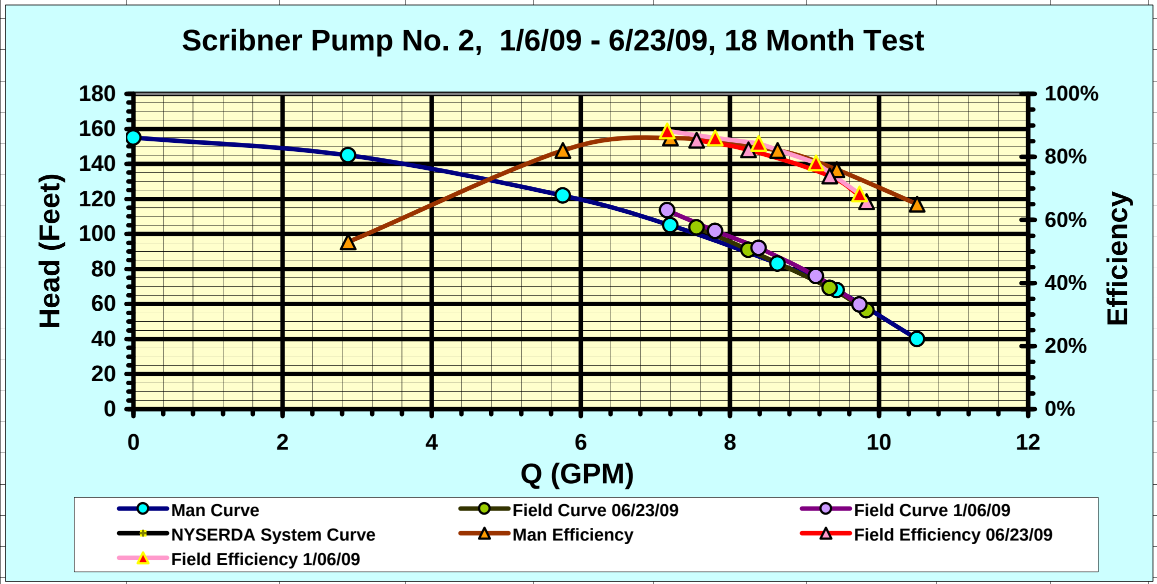

Scribner Pump No. 2, 5/21/07- 7/6/07 30 Day Test
Head (Feet)
Efficiency
Q (GPM)
Man Curve
Field Curve 5/21/07
Field Curve 7/6/07
NYSERDA System Curve
Man Efficiency
Field Efficiency 5/21/07
Field Efficiency 7/6/07

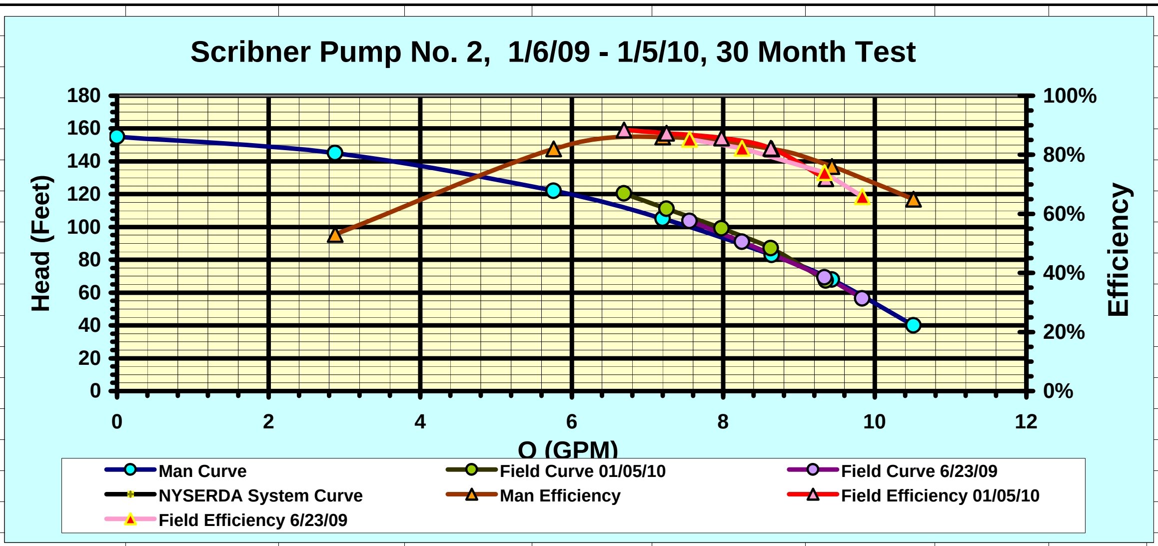

Scribner Pump No. 2, 7/6/07- 9/10/07 90 Day Test
Head (Feet)
Efficiency
Q (GPM)
Man Curve
Field Curve 9/10/07
Field Curve 7/6/07
NYSERDA System Curve
Man Efficiency
Field Efficiency 9/10/07
Field Efficiency 7/6/07


Scribner Pump No. 2, 9/10/07 - 1/22/08 6 Month Test After impeller Re-Coating
Head (Feet)
Efficiency
Q (GPM)
Man Curve
Field Curve 9/10/07
Field Curve 1/22/08
NYSERDA System Curve
Man Efficiency
Field Efficiency 9/10/07
Field Efficiency 1/22/08

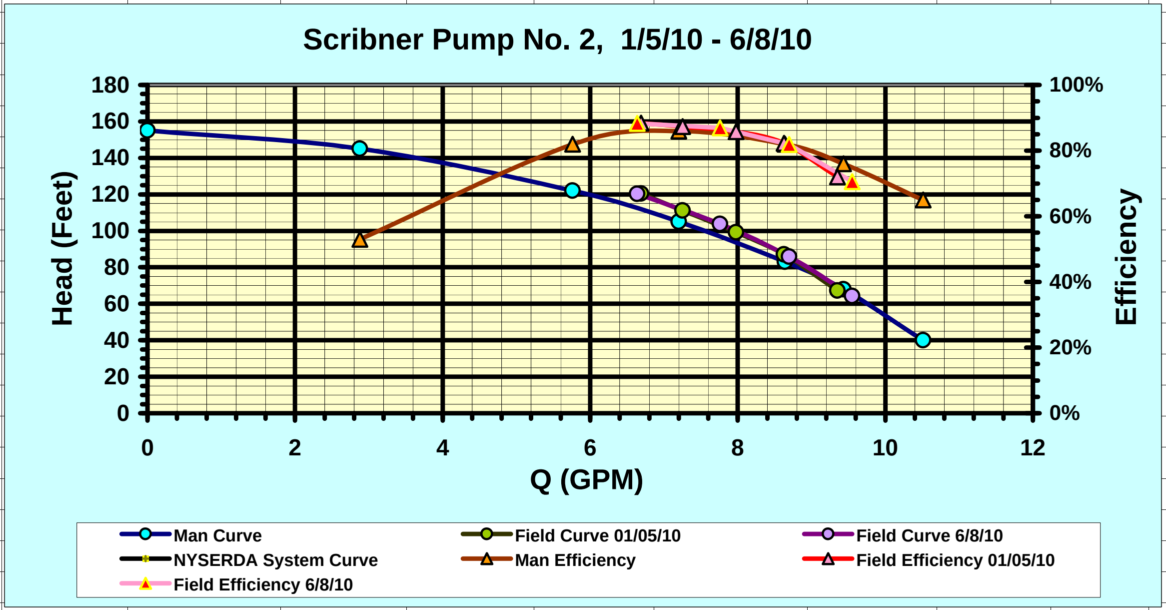

Scribner Pump No. 2, 1/22/08 - 5/6/08 (1 Year Test)
Head (Feet)
Efficiency
Q (GPM)
Man Curve
Field Curve 05/06/08
Field Curve 1/22/08
NYSERDA System Curve
Man Efficiency
Field Efficiency 05/06/08
Field Efficiency 1/22/08


Scribner Pump No. 2, 5/6/08 - 1/6/09, 18 Month Test
Head (Feet)
Efficiency
Q (GPM)
Man Curve
Field Curve 05/06/08
Field Curve 1/06/08
NYSERDA System Curve
Man Efficiency
Field Efficiency 05/06/08
Field Efficiency 1/06/09

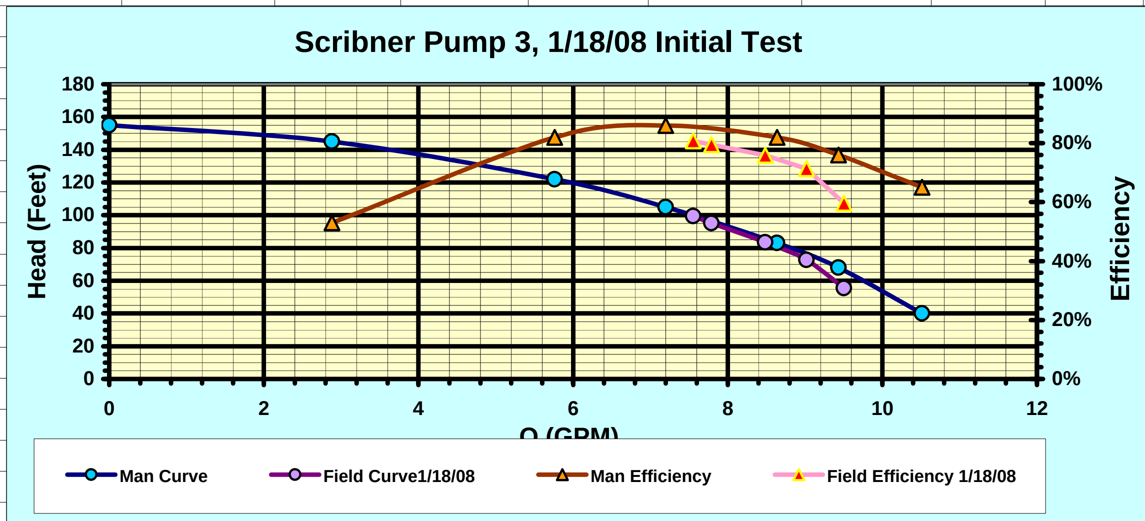

Scribner Pump No. 2, 1/6/09 - 6/23/09, 18 Month Test
Head (Feet)
Efficiency
Q (GPM)
Man Curve
Field Curve 06/23/09
Field Curve 1/06/09
NYSERDA System Curve
Man Efficiency
Field Efficiency 06/23/09
Field Efficiency 1/06/09



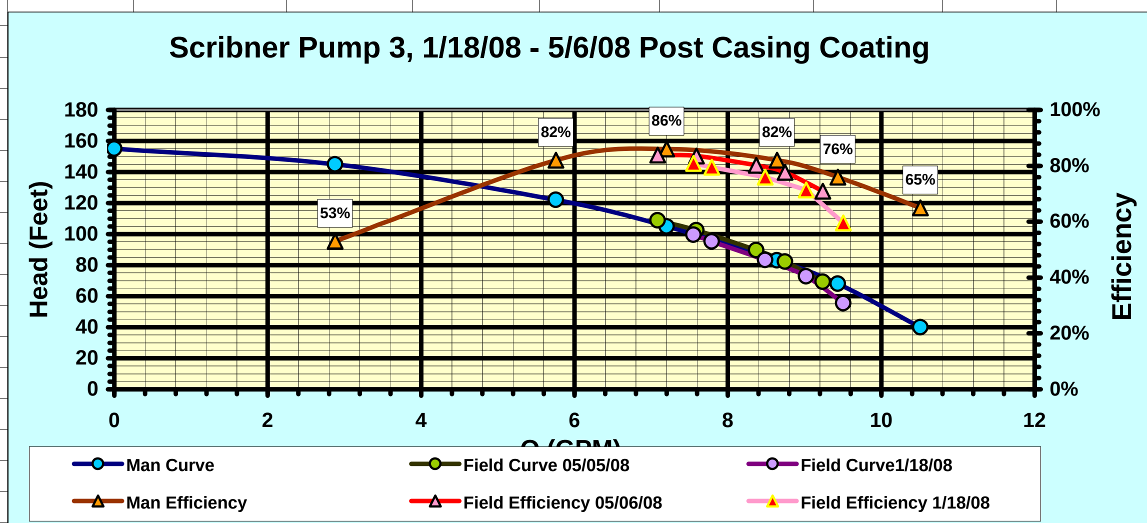
Scribner Pump No. 2, 1/6/09 - 1/5/10, 30 Month Test
Head (Feet)
Efficiency
Q (GPM)
Man Curve
Field Curve 01/05/10
Field Curve 6/23/09
NYSERDA System Curve
Man Efficiency
Field Efficiency 01/05/10
Field Efficiency 6/23/09



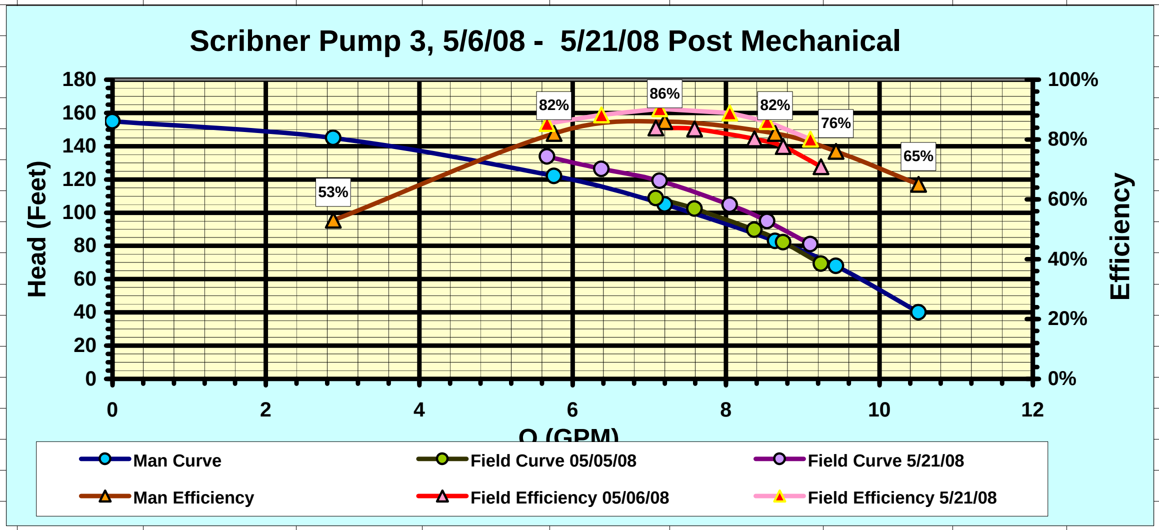
Scribner Pump No. 2, 1/5/10 - 6/8/10
Head (Feet)
Efficiency
Q (GPM)
Man Curve
Field Curve 01/05/10
Field Curve 6/8/10
NYSERDA System Curve
Man Efficiency
Field Efficiency 01/05/10
Field Efficiency 6/8/10



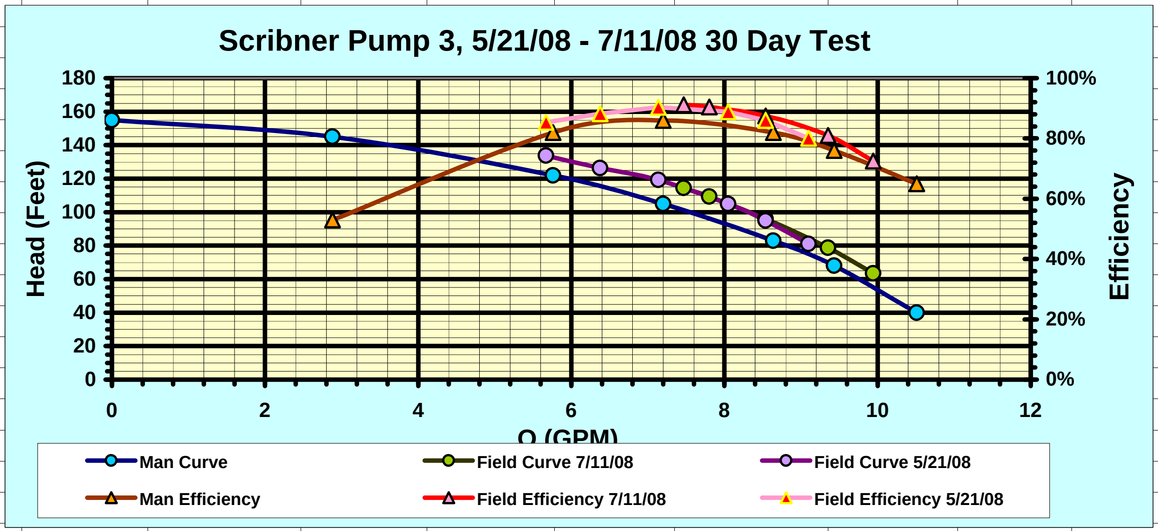
Scribner Pump 3, 1/18/08 Initial Test
Head (Feet)
Efficiency
Q (GPM)
Man Curve
Field Curve1/18/08
Man Efficiency
Field Efficiency 1/18/08



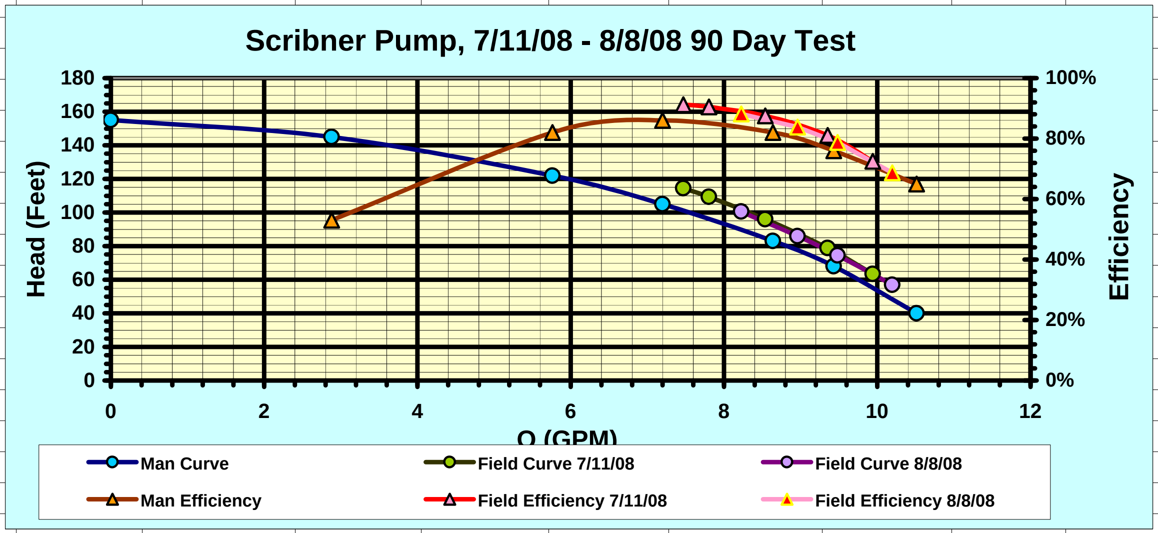
Scribner Pump 3, 1/18/08 - 5/6/08 Post Casing Coating
Head (Feet)
Efficiency
Q (GPM)
53%
82%
86%
82%
76%
65%
Man Curve
Field Curve 05/05/08
Field Curve1/18/08
Man Efficiency
Field Efficiency 05/06/08
Field Efficiency 1/18/08

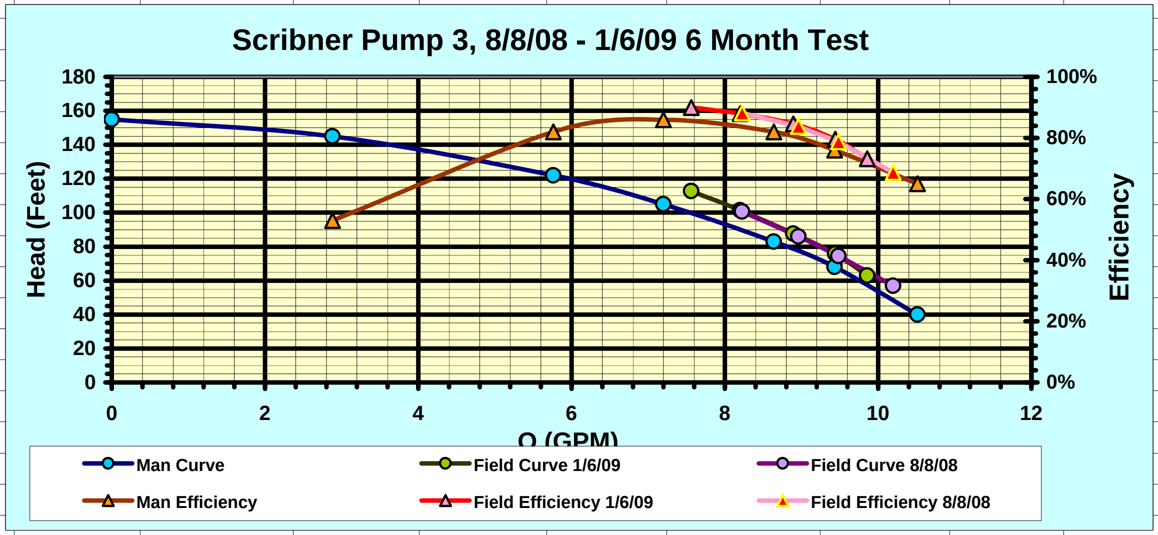


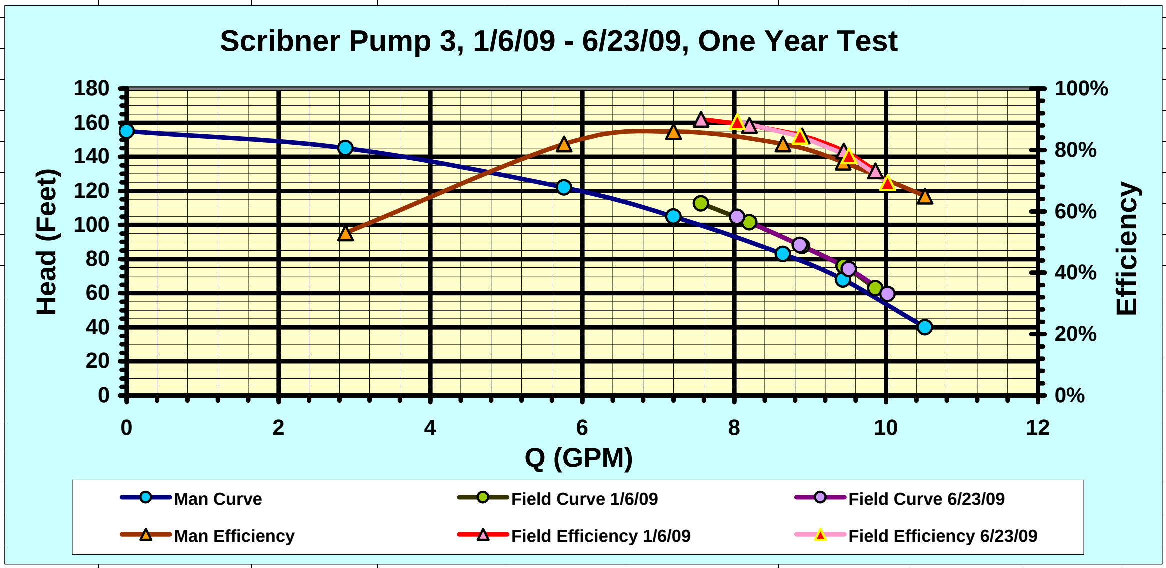
Scribner Pump 3, 5/6/08 - 5/21/08 Post Mechanical
Head (Feet)
Efficiency
Q (GPM)
180
160
140
120
100
80
60
40
20
0
100%
80%
60%
40%
20%
0%
0
2
4
6
8
10
12
82%
86%
82%
76%
65%
53%
Man Curve
Field Curve 05/05/08
Field Curve 5/21/08
Man Efficiency
Field Efficiency 05/06/08
Field Efficiency 5/21/08

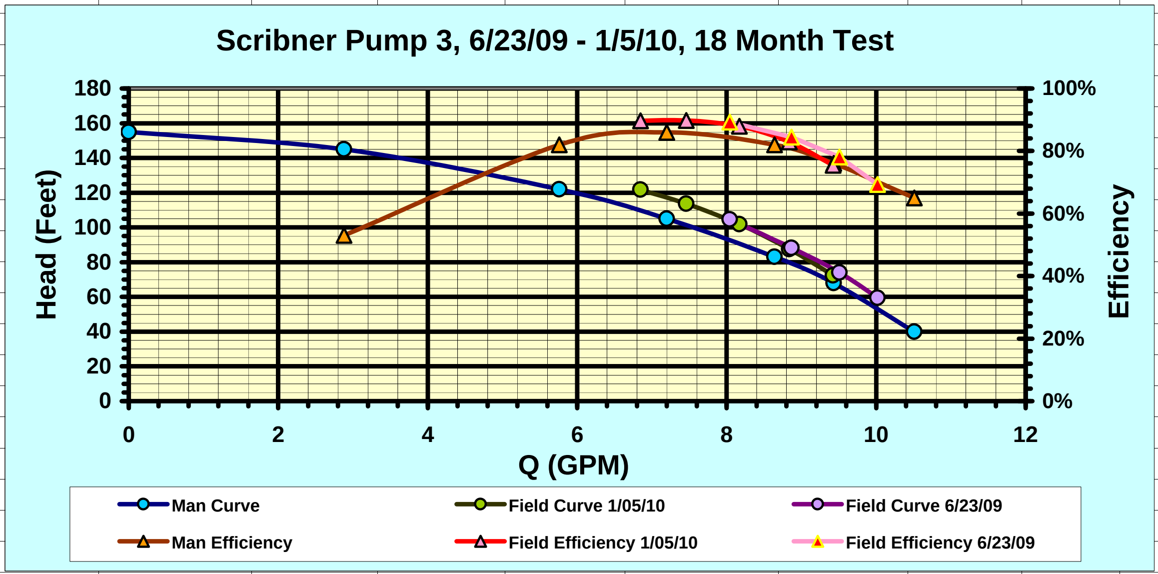


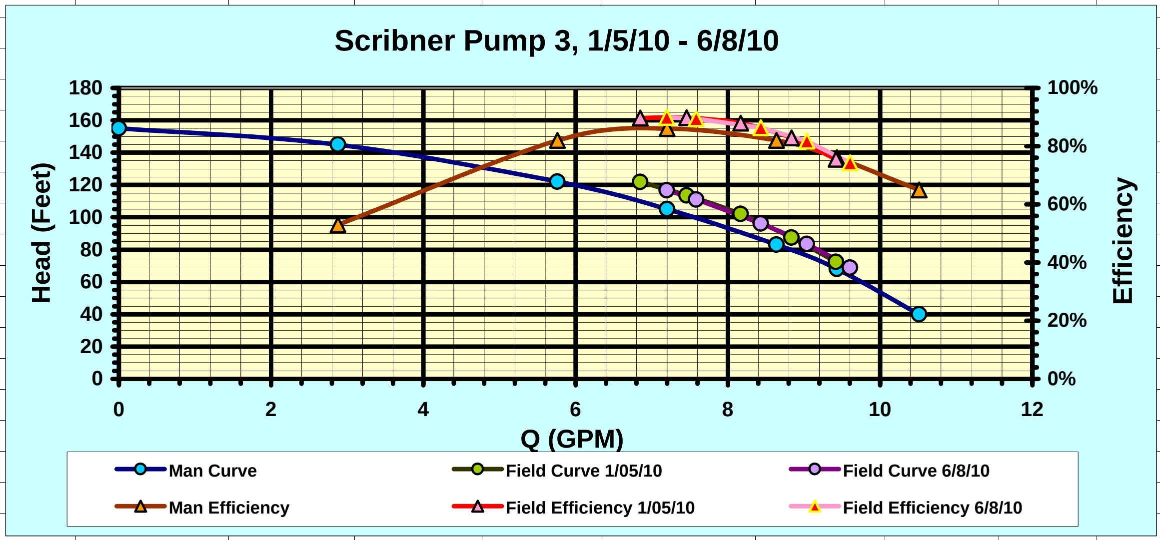
Scribner Pump 3, 5/21/08 - 7/11/08 30 Day Test
Head (Feet)
Efficiency
Q (GPM)
180
160
140
120
100
80
60
40
20
0
100%
80%
60%
40%
20%
0%
0
2
4
6
8
10
12
Man Curve
Field Curve 7/11/08
Field Curve 5/21/08
Man Efficiency
Field Efficiency 7/11/08
Field Efficiency 5/21/08


Scribner Pump, 7/11/08 - 8/8/08 90 Day Test
Head (Feet)
Efficiency
Q (GPM)
180
160
140
120
100
80
60
40
20
0
100%
80%
60%
40%
20%
0%
0
2
4
6
8
10
12
Man Curve
Field Curve 7/11/08
Field Curve 8/8/08
Man Efficiency
Field Efficiency 7/11/08
Field Efficiency 8/8/08


Scribner Pump 3, 8/8/08 - 1/6/09 6 Month Test
Head (Feet)
Efficiency
Q (GPM)
180
160
140
120
100
80
60
40
20
0
100%
80%
60%
40%
20%
0%
0
2
4
6
8
10
12
Man Curve
Field Curve 1/6/09
Field Curve 8/8/08
Man Efficiency
Field Efficiency 1/6/09
Field Efficiency 8/8/08


Scribner Pump 3, 1/6/09 - 6/23/09, One Year Test
Head (Feet)
Efficiency
Q (GPM)
180
160
140
120
100
80
60
40
20
0
100%
80%
60%
40%
20%
0%
0
2
4
6
8
10
12
Man Curve
Field Curve 1/6/09
Field Curve 6/23/09
Man Efficiency
Field Efficiency 1/6/09
Field Efficiency 6/23/09


Scribner Pump 3, 6/23/09 - 1/5/10, 18 Month Test
Head (Feet)
Efficiency
Q (GPM)
180
160
140
120
100
80
60
40
20
0
100%
80%
60%
40%
20%
0%
0
2
4
6
8
10
12
Man Curve
Field Curve 1/05/10
Field Curve 6/23/09
Man Efficiency
Field Efficiency 1/05/10
Field Efficiency 6/23/09



Scribner Pump 3, 1/5/10 - 6/8/10
Head (Feet)
Efficiency
Q (GPM)
180
160
140
120
100
80
60
40
20
0
100%
80%
60%
40%
20%
0%
0
2
4
6
8
10
12
Man Curve
Field Curve 1/05/10
Field Curve 6/8/10
Man Efficiency
Field Efficiency 1/05/10
Field Efficiency 6/8/10

Woodcliff Pump No. 1
Energy Efficiency Cost Calculator

Continuous Service

Pre Mechanical	
Head (ft)	123
Flow (gpm)	515
Effieicny	42.0%
Hours Operation/month	730
BHP	38
kW (Assumes Motor Eff 95%)	29.9
kW Demand Charge	$299
kwh cost	$1,856
Total Monthly kWH	21,833
Monthly Cost	**$2,154.85**

Constants	
Hours/ Month	730
kW Demand Cost	$10.00
kwh Cost	$0.085
Motor Efficiency	95.0%

Post Mechanical	
Head (ft)	129
Flow (gpm)	590
Effieicny	57.0%
Hours Operation/month	637
BHP	34
kW (Assumes Motor Eff 95%)	26.5
kW Demand Charge	$265
kwh cost	$1,434
Total Monthly kWH	16872
Monthly Cost	**$1,698.90**

Pre - Post Mechanical Comparison	
Monthly Savings	$456
Annual Savings	$5,471
5 Year Savings	$27,357
kW Demand Reduction	3.4
Monthly kwh Savings	4961
Yearly kwh Savings	59528

Post Casing Coating	
Head (ft)	141
Flow (gpm)	764
Effieicny	74.0%
Hours Operation/month	492
BHP	37
kW (Assumes Motor Eff 95%)	28.9
kW Demand Charge	$289
kwh cost	$1,207
Total Monthly kWH	14205
Monthly Cost	**$1,496.08**

Pre - Post Internal Coating Comparison	
Monthly Savings	$203
Annual Savings	$2,434
5 Year Savings	$12,169
kW Demand Reduction	-2.39
Monthly kwh Savings	15665
Yearly kwh Savings	187974

Pre Mechanical to Post Interior Coating Comparison	
Monthly Savings	$659
Annual Savings	$7,905
5 Year Savings	$39,526
kW Demand Reduction	1.04
Monthly kwh Savings	7628
Yearly kwh Savings	91533

20% Service Time

Pre Mechanical	
Head (ft)	123
Flow (gpm)	515
Effieicny	42.0%
Hours Operation/month	146
BHP	38
kW (Assumes Motor Eff 95%)	29.9
kW Demand Charge	$299
kwh cost	$371
Total Monthly kWH	4,367
Monthly Cost	**$670.23**

Constants	
Hours/ Month	730
kW Demand Cost	$10.00
kwh Cost	$0.085
Motor Efficiency	95.0%

Woodcliff Pump No. 1 Cont'

Post Mechanical

Head (ft)	129
Flow (gpm)	590
Effieicny	57.0%
Hours Operation/month	127
BHP	34
kW (Assumes Motor Eff 95%)	26.5
kW Demand Charge	$265
kwh cost	$287
Total Monthly kWH	3374
Monthly Cost	**$551.60**

Pre - Post Mechanical Comparison

Monthly Savings	$119
Annual Savings	$1,424
5 Year Savings	$7,118
kW Demand Reduction	3.4
Monthly kwh Savings	992
Yearly kwh Savings	11906

Post Casing Coating

Head (ft)	141
Flow (gpm)	764
Effieicny	74.0%
Hours Operation/month	98
BHP	37
kW (Assumes Motor Eff 95%)	28.9
kW Demand Charge	$289
kwh cost	$241
Total Monthly kWH	2841
Monthly Cost	**$530.15**

Pre - Post Internal Coating Comparison

Monthly Savings	$21
Annual Savings	$257
5 Year Savings	$1,287
kW Demand Reduction	-2.39
Monthly kwh Savings	3133
Yearly kwh Savings	37595

Pre Mechanical to Post Interior Coating Comparison

Monthly Savings	$140
Annual Savings	$1,681
5 Year Savings	$8,405
kW Demand Reduction	1.04
Monthly kwh Savings	1526
Yearly kwh Savings	18307

Total Savings (Mechanical & Coating)

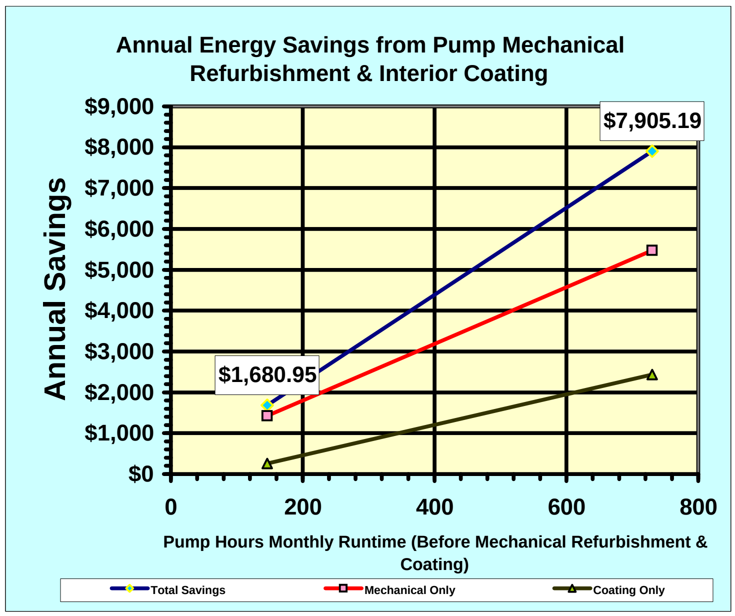
Pump Hours of Operation Before Refurbishment & Interior Coating	Annual Savings Through Refurbishment & Interior Coatings
730	$7,905.19
146	$1,680.95

Mechanical Savings Only

Pump Hours of Operation Before Refurbishment & Interior Coating	
730	$5,471.45
146	$1,423.53

Coating Savings Only

Pump Hours of Operation Before Refurbishment & Interior Coating	
730	$2,433.74
146	$257.42



Woodcliff Pump No. 2
Energy Efficiency Cost Calculator

Continuous Service

Pre Mechanical

Head (ft)	120
Flow (gpm)	490
Effieicny	43.0%
Hours Operation/month	730
BHP	35
kW (Assumes Motor Eff 95%)	27.1
kW Demand Charge	$271
kwh cost	$1,683
Total Monthly kWH	19,795
Monthly Cost	**$1,953.72**

Constants

Hours/ Month	730
kW Demand Cost	$10.00
kwh Cost	$0.085
Motor Efficiency	95.0%

Post Mechanical

Head (ft)	126
Flow (gpm)	563
Effieicny	58.5%
Hours Operation/month	635
BHP	31
kW (Assumes Motor Eff 95%)	24.0
kW Demand Charge	$240
kwh cost	$1,299
Total Monthly kWH	15278
Monthly Cost	**$1,539.05**

Pre - Post Mechanical Comparison

Monthly Savings	**$415**
Annual Savings	**$4,976**
5 Year Savings	**$24,880**
kW Demand Reduction	**3.1**
Monthly kwh Savings	**4517**
Yearly kwh Savings	**54207**

Post Sandblasting

Head (ft)	134.5
Flow (gpm)	649
Effieicny	65.2%
Hours Operation/month	551
BHP	34
kW (Assumes Motor Eff 95%)	26.5
kW Demand Charge	$265
kwh cost	$1,244
Total Monthly kWH	14632
Monthly Cost	**$1,509.23**

Pre - Post Internal Sandblast Comparison

Monthly Savings	**$30**
Annual Savings	**$358**
5 Year Savings	**$1,789**
kW Demand Reduction	**-2.50**
Monthly kwh Savings	**14034**
Yearly kwh Savings	**168406**

Pre Mechanical to Post Sandblast *Comparison*

Monthly Savings	**$444**
Annual Savings	**$5,334**
5 Year Savings	**$26,669**
kW Demand Reduction	**0.57**
Monthly kwh Savings	**5162**
Yearly kwh Savings	**61950**

20% Service Time

Pre Mechanical

Head (ft)	120
Flow (gpm)	490
Effieicny	43.0%
Hours Operation/month	146
BHP	35
kW (Assumes Motor Eff 95%)	27.1
kW Demand Charge	$271
kwh cost	$337
Total Monthly kWH	3,959
Monthly Cost	**$607.67**

Constants

Hours/ Month	730
kW Demand Cost	$10.00
kwh Cost	$0.085
Motor Efficiency	95.0%

Woodcliff Pump No. 2 Cont'

Post Mechanical

Head (ft)	126
Flow (gpm)	563
Effieicny	58.5%
Hours Operation/month	127
BHP	31
kW (Assumes Motor Eff 95%)	24.0
kW Demand Charge	$240
kwh cost	$260
Total Monthly kWH	3056
Monthly Cost	**$500.18**

Pre - Post Mechanical Comparison

Monthly Savings	**$107**
Annual Savings	**$1,290**
5 Year Savings	**$6,450**
kW Demand Reduction	**3.1**
Monthly kwh Savings	**903**
Yearly kwh Savings	**10841**

Post Sandblasting

Head (ft)	134.5
Flow (gpm)	649
Effieicny	65.2%
Hours Operation/month	110
BHP	34
kW (Assumes Motor Eff 95%)	26.5
kW Demand Charge	$265
kwh cost	$249
Total Monthly kWH	2926
Monthly Cost	**$514.23**

Pre - Post Internal Sandblast Comparison

Monthly Savings	**-$14**
Annual Savings	**-$169**
5 Year Savings	**-$843**
kW Demand Reduction	**-2.50**
Monthly kwh Savings	**2807**
Yearly kwh Savings	**33681**

Pre Mechanical to Post Sandblast *Comparison*

Monthly Savings	**$93**
Annual Savings	**$1,121**
5 Year Savings	**$5,606**
kW Demand Reduction	**0.57**
Monthly kwh Savings	**1032**
Yearly kwh Savings	**12390**

Total Savings (Mechanical & Coating)

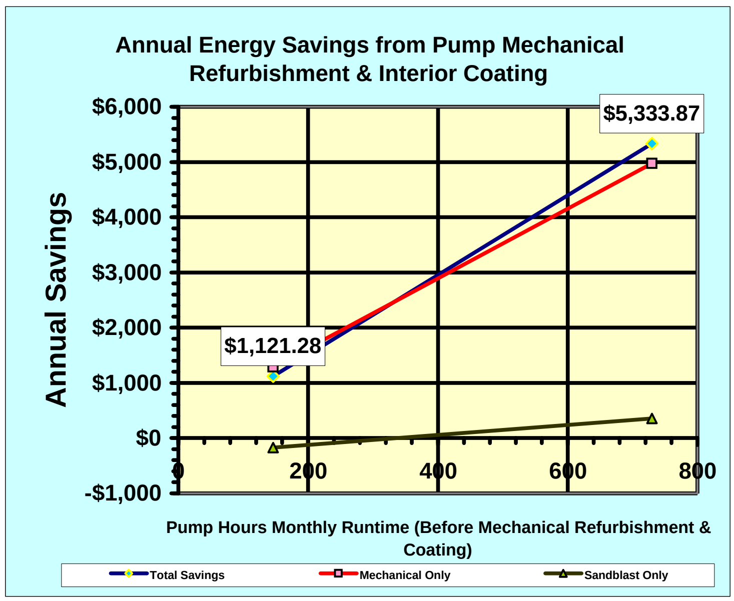
Pump Hours of Operation Before Refurbishment & Interior Coating	Annual Savings Through Refurbishment & Interior Coatings
730	$5,333.87
146	$1,121.28

Mechanical Savings Only

Pump Hours of Operation Before Refurbishment & Interior Coating	
730	$4,976.05
146	$1,289.95

Sandblast Savings Only

Pump Hours of Operation Before Refurbishment & Interior Coating	
730	$357.82
146	-$168.67



Woodcliff BPS

Pumps 1 & 2, Goulds 3410 4x6x13

Manufacturers Curve

Q (gpm)	Q (mgd)	H	Hp	Eff	kW	Ns
0	0.0	166				
200	0.3	164	16	52%	13	549
400	0.6	159	23	70%	18	795
600	0.9	149	29	77%	23	1022
700	1.0	140	32	78%	25	1157
800	1.2	130	35	76%	27	1308
900	1.3	117	37	71%	29	1501
1000	1.4	98	41	61%	32	1807

Average Day System Curve

S	D	Q (gpm)	Q (mgd)	H
77	108	0	0	71.61
77	108	250	0.36	71.61
76	109	500	0.72	76.23
75	112	750	1.08	85.47
74	115	1000	1.44	94.71
73	120	1250	1.8	108.57

NYSERDA System Curve

Q (mgd)		H (feet)	
50.0%	0.50	80%	112
75.0%	0.75	88%	123.2
BEP	1.00	100%	140
125.0%	1.25	120%	168

Pump No. 1 Field Curve 2/4/05 Initial Test													
Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
313	0.45	73.88	3.55	134.23	7.98	139.4	0.20	0.99	140.2	33.9%	32.6	27	1781
458	0.66	73.74	5.20	129.53	11.70	128.9	0.42	2.12	130.6	41.7%	36.3	30	1778
750	1.08	71.84	8.51	106.88	19.14	80.9	1.13	5.69	85.5	40.6%	39.9	33	1780
Corrected to 1780 RPM													
Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mgd						
312	0.45	140	33.9%	32.6	27	1780	60						
459	0.66	131	41.7%	36.4	30	1780	46						
750	1.08	86	40.6%	39.9	33	1780	31						
Pump No. 1 Field Curve 4/15/05, Post Mechanical													
Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
368	0.53	73.66	4.18	136.63	9.39	145.5	0.27	1.37	146.6	45.1%	30.2	25	1784
590	0.85	72.88	6.70	127.76	15.06	126.8	0.70	3.52	129.6	57.1%	33.9	28	1782
854	1.23	71.07	9.69	105.5	21.80	79.5	1.46	7.38	85.5	46.2%	39.9	33	1779
Corrected to 1780 RPM													
Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mgd						
367	0.53	145.9	45.1%	30.0	25	1780	47						
590	0.85	129.3	57.1%	33.7	28	1780	33						
855	1.23	85.5	46.2%	40.0	33	1780	27						
Pump No. 1 Field Curve 11/22/05, Post Coating													
Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
660	0.95	71.66	7.49	132.33	16.84	140.1	0.87	4.40	143.7	74.7%	32.0	26.5	1783
806	1.16	70.79	9.14	125.28	20.56	125.9	1.30	6.56	131.1	72.3%	36.9	30.5	1782
868	1.25	70.78	9.85	118.96	22.15	111.3	1.51	7.62	117.4	68.7%	37.5	31.0	1782
979	1.41	69.76	11.11	107.31	24.99	86.7	1.92	9.70	94.5	57.7%	40.5	33.5	1781
Corrected to 1780 RPM													
Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mgd						
659	0.95	143.2	74.7%	31.9	26	1780	28						
805	1.16	130.8	72.3%	36.8	30	1780	26						
867	1.25	117.1	68.7%	37.4	31	1780	25						
979	1.41	94.4	57.7%	40.4	33	1780	24						

Pump No. 1 Field Curve 9/14/06, 10 Month Test

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
1000	1.44	71.05	11.35	104.68	25.52	77.7	2.00	10.11	85.8	53.5%	40.5	33.5	1780
931	1.34	71.83	10.56	115.98	23.75	102.0	1.73	8.76	109.0	66.2%	38.7	32.0	1781
861	1.24	72.29	9.77	121.88	21.98	114.6	1.48	7.50	120.6	69.9%	37.5	31.0	1781
771	1.11	72.97	8.75	129.76	19.67	131.2	1.19	6.01	136.0	74.7%	35.4	29.3	1781
597	0.86	74.65	6.78	138.6	15.24	147.7	0.71	3.61	150.6	74.3%	30.6	25.3	1783

Corrected to 1780 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mgd
1000	1.44	85.8	53.5%	40.5	33.5	1780	23
930	1.34	108.9	66.2%	38.6	31.9	1780	24
861	1.24	120.4	69.9%	37.4	30.9	1780	25
770	1.11	135.9	74.7%	35.4	29.3	1780	26
596	0.86	150.1	74.3%	30.4	25.2	1780	29

Pump No. 1 Field Curve 4/19/07, 1.5 Year Test

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
924	1.33	68.47	10.48	111.33	23.57	99.0	1.71	8.63	105.9	63.9%	38.7	32.0	1775
847	1.22	69.1	9.62	118.89	21.62	115.0	1.44	7.26	120.8	69.6%	37.1	30.7	1775
799	1.15	69.91	9.06	124.65	20.38	126.4	1.28	6.45	131.6	74.7%	35.5	29.4	1776
688	0.99	70.84	7.80	130.62	17.55	138.1	0.95	4.78	141.9	73.6%	33.5	27.7	1778
521	0.75	72.4	5.91	139.08	13.29	154.0	0.54	2.74	156.2	72.9%	28.2	23.3	1780

Corrected to 1780 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mgd
926	1.33	106.5	63.9%	39.0	32.3	1780	24
850	1.22	121.5	69.6%	37.4	31.0	1780	25
800	1.15	132.2	74.7%	35.8	29.6	1780	26
688	0.99	142.2	73.6%	33.6	27.8	1780	28
521	0.75	156.2	72.9%	28.2	23.3	1780	31

Pump No. 1 Field Curve 1/14/08, 2 Year Test

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
1007	1.45	71.12	11.43	104.84	25.70	77.9	2.03	10.25	86.1	54.7%	40.0	33.12	1781
951	1.37	71.63	10.80	111.75	24.28	92.7	1.81	9.15	100.0	61.7%	39.0	32.23	1781
840	1.21	72.75	9.54	123.18	21.44	116.5	1.41	7.14	122.2	70.4%	36.8	30.47	1783
729	1.05	73.82	8.28	132.05	18.61	134.5	1.06	5.38	138.8	74.5%	34.3	28.39	1783
493	0.71	75.83	5.60	143.03	12.58	155.2	0.49	2.46	157.2	70.1%	27.9	23.09	1786

Corrected to 1780 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mgd
1006	1.45	86.0	54.7%	40.0	33.1	1780	23
951	1.37	99.9	61.7%	38.9	32.2	1780	23
839	1.21	121.8	70.4%	36.7	30.3	1780	25
728	1.05	138.4	74.5%	34.2	28.2	1780	27
491	0.71	156.1	70.1%	27.6	22.9	1780	32

Pump No. 1 Field Curve 6/2/08, 2.5 Year Test

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
910	1.31	67.57	10.33	110.88	23.22	100.0	1.66	8.37	106.8	64.3%	38.2	31.6	1781
819	1.18	68.24	9.30	121.33	20.91	122.6	1.34	6.79	128.1	73.0%	36.3	30.0	1782
646	0.93	69.52	7.33	130.95	16.48	141.9	0.83	4.22	145.3	73.6%	32.2	26.6	1784
521	0.75	70.38	5.91	136.72	13.29	153.2	0.54	2.74	155.4	71.6%	28.6	23.6	1785
264	0.38	71.27	3.00	143.07	6.73	165.9	0.14	0.70	166.4	48.7%	22.8	18.8	1789

Corrected to 1780 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mgd
909	1.31	106.6	64.3%	38.1	31.5	1780	24
819	1.18	127.8	73.0%	36.2	29.9	1780	25
644	0.93	144.6	73.6%	32.0	26.5	1780	29
519	0.75	154.6	71.6%	28.3	23.4	1780	31
263	0.38	164.8	48.7%	22.4	18.5	1780	49

Pump No. 1 Field Curve 9/29/08 Pre-New Motor													
Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
889	1.28	66.14	10.09	112.06	22.69	106.1	1.58	7.99	112.5	66.6%	37.9	31.3	1781
764	1.10	67.23	8.67	124.13	19.50	131.4	1.17	5.90	136.2	74.7%	35.2	29.1	1782
639	0.92	67.77	7.25	129.81	16.31	143.3	0.82	4.13	146.6	74.2%	31.9	26.4	1784
590	0.85	68.53	6.70	132.38	15.06	147.5	0.70	3.52	150.3	73.2%	30.6	25.3	1789
222	0.32	70.08	2.52	142.4	5.67	167.1	0.10	0.50	167.5	42.4%	22.2	18.4	1785

Corrected to 1780 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mgd
888	1.28	112.4	66.6%	37.8	31.3	1780	24
763	1.10	135.9	74.7%	35.1	29.0	1780	26
637	0.92	146.0	74.2%	31.7	26.2	1780	29
587	0.85	148.8	73.2%	30.1	24.9	1780	29
222	0.32	166.5	42.4%	22.0	18.2	1780	57

Pump No. 1 Field Curve 12/08/08 Pre-New Motor II													
Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
917	1.32	69.6	10.40	112.51	23.39	99.1	1.68	8.50	105.9	63.1%	38.9	32.2	1782
826	1.19	70.34	9.38	122.2	21.09	119.8	1.37	6.91	125.3	71.1%	36.8	30.4	1782
674	0.97	71.7	7.65	131.96	17.19	139.2	0.91	4.59	142.9	73.5%	33.1	27.4	1783
556	0.80	72.5	6.31	137.15	14.18	149.3	0.62	3.12	151.8	71.5%	29.8	24.6	1785
347	0.50	73.21	3.94	143.89	8.86	163.3	0.24	1.22	164.2	58.9%	24.4	20.2	1786

Corrected to 1780 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mgd
916	1.32	105.7	63.1%	38.8	32.1	1780	24
825	1.19	125.1	71.1%	36.7	30.3	1780	26
672	0.97	142.4	73.5%	32.9	27.2	1780	28
554	0.80	151.0	71.5%	29.5	24.4	1780	31
346	0.50	163.1	58.9%	24.2	20.0	1780	40

Pump No. 1 Field Curve 1/7/09 Post New Motor

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
910	1.31	67.67	10.33	110.63	23.22	99.2	1.66	8.37	106.0	62.2%	39.1	31.0	1777
868	1.25	67.88	9.85	115.6	22.15	110.2	1.51	7.62	116.3	69.2%	36.8	29.2	1779
785	1.13	68.5	8.91	123.14	20.03	126.2	1.23	6.23	131.2	71.7%	36.3	28.8	1779
667	0.96	69.47	7.57	129.79	17.01	139.3	0.89	4.50	142.9	72.5%	33.2	26.3	1779
521	0.75	70.44	5.91	136.44	13.29	152.5	0.54	2.74	154.7	70.3%	28.9	22.9	1783

Corrected to 1780 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mgd
911	1.31	106.3	62.2%	39.3	31.2	1780	24
869	1.25	116.5	69.2%	36.9	29.2	1780	23
785	1.13	131.4	71.7%	36.3	28.8	1780	25
667	0.96	143.1	72.5%	33.2	26.4	1780	27
520	0.75	154.1	70.3%	28.8	22.8	1780	30

Pump No. 1 Field Curve 4/21/09, 3.5 Year Test

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
924	1.33	64.9	10.48	107.42	23.57	98.2	1.71	8.63	105.1	63.1%	38.9	30.8	1777
854	1.23	69.5	9.69	118.43	21.80	113.0	1.46	7.38	118.9	69.7%	36.8	29.2	1779
799	1.15	70.28	9.06	124.19	20.38	124.5	1.28	6.45	129.7	71.3%	36.7	29.1	1779
729	1.05	71.27	8.28	129.14	18.61	133.7	1.06	5.38	138.0	73.5%	34.6	27.4	1779
618	0.89	72.37	7.01	134.28	15.77	143.0	0.76	3.86	146.1	71.2%	32.0	25.4	1783

Corrected to 1780 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mgd
925	1.33	105.5	63.1%	39.0	31.0	1780	23
855	1.23	119.1	69.7%	36.9	29.2	1780	24
799	1.15	129.9	71.3%	36.8	29.1	1780	25
730	1.05	138.1	73.5%	34.6	27.4	1780	26
617	0.89	145.6	71.2%	31.9	25.3	1780	28

Pump No. 1 Field Curve 9/4/09, 4 Year Test													
Q (gpm)	**Q (mgd)**	**S**	**SV ft/sec**	**D**	**DV ft/sec**	**Pump H**	**Suc V H**	**Dis V H**	**Total H**	**Eff**	**BHP**	**KW**	**RPM**
910	1.31	67.59	10.33	110.3	23.22	98.7	1.66	8.37	105.4	63.1%	38.4	30.4	1777
861	1.24	68.02	9.77	116.11	21.98	111.1	1.48	7.50	117.1	68.2%	37.3	29.6	1779
792	1.14	68.56	8.99	123.11	20.20	126.0	1.25	6.34	131.1	72.9%	35.9	28.5	1779
667	0.96	69.78	7.57	130.07	17.01	139.3	0.89	4.50	142.9	73.6%	32.7	25.9	1779
556	0.80	70.44	6.31	134.88	14.18	148.9	0.62	3.12	151.4	71.6%	29.7	23.5	1783
Corrected to 1780 RPM													
Q (gpm)	**Q (mgd)**	**H**	**Eff**	**BHP**	**KW**	**RPM**	**kw/mgd**						
911	1.31	105.7	63.1%	38.6	30.6	1780	23						
862	1.24	117.2	68.2%	37.4	29.6	1780	24						
792	1.14	131.2	72.9%	36.0	28.5	1780	25						
667	0.96	143.0	73.6%	32.8	26.0	1780	27						
555	0.80	150.9	71.6%	29.5	23.4	1780	29						
Pump No. 1 Field Curve 6/1/10,													
Q (gpm)	**Q (mgd)**	**S**	**SV ft/sec**	**D**	**DV ft/sec**	**Pump H**	**Suc V H**	**Dis V H**	**Total H**	**Eff**	**BHP**	**KW**	**RPM**
896	1.29	67.17	10.17	111.61	22.86	102.7	1.61	8.12	109.2	63.8%	38.7	30.7	1777
819	1.18	67.84	9.30	120.43	20.91	121.5	1.34	6.79	126.9	70.8%	37.1	29.4	1778
708	1.02	68.85	8.04	128.02	18.08	136.7	1.00	5.07	140.8	73.4%	34.3	27.2	1779
514	0.74	70.05	5.83	136.7	13.12	154.0	0.53	2.67	156.1	70.2%	28.9	22.9	1783
167	0.24	71.29	1.89	144.19	4.25	168.4	0.06	0.28	168.6	33.0%	21.5	17.1	1787
Corrected to 1780 RPM													
Q (gpm)	**Q (mgd)**	**H**	**Eff**	**BHP**	**KW**	**RPM**	**kw/mgd**						
897	1.29	109.5	63.8%	38.9	30.9	1780	24						
820	1.18	127.2	70.8%	37.2	29.5	1780	25						
709	1.02	140.9	73.4%	34.4	27.2	1780	27						
513	0.74	155.6	70.2%	28.7	22.8	1780	31						
166	0.24	167.3	33.0%	21.3	16.9	1780	70						

Pump No. 2 Field Curve 9/14/06, Initial Test

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
764	1.10	72.41	8.67	104.92	19.50	75.1	1.17	5.90	79.8	38.1%	40.4	33.4	1778
667	0.96	73.17	7.57	113.54	17.01	93.3	0.89	4.50	96.9	41.8%	39.1	32.3	1779
604	0.87	73.8	6.86	119.11	15.42	104.7	0.73	3.69	107.6	44.0%	37.4	30.9	1780
438	0.63	75.2	4.97	128.86	11.17	124.0	0.38	1.94	125.5	41.1%	33.7	27.9	1781
271	0.39	75.95	3.07	133.31	6.91	132.5	0.15	0.74	133.1	29.2%	31.2	25.8	1784

Corrected to 1780 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mgd
765	1.10	80.1	38.1%	40.6	34	1781	30
681	0.98	97.2	42.6%	39.3	32	1782	33
597	0.86	108.0	43.4%	37.6	31	1783	36
438	0.63	125.9	41.1%	33.9	28	1784	44
271	0.39	133.2	29.2%	31.2	26	1785	66

Pump No. 2 Field Curve 12/8/06 Post Mechanical Refurbishment

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
792	1.14	72.65	8.99	108.56	20.20	83.0	1.25	6.34	88.0	46.2%	38.1	31.5	1780
694	1.00	73.11	7.88	119.04	17.72	106.1	0.96	4.88	110.0	54.3%	35.5	29.4	1782
625	0.90	73.7	7.09	124.29	15.95	116.9	0.78	3.95	120.0	57.0%	33.3	27.5	1782
535	0.77	74.09	6.07	129.58	13.65	128.2	0.57	2.89	130.5	58.5%	30.1	24.9	1784
458	0.66	73.79	5.20	132.33	11.70	135.2	0.42	2.12	136.9	55.3%	28.7	23.7	1784
306	0.44	74.64	3.47	136.27	7.80	142.4	0.19	0.94	143.1	43.3%	25.5	21.1	1786

Corrected to 1780 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mgd
792	1.14	88.0	46.2%	38.1	32	1780	28
694	1.00	109.8	54.3%	35.4	29	1780	29
624	0.90	119.8	57.0%	33.1	27	1780	30
534	0.77	129.9	58.5%	29.9	25	1780	32
457	0.66	136.3	55.3%	28.5	24	1780	36
305	0.44	142.2	43.3%	25.3	21	1780	48

Pump No. 2 Field Curve 1/12/07 Post Sandblasting (No Interior Coating)

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
833	1.20	68.53	9.46	111.03	21.27	98.2	1.39	7.02	103.8	55.9%	39.1	32.3	1782
736	1.06	69.03	8.35	120.61	18.79	119.1	1.08	5.48	123.5	63.1%	36.4	30.1	1781
681	0.98	69.24	7.72	124.58	17.37	127.8	0.93	4.68	131.6	64.9%	34.8	28.8	1780
590	0.85	70.03	6.70	129.14	15.06	136.5	0.70	3.52	139.4	64.1%	32.4	26.8	1783
410	0.59	70.63	4.65	135.16	10.46	149.1	0.34	1.70	150.4	56.7%	27.4	22.7	1784

Corrected to 1780 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mgd
832	1.20	103.6	55.9%	38.9	32	1780	27
736	1.06	123.4	63.1%	36.3	30	1780	28
681	0.98	131.6	64.9%	34.8	29	1780	29
589	0.85	138.9	64.1%	32.2	27	1780	31
409	0.59	149.8	56.7%	27.3	23	1780	38

Pump No. 2 Field Curve 2/15/07, 30 Day Test

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
875	1.26	66.99	9.93	107.07	22.33	92.6	1.53	7.74	98.8	52.9%	41.2	34.1	1778
799	1.15	67.56	9.06	115.41	20.38	110.5	1.28	6.45	115.7	57.1%	40.9	33.8	1781
715	1.03	67.89	8.12	120.41	18.25	121.3	1.02	5.17	125.5	59.9%	37.8	31.3	1779
563	0.81	68.92	6.38	129.99	14.36	141.1	0.63	3.20	143.6	61.6%	33.1	27.4	1783
458	0.66	69.37	5.20	134.06	11.70	149.4	0.42	2.12	151.1	58.6%	29.9	24.7	1784

Corrected to 1780 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mgd
876	1.26	99.0	52.9%	41.4	34	1780	27
798	1.15	115.6	57.1%	40.8	34	1780	29
716	1.03	125.6	59.9%	37.9	31	1780	30
562	0.81	143.2	61.6%	33.0	27	1780	34
457	0.66	150.5	58.6%	29.7	25	1780	37

Pump No. 2 Field Curve 4/19/07, 90 Day Test

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
813	1.17	67.11	9.22	111.09	20.74	101.6	1.32	6.68	106.9	57.1%	38.4	31.8	1781
681	0.98	67.79	7.72	121.42	17.37	123.9	0.93	4.68	127.6	62.1%	35.3	29.2	1782
535	0.77	68.83	6.07	129.84	13.65	140.9	0.57	2.89	143.3	63.7%	30.3	25.1	1783
403	0.58	72.39	4.57	137.4	10.28	150.2	0.32	1.64	151.5	57.9%	26.6	22.0	1785

Corrected to 1780 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mgd
812	1.17	106.8	57.1%	38.4	32	1780	27
681	0.98	127.6	62.1%	35.3	29	1782	30
535	0.77	143.3	63.7%	30.3	25	1783	33
403	0.58	151.3	57.9%	26.6	22	1784	38

Pump No. 2 Field Curve 7/6/07, 6 Month Test

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
868	1.25	68.87	9.85	104.04	22.15	81.2	1.51	7.62	87.4	49.5%	38.7	32.0	1780
813	1.17	69.2	9.22	113.22	20.74	101.7	1.32	6.68	107.0	58.8%	37.3	30.9	1780
736	1.06	69.66	8.35	119.7	18.79	115.6	1.08	5.48	120.0	62.8%	35.5	29.4	1780
576	0.83	70.7	6.54	129.86	14.71	136.7	0.66	3.36	139.4	65.5%	31.0	25.6	1782
313	0.45	71.84	3.55	137.74	7.98	152.2	0.20	0.99	153.0	48.6%	24.9	20.6	1787

Corrected to 1780 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mgd
868	1.25	87.4	49.5%	38.7	32	1780	26
813	1.17	107.0	58.8%	37.3	31	1780	26
736	1.06	120.0	62.8%	35.5	29	1780	28
576	0.83	139.0	65.5%	30.9	26	1780	31
311	0.45	151.8	48.6%	24.6	20	1780	45

Pump No. 2 Field Curve 1/14/08, 12 Month Test

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
889	1.28	73.37	10.09	103.9	22.69	70.5	1.58	7.99	76.9	45.1%	38.3	31.67	1780
826	1.19	73.88	9.38	112.59	21.09	89.4	1.37	6.91	95.0	53.3%	37.2	30.73	1780
743	1.07	74.66	8.43	122.07	18.96	109.5	1.10	5.58	114.0	60.1%	35.6	29.45	1780
604	0.87	75.95	6.86	131.63	15.42	128.6	0.73	3.69	131.6	62.1%	32.3	26.75	1782
410	0.59	77.34	4.65	141.36	10.46	147.9	0.34	1.70	149.2	57.8%	26.7	22.11	1787

Corrected to 1780 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mgd
889	1.28	76.9	45.1%	38.3	32	1780	25
826	1.19	95.0	53.3%	37.2	31	1780	26
743	1.07	114.0	60.1%	35.6	29	1780	28
603	0.87	131.3	62.1%	32.2	27	1780	31
408	0.59	148.1	57.8%	26.4	22	1780	37

Pump No. 2 Field Curve 6/02/08, 18 Month Test

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
819	1.18	70.98	9.30	110.78	20.91	91.9	1.34	6.79	97.4	54.5%	37.0	30.60	1780
701	1.01	72.28	7.96	122.32	17.90	115.6	0.98	4.98	119.6	60.5%	35.0	28.96	1780
611	0.88	73.19	6.94	128.48	15.60	127.7	0.75	3.78	130.7	61.7%	32.7	27.04	1780
479	0.69	74.27	5.44	135.27	12.23	140.9	0.46	2.32	142.8	59.6%	29.0	23.99	1782
326	0.47	75.48	3.70	140.21	8.33	149.5	0.21	1.08	150.4	48.4%	25.6	21.17	1787

Corrected to 1780 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mgd
819	1.18	97.4	54.5%	37.0	31	1780	26
701	1.01	119.6	60.5%	35.0	29	1780	29
611	0.88	130.7	61.7%	32.7	27	1780	31
479	0.69	142.5	59.6%	28.9	24	1780	35
325	0.47	149.2	48.4%	25.3	21	1780	45

Pump No. 2 Field Curve 9/29/08, Pre-New Motor

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
785	1.13	68.23	8.91	111.52	20.03	100.0	1.23	6.23	105.0	57.7%	36.1	29.83	1780
632	0.91	69.4	7.17	123.29	16.13	124.5	0.80	4.04	127.7	62.2%	32.8	27.12	1780
542	0.78	69.64	6.15	127.88	13.82	134.5	0.59	2.97	136.9	61.8%	30.3	25.08	1780
479	0.69	70.31	5.44	131.22	12.23	140.7	0.46	2.32	142.6	60.2%	28.7	23.70	1782
222	0.32	71.46	2.52	137.09	5.67	151.6	0.10	0.50	152.0	36.0%	23.7	19.62	1787

Corrected to 1780 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mgd
785	1.13	105.0	57.7%	36.1	30	1780	26
632	0.91	127.7	62.2%	32.8	27	1780	30
542	0.78	136.9	61.8%	30.3	25	1780	32
479	0.69	142.2	60.2%	28.6	24	1780	34
221	0.32	150.8	36.0%	23.4	19	1780	61

Pump No. 2 Field Curve 12/08/08, Pre-New Motor II

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
785	1.13	69.98	8.91	112.37	20.03	97.9	1.23	6.23	102.9	56.3%	36.2	29.97	1780
681	0.98	69.83	7.72	120.86	17.37	117.9	0.93	4.68	121.6	61.6%	34.0	28.08	1780
528	0.76	71.26	5.99	129.83	13.47	135.3	0.56	2.82	137.6	60.7%	30.2	24.97	1780
375	0.54	71.99	4.26	135.72	9.57	147.2	0.28	1.42	148.4	53.8%	26.1	21.61	1782
42	0.06	72.91	0.47	141.14	1.06	157.6	0.00	0.02	157.6	8.0%	20.8	17.18	1787

Corrected to 1780 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mgd
785	1.13	102.9	56.3%	36.2	30	1780	27
681	0.98	121.6	61.6%	34.0	28	1780	29
528	0.76	137.6	60.7%	30.2	25	1780	33
375	0.54	148.0	53.8%	26.0	22	1780	40
42	0.06	156.4	8.0%	20.5	17	1780	284

Pump No. 2 Field Curve 1/7/09 Post New Motor & 2 Year Test

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
785	1.13	67.9	8.91	111.52	20.03	100.8	1.23	6.23	105.8	56.6%	37.0	29.37	1780
688	0.99	68.56	7.80	119.55	17.55	117.8	0.95	4.78	121.6	60.6%	34.9	27.64	1780
569	0.82	69.35	6.46	126.37	14.53	131.7	0.65	3.28	134.3	60.9%	31.7	25.13	1780
507	0.73	69.67	5.75	129.41	12.94	138.0	0.51	2.60	140.1	59.8%	30.0	23.79	1782
417	0.60	70.06	4.73	133.33	10.63	146.2	0.35	1.76	147.6	56.8%	27.3	21.66	1787

Corrected to 1780 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mgd
785	1.13	105.8	56.6%	37.0	29	1780	26
688	0.99	121.6	60.6%	34.9	28	1780	28
569	0.82	134.3	60.9%	31.7	25	1780	31
506	0.73	139.8	59.8%	29.9	24	1780	33
415	0.60	146.4	56.8%	27.0	21	1780	36

Pump No. 2 Field Curve 4/21/09, 2.5 Year Test

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
854	1.23	70.7	9.69	106.52	21.80	82.7	1.46	7.38	88.7	50.5%	37.8	30.00	1780
813	1.17	71.3	9.22	113.48	20.74	97.4	1.32	6.68	102.8	57.1%	37.0	29.30	1780
681	0.98	72.47	7.72	123.63	17.37	118.2	0.93	4.68	121.9	61.3%	34.2	27.10	1780
625	0.90	73.24	7.09	128.06	15.95	126.6	0.78	3.95	129.8	62.5%	32.8	26.00	1782
486	0.70	74.32	5.52	135.01	12.41	140.2	0.47	2.39	142.1	59.9%	29.1	23.10	1787

Corrected to 1780 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mgd
854	1.23	88.7	50.5%	37.8	30	1780	24
813	1.17	102.8	57.1%	37.0	29	1780	25
681	0.98	121.9	61.3%	34.2	27	1780	28
624	0.90	129.5	62.5%	32.7	26	1780	29
484	0.70	141.0	59.9%	28.8	23	1780	33

Pump No. 2 Field Curve 9/4/09, 3 Year Test

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
826	1.19	70.23	9.38	110.04	21.09	92.0	1.37	6.91	97.5	54.2%	37.5	29.76	1784
757	1.09	70.88	8.59	117.01	19.32	106.6	1.15	5.79	111.2	58.9%	36.1	28.61	1785
708	1.02	71.12	8.04	121.38	18.08	116.1	1.00	5.07	120.2	61.6%	34.9	27.67	1785
597	0.86	71.72	6.78	128	15.24	130.0	0.71	3.61	132.9	62.5%	32.1	25.42	1786
451	0.65	72.63	5.12	135.03	11.52	144.1	0.41	2.06	145.8	59.5%	28.0	22.16	1788

Corrected to 1780 RPM

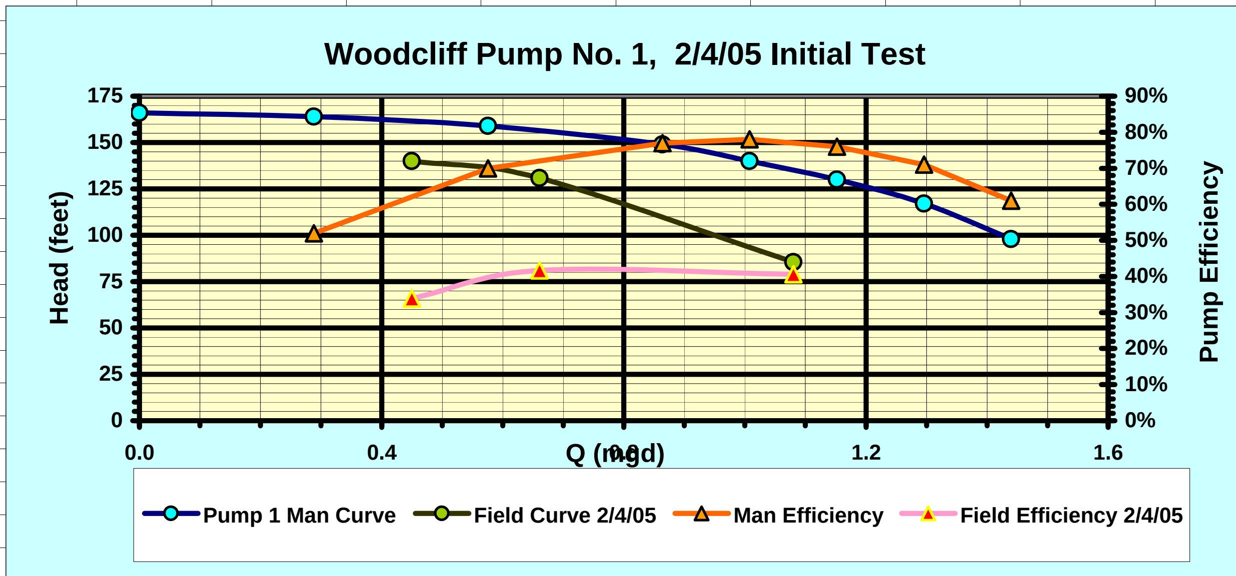
Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mgd
825	1.19	97.1	54.2%	37.3	30	1780	25
755	1.09	110.6	58.9%	35.8	28	1780	26
706	1.02	119.5	61.6%	34.6	27	1780	27
595	0.86	132.0	62.5%	31.7	25	1780	29
449	0.65	144.5	59.5%	27.6	22	1780	34

Pump No. 2 Field Curve 6/1/10

Q (gpm)	Q (mgd)	S	SV ft/sec	D	DV ft/sec	Pump H	Suc V H	Dis V H	Total H	Eff	BHP	KW	RPM
813	1.17	67.24	9.22	111.33	20.74	101.8	1.32	6.68	107.2	55.3%	39.8	31.52	1784
771	1.11	67.51	8.75	115.57	19.67	111.0	1.19	6.01	115.8	58.1%	38.8	30.78	1785
639	0.92	68.26	7.25	124.56	16.31	130.1	0.82	4.13	133.4	60.5%	35.5	28.18	1785
486	0.70	69.11	5.52	132	12.41	145.3	0.47	2.39	147.2	58.2%	31.1	24.63	1786
299	0.43	69.85	3.39	136.82	7.62	154.7	0.18	0.90	155.4	43.7%	26.8	21.26	1788

Corrected to 1780 RPM

Q (gpm)	Q (mgd)	H	Eff	BHP	KW	RPM	kw/mgd
811	1.17	106.7	55.3%	39.5	31	1780	27
769	1.11	115.2	58.1%	38.5	31	1780	28
637	0.92	132.6	60.5%	35.2	28	1780	30
484	0.70	146.2	58.2%	30.8	24	1780	35
297	0.43	154.0	43.7%	26.5	21	1780	49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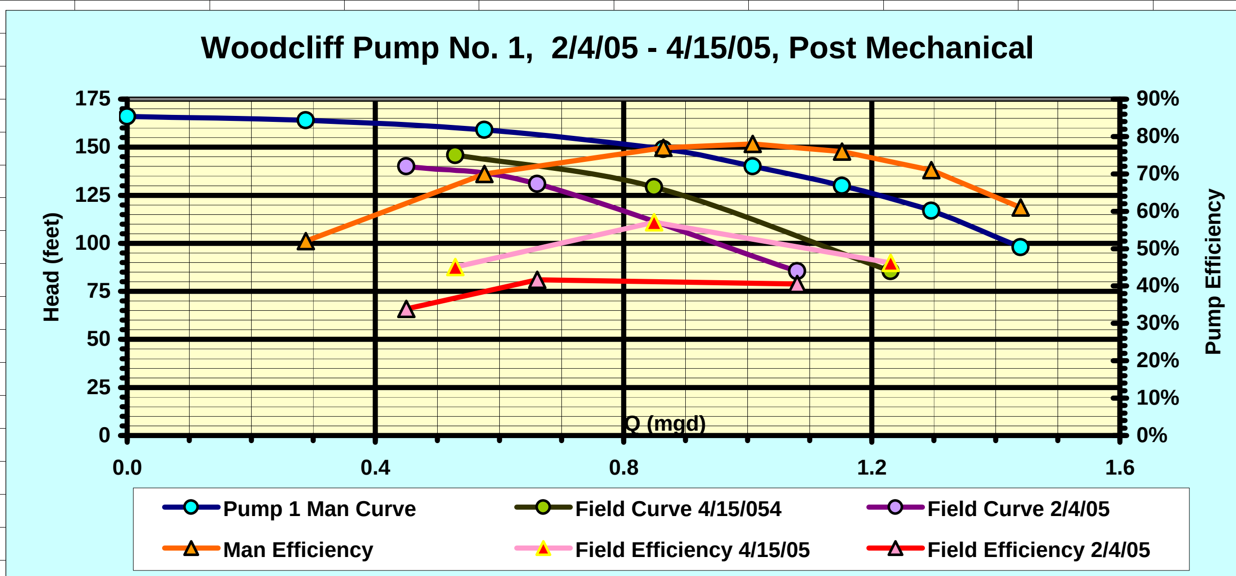
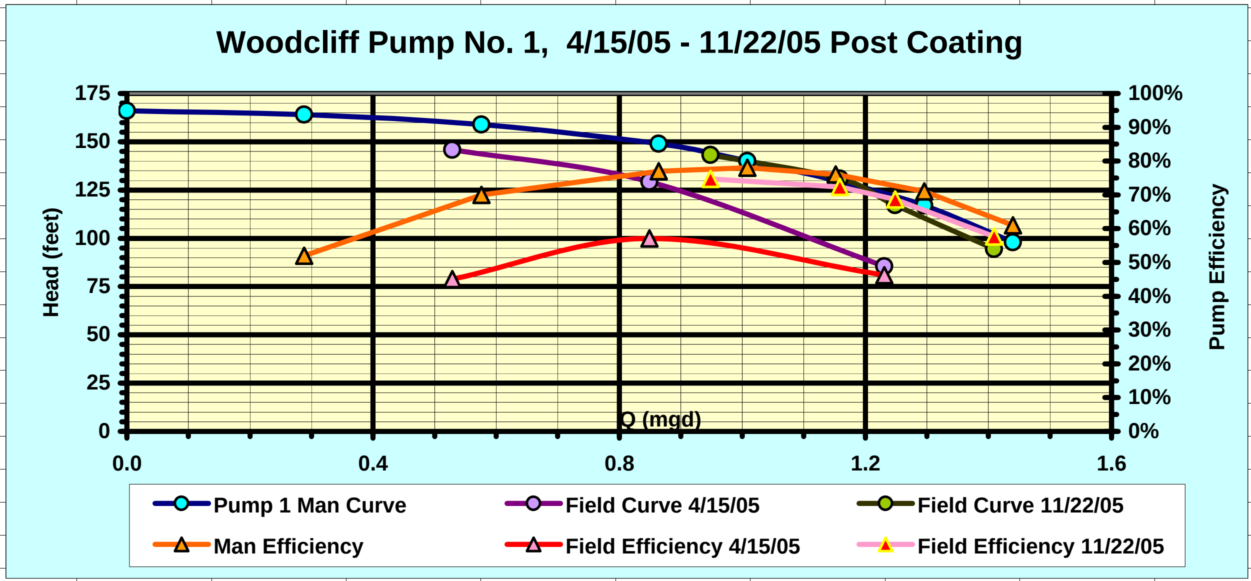
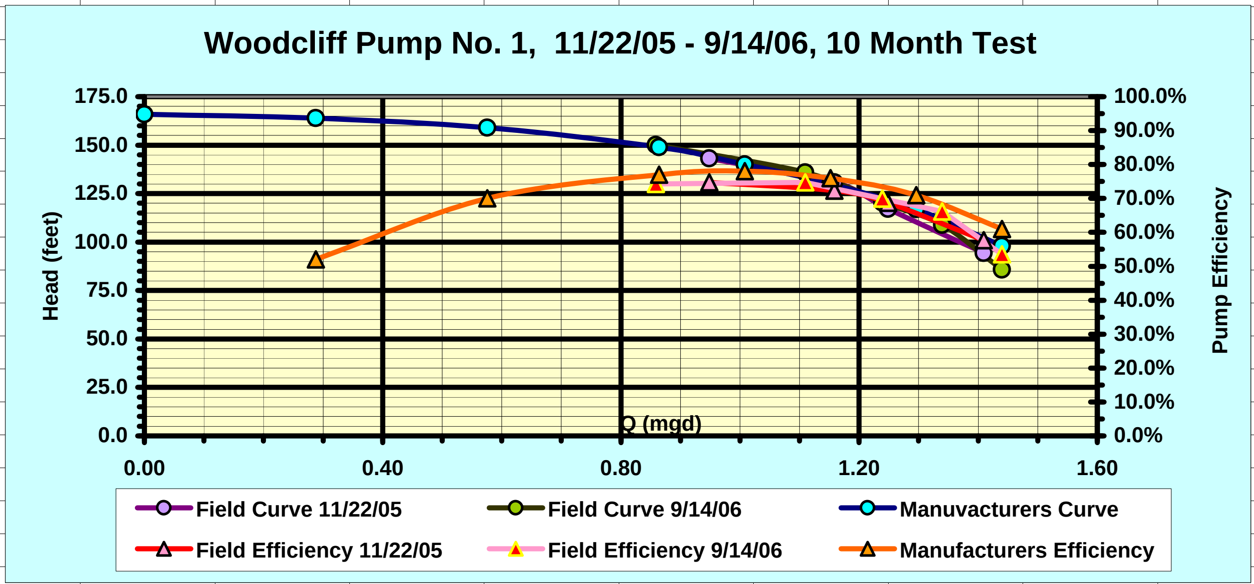
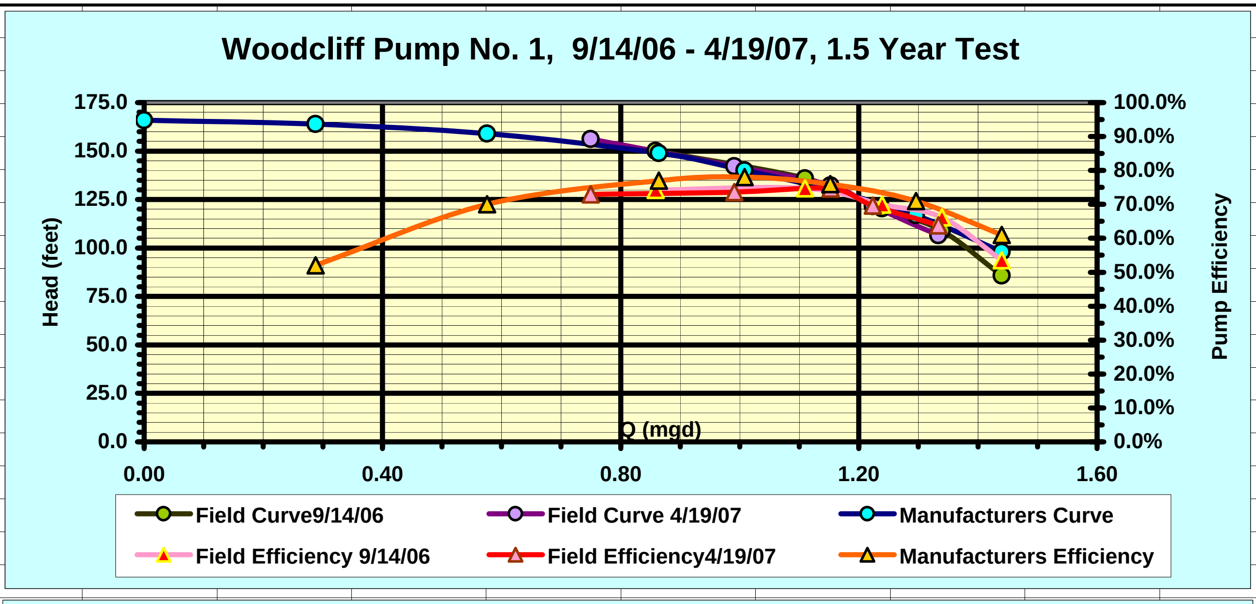
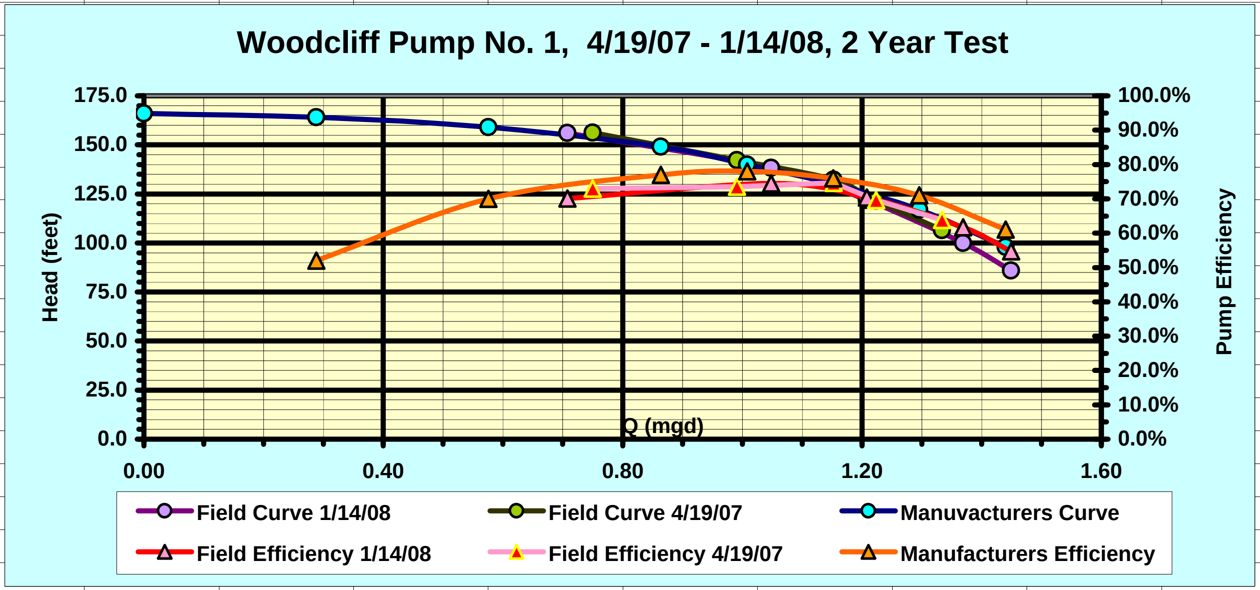
Head (feet)
Pump Efficiency
Q (mgd)
Pump 1 Man Curve
Field Curve 2/4/05
Man Efficiency
Field Efficiency 2/4/05

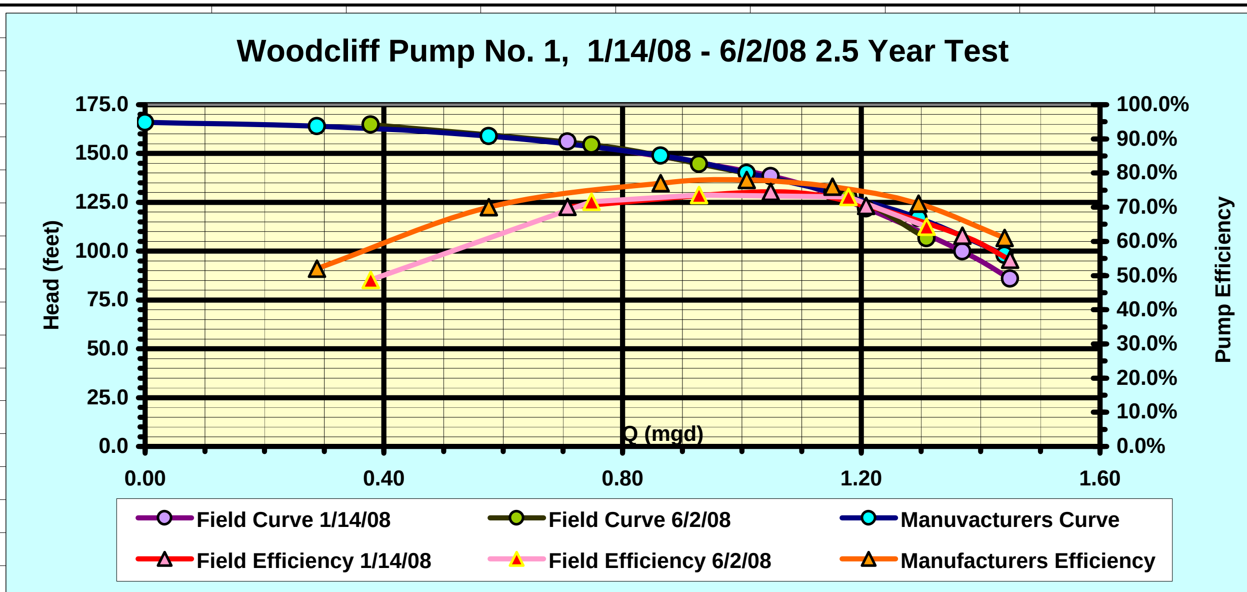

Woodcliff Pump No. 1, 2/4/05 - 4/15/05, Post Mechanical
Head (feet)
Pump Efficiency
Q (mgd)
Pump 1 Man Curve
Field Curve 4/15/054
Field Curve 2/4/05
Man Efficiency
Field Efficiency 4/15/05
Field Efficiency 2/4/05

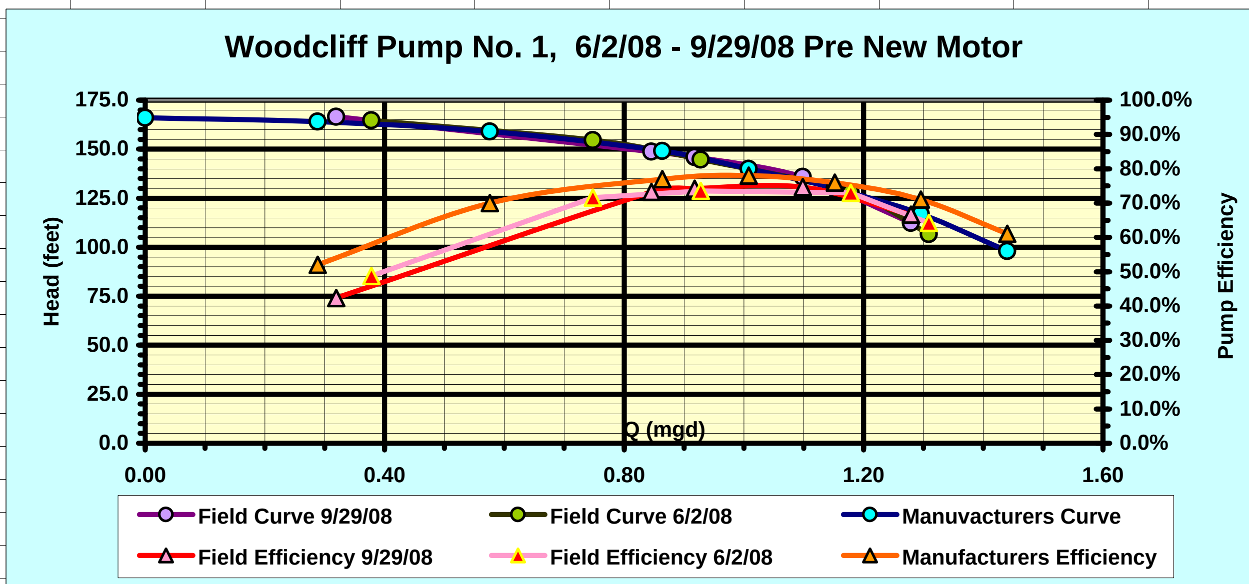

Woodcliff Pump No. 1, 4/15/05 - 11/22/05 Post Coating
Head (feet)
Pump Efficiency
Q (mgd)
175
150
125
100
75
50
25
0
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0.0
0.4
0.8
1.2
1.6
Pump 1 Man Curve
Field Curve 4/15/05
Field Curve 11/22/05
Man Efficiency
Field Efficiency 4/15/05
Field Efficiency 11/22/05

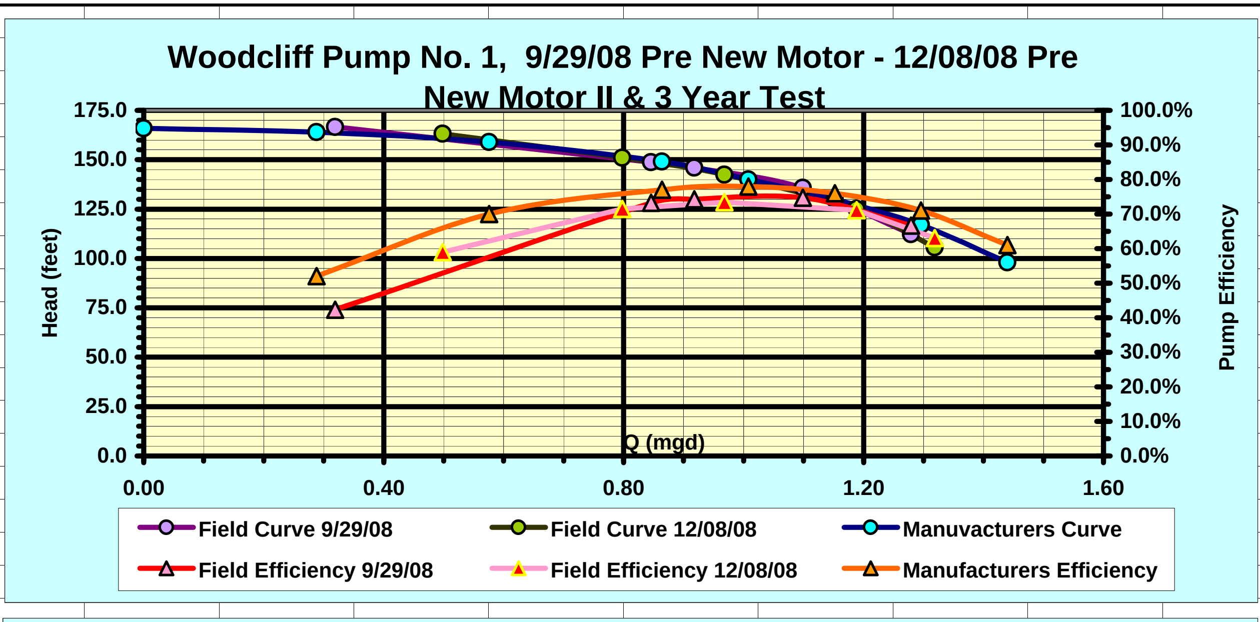

Woodcliff Pump No. 1, 11/22/05 - 9/14/06, 10 Month Test
Head (feet)
Pump Efficiency
Q (mgd)
175.0
150.0
125.0
100.0
75.0
50.0
25.0
0.0
100.0%
90.0%
80.0%
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
0.00
0.40
0.80
1.20
1.60
Field Curve 11/22/05
Field Curve 9/14/06
Manuvacturers Curve
Field Efficiency 11/22/05
Field Efficiency 9/14/06
Manufacturers Efficiency


Woodcliff Pump No. 1, 9/14/06 - 4/19/07, 1.5 Year Test
175.0
150.0
125.0
100.0
75.0
50.0
25.0
0.0
Head (feet)
100.0%
90.0%
80.0%
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
Pump Efficiency
Q (mgd)
0.00
0.40
0.80
1.20
1.60
Field Curve9/14/06
Field Curve 4/19/07
Manufacturers Curve
Field Efficiency 9/14/06
Field Efficiency4/19/07
Manufacturers Efficiency

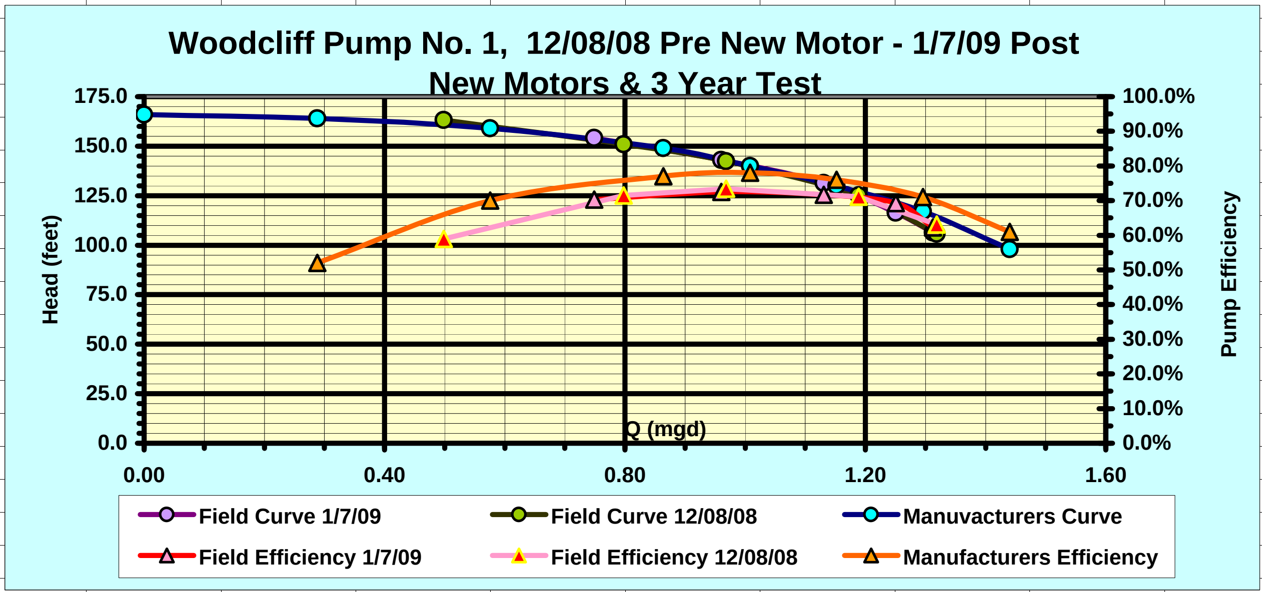

Woodcliff Pump No. 1, 4/19/07 - 1/14/08, 2 Year Test
175.0
150.0
125.0
100.0
75.0
50.0
25.0
0.0
Head (feet)
100.0%
90.0%
80.0%
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
Pump Efficiency
Q (mgd)
0.00
0.40
0.80
1.20
1.60
Field Curve 1/14/08
Field Curve 4/19/07
Manuvacturers Curve
Field Efficiency 1/14/08
Field Efficiency 4/19/07
Manufacturers Efficiency


Woodcliff Pump No. 1, 1/14/08 - 6/2/08 2.5 Year Test
Head (feet)
Pump Efficiency
Q (mgd)
175.0
150.0
125.0
100.0
75.0
50.0
25.0
0.0
100.0%
90.0%
80.0%
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
0.00
0.40
0.80
1.20
1.60
Field Curve 1/14/08
Field Curve 6/2/08
Manuvacturers Curve
Field Efficiency 1/14/08
Field Efficiency 6/2/08
Manufacturers Efficiency

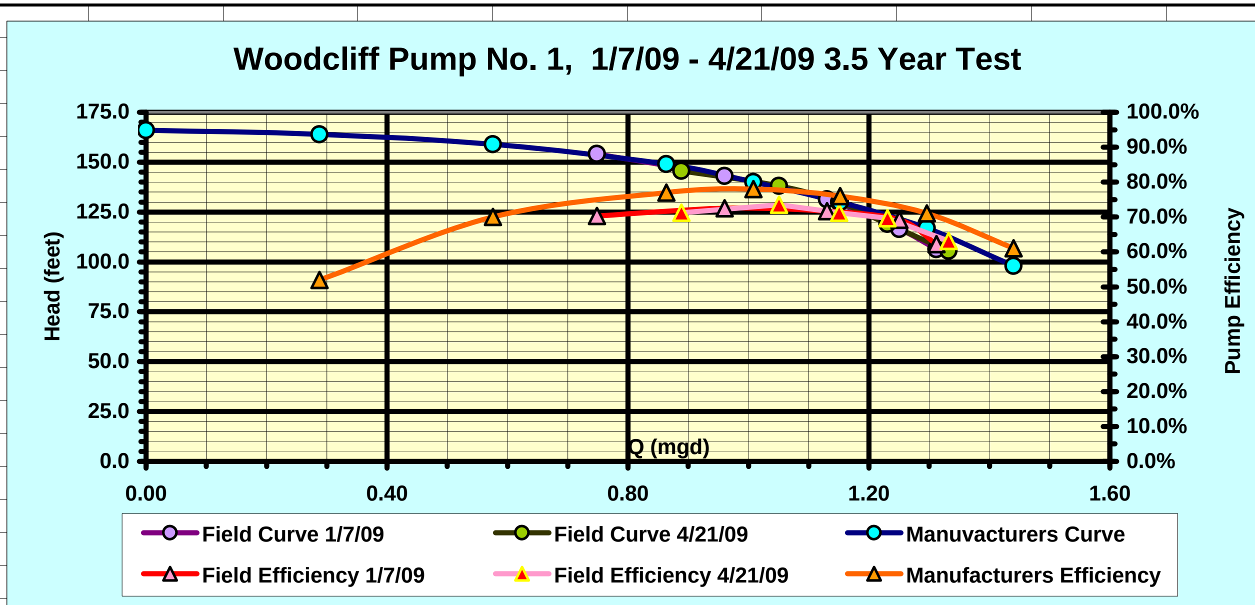

Woodcliff Pump No. 1, 6/2/08 - 9/29/08 Pre New Motor
Head (feet)
Pump Efficiency
Q (mgd)
175.0
150.0
125.0
100.0
75.0
50.0
25.0
0.0
100.0%
90.0%
80.0%
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
0.00
0.40
0.80
1.20
1.60
Field Curve 9/29/08
Field Curve 6/2/08
Manuvacturers Curve
Field Efficiency 9/29/08
Field Efficiency 6/2/08
Manufacturers Efficiency

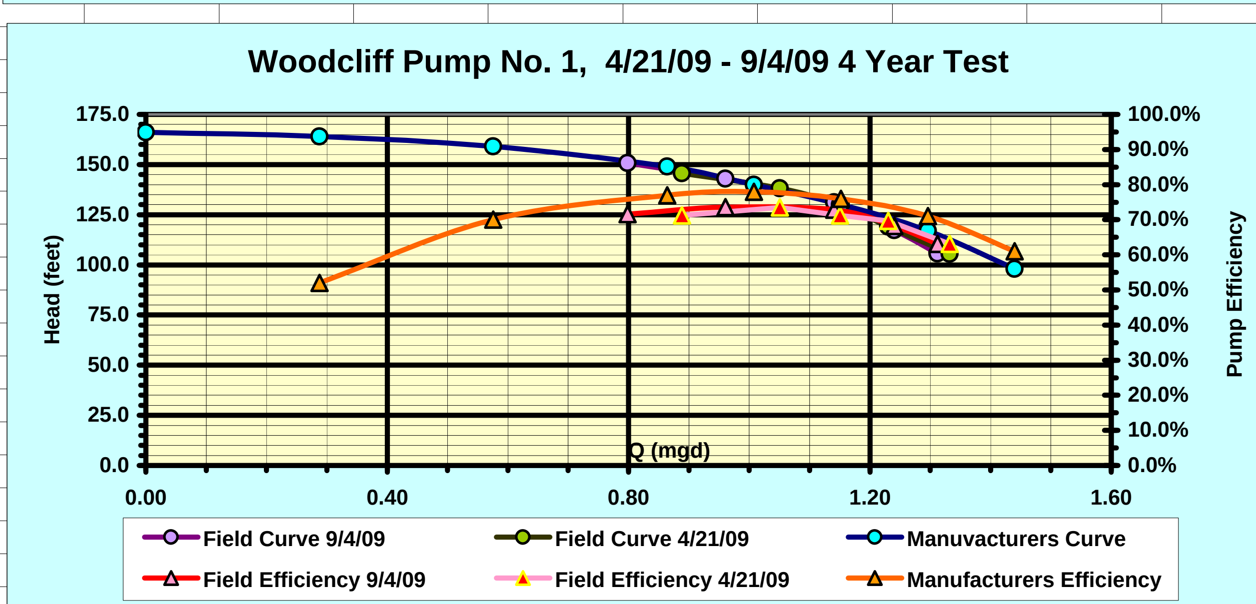


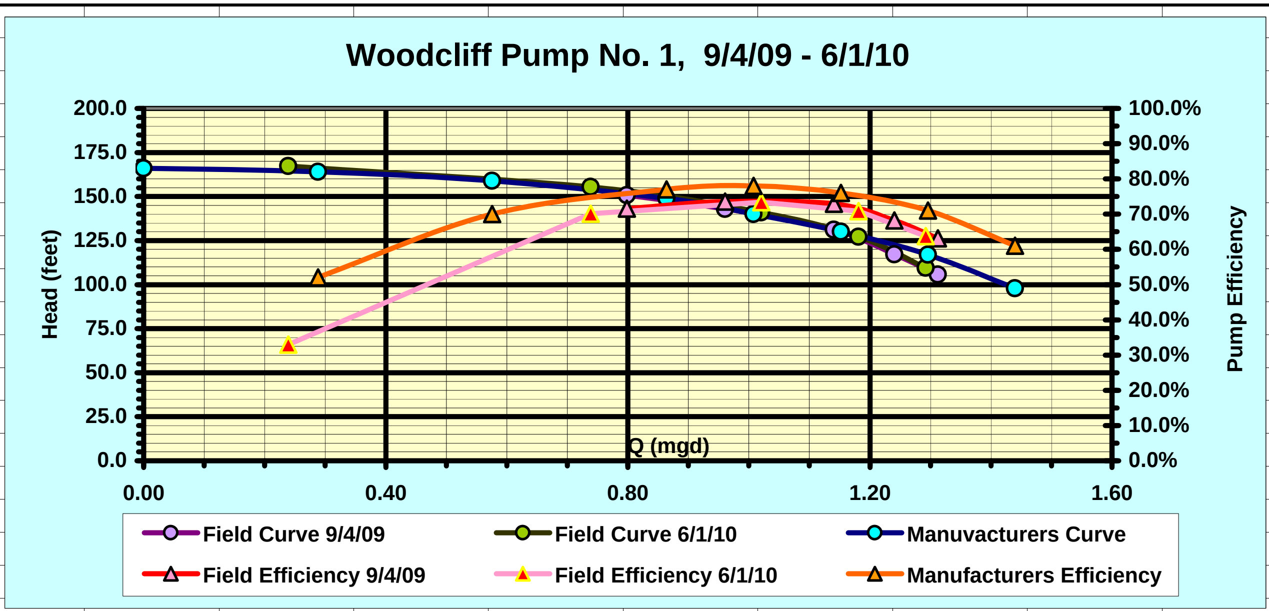
Woodcliff Pump No. 1, 9/29/08 Pre New Motor - 12/08/08 Pre New Motor II & 3 Year Test
Head (feet)
175.0
150.0
125.0
100.0
75.0
50.0
25.0
0.0
Pump Efficiency
100.0%
90.0%
80.0%
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
Q (mgd)
0.00
0.40
0.80
1.20
1.60
Field Curve 9/29/08
Field Curve 12/08/08
Manuvacturers Curve
Field Efficiency 9/29/08
Field Efficiency 12/08/08
Manufacturers Efficiency



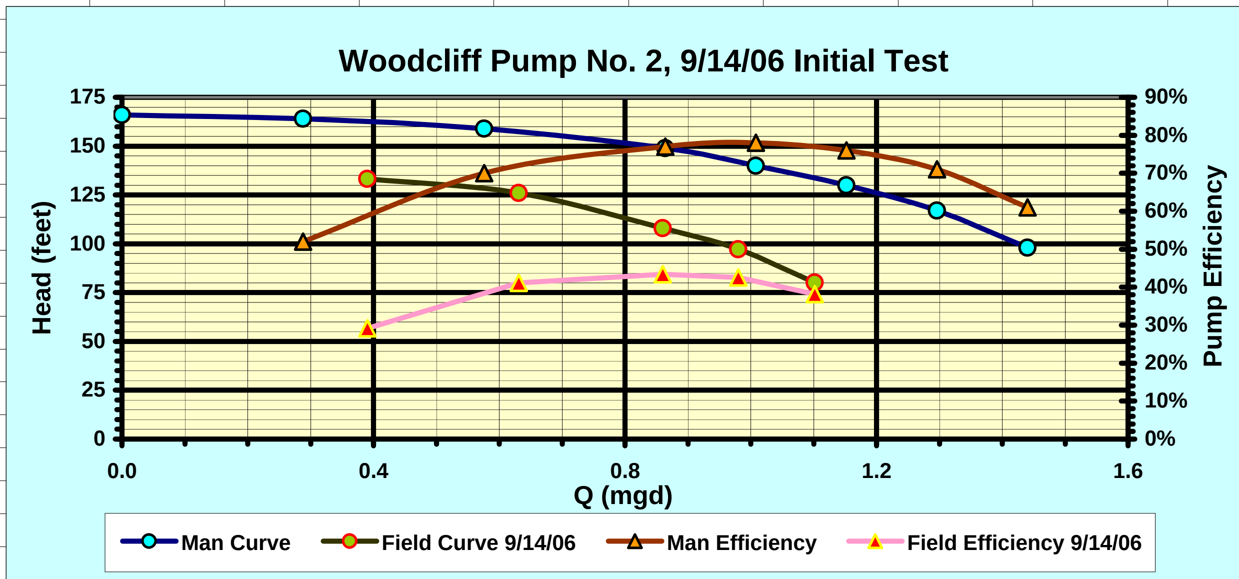
Woodcliff Pump No. 1, 12/08/08 Pre New Motor - 1/7/09 Post New Motors & 3 Year Test
Head (feet)
175.0
150.0
125.0
100.0
75.0
50.0
25.0
0.0
Pump Efficiency
100.0%
90.0%
80.0%
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
Q (mgd)
0.00
0.40
0.80
1.20
1.60
Field Curve 1/7/09
Field Curve 12/08/08
Manuvacturers Curve
Field Efficiency 1/7/09
Field Efficiency 12/08/08
Manufacturers Efficiency

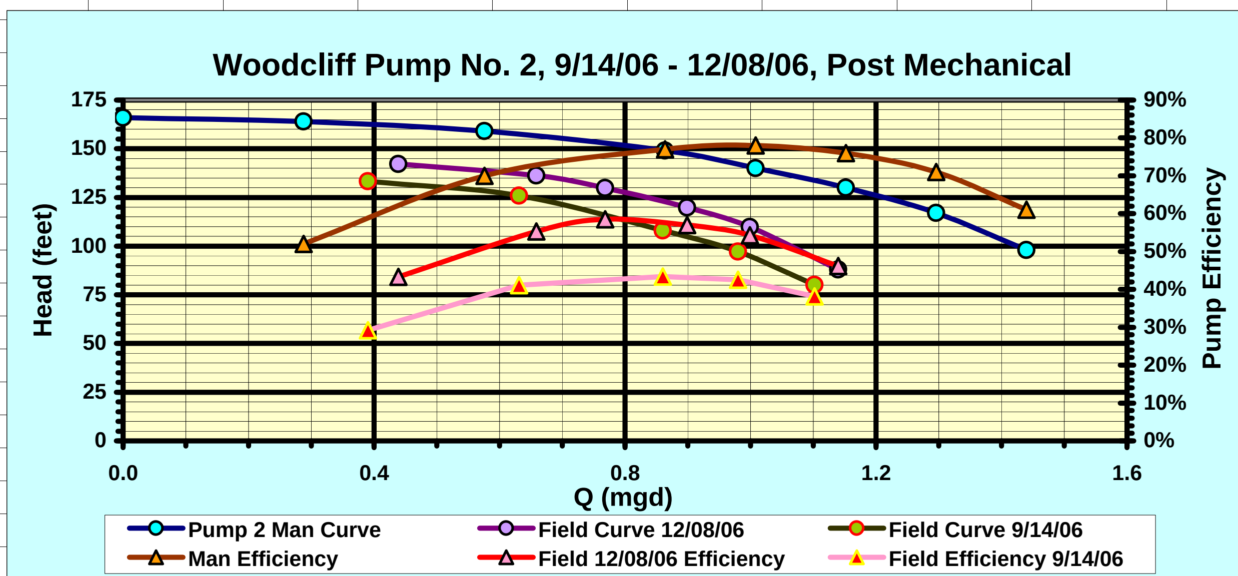

Woodcliff Pump No. 1, 1/7/09 - 4/21/09 3.5 Year Test
Head (feet)
Pump Efficiency
Q (mgd)
Field Curve 1/7/09
Field Curve 4/21/09
Manuvacturers Curve
Field Efficiency 1/7/09
Field Efficiency 4/21/09
Manufacturers Efficiency

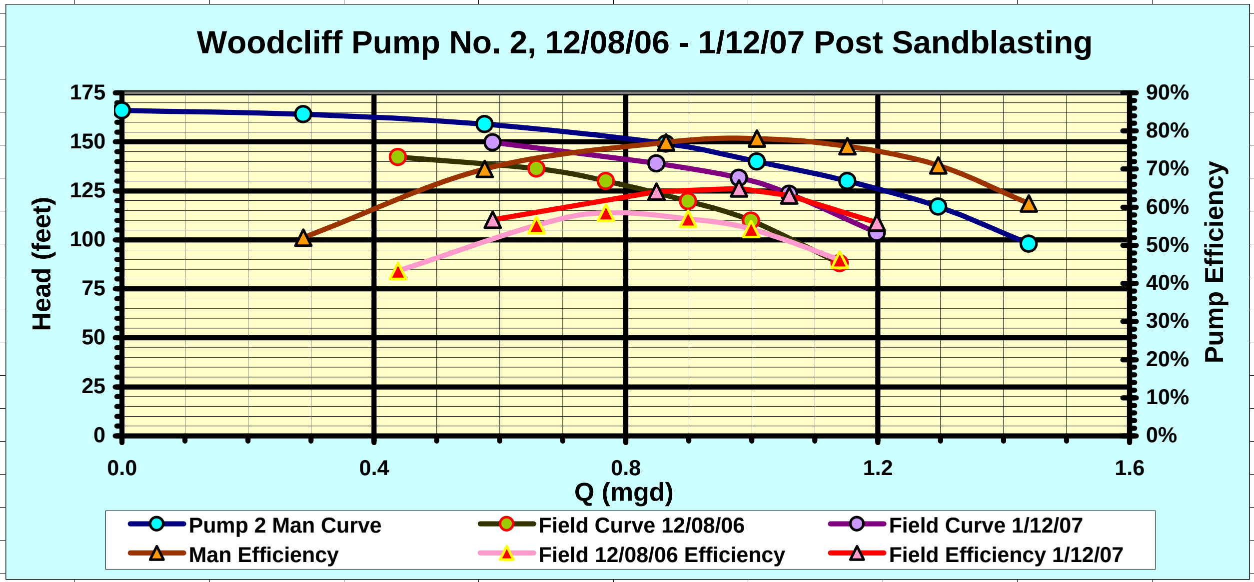

Woodcliff Pump No. 1, 4/21/09 - 9/4/09 4 Year Test
Head (feet)
Pump Efficiency
Q (mgd)
Field Curve 9/4/09
Field Curve 4/21/09
Manuvacturers Curve
Field Efficiency 9/4/09
Field Efficiency 4/21/09
Manufacturers Efficiency



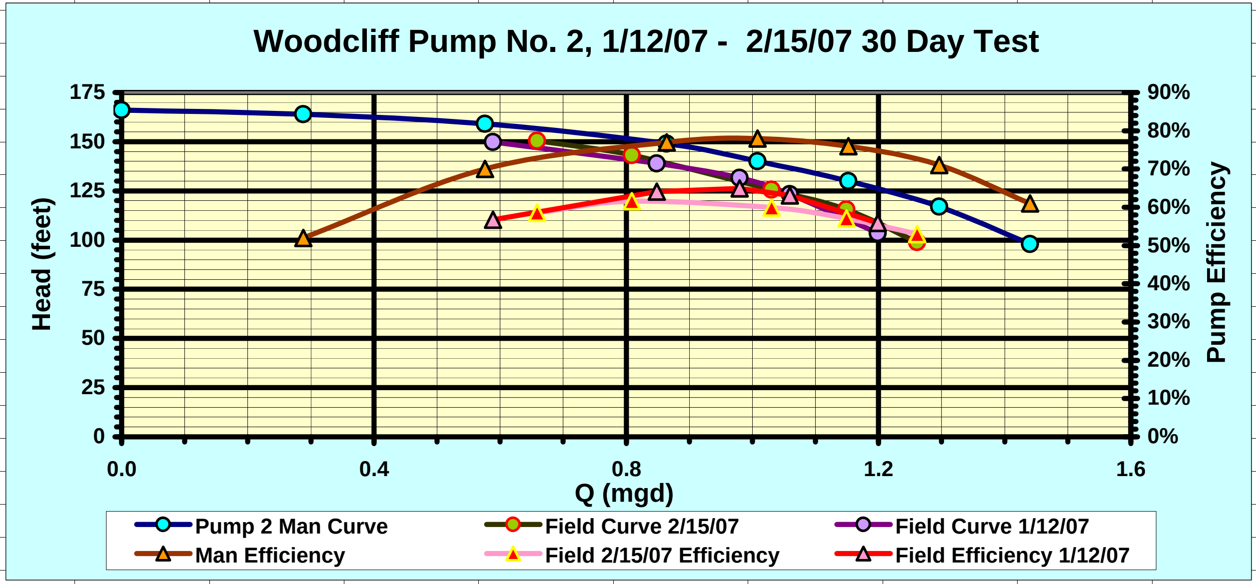
Woodcliff Pump No. 1, 9/4/09 - 6/1/10
Head (feet)
Pump Efficiency
Q (mgd)
200.0
175.0
150.0
125.0
100.0
75.0
50.0
25.0
0.0
100.0%
90.0%
80.0%
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
0.00
0.40
0.80
1.20
1.60
Field Curve 9/4/09
Field Curve 6/1/10
Manuvacturers Curve
Field Efficiency 9/4/09
Field Efficiency 6/1/10
Manufacturers Efficiency


Woodcliff Pump No. 2, 9/14/06 Initial Test
Head (feet)
Pump Efficiency
Q (mgd)
175
150
125
100
75
50
25
0
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0.0
0.4
0.8
1.2
1.6
Man Curve
Field Curve 9/14/06
Man Efficiency
Field Efficiency 9/14/06

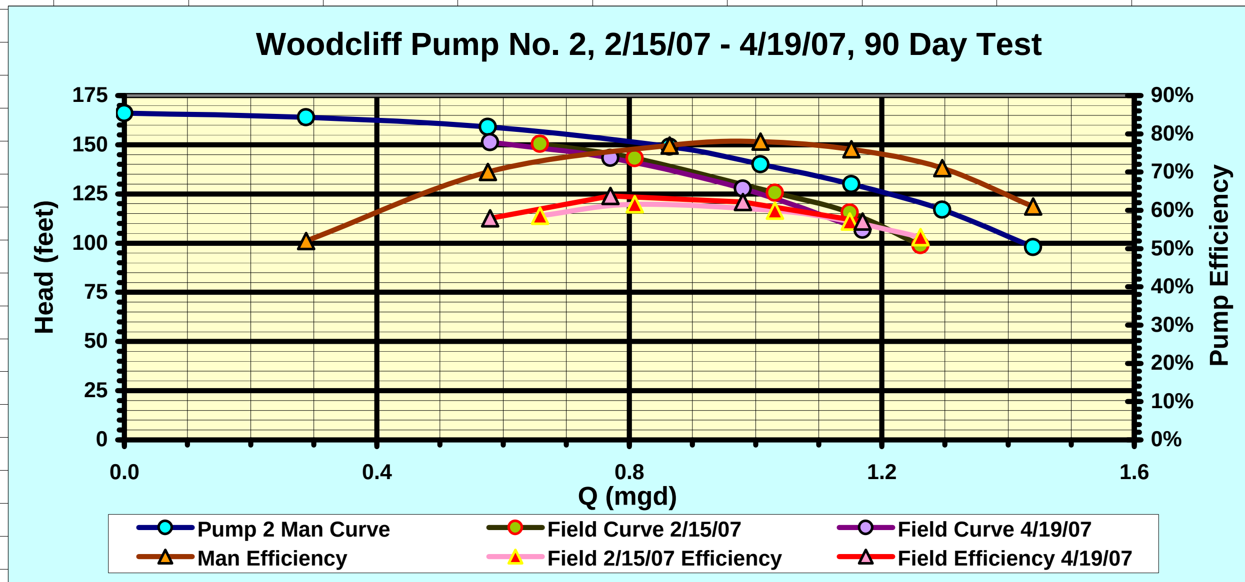

Woodcliff Pump No. 2, 9/14/06 - 12/08/06, Post Mechanical
Head (feet)
Pump Efficiency
Q (mgd)
175
150
125
100
75
50
25
0
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0.0
0.4
0.8
1.2
1.6
Pump 2 Man Curve
Field Curve 12/08/06
Field Curve 9/14/06
Man Efficiency
Field 12/08/06 Efficiency
Field Efficiency 9/14/06

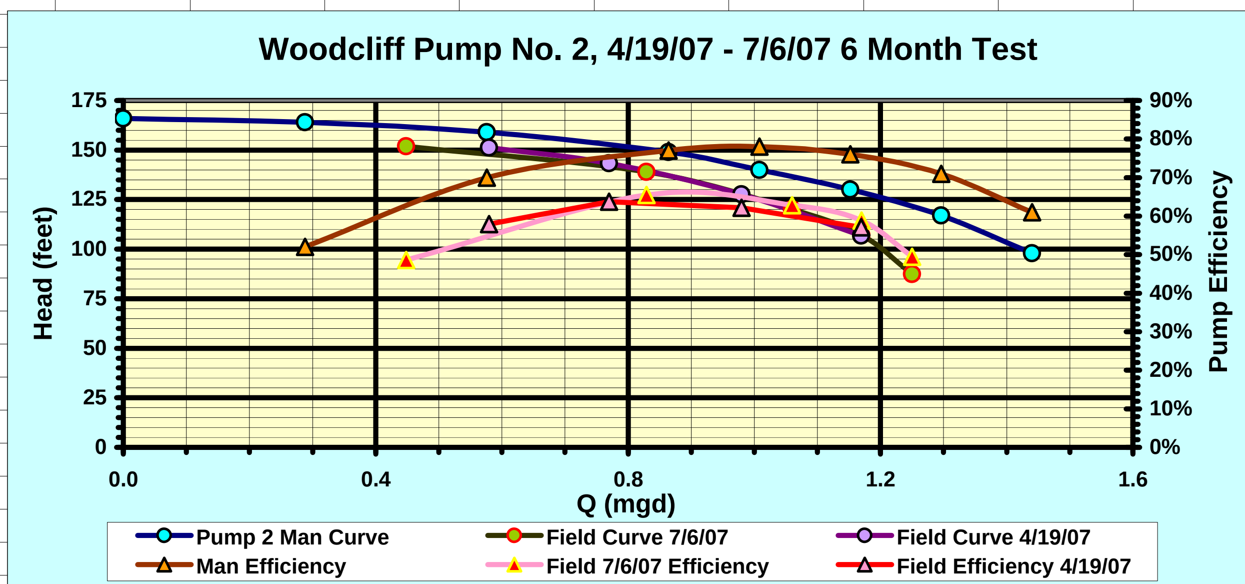


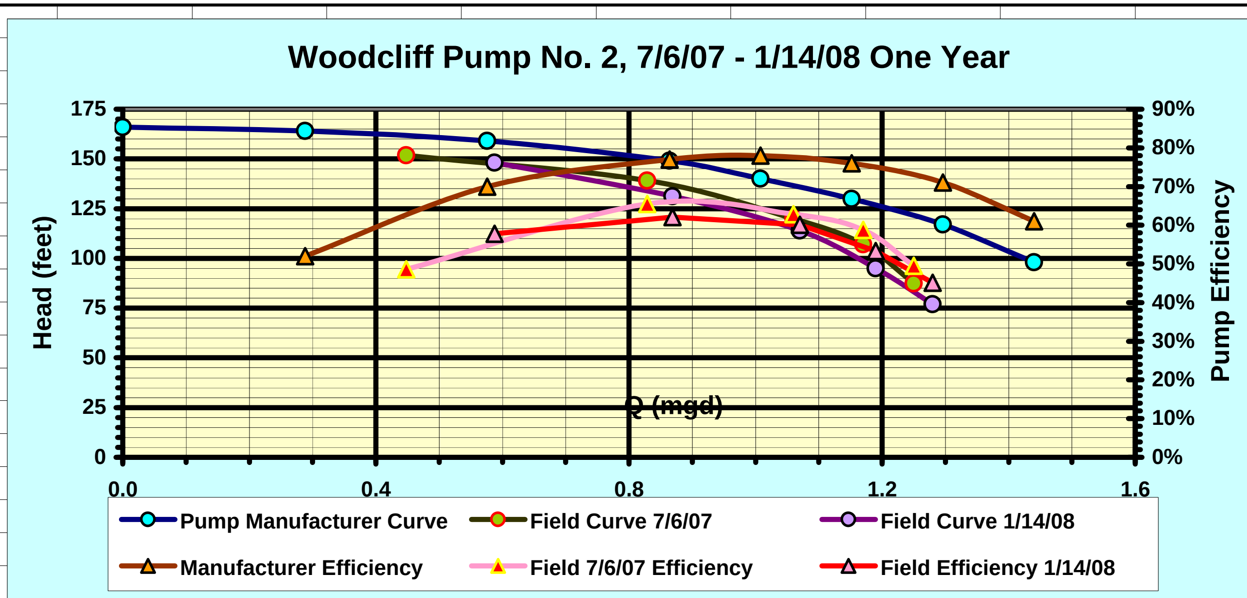
Woodcliff Pump No. 2, 12/08/06 - 1/12/07 Post Sandblasting
Head (feet)
Pump Efficiency
Q (mgd)
175
150
125
100
75
50
25
0
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0.0
0.4
0.8
1.2
1.6
Pump 2 Man Curve
Field Curve 12/08/06
Field Curve 1/12/07
Man Efficiency
Field 12/08/06 Efficiency
Field Efficiency 1/12/07



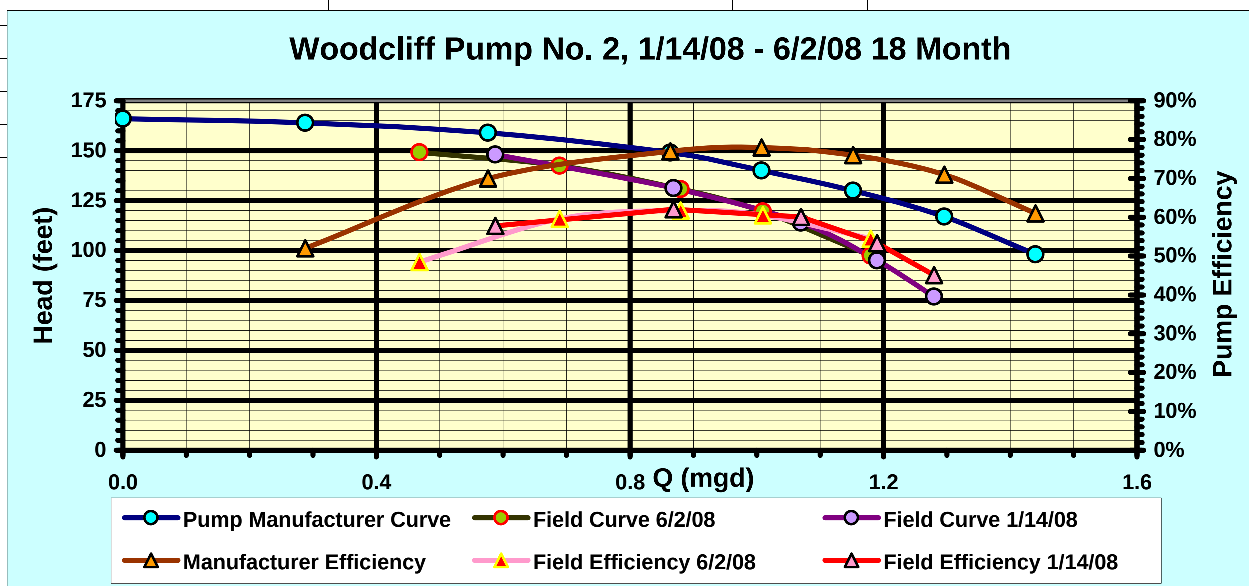
Woodcliff Pump No. 2, 1/12/07 - 2/15/07 30 Day Test
Head (feet)
Pump Efficiency
Q (mgd)
175
150
125
100
75
50
25
0
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0.0
0.4
0.8
1.2
1.6
Pump 2 Man Curve
Field Curve 2/15/07
Field Curve 1/12/07
Man Efficiency
Field 2/15/07 Efficiency
Field Efficiency 1/12/07


Woodcliff Pump No. 2, 2/15/07 - 4/19/07, 90 Day Test
Head (feet)
Pump Efficiency
Q (mgd)
175
150
125
100
75
50
25
0
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0.0
0.4
0.8
1.2
1.6
Pump 2 Man Curve
Field Curve 2/15/07
Field Curve 4/19/07
Man Efficiency
Field 2/15/07 Efficiency
Field Efficiency 4/19/07

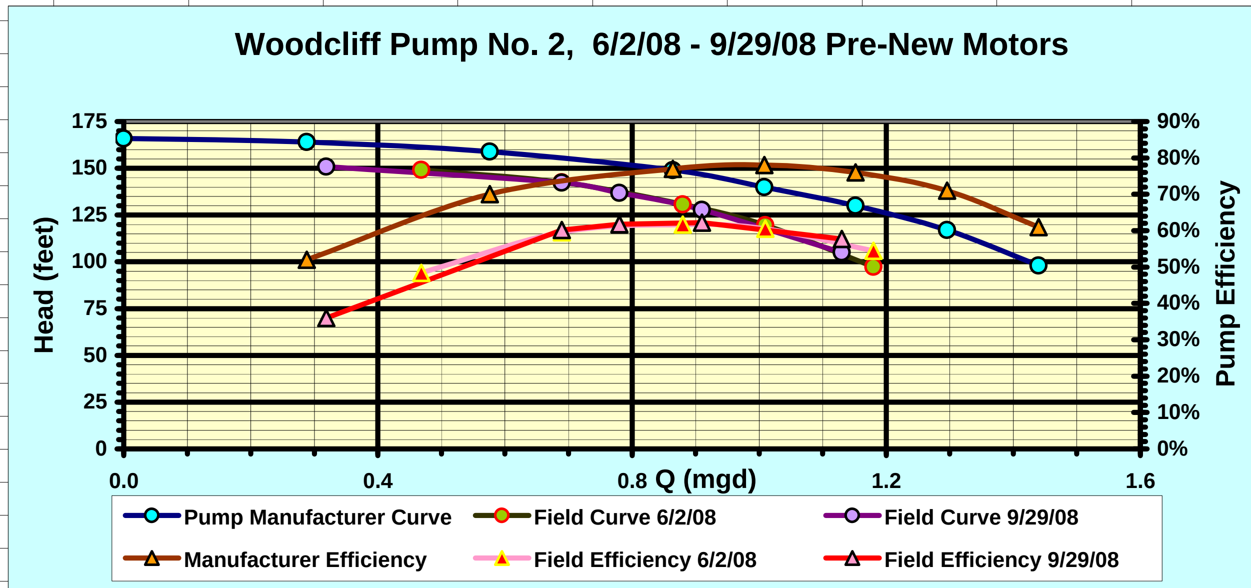

Woodcliff Pump No. 2, 4/19/07 - 7/6/07 6 Month Test
Head (feet)
Pump Efficiency
Q (mgd)
175
150
125
100
75
50
25
0
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0.0
0.4
0.8
1.2
1.6
Pump 2 Man Curve
Field Curve 7/6/07
Field Curve 4/19/07
Man Efficiency
Field 7/6/07 Efficiency
Field Efficiency 4/19/07

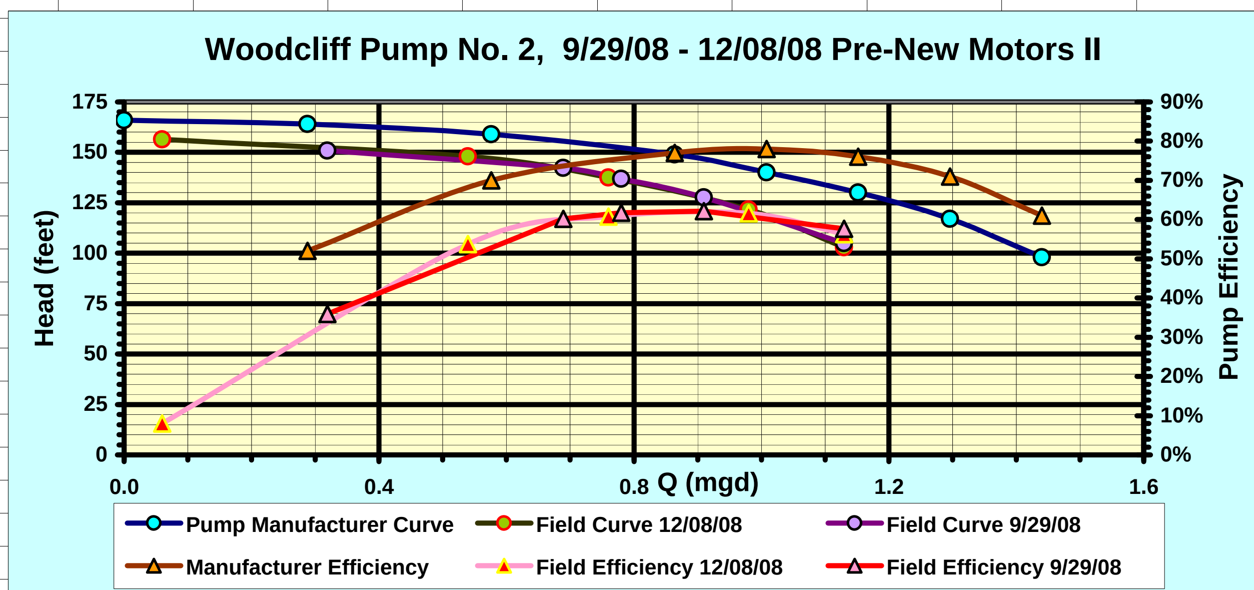


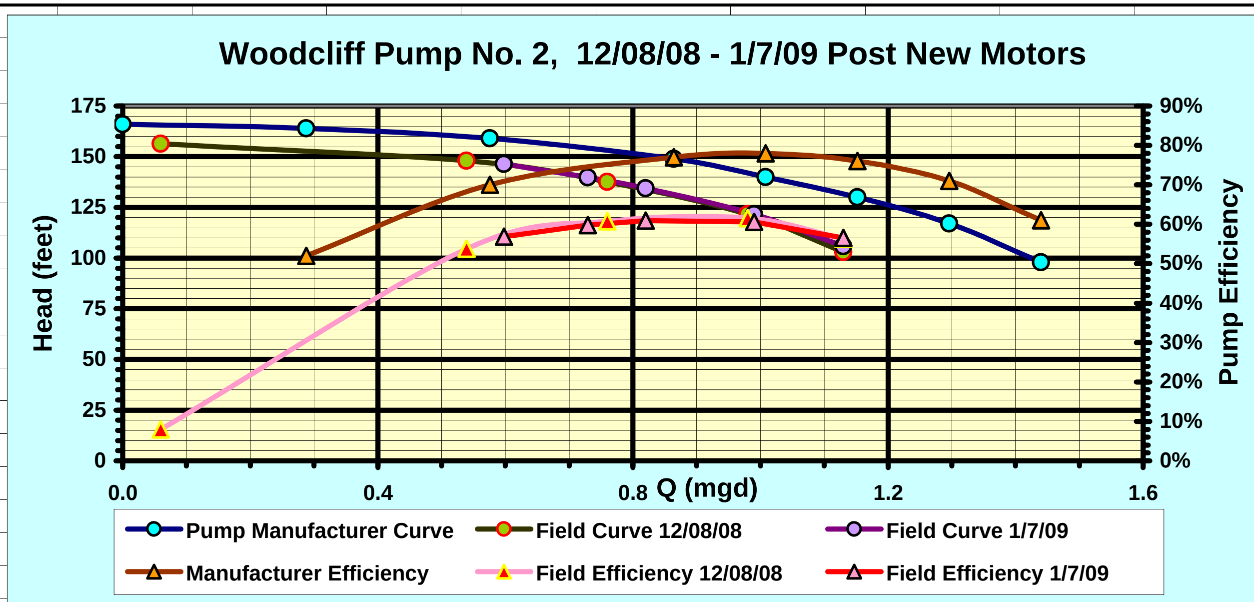
Woodcliff Pump No. 2, 7/6/07 - 1/14/08 One Year
Head (feet)
Pump Efficiency
Q (mgd)
175
150
125
100
75
50
25
0
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0.0
0.4
0.8
1.2
1.6
Pump Manufacturer Curve
Field Curve 7/6/07
Field Curve 1/14/08
Manufacturer Efficiency
Field 7/6/07 Efficiency
Field Efficiency 1/14/08

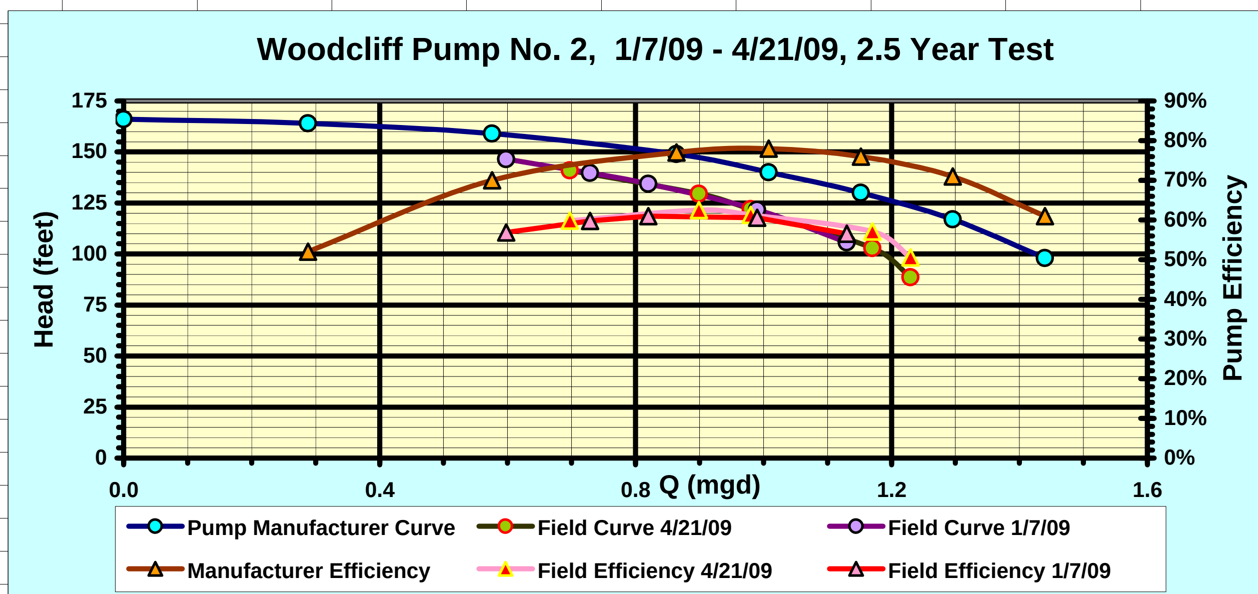


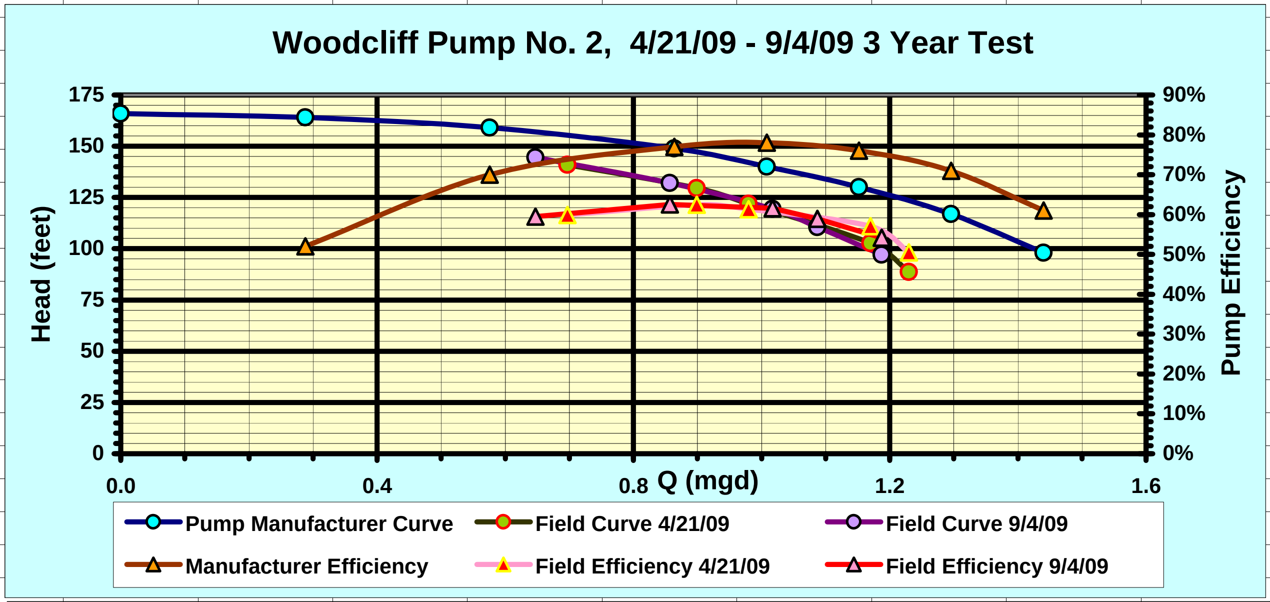
Woodcliff Pump No. 2, 1/14/08 - 6/2/08 18 Month
Head (feet)
Pump Efficiency
Q (mgd)
175
150
125
100
75
50
25
0
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0.0
0.4
0.8
1.2
1.6
Pump Manufacturer Curve
Field Curve 6/2/08
Field Curve 1/14/08
Manufacturer Efficiency
Field Efficiency 6/2/08
Field Efficiency 1/14/08

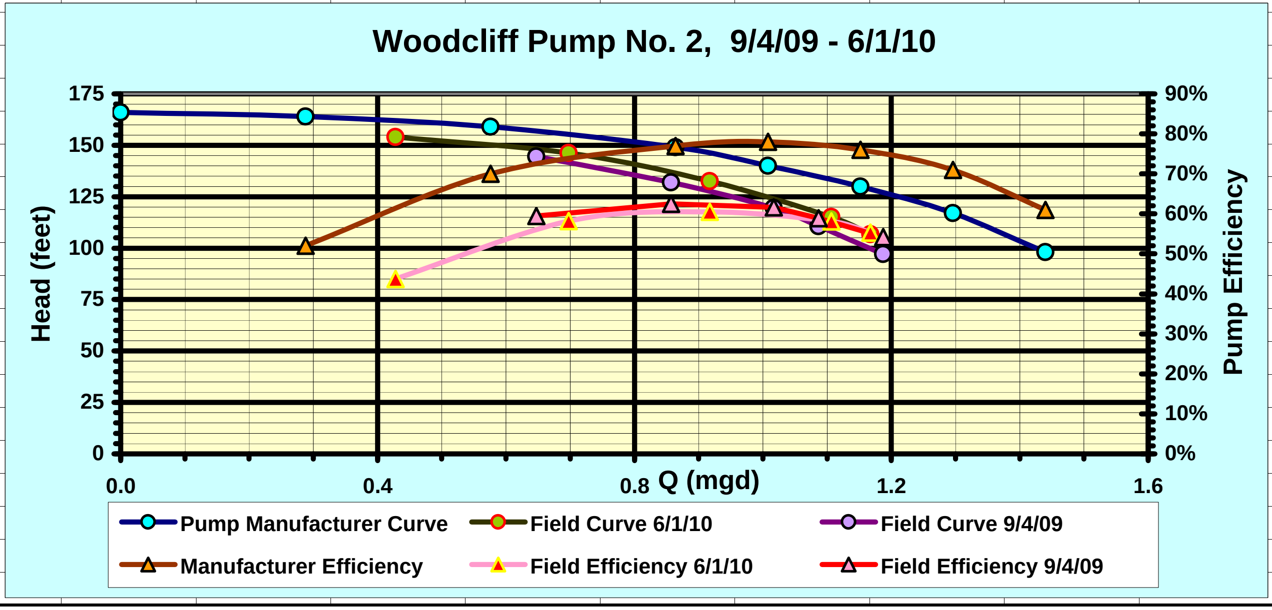

Woodcliff Pump No. 2, 6/2/08 - 9/29/08 Pre-New Motors
Head (feet)
Pump Efficiency
Q (mgd)
175
150
125
100
75
50
25
0
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0.0
0.4
0.8
1.2
1.6
Pump Manufacturer Curve
Field Curve 6/2/08
Field Curve 9/29/08
Manufacturer Efficiency
Field Efficiency 6/2/08
Field Efficiency 9/29/08


Woodcliff Pump No. 2, 9/29/08 - 12/08/08 Pre-New Motors II
Head (feet)
Pump Efficiency
Q (mgd)
175
150
125
100
75
50
25
0
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0.0
0.4
0.8
1.2
1.6
Pump Manufacturer Curve
Field Curve 12/08/08
Field Curve 9/29/08
Manufacturer Efficiency
Field Efficiency 12/08/08
Field Efficiency 9/29/08


Woodcliff Pump No. 2, 12/08/08 - 1/7/09 Post New Motors
Head (feet)
Pump Efficiency
Q (mgd)
Pump Manufacturer Curve
Field Curve 12/08/08
Field Curve 1/7/09
Manufacturer Efficiency
Field Efficiency 12/08/08
Field Efficiency 1/7/09


Woodcliff Pump No. 2, 1/7/09 - 4/21/09, 2.5 Year Test
Head (feet)
Pump Efficiency
Q (mgd)
Pump Manufacturer Curve
Field Curve 4/21/09
Field Curve 1/7/09
Manufacturer Efficiency
Field Efficiency 4/21/09
Field Efficiency 1/7/09


Woodcliff Pump No. 2, 4/21/09 - 9/4/09 3 Year Test
Head (feet)
Pump Efficiency
Q (mgd)
0
25
50
75
100
125
150
175
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
0.0
0.4
0.8
1.2
1.6
Pump Manufacturer Curve
Field Curve 4/21/09
Field Curve 9/4/09
Manufacturer Efficiency
Field Efficiency 4/21/09
Field Efficiency 9/4/09


Woodcliff Pump No. 2, 9/4/09 - 6/1/10
Head (feet)
Pump Efficiency
Q (mgd)
0
25
50
75
100
125
150
175
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
0.0
0.4
0.8
1.2
1.6
Pump Manufacturer Curve
Field Curve 6/1/10
Field Curve 9/4/09
Manufacturer Efficiency
Field Efficiency 6/1/10
Field Efficiency 9/4/09