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Agriculture, Water and Power Demands in the Pacific Northwest

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Introduction

The headlines are ominous: [1]"Twin Falls could run out of water in next five years - Report finds aquifer declining in city as drought takes continuing toll." Drought has always been a fact of life throughout the arid west, but signs such as this are becoming all too common. This paper looks at agriculture in the Pacific Northwest, the increasing struggles over water, energy and the environment and how electric utilities are responding to meet the demands of an ever-growing population.

Miners were the first to settle much of the interior Pacific Northwest, but beginning in the mid to late 1800's, families arrived to farm. The weather was so beautiful - sunny skies and low humidity day after day, but in the end, this kind of weather was not very conducive for raising a crop. The early homesteaders soon realized that if you wanted to farm, irrigation was a necessity. Soon, both private and government funded projects transformed the desert landscape. Dams allowed both water and power to be brought to rural areas. Power from the dams was inexpensive and there was plenty of it. Today, dams along the Columbia and Snake Rivers provide up to [2]80% of the entire Northwest's electric power needs and an inland waterway extends from the Pacific ocean to Lewiston, Idaho allowing barges to ship agricultural products to overseas' markets, primarily Asia.

The Columbia River and its major tributary, the Snake River are the lifeblood for a majority of the irrigated farmland in the interior Northwestern U.S. This area is geographically known as the Columbia River plateau region, which extends from Central Washington state to Southern Idaho. The Cascade mountain range running north and south to the west of this region and extending through Washington, Oregon and Northern California prevents most Pacific storms from reaching the dry interior. Most of the irrigated farming areas east of the Cascades average less than 10 inches of rainfall per year.

Today, agriculture in the Pacific Northwest is highly diverse. Major commodities include dairy, wheat, potatoes, barley, sugar beets, onions, alfalfa, fruit trees and grapes. While wheat is primarily grown in dry land areas and comprises the largest acreage, most other crops require more water and are grown on irrigated lands.

Irrigated agriculture initially began in areas where water could be diverted from a river or stream by gravity. Beginning in the 1950's, a shift occurred. Inexpensive electricity rates from hydroelectric power created a boom in electric pumping for irrigation. This allowed lands previously too high in elevation to now receive water from rivers, streams or underground aquifers. Land formerly growing sagebrush instantly became a potato field. Three-phase distribution power lines went up throughout the rural areas to serve these new irrigation pumps. Today, approximately 98% of the energy used in the Northwest for agricultural pumping is electric. While flood irrigation still exists, most irrigated acres in the Northwest are now watered using sprinklers. Pivots, side-rolls and hand-moves are most common. Drip irrigation is generally found in orchards, tree farms and vineyards.

A Looming Western Crisis

In the 1950's and 1960's electric energy growth in the northwest was running at a 7% rate, a doubling every 10 years. There was nothing in the forecast to see that growth rate change. Available northwest electric energy was highly dependent on the hydropower system, so in drought years there was a growing concern the power system could face risks of shortages. It was now the 1970's and it was decided action was needed. Most of the northwest utilities formed a consortium known as the Washington Public Power Supply System (WPPSS). WPPSS proposed to construct and operate seven new nuclear plants. But the 1970's were different than the 1950's and 60's. Energy costs rose with the 1973 oil embargo and interest rates soared. With high energy costs, people began to conserve and the economy slowed. Electric growth rates fell to 1 to 2% per year. Meanwhile, five of the seven nuclear plants in the northwest were under construction. Then in 1979, an accident occurred at the Three-Mile Island nuclear plant at Middletown, Pennsylvania that changed the direction of the entire nuclear industry. Public confidence eroded. New safety requirements were handed down. The WPPSS plants, nearing completion were suddenly caught in the midst of a shrinking need for new energy sources, public fear, and mounting costs. Costs soared on the five plants to $24 billion. With a northwest population of 10 million, this was a $2,400 burden on every man women and child. WPPSS decided to default on two of the plants – at the time, the largest public default in U.S. history. Only one of the seven originally planned nuclear plants was eventually completed. The remaining four plants under construction were eventually abandoned. Parts from the abandoned plants are still being sold. Known originally as WPPSS plant #2, it is the only nuclear plant still operating in the Pacific Northwest with 1000 MW of output.

Although 7% growth rates are well in the past, there continues to be a growing need for power. The northwest now faces other issues including drought, environmental impacts, increasing demands for water and higher energy prices. Various legal battles have erupted regarding endangered species and water rights. For the agricultural sector, beset by low commodity prices and being caught in the middle of these conflicts, large tracts of irrigated acres are potentially at risk. The following are some specific cases throughout the Pacific Northwest and the impacts on agriculture.

Anadromous Fish

The Northwest once boasted anadromous fish numbers in the millions throughout Pacific Northwest waterways. The largest population was on the Columbia and its tributaries. Steelhead and Salmon make their way up the river during the summer and fall to spawn. Those that have made their way to Idaho will travel upwards of 1,000 miles from the ocean. After spawning, they die. In the spring, the small smolts make their way to the ocean to repeat the cycle. Those heading to the ocean from Idaho must pass through eight dams along the way. At each dam, fish may lose their direction in the slack water. This slows and may even prevent them from finding their way to the ocean. For the fish that find their way, the trip through a turbine sluice gate can be deadly. It is estimated a 20% mortality rate occurs at each dam. Besides the dams, fishing, irrigation, predation, changing ocean conditions and drought have impacted the population dramatically. For the past quarter of a century, a regional effort to save the wild salmon runs has been undertaken. A fish flush is done every spring to help move the smolts through the slack waters by releasing water from upstream reservoirs and barges are loaded with smolts to carry the smolts around the dams. The consequences of the fish flush potentially means less water for irrigation and power production. Other measures to improve conditions for the fish include providing incentives to fisherman to reduce predator fish numbers and installing fish screens at irrigation canal diversions to keep the fish in the river. A controversial measure being suggested is to remove four of the dams along the lower Snake River in Washington state.

Klamath Basin – Southern Oregon, Northern California
Water for the Klamath Falls irrigation project began flowing in 1905. Nearly 100 years later, in the summer of 2001, water to the Klamath Falls irrigation project was cut off for the first time ever to maintain river water levels to protect an endangered sucker and coho salmon. 1400 families were impacted. Conflicts for the Klamath Basin will not end soon as demonstrated by a recent ruling on October 18, 2005 by the Ninth Circuit Court of Appeals stating that the Klamath Project Operations Biological Opinion prepared by National Oceanic and Atmospheric Administration Fisheries for coho salmon was capricious. As it stands now, the ruling will significantly impact future diversions for irrigation in the Klamath Basin.

[3]Bell Rapids – Southern Idaho
Originally developed in 1970, the Bell Rapids project operated sixteen 1500 horsepower river pumps and watered up to 25,000 acres. The pumps were used to lift water 600 feet into a canal above the Snake River. Additional pumps on the plateau above were used to pressurize the water for the irrigation systems. With an extended drought since the 1980's, the local electric utility was forced to rely more heavily on fossil fuels and outside power purchases over hydropower for their generation. Pumping costs soared to $120 per acre for beans and barley, $160 per acre for alfalfa and $250 per acre for sugar beets. Low commodity prices didn't help. Many of the farmers were planning on weathering the downturn, but when Bell Rapids was offered $1,250 per acre by the State of Idaho in early 2005 to buy their water right for anadromous fish protection, it was a deal they couldn't refuse.

[3]Upper Snake River Valley Aquifer – Southern Idaho
In February 2005, a water call was placed by several canal companies and irrigation districts on approximately 10,000 irrigation wells serving 850,000 acres in the upper Snake River plain of southeast Idaho. The upper Snake River plain is a land of ancient lava flows. Several rivers and streams descending from the surrounding mountains disappear as they enter the plain. The waters form the upper Snake River Plain aquifer, an underground reservoir nearly the size of Lake Erie. Water eventually flows out of the aquifer naturally through springs along two reaches of the Snake River. One reach is between Blackfoot and American Falls, the other more significant reach is downriver between Twin Falls and Hagerman. Early irrigation projects in the State applied for the water rights on the spring flows. With water being pumped out of the aquifer at a faster rate than being replenished, aquifer levels have declined. This has in turn reduced outflow at the springs. Six canal companies and irrigation

districts laying claim to the spring flow water rights allege that upstream junior groundwater users materially injure their water users. “Junior” refers to water users with later water rights. The State of Idaho had to make a decision whether to uphold the call and potentially shut down 850,000 acres of farmland – a move that would economically devastate the entire state. Negotiations ensued among the parties. The final decision by the State was for the groundwater users to find water to make the canal companies and irrigation district whole. Options included purchasing unused storage water, water conservation or buying water from other water users. This ruling is in effect until natural spring flows return to previously established levels.

A&B Irrigation District – Southern Idaho

In another case involving the eastern Snake River plain aquifer, A&B Irrigation District located near Rupert, Idaho has had a history of declining water tables in their portion of the aquifer ever since the mid-1970’s. A&B Irrigation District formed in 1948, the first irrigation district to begin pumping from the aquifer. As a result of the decline, the District now has to drill old wells deeper, install larger pumps and motors and extend pump columns. This is very expensive and results in higher pumping costs. A&B sites the junior groundwater users as materially injuring them. A&B Irrigation District is asking the State of Idaho to enforce the priority water appropriation law. The case is currently under review. Meanwhile, A&B Irrigation district is looking for ways to become more efficient.

Energy Efficiency Mandated

As a way to help mitigate the growing number of conflicts surrounding the natural resources of the Pacific Northwest, the Pacific Northwest Power Planning and Conservation Act (Act) was passed by Congress and signed by President Jimmy Carter on December 5, 1980. This Act mandated energy efficiency programs be implemented to help sustain the federal hydropower system of the Pacific Northwest. The Act also created the Northwest Power Planning Council (NWPPC). This council, represented by the states of Oregon, Washington, Idaho and Montana was formed to prepare a program to protect, mitigate and enhance fish and wildlife of the Columbia River Basin affected by hydropower dams while also assuring the region an adequate, efficient, economical and reliable power supply.

Since passage of the Act, a number of organizations have formed to promote and deliver energy efficiency programs. Two of the larger organizations are the Northwest Energy Efficiency Alliance (NEEA) and The Energy Trust of Oregon.

Northwest Energy Efficiency Alliance

The Northwest Energy Efficiency Alliance (NEEA) is a non-profit corporation supported by electric utilities, public benefits administrators, state governments, public interest groups and energy efficiency industry representatives. These entities work together to make affordable, energy-efficient products and services available in the marketplace. By 2010, NEEA and related utility efforts are expected to save the region over 500 aMW-enough to offset the need to build two new power plants.

Financial contributions to the NEEA are pooled and used to fund energy-saving projects for residential, commercial, industrial and agricultural sectors. From 1996 through 2004, $165

million was committed to the Alliance by its sponsors. Starting in 2005, an additional $20 million a year has been pledged for five years through 2009.
For the agricultural sector, projects sponsored by the NEEA include AgriMet, the AM 400 soil moisture monitor, scientific irrigation scheduling, subsurface drip irrigation and MagnaDrive.

AgriMet - In 1983, the Bonneville Power Administration (BPA) in cooperation with the United States Bureau of Reclamation (Reclamation), installed the first automatic agricultural weather stations. The agricultural weather stations were "piggy-backed" onto the regional Hydromet satellite telemetry network. The Hydromet network is a series of automated data collection platforms that provide information necessary for near-real-time management of the water operations in the Pacific Northwest. As a subset of the Reclamation's overall Hydromet network, this agricultural network, dedicated to crop water use modeling and other agricultural applications, has been identified as AgriMet.

The present Pacific Northwest Agrimet network consists of over 70 agricultural weather stations across seven states in the Northwest. There is also a separate Great Plains network for Montana east of the continental divide that brings the total number of stations to over 90. Near real-time weather data is transmitted from individual stations to Reclamation's receiving site in Boise, Idaho through the Geo-stationary Operational Environmental Satellites (GOES-8, GOES-9 and DOMSAT satellites). Each station transmits data at regular intervals of either 1 or 4 hours. The data is processed in Boise and is made available on the World Wide Web at www.usbr.gov/pn/agrimet.

All stations are equipped with data collection sensors for solar, air temperature, relative humidity, precipitation, wind speed and wind direction. Some sites also have sensors to measure soil temperature and leaf wetness.

Crop evapo-transpiration data is provided by AgriMet daily to help predict soil water conditions. This information can help farmers determine when and how much to irrigate. Sample evapo-transpiration crop information charts are shown in Appendix A-1.

Scientific Irrigation Scheduling – NEEA funded all the northwest states to educate and expand the practice of scientific irrigation scheduling. Scientific irrigation scheduling (SIS) enables irrigators to supply the right amount of moisture to their crops at the right time according to plant growth needs and weather data. In addition to reducing energy costs for pumping water for irrigation, SIS conserves water and reduces fertilizer use and run off.

The Northwest Energy Efficiency Alliance worked with the Washington State University Cooperative Extension Energy Program, the Oregon State University Cooperative Extension Service, the Idaho Department of Water Resources Energy Division and the Soil and Water Conservation Districts of Montana to implement the program.

When the Alliance project concluded at the end of 2000, a number of agricultural consultants and field men were offering SIS throughout the Northwest as part of their on-farm services. The practice of scientific irrigation scheduling was being applied to about 38% of the available acreage in the region.

AM 400 Soil Moisture Monitor – Developed by M.K Hansen Co., the AM 400 soil moisture monitor is a relatively inexpensive six channel soil moisture data logger. Using water marks to measure the soil moisture, the monitor displays up to 5 weeks of current and historical soil moisture. Sensors can be placed in the field up to 1,000 ft away from the data logger at any depth. The AM 400 is targeted for smaller growers to be able to measure soil moisture levels on their own.

Subsurface Drip Irrigation – This project was part of NEEA's strategy toward market transformation in the agricultural sector to accelerate the market penetration of the use of subsurface drip irrigation. Subsurface drip irrigation is arguably the most efficient method for irrigating agricultural crops as virtually all water loss is eliminated due to runoff and evaporation. Increased yields, better quality and reduced pumping and disease control costs can outweigh the $1,200 to $1,400 per acre installation cost. A significant number of onion growers in the Northwest now have switched to subsurface drip irrigation.

MagnaDrive – When varying pressure or varying flow rates are needed, irrigators typically use a valve at the pump for control. An analogy we like to use is that this is like driving your car down the road with your foot on the accelerator while simultaneously depressing the brake pedal. For certain irrigation pumping applications, a variable speed drive can make sense. To provide speed control, variable frequency drives (VFD's) are most commonly installed on electric induction motors. However, there are some drawbacks to using a VFD:

- VFD's can create so-called "dirty" power as they generate a significant amount of harmonics on the electrical system. Expensive filters or isolation transformers must be installed to eliminate harmonics.

- VFD's are sensitive to heat, dust and vermin. On a relatively new VFD that was installed on a 700 hp vertical turbine well pump in Oregon, mice had chewed through insulation inside the VFD panel over the winter. When the farmer turned the pump on in the spring, the VFD short-circuited resulting in a $45,000 repair bill.

- A cost premium applies to variable frequency drive applications involving medium voltage motors or motors larger than 300 hp. Typical VFD costs will run $100/hp for smaller motors, but will double for the larger motors.

NEEA helped fund a start-up company to promote the development and application of a new variable speed drive technology that would overcome the problems with variable frequency drives. This start-up company, known as MagnaDrive uses a magnetic air-gap coupling to vary speed. The closer the magnetic plates are together, the faster the speed.

The advantages of this technology compared to a variable frequency drive include:

- Separates motor from vibrating equipment reducing wear and tear.
- Increases motor life and protects equipment from overload damage.
- Does not generate electrical harmonics.
- Can operate in harsh environments without special protection.

Disadvantages include:

- Rotational speed of the drive is always slower than the speed of the motor.
- Vertical hollow-shaft motor applications are more expensive.
- Torque is reduced.

Energy Trust of Oregon

In 2002, the Energy Trust of Oregon was created to serve the natural gas and investor-owned electric utility customers of the state of Oregon.

The Energy Trust includes an irrigation efficiency program in their portfolio. The program is limited in scope to only the irrigators in the Klamath Basin. Free pump tests are offered along with incentives for new nozzles and pump efficiency improvements. Eligible projects can receive up to 30% of the cost for the project.

Electric Utility Sponsored Agricultural Irrigation Programs

[5]Irrigated agriculture consumed approximately 650 average megawatts of electricity in the year 2000, or about four percent of the non-direct served industrial electricity consumption in the region. Northwest agricultural loads are forecast to increase by approximately 30 average megawatts by 2025 or about 0.17 percent per year. It is estimated that 80 average megawatts of conservation savings can be realistically achieved by 2025 at an average total resource cost of 2.7 cents per kilowatt-hour.

Between 1987 and 1997, the amount of irrigated land in the region increased just under 10 percent or about 760,000 acres. The greatest increases in irrigated acreage were in Oregon, followed by Idaho and Washington. Only in Montana did irrigated acreage remain roughly unchanged over the decade. However, despite the increase in irrigated land, electricity use in this sector actually decreased by about ten percent between 1994 and 1997. This was largely a result of conversion from high-pressure to low-pressure center-pivot irrigation systems.

Energy efficiency targets are recommended to Northwest utilities annually by the NWPPC. Utility sponsored agriculture efficiency programs have played a key role in meeting the energy efficiency targets. Up until the western energy crisis of the summer of 2001, little attention was paid to summer electric loads. Most electric loads in the northwest peak during the winter to meet electric heating demands. The western electrical crisis of 2001 changed this viewpoint. The electrical transmission system in much of western North America is tied together. If power supplies are low in California, additional power may be supplied by the Pacific Northwest and vise versa. Generally, the northwest supplies California power during the summer to meet their air-conditioning needs and California in turn supplies the northwest power in the winter to help meet heating needs. When the Northwest could not meet the needs of California in the summer of 2001, wholesale power costs skyrocketed upwards, exceeding $500 per MWh at times. The value for saving electric energy from irrigation became much more valuable and the savings was counted on more than ever to meet the overall energy efficiency targets set by the NWPPC.

Center pivots are becoming the predominate method of irrigation in the Northwest and these systems are being designed to operate at ever lowering pressures. Sprinkler packages designed to operate down to 6 lbs/sqin are becoming more and more common. Drop tubes are being extended to apply the water closer to the soil to reduce evaporation. Some systems are even applying the water directly on the ground to eliminate any evaporation of water that had previously resulted when water droplets landed on the plant canopy and never reached the soil. Such systems can have application efficiencies as high as 95% to 98%. With less evaporation, more water can be applied to crops with the same number of kilowatt-hours or the same amount of water can be applied with fewer kilowatt-hours.

In addition to reducing system-operating pressures, improvements in the efficiency of irrigation are possible through the use of higher efficiency pumping and by reducing system friction losses and eliminating water leaks. All 80 average megawatts of the achievable resource potential in the irrigated agriculture sector are "dispatchable" conservation resources. These resources can be scheduled for development any time during the next 20 years. If the Northwest were to acquire the dispatchable agricultural sector conservation resources in equal annual amounts (4 average megawatts per year) over the next 20 years, the total resource cost of doing so would be approximately $7 million per year.

Bonneville Power Administration has historically offered both irrigation hardware and scheduling efficiency programs. BPA is a federal agency under the U.S. Department of Energy. BPA markets wholesale electrical power and operates and markets transmission services in the Pacific Northwest. The power comes from 31 federal hydro projects, one non-federal nuclear plant and several other small non-federal power plants. BPA provides power to 59 rural cooperatives, 41 municipalities, 30 public utility districts, 7 federal agencies, 6 investor owned utilities, 5 direct service industries and one port district.

Since 1984, savings from BPA's sponsored agricultural programs have totaled approximately 20 average MW. Idaho Power, an investor-owned utility in the Northwest, offered a similar hardware program and accumulated savings of another 3.6 average MW.

Hardware Program

Many utilities in the Northwest offer similar irrigation hardware programs. Generally the programs provide financial incentives to improve pump and motor efficiency, reduce leaks, lower operating pressures, streamline fittings around the pump, improve application efficiency and reduce friction losses in pipelines. Rebates are available for sprinklers, gaskets, pressure regulators, premium efficient motors and a few other miscellaneous items. Appendix A-1 is the rebate form used in BPA's program. For other energy efficiency measures requiring more extensive engineering analyses, agricultural consultants are hired by local electric utilities to evaluate irrigation systems. A simple pre-screening tool is first used to conduct a general overall assessment of the system without having to visit the irrigation system site. The screening tool can help determine if more energy is being used than what would be typical with a similar efficiently operating system. If it is felt there are some efficiency improvement opportunities, a pump efficiency test and distribution system evaluation is conducted. Flow, pressure, lift and power measurements are taken at the pump. Various methods can be used to measure flow. The most common technique used is a non-intrusive ultrasonic flow meter. Other instruments used to measure flow include the use of pitot tube type meters or a fluorescent dye dilution technique employing the use of a fluorometer. With the [4]dye method, a known concentration of WT Rhodamine dye is injected into the water stream using a positive displacement pump. Discrete samples of the diluted dye are taken at a point downstream where the dye is thoroughly mixed into solution. A fluorometer is used to measure the concentration of the dye. Concentrations of dye in both the diluted samples and a sample taken from concentrate that is injected into the flow stream are measured. The flow can be determined from these measurements using an inverse relationship - the more dilute the dye, the higher the flow. Other field measurement data collected include distribution pipe materials, diameters and lengths, soil type and depth, nozzles sizes, nozzle spacing, irrigation duration times, cropping information and acreage are also noted. Field data collected are entered into a computer program to assist with analysis of the system. Proposed irrigation system changes are entered into the analysis. If energy savings can be achieved, the irrigator is eligible for incentives to make the improvements. A sample output evaluation report for an actual irrigation system is shown in Appendix A-3. For the system shown, there are four wells serving a single ¼ mile long center pivot. Pages A.3-27 through A.3-30 is a summary of the savings for this project. Opportunities for savings for this project were identified through improvements in pump and motor efficiency and mainline.

Once improvements are made to the irrigation system, the consultant returns to conduct a post evaluation. This post-evaluation assures that the irrigation system is performing as expected. Distribution system changes are inspected and a pump test performed. The actual incentive payment to the irrigator is based on the kWh savings as measured in the before and after test data. Reimbursement rules vary depending upon specific utility program benefits, but generally, a one-time program payment is made that generally will cover 50% to 75% of the project cost.

Scheduling Program

Agricultural consultants offer farmers irrigation scheduling services during the growing season. These services generally include weekly in-field soil moisture and precipitation measurements. Common instruments used to measure soil moisture are watermarks, tensiometers, neutron probes, and time and frequency-domain reflectometry probes. Some consultants also offer infrared flyovers. BPA has funded various irrigation scheduling programs since 1985.

Use of irrigation scheduling not only can help save energy by preventing over-watering but also reduce potential contamination to groundwater supplies as a result of deep percolation. A case in point is the ground water management project in Adams, Franklin, and Grant Counties of Washington state. Irrigation water is pumped from Lake Roosevelt to serve this farmland. Lake Roosevelt is the reservoir behind Grand Coulee Dam. Concerns over high groundwater nitrate concentrations led to official designation of the tri-county area as a Ground Water Management Area (GWMA) by the Washington State Department of Ecology (Ecology) in February 1998. Subsequently, a nitrate mitigation plan was developed to target 400,000 acres or about one-half of the irrigated farmland in the three counties to implement an irrigation and fertilizer management program. Grants were applied for and received from the U.S. Environmental Protection Agency (EPA) to implement and administer the program. In 2005, funding from the EPA was significantly reduced. To enable continuation of the program at levels consistent with previous years, BPA offered incentives with the understanding that energy savings be documented. Besides the benefits previously stated, this project also has potential benefits to the power system. Water saved by the irrigators through better water management results in less water having to be pumped from Lake Roosevelt. So, not only is energy saved at the Lake Roosevelt pumping station, but water is left in the Columbia river for power production downstream through 5 large federal dams. A final report on this project is expected in December 2005.

Demand Response Programs

Interruptible rates have long been offered to Utah Power and Light's Idaho irrigators. This has helped Utah Power meet the growing summer air-conditioning load along the Wasatch Front of northern Utah. Today, the program works simply by installing an electronic timer at each participating pump site. The timer temporarily interrupts power to the pump according to an agreed upon schedule between the irrigator and Utah Power. Power is typically interrupted twice each week for three to six hours at a time. When the schedule is met, power is restored to the pump. The schedule is implemented between June 1 and September 15. Discounts for participation are reflected in the irrigation rate demand charge. Results of this program were quite impressive in 2004. 207 irrigators with 403 metered irrigation sites participated, which represented about 12% of Utah Power & Light's irrigation load, resulting in a shift or curtailment of 21 megawatts during the irrigation season.

Other utilities in the northwest are looking into similar strategies. The Bonneville Power Administration program is known as "Non-Wires Solution".

Conclusion

Northwest agriculture has historically been blessed with inexpensive energy, adequate water, a dry warm summer climate and volcanic soils. The combination has allowed the area to be one of the leaders in the nation in potato, onion, dairy, malt barley, hop, apple, mint and grape production; yet, water demands, energy costs and environmental issues are threatening the viability of many agricultural lands. Energy efficiency programs have been introduced to assist irrigators meet some of the challenges, yet even energy efficiency programs may have environmentally challenging consequences. The Twin Falls situation mentioned at the beginning of this paper partly resulted by being more efficient. As mentioned earlier, irrigation originally was done by flooding the fields. Water from the flooded fields percolated down past the root zone and into the aquifer below. In the case of Twin Falls, a man-made aquifer ensued. Many years later, Twin Falls drilled wells to tap the man-made aquifer for irrigation and drinking supply. As time went on, farmers converted over to sprinkler irrigation and began practicing better water management. The primary water source for the aquifer slowly was eliminated. Drought has now hastened the water table decline – the result: Twin Falls is running out of water.

The challenges are great, yet by working together the northwest plans to meet such challenges by continuing to be a leader in promoting and implementing energy efficient technologies.

Appendices

Appendix A-1.

AgSO – Irrigated Agriculture Sprinkler Verification Report
Fill out one report for each Sub-Project

Project Title:		Project #:	
Farm Address:		Utility:	

Category	Measure Description		Rebate Per Unit	Est. Savings Per Unit	Number of Units	Total Savings by Measure	Total Rebate by Measure
Sprinklers		Sprinkler Equipment Rebates	a.	b.	c.	(b*c)	(a*c)
		Replacement sprinklers are eligible for retrofits identified by utility staff, the Consumer, the irrigation equipment dealer, or through pump testing and system evaluation.					
	1.	New flow controlling type nozzle for impact sprinklers.	$3.00	20 kWh/yr			
	2.	Rebuilt or new brass sprinklers.	$4.00	40 kWh/yr			
	3.	New rotating type sprinkler replacing impact sprinklers.	$3.00	40 kWh/yr			
	4.	New gasket for wheel-lines or hand-lines.	$1.00	30 kWh/yr			
	5.	New low-pressure regulators with pivot sprinklers (entire pivot must be upgraded).	$6.00	40 kWh/yr			
	6.	New multiple configuration nozzles for low-pressure pivot sprinklers.	$2.00	20 kWh/yr			
	7.	New “goose neck” elbow for new drop tubes.	$1.00	20 kWh/yr			
	8.	New drop tube for low-pressure pivot sprinklers (min. 3 feet length).	$3.00	20 kWh/yr			

A. Reimbursement Total:	
B. __% Admin of A. above:	
C. «Customer Name» Reimbursement (A + B):	
D. Energy Savings (kWh/yr):	

Required Information

1.	The installed equipment meets the program requirements and specifications.	(Yes/No)	
2.	The rebate items listed have been installed and are operational.	(Yes/No)	
3.	Copies of invoice(s) from equipment supplier(s) are attached.	(Yes/No)	
4.	Annual kWh usage of participating irrigation system(s).	(kWh/yr)	
5.	Total acreage under irrigation and reflected in kWh usage above.	(acres)	
6.	Acreage covered by new sprinklers.	(acres)	
7.	Estimated pressure at first sprinkler or at center pivot.	(PSI)	

Submitted By: ______________________________ Date: ______________________

AgSO – Irrigated Agriculture Pump Motor
Verification Report
Fill out one report for each Sub-Project

Project Title:		Project #:	
Farm Address:		Utility:	

Category	Measure Description	NEMA Premium Efficiency	Rebate Per Unit	Est. Savings Per Unit (kWh/yr).	No. of Units	Total Savings for Measures	Total Rebate for Measures
	Pump Motor Rebates	a.	b.	c.	d.	(c*d)	(b*d)
	Qualifying motors may be purchased anywhere, but shall be installed in an irrigated agriculture application in the service area of «Customer Name». Motors must be three phase, AC induction motors 25 to 500 horsepower, NEMA design A, B, or C.						
Motors	25 horsepower	94.5%	$300	2,400			
	30 horsepower	94.5%	$310	2,526			
	35 horsepower	94.5%	$325	2,688			
	40 horsepower	94.5%	$370	3,072			
	50 horsepower	95.0%	$500	4,210			
	60 horsepower	95.0%	$585	4,874			
	75 horsepower	95.0%	$730	6,093			
	100 horsepower	95.4%	$975	7,976			
	125 horsepower	95.4%	$1,130	9,416			
	150 horsepower	95.8%	$1,330	11,078			
	200 horsepower	95.8%	$1,700	14,180			
	250 horsepower	95.8%	$2,130	17,725			
	300 horsepower	95.8%	$2,550	21,270			
	350 horsepower	95.8%	$2,980	24,815			
	400 horsepower	96.2%	$3,690	30,723			
	450 horsepower	96.2%	$4,150	34,564			
	500 horsepower	96.2%	$4,600	38,404			

A. Rebate Item Total ($):	
B. ___% of A. above:	
C. Customer Rebate ("A" plus "B"):	
D. Energy Savings (kWh/yr):	

Required Information

1.	The installed equipment meets the program requirements and specifications.	(Yes/No)	
2.	The rebate items listed have been installed and are operational.	(Yes/No)	
3.	Copies of invoice(s) from equipment supplier(s) are attached.	(Yes/No)	

Submitted By: ______________________________ Date: ______________________

BONNEVILLE POWER ADMINISTRATION

Typical Evapo-Transpiration Chart Used by Growers (Bandon, OR)

ESTIMATED CROP WATER USE - OCT 18, 2005 BANO

CROP	START DATE	DAILY CROP WATER USE-(IN) PENMAN ET - OCT				DAILY FORE CAST	COVER DATE	TERM DATE	SUM ET	7 DAY USE	14 DAY USE
		14	15	16	17						
ETr	201	0.06	0.00	0.00	0.00	0.00	201	1015	31.9	0.3	0.8
LAWN	201	0.05	0.00	0.00	0.00	0.00	401	1015	25.0	0.2	0.6
PAST	201	0.02	0.00	0.00	0.00	0.00	601	1015	20.2	0.1	0.4
BLUB	320	0.00	0.00	0.00	0.00	0.00	715	810	18.2	0.0	0.0
CRAN	315	0.05	0.00	0.00	0.00	0.00	701	1015	22.6	0.2	0.7

Annual Evapo-Transpiration Crop Data for Corvallis, OR

CRVO -- Corvallis, Oregon

	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	Average
Alfalfa (Mean)	--	--	--	33.5	39.0	35.9	34.2	33.7	31.6	30.0	29.2	31.9	33.7	32.2	34.4	35.1	35.0	33.5
Pasture	--	--	--	26.1	30.7	28.2	27.2	26.6	25.1	23.9	--	--	--	--	--	--	--	26.8
Lawn	--	--	--	31.8	37.1	34.2	33.1	32.1	30.2	28.6	28.4	30.5	32.0	30.6	33.0	33.7	33.3	32.0
Winter Grain	--	--	--	15.2	21.0	19.1	18.3	15.9	15.7	14.5	14.2	15.4	15.4	15.2	15.2	15.2	16.1	16.2
Spring Grain	--	--	--	17.3	21.9	21.5	20.7	17.6	19.3	16.1	17.5	18.3	19.0	19.1	16.3	16.4	17.4	18.5
Dry Beans	--	--	--	17.2	21.4	18.7	18.8	18.6	17.8	16.0	--	--	--	--	--	--	--	18.4
Field Corn	--	--	--	22.2	27.8	24.0	23.4	24.0	20.5	18.5	19.7	20.5	20.9	19.2	23.1	24.9	24.8	22.4
Sweet Corn	--	--	--	17.9	22.4	19.3	19.2	18.6	18.6	18.5	--	--	--	--	--	--	--	19.2
Apples	--	--	--	--	38.3	34.6	33.1	33.2	30.3	25.6	28.0	28.7	30.5	30.5	31.7	35.6	34.1	31.9
Cabbage	--	--	--	13.6	16.4	15.1	15.2	14.0	14.9	13.4	--	--	--	--	--	--	--	14.7
Broccoli	--	--	--	24.8	28.6	27.5	26.4	24.6	26.2	24.0	--	--	--	--	--	--	--	26.0
Strawberries	--	--	--	22.2	26.1	25.5	25.1	21.5	23.5	22.5	19.4	22.3	24.1	20.6	24.5	22.9	24.1	23.2
Trailing Berries	--	--	--	16.3	20.2	19.9	18.9	16.2	16.7	16.1	12.7	14.7	20.0	17.1	18.3	23.0	22.4	18.0
Blueberries	--	--	--	23.6	27.8	26.9	26.4	23.4	23.6	23.0	19.4	23.6	25.4	22.3	25.7	26.8	27.5	24.7
Pears	--	--	--	--	--	--	--	--	--	19.3	--	--	--	--	--	--	--	19.3
Potatoes	--	--	--	--	--	--	--	--	--	--	20.4	19.6	18.9	17.5	19.9	24.71	24.2	20.7

Sample Daily Evapo-Transpiration Crop Chart for Hermiston, OR (June 2005)

HERO - ET SUMMARY - 2005

DATE	ETr	ALFP	ALFM	PAST	LAWN	WGRN	SGRN	ONYN	ONYN	POTA	POTA	POTA	BEAN	FCRN	SCRN	SCRN	PEAS	PEAS	PPMT	APPL	RAPE	WGRP	MELN
601	0.41	0.41	0.35	0.28	0.33	0.41	0.41	0.39	0.32	0.35	0.31	0.25	0.12	0.22	0.22	0.14	0.41	0.41	0.38	0.39	0.41	0.27	0.12
602	0.39	0.39	0.33	0.27	0.31	0.39	0.39	0.37	0.31	0.33	0.30	0.25	0.12	0.21	0.21	0.13	0.39	0.39	0.36	0.37	0.39	0.25	0.12
603	0.41	0.41	0.35	0.28	0.33	0.41	0.41	0.39	0.33	0.35	0.32	0.27	0.13	0.23	0.23	0.14	0.41	0.41	0.38	0.39	0.41	0.27	0.13
604	0.37	0.37	0.31	0.25	0.30	0.37	0.37	0.36	0.30	0.32	0.30	0.25	0.13	0.21	0.21	0.13	0.36	0.37	0.35	0.35	0.37	0.24	0.13
605	0.34	0.34	0.29	0.23	0.27	0.34	0.34	0.33	0.29	0.30	0.28	0.23	0.12	0.19	0.19	0.12	0.33	0.34	0.32	0.32	0.34	0.22	0.12
606	0.23	0.23	0.20	0.16	0.18	0.23	0.23	0.22	0.20	0.20	0.19	0.16	0.09	0.13	0.13	0.08	0.21	0.23	0.22	0.22	0.23	0.15	0.09
607	0.39	0.39	0.33	0.27	0.31	0.39	0.39	0.38	0.34	0.34	0.32	0.28	0.16	0.23	0.23	0.15	0.35	0.39	0.37	0.37	0.39	0.25	0.15
608	0.32	0.32	0.27	0.22	0.26	0.32	0.32	0.32	0.28	0.28	0.27	0.23	0.14	0.19	0.19	0.12	0.27	0.32	0.30	0.31	0.32	0.21	0.13
609	0.32	0.32	0.27	0.22	0.26	0.32	0.32	0.32	0.29	0.28	0.27	0.23	0.15	0.20	0.20	0.12	0.25	0.31	0.30	0.31	0.32	0.21	0.14
610	0.44	0.44	0.37	0.30	0.35	0.43	0.44	0.44	0.40	0.39	0.38	0.33	0.22	0.28	0.28	0.17	0.33	0.41	0.42	0.42	0.44	0.29	0.20
611	0.43	0.43	0.37	0.29	0.34	0.42	0.43	0.43	0.40	0.39	0.37	0.33	0.22	0.28	0.28	0.18	0.30	0.39	0.41	0.41	0.43	0.28	0.21
612	0.40	0.40	0.34	0.27	0.32	0.39	0.40	0.40	0.38	0.36	0.35	0.31	0.22	0.26	0.26	0.17	0.26	0.34	0.38	0.38	0.39	0.26	0.20
613	0.39	0.39	0.33	0.27	0.31	0.38	0.39	0.39	0.37	0.35	0.34	0.31	0.23	0.26	0.26	0.17	0.23	0.32	0.37	0.37	0.38	0.25	0.20
614	0.31	0.31	0.26	0.21	0.25	0.30	0.31	0.31	0.30	0.28	0.27	0.25	0.19	0.21	0.21	0.14	0.17	0.24	0.29	0.30	0.30	0.20	0.17
615	0.32	0.32	0.27	0.22	0.26	0.31	0.32	0.32	0.31	0.29	0.28	0.26	0.20	0.22	0.22	0.15	0.16	0.23	0.30	0.31	0.30	0.21	0.18
616	0.23	0.23	0.20	0.16	0.18	0.21	0.23	0.23	0.22	0.21	0.20	0.19	0.15	0.16	0.16	0.11	0.11	0.15	0.22	0.22	0.20	0.15	0.13
617	0.34	0.34	0.29	0.23	0.27	0.31	0.34	0.34	0.33	0.31	0.30	0.28	0.23	0.24	0.24	0.17	0.14	0.21	0.32	0.33	0.28	0.22	0.20
618	0.29	0.29	0.25	0.20	0.23	0.26	0.29	0.29	0.28	0.27	0.26	0.24	0.21	0.21	0.21	0.15	0.11	0.17	0.28	0.28	0.23	0.19	0.18
619	0.32	0.32	0.27	0.22	0.26	0.27	0.32	0.32	0.31	0.30	0.29	0.27	0.24	0.24	0.24	0.17	0.11	0.17	0.30	0.31	0.24	0.21	0.20
620	0.31	0.31	0.26	0.21	0.25	0.26	0.31	0.31	0.31	0.29	0.28	0.26	0.24	0.23	0.23	0.17	0.10	0.15	0.29	0.30	0.22	0.20	0.20
621	0.39	0.39	0.33	0.27	0.31	0.31	0.39	0.39	0.39	0.36	0.36	0.34	0.31	0.30	0.30	0.22	0.11	0.18	0.37	0.38	0.26	0.25	0.25
622	0.46	0.46	0.39	0.31	0.37	0.36	0.46	0.46	0.46	0.43	0.42	0.40	0.38	0.36	0.36	0.27	0.11	0.19	0.44	0.45	0.29	0.30	0.30
623	0.33	0.33	0.28	0.22	0.26	0.25	0.33	0.33	0.33	0.31	0.30	0.29	0.28	0.26	0.26	0.20	0.07	0.12	0.31	0.32	0.19	0.21	0.21
624	0.32	0.32	0.27	0.22	0.26	0.23	0.32	0.32	0.32	0.30	0.30	0.28	0.28	0.26	0.26	0.19	0.06	0.11	0.30	0.31	0.17	0.21	0.21
625	0.39	0.39	0.33	0.27	0.31	0.28	0.39	0.39	0.39	0.36	0.36	0.34	0.34	0.32	0.32	0.24	0.00	0.12	0.37	0.38	0.20	0.25	0.25
626	0.47	0.47	0.40	0.32	0.38	0.32	0.47	0.47	0.47	0.44	0.44	0.42	0.42	0.39	0.39	0.30	--	0.13	0.45	0.46	0.22	0.31	0.31
627	0.28	0.28	0.24	0.19	0.22	0.19	0.28	0.28	0.28	0.26	0.26	0.25	0.26	0.24	0.24	0.18	--	0.07	0.27	0.27	0.12	0.18	0.18
628	0.33	0.33	0.28	0.22	0.26	0.21	0.33	0.33	0.33	0.31	0.31	0.30	0.30	0.28	0.28	0.22	--	0.07	0.31	0.32	0.13	0.21	0.21
629	0.37	0.37	0.31	0.25	0.30	0.23	0.37	0.37	0.37	0.34	0.34	0.33	0.35	0.32	0.32	0.25	--	0.07	0.35	0.36	0.13	0.24	0.24
630	0.41	0.41	0.35	0.28	0.33	0.25	0.41	0.41	0.41	0.38	0.38	0.37	0.39	0.36	0.36	0.29	--	0.00	0.39	0.40	0.13	0.27	0.27

Appendix A-3
Irrigation System Energy Efficiency Report

Prepared For: Farmer Joe
Audit Date: 6/20/2005

Owner and Farm Identification

Project No.:	WRE0105
Project Description:	Pumps 5, 6 7 & 8 center pivot system
Owner:	Farmer Joe
Farm:	Joe’s Farms
Account #:	1435232, 1433992, 1434242
Address:	HC Box 129
City, State, Zip:	Wells, NV 89835
Phone:	(775) 752-2000, Home

Farm Operator

Farm Operator:
Address:
City, State, Zip:
Phone:

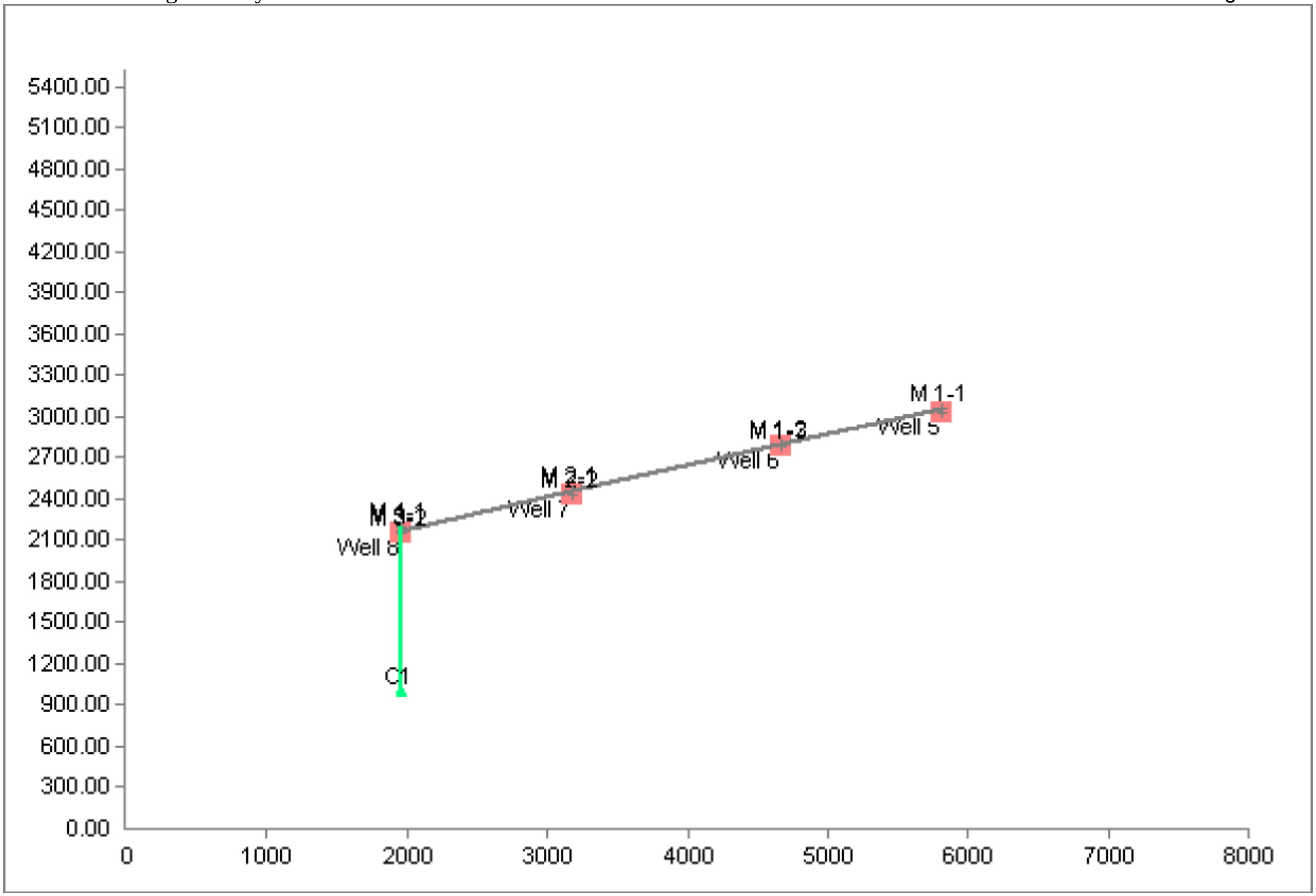
Analyst Information

Wells Rural Electric Co.
Analyst: Jim Dunn
Analyst: Troy Hobbs

Project Notes and Recommendations:

Date 7/29/2005

All pumps and the mainline between well 5 and well 6 have opportunities for efficiency improvements. Pumps are generally oversized for the wells. All pumps were partially valved to reduce air entrainment. It is recommended that the pumps be redesigned to match system operating conditions and the section of mainline between well 5 and well 6 changed from 6" PVC to 8" PVC.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1000
2000
3000
4000
5000
6000
7000
8000
M 1-1
Well 5
Well 6
Well 7
Well 8
C1

Crops

Project
No.: WRE0 105

Crop Year: 2002
Weather Station: Eureka, NV
Condition: Existing

Details for Continuous Moving Laterals

Field	Acres	Crop	Soil Type	Allowable Depletion (%)	Available Moisture (In/Ft)	System No.	System Type	Avg. Field Precipitation (In/Hr)	Run Time (%)	Appl. Effic. (%)	Intake Rate (In/Hr)
A	106.0	Alfalfa	Clay Loam	55%	2.40	C1	Pivot	0.0360	111.0%	80%	0.20

Crop Summary

Crop	Acres	Effective Root Depth (Ft)	Design ET (In/Day)	Allowable Depletion (In)	Max. Allowable Return Time (Days)	Seasonal ET (In)	Seasonal Water Requirement (Acre-Ft)
Alfalfa	106.0	3.5	0.32	4.62	14.4	39.60	349
Total:	106.0						349

Irrigated Total (Acre-Ft): 226
Total Water (Acre-Ft): 252
% of Recommended: 72.4%

Crops

Project No.: WRE0 105
Crop Year: 2003
Weather Station: Eureka, NV
Condition: Existing

Details for Continuous Moving Laterals

Field	Acres	Crop	Soil Type	Allowable Depletion (%)	Available Moisture (In/Ft)	System No.	System Type	Avg. Field Precipitation (In/Hr)	Run Time (%)	Appl. Effic. (%)	Intake Rate (In/Hr)
A	106.0	Alfalfa	Clay Loam	55%	2.40	C1	Pivot	0.0360	111.0%	80%	0.20

Crop Summary

Crop	Acres	Effective Root Depth (Ft)	Design ET (In/Day)	Allowable Depletion (In)	Max. Allowable Return Time (Days)	Seasonal ET (In)	Seasonal Water Requirement (Acre-Ft)
Alfalfa	106.0	3.5	0.32	4.62	14.4	39.60	349
Total:	106.0						349

Irrigated Total (Acre-Ft)	269
Total Water (Acre-Ft):	287
% of Recommended:	82.3%

Crops

Project No.: WRE0 105
Crop Year: 2004
Weather Station: Eureka, NV
Condition: Existing

Details for Continuous Moving Laterals

Field	Acres	Crop	Soil Type	Allowable Depletion (%)	Available Moisture (In/Ft)	System No.	System Type	Avg. Field Precipitation (In/Hr)	Run Time (%)	Appl. Effic. (%)	Intake Rate (In/Hr)
A	106.0	Alfalfa	Clay Loam	55%	2.40	C1	Pivot	0.0360	111.0%	80%	0.20

Crop Summary

Crop	Acres	Effective Root Depth (Ft)	Design ET (In/Day)	Allowable Depletion (In)	Max. Allowable Return Time (Days)	Seasonal ET (In)	Seasonal Water Requirement (Acre-Ft)
Alfalfa	106.0	3.5	0.32	4.62	14.4	39.60	349
Total:	106.0						349

Irrigated Total (Acre-Ft): 267
Total Water (Acre-Ft): 293
% of Recommended: 84.0%

Pump Test Data
Existing Pump Evaluation

Project No.: WRE0 105
Project No.: WRE0105
Pump Station No.: Well 5 Pump No.: 1

Motor Nameplate

Motor Make: Newman
Model No:
Serial No:
Rated Hp: 40
Rated Voltage: 230/460
Rated Amperage: 100/50 **Ins. Class:** None
Full Load RPM: 0 **Code:** None
Enclosure: TEFC
Design: NEMA Design B
Frame: 324TP
Service Factor: 1.15

Utility Meter Nameplate

Make: None **Meter ID:** 9900081
Type: Digital **Serial No.:** None
Meter Constant (kh): **PTR:** **CTR:**

Pump Nameplate

Pump Make: Verti-Line
Type: Vertical Turbine
Serial No: None
Model No: None **Impeller No:**
Impeller Dia (in): **No. of Stages:** 0
Impeller Dia (in): **No. of Stages:** 0
Sec. Model No: None **Impeller No:**
Impeller Dia (in): **No. of Stages:** 0
Impeller Dia (in): **No. of Stages:** 0
Rated Flow (gpm): 0
Rated Head (ft): 0
Rated RPM: 0
Column Dia (in): 8.00
Column Length (ft): 180.0
Shaft Dia. (in): 1.500
Tube Dia. (in): 2.500
Thrust Factor (lbs/ft):
Impeller Wt. (lbs):

Field Test Data

	Voltages				Amperages				Power Factor				Utility Meter		Motor	
Test No.	1-2	1-3	2-3	Avg.	1	2	3	Avg.	1	2	3	Avg.	Rev.	Sec.	RPM	% Load
1	478.0	483.0	481.0	480.7	37.1	40.3	39.8	39.1				80.7%				78.7%

Test No.	Flow	Lift				Pressures		Total Dynamic Head	Pump Speed
	(gpm)	Air Line (PSI)	Static Level (ft)	Pumping Lift (ft)	Misc. Losses (ft)	Discharge (PSI)	Delivered (PSI)	(ft)	RPM
1	250			145.0	0.6	55.0	45.2	272.7	1782

Test No.	Power Calculations							Utility Meter	Efficiencies			
	ShaftHP	ThrustHP	Water HP	Brake HP	Pump HP	Input kW	Input HP	(kW)	Motor	Pump	Discharge	Delivered
1	2.05	0.00	17.2	31.5	29.5	26.3	35.2		89.4%	58.5%	48.8%	44.7%

Pump Test Data
Initial Pump Evaluation

Project No.: WRE0105
Pump Station No.: Well 6 Pump No.: 1

Motor Nameplate

Motor Make: General Electric
Model No:
Serial No:
Rated Hp: 100
Rated Voltage: 460
Rated Amperage: 120 **Ins. Class:** None
Full Load RPM: 1765 **Code:** None
Enclosure: TEFC
Design: NEMA Design B
Frame: 324TP
Service Factor: 1.15

Utility Meter Nameplate

Make: None **Meter ID:** 9900078
Type: Digital **Serial No.:** None
Meter Constant (kh): **PTR:** **CTR:**

Pump Nameplate

Pump Make: Verti-Line
Type: Vertical Turbine
Serial No: None
Model No: None **Impeller No:**
Impeller Dia (in): **No. of Stages:** 0
Impeller Dia (in): **No. of Stages:** 0
Sec. Model No: None **Impeller No:**
Impeller Dia (in): **No. of Stages:** 0
Impeller Dia (in): **No. of Stages:** 0
Rated Flow (gpm): 0
Rated Head (ft): 0
Rated RPM: 0
Column Dia (in): 8.00
Column Length (ft): 180.0
Shaft Dia. (in): 1.500
Tube Dia. (in): 2.500
Thrust Factor (lbs/ft):
Impeller Wt. (lbs):

Field Test Data

	Voltages				Amperages				Power Factor				Utility Meter		Motor	
Test No.	1-2	1-3	2-3	Avg.	1	2	3	Avg.	1	2	3	Avg.	Rev.	Sec.	RPM	% Load
1	482.0	483.0	481.3	480.7	55.4	59.2	62.0	58.9				54.1%				31.0%

Test No.	Flow	Lift				Pressures		Total Dynamic Head	Pump Speed
	(gpm)	Air Line (PSI)	Static Level (ft)	Pumping Lift (ft)	Misc. Losses (ft)	Discharge (PSI)	Delivered (PSI)	(ft)	RPM
1	263			135.0	0.7	42.4	41.3	233.7	1794

Test No.	Power Calculations							Utility Meter	Efficiencies			
	ShaftHP	ThrustHP	Water HP	Brake HP	Pump HP	Input kW	Input HP	(kW)	Motor	Pump	Discharge	Delivered
1	2.06	0.00	15.5	31.0	28.9	26.6	35.6		87.2%	53.6%	43.5%	43.0%

Pump Test Data
Initial Pump Evaluation

Project No.: WRE0105
Pump Station No.: Well 7 Pump No.: 1

Motor Nameplate

Motor Make: Newman
Model No:
Serial No:
Rated Hp: 40
Rated Voltage: 230/460
Rated Amperage: 120 **Ins. Class:** None
Full Load RPM: 1765 **Code:** None
Enclosure: TEFC
Design: NEMA Design B
Frame: 324TP
Service Factor: 1.15

Utility Meter Nameplate

Make: None **Meter ID:** 9900081
Type: Digital **Serial No.:** None
Meter Constant (kh): **PTR:** **CTR:**

Pump Nameplate

Pump Make: Verti-Line
Type: Vertical Turbine
Serial No: None
Model No: None **Impeller No:**
Impeller Dia (in): **No. of Stages:** 0
Impeller Dia (in): **No. of Stages:** 0
Sec. Model No: None **Impeller No:**
Impeller Dia (in): **No. of Stages:** 0
Impeller Dia (in): **No. of Stages:** 0
Rated Flow (gpm): 0
Rated Head (ft): 0
Rated RPM: 0
Column Dia (in): 8.00
Column Length (ft): 180.0
Shaft Dia. (in): 1.500
Tube Dia. (in): 2.500
Thrust Factor (lbs/ft):
Impeller Wt. (lbs):

Field Test Data

	Voltages				Amperages				Power Factor				Utility Meter		Motor	
Test No.	1-2	1-3	2-3	Avg.	1	2	3	Avg.	1	2	3	Avg.	Rev.	Sec.	RPM	% Load
1	480.0	483.0	477.0	480.0	38.0	40.2	40.2	39.5				81.4				80.0%

Test No.	Flow (gpm)	Lift: Air Line (PSI)	Static Level (ft)	Pumping Lift (ft)	Misc. Losses (ft)	Pressures: Discharge (PSI)	Delivered (PSI)	Total Dynamic Head (ft)	Pump Speed RPM
1	211			102.0	0.7	48.8	47.7	215.5	1784

Test No.	Power Calculations: ShaftHP	ThrustHP	Water HP	Brake HP	Pump HP	Input kW	Input HP	Utility Meter (kW)	Efficiencies: Motor	Pump	Discharge	Delivered
1	2.06	0.00	11.5	33.0	29.9	26.7	35.8		89.5%	35.8%	32.0%	31.6%

Pump Test Data
Initial Pump Evaluation

Project No.: WRE0105
Pump Station No.: Well 8 Pump No.: 1

Motor Nameplate

Motor Make: General Electric
Model No:
Serial No:
Rated Hp: 40
Rated Voltage: 230/460
Rated Amperage: 120 **Ins. Class:** None
Full Load RPM: 1765 **Code:** None
Enclosure: TEFC
Design: NEMA Design B
Frame: 324TP
Service Factor: 1.15

Utility Meter Nameplate

Make: None **Meter ID:** 9900081
Type: Digital **Serial No.:** None
Meter Constant (kh): **PTR:** **CTR:**

Pump Nameplate

Pump Make: Verti-Line
Type: Vertical Turbine
Serial No: None
Model No: None **Impeller No:**
Impeller Dia (in): **No. of Stages:** 0
Impeller Dia (in): **No. of Stages:** 0
Sec. Model No: None **Impeller No:**
Impeller Dia (in): **No. of Stages:** 0
Impeller Dia (in): **No. of Stages:** 0
Rated Flow (gpm): 0
Rated Head (ft): 0
Rated RPM: 0
Column Dia (in): 8.00
Column Length (ft): 180.0
Shaft Dia. (in): 1.500
Tube Dia. (in): 2.500
Thrust Factor (lbs/ft):
Impeller Wt. (lbs):

Field Test Data

	Voltages				Amperages				Power Factor				Utility Meter		Motor	
Test No.	1-2	1-3	2-3	Avg.	1	2	3	Avg.	1	2	3	Avg.	Rev.	Sec.	RPM	% Load
1	482.0	480.0	477.0	479.7	35.5	33.4	36.3	35.1				64.5%				55.7%

Test No.	Flow	Lift				Pressures		Total Dynamic Head	Pump Speed
	(gpm)	Air Line (PSI)	Static Level (ft)	Pumping Lift (ft)	Misc. Losses (ft)	Discharge (PSI)	Delivered (PSI)	(ft)	RPM
1	100			99.0	0.1	96.3	28.9	321.6	1782

Test No.	Power Calculations							Utility Meter	Efficiencies			
	ShaftHP	ThrustHP	Water HP	Brake HP	Pump HP	Input kW	Input HP	(kW)	Motor	Pump	Discharge	Delivered
1	1.71	0.00	8.1	22.3	20.6	18.8	25.2		88.6%	39.3%	32.1%	16.6%

Pump Test Data
Existing Pump Evaluation

Project No.: WRE0105
Pump Station No.: Well 5 Pump No.: 1

Motor Nameplate

Motor Make: General Electric
Model No:
Serial No:
Rated Hp: 40
Rated Voltage: 230/460
Rated Amperage: 100/50 **Ins. Class:** None
Full Load RPM: **Code:** None
Enclosure: TEFC
Design: NEMA Design B
Frame: 324TP
Service Factor: 1.15

Utility Meter Nameplate

Make: None **Meter ID:** 9900081
Type: Digital **Serial No.:** None
Meter Constant (kh): **PTR:** **CTR:**

Pump Nameplate

Pump Make: Verti-Line
Type: Vertical Turbine
Serial No: None
Model No: None **Impeller No:**
Impeller Dia (in): **No. of Stages:** 0
Impeller Dia (in): **No. of Stages:** 0
Sec. Model No: None **Impeller No:**
Impeller Dia (in): **No. of Stages:** 0
Impeller Dia (in): **No. of Stages:** 0
Rated Flow (gpm): 0
Rated Head (ft): 0
Rated RPM: 0
Column Dia (in): 8.00
Column Length (ft): 180.0
Shaft Dia. (in): 1.500
Tube Dia. (in): 2.500
Thrust Factor (lbs/ft):
Impeller Wt. (lbs):

Field Test Data

	Voltages				Amperages				Power Factor				Utility Meter		Motor	
Test No.	1-2	1-3	2-3	Avg.	1	2	3	Avg.	1	2	3	Avg.	Rev.	Sec.	RPM	% Load
1																38.7%

Test No.	Flow	Lift				Pressures		Total Dynamic Head	Pump Speed
	(gpm)	Air Line (PSI)	Static Level (ft)	Pumping Lift (ft)	Misc. Losses (ft)	Discharge (PSI)	Delivered (PSI)	(ft)	RPM
1	250			145.0	0.7	35.5	35.5	227.7	

Test No.	Power Calculations							Utility Meter	Efficiencies			
	ShaftHP	ThrustHP	Water HP	Brake HP	Pump HP	Input kW	Input HP	(kW)	Motor	Pump	Discharge	Delivered
1	2.05	0.00	14.4	20.5	18.4	17.3	23.2		89.4%	78.0%	61.8%	61.8%

Pump Test Data
Proposed Pump Evaluation

Project No.: WRE0105
Pump Station No.: Well 6   Pump No.: 1

Motor Nameplate

Motor Make: General Electric
Model No:
Serial No:
Rated Hp: 100
Rated Voltage: 460
Rated Amperage: 120   **Ins. Class:** None
Full Load RPM: 1765   **Code:** None
Enclosure: TEFC
Design: NEMA Design B
Frame: 324TP
Service Factor: 1.15

Utility Meter Nameplate

Make: None   **Meter ID:** 9900081
Type: Digital   **Serial No.:** None
Meter Constant (kh): **PTR:** **CTR:**

Pump Nameplate

Pump Make: Verti-Line
Type: Vertical Turbine
Serial No: None
Model No: None   **Impeller No:**
Impeller Dia (in):   **No. of Stages:** 0
Impeller Dia (in):   **No. of Stages:** 0
Sec. Model No: None   **Impeller No:**
Impeller Dia (in):   **No. of Stages:** 0
Impeller Dia (in):   **No. of Stages:** 0
Rated Flow (gpm): 0
Rated Head (ft): 0
Rated RPM: 0
Column Dia (in): 8.00
Column Length (ft): 180.0
Shaft Dia. (in): 1.500
Tube Dia. (in): 2.500
Thrust Factor (lbs/ft):
Impeller Wt. (lbs):

Field Test Data

	Voltages				Amperages				Power Factor				Utility Meter		Motor	
Test No.	1-2	1-3	2-3	Avg.	1	2	3	Avg.	1	2	3	Avg.	Rev.	Sec.	RPM	% Load
1																78.7%

Test No.	Flow	Lift				Pressures		Total Dynamic Head	Pump Speed
	(gpm)	Air Line (PSI)	Static Level (ft)	Pumping Lift (ft)	Misc. Losses (ft)	Discharge (PSI)	Delivered (PSI)	(ft)	RPM
1	263			135.0	0.7	41.3	41.3	231.2	

Test No.	Power Calculations							Utility Meter	Efficiencies			
	ShaftHP	ThrustHP	Water HP	Brake HP	Pump HP	Input kW	Input HP	(kW)	Motor	Pump	Discharge	Delivered
1	2.06	0.00	15.4	21.7	19.7	19.0	25.5		87.2%	78.0%	60.0%	60.0%

Pump Test Data
Proposed Pump Evaluation

Project No.: WRE0105
Pump Station No.: Well 8 Pump No.: 1

Motor Nameplate

Motor Make: General Electric
Model No:
Serial No:
Rated Hp: 100
Rated Voltage: 230/460
Rated Amperage: 100/50 **Ins. Class:** None
Full Load RPM: 1765 **Code:** None
Enclosure: TEFC
Design: NEMA Design B
Frame: 324TP
Service Factor: 1.15

Utility Meter Nameplate

Make: None **Meter ID:** 9900078
Type: Digital **Serial No.:** None
Meter Constant (kh): **PTR:** **CTR:**

Pump Nameplate

Pump Make: Verti-Line
Type: Vertical Turbine
Serial No: None
Model No: None **Impeller No:**
Impeller Dia (in): **No. of Stages:** 0
Impeller Dia (in): **No. of Stages:** 0
Sec. Model No: None **Impeller No:**
Impeller Dia (in): **No. of Stages:** 0
Impeller Dia (in): **No. of Stages:** 0
Rated Flow (gpm): 0
Rated Head (ft): 0
Rated RPM: 0
Column Dia (in): 8.00
Column Length (ft): 180.0
Shaft Dia. (in): 1.500
Tube Dia. (in): 2.500
Thrust Factor (lbs/ft):
Impeller Wt. (lbs):

Field Test Data

	Voltages				Amperages				Power Factor				Utility Meter		Motor	
Test No.	1-2	1-3	2-3	Avg.	1	2	3	Avg.	1	2	3	Avg.	Rev.	Sec.	RPM	% Load
1																

Test No.	Flow (gpm)	Lift: Air Line (PSI)	Lift: Static Level (ft)	Lift: Pumping Lift (ft)	Lift: Misc. Losses (ft)	Pressures: Discharge (PSI)	Pressures: Delivered (PSI)	Total Dynamic Head (ft)	Pump Speed RPM
1	211			102.0	0.7	47.7	47.7	212.9	

	Power Calculations							Utility Meter	Efficiencies			
Test No.	ShaftHP	ThrustHP	Water HP	Brake HP	Pump HP	Input kW	Input HP	(kW)	Motor	Pump	Discharge	Delivered
1	2.06	0.00	11.3	14.5	12.4	12.5	16.8		89.5%	78.0%	67.3%	67.3%

Pump Test Data
Proposed Pump Evaluation

Project No.: WRE0105
Pump Station No.: Well 8 Pump No.: 1

Motor Nameplate

Motor Make: General Electric
Model No:
Serial No:
Rated Hp: 40
Rated Voltage: 230/460
Rated Amperage: 100/50 **Ins. Class:** None
Full Load RPM: 0 **Code:** None
Enclosure: TEFC
Design: NEMA Design B
Frame: 324TP
Service Factor: 1.15

Utility Meter Nameplate

Make: None **Meter ID:** 9900078
Type: Digital **Serial No.:** None
Meter Constant (kh): **PTR:** **CTR:**

Pump Nameplate

Pump Make: Verti-Line
Type: Vertical Turbine
Serial No: None
Model No: None **Impeller No:**
Impeller Dia (in): **No. of Stages:** 0
Impeller Dia (in): **No. of Stages:** 0
Sec. Model No: None **Impeller No:**
Impeller Dia (in): **No. of Stages:** 0
Impeller Dia (in): **No. of Stages:** 0
Rated Flow (gpm): 0
Rated Head (ft): 0
Rated RPM: 0
Column Dia (in): 8.00
Column Length (ft): 180.0
Shaft Dia. (in): 1.500
Tube Dia. (in): 2.500
Thrust Factor (lbs/ft):
Impeller Wt. (lbs):

Field Test Data

	Voltages				Amperages				Power Factor				Utility Meter		Motor	
Test No.	1-2	1-3	2-3	Avg.	1	2	3	Avg.	1	2	3	Avg.	Rev.	Sec.	RPM	% Load
1																

Test No.	Flow (gpm)	Lift: Air Line (PSI)	Static Level (ft)	Pumping Lift (ft)	Misc. Losses (ft)	Pressures: Discharge (PSI)	Delivered (PSI)	Total Dynamic Head (ft)	Pump Speed RPM
1	100			99.0	0.1	28.9	28.9	165.9	

Test No.	Power Calculations: ShaftHP	ThrustHP	Water HP	Brake HP	Pump HP	Input kW	Input HP	Utility Meter (kW)	Efficiencies: Motor	Pump	Discharge	Delivered
1	1.71	0.00	4.2	7.1	5.4	6.3	8.5		88.6%	78.0%	49.2%	49.2%

Sprinkler Distribution Data

Existing Condition

	Critical	System Type	Length (ft)	Flow (gpm)	Sprinkler Spacing (ft)	Initial PSI	End PSI	Avg. PSI	Initail Elev. (ft)	End Elev. (ft)	Nozzle Size	Friction Loss (ft)
C1	Yes	Pivot	1200	720		23.0	16.0		0.0	0.0	None	16.23
Total:				720								

Proposed Condition

	Critical	System Type	Length (ft)	Flow (gpm)	Sprinkler Spacing (ft)	Initial PSI	End PSI	Avg. PSI	Initail Elev. (ft)	End Elev. (ft)	Nozzle Size	Friction Loss (ft)
C1	Yes	Pivot	1200	720		23.0	16.0		0.0	0.0	None	16.23
Total:				720								

Mainline Section Data

Project No.: WRE0105
Pump Station No.: Well 5 **Pump No.:** 1

Existing Condition

Mainline	Length (ft)	Diameter (in)	Material	Flow (gpm)	Velocity (ft/sec)	Friction Loss (ft)	Include
M1-1	30	6.400	Steel, Old	200	1.99	0.13	Yes
M1-2	1,175	6.000	PVC	200	2.26	3.40	Yes
M2-1	1,534	6.000	PVC	415	4.70	17.07	Yes
M3-1	1,250	6.000	PVC	626	7.09	29.78	Yes
M4-1	30	6.000	Steel, Old	100	1.13	0.05	Yes
Total:						50.43	

Mainline Section Data

Project No.: WRE0105
Pump Station No.: Well 6 **Pump No.:** 1

Existing Condition

Mainline	Length (ft)	Diameter (in)	Material	Flow (gpm)	Velocity (ft/sec)	Friction Loss (ft)	Include
M1-3	18	6.400	Steel, Old	215	2.14	0.09	Yes
M2-1	1,534	6.000	PVC	415	4.70	17.07	Yes
M3-1	1,250	6.000	PVC	626	7.09	29.78	Yes
M4-1	30	6.000	Steel, Old	100	1.13	0.05	Yes
Total:						46.99	

Mainline Section Data

Project No.: WRE0105
Pump Station No.: Well 7 **Pump No.:** 1

Existing Condition

Mainline	Length (ft)	Diameter (in)	Material	Flow (gpm)	Velocity (ft/sec)	Friction Loss (ft)	Include
M2-2	18	6.000	Steel, Old	211	2.39	0.12	Yes
M3-1	1,250	6.000	PVC	626	7.09	29.78	Yes
M4-1	30	6.000	Steel, Old	100	1.13	0.05	Yes
Total:						29.95	

Mainline Section Data

Project No.: WRE0105
Pump Station No.: Well 8 **Pump No.:** 1

Existing Condition

Mainline	Length (ft)	Diameter (in)	Material	Flow (gpm)	Velocity (ft/sec)	Friction Loss (ft)	Include
M3-2	15	6.000	Steel, Old	100	1.13	0.03	Yes
M4-1	30	6.000	Steel, Old	100	1.13	0.05	Yes
Total:						0.08	

Mainline Section Data

Project No.: WRE0105
Pump Station No.: Well 5 **Pump No.:** 1

Proposed Condition

Mainline	Length (ft)	Diameter (in)	Material	Flow (gpm)	Velocity (ft/sec)	Friction Loss (ft)	Include	Head Loss Savings (ft)
M1-1	30	6.400	Steel, Old	200	1.99	0.13	Yes	0.00
M1-2	1,175	6.000	PVC	200	2.26	3.40	Yes	0.00
M2-1	1,534	6.000	PVC	415	4.70	17.07	Yes	0.00
M3-1	1,250	8.000	PVC	626	3.99	7.34	Yes	22.44
M4-1	30	6.000	Steel, Old	100	1.13	0.05	Yes	0.00
Total:						27.99		22.44

Mainline Section Data

Project No.: WRE0105
Pump Station No.: Well 6 **Pump No.:** 1

Proposed Conditions

Mainline	Length (ft)	Diameter (in)	Material	Flow (gpm)	Velocity (ft/sec)	Friction Loss (ft)	Include	Head Loss Savings (ft)
M1-3	18	6.400	Steel, Old	215	2.14	0.09	Yes	0.00
M2-1	1,534	6.000	PVC	415	4.70	17.07	Yes	0.00
M3-1	1,250	8.000	PVC	626	3.99	7.34	Yes	22.44
M4-1	30	6.000	Steel, Old	100	1.13	0.05	Yes	0.00
Total:						24.55		22.44

Mainline Section Data

Project No.: WRE0105
Pump Station No.: Well 7 **Pump No.:** 1

Proposed Conditions

Mainline	Length (ft)	Diameter (in)	Material	Flow (gpm)	Velocity (ft/sec)	Friction Loss (ft)	Include	Head Loss Savings (ft)
M2-2	18	6.000	Steel, Old	211	2.39	0.12	Yes	0.00
M3-1	1,250	8.000	PVC	626	3.99	7.34	Yes	22.44
M4-1	30	6.000	Steel, Old	100	1.13	0.05	Yes	0.00
Total:						7.51		22.44

Mainline Section Data

Project No.: WRE0105
Pump Station No.: Well 8 **Pump No.:** 1

Proposed Conditions

Mainline	Length (ft)	Diameter (in)	Material	Flow (gpm)	Velocity (ft/sec)	Friction Loss (ft)	Include	Head Loss Savings (ft)
M3-2	15	6.000	Steel, Old	100	1.13	0.03	Yes	0.00
M4-1	30	6.000	Steel, Old	100	1.13	0.05	Yes	0.00
Total:						0.08		0.00

Utility Meter Data

Project: WRE0105

Meter No: 9900081

Meter Make:	None	Serial No.:
Meter Type:	Digital	
CTR: 0	PTR: 0	k_h :0.0

kWh Usage

Year	kWH	Not Used
2002	48,622	
2003	57,504	
2004	61,303	
Average:	55,809	

Meter No: 9900078

Meter Make:	None	Serial No.:
Meter Type:	Digital	
CTR: 0	PTR: 0	k_h :0.0

kWh Usage

Year	kWH	Not Used
2002	48,850	
2003	56,819	
2004	52,078	
Average:	52,582	

Utility Meter Data

Project: WRE0105

Meter No: 9900066
Meter Make: None Serial No.:
Meter Type: Digital

CTR: 0 PTR: 0 k_h :0.0

kWh Usage

Year	kWH	Not Used
2002	45,281	
2003	55,927	
2004	52,185	
Average:	51,131	

Meter No: 9900066
Meter Make: None Serial No.:
Meter Type: Digital

CTR: 0 PTR: 0 k_h: 0.0

kWh Usage

Year	kWH	Not Used
2002	43,562	
2003	52,290	
2004	56,505	
Average:	50,785	

Project Summary and Estimated Savings

Pump Station: Well 5 **Pump No.:** 1

	Existing Conditions	Proposed Conditions	Final Conditions
Flow (gpm):	250	250	None
Total Dynamic Head (ft):	249.4	226.9	None
Measured Horsepower:	35.2	23.2	None
Efficiency (%):	48.8	61.8	None
Rated Motor Horsepower:	40	40	
Annual Hours Operation:	2,125	2,125	None
Average Energy Use (kWh):	55,800	36,777	None
Annual Water Pumped (acft):	97	97	None
Annual Demand Cost:	$656.48	$432.68	None
Annual kWh Cost:	$2774.93	$1828.92	None
Hp and Customer Charges:	$0.00	$0.00	$0.00
Total Annual Cost:	$3431.41	$2261.60	None

Detailed Energy Savings (kWh)

Pivot Low Pressure Savings (kWh):	0	0
Pivot Friction Loss Savings (kWh):	0	0
Set System Low Pressure Savings (kWh):	0	0
Set System Friction Loss Savings (kWh):	0	0
Mainline Friction Loss Savings (kWh):	4,602	0
Fittings Friction Loss Savings (kWh):	0	0
Control Valve Loss Savings (kWh):	4,642	0
Flow Savings (kWh):	0	None
Pump Efficiency Savings (kWh):	8,235	None
Motor Efficiency Savings (kWh):	1,544	None
Water Management Savings (kWh):	0	None
Total Pump Savings (kWh):	19,023	None

Project Summary and Estimated Savings

Pump Station: Well 6 **Pump No.**: 1

	Existing Conditions	Proposed Conditions	Final Conditions
Flow (gpm):	263	263	None
Total Dynamic Head (ft):	230.4	230.4	None
Measured Horsepower:	35. 6	25.5	None
Efficiency (%):	43.5	60.0	None
Rated Motor Horsepower:	100	100	
Annual Hours Operation:	1,979	1,979	None
Average Energy Use (kWh):	52,557	37,646	None
Annual Water Pumped (acft):	95	95	None
Annual Demand Cost:	$663.94	$475.58	None
Annual kWh Cost:	$2613.66	$1872.14	None
Hp and Customer Charges:	$0.00	$0.00	$0.00
Total Annual Cost:	$3277.60	$2347.71	None

Detailed Energy Savings (kWh)

Pivot Low Pressure Savings (kWh):	0	0
Pivot Friction Loss Savings (kWh):	0	0
Set System Low Pressure Savings (kWh):	0	0
Set System Friction Loss Savings (kWh):	0	0
Mainline Friction Loss Savings (kWh):	5,058	0
Fittings Friction Loss Savings (kWh):	0	0
Control Valve Loss Savings (kWh):	572	0
Flow Savings (kWh):	0	None
Pump Efficiency Savings (kWh):	8,035	None
Motor Efficiency Savings (kWh):	1,245	None
Water Management Savings (kWh):	0	None
Total Pump Savings (kWh):	14, 911	None

Project Summary and Estimated Savings

Pump Station: Well 7 **Pump No.:** 1

	Existing Conditions	Proposed Conditions	Final Conditions
Flow (gpm):	211	211	None
Total Dynamic Head (ft):	212.1	212.1	None
Measured Horsepower:	35.8	16.8	None
Efficiency (%):	32.0	67.3	None
Rated Motor Horsepower:	40	40	
Annual Hours Operation:	1,914	1,914	None
Average Energy Use (kWh):	51, 116	23,987	None
Annual Water Pumped (acft):	74	74	None
Annual Demand Cost:	$667.67	$313.32	None
Annual kWh Cost:	$2542.00	$1192.87	None
Hp and Customer Charges:	$0.00	$0.00	$0.00
Total Annual Cost:	$3209.67	$1506.19	None

Detailed Energy Savings (kWh)

Pivot Low Pressure Savings (kWh):	0	0
Pivot Friction Loss Savings (kWh):	0	0
Set System Low Pressure Savings (kWh):	0	0
Set System Friction Loss Savings (kWh):	0	0
Mainline Friction Loss Savings (kWh):	5,335	0
Fittings Friction Loss Savings (kWh):	0	0
Control Valve Loss Savings (kWh):	604	0
Flow Savings (kWh):	0	None
Pump Efficiency Savings (kWh):	19,056	None
Motor Efficiency Savings (kWh):	2,134	None
Water Management Savings (kWh):	0	None
Total Pump Savings (kWh):	27, 129	None

Project Summary and Estimated Savings

Pump Station: Well 8 **Pump No.**: 1

	Existing Conditions	Proposed Conditions	Final Conditions
Flow (gpm):	100	100	None
Total Dynamic Head (ft):	165.7	165.7	None
Measured Horsepower:	25.2	8.5	None
Efficiency (%):	32.1	49.2	None
Rated Motor Horsepower:	40	40	
Annual Hours Operation:	2,701	2,701	None
Average Energy Use (kWh):	50,776	17, 127	None
Annual Water Pumped (acft):	49	49	None
Annual Demand Cost:	$469.98	$158.53	None
Annual kWh Cost:	$2525.09	$851.73	None
Hp and Customer Charges:	$0.00	$0.00	$0.00
Total Annual Cost:	$2995.07	$1010.25	None

Detailed Energy Savings (kWh)

Pivot Low Pressure Savings (kWh):	00	
Pivot Friction Loss Savings (kWh):	0	0
Set System Low Pressure Savings (kWh):	0	0
Set System Friction Loss Savings (kWh):	0	0
Mainline Friction Loss Savings (kWh):	0	0
Fittings Friction Loss Savings (kWh):	0	0
Control Valve Loss Savings (kWh):	24,680	0
Flow Savings (kWh):	0	None
Pump Efficiency Savings (kWh):	5,995	None
Motor Efficiency Savings (kWh):	2,974	None
Water Management Savings (kWh):	0	None
Total Pump Savings (kWh):	33,649	None

References

[1]Idaho State Journal – October 21, 2005
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[5]Northwest Power Planning Council "*Conservation Resources*", Dec 2004