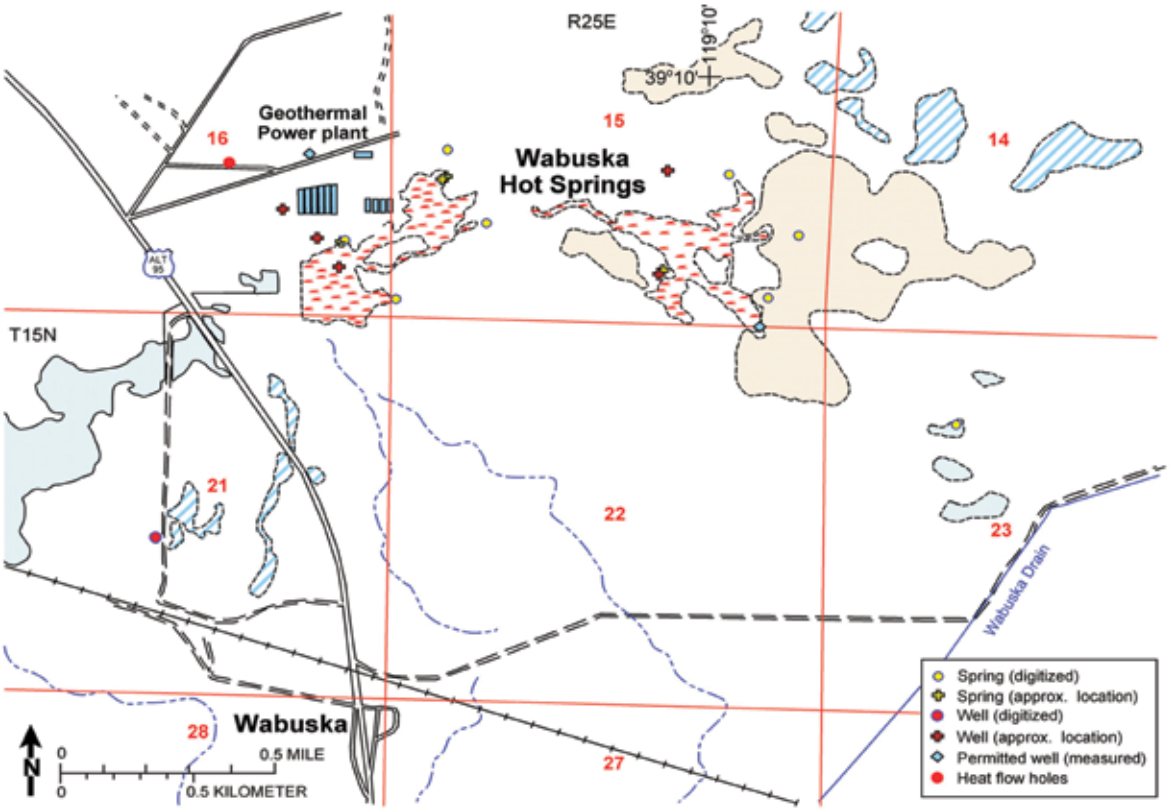
GEOTHERMAL POWER GENERATION AND BIODIESEL PRODUCTION IN WABUSKA, NEVADA

Claude Sapp, Infinifuel Biodiesel, Dayton, NV



INTRODUCTION

Wabuska (wuh-BUHS-kuh) is a very small unincorporated village in Lyon County, Nevada. The population is 150. It is in the Walker River Basin, on the north end of the Mason Valley, 10 miles north of Yerington, the Lyon County seat. The elevation is 4300 feet. The town is on Highway 95A, and a Union Pacific rail line crosses the highway at Wabuska.

The history of Wabuska (the Washoe Indian term for white grass) started in the 1870's when the settlement served as a coach and freight stop for travelers and shipments of supplies going to the booming mining towns of Nevada, including Aurora, Goldfield, and Bodie, California. By 1881 the town was a stop on the newly constructed Carson and Colorado railroad. Southern Pacific Rail purchased the rail line around 1900, and soon after copper was discovered in the Mason Valley, increasing freight and passenger traffic through Wabuska until the decline of mining throughout Nevada in the 1920's.

While Nevada mining operations drove the development of Wabuska in the late 19th and early 20th centuries, Wabuska today is in a predominantly agricultural area. Current local industry includes hay and alfalfa, cattle and sheep, and dairy. The only notable current non-agricultural business and industry in Wabuska includes a plastics fabricator (AES Industries), Linda's Old Wabuska Bar, Homestretch Geothermal and Infinifuel Biodiesel.

There are hot springs in and near Wabuska, and the 20th century saw a few businesses that sought to utilize the hot water. Probably in response to the oil shock of the 70's, in 1981 TAD's Enterprises built a 400,000 gallons per year ethanol plant in Wabuska, hoping to rail in corn as the feedstock. The plant was operational for a few years, and had an old geothermal well that supplied heat for the ethanol process. The owners commissioned a feasibility study performed by the Geo-Heat Center (GHC), to assess the financial impact of expanded use of the geothermal resource, looking for improvements that would lead to cost savings, including electrical power generation.

Subsequent to the GHC study, Wabuska became home to the first geothermal power production unit in Nevada. In 1984, Wabuska I went online, an Ormat binary power production unit. This was followed by Wabuska II in 1987, another Ormat unit. While the ethanol plant was decommissioned by the mid 1980's and then mothballed for decades, geothermal power production continues today, and has been operational in Wabuska almost continuously since going online. Homestretch Geothermal currently operates the geothermal facility.

Figure 1. 2MW geothermal power plant that provides electricity for the biodiesel plant.

GEOLOGY AND HYDROLOGY

The Wabuska geothermal area is located at the margin of Mason Valley, where both the valley margin and the thermal springs coincide with a northeast-striking zone of faults referred to as the Wabuska lineament (Stewart, 1988). Some faults are associated with the lineament cut Pleistocene units (Sawyer and Sawyer, 1999). Production is apparently from Quaternary gravels and sands; geothermal fluid may circulate along faults related to the Wabuska lineament as well as an unconformity above Mesozoic metasedimentary rocks possibly present at depth (Nevada Bureau of Mines and Geology, 2006).

Table 1. Water Chemistry

	mg/L		mg/L
Al	0.08	K	19.83
As	0.05	Na	300.67
B	0.02	Cl	63.40
Ba	1.09	F	9.47
Ca	42.17	SO_4	447.00
Cu	0.02	pH	7.39
Fe	0.02	TDS	1107.67
Mg	0.28	Hardness	106.33

Constituents with concentrations in excess of water quality criteria are arsenic (As), boron (B), copper (Cu), fluoride (F), sulfate (SO4) and TDS (Nevada Division of Environmental Protection Fact Sheet 2003 – 2005).

LOCATION AND DESCRIPTION

Homestretch Geothermal operates the facility at 15 Julian Lane in Wabuska, NV (39º 09' 40" N, 119º 11' 00" W, T15N R25E S15SW¼ and S16SE¼).

Homestretch Geothermal owns 500 acres fee simple along with the geothermal rights and 8500 acre feet of water rights. The majority of the land is undeveloped, but expansion plans include the development and sale of an industrial park served by geothermal utilities on the property.

GEOTHERMAL WELLS & DISCHARGE WATER

The resource consists of two wells referred to as Production Well #1 (PW#1) and Production Well #2 (PW#2), each less than 500 feet deep. PW#1 was drilled in 1959 and was first used as the water and heat supply for a large hydroponic vegetable business. In 1984, Tad's Enterprises who then owned the property and resource built the first geothermal power plant to ever sell power in Nevada. They utilized the flow from PW#1 for the brine to power the binary Rankine cycle generator and then used the discharge brine to provide the cooling water.

The original temperature of the resource was 220ºF. The flow rate of the well was 750 gpm. The original well is still producing 750 gpm at 218ºF 48 years later, and the well has produced water continuously at least 97% of the entire past 20 years. Flow has not diminished at all. The water level in the well while pumping is regularly monitored and only fluctuates minimally from season to season but remains constant year to year. In May 2003, Homestretch Geothermal had the well televised while it was down for a pump change-out. The televising revealed that the original casing is still in excellent condition even though it is 48 years old.

Production Well #2 was drilled in 1986 by TAD's Enterprises and a second power generation unit was built and put on line that year. PW#2 also started with a temperature of 220ºF. It also, 20 years later, continues to produce water at 218ºF. It originally was set up to pump 800 gpm. In May of 2003 Homestretch Geothermal also had PW#2 televised and the casing was in perfect condition. Every aspect of the well design showed to be excellent. Another flow test was conducted by Homestretch Geothermal and the well produced 2,200 gpm for 48 hours with very little draw down on the well and no apparent affect on PW#1. The well currently produces 2,800 gpm with virtually no change in temperature, flow or draw down.

Currently, PW#1 is off-line, and has not been pumped for two years. PW#2 is flowing 2,800gpm at 218ºF, and is running the two original power production units, and a third unit that was added by Homestretch Geothermal. Plans for expanded production include drilling a third well in 2007 and putting four more power production units online.

One unique fact about Wabuska is that geothermal water is not reinjected after passing through power generation. It is the only geothermal site in Nevada that is not required by the State to reinject, so the water simply passes through ponds to cool off. Water exits the geothermal units at 180ºF, and is pumped to two 400' x 125' cooling ponds. Each pond has 110 spray nozzles three feet above the pond surface that the hot water sprays through to air cool and settle in the pond. Water exits the ponds, and then drains onto property to leech back into the soil.

Figure 2. Spray pond.

POWER PRODUCTION & OPERATIONS

Homestretch Geothermal purchased the two power production units TAD's installed in the 1980's, and in 2002 added a third power production unit that is producing power today. There are four more power production units staged on property that are offline. Once drilling of the third well on property is complete, these last four units will be brought online. Each of the seven units is rated at 800kW.

Current total power production from the three units averages 1.2MW, throughout the year. Peak production in the winter is about 1.4MW, and in the warmer summer months electrical generation dips to about 1.1MW. The plant service requirement is 290kW, so a net of approximately 910kW is sold back to Sierra Pacific Power Company and put back on the grid, connected via a 24.9kV line. The current electricity is purchased under the terms of a 30 year power purchase agreement (PPA) that was entered into with Sierra Pacific in 1985, with purchase rates in the range of $0.06/kWh. Another PPA is being negotiated for the planned capacity increase and additional electrical generation expected to come online this year.

Operation and maintenance is performed by a staff of two persons. The units operate mostly unattended and automatically, with an estimated 98% runtime. Should the units fail or shutdown, the service panel identifies the problem to be fixed, and an emergency diesel generator provides startup power for the facility after problems have been fixed. Routine maintenance costs average approximately $60,000 per year excluding salary. In 2006, routine and emergency maintenance included replacing a well pump, cleaning condensers, cleaning out heat exchanger tubing, rebuilding the turbine in unit #1, and replacing two iso-pentane pumps. The only extended downtime the plant has ever experienced was between 1996 and 1998. The plant was shutdown in 1996 due to the unavailability of Freon 114, the working fluid in the power units. The units were converted to iso-pentane in 1998, and resumed regular operations.

BIODIESEL PLANT

In 2006, Homestretch Geothermal and Infinifuel Biodiesel entered into an agreement to form Infinifuel Wabuska, a company that would retrofit the decommissioned ethanol plant on property in order to produce biodiesel. The goal was to produce a liquid renewable fuel using renewable energy for the heat and electricity used in biodiesel production, and in so doing, build the world's first geothermal biodiesel plant.

The biodiesel facility is a 3,600 sq. ft. building housing two reactor processors (7,000 and 4,000 gallons), and eight 7,600 gallon wash tanks in two banks of four. Though current production is under 1.0 million gpy, capacity of the plant is between 4-5 million gpy of biodiesel. Additional storage tanks are outside, the whole system is stainless steel, and all is connected by stainless steel piping and approximately 200 connected HP of motors and pumps.

The raw material needed for biodiesel is vegetable oil and alcohol. Current production is from used vegetable oil collected from local restaurants, with additional oil coming from a grease collector in California. The alcohol used is methanol, and this is the only petroleum product directly used in the process. In order to be more "green" Infinifuel has entered into discussion with a company that recycles medical waste, their byproduct being methanol. If this methanol from a recycled product is used in Wabuska, Infinifuel may run the only liquid fuel plant in the world that does not use petroleum products. To further efficiency, Infinifuel is planning to use the two distillation towers from the old ethanol facility to recover unused methanol from the biodiesel production process. Distillation is an energy intensive process, but geothermal makes it much more economic to pursue.

Infinifuel has also partnered with the University of Nevada Reno (UNR) and Desert Research Institute (DRI) to investigate the feasibility of growing oil crops in Nevada as an alternative to the predominant dirt crops, hay and alfalfa.

Figure 3. Grain silo, methanol recovery towers, tank farm.

Figure 4. Biodiesel processors and wash tanks are in the building to the left.

Figure 5. Algae research ponds.

Nevada farmers have been receptive to the idea, accepting crops like crambe, flax, and sunflower as rotation crops that improve the soil and use less water than hay or alfalfa. As Wabuska is in a ripe agricultural valley and there is much land proximate to the geothermal and biodiesel plants to cultivate, Infinifuel can experiment with oil crops in partnership with UNR and DRI.

Algae is also being investigated as an oil crop. In the 1980's the Department of Energy's Renewable Fuels Lab did research on algae to determine if it was feasible to extract oil from algae to produce biodiesel. Their findings generally supported the concept. One point to consider was that they were proposing to grow algae in the western deserts where land and sunlight are abundant, but where temperatures could drop at night providing a less than ideal environment for algae to grow. The lack of a system to regulate temperature was considered a hurdle, but the geothermal at Wabuska gives Infinifuel, UNR, and DRI the means to keep a constant and ideal temperature for algae research and production. The researchers at UNR are perfecting an oil extraction process for the algae that is based on heating the oil out of the algae, eliminating the need for mechanical or chemical extraction. The extraction process is efficient at 200ºF, a perfect temperature for the resource at Wabuska. While there is also a grain storage silo and a hammer mill at the Wabuska facility for mechanical oil extraction, the oil extraction process using heat alone is an example of how we are searching for every way to make use of the geothermal resource onsite.

CONCLUSION

Though Wabuska is a sleepy little village where there are more sheep than persons, exciting things are being done there with geothermal water. It has a long history of direct and indirect geothermal use, and is notable as being the site of the first geothermal electricity production in the State of Nevada. In the past, geothermal was used in numerous businesses in Wabuska, from growing hot house tomatoes to distilling ethanol. Recently we have added to the history, producing biodiesel using geothermal for the heat and electricity needed in the biodiesel plant. The future looks promising. As our academic research partners are looking for ways to expand renewable energy production in Nevada, Wabuska may turn into an important field research center. Hopefully, others may benefit from our experience as well.

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