ISSN 0276-1084

Vol. 25, No. 1 MARCH 2004

GEO-HEAT CENTER *Quarterly Bulletin*

OREGON INSTITUTE OF TECHNOLOGY -KLAMATH FALLS, OREGON 97601-8801
PHONE NO. (541) 885-1750

GEOTHERMAL DIRECT-USE CASE STUDIES II

Vol. 25, No. 1 **March 2004**

GEO-HEAT CENTER QUARTERLY BULLETIN

ISSN 0276-1084

A Quarterly Progress and Development Report on the Direct Utilization of Geothermal Resources

CONTENTS

Page

Cover Photographs: Top: Kah-Nee-Ta Swimming Pool, Warm Springs, OR (John Lund photo) - Bottom: Canyon Bloomers, Hagerman, ID (Canyon Bloomers photo)

PUBLISHED BY

GEO-HEAT CENTER
Oregon Institute of Technology
3201 Campus Drive
Klmath Falls, OR 97601
Phone: 541-885-1750
Email: geoheat@oit.edu

All articles for the Bulletin are solicited. If you wish to contribute a paper, please contact the editor at the above address.

EDITOR

John W. Lund
Typesetting/Layout - Donna Gibson
Graphics - Tonya "Toni" Boyd

WEBSITE http://geoheat.oit.edu

FUNDING

The bulletin is provided compliments of the Geo-Heat Center. This material was prepared with the support of the U.S. Department of Energy (DOE Grant No. FG01-99-EE35098)> However, any opinions, findings, conclusions, or recommendations expressed herein are those of the author(s) and do not necessarily reflect the view of USDOE.

SUBSCRIPTIONS

The bulletin is mailed free of charge. Please send your name and address to the Geo-Heatr Center for addition to the mailing list.

If you wish to change your bulletin subscription, please complete the form below and return it to the Center.

Name ______________________________

Address ______________________________

______________________ Zip ______________

Country ______________________________

KAH-NEE-TA SWIMMING POOL
WARM SPRINGS, OREGON

John W. Lund
Geo-Heat Center

LOCATION

The Kah-Nee-Ta swimming pool is located on the Confederated Tribes of Warm Spring Reservation in north-central Oregon south-east of Mt. Hood. The 600,000-acre reservation was formed in 1879 and settled by Paiutes, Warm Springs and Wasco tribes. The swimming pool is located adjacent to the Warm Springs River, a tributary of the Deschutes River. The resort was started in the early 1960s, and in addition to the swimming pool includes a lodge, an RV village with condos and tepees, and more recently, a gambling casino. A flood in February of 1996 cause major damage to the RV park and pool area, but they were rebuilt and available for use in 1997. Additional details can be found at their website: www.warmsprings.com.

RESOURCE

The resource is located on the eastern flank of the Cascades, where there are numerous hot springs such as Breitenbush, Bagby and Austin. Warm Springs is located east of these springs in the Columbia River basalts. These springs are associated with a high temperature resource and issue from north-south trending fault systems. The seven warm springs have been used by the local Indians for centuries. Today, the warm spring, on the banks on the Warm Springs River, produce about 400 gpm at 128ºF and are used to heat the swimming pool, None of the other facilities on the resort/casino area are heated by geothermal energy due to the limitation on the flow rate from the springs. Piping hot water to the casino would require about a 1.5-mile pipeline with several 100 feet in elevation gain.

UTILIZATION

Spring water at 128ºF is gravity fed from the warm spring adjacent to the river. The water flows first into a small concrete holding tank with capacity of 1,400 gallons (6x6x5 ft), and then into a larger one of 54,000 (30x30x8 ft) gallons, both located in the basement of the pool building. An overflow goes into a sump and then to the drain, dechlorinator and finally into the Warm Springs River. From the smaller holding tank, the water at 128ºF is pumped through a filter and then through a brazed plate heat exchanger. The secondary side of this heat exchanger goes into a 400-gallon storage tank from which hot water is fed to the showers. Cold water, piped over the mountain from the water treatment plant at 52ºF is used to cool the shower water to 100ºF and in summer, used to cool the pool water. From the larger storage tank water at 125ºF is pumped by three 20-hp pumps in parallel through a sand filter and chlorinator to the hot tubs and outdoor swimming pools. The two hot tubs are kept at 103ºF and the 530,000 gallon outdoor pools are kept at 90 to 94ºF, depending upon the season. The waste water from the hot tubs, pools and showers are then fed through the dechlorinators and disposed in the Warm Springs River. Finally, from the smaller holding tank, water is pumped through a sand filter into three indoor tubs in the Wanapine Spa which are kept at 103ºF. Water is also pumped to the Tribal Bath House, for exclusive use of the tribal members, and to the Necsha Cottage, the larger rental facility on the grounds. Waste water from these three uses is again piped through the dechlorinator and into the river. The overflow rate from the smaller concrete tank is controlled by a temperature sensor between the overflow line valve to the sump which feeds into the waste water line.

The entire complex has a peak usage of 6.8 million Btu/hr for an installed capacity of 2.00 MWt. The annual use is estimated at about 30 billion Btu with a saving of around $400,000 compared to natural gas.

OPERATING COSTS

Annual operating costs consist of two items: 1) electricity cost to run the various pumps, and 2) maintenance and chemical costs. The pumping cost for about 95 hp of circulation/booster pumps is estimated at $30,000 per year. The annual maintenance costs ($10,000), chemicals for the chlorinator and declorinator ($50,000) , and salary for one part-time maintenance worker ($15,000) is estimated at $75,000.

REGULATORY/ENVIRONMENTAL ISSUES

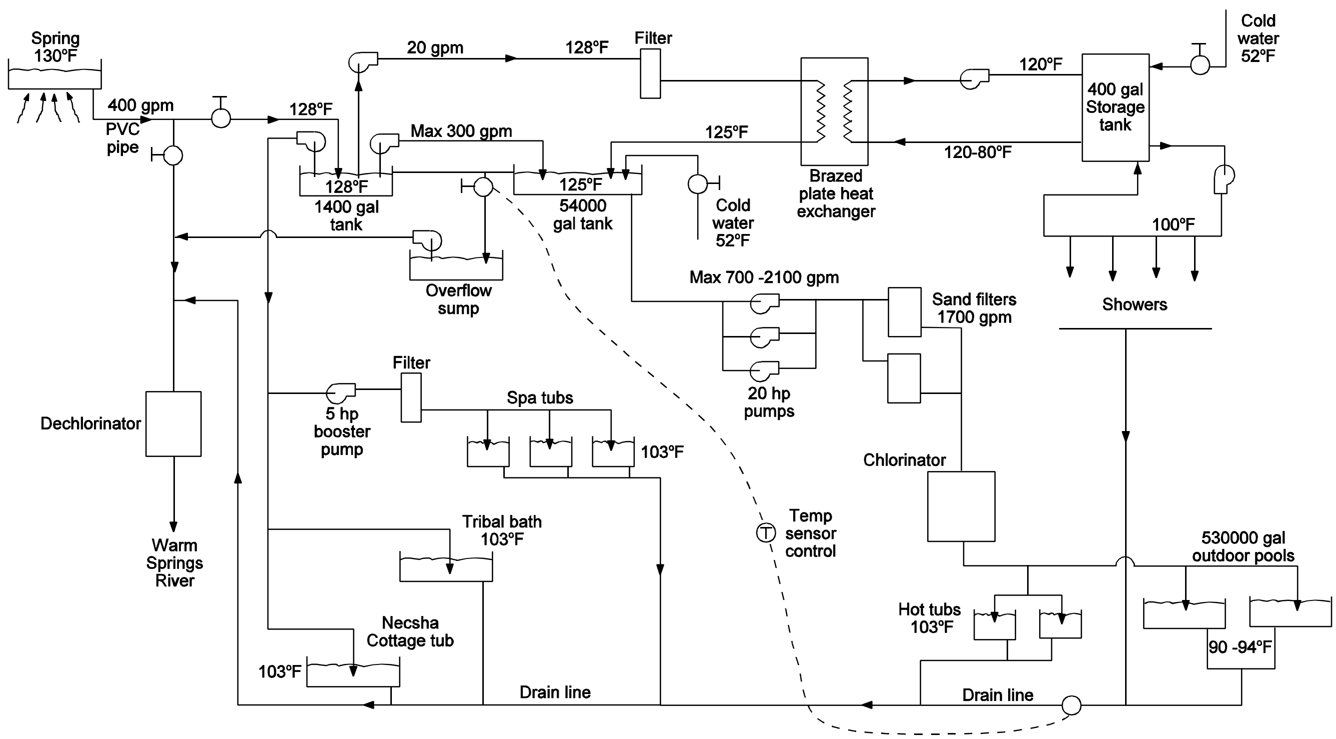
Since the facility is on reservation land, the tribes are their own steward. They, however, use the federal EPA standard concerning discharging the waste water into the Warm Springs River. This is accomplished by having a dechlorination filter at the end of the disposal line. The standards set by the tribes are higher than that required by the Oregon DEQ. One of the main concerns is the resortation of trout, steelhead and salmon to the river.

PROBLEMS AND SOLUTIONS

Initially there were problems from iron oxide and algae depositions in the water. With the installation of the sand filters, this problem has been solved. After the 1996 floods they considered providing radiant floor heating to the service buildings adjacent to the pool along with heating the concrete slabs in the tepees; however, there was not enough flow to accomplish this. As mentioned above, piping hot water to the lodge/casino complex would require a 1.5-mile line pumping water uphill, which was not considered economical.

REFERENCES

Oregonian Newspaper, Travel Section, June 8, 1997. "Kah-Nee-Ta: A Spirit of Survival." Portland, OR, pp. T1-T2.



KLAMATH COUNTY VANDENBERG ROAD COMPLEX

Gene Culver
Geo-Heat Center

LOCATION

The Klamath County Vandenberg Road Complex is located on the eastern edge of Klamath Falls in south central Oregon. Elevation at Klamath Falls is approximately 4,100 ft and the climate is characterized by an annual total of 6,500 heating degree days. The complex is on a hill top about 100 ft higher than the surrounding terrain and originally, somewhat isolated but some residential and businesses are recently developing nearby.

RESOURCE

The complex well produces from the same aquifer as most of the other 550 wells in Klamath Falls. Geothermal water issues from northwest trending faults bordering the east side of town. Water flows in a generally southwest direction from the major faults cooling and mixing with surface water as it proceeds. Temperatures reach a maximum of 220°F nearest the fault. At 151°F, the well serving the complex is 10 - 15°F warmer than nearby wells, but it is also deeper. Water chemistry is relatively benign with pH of about 8 and total dissolved solids of 800 - 1,000 ppm. Isolation heat exchangers are typically used since the water contains approximately 0.5 ppm hydrogen sulphide.

The county complex utilizes one production well 1,400 ft deep. The original pump test produced 760 gpm of 151°F water with a drawdown of 38 ft. A note on the pump test report reads "Well is capable of pumping more water. We need a larger test pump."

Water is injected into a 1,154-ft deep well that tested 210 gpm at 134°F with no measurable drawdown.

UTILIZATION

The history of the complex is somewhat sketchy. Some of the drawings and most of the mechanical specifications for the buildings kept by the county were lost or misplaced after the September 1993 6.0 earthquake. County building and engineering departments were moved and split up several times because their offices were badly damaged and temporary offices were utilized.

Work at the site started on August 10, 1960, when a cable tool well drilling rig was moved in. The well, now the injection well above, was completed as a production well at 1,154 ft on June 10, 1961. A second well, the original injection well, was completed in October 1962 at 205 ft and accepted 75 gpm with water level raising from 130 ft to 82 ft below the casing top.

The Juvenile Detention Home, located near the wells, was the first building at 18,300 sq ft. It was occupied in late-1962. The home had radiant floor heating and domestic hot water supplied by tube-and-shell heat exchangers. The well was equipped with a 7 ½-hp 88-gpm submersible pump set at 150 ft.

In 1954, the County Health Department building, about 5,500 sq ft, now the County Sheriffs Office, was occupied. The building had two heating air handlers (no cooling) supplied from a hot water boiler, probably oil-fired. About 1974, the Mental Health building at 3,880 sq ft was built. The heating system is believed to have been one or more oil-fired forced-air furnaces. About the same time, there was a small, about 600 sq ft, addition to the Juvenile Detention Home. Heating was by radiant floor utilizing the existing system.

In 1979, the Oregon State University County Agriculture Extension Office was built. The building was 8,440 sq ft, and had eight air-source heat pumps for heating and cooling.

In 1982, drawings for the retrofit of the well house for the Juvenile Home called for replacement of the tube-and-shell heat exchanges with a plate-and-frame exchanger, connection to existing underground insulated piping to the Health Dept., Mental Health and Extension buildings, and the addition of a plate-and-frame exchanger and cooling tower, a four-pipe system. These drawings show a fluid coupling variable-speed drive on the wellhead. It appears that some time earlier, the Juvenile Home radiant floor system had failed and been replaced by four fan coil units, and the County Health, Mental Health and Extension Offices had been converted to geothermally-heated four-pipe heating and cooling system. It is believed the fluid coupling and motor were 25-hp, but no records could be found.

In 1988, the new well for the then proposed County Jail was completed (above) at 1,400 ft and 151°F. The well was located off the hill and nearer known higher temperature wells, but does require about 100 ft of lift from the well to the buildings, about 200 ft total lift at current flow rates (100 ft pumping level).

The County Jail, 42,600 sq ft, was completed in 1990. The production well serving the Juvenile Home, County Health, Mental Health and Extension Offices converted to an injection well and the entire complex supplied from the new well. The system schematic is shown. Flows shown are peak design from drawings and are probably never that high. The jail has six fan coils, reheat boxes and unit heaters supplied from a main stainless steel plate heat exchanger. A separate heat exchanger supplies hot water for showers, kitchen, laundry, etc.

The Community Corrections Center, 19,500 sq ft, was occupied in 2003. The heating is provided by two large air handlers with hot water coils and a number of reheat boxes. The building is supplied from the main heating heat exchanger in the jail's mechanical room.

In January of 2004, a 9,000-sq ft addition to the Juvenile Home was occupied. The heating system utilizes two fan coils and reheat boxes supplied from the heat exchanger outside the home.

Currently, the total building area is just under 100,000 sq ft with future additions in planning stages. The design peak load is unknown; since, most of the specifications are not available, but is estimated at approximately 5.6 million Btu/hr plus domestic hot water. A totalizing flow meter indicates the average flow for the year of 207 gpm. The pump motor is on a variable-frequency speed control, but the control system is not yet completed so it is on manual control. There are, however, flow control valves at the mechanical room responding to heating requirements. Monthly average flows vary from a high of 325 gpm down to 116 gpm.

OPERATING AND MAINTENANCE COSTS

Practically nothing is known about operating and maintenance prior to the current maintenance staff, about 10 years. It is believed the submersible 7 ½-hp pump was repaired or replaced at least once, perhaps twice. The 25-hp variable-speed drive and pump were probably never repaired or replaced, but their life is unknown.

The existing heat exchangers in the jail mechanical room were cleaned about 1995 when it was noted that the pressure drop across the exchangers had increased. At that time, corrosion products from the well were found in the exchangers geothermal side. There was also some scale buildup on the clean water side assumed to be from lack of corrosion/scale inhibitors in the closed loop. Shortly thereafter, pressure drop across the exchangers began to increase again and it was apparent the pump needed to be pulled and repaired. It was also obvious that the 120-hp motor, variable-speed fluid drive and 12-in. pump bowls were oversized for the existing load; so, it was decided to replace them with a smaller pump and variable-frequency drive.

On pulling the pump, it was found that about 100 ft of pump column was corroded. The 120 ft below the pumping water level and the pump were in good shape.

In August of 1997, the pump was replaced by a 9LA 14-stage pump with 9-in. bowls, 100 ft of new column, new shaft, oil tube and bearings, and a 60-hp motor with variable-frequency speed control. Although the shaft, oil tube and bearings were in good condition, the new pump required a smaller shaft; so, the assembly was replaced. The pump was salvaged and put in service without repair in an irrigation well, where it remains today. Total cost was $37,492.50.

At the same time, the jail mechanical room heat exchangers were cleaned and new gaskets installed. Total cost was $2,300. The exchangers are currently (February 2004) in good condition with no leaks.

As noted above, the DDC controls for the jail have not been completed; so, the pump is on manual speed control at about 40% speed. Immediately after the new pump was installed, total power costs for the jail were over $1,000 less per month. Since there were no other changes, it was attributed to the pump–a simple payback of less than three years.

At the time the pump was installed, an electricity meter was installed on the pump with the thought of charging individual buildings a share of pumping costs based on building size. This never occurred; however, the use was recorded over 19 months, August 1997 - March 1999. At current electricity cost, the average cost per month would be $953.

Totaling the gallons pumped for the same months (albeit different years) and assuming a temperature drop of 30°F, the cost of natural gas replaced by geothermal would be $18,500 per month.

REGULATORY/ENVIRONMENTAL ISSUES

There have been no problems. Drilling low-temperature geothermal production and injection wells in Oregon requires only a start card and completion report (depth, lithology, water bearing zones, casings); unless, it is in a critical water area. The system was designed to meet the city ordinance geothermal injection requirement.

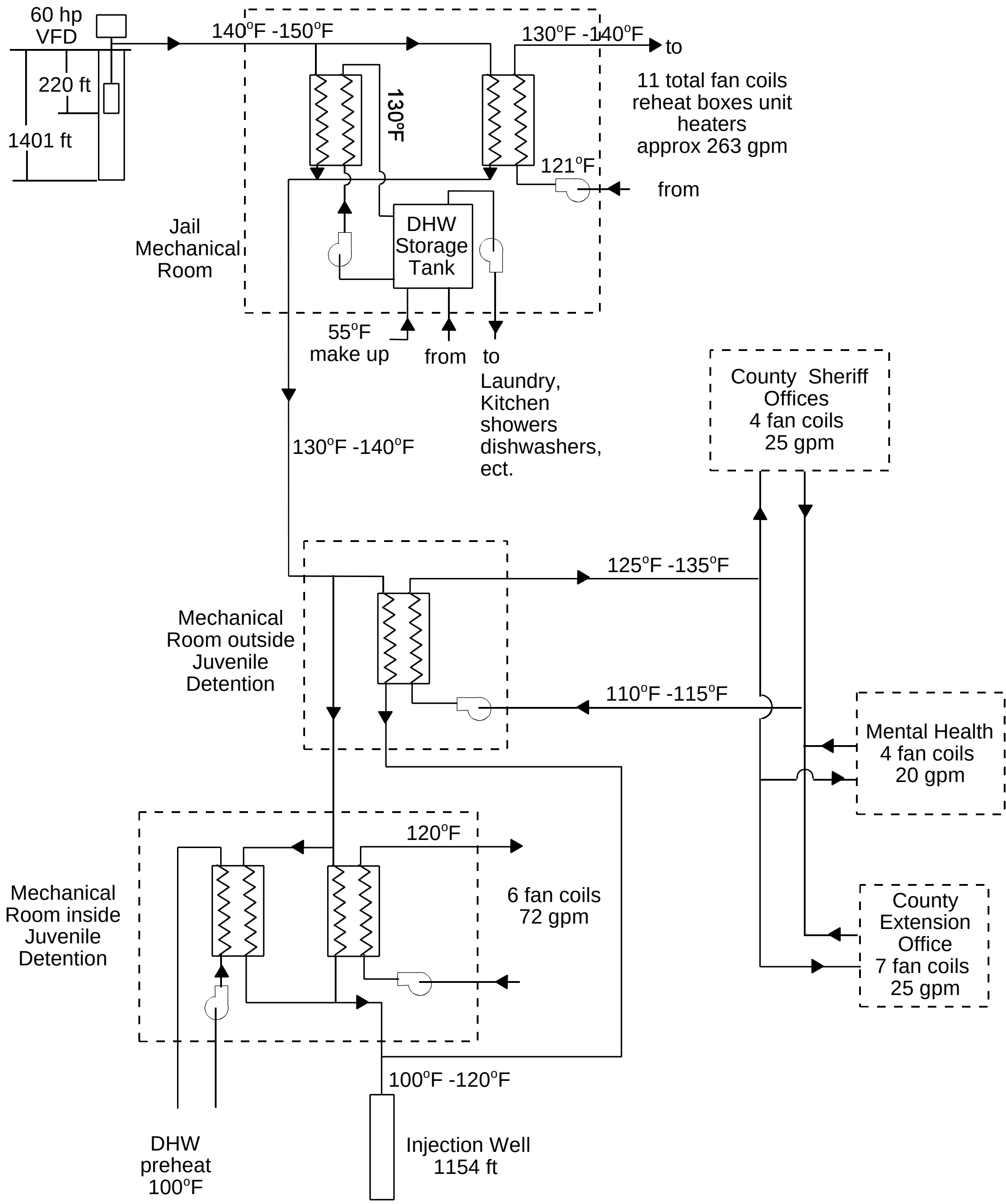
PROBLEMS AND SOLUTIONS

Aside from the oversized pump and corrosion of the pump column noted above, the only problems have been with the outdated pneumatic controls. These are being converted to DDC also as noted.

CONCLUSIONS AND RECOMMENDATIONS

The original 120-hp pump was grossly oversized. It was sized either based on the maximum well capacity or plans to greatly expand the facilities, which never came to fruition.

The system has operated without any major problems for some 40 years and grown over 5 ½ times the original size, while changing system configuration as growth required. Currently, the system is saving $210,000 in operating cost per year.



RESIDENTIAL DOWNHOLE HEAT EXCHANGER KLAMATH FALLS, OREGON

John W. Lund
Geo-Heat Center

Well with three DHEs, a single 2-in. (5-cm) pipe used for space heating and two 3/4-in. (2-cm) pipes used for domestic hot water.

LOCATION

Klamath Falls, Oregon is located on the western edge of the Basin and Range physiographic province on the east flank of the Cascades approximately 30 miles north of the California border. It is located in a graben structure about 10 miles wide flanked by horst blocks rising over a 1,500 feet with steeply dipping normal faults trending in a northwest-southeast direction. Upper Klamath Lake, a shallow body of water about 35 miles long, dominates the graben.

RESOURCE

Geothermal wells and springs are widespread in the Klamath Falls area. The springs were prevalent over 100 years ago and were used by the Indians and early European settlers. However, due to pumping from wells, all of the springs no longer flow on the surface. Today more than 500 hot water wells have been drilled in the area, most of which are located along the eastern edge of the graben taping into the upflow zones along the fault system. Hot water, heated at depth, migrates up along these fracture zones and then flows southwesterly in permeable zones of volcanic cinders and fractured lava flows. Wells were drilled in the area, starting around 1930, to provide space heating for local residences using downhole heat exchangers (DHE). These DHEs consist of a closed loop of pipe in the well with city water in them extracting heat from the well water. The DHE conserve the resource by extracting only heat from the well water, and can provide space heating and domestic hot water to individual homes, several homes or even schools and businesses in the area. A typical residential well can provide up to about 250,000 Btu/hr (0.1 MWt) of energy, and installations with multiple DHE, such as for schools, provide about 10 times this amount of energy. Well depths in the city vary from 100 to 1,800 feet, with 300 feet being the average. Temperatures vary from 120 to 220ºF, with 140ºF and above considered desirable for providing sufficient energy using a DHE.

UTILIZATION

The DHE example selected from Klamath Falls serves two residences from a single well. The system design is fairly simple, but typical of others in the city that provides both space and domestic hot water heating. The well is 200 feet deep, with a temperature of 196ºF at the top, and 204ºF at the bottom (when drilled). The static water level is 75 below the casing top. The well was drilled in 1954 and cased to the bottom with a 10-inch diameter casing, which is perforated just below the water surface and at the bottom of the well in the live water area. The perforations are about 0.5 inches wide and 6 inches long for a total distance of about 15 feet at each location. The casing is sealed with cement from the surface down to 21 feet, and then the annulus is open below this point providing about a 1-inch clearance. The perforations and opening between the casing and wellbore allows a vertical convection cell to develop, bringing the hotter water from the aquifer (live water zone) at the bottom to the top.

Originally there were four DHEs in the well, two 2-inch diameter closed-loop pipes for the space heating and two 3/4-inch diameter open loop pipes for the domestic hot water heating–one set for each home. After 19 years of service (1974), the black iron pipes were replaced due to corrosion at the water line. The two 2-inch diameter heating loops were replaced with a single 2-inch diameter heating loop which is now shared by both homes. Since the domestic hot water is a consumptive system, the two loops for this system were retained.

The space heating system consists of baseboard hot water radiators on a two-pipe system with flow control valves on each heating unit. A motorized valve on the return leg of the heating loop controls the flow via a thermostat. Recently, a solid state controller hooked to a storage battery was installed in case of a power failure. A 10-gallon expansion tank is connected to the high point in the heating system, and pressure reducing and relief valves are part of the cold water supply line used to initially fill the heating loop. City water is also provided to the domestic hot water loops in an open system. There is no storage tank for the domestic hot water, and there is also no circulation pump on the space heating loop, as the circulation is produced by normal thermal syphoning.

The estimated utilization of the system for both houses is about 164 million Btu/yr (48,000 kWh). The maximum capacity of the well is probably 10 times this utilization, but obviously it has not been plumbed or tested to this amount, which depends upon the aquifer flow and efficiency of the vertical convection cell.

OPERATING COST

The original cost of the well was $2,400 and $800 for the DHE for each house. Thus, each homeowner paid about $2,000 for the system. At today's prices, the well would cost around $10,000 and $3,000 for the three DHEs. The annual O & M cost are only for the electricity to run the motorized valve and the equivalent annual cost of replace parts of the DHE on about a 25-year intervals, amounting to probably less than $100 per year. The estimated annual heating and domestic hot water cost for the two homes at about 4,500 sq ft total of heated space using natural gas would be about $1,800 per year or $2,900 per year for electricity, plus $5,000 for the capital cost of two furnaces and hot water heaters. This would give a simple payback of five and three years, respectively.

ENVIRONMENTAL IMPACT

Initially, to prevent corrosion of the DHEs at the water-air interface, several pounds of paraffin were placed in the well. This was considered a pollutant to the groundwater; thus in 1974, after the DHEs were replaced, a steel plate was welded to the top of the water to limit air (oxygen) entering the wellbore. This is the recommended procedure today.

REGULATORY ISSUES

Drilling a geothermal well with less than 250ºF temperature is under the jurisdiction of the Oregon Department of Water Resources (DWR). Wells that exceed this value are under the jurisdiction of the Department of Geology and Mineral Industries (DOGAMI). A drilling log must be filed by the driller to the state (DWR) once the well is completed. The well casing must also be sealed from the surface down to competent formation or to 21 feet below the surface. The city of Klamath Falls passed an ordinance in 1990 to prevent the dumping of geothermal water in the storm sewer or waterways–-all water must be reinjected into the same aquifer. Since only heat is removed from a well using DHE, this ordinance does not apply.

PROBLEMS AND SOLUTIONS

The only major problem was the corrosion of the DHEs at the air-water interface. These were replaced in 1974 at a cost of about $500. The homeowners were able to save on purchasing new pipe, as the two space heating DHEs, were replaced with a single DHE. There has been no corrosion problems since this date. Typical life of DHE in Klamath Falls wells average 14 years. Recently, the pressure reducing and pressure relief valves on the city water supply side connected to the closed loop DHE had to be replaced; as, they were causing high pressure in the system, producing leaks.

CONCLUSIONS

This system has been operating with few maintenance problems and low annual costs. This is an ideal configuration providing the resource temperature is at least 140ºF. It also conserves the resource as only heat is removed from the water. The design of these system is extremely simple; however, more complex systems can be found in the city and are documented in the reference below.

REFERENCES

Geo-Heat Center Quarterly Bulletin, Vol. 20, No. 3 (September 1999). "Downhole Heat Exchangers," Klamath Falls, OR, 28 p. (available on the GHC website: http://geoheat.oit.edu/bulletin/bull20-3/bull20-3.pdf).

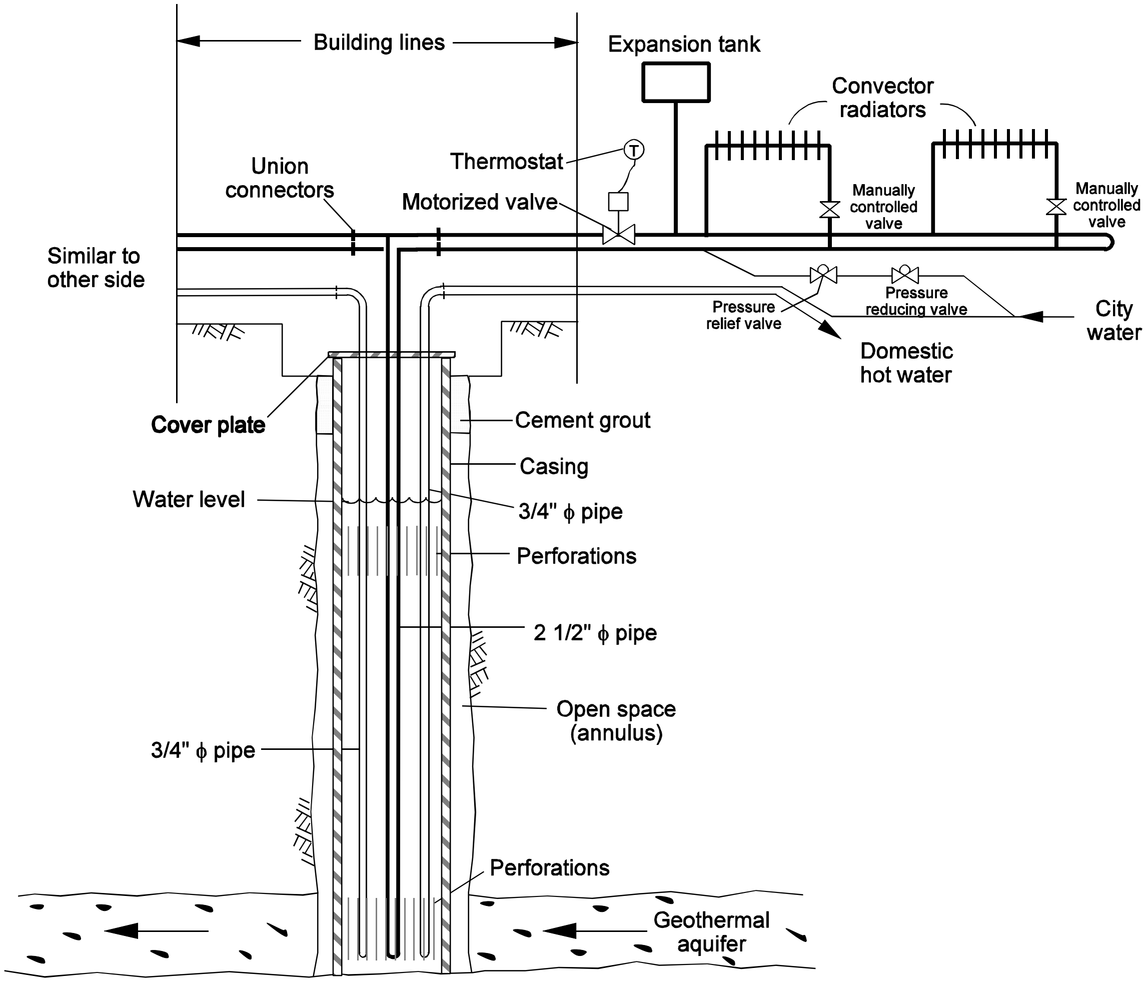


Diagram of the entire system for the basic installation.

REACH, INC. JUNIPER PROCESSING PLANT KLAMATH FALLS, OREGON

Tonya L. Boyd
Geo-Heat Center

LOCATION

REACH (Rehabilitation, Employment and Community Housing) Inc. (in the building formerly occupied by Maywood, Inc.) is located just outside the Klamath Falls city limits. REACH is a non-profit organization which has found a niche in the specialty area of the selective and environmentally-friendly removal of juniper and also finding uses for the entire tree. They are currently planning on expanding operations in the building such as adding two drying kilns. The 110,000 sq ft building was constructed in 1976. REACH has been in the building since 1993 and incorporates vocational-rehabilitation programs with their workforce. About a third of their gross income is from mill work and a third from the juniper products.

RESOURCE

Klamath Falls is located on the western edge of the Basin and Range Physiographic province, and is situated in a graben structure. Geothermal waters upwell along faults to the northeast as high as 220ºF and then flow down gradient to the southwest. REACH is located in this outflow zone where the water is cooler.

REACH is served by a single production well, 1520 ft deep, which had a temperature of 118ºF when drilled. The well was pump tested at a flow of 320 gpm with a 115 ft drawdown. The maximum flow rate for the pump is 535 gpm. This is the lowest temperature well in Klamath Falls for direct-use. The well is currently producing at 105ºF.

UTILIZATION

The well located adjacent to the building has a 75 hp motor running a lineshaft pump. The system is operated from approximately October to April, 24 hours a day. The original system was designed by Balzhiser and Colvin Engineering with nine air handling units (378,000 Btu/hr) and four make-up air handlers (1,856,000 Btu/hr). Because Maywood had a large number of machines with high air volume dust collectors, a large amount of make-up air was required. The nine air handling units have a four-pass coil system (106” x 27", 14 fins/in) and the four make-up air handlers have an eight-pass coil system (83" x 30", 14 fins/in). There have been two smaller HVAC systems installed for the office and a small fan coil unit installed in the shaver room that has been added to the building. The system was installed with pneumatic controls.

The geothermal water is run directly through the system. The system currently utilizes only four air handlers since REACH has fewer machines generating less dust; so, the make-up air heaters are not required. The two office units and the fan coil unit are being used at this time. The water enters the system at about 105ºF and is then discharged to a drainage ditch at 95ºF. The drainage ditch combines with the Klamath County Maintenance shop geothermal discharge water which will end up in Lake Ewana. The system has a parallel flow with supply and return lines.

OPERATING COSTS

There are several costs associated with operating the system: 1) city water used to cool the oil in the fluid coupling system, 2) maintenance of the pump and replacing of the coils in the system, and 3) electricity to run the pumps. The costs for the water and electricity are not separated out for the system, but an estimate can be made.

They use about 114,100 ft^3 of water per heating season for cooling the oil in the fluid coupling system which has an annual cost of about $970. They use approximately on average 1000 kWh/day of electricity more during the heating season, which could be attributed to the running of the pump. If the system is run for eight months out of the year, we can assume they use 240,000 kWh for the heating system for a cost of $16,000. The cost of the electricity is approximately $.07/kWh. The total operating cost for the system is, therefore, almost $17,000.

They replace either one or two coils a year with cost of about $6,000 per coil including labor. This would make a maintenance cost average of $9,000 per year.

It has been estimated that the well pump has been pulled twice since it was first installed. The impellers were replaced at a cost of $12,000, but there is no information about additional repairs at those times.

REGULATORY/ENVIRONMENTAL ISSUES

Since the system is located outside the city limits of Klamath Falls, REACH is not required to reinject the geothermal fluid after use. The geothermal is surface disposed of to a ditch which combines with the County Maintenance discharge, which then flows to Lake Ewana

They obtained an Industrial Geothermal Permit in January 2004 from the Department of Environmental Quality (DEQ). This permit authorizes them to discharge their spent geothermal fluids into the waters of the state while they are in compliance with all the requirements, limitations, and conditions set forth in the permit. The parameters and limitations they must meet are:

Flow	shall not exceed the natural geothermal source flow
Temperature	shall not exceed the geothermal source temperature
pH	shall be between 6.0 - 9.0
Other Pollutants	no biocides or water treatment chemicals shall be discharged

All of these measurements are to be taken monthly and a report submitted at the end of the calendar year to DEQ.

PROBLEMS AND SOLUTIONS

Since they are using the geothermal water directly in the system, this has been causing corrosion problems in the coils. They run the system at 20 psi for that is all the pressure the coils can handle without leaking. When REACH bought the building, there were replacement coils left in the building: thus, they have not bought any new coils since they started operation in the building. Due to the corrosion of the coils, they are only running 3 or 4 heaters at a time. They do not use the make-up air handlers as the coils will clog very rapidly. The pneumatic controls are also not working on the system.

Switching to a smaller variable-frequency pump ($36,000) with DDC system controls ($13,000) would greatly increase the efficiency of the system. The corrosion in the coils can be eliminated by placing a plate heat exchanger ($7,500) in the system as the geothermal water enters the building. This would allow clean city water to be run through the coils instead of the more corrosive geothermal water. This would mean that all the coils (9) should be replaced at the time the heat exchanger is installed. This would extend the life of the coils. They are looking into to ways to make the heating system more efficient.

Since the well is only cased for the first 600 feet, it appears that some sloughing has occurred near the bottom, as the temperature has dropped from 118ºF to 105ºF.

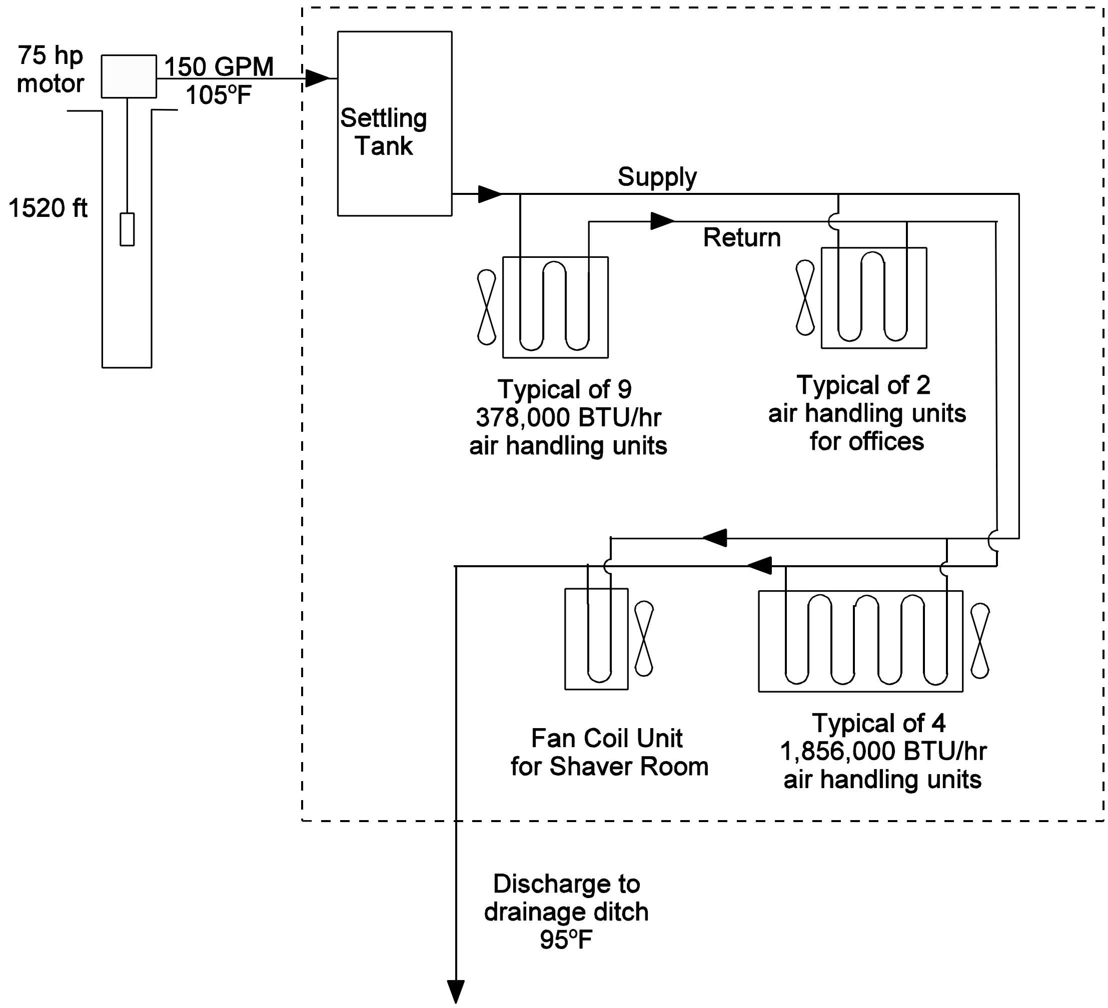
CONCLUSIONS

The system seems to be supplying adequately heat to the building, as the workforce only needs about 60ºF room temperature. However, an overhaul of the system including cleaning the well, appears to be necessary to make efficient use of the resource.

The present installed capacity is about 0.5 MWt, utilizing 8.2 billion Btu/yr at a savings of $75,000/yr (compared to natural gas).

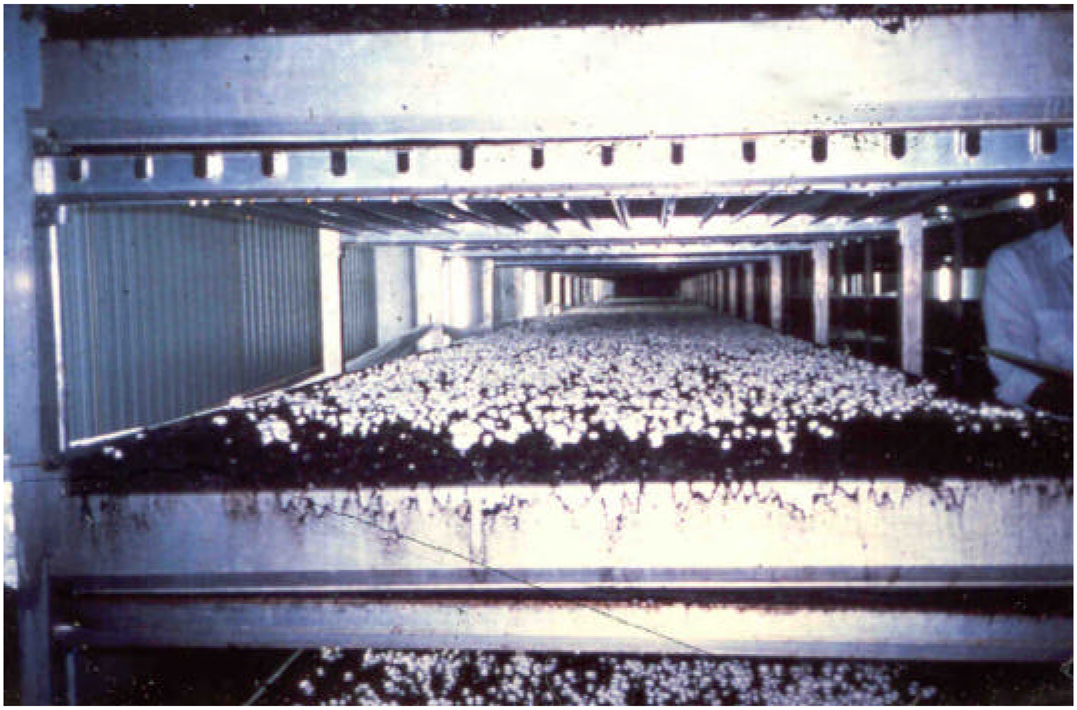
REFERENCES

Lienau, Paul, 1976. "Maywood Industries of Oregon uses 118ºF Well for Heating," *Geo-Heat Center Quarterly Bulletin,* Vol. 2, No. 2, p 3-4.


75 hp motor
150 GPM
105ºF
1520 ft
Settling Tank
Supply
Return
Typical of 9
378,000 BTU/hr
air handling units
Typical of 2
air handling units
for offices
Fan Coil Unit
for Shaver Room
Typical of 4
1,856,000 BTU/hr
air handling units
Discharge to
drainage ditch
95ºF

OREGON TRAIL MUSHROOMS

Gene Culver
Geo-Heat Center



LOCATION

Oregon Trail Mushrooms is located on the east edge of Vale, Oregon, 15 miles west the Oregon-Idaho border. Elevation is about 2,240 ft. Winter temperatures reach -20ºF and summer temperatures 100ºF. The mushroom plant construction was financed through the USDOE Loan Guarantee Program and began production in 1986. Initially, 2,500 tons of white button mushrooms were produced annually. Production now includes other varieties and has increased to 4,000 tons annually. There are 130 employees year round.

RESOURCES

Vale has long been known for its geothermal resources. There are several hot springs in the area. The mushroom plant is on the previous site of hot springs. A geothermally-heated greenhouse, and a slaughter house still utilizes geothermal hot water for cleaning and hog scalding. There was a large geothermal swimming pool and sanatorium just across the highway and several nearby homes also utilize the hot water. Temperature of 198.5ºF with total springs flow of 20 gpm and a 140-ft well were reported by Russell in 1903. Today, wells that more accurately target the resources have temperatures above 220ºF. In the hotter wells, pH ranges from 7.2 to 8.3, TDS is about 1,000 with SiO_2 74 to 113 ppm, Cl about 370 ppm and F 6.1 to 6.6 ppm.

The resource appears to be the result of deep circulating water rising along fractures in completely silicified sandstone and conglomerates along the Willow Creek fault zone. Although there is anomalous heat flow (at least 3 times the surrounding area) in an area about two miles wide and 10 miles long along the fault zone, the only surface manifestations and 29 wells are in an area of about 40 acres between the northern end of Reinhardt Buttes and the Malheur River (Gannett, 1988).

UTILIZATION

250 gpm of geothermal fluid at 220ºF is pumped from one 250-ft deep well by an oil- lubricated vertical lineshaft 20-hp pump. A similar well with a 10-hp pump is available as standby. Geothermal fluid flows through two plate-and-frame titanium heat exchangers in series, which supply 213ºF hot water to a 400-ton lithium bromide chiller and growing room where fan coil units are supplied with 191ºF hot and 40ºF chilled water via a 4-pipe system. The geothermal effluent is also provided to five homes for space and domestic hot water heating, a swimming pool located about one mile away in the city and to a corn dryer (in season), and/or injected into two injection wells.

The growing medium, a mixture of wheat straw, chicken manure, gypsum, alfalfa seed screenings and urea is composted off site and trucked to the plant. The compost is then moved by conveyor to one of three pasteurizing rooms; where, it is held for a 7-day controlled heating and cooling schedule. Maximum pasteurizing temperature is 140ºF. Air is forced through the compost via tunnels and grated floors. After pasteurization, the compost is moved to the growing rooms by conveyor. There are 42 growing rooms, each 20 ft wide, 85 ft long and 12 ft high with removable ends to facilitate conveying compost in and out. Compost is loaded into six shelves on either side of a corridor providing a growing area of 4,320 ft^2 per room. Spawn is added and the room is held at 80°F and 94% relative humidity for 35 days when the first crop is harvested. Rooms are held at 64°F and 94% relative humidity for a 21-day growing period during which three crops are harvested. Harvesting is done by hand. Temperature and humidity are closely controlled by a central computer system. After harvesting, mushrooms are sent to chill rooms for sorting, packaging and storage awaiting shipment. Chill and storage areas are cooled by centrifugal (electric) chillers.

The geothermal system provides about 5 x 10^6 Btu/hr (1.47 MWt) (depending on outdoor air conditions) and replaces about 430,000 therms of natural gas annually to the mushroom facility; plus provides heat for the homes, pool and corn drier.

OPERATING COSTS

Operating costs for the geothermal system are minimal. Geothermal fluids are limited to the two heat exchangers and a small amount of piping. There have been no problems with the piping, but one set of pump bowls have been replaced since plant startup. Stainless steel plates in the heat exchangers were replaced with titanium and there has been no problems, not even cleaning since then. Maintenance personnel stated that it cost less than $500 per month to operate the chiller including maintenance and pumping, and that a chiller of equal duty would cost at least $500 per week.

REGULATORY/ENVIRONMENTAL ISSUES

None after obtaining production and injection well permits.

PROBLEMS AND SOLUTIONS

Shortly after plant startup, it was noted that wells supplying the five homes, the corn drier and a slaughter house were declining in both water levels and temperatures. Oregon Trail Mushrooms obtained the water rights for the five home wells in exchange for a guaranteed supply of effluent water sufficient to meet their needs. They no longer have pumping nor pump and well maintenance costs. The corn drier owner maintains his rights, but agreed not to pump so long as he is supplied with sufficient effluent. All effluent ultimately is injected into Oregon Trail's injections wells. Since the homes and drier wells are not used, the slaughter house well has stabilized and the owner continues on his original system. The remainder of the 29 wells in the immediate area are not used.

As noted above, there were problems with the stainless steel heat exchangers leaking at the gaskets. Converting to titanium has solved the problem.

At plant startup, the temperature at the production wells was 228°F. This has dropped to 220°F, probably due to lower water levels allowing cool water intrusion from the river, the injection wells, or the other side of the fault where wells were historically cooler by 20 - 40°F. The temperature drop caused a decrease in the capacity of the lithium bromide chiller. This was somewhat offset by running chilled water through the heating coils when cooling the grow rooms. Also, when a few of the coils needed replacing, higher capacity coils were installed. Now they plan to add more grow rooms–hence, the recent installation of a booster boiler in the closed chiller circuit. It has not yet been operated except for testing. Also planned are modifications to the piping to handle additional load and changing fan coils to increase efficiency.

CONCLUSIONS

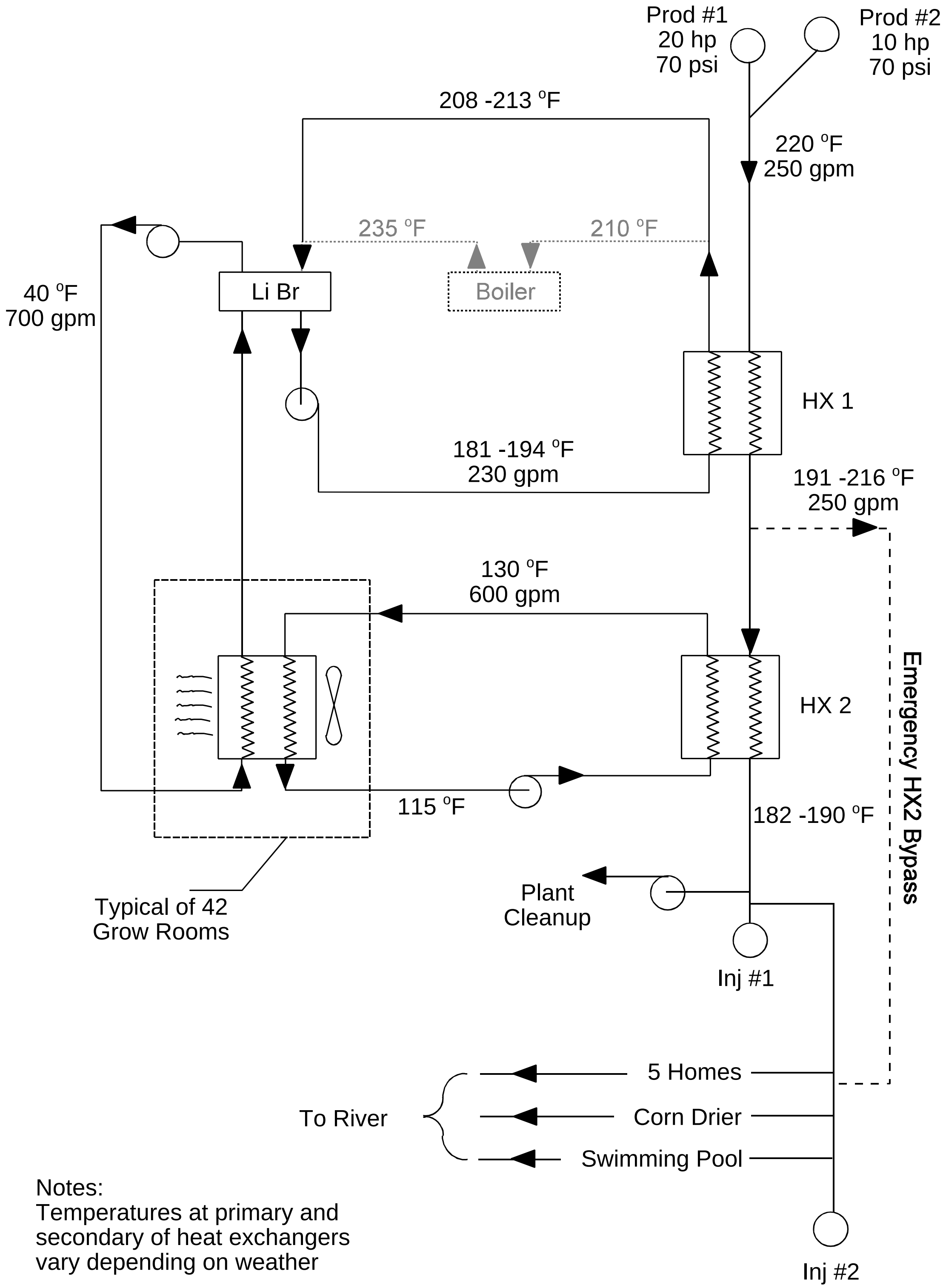
This is a very successful project that is the result of the USDOE Loan Guarantee Program. The plant has expanded and increased production since startup and continues to expand.

Lithium bromide chillers, while not common in geothermal applications, are economical where temperatures of 220°F are available.

Where there is interference between wells of a number of owners and uses, reasonable people can probably reach an agreement that is beneficial to all.

REFERENCES

Gannett, Marshall W., 1988. "Hydrogeologic Assessment of the Developed Aquifer Near Vale, Oregon." State of Oregon Water Resources Department. Open-File Report No. 88-04.



Notes:
Temperatures at primary and
secondary of heat exchangers
vary depending on weather

FISH BREEDERS OF IDAHO INC.
HAGERMAN, IDAHO

Gene Culver
Geo-Heat Center

LOCATION

The aquaculture facility is located along the Snake River, approximately 30 miles northwest of Twin Falls, Idaho and near the town of Hagerman. There are also several greenhouse operations, hot springs spa/resorts and residential heating within about three miles in either direction along the river. Elevation is about 3,800 ft ASL and average annual temperature about 50ºF. The operation began in 1973 after drilling the first well.

RESOURCES

The resource is known as the Banbury Hot Springs area. Most of the wells are in an area about 10 miles long by one mile wide. The occurrence of thermal water in the area appears to be fault controlled. The better (higher flow and temperature) wells occur on the downthrown side of the fault. Temperatures range from 77 to 162ºF. Water quality is generally good– pH 7.9 - 9.5, total dissolved solids 230 - 420 mg/l with higher temperature fluids having higher pH and TDS. Artesian heads range from slightly above, to 360 ft above, land surface. Based on heat flow data, depth of circulation to attain the highest temperatures in the wells is about 4400 ft and since most wells are only 420 - 700 ft deep, convective transport along faults is indicated. Probable maximum temperature based on geothermometers is about 195ºF.

Fish Breeders of Idaho utilizes eight wells with temperatures ranging from 90 - 95ºF. Most of the wells are about 500 ft deep–one at 1,100 ft hit the main flow at 500 ft, which increased very little in flow or temperature beyond that depth. Wells have shut-in pressure of about 40 psi (92 ft). Total flow is 6,000 gpm, but has declined to about 4,000 gpm as more wells have been drilled in the area. Seven of the wells are fairly high in the river canyon–the deeper 1,100 ft one being at the lowest elevation and has the lowest flow–only 200 gpm. It may have been drilled through the fault and into less fractured formation below the 500 ft depth.

UTILIZATION

This site is ideal for warm water species. The wells (expect one) are neat the top of the canyon; so, water flows down a quarter mile with an 80 ft drop. Raceways are interspersed with rocky brook-like channels that help add oxygen utilized by the fish.

Stocking starts with the water flow at the top with channel catfish, followed by lower oxygen tolerant blue catfish (350,000 - 400,000 lb/yr combined), to even more tolerant tilapia (100,000 - 200,000 lb/yr) near the bottom, then to settling ponds where solid waste is removed. More oxygen is added and water cooled in the rocky brook on its way to the river. Starting in 1994, in the lower portion, water is diverted to alligator houses (1,000 6-footers/yr) and outdoor ponds for 1,000 lb 10 - 14 ft breeding stock. The alligators are fed dead fish from this site and from the numerous nearby cold water fish farms (trout). Since the fish are cleaned on site, the alligators are also fed the entrails.

In winter, about 1,000 gpm of cold water from shallow springs is mixed with geothermal to maintain correct growing temperatures. In summer, 4,000 - 5,000 gpm is obtained from an irrigation canal.

Fish Breeders of Idaho also has a fish processing plant and a cold water fish farm that raises a million pounds of trout and 200,000 lb of sturgeon annually at another location. It is planned to move some of the sturgeon to the geothermal site for faster growout in the warmer water.

OPERATING COST

There are no pumps, pipes, heat exchangers, valves, etc. Operating cost is zero for the geothermal system.

Assuming a 50 ºF temperature increase if river water was used, at current natural gas rates, the cost to maintain optimum growing temperatures would be about a half a million dollars per month. Using the geothermal water, the estimated capacity is 8.8 MWt and annual use is 210 billion Btu.

REGULATORY/ENVIRONMENTAL ISSUES

During the late-1970s and early-1980s, there was a large increase in the number of wells in the area. As a result, artesian heads and flows decreased. The Idaho Water Resources Department instituted a "Ground Water Management Area" in 1983 meaning that no new commercial well water rights will be issued.

There have been concerns voiced about geothermal uses thermally polluting the Snake River. Most of the users discharge relatively cool effluent so nothing has come of the concerns to date. This may become a problem in the future that all the geothermal users in the area are aware of.

As with most confined animal operations (i.e., feed lots, dairies and fish farms), run off or effluent contains elevated phosphorous levels. This is another future problem for Fish Breeders of Idaho–as well as all other confined animal operations. Fish Breeders is investigating the use of certain varieties of barley that contain less phosphorous as a substitute for the fish meal. They are also looking for ways to remove the phosphorous from the effluent.

PROBLEMS AND SOLUTIONS

As noted above, there have been problems with resource decline and the potential problems of thermal pollution and phosphorous.

Well pressures and flow seem to have stabilized somewhat since the water management area was instituted. The past several years of drought in the region has undoubtedly had some effect; so, restrictions on increased water use are difficult to access.

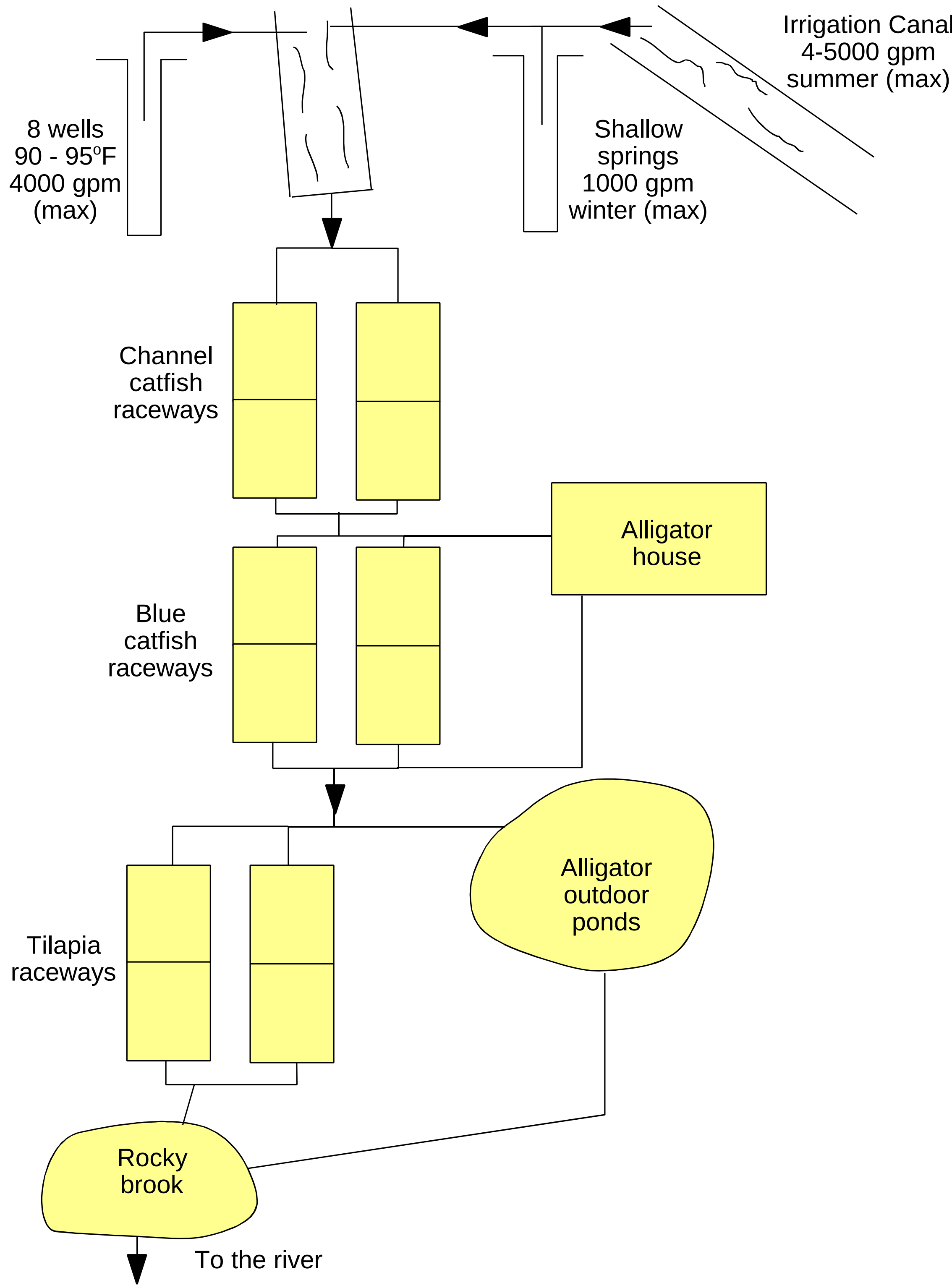
They are aware of the potential for thermal pollution and elevated phosphorous and are attempting to solve the problems before legal restrictions are enacted.

CONCLUSIONS

This is an ideal site with both good quality warm artesian and cold water available up slope providing simple and economical design and operation. This combined with the operator's knowledge, experience and business acumen have combined to make a very successful operation.

REFERENCES

Clutter, Ted, 2002. "Gators in the Sage," *Geo-Heat Center Quarterly Bulletin,* Vol. 23, No. 2 (June), Klamath Falls, OR, pp. 8-10.


Irrigation Canal
4-5000 gpm
summer (max)
8 wells
90 - 95°F
4000 gpm
(max)
Shallow
springs
1000 gpm
winter (max)
Channel
catfish
raceways
Alligator
house
Blue
catfish
raceways
Alligator
outdoor
ponds
Tilapia
raceways
Rocky
brook
To the river

CANYON BLOOMERS
(Formerly M & L Greenhouses)
Hagerman, Idaho

Gene Culver
Geo-Heat Center

LOCATION

These greenhouses are located along the Snake River, approximately 30 miles northwest of Twin Falls, Idaho and near the town of Hagerman. There are also several more greenhouse operations, a catfish/tilapia/alligator farm, hot springs spa/resorts and residential heating within about three miles in either direction along the river. Elevation is about 3800 ft ASL and average annual temperature about 50ºF.

RESOURCES

The resource is known as the Banbury Hot Springs area. Most of the wells are in an area about 10 miles long by one mile wide. The occurrence of thermal water in the area appears to be fault controlled. The better (higher flow and temperature) wells occur on the down-throw side of the fault. Temperatures range from 77 to 162ºF. Water quality is generally good–pH 7.9 - 9.5, total dissolved solids 230 - 420 mg/l with higher temperature fluids having higher pH and TDS. Artesian heads range from slightly above, to 360 ft above, land surface. Based on heat flow data, depth of circulation to attain the highest temperatures in the wells is about 4400 ft and since most wells are only 420 - 700 ft deep, convective transport along faults is indicated. Probable maximum temperature based on geothermometers is about 195ºF.

Canyon Bloomers utilizes two wells, one 505 ft deep will produce about 400 gpm at 107ºF; the other 1,000 ft deep produces about 250 gpm at 130ºF.

UTILIZATION

M & L Greenhouses started operation in 1970 with one greenhouse using propane and electricity for heating. In 1974, the 107ºF well was drilled and the greenhouse converted to geothermal. Currently, there are 20 houses of 5,000 sq ft each (2.3 acres). Geothermal at 130ºF is used in fan coil units, then cascaded to radiant floors in 16 of the houses. The remaining four use water cascaded from the 16 in their radiant floors. Water is also cascaded to radiant floors in the large office and shop, and to a swimming pool. Three houses have table top heating using 107ºF water and the owners residence uses mostly 107ºF water in radiant floors, but can be switched to 130ºF water if needed. Total peak flow is 450 gpm providing an estimated installed capacity of 1.9 MWt. Annual energy use is estimated at 14.3 x 10^9 Btu/yr.

Canyon Bloomers is a contract grower supplying 2,000 varieties of annual spring plants to large retailers. Their growing season starts about mid-December and finishes in late-June.

OPERATING COST

Operating costs for the geothermal system is minimal; since, the wells have an artesian head. Wellhead pressure in the shallower 107ºF well varies from 60 psi down to 20 psi at peak flow. A booster pump is required only when wellhead pressure is down near 20 psi. The other well is not pumped. Fan coil units last about 15 years and cost about $2,600. The black steel piping has had no problems. "Sometimes weak acid is run, through the pipes to clean them," the owner reported.

REGULATORY/ENVIRONMENTAL ISSUES

During the late-1970s and early-1980s, there was a large increase in the number of wells in the area. As a result, artesian heads and flows decreased. The Idaho Water

Resources Department instituted a "Ground Water Management Area" in 1983 meaning that no new commercial well water rights will be issued.

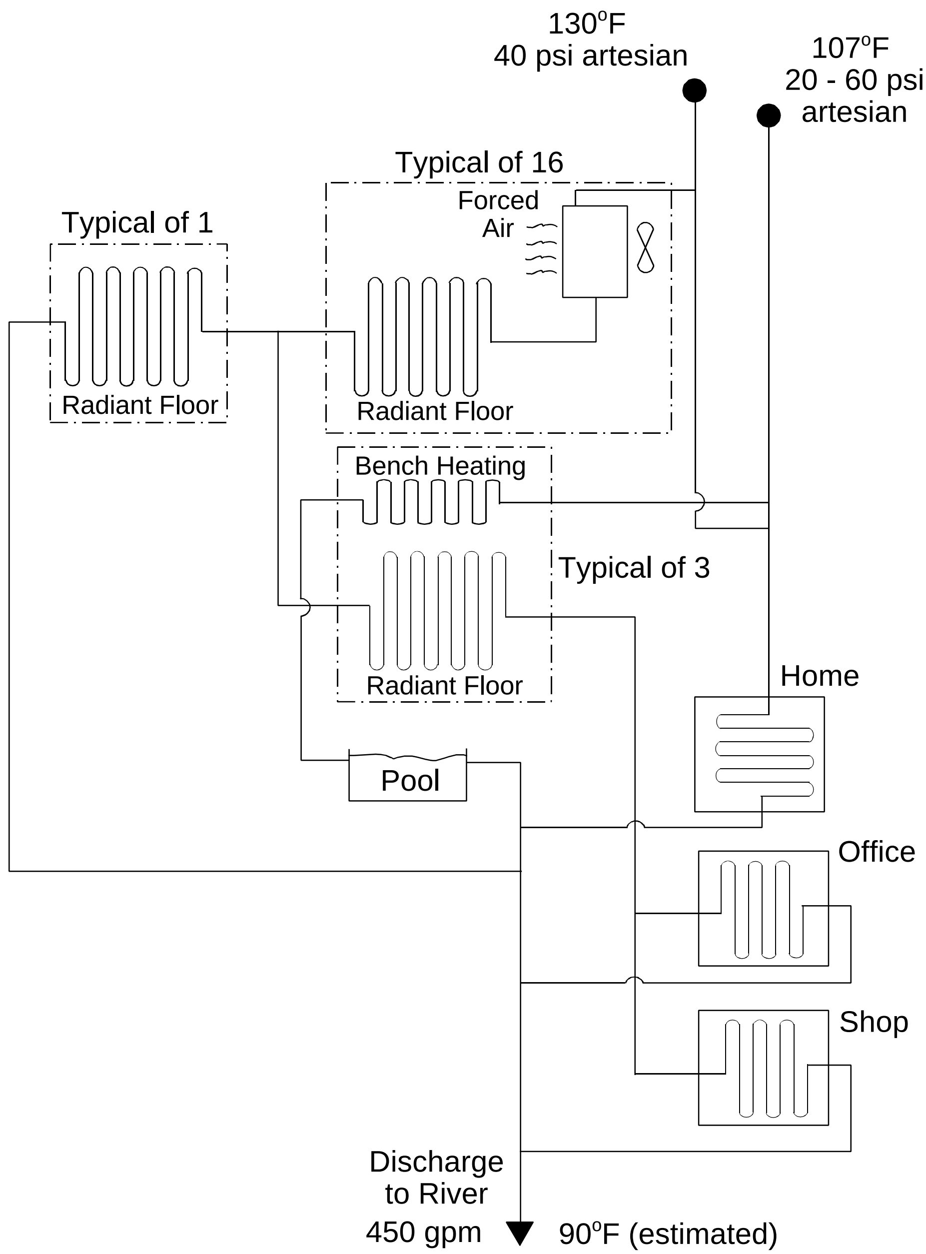
There have been concerns voiced about geothermal uses thermally polluting the Snake River. Most of the users discharge relatively cool effluent so nothing has come of the concerns to date.

PROBLEMS AND SOLUTIONS

Aside from the artesian head loss, there have been no major problems. Very early on, it was learned that copper piping rapidly corroded and galvanized piping tended to scale and plug, but since the operation was small, the conversion to black iron was fairly easy and inexpensive.

CONCLUSIONS

This operation demonstrates the feasibility of utilizing very low temperature geothermal resources. Several of the greenhouses, the residence, shop and office are heated by 107°F geothermal water. The operation started small and grew as the owner learned greenhousing and geothermal, and was not afraid to try using the lower than normal temperatures.



GEOTHERMAL PIPELINE

Progress and Development Update
Geothermal Progress Monitor

CALIFORNIA

Historical Perspective - Coso Hot Springs Resort

The earliest written record describing Coso Hot Springs dates to 1860, when a miner at nearby Silver Peak named M. H. Farley mentioned "boiling hot springs to the south." An 1881-survey of the area by the U.S. government noted "thousands of hot mud springs of all consistencies and colors," and early maps show "Hot Sulphur Springs" at the location referred to today as Coso Hot Springs.

In 1895, William T. Grant was deeded a quarter interest in the Coso Hot Springs area and by 1909, had established a health resort there. The first documented owner and proprietor of the Coso Hot Springs Resort was Frank Adams, who lived on the site from 1912 until approximately 1920. Some believe that Adams was hired by Grant and his partner Dr. I. J. Woodin to manage the property that they actually owned.

Claims of medicinal value of Coso waters, mud and steam ranged from cures for venereal disease to constipation. In 1917, an advertising brochure issued by the Owl Drug Co. announced availability of mud from Coso Hot Springs at the bargain price of "$3.00 per jar"—a hefty sum for that period. Water was also bottled and sold bearing the promise of, "Volcanic Health and Beauty from Natures's Great Laboratory." The bottle bore the claim that it, "...is a vitalizing blood builder which aids digestion, destroys invading bacteria and is especially recommended in cases of gastritis, stomach and intestinal catarrh. The water acts directly upon the liver and kidneys, thus eliminating toxic water, the neglect of which so often causes nervousness, high blood pressure and rheumatism. Recommended four doses daily."

Clientele at the Coso Hot Springs Resort during the early years were primarily residents of nearby Rose Valley, Owens Valley, and a doctor from Santa Maria. Later visitors, able to take advantage of the newfangled "horseless carriage," came from the Los Angeles Basin, San Bernardino, and as far away as San Francisco.

The resort remained in operation until 1943, when the U.S. Navy began purchasing land for their China Lake Naval Ordinance Test Station (forerunner of today's Naval Air Weapons Station). By 1947, all land purchases had been completed and the Coso Resort Hot Springs–now located within the boundary of the Navy base–was permanently closed.

(Edited from *A Land Use History of Coso Hot Springs, Inyo County, California*. Naval Weapons Center Administrative Publication 200, 1979, 233 p. - published in the *Geothermal Resources Council Bulletin*, Vol. 31, No. 5 (2002) - Ted Clutter, editor)

Lassen Volcanic National Park - "A Nose for Viruses"

"Extreme" viruses that live in reeking volcanic pools are being studied by microbiologist, Ken Stedman, from Portland State University. The microorganisms, called thermophiles for their ability to live in geothermal hot springs, bear a primeval resemblance to human cells. They look like bacteria, but belong to a completely different category of organisms called archaea. These viruses could provide clues to the way human viruses attack us; since, they are parasites and penetrate a cell and take over the cell's reproductive ability. Biotechnology companies are studying the viruses as they might trigger thermophile genes responsible for certain biochemical catlysts. Many industrial processes, such as paper pulping and animal feed milling, rely on expensive chemicals that work in harsh, high-temperature environments.

Dr. Stedman's work have taken him to Kamchatka, in eastern Siberia and more recently to Yellowstone and Lassen Volcanic national parks. At Lassen, he worked at the Sulphur Works, Bumpass Hell and Devil's Kitchen - looking especially for a particular archaean thermophile called sulfolobus. The sulfolobus habitat is in water around 176^{o}F and an acidic environment that is identified by the hydrogen sulfide "rotten egg" smell.

The samples taken in the Park are returned to the lab and allowed to grow and be experimented with to determined their DNA sequences. As a result, Dr. Steadman and a handful of other scientists have described about 40 new archaean viruses. For him, the beauty of the viral biology itself is more appealing than potential applications for swine feed and paper pulping. He is trying to understand the biology instead of just crunching DNA up and spitting it out. Industry, on the other hand, is hoping the virus cells contain the genetic codes for thousand of enzymes, proteins that act as catalysts for chemical reactions. Dutch scientists may have triggered sulfolobus to produce the enzyme that breaks down cellulose, the woody material in paper. Paper companies, who pulping processes operate at high temperatures, are interested. Diversa, a San Diego-based biotech company, is looking at the possibility for the animal feed market--which could enhance nutrient digestion in pigs and chickens, and reduce the harsh wastes the animals produce. (Eric K. Hand, 2002. "A Nose for Viruses," *Oregonian* (August 21), Portland, OR, pp. A17-A18).

HAWAII

Tropical Ponds Hawaii, Puna, Hawaii

Tropical Ponds Hawaii are located on the "Big Island" near Puna adjacent to the PGV 30-MWe geothermal power plant. This is an aquaculture facility consisting of 34 ponds with two acres of water surface. They have been raising sword tails, platties, guppies and gourami since 1993, which are shipped to the West Coast market. The facility uses a well provided by PGV with 110ºF water at about 10 gpm. The ponds are kept at 72ºF. Plans are to expand to 10 acres. (Personal visit by John Lund, Jan. 2004).

AUSTRALIA

Sit and Soak - Brothers with a Dream are Tapping Geothermal Water under Victoria, Australia for a Japanese-Style Resort and Spa Complex

Charles and Richardson Davidson have a dream–to tap vast reservoirs of geothermal water lying under the southern region of Victoria in Australia for a Japanese-style spa resort. The brothers are making that dream a reality with development of a $30-million complex on a 42-acre property in the rolling hills of "The Cups" on the Mornington Peninsula, about an hour's drive south of Melbourne.

Before selecting and purchasing the property, the brothers engaged geothermal consulting firm Sinclair Knight Merz (SKM - Auckland, NZ) to identify the optimal location for a reliable and sustainable supply of high-quality geothermal water, and to provide siting advice for the spa and resort.

SKM Senior Hydrogeologist David Stanley says the existence of low-temperature (86 to 158ºC) geothermal groundwater has been known across Victoria for years, from drilling for petroleum and water wells for stock, irrigation and urban supplies. "The major Selwyn Fault runs across the Mornington Peninsula," says Stanley. "It is believed that the origin of geothermal water in the region is an upwelling of deep circulating fluids along the fault," he explains. "As they rise toward the surface, the geothermal waters are accessible by drilling in the vicinity of the fault line."

Preliminary sampling studies carried out on a groundwater observation borehole near the proposed resort site confirmed that mineralized water–at a temperature of about 122ºC–is present at depths of little more than 1640 ft that can be produced at flow rates of 320 gpm. "Hydrochemical analysis established that the water is somewhat saline and contains elevated bicarbonate levels, making it ideal for spa bathing applications," Stanley said. Wells drilled within the development site subsequently confirmed the tests.

Extraction wells are complete and waters have begun to flow, making it possible for the Davidsons to move to the next phase of their project to bring geothermal hot spring bathing to Victoria. "We are currently evaluating the extraction bore test results and considering other options for using the geothermal water, such as hydronic heating and aquaculture," says Stanley. "We are also planning a 130-ft well into a shallow aquifer lying under the Davidson's property to provide additional water at a temperature of 15ºC, suitable for irrigating the resort's gardens and topping off its proposed lakes."

To ensure that the development has a sustainable outcome, the resort's geothermal water delivery process will include injection back into the underlying aquifer. SKM has supervised critical phases of the geothermal drilling process and has represented the Davidson bothers at local government meetings. In addition, SKM successfully negotiated and secured the project's extraction and injection licenses from Southern Rural Water and the Victoria Environmental Protection Agency.

All planning approvals for the Davidson's Bathe Peninsula Hot Springs Resort have been secured and master plans completed. Design is being carried out by Gregory Burgess Pty., Ltd. Architects (Victoria, Australia), with construction expected to be completed within two years. The complex will offer both indoor and outdoor geothermal bathing, complete with a hotel, private cottages, convention facilities, massage and therapy services, a restaurant, gift shop and geothermal education facilities. The resort will also feature its own food production area with greenhouses, aquaculture and a vineyard.

In January , the Davidsons built a significantly smaller spa within a 5 min walk from the Bathe resort site. Called Mizu, it is meant to draw local attention to Japanese-style spa bathing in anticipation of the larger facility to come. With groundwater heated by natural gas, Mizu offers a complete bathing, culinary and relaxation experience on a 7-acre property with a vineyard, cellar, sauna and steam room, two outdoor baths, relaxation room and pool. Called a "boutique" spa, Mizu is limited to six overnight visitors, making it among the most intimate of private resort spas.

Sinclair Knight Merz is a leading multi-disciplinary consulting firm, employing close to 3,000 people in offices across Australia, New Zealand, Europe, South East Asia, the Pacific and South America. It is highly regarded for its hydrogeological and hydrological project work, and for its development of geothermal power stations across the globe. For further information on the Bathe Resort and Spa Project, contact David Stanley, Senior Hydrogeologist, Sinclair Knight Merz, 25 Tead Street, PO Box 9806, Newmarket, Auckland, New Zealand. Phone: +613 9248 3306. Email: dstanley@skm.com.au. The Davidson's website can be found at: www.bathe.com.au.

GRC 2004
ANNUAL MEETING

Plan now to submit your technical work for presentation and participation at the GRC 2004 Annual Meeting , on August 29 - September 1, 2004, at the Hyatt Grand Champions Resort near sunny Palm Springs, California. The deadline for draft papers is April 16th and for the final papers, it is May 28th. Through a special arrangement with the hotel, GRC room rates will be an affordable $109/night in first-rate accommodations at this truly splendid resort. The meeting will include the GRC's traditional Technical and Poster Sessions, Opening Session, Annual Banquet, Workshops and Field Trips to nearby geothermal power operations such as Coso, the Salton Sea and Imperial Valley, and Cerro Prieto in Baja, Mexico. The 2004 Annual Meeting Committee will release information in the *GRC Bulletin* and on their website: (www.geothermal.org) as planning progresses.

WORLD GEOTHERMAL
CONGRESS 2005

The World Geothermal Congress 2005 (WGC2005) will be convened on April 24 - 29, 2005, in Antalya, Turkey. The event is a cooperative effort of the International Geothermal Association and the Turkish Geothermal Association. The national government of Turkey, along with several provincial and local governments, have offered support for the conference. Antalya is a major resort city with a population of over one-half million on Turkey's southern coast. The conference will feature pre-meeting field trips, short courses, a technical program of up to five days in length, a technical exhibition and social/cultural programs. More information is available on the conference website at: www.wgc2005.org.

WGC2005 Call for Papers

Authors are invited to submit abstracts for WGC2005. Papers may be presented verbally or as posters. The official language of the event is English. Deadline for submission of abstracts is January 2004. Accepted papers must be submitted by May 2004. Papers will be reviewed, and if necessary, edited by November 2004. Note that only authors of accepted papers are eligible for financial support. All paper will be in English. Abstracts can be submitted online at : www.wgc2005.org/. They can also be faxed to Technical Program Chairman Prof. Roland N. Horne at: (650) 725-2099.