Medicine Lake Milestones

Maurice Richard, Project Manager, Calpine Corporation (San Jose, CA)
Dale Shuster, Project Manager, California Energy General Corp. (Omaha, NB)
and David McClain, DW McClain & Associates (Beaverton, OR)

Power plant projects proposed by Calpine Corp. and California Energy General Corp. (CalEnergy) in Northern California's Medicine Lake Highlands mark a new era in the development of U.S. geothermal energy resources. Planned for construction on sites in the Klamath and Modoc National Forests, Calpine's 49.9 megawatt (MW) Fourmile Hill and CalEnergy's 48-MW Telephone Flat projects are the first major geothermal power facilities to be reviewed in the context of a deregulated market for electricity.

Geothermal power development plateaued during the past decade as the result of low demand for new power plants in the western United States, undervaluation of geothermal's environmental advantages, and lack of access to the ultimate consumer. Construction of the Fourmile Hill and Telephone Flat projects, however, would change that trend in ways that spell new opportunities for U.S. geothermal power development.

Electric power reserve margins in Northern California recently dropped into single digits, and new power capacity appears to be needed by 2000. In addition, most of California's (and the nation's) power plants are old, inefficient, and major pollution sources that must be replaced. Electric utility deregulation and consumer choice add yet another wrinkle to power capacity planning.

A new "green market" for environmentally friendly electricity is now developing in California and across the country, in which retail consumers will have a voice in new power plant selection decisions. Consumer demand is the best endorsement for clean, reliable geothermal power. Economic votes by environmentally conscious consumers for non-polluting power plants mean that more geothermal facilities like Fourmile Hill and Telephone Flat will be needed.

Other incentives, both state and national, will help geothermal energy succeed in the evolving power market. For example, the California Assembly's approval of $162 million of support for new renewable resources as part of its AB 1890 deregulation package should assist the launch of several power plants. The legislature wisely included this green power incentive in response to strong interest from California consumers—many of whom consider environmental protection a priority.

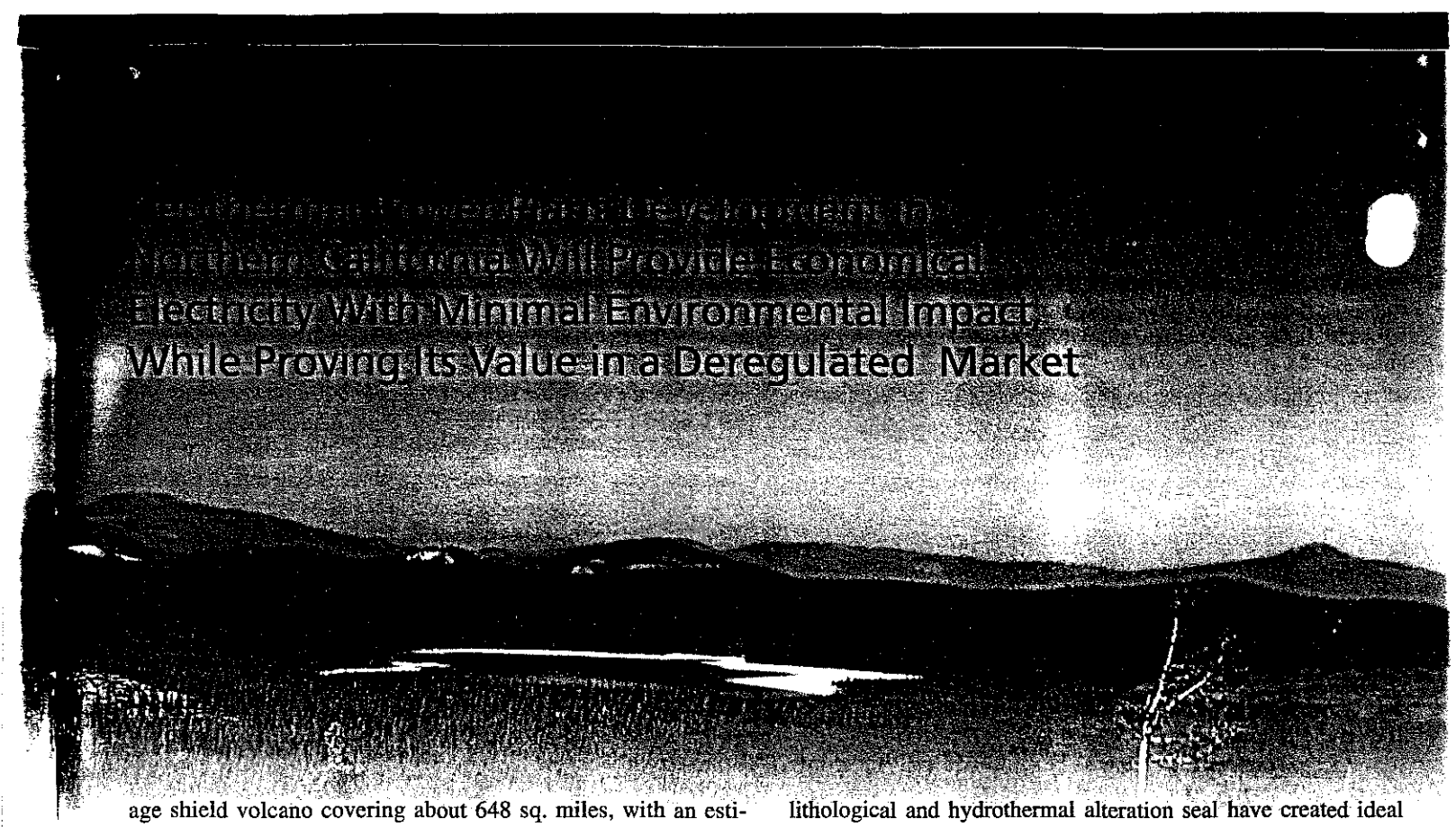
A Renewable Portfolio Standard (RPS) is a central part of the Clinton Administration's federal electric utility deregulation proposal. The provision would require that a certain percentage of power on the grid be available from clean, renewable power sources like geothermal. With increasing concerns about global climate change in the forefront of the news, enactment of a national RPS—and the new demand for renewable energy it will create—seems a reasonable bet.

Federal, state and local approvals of Calpine's Fourmile Hill and CalEnergy's Telephone Flat projects will mark the first large-scale, geothermal power plants cleared for construction in California's new era of deregulated electric power. The projects promise minimal environmental impacts, while offering a number of positive societal and economic benefits to the region surrounding the Medicine Lake Highlands. And they will showcase the need for continued geothermal power development to satisfy increasing energy demand while helping the nation achieve its environmental and climate change goals.

Geological Setting

The Medicine Lake Highlands are located in north-central California in eastern Siskiyou County and western Modoc County. To the north lies the Tule Lake region and Lava Beds National Monument. To the east lies the Modoc Plateau, the Mount Warner Wilderness, Surprise Valley and Alturas, CA. To the south lies the Pit River, the Fall River Valley and McArthur, CA. To the west lie the Cascade Mountains and Mount Shasta.

The Medicine Lake Volcano is located east of the Cascade Mountain Range Province and west of the Basin & Range Province. The Medicine Lake Highlands is a Pleistocene- to Holocene-



Northern California Will Provide Economical Electricity With Minimal Environmental Impact While Proving Its Value in a Deregulated Market

age shield volcano covering about 648 sq. miles, with an estimated volume of 130 cubic miles. The topography and geology of the Medicine Lake Highlands have been significantly influenced by tectonic forces within the geomorphological provinces in which it lies.

At least 17 eruptions of the Medicine Lake Volcano have occurred in the last 12,000 years, with the most recent about 900 years ago. The large, gently sloping volcano is about 20 miles in diameter, with an elliptical upper rampart formed by cones and domes. Medicine Lake is located in a large, crater-like depression at the summit of the volcano, which is thought to have collapsed to form its large, elliptical caldera.

Fractures along the volcano's edge served as conduits for flows of andesitic lava, forming cones that eventually obscured the boundaries of the original caldera and spilled over the outer flanks of the shield. These rim volcanoes along the former caldera rim eventually created the present constructional basin. Recent eruptions of more silicic lava, such as dacites and rhyolites that overlie the post-caldera andesites, are predominately found in the center of the 4x6-mile basin and along its ramparts.

Concurrent with the silicic eruptions, basaltic lava erupted along vents at the lower flanks of the shield. These basalt flows formed the Lava Beds National Monument on the north side of the shield and the Burnt Lava Flow along its south flank. In the Modoc Plateau, the general north-south striking faults associated with the Basin & Range Province also permeate the volcano with many fissures, vents, craters and cinder cones, showing distinct linear alignments associated with either the regional structural trends or the circular rampart surrounding the Medicine Lake Basin.

The silicic intrusions associated with younger volcanic systems in the Medicine Lake Highlands are believed to be the heat source for the geothermal systems discovered in the area. A combination of shallow heat source, permeable subsurface rocks and a lithological and hydrothermal alteration seal have created ideal conditions for a geothermal reservoir. The geothermal system is a liquid-dominated, possibly two-phase (boiling liquid and vapor) hydrothermal system probably related to the recent silicic intrusions and regional fault systems.

Geothermal Development History

The Medicine Lake Highlands has been the focus of geothermal interest since the mid-1960s. With the Geothermal Steam Act of 1970, a regulatory framework was developed to authorize geothermal exploration and leasing on federal lands in the area. Reviews of the geology and recent volcanism in the Medicine Lake Highlands by the U.S. Geological Survey (USGS) led to designation of the Glass Mountain Known Geothermal Resource Area (KGRA) and offers of federal leases by competitive bid.

Initial designation of lease areas by the USGS in December 1970 incorporated 15,371 acres into the Glass Mountain KGRA. Subsequent work included the drilling of five temperature-gradient boreholes in the area during 1982, which led to expansion of the KGRA to 134,254 acres by 1983.

Issuance of federal leases began in 1982, after preparation of a U.S. Forest Service (USFS) Environmental Assessment for exploration that resulted in two competitive bid sales for more than 32,500 acres. The 1983 KGRA expansion led to a joint USFS/Bureau of Land Management (BLM) supplemental Environmental Assessment for geothermal exploration, development and utilization. In 1988, a third competitive bid sale resulted in geothermal development leases covering 38,283 acres.

In May 1982, major geothermal operators formed the Glass Mountain Unit Area. Between 1981 and 1984, they drilled 24 temperature-gradient boreholes that led to deep exploration drilling. The first deep exploration test hole, Well 17A-6, was drilled by Occidental Geothermal (Oxy) and Phillips Petroleum. Unocal C[illegible] drilled three deep exploration holes, Well 68-8 in 1985, Well 31-

17 in 1988, and Well 87-13 in 1989.

Between 1992 and 1997, Calpine obtained its current interest in the Phillips and Oxy leases, and CalEnergy acquired Unocal's leases in the Glass Mountain Unit Area.

Calpine began development activities at its Fourmile Hill lease area in 1994 after successfully completing a deep temperature gradient borehole. An environmental assessment for the company's exploration drilling program was approved in 1996. Calpine then initiated its Environmental Impact Statement (EIS) process, and submitted an operations plan for a 49.9-MW power plant and 23-mile transmission line.

In 1995, CalEnergy submitted an exploration plan and Environmental Assessment for five deep test wells in its Telephone Flat lease area. In 1996, the company submitted an operations plan for a 30-MW, dual-flash geothermal power plant, wellfield and transmission line. With additional leases the plan was modified to accommodate a 48-MW project. CalEnergy's application was based on the three wells it acquired from Unocal that together defined the geothermal reservoir.

Prior to development, Calpine's Fourmile Hill and CalEnergy's Telephone Flat projects required completion and approval of separate, site-specific EISs under the National Environmental Policy Act (NEPA), and Environmental Impact Reports (EIR) under the California Environmental Quality Act (CEQA).

Projects Description

Calpine's Fourmile Hill and CalEnergy's Telephone Flat projects will respectively consist of 49.9-MW and 48-MW dual-flash geothermal power plants, with wet cooling towers, steam production wells, injection wells, steam separators, above-ground pipelines and 230 kV transmission lines. The new power lines will connect with an existing Bonneville Power Administration (BPA) transmission line near Tionesta, CA, some 22 miles east of the Glass Mountain KGRA.

BPA will be the primary customer for electricity generated by both projects; excess power will be offered to marketers and wholesale customers nationwide through the California Power Exchange.

Project facilities will occupy surface locations previously impacted by timber harvesting. Each project will require 10 to 12 production wells to produce geothermal fluids (steam and hot water), and three to five injection wells to return spent fluids, condensate and cooling tower blowdown to the geothermal reservoir. Pads for both production and injection wells will cover approximately 400 square feet, and each will accommodate two to four directionally drilled wells. Spaced to optimize field development, the pads will incorporate sumps for drilling fluid storage.

At both projects, flash units will separate high- and low-pressure steam from produced geothermal fluids. The steam will flow through above-ground, insulated pipelines to the power plants, while residual fluids (excess condensate and cooling tower overflow) will be sent to injection wells. Eighty percent of produced geothermal resources will be returned to the deep reservoir through injection. Wherever possible, all surface pipelines will be routed through existing cleared areas and along logging roads.

Approximately two percent of produced geothermal resources at each project will be non-condensable gas, of which 98 percent will be carbon dioxide (CO_2) and two percent hydrogen sulfide (H_2S). The $C0_2$ will be vented to cooling towers, and 99 percent of the H_2S will be processed through emission control systems that convert the gas to elemental sulfur for sale in regional markets.

To attenuate operations noise, turbine-generators and control rooms for the Fourmile Hill and Telephone Flat power plants will be housed in metal buildings. Covering approximately 15,000 square feet and approaching 70-feet tall, the buildings will be painted with colors compatible to the surrounding forest. Cooling of spent fluids will be accomplished in seven- to ten-cell, mechanical draft, evaporative towers approximately the same height as the operations buildings.

Calpine's Fourmile Hill project includes a new, 230 kV transmission line, supported by H-frame wood-poles in a 100-ft. wide corridor. Clearing limits will minimize forest habitat impacts. CalEnergy's Telephone Flat connector line will merge with Calpine's transmission line approximately halfway between the Fourmile Hill Power Plant and the BPA intertie 22 miles to the east of the Glass Mountain KGRA.

Implementation schedules for the Fourmile Hill and Telephone Flat geothermal power projects forecast regulatory approvals during 1998, with drilling and significant construction activities starting in 1999. Both projects will be decommissioned after decades of operation, followed by restoration of the sites to pre-project condition.

Environmental Issues

The Fourmile Hill and Telephone Flat projects present excellent case studies of the many environmental issues that must be addressed and minimized to develop geothermal resources. Before construction of either geothermal project can begin, their development and operations plans must undergo rigorous social, economic and environmental tests by many constituencies. The process includes separate approvals by three federal agencies and the need to secure several state permits.

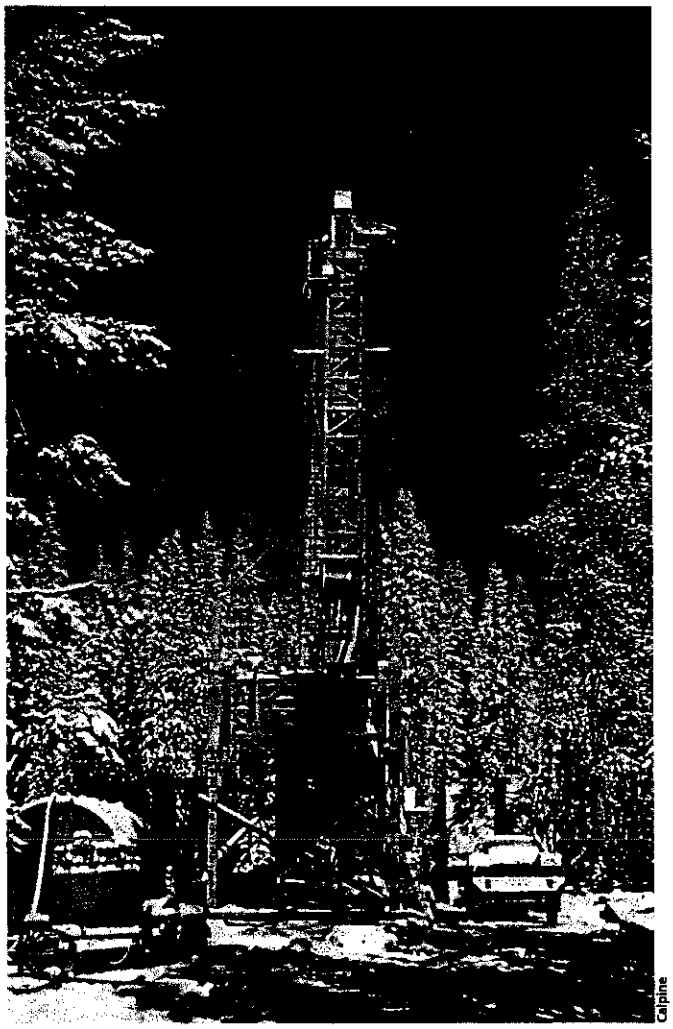
To minimize and abate environmental impacts, both geothermal power projects incorporate extensive monitoring, mitigation and reporting programs. These include attention to local geology, soils and hydrology, as well as to air quality, noise, vegetation and wildlife. Equally important considerations include effects on local transportation systems, cultural values, recreation opportunities, and above all—human health and safety.

Efforts by Calpine and CalEnergy to protect these values as their projects proceed in the Medicine Lake Highlands have produced some of the most stringent environmental safeguards in the history of U.S. geothermal power development. Sites and transmission line corridors for the Fourmile Hill and Telephone Flat power plants have been intensely studied to establish baseline data for their EISs, stakeholder comments have been solicited, and several public scoping meetings have been held in conjunction with project environmental reviews.

Environmental analysis for the Fourmile Hill Project was prepared by MHA Environmental Consulting Inc. (MHA), and for the Telephone Flat Project by Environmental Management Asso-

ciates. In general, both studies found that potential environmental impacts were below levels of significance defined under NEPA and CEQA for all issues except impacts on Native American traditional cultural uses.

Air Quality. Air emissions associated with geothermal power plants can come from well drilling, well testing, plant operations and plant upsets. To develop dispersion models used to predict air quality impacts, Calpine and CalEnergy collected two years of baseline meteorological data. All operating scenarios and possible combinations were accounted for with the U.S. Environmental Protection Agency's Industrial Source Complex Model (ISC3), which considers local worst-case meteorological conditions, topography, and emission source and type. The projects are designed to control and abate H_2S venting in compliance with California's one-hour, odor threshold standard. Dispersion modeling indicates that project operations and emissions abatement plans will meet or exceed all federal and state ambient air quality standards. Modeling also indicates no significant air quality impact on summer homes and campgrounds near Medicine Lake or other significant uses in the highlands area. Similarly, no significant impacts on surface water quality or nearby vegetation are expected from airborne salt and metals deposition.



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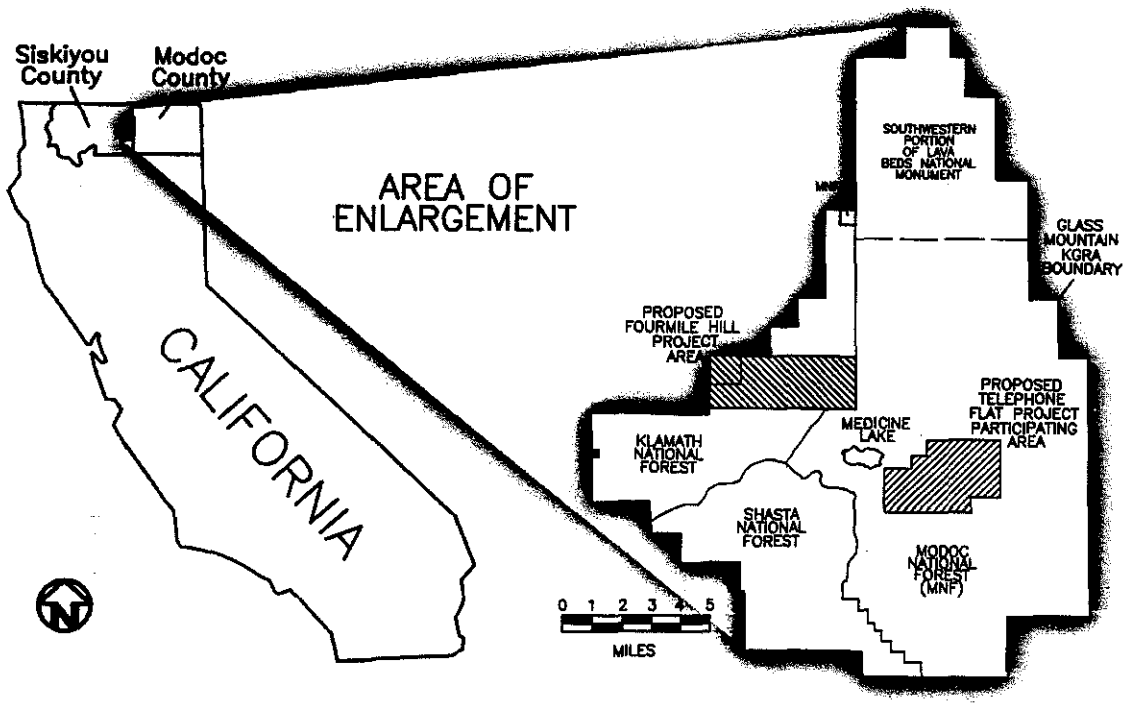
Surface and Ground Waters. An independent review of all available proprietary data and public information established hydrological baselines for the Medicine Lake Highlands from the Tule Lake Basin to the Fall River Valley. Though the area holds several small lakes and springs emanating from shallow groundwater systems, environmental analysis concludes that the Fourmile Hill and Telephone Flat projects will have no significant effect on either the quality or availability of water in the Medicine Lake Basin and region surrounding the highlands. Both projects are designed to protect water quality by avoiding surface waters and drainages leading to these areas, and by casing wells to isolate and protect shallow groundwater zones from deeper geothermal fluid production zones. Water supply wells in the Medicine Lake Basin will be used for construction, drilling and operations support. Water consumption is expected to peak during project construction, and the total amount of water consumed during this period will be less than one percent of annual average groundwater recharge into the basin. Water for power plant operations will be acquired from turbine condensate, not groundwater.

Endangered and Special Status Species. Previous timber harvesting operations have substantially changed the environment of the Medicine Lake Highlands. Biological analysis concluded that the Fourmile Hill and Telephone Flat projects will pose no significant impact to any rare, threatened, endangered or special status wildlife and plant species, for which the area was inventoried. Habitat types were mapped, noting unique plant colonies, meadows, wetlands and active nesting sites. The surveys found several areas with special-status plants and one area of special-status wildlife species, forcing adjustments to well pad and pipeline placement plans. Bald eagle and northern spotted owl nesting and roosting sites can be found in the Medicine Lake Highlands, but none were located in the project areas. Transmission line route will pass through some areas of potential owl habitat, but there are no known nesting pairs along the route. Additional surveys prior to construction will ensure that any active or potential nesting and roosting sites are avoided. Most wildlife habitat impacts will be mitigated through revegetation programs and the creation of offset habitat elsewhere within the national forest.

Snowmobile Recreation. Several roads into the Fourmile Hill and Telephone Flat project areas are currently used for snowmobile trails. Some of these roads will be plowed in winter for project access. Snowmobile recreation impacts will be offset by creating new trail areas and by developing or improving a new snowmobile park adjacent to the plowed roads. The developers have agreed to assist in creating improved snowpark facilities that will provide a high-elevation access point that currently does not exist. In addition, Calpine and CalEnergy will work with the USFS and a local snowmobile club to provide a refueling station for trail-grooming equipment, and provide access to emergency first aid and telecommunications equipment at their power plants.



Medicine Lake Recreation Areas. The Fourmile Hill and Telephone Flat projects were designed to avoid direct impacts to recreation areas immediately surrounding Medicine Lake and other established camping areas. In essence, visitors and other users who frequent forest campgrounds and other areas will not be impacted by the geothermal projects or their operations. Air quality, visual and noise impact analyses were conducted to determine direct, indirect and cumulative effects on recreation. Air dispersion and noise modeling completed for environmental analyses used private home and campground areas adjacent to Medicine Lake as sensitive receptor sites for predicting impact levels. Federal, state and county standards for ambient air quality and noise were met (and fell substantially below requirements) in all operating scenarios. Calpine and CalEnergy will institute air quality and noise monitoring programs during project construction to ensure that recreation impacts are not significant.

Native American Cultural Uses. The Medicine Lake Highlands has a long history of Native American use as spiritual place and source of obsidian for arrowheads, tools and trade. Calpine and CalEnergy conducted inventories at each project area, finding that wellfield and power plant areas did not contain significant archeological sites. A potential for buried sites along project transmission line corridors prompted the companies to propose additional inventories and monitoring during construction. By law, access and ceremonial use of sacred sites by native religious practitioners must be accommodated on federal lands, and adverse physical impacts to such sites avoided. In 1997, MHA completed a Calpine-sponsored ethnographic study of the Medicine Lake Highlands which established a baseline of places with traditional or religious significance. CalEnergy conducted additional interviews with members of the Klamath Modoc and Pit River tribes during the same year. It was determined that neither power plant project will directly nor significantly impact identified traditional cultural sites and spiritual uses. Even so, the Pit River Tribes believe that geothermal development will adversely affect the area's sacred integrity, even though that integrity has already been violated by recreational development, logging activities and road construction. The Klamath Modoc tribes, on the other hand, have been willing to discuss mitigation programs. CalEnergy has negotiated a separate Memorandum of Agreement with the Klamath Modoc Tribes which agrees to specific operating procedures and mitigation efforts to protect traditional cultural uses.

Regional Economic Benefits

The Fourmile Hill and Telephone Flat geothermal projects will provide significant benefits to the economy of California, in addition to the local and regional economies surrounding the Medicine Lake Highlands. According to experts at the World Bank and other major financial institutions, the "multiplier effect" of the approximately $90-million Telephone Flat and Fourmile Hill projects will generate about three times their total value—or $540 million—in regional economic benefits over their projected life spans.

Employment payroll during project construction will offer immediate local benefits that will continue with operations and maintenance workers as the power plants are completed. In addition to payroll taxes to the state, California and Siskiyou County will benefit from a substantial share of federal royalty payments, and the county will receive millions of dollars in property taxes throughout the lives of the projects. This new revenue stream is critical for the future of Siskiyou County, which is now suffering from the collapse of its timber industry.

Employment and payroll. The Fourmile Hill and Telephone Flat projects will employ approximately 150 workers each during their construction phases, and approximately 20 permanent operations and maintenance employees each after the power plants are on-line. Construction payroll for each project is estimated at $15 million to $20 million, and operating payroll for each project is estimated at more than $1 million per year.

Royalties. Annual royalties to the federal government from each project are estimated at approximately $650,000. Under current law, the federal government will return 50 percent of those royalties ($325,000 per year from each project) to the State of California, which must pass along 40 percent of the amount received to the county where geothermal production occurs. The 60/40 split of royalty revenues from each project would result in $260,000 of new revenue for Siskiyou County every year.

Property taxes. When completed and on-line, the Fourmile Hill and Telephone Flat geothermal power plant projects would become the largest property taxpayers in Siskiyou County, with an estimated combined total of approximately $2 million per year.

Geothermal Industry Opportunity

The geothermal energy industry as a whole has a significant stake in governmental decisions on development of both Calpine's and CalEnergy's geothermal power plant projects in the Medicine Lake Highlands of Northern California. Indeed, as the first major geothermal power facilities developed in the new deregulated electric generation market, approval and construction of these projects will be milestones for the U.S. domestic geothermal industry.

More importantly, the Fourmile Hill and Telephone Flat projects will provide significant platforms for educating vital public constituencies about the economic, environmental and social benefits of geothermal energy development. With promotion of continuing research, development and demonstration projects to make geothermal cost-competitive with other power sources, this effort will ensure that geothermal energy is considered as a critical component of the nation's power supply both today and into the next millennium.

Editors Note: Calpine's Final Environmental Impact Statement for its Fourmile Hill project will be filed in the *Federal Register* in July, with a Record of Decision expected in October. Hearings on Calpine's county building permit will probably occur in September. CalEnergy distributed its Draft Environmental Impact Statement for the Telephone Flat Project in May. Public comments will be solicited for 60 days, ending on July 22.

The geothermal community is encouraged to submit comments on the Calpine and CalEnergy geothermal power plant projects in Northern California. Contact USFS/BLM Project Leader Randall Sharp with your views at 800 West 12th Street, Alturas, CA 96101. Telephone: (530) 233-8848.