NEVADA DIVISION OF ENVIRONMENTAL PROTECTION
Underground Injection Control Program

UIC PERMIT FACT SHEET

(Pursuant to NAC 445A.874)

Project Name: **Steamboat Geothermal Power Project**
Permittee Name: **Steamboat Geothermal LLC, Steamboat Hills LLC, ORNI 7 LLC, ORNI 6 LLC**
Permit Number: **UNEV2007204**

Note: This permit replaces both previous Steamboat UIC permits UNEV50018 and UNEV70007, due to the acquisition of both projects by Ormat Nevada Inc. in 2006.

A. Description of Discharge

Injection wells: IW-1, IW-2, IW-3, IW-4, IW-5, IW-6, 64A-32, 42-32, 14-33, 14A-33, 23-33, 43-33 and 21-32.

Injection wells and surface basins located in: T17N R20E Sections 5 & 6, T18N R20E Sections 28, 29, 32, & 33, Washoe County.

Cooling tower water (upper plant) is discharged to the injection system, and injected into well 42-32, 21-32 and 64A-32.

Characteristics: All injectate is geothermal fluid (predominantly NaCl with high bicarbonate content) which has passed through six geothermal power plants (binary or flash/binary) located at Steamboat, Nevada. Injectate has a TDS concentration of approximately 2,300 mg/l. The major constituents are fluoride (2.48 mg/l), chloride (800-900 mg/l), arsenic (1.5- 3.2 mg/l), and boron (36.1-42.5 mg/l).

Power Plants the produced geothermal water passes through:

Upper SB plants:
- Steamboat Hills
- Galena 2

Lower SB plants: (Galena 1/1A)
- SB2/3
- Burdette/Galena 1
- Galena 3

2007 Production wells – 17 (5 new proposed)
2016 - Number of Production wells = 23
1) with line shaft pump = 20
2) with submersible = 1
3) number without pump = 2

Historical injection rates (averages for 2007)
- SB I/IA - 4,000 gpm
- SB II/III - 18,000 gpm
- SB Hills – 3,500 gpm

Permittee is requesting potential injection rates up to 45,000 gpm for all injection wells combined.

B. Receiving Water Characteristics

Fluid chemistry of the production and injection wells has been shown to be similar, of geothermal temperature and chemistry. Analysis of the receiving zone indicates boron of 48.8 mg/l; fluoride of 2.4 mg/1; arsenic of 3.2 mg/l; and chloride of 950 mg/l. All available data indicate there is no potable shallow ground water in the immediate area of the power plant, production or injection wells. However, there is high-quality shallow ground water surrounding the project site, to the north of Mt. Rose Hwy, east of Hwy 395 and in the Pleasant Valley area.

Hydrogeologic and water chemistry data indicate the ground water in the immediate area of the lower Steamboat project area/lease is of geothermal nature and exceeds drinking water standards. Monitoring over the last twelve years indicates environmental impacts (water quality and water level elevations) from the existing geothermal power production and injection activities in the area have not occurred. There have been changes in some monitoring wells since original operation began in 1985, however, some changes remain unexplained due to lack of data and spatial/vertical monitoring points, or can be attributed to the monitoring well penetrating the shallow, fresh water zone and the slightly deeper geothermal zone and changes in chemistry occur within the wellbore from declines in fresh water fluxes into area around the well, thus allowing the geothermal component of the lower part to increase the chemistry within the wellbore.

In 2007, NDEP worked with the operator – Ormat, and Washoe Co Water Resources Department (who operates many of the municipal wells in south Reno) to make significant updates in the monitoring program to focus in on areas concern (which included eliminating some wells with private land access issues, including new existing wells for better spatial distribution, and discussed drilling of new dedicated monitoring wells on accessible land (local or state land). Many aspects of the monitoring program itself were discussed and the operator has put together a "Monitoring Program" to ensure more consistency and guidance in sampling and field monitoring in the future.

Public Water System wells – no geothermal injection wells are within 10-year WHPA or DWPA 1, 2, 3. Some injection wells (IW-2, IW-3, 14-33, 23-33) are in the DWPA 4 of the Steamboat Waterworks system wells and STMGID wells.

C. Synopsis

2016 Update

Currently, 13 approved injection well of 13 permitted. Added injection wells 43-33 and 21-32. Each one of these wells had new monitoring wells (one and two, respectively) installed near well location due to the injection well locations on the edge of the project. 23 production wells are in operation. Ormat is not planning on any additional field changes in the coming years.

2014 Update

Currently, 22 production wells, and 9 injection wells

Ormat is proposing to drill new injection well(s) and convert existing wells to injection wells to better manage the resource. These wells are new well 21-32 (NW of 42-32), and existing wells 14-33 and 14A-33. Also, planed is to stop injection into 23-33 and 64A-32.

2007 Events

March 25, 2008 – approve rate increase in 42-32 for higher than 4,000 – up to approx. 6,000 gpm
February 12, 2008 – approve rate increase in 42-32 to 4,000 gpm
February 6, 2008 – Rec'd TPH SOC Item results
November 30, 2007 – Original Permit issued
November 7, 2007 – 42-32 online at low injection rate
September 2007 – Tracer test started
June 30, 1987 - Original UNEV70007 permit issued
September 26, 1986- Original UNEV50018 permit issued

The applicant (Ormat Nevada Inc.) is seeking issuance of a new permit UNEV2007204 to combine (and renew) two existing permits UNEV50018 & UNEV70007, and proposes to continue injection into IW-1, IW-2, IW-3, IW-4, IW-5, IW-6 and 64A-32 to reinject spent geothermal fluids. Ormat is proposing to add up to an additional six injection wells, including 42-32, 14-33 and 23-33. The water is produced from the operation of the existing, recently constructed and proposed power plants listed above. The existing geothermal electrical generation facility is within the Steamboat Springs Known Geothermal Resource Area.

The injection pressure will be limited so as to not cause any new fractures or open any existing fractures in the formation, increase natural outflow of geothermal water in the surrounding area, or affect the natural geothermal spring dynamics. Historically, injection pressures have been low, generally between 40 - 90 psig, depending on injection well. (Pressure limits are described above in Table 2).

In recent years, two additional power plants have been constructed. Burdette/Galena I, close to the lower power plants, which was put online in 2006, however did not require additional geothermal water to operate. Galena 2 is a binary plant which has not been put online as of June 2007, but should come online later this year. It will use liquid brine from production wells on the hill, and increase the output from the upper Steamboat production.

2003-2005 Events

It was found that the CoxI-1 injection well used as the sole injection well for the

Steamboat Hills flash plant had many corroded zones in the casing and could not be repaired. CoxI-1 well was subsequently plugged after a new injection well had been completed – 64A-32. Well 64-32 was drilled, however due to loss circulation zones, casing was not set properly and parted, causing the well to be unrepairable and required plugging. After plugging 64-32, well 64A-32 was drilled and was approved in December 2004. After being online for 1 ½ years, it was found in December 2006, the liner lap was leaking in 64A-32 after running a temperature/spinner log. The well was taken offline, and repaired in January 2007. 64A-32 was put back online.

Well 42-32 was drilled in September 2005, however, due to questions surrounding water quality degradation, the well has not been approved by NDEP for injection. In June 2007, it was found that there are holes in the casing, probably due to corrosion while sitting idle for the last two years.

Historical Notes

The Steamboat Hot Springs Geothermal Area is located in southern Washoe County, 10 miles south of Reno. The geothermal reservoir is confined to Cretaceous granodiorite, Tertiary volcanics and Quaternary siliceous sinter. Steeply dipping, northeast to occasional northwest trending faults control the flow of geothermal waters. There is evidence of horizontal structure/ movement of geothermal water in some zones – mostly in the granitic rock. Ground water in the area outside the project area is influenced by natural geothermal activity, as evidenced by high temperatures, arsenic, boron and chloride. "Productive" geothermal horizons lie below depths of 400 feet below ground surface in fractured volcanics and granodiorite.

In addition to confirming the injection zone waters are similar in quality to the production fluids (i.e. both are within the geothermal reservoir), the other major concern is that the production and injection fluids do not cause degradation to the surrounding surface or "fresh" ground water zones. The Steamboat geothermal system is a complex system. The most extensive work on the system was done by Donald E. White, a geologist with the U.S. Geological Survey. White's reports and work conducted by others indicate a high degree of fluctuation in the natural geothermal discharge from the system to the surrounding surface and ground waters.

This variation is due to such factors as yearly and seasonal changes in precipitation, changes in barometric pressure, earth tides, local earthquakes, discharge from geothermal wells, and other random short-term events (White, 1968, USGS Prof. Paper 458-C, 109p.). Recent studies conducted by P.C. Van de Kamp and C.B. Goranson indicate regional groundwater decline during the drought period (1986 to 1997) and consequent reduction in freshwater heads. This has resulted in a greater influx of geothermal waters containing high amounts of dissolved salts from shallow subsurface sources into the ground water aquifers (April, 1990).

1998 Changes

Some constituents were dropped from sampling requirements due to the absence in historical sampling results. Some constituents have been added, such as lithium and

antimony. Lithium can be used as a geothermal fluid tracer (lithium not generally seen in fresh ground water sources) and antimony is a new drinking water standard. Please note that it is expected that antimony (drinking water standard = 6 ppb) will be found at elevated level in the geothermal fluid as well as selected points in the shallow ground water. The mineral stibnite (Sb_2S_3) is commonly found in the drill cuttings within the geothermal field.

Some sampling points (monitoring wells/surface channels) were dropped due to historically consistent data, only seasonal changes related to flow rate observed. In regards to the creek/ditch measurements, the only influence injection could have on these is if there is increase activity in spring discharge. This has not been observed in the last ten years (it is possible, but not common, for production and injection to either increase or decrease natural surface discharges). Some of the natural surface discharges have ceased (which does occur naturally from time to time). If surface discharges increase in the future and appears to be affecting the surface channels in any way, monitoring at these points may be required again.

The injection rate limit is being increased from 24,000 gpm to 30,000 gpm. The higher value was requested by the permittee to accommodate higher production rates. SB Geo is currently testing submersible pumps and may be replacing the line shaft pumps with submersibles. Submersibles would produce at a higher rate, hence the justification for the limit increase.

** There are numerous factors to weigh when determining the cause of water quality changes within a known geothermal resource area (KGRA). Within the Steamboat KGRA, the following factors have been observed:

1) There are at least two hydrologic systems working in the area, the shallow ground water (mostly outside the geothermal area) and the thermal waters;
2) The shallow ground water is in the alluvial layers north of the Steamboat Hills and in Pleasant Valley, the source being precipitation from the surrounding mountains/highlands/creeks. The shallow ground water typically has a gradient which follows the topography towards local creeks, such as Steamboat Creek;
3) The thermal waters upwell beneath the Steamboat Hills along NNE-trending faults (i.e. the Mud Volcano Fault, and the fissures on the Main Terrace), as well as other minor fault systems, the thermal water have also been discovered as natural discharge zones north of Highway 341/431, and either dominates the well water characteristics or exhibiting a mixing of shallow and thermal waters, once the thermal water migrates up a fracture and discharges into alluvial material, it will move with the shallow ground water, so the influences of thermal water might be seen down gradient of the discharge zones;
4) There is some mounding of the shallow ground water table in the vicinity of the Steamboat Ditch north and south of Mt. Rose Hwy, near some of the monitoring wells (MW);
5) There have been localized areas where shallow ground water moves downward along faults, but this has not been well documented due to the lack of monitoring points;
6) Water quality in the monitoring wells surrounding the project area is a function of the

well's depth and proximity to natural thermal discharge zones. A monitoring well may be of any depth and exhibit thermal water characteristics, shallow ground water characteristics, or a mixture of the two water types;

7) Some MWs might have very warm water, but water chemistry may be similar to shallow ground water, this might indicate conductive heating of shallow ground water from shallow thermal waters which do not mix with the water within the well;
8) Two potential causes of water quality changes in the MWs could be 1) injecting high volumes of produced-geothermal water into a fracture/fault via an injection well and creating an anomaly within a natural thermal water discharge zone, and/or 2) a decrease in the shallow ground water table due to regional over-pumping and/or drought conditions.

D. Procedures for Public Comment

The Notice of the Division's intent to modify and reissue a permit authorizing the facility to discharge to the ground water of the State of Nevada subject to the conditions contained within the permit, is being sent to the *Reno Gazette-Journal* for publication no later than June 26, 2016. The notice is being mailed to interested persons on our mailing list via email. Anyone wishing to comment on the proposed permit issuance can do so in writing for a period of 30 days following the date of the public notice – ending July 29, 2016.

All written comments received during the comment period will be retained and considered in the final determination. A public hearing on the proposed determination can be requested by the applicant, any affected State, any affected interstate agency, the regional administrator of EPA or any interested agency, person or group of persons. Any public hearing determined by the Administrator to be held must be conducted in the geographical area of the proposed discharge or any other area the Administrator determines to be appropriate. All public hearings will be conducted in accordance with NAC 445A.605. The final determination of the Administrator may be appealed to the State Environmental Commission pursuant to NRS 445A.605.

E. Proposed Determination

The Division has made the tentative determination to issue the permit, with conditions under the new monitoring program.

F. Proposed Discharge Limitations and Special Conditions

Injected water will not require treatment prior to injection to improve water quality since the injection zones are of similar quality and geothermal in nature. Extensive monitoring of wells in surrounding are shall be required to ensure offsite degradation does not occur due to injection practices.

G. Rationale for Permit Requirements

Verification that the quality of fluid discharged to the injection well(s) remains

constant, and does not impact regional groundwater. "See 1998 Changes above"

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