

Blundell Geothermal Power Plant

April 22, 2008

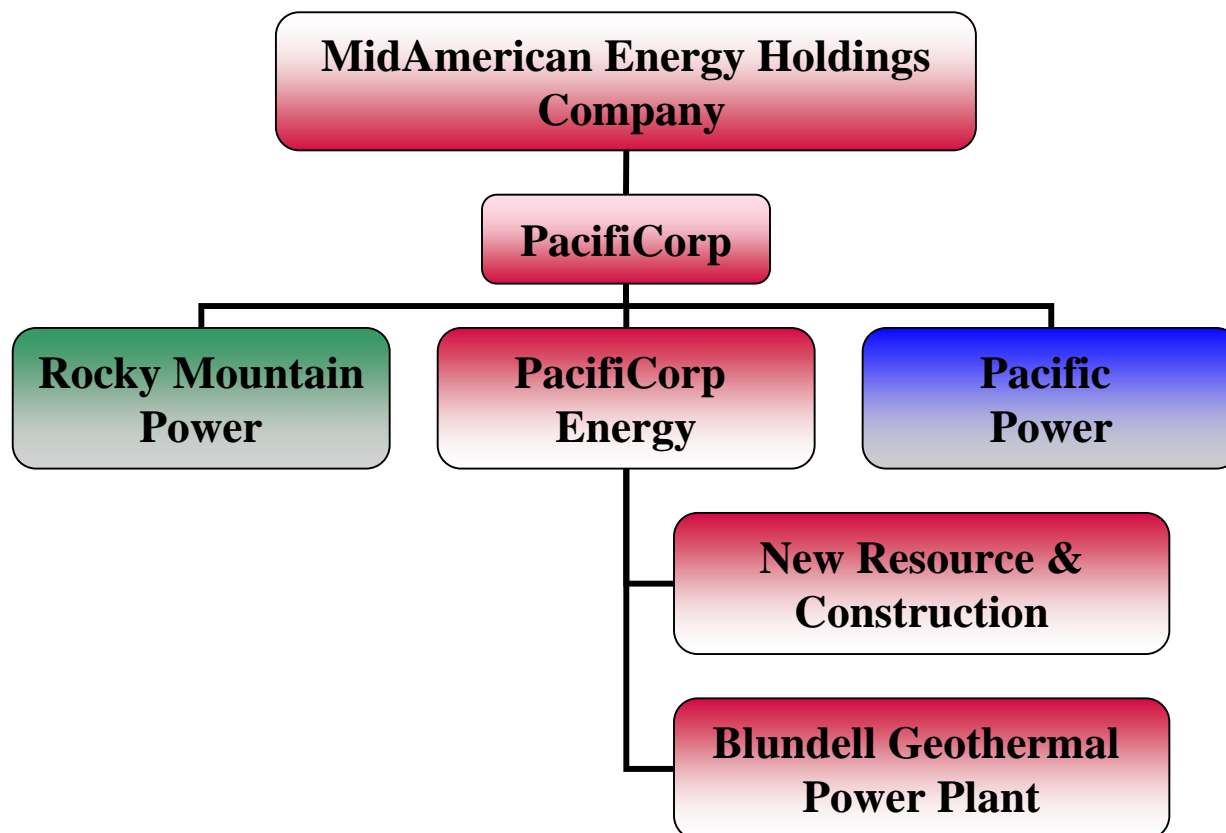
PacifiCorp Energy Representatives

- Garth Larsen
 - ▶ Blundell Geothermal Plant Manager
- Mike Saunders
 - ▶ Blundell Unit 3 Project Manager

Introduction - Agenda

- Blundell Geothermal Power Plant
 - ▶ PacifiCorp Corporate Structure
 - ▶ Roosevelt Hot Springs (KGRA)
 - ▶ History
 - ▶ Blundell Unit 1
 - ▶ Blundell Unit 2
 - ▶ Blundell Unit 3
 - ▶ Other Geothermal Resources

PacifiCorp Corporate Structure

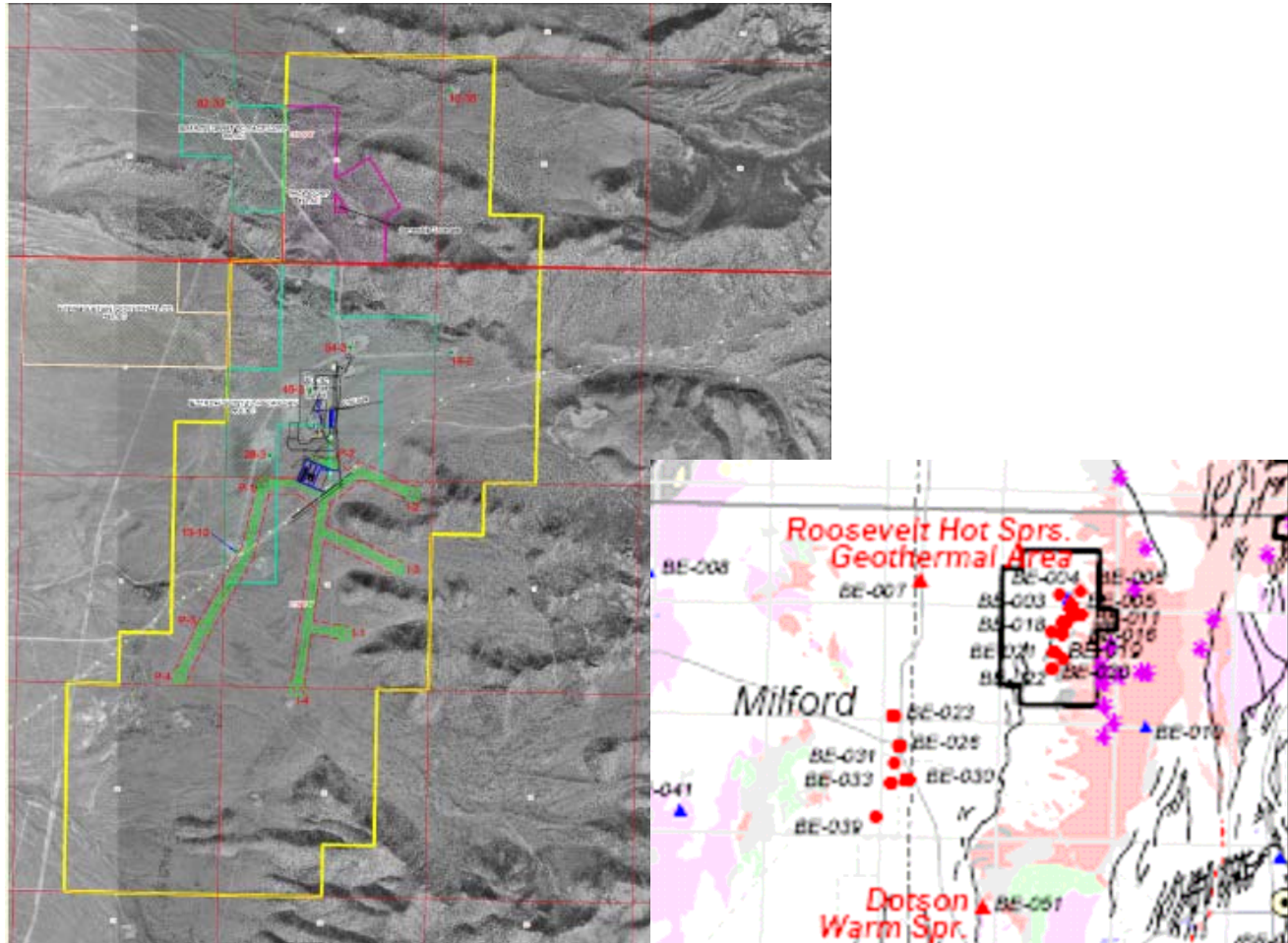


Roosevelt Hot Spring Known Geothermal Area

- Located approximately 15 miles north-east of Milford Utah
- Roosevelt Hot Spring Unit Area
 - ▶ Established in 1976
 - First geothermal Unit Agreement approved by the U.S. Dept. of the Interior
 - ▶ Area is eight (8) miles long by six (6) miles wide
 - ▶ Encompasses 30,720 Acres
- Production depths between 1,253 feet to 7,321 feet
- Reservoir temperatures between 464°F to 514°F



Roosevelt Hot Springs Known Geothermal Area



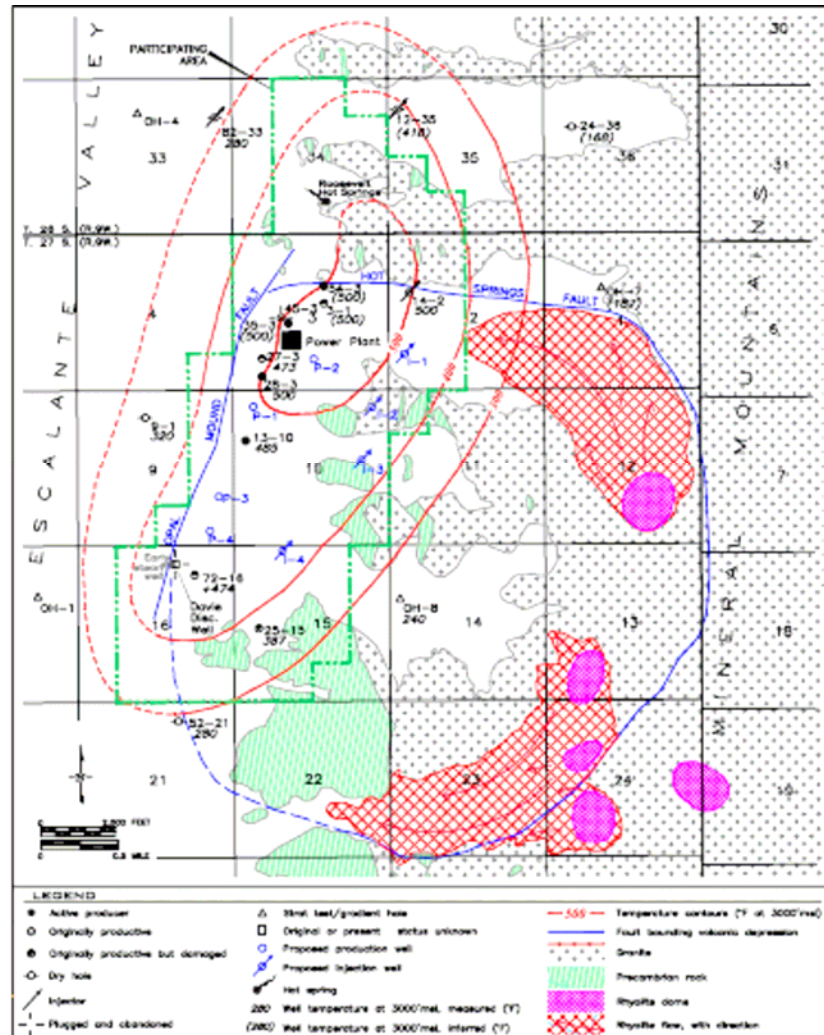
Roosevelt Hot Spring – Geology

- Located in the Basin and Range geological province
- Many systems in the Basin Range province are heated by regional circulation of groundwater.
- Ground water circulation reservoirs temperatures range between 300°F and 400°F
- Roosevelt Hot springs is heated by a young volcanic heat source. Temperatures between 600°F to 400°F.
- Volcanic depression can be seen. (Located south-east of the plant)
- Depression typically forms over rising magma.

Roosevelt Hot Spring – Geology

- Roosevelt has high vertical permeability upward flow zones due to highly fracture rock formations
- Sub-surface fractures allow for circulation of fluid around heat source
- Production zones bordered by the Opal Mound Fault and the Negro Mag Fault
- Geothermal fluid mainly water with a partial steam cap
- Water source is from snow and spring runoff.
- Water is circulated within the reservoir. Higher temperature (lower density) water located near top of the reservoir.

Roosevelt Hot Spring – Geology



Roosevelt Geothermal Hot Spring – Temperature Model

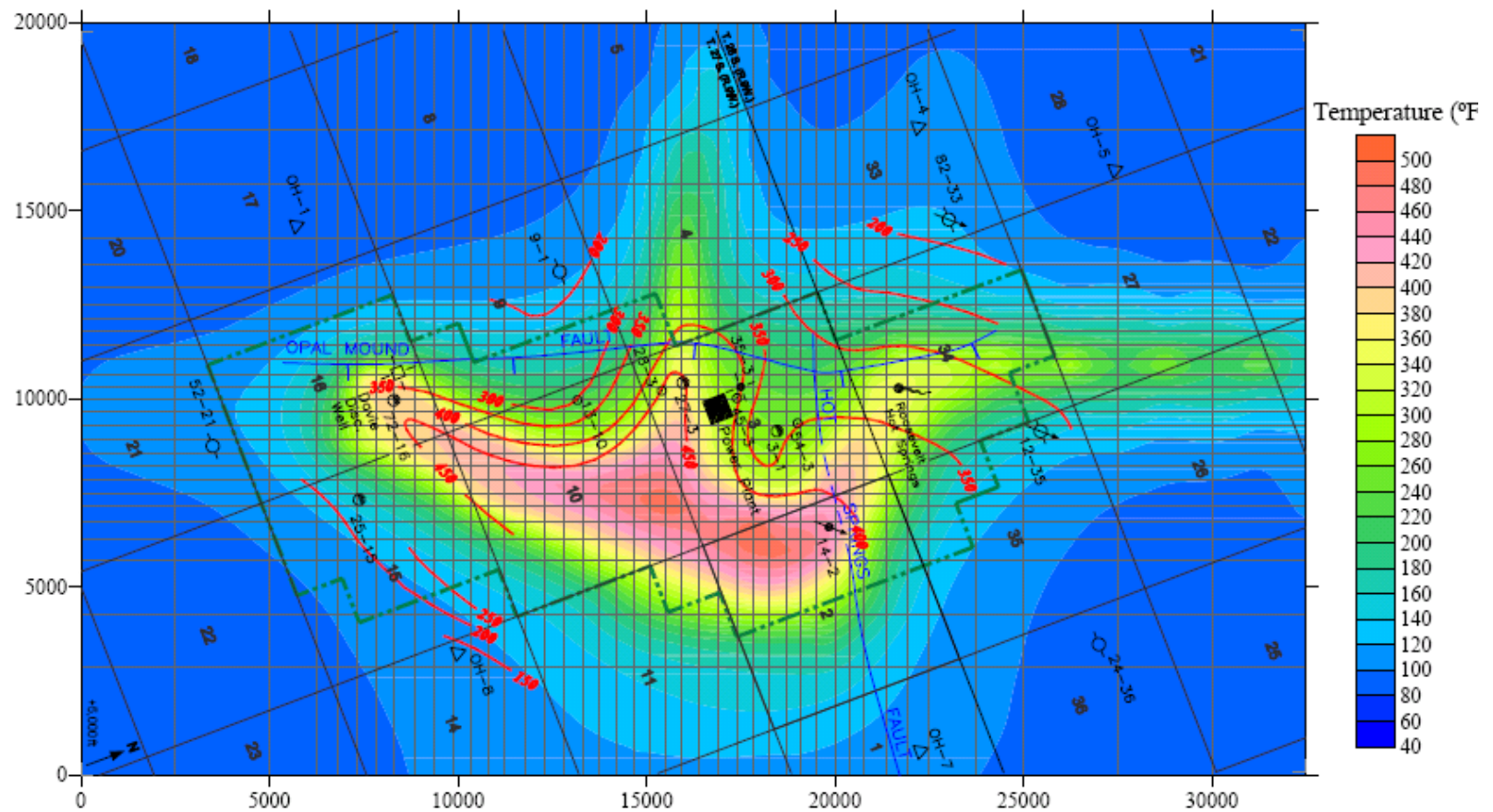


Figure 4.3: Initial State temperature matching, layer 2, at 5000 ft, msl

2007, GeothermEx, Inc.

Roosevelt Geothermal Hot Spring – Temperature Model

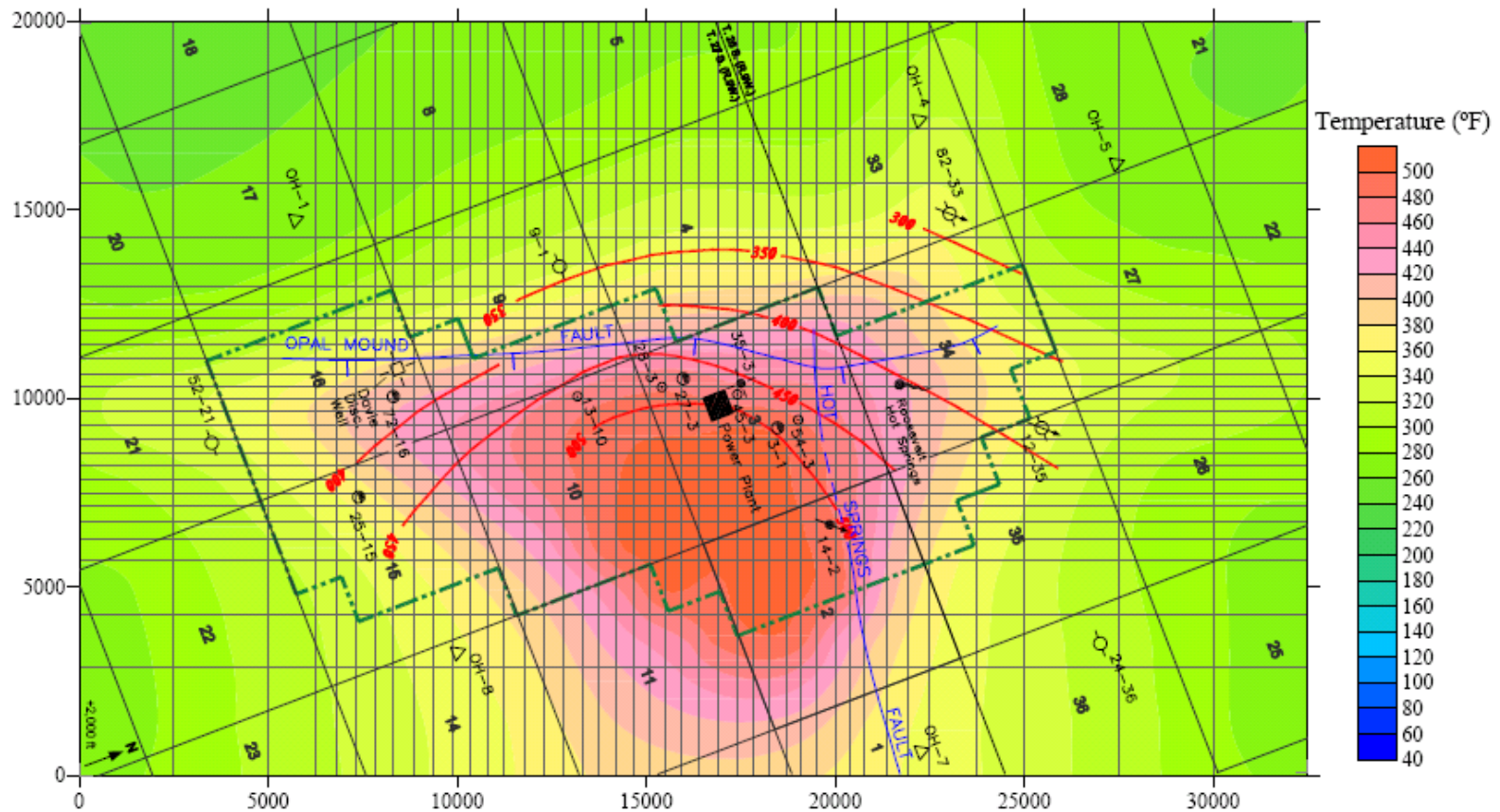


Figure 4.6: Initial State temperature matching, layer 5, at 2000 ft, msl

2007, GeothermEx, Inc.

Roosevelt Geothermal Hot Spring – Temperature Model

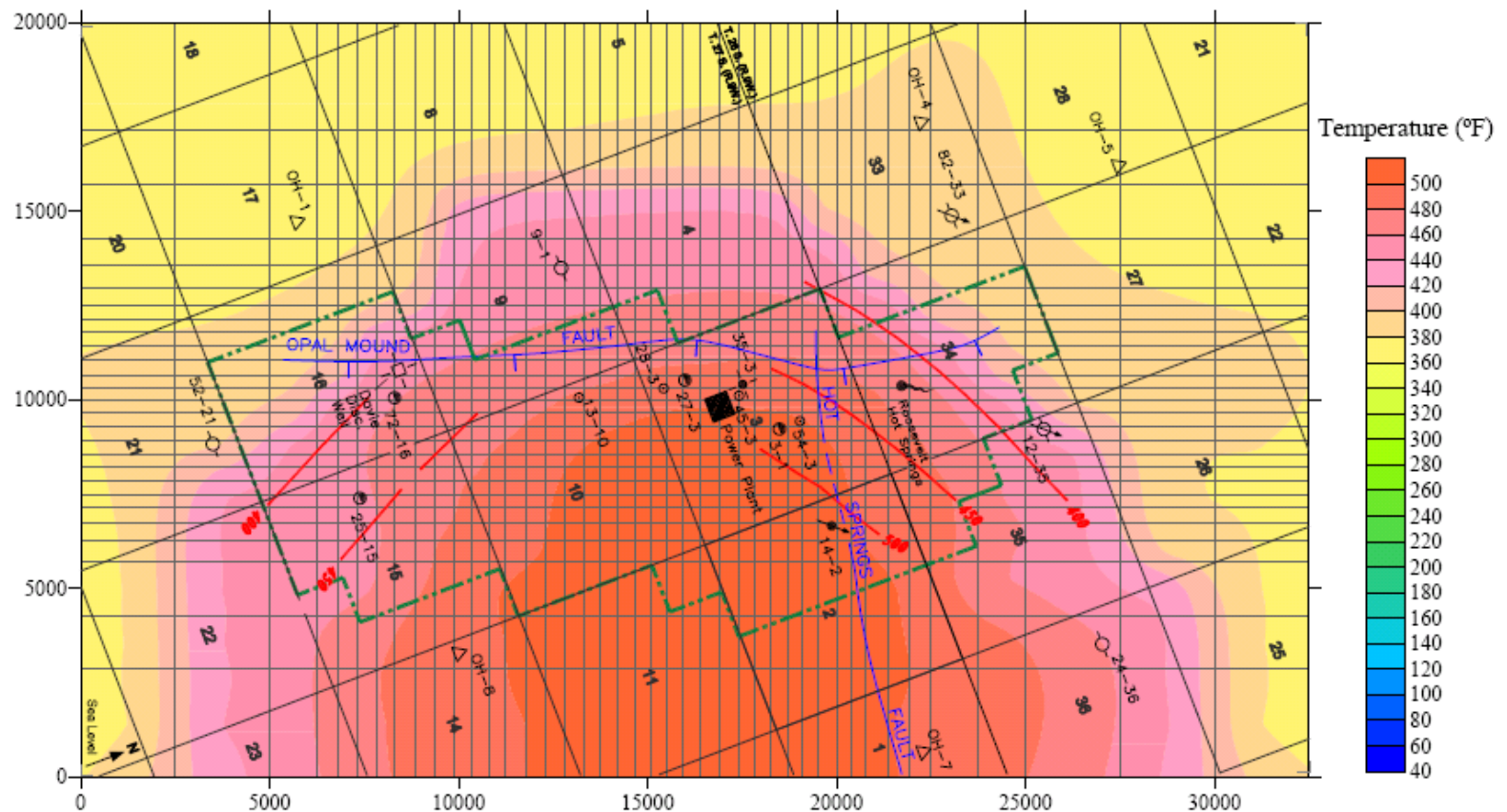


Figure 4.8: Initial State temperature matching, layer 7, at 0 ft, msl

2007, GeothermEx, Inc.

Blundell Geothermal Power Plant – History

- 1880s: Hot Springs first discovered
- 1900s: Resort established
- 1972: University of Utah initiated scientific studies
- 1974: Phillips Petroleum Company obtains 18,871 acres through a competitive lease
- 1975-1979: Productive wells drilled near the old resort. Reservoir determined to be productive
- 1980: Phillips Petroleum and Utah Power & Light (now PacifiCorp) signed an agreement to develop the resource for electrical production
- 1981: A 1.6 MW bi-phase turbine was installed as a research project. Turbine used energy from one geothermal well
- 1982: Construction begin on Blundell Unit 1. A single flash geothermal power plant
- 1984: Blundell Unit 1 goes on-line
- 2007: Blundell Unit 2 goes on-line
- 2007: Blundell Unit 3 development begins
- Utah's only operating flash geothermal plant

Blundell Unit 1



Blundell Unit 1

- Single flash facility producing 23 net Megawatts
- Four (4) production wells producing 2.25 million pounds per hour of geothermal brine
 - ▶ Brine temperature at wellhead ~ 450°F
- Four (4) well head separators flash 400,000 pound per hour steam and deliver it via pipeline to turbine

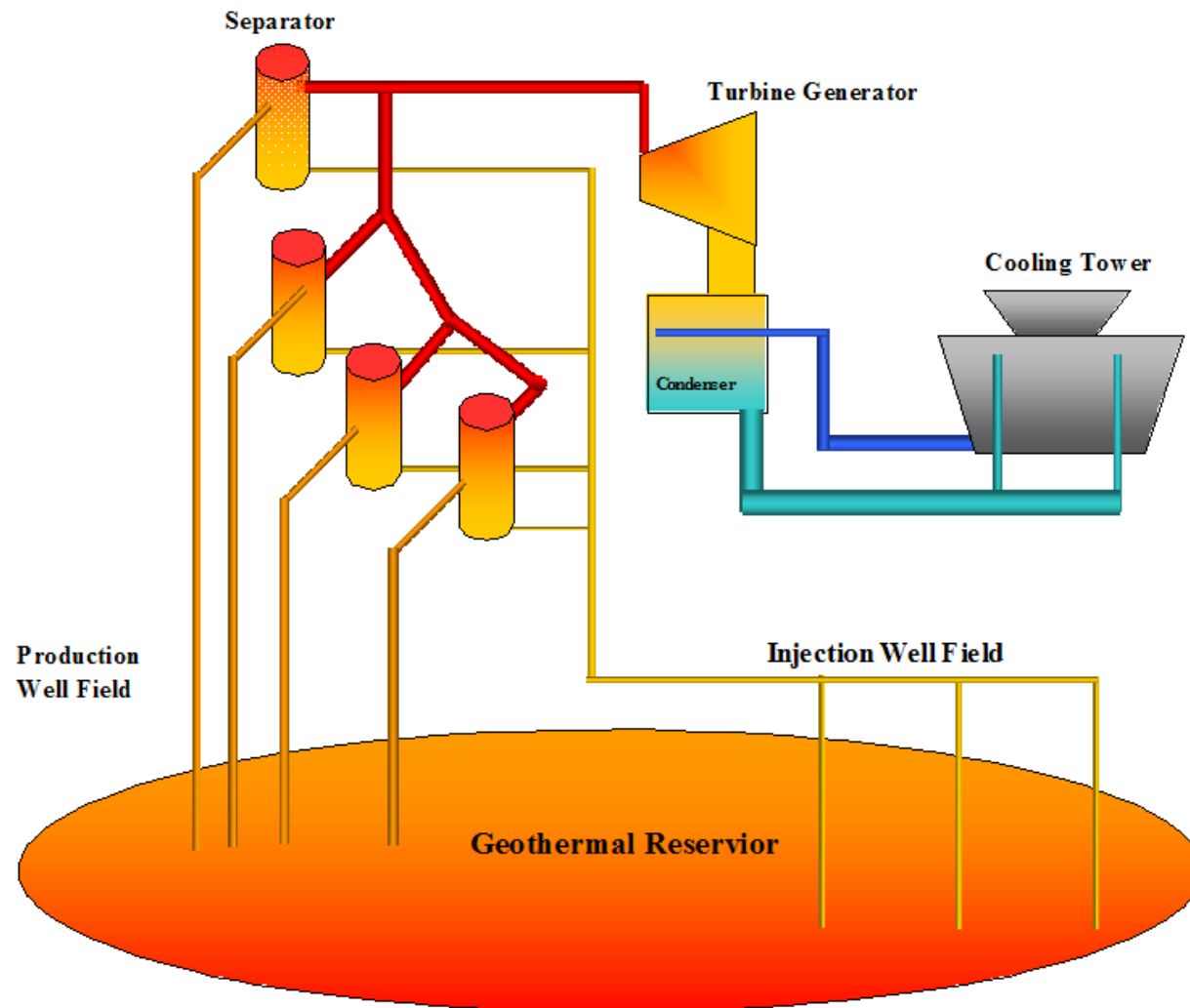


Blundell Unit 1

- General Electric turbine generator set
 - ▶ 26 Gross Megawatts
 - ▶ 23 Net Megawatts
- Three (3) injection wells used to return spent geothermal brine back into reservoir.
 - ▶ Brine temperature ~ 350°F
- Continuous operation since 1984



Blundell Unit 1 – Process Diagram



Blundell Unit 2

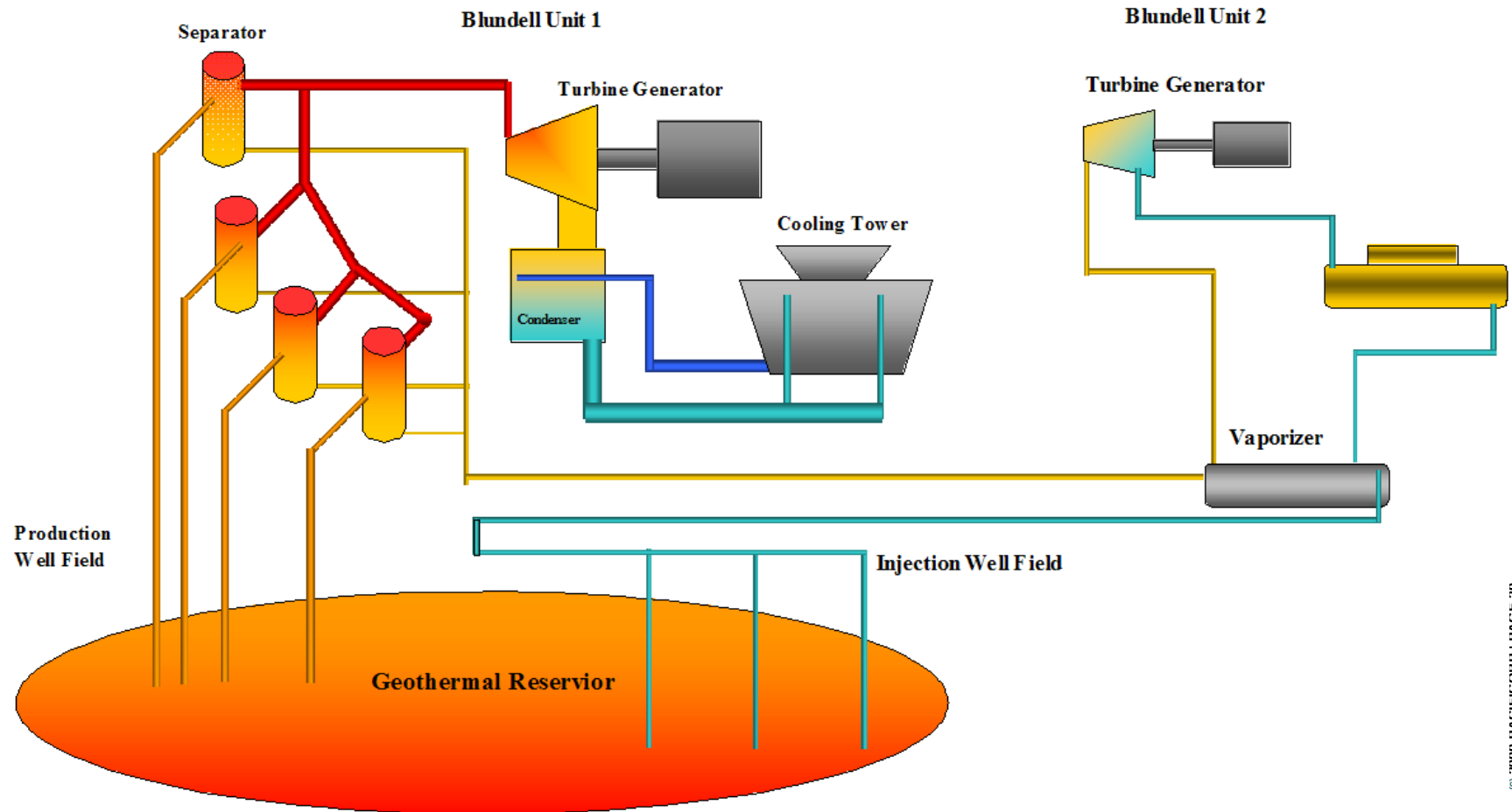


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Blundell Unit 2

- Became operational December 2007
- Ormat bottoming cycle
- Average net output: 10 Megawatts
- Working fluid: iso-pentane
- Heat source: Blundell Unit 1 spent geothermal brine
 - ▶ Inlet temperature: 350°F
 - ▶ Outlet Temperature: 190°F
- Acid injection to control silica scaling
- Air condenser used for cooling n-pentane

Blundell Unit 2 – Process Diagram



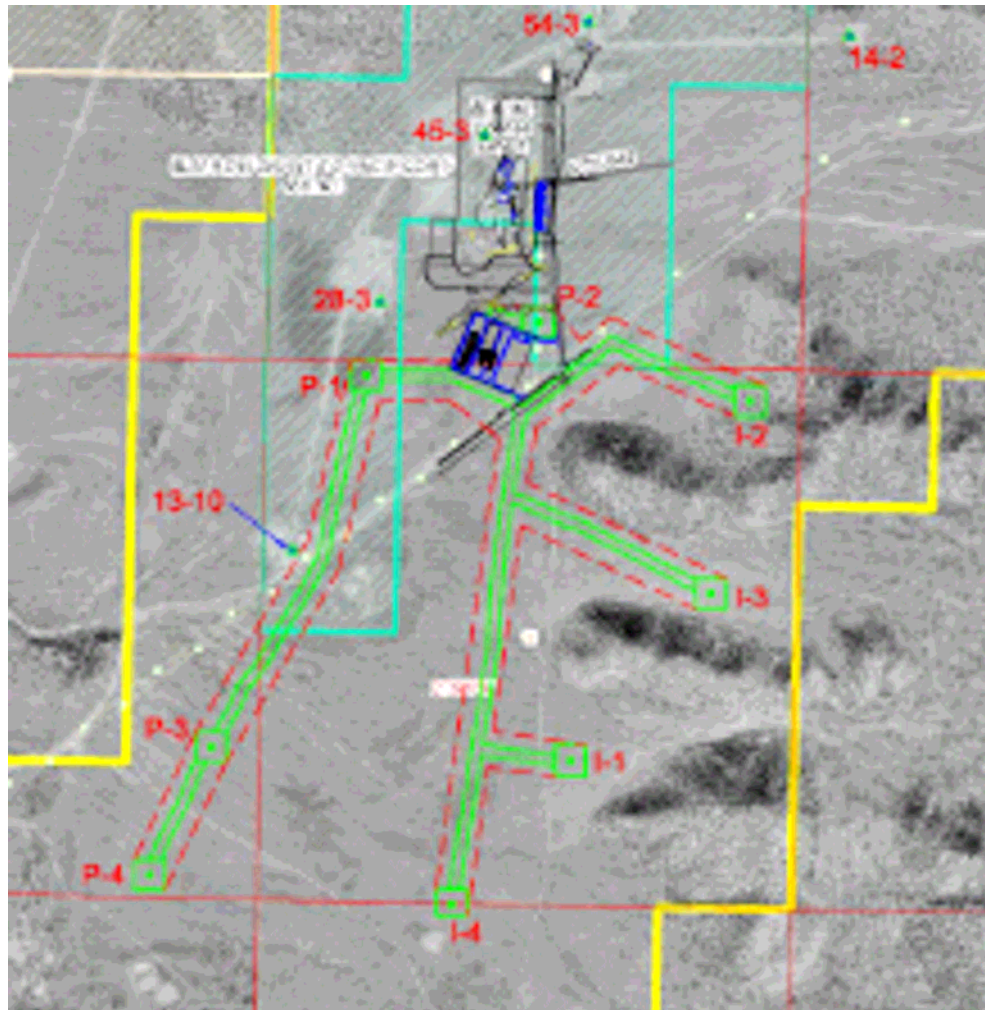
Blundell Unit 3

- In May 2007 PacifiCorp begun investing in development of Unit 3
- Reason for Development:
 - ▶ PacifiCorp renewable energy commitment.
 - 2000 Megawatts by 2013
 - ▶ Bring Roosevelt Geothermal Hot Spring extraction up to its maximum sustainable capacity
 - ▶ Part of PacifiCorp's environmental stewardship commitment
 - ▶ Rising cost of natural gas & coal makes geothermal development more attractive
- Potential Unit 3 Location: Directly south of Blundell Units 1 & 2

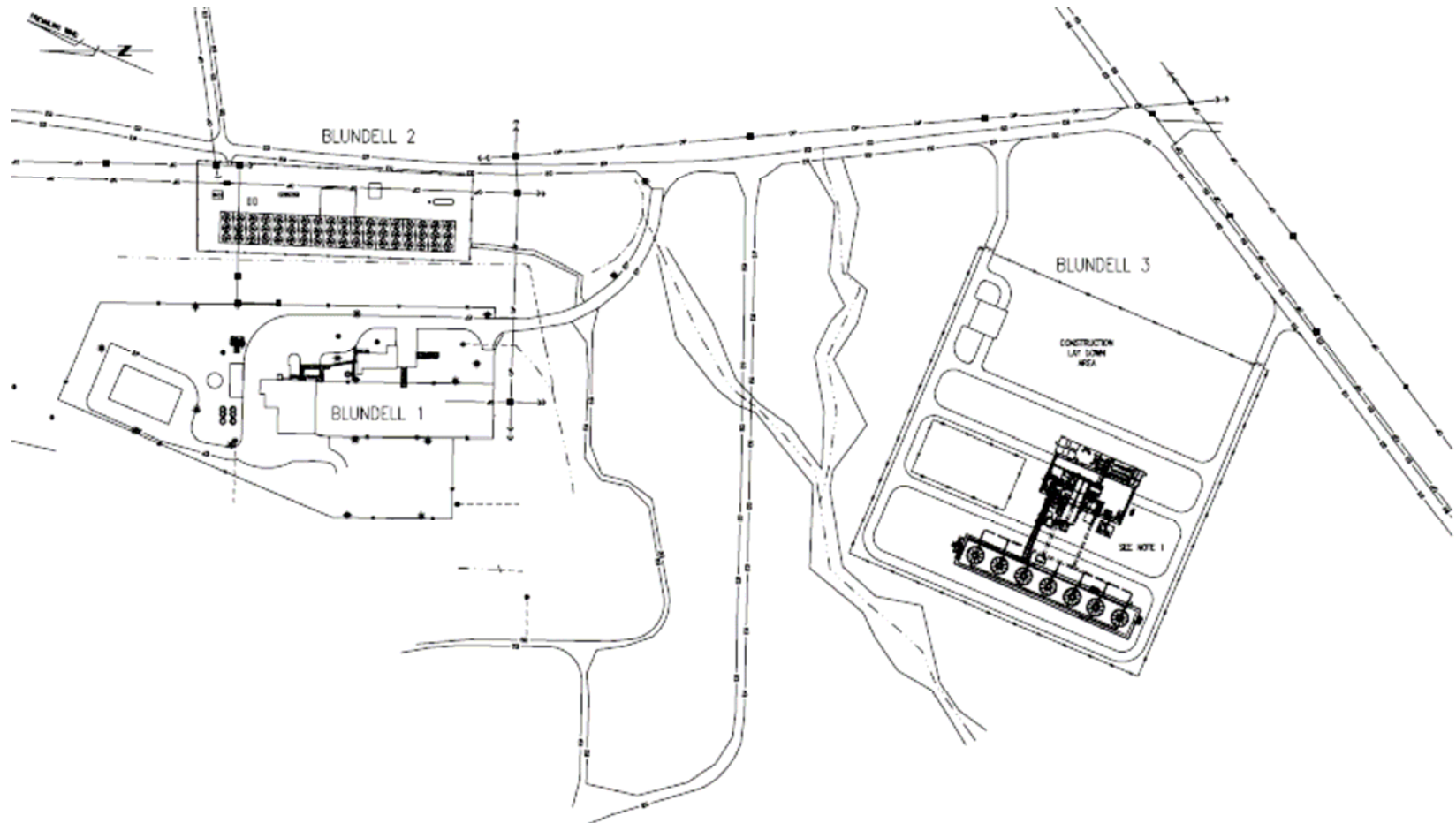
Blundell Unit 3

- Proposed plant would be 33 net Megawatts
 - ▶ Depending on outcome of production well test
- Dual flash technology selected at this time
 - ▶ Lower capital cost
 - ▶ Higher efficiency
- Unit 3 design
 - ▶ Four (4) production wells of 5,000 feet deep
 - ▶ Four (4) injection wells 6,500 feet deep
- Expected temperatures between 500°F to 650°F
- Chemical injection system to control silica scaling
- Five steam separators
 - ▶ Four high pressure
 - ▶ One low pressure

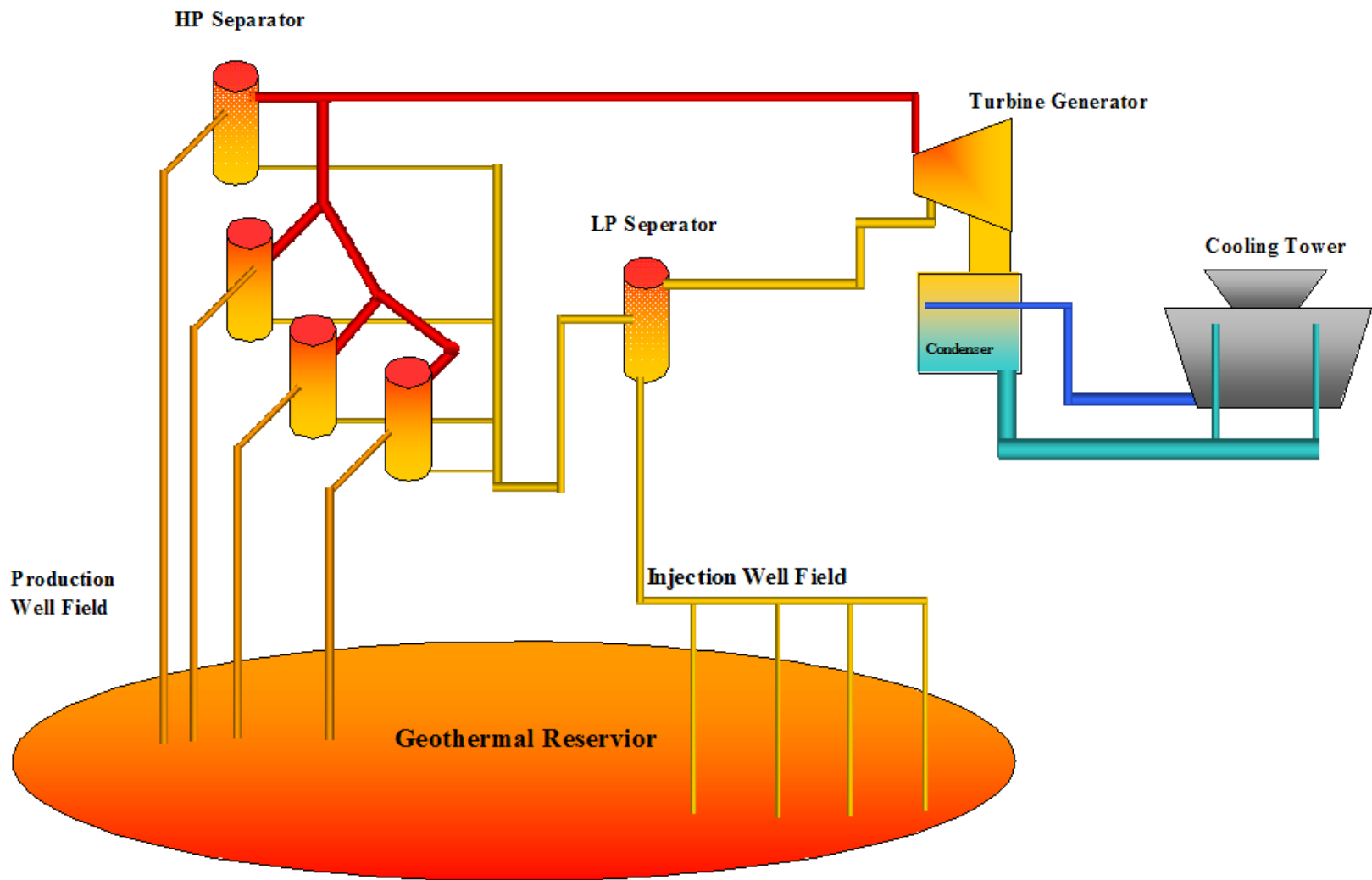
Blundell Unit 3 – Proposed Site Map



Blundell Unit 3 – Proposed Site Map



Blundell Unit 3 – Process Diagram



Blundell Unit 3 – Development Activities

- Drill two (2) “proofing wells”
 - ▶ One production (completed)
 - ▶ One injection (in set up)
- Permitting
 - ▶ Cultural Artifacts
 - ▶ Biological surveys
 - ▶ Drill Permits
 - ▶ Air Permits
 - ▶ Environmental Assessments
 - ▶ Storm water permits
- Pilot Plant test
 - ▶ Silica scaling control



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Blundell Unit 3 – Development Activities

- Production well testing
 - ▶ Rig test
 - ▶ Full production test
- Injection well testing
 - ▶ Rate of injection of fluid
- Turbine-generator sizing
 - ▶ Size
 - ▶ Flow rates
- Transmission upgrades
 - ▶ 16 miles of transmission line would need to be upgraded



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Blundell – Well Test Preliminary Results

- On April 17, 2008 a rig test was conducted and the results were encouraging.



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Blundell Unit 3 – Proposed Plant Parameters

- 33.7 net Megawatts
 - ▶ Axial exhaust turbine
 - ▶ 138 kilovolts output voltage
 - ▶ 3600 RPM
- Production parameters:
 - ▶ Geothermal Fluid – 2.40 million pounds per hour
 - ▶ Steam Flash Rate – ~25% (625,000 lbs/hr)
 - ▶ Temperature at wellhead – 450°F
 - ▶ Pressure at wellhead – 400 psig.
 - ▶ Turbine Inlet pressure – 125 psig.
 - ▶ Four high pressure wellhead separators
 - ▶ One low pressure plant separator

Blundell Unit 3 - Challenges

- Production Tax Credit Expiration
 - ▶ Current PTC expires December 31, 2008
- Utilizing new portion of steam field
 - ▶ Concerns over dry or non-productive wells
- Scheduling / Construction
 - ▶ One year worth of well drilling
 - ▶ Turbine-generator lead-times, 18 to 24 months
 - ▶ Labor shortages
 - ▶ Technical expertise
- Drilling
 - ▶ Water Supply
 - ▶ Large Equipment
 - ▶ Time

Other Geothermal Resources

- PacifiCorp would like to develop more geothermal resources in Utah
- Challenges in locating good resources
 - ▶ Limited in development and accessible locations
 - ▶ Regulatory
- Development cost
 - ▶ Until Senate Bill 202 a utility could not recoup any development costs
 - ▶ Well field development expensive. Approximately \$1,700 per kilowatt.
- Purchase existing operating resource

Blundell Geothermal Power Plant

April 22, 2008

End