The state of Utah is endowed with an abundance of natural resources. It contains significant supplies of oil, natural gas, coal, uranium, and oil shale and oil sands; base metals such as copper, beryllium, magnesium and molybdenum; and industrial minerals such as potash, salt, magnesium chloride and gilsonite. Renewable resources in Utah include geothermal, wind and solar energy and timber.

As of 2012 proved reserves of oil and natural gas in Utah stood at 613 million barrels of crude oil, 7.8 trillion cubic feet of natural gas, and 268 million barrels of natural gas liquids. As of 2013 there were an estimated 14.9 billion tons of recoverable coal remaining in the state. In addition, Utah hosts an estimated 1.3 trillion barrels of oil contained in the oil shale of the Green River Formation in the Uinta Basin (Johnson et al. 2010). Of this, approximately 77 billion barrels could be considered as a potential economic resource (Vanden Berg 2008).

Total energy production in 2013 was valued at $5.2 billion, including almost $3.0 billion from crude oil production, $1.7 billion from natural gas production, and nearly $0.6 billion from coal production. In addition, $423.6 million of natural gas liquids were produced.

Nonfuel mineral production was valued at $3.7 billion in 2012, including $2.1 billion from base metal production, $1.2 billion from industrial mineral production, and $0.4 billion from precious metal production. In 2012, copper was the largest contributor to the value of nonfuel minerals in Utah, having an estimated value of $1.4 billion, mostly produced from Rio Tinto’s Bingham Canyon mine. The largest overall contributors to the value of industrial mineral production in Utah during 2012 were the brine-derived products potash, salt and magnesium chloride, having a combined estimated value of $421 million. Utah remains the only state in the nation to produce magnesium metal, beryllium concentrate and gilsonite.

The Utah Renewable Energy Zones Task Force has identified an estimated 24.0 Gigawatts of potential electricity generation from geothermal, solar and wind sources. These are located in 27 zones defined to provide a sufficient concentration of generation potential to justify the construction of the necessary transmission lines.

Utah has approximately 3.8 million acres of timberland, though it will take a major change in forest management, significant infrastructure investments, and several years of remediation to get the state’s forests to the point where they could be profitably harvested on a commercial scale. In fiscal year 2012 there were a reported 39.5 million board feet of timber harvested from federal and state lands in Utah. In 2007, the most recent year for which data are available, Utah sawmills received 11.6 million board feet in harvested timber from private and tribal lands, which represented 42.2 percent of the total received by mills that year.

The sections on oil and gas, coal, uranium, base and precious metals, and industrial minerals are reproduced from the Utah Geological Survey’s *Utah’s Extractive Resource Industries 2012* (Boden et al. 2013). Data were updated with 2013 values where they were available. As we were wrapping up this study, UGS released *Utah’s Extractive Resource Industries 2013*; it is available online at geology.utah.gov/online/c/c-118.pdf.
8.1 NONRENEWABLE RESOURCES

8.1.1 Crude Oil and Natural Gas Reserves

As of 2012 proved reserves\(^{204}\) of oil and natural gas in Utah stood at 613 million barrels (bbls) of crude oil, 7.8 trillion cubic feet (TCF) of natural gas, and 268 million bbls of natural gas liquids\(^{205}\) (Figure 8.1 and Table 8.1). Between 1960 and 2005 crude oil reserves in Utah were relatively stable, fluctuating between 166 million and 284 million bbls. However, in 2006 reserves began to increase rapidly, with only a brief dip from 2007 to 2008, to reach over 600 million bbls in 2012, with no signs of slowing. Natural gas reserves\(^{206}\) declined from 2.0 TCF in 1961 to 675 billion cubic feet in 1979. They then rose back to almost 2.1 TCF in 1981 and remained at about this level through 1998. Since 1999 natural gas reserves have grown rapidly, albeit with a 24 percent stumble between 2001 and 2003, peaking at 8.1 TCF in 2011. Natural gas liquids are hydrocarbons such as propane, ethane and butane that are extracted from the natural gas production stream in natural gas processing plants.\(^{207}\) Proved reserves of natural gas liquids hovered around 50 million bbls between 1960 and 1979. They began to rise rapidly in 1980, peaking at 335 million bbls in 1988. Reserves then declined to 89 million bbls in 2006. Since then, proved reserves of natural liquids have grown to 268 million bbls. Proved reserves of all three resources more than doubled between 2003 and 2012, with crude oil reserves growing by 177 percent, natural gas reserves increasing by 115 percent, and natural gas liquids growing by 113 percent (Table 8.1).

### Table 8.1
Crude Oil and Natural Gas Proved Reserves in Utah, 2003–2012

<table>
<thead>
<tr>
<th>Year</th>
<th>Crude Oil (000 bbls)</th>
<th>Natural Gas (MMCF)</th>
<th>Natural Gas Liquids (000 bbls)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2003</td>
<td>221,000</td>
<td>3,621,694</td>
<td>125,720</td>
</tr>
<tr>
<td>2004</td>
<td>215,000</td>
<td>3,947,730</td>
<td>111,240</td>
</tr>
<tr>
<td>2005</td>
<td>256,000</td>
<td>4,358,894</td>
<td>96,690</td>
</tr>
<tr>
<td>2006</td>
<td>334,000</td>
<td>5,208,392</td>
<td>88,700</td>
</tr>
<tr>
<td>2007</td>
<td>355,000</td>
<td>6,460,995</td>
<td>108,000</td>
</tr>
<tr>
<td>2008</td>
<td>286,000</td>
<td>6,712,995</td>
<td>116,000</td>
</tr>
<tr>
<td>2009</td>
<td>398,000</td>
<td>7,410,707</td>
<td>206,000</td>
</tr>
<tr>
<td>2010</td>
<td>449,000</td>
<td>7,147,769</td>
<td>201,000</td>
</tr>
<tr>
<td>2011</td>
<td>504,000</td>
<td>8,100,228</td>
<td>274,000</td>
</tr>
<tr>
<td>2012</td>
<td>613,000</td>
<td>7,779,530</td>
<td>268,000</td>
</tr>
<tr>
<td>Change</td>
<td>177.4%</td>
<td>114.8%</td>
<td>113.2%</td>
</tr>
</tbody>
</table>

---

\(^{204}\) Proved reserves are estimated quantities of energy sources that are demonstrated to exist with reasonable certainty on the basis of geologic and engineering data.

\(^{205}\) Natural gas liquids are those hydrocarbons in natural gas which are separated from the gas through the processes of absorption, condensation, adsorption, or other methods in gas processing or cycling plants. Generally such liquids consist of propane and heavier hydrocarbons and are commonly referred to as condensate, natural gasoline, or liquefied petroleum gases. (www.eia.gov/dnav/ng/TblDefs/ng_enr_ngl_tbldef2.asp)

\(^{206}\) Natural gas reserves comprise nonassociated and associated-dissolved reserves plus net withdrawals from storage.

Figure 8.1
Proved Reserves of Crude Oil and Natural Gas in Utah, 1960–2012

Most of Utah’s oil and gas resources are located in the eastern half of the state, with much of the current production concentrated in Duchesne and Uintah, Carbon and Emery, Grand and San Juan counties. As shown in Figure 8.2, federal lands overlay a significant portion of the state’s oil and gas deposits. With the transfer of much of these lands to the state, additional areas may be opened to oil and gas exploration and development to which access is currently restricted by the BLM (see the Chapter 13 for more details).
Production and Values
The most current statistical data on oil and gas can be found on the Division of Oil and Gas website at oilgas.ogm.utah.gov/Statistics/Statistics.cfm. At an estimated value of almost $4.7 billion, oil and gas production was the largest contributor to the total value of fuel commodities produced in Utah during 2013, with 34.9 million bbls of oil and 470.6 billion cubic feet (BCF) of gas produced from Utah’s oil and gas fields. Oil and gas constituted 89 percent of Utah’s total fuel production value in 2013. Oil and gas values increased about $847 million (22 percent) in
2013 compared with 2012. Both the volume and value of oil were up, and the value of gas was up due solely to a 35 percent increase in the average annual price—gas production actually declined by 20.3 BCF (4 percent). Utah’s nominal oil price rose 57 percent between 2005 and 2013, while production doubled; during that same period the nominal natural gas price decreased by 48 percent, while marketed gas production rose by 54 percent. Thus, gas and oil are following different market trends with oil production following price upward, but gas production increasing in spite of falling prices. Utah’s 2013 oil and gas production came from 12,420 producing wells (5,059 oil wells and 7,361 gas wells), an increase from the 11,124 producing wells in 2012 (4,253 oil and 6,871 gas).

Oil’s contributions were the largest to the total value of fuel production in Utah in 2013, with a value of almost $3.0 billion, about $463 million (19 percent) more than in 2012. Duchesne, Uintah, San Juan, and Sevier counties, in decreasing order of production, were the four largest oil-producing counties in Utah in 2013, and when combined, contributed about 96 percent of the total state production volume. The five largest producing oil fields in 2013, Monument Butte (Duchesne and Uintah), Altamont (Duchesne), Greater Aneth (San Juan), Bluebell (Duchesne and Uintah), and North Myton Bench (Duchesne), accounted for about 54 percent of Utah’s total oil production. About 36 percent of the oil produced in Utah in 2013 (12.4 million bbls) came from federal leases.

Gas contributed the second-largest share of the overall value of fuel commodities produced in Utah during 2013, with an estimated value of $1.7 billion, a $384 million (29 percent) increase from 2012. Uintah, Carbon, Duchesne, and Emery counties, in decreasing order of production, were the four largest gas-producing counties in Utah in 2013, and when combined, contributed 96 percent of the total state gas production volume. The five largest producing gas fields in 2013, Natural Buttes (Uintah), Drunkards Wash (Carbon), Peters Point (Carbon), Nine Mile Canyon (Carbon), and Red Wash (Uintah), accounted for 74 percent of the total gas production, but Natural Buttes alone accounted for about 58 percent of Utah’s 2013 gas production. More than half (56 percent, 264 BCF) of the natural gas produced in 2013 came from federal leases.

**Exploration and Development Activity**

Utah experienced a decrease in oil and gas exploration and development activity in 2013, and, in comparison with 2012, the number of wells permitted declined 23 percent from 2,105 to 1,611, and the number of wells started (spudded) decreased 10 percent from 1,107 to 997. The county with the most oil and gas exploration and development activity was Uintah with 737 new well permits and 524 well spuds; the second most active was Duchesne with 794 new well permits and 443 well spuds; and the third most active was San Juan with 50 new well permits and 16 well spuds. These top three counties accounted for about 98 percent of the new well permits and well spuds in Utah in 2013. The 983 new oil and gas wells completed during 2013 were a decrease from the 1,076 completed in 2012. The new oil and gas wells completed in 2013 consist of 730 new wells within established field boundaries, 136 wells drilled outside of an existing field boundary with the intent of extending the field boundary, and 117 wildcat wells drilled in unproven areas. Of the 983 new wells, 673 (68 percent) were oil wells, 291 (30 percent) were gas wells, and 7 (1 percent) were service wells (injection or disposal wells). Not all of the 983 new wells drilled in 2013 were productive and 11 (1 percent) were plugged and abandoned. The ratio of new oil wells to new gas wells drilled has increased in the past few years in response to the high oil prices and depressed gas prices, and this trend will continue until gas prices recover to a more attractive level.
8.1.2 Coal

Reserves

As of 2013, the most recent year for which coal reserves data are available, there were an estimated 14.9 billion tons\(^{208}\) of recoverable coal remaining in the state (Table 8.2). This does not take into account economic or land use constraints. In some fields this was limited to coal seams with a minimum height of four feet and not more than 3,000 feet of overburden. Overall, ownership of the surface land above this coal lies 73 percent with the federal government, 22 percent with private landowners, and 5 percent with the state government (Table 8.2 and Figure 8.3). Mineral ownership of the coal is 80 percent federal, 13 percent private and 6 percent state. These ownership shares vary by coal field. The highest federal ownership is the Kaiparowits field under the Grand Staircase–Escalante National Monument in Kane and Garfield counties; 99 percent of both the surface and minerals are owned by the federal government. In contrast, just 20 percent of the surface and 59 percent of the minerals are federally owned at the Kolob coal field, in Kane and Iron counties.

Table 8.2

Utah Coal Resources by Landownership, 2013

(Million Tons)

<table>
<thead>
<tr>
<th>Coal Field</th>
<th>Original Principal Resource</th>
<th>Remaining Estimated Recoverable Resource</th>
<th>Surface Ownership</th>
<th>Mineral Ownership</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Federal</td>
<td>State</td>
<td>Private</td>
<td>Federal</td>
</tr>
<tr>
<td>Kaiparowits</td>
<td>22,740.0</td>
<td>9,095.9</td>
<td>99%</td>
<td>1%</td>
</tr>
<tr>
<td>Wasatch Plateau</td>
<td>6,378.9</td>
<td>1,216.7</td>
<td>75%</td>
<td>1%</td>
</tr>
<tr>
<td>Alton</td>
<td>2,155.0</td>
<td>1,054.0</td>
<td>75%</td>
<td>2%</td>
</tr>
<tr>
<td>Kolob</td>
<td>2,014.3</td>
<td>805.0</td>
<td>20%</td>
<td>7%</td>
</tr>
<tr>
<td>Emery</td>
<td>2,336.0</td>
<td>801.0</td>
<td>68%</td>
<td>9%</td>
</tr>
<tr>
<td>Book Cliffs</td>
<td>3,527.3</td>
<td>657.3</td>
<td>61%</td>
<td>9%</td>
</tr>
<tr>
<td>Henry Mountains</td>
<td>925.5</td>
<td>484.7</td>
<td>88%</td>
<td>10%</td>
</tr>
<tr>
<td>Sego</td>
<td>1,144.0</td>
<td>340.5</td>
<td>85%</td>
<td>11%</td>
</tr>
<tr>
<td>Salina Canyon</td>
<td>692.7</td>
<td>207.3</td>
<td>68%</td>
<td>0%</td>
</tr>
<tr>
<td>Others</td>
<td>599.2</td>
<td>174.7</td>
<td>72%</td>
<td>6%</td>
</tr>
<tr>
<td>Mt. Pleasant</td>
<td>249.1</td>
<td>99.6</td>
<td>82%</td>
<td>1%</td>
</tr>
<tr>
<td>Wales</td>
<td>12.2</td>
<td>2.9</td>
<td>78%</td>
<td>4%</td>
</tr>
<tr>
<td>Total</td>
<td>42,774.2</td>
<td>14,939.6</td>
<td>73%</td>
<td>5%</td>
</tr>
</tbody>
</table>

1. Total coal resource with no economic, land use, or geologic constraints.
2. For Wasatch Plateau, Alton, Emery, Book Cliffs, and Henry Mountains; resources were constrained by a seam height minimum of four feet, with no more than 3,000 feet of overburden. For the remaining fields, resources were constrained by an estimated resource factor ranging from 30 percent to 40 percent of principal resources. Estimated recoverable resources do not take into account economic or land use constraints.


\(^{208}\) The standard American 2,000-pound ton, also called the “short ton,” is used throughout.
Production and Value

Seven Utah coal operators produced 16.9 million tons of coal valued at $579 million from nine underground mines in 2013 (Figures 8.4 and 8.5). This production was 202,000 tons (1.2 percent) less than in 2012. The majority of this decrease was attributed to lower output from the Dugout Canyon mine as longwall production ceased in late 2012 and mining continued with only one continuous miner, reducing the mine’s production to just 561,000 tons for the year. In addition, the Horizon mine was idled in mid-2012 and eventually shut down and production at
the Deer Creek mine declined by 509,000 tons (Table 8.3). Demand for coal declined from a regulatory-induced drop in demand for coal-generated electricity.

Figure 8.4
Production and Value of Coal in Utah, 1960–2013

Table 8.3
Coal Production in Utah by Mine, 2008–2013
(Thousands of Tons)

<table>
<thead>
<tr>
<th>Company</th>
<th>Mine</th>
<th>County</th>
<th>Coalfield</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>Utah American Energy, Inc. / Murray Energy Corp.</td>
<td>Aberdeen</td>
<td>Carbon</td>
<td>Book Cliffs</td>
<td>242</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>Lila Canyon</td>
<td>Emery</td>
<td>Book Cliffs</td>
<td>–</td>
<td>72</td>
<td>157</td>
<td>304</td>
<td>257</td>
<td></td>
</tr>
<tr>
<td>Canyon Fuel, LLC / Bowie Resources, Inc.¹</td>
<td>Dugout Canyon</td>
<td>Carbon</td>
<td>Book Cliffs</td>
<td>4,135</td>
<td>3,291</td>
<td>2,307</td>
<td>2,395</td>
<td>1,588</td>
<td>561</td>
</tr>
<tr>
<td></td>
<td>Skyline #3</td>
<td>Carbon</td>
<td>Washatch Plateau</td>
<td>3,120</td>
<td>2,910</td>
<td>3,050</td>
<td>2,950</td>
<td>1,954</td>
<td>3,135</td>
</tr>
<tr>
<td></td>
<td>SUFCO</td>
<td>Sevier</td>
<td>Washatch Plateau</td>
<td>6,946</td>
<td>6,748</td>
<td>6,398</td>
<td>6,498</td>
<td>5,651</td>
<td>5,959</td>
</tr>
<tr>
<td>CONSOL Energy</td>
<td>Emery</td>
<td>Emery</td>
<td>Emery</td>
<td>1,050</td>
<td>1,238</td>
<td>999</td>
<td>–</td>
<td>–</td>
<td>4</td>
</tr>
<tr>
<td>Castle Valley Mining LLC² / Rhino Resources</td>
<td>Castle Valley #4</td>
<td>Emery</td>
<td>Washatch Plateau</td>
<td>868</td>
<td>651</td>
<td>–</td>
<td>592</td>
<td>1,004</td>
<td>875</td>
</tr>
<tr>
<td>Energy West Mining Co.</td>
<td>Deer Creek</td>
<td>Emery</td>
<td>Washatch Plateau</td>
<td>3,878</td>
<td>3,833</td>
<td>2,954</td>
<td>3,143</td>
<td>3,295</td>
<td>2,785</td>
</tr>
<tr>
<td>Hidden Splendor Resources, Inc. / America West Resources, Inc.</td>
<td>Horizon</td>
<td>Carbon</td>
<td>Washatch Plateau</td>
<td>229</td>
<td>194</td>
<td>270</td>
<td>370</td>
<td>210</td>
<td>–</td>
</tr>
<tr>
<td>Alton Coal Development</td>
<td>Coal Hollow</td>
<td>Kane</td>
<td>Alton</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>403</td>
<td>570</td>
<td>747</td>
</tr>
</tbody>
</table>

Total                                         |                  |        |                    | 24,275| 21,927| 19,406| 20,073| 17,155| 16,953|

1. Owned by Arch Coal until summer 2013.
2. Owned by C.W. Mining (Co-op) until summer 2010, mines formally called Bear Canyon.
In 2013, the majority of Utah coal, 12.7 million tons, was produced from the Wasatch Plateau coalfield, with 3.4 million tons coming from mines in the Book Cliffs coalfield and 747,000 tons from the Coal Hollow mine in the Alton coalfield. The majority of Utah coal, 83.0 percent (14.1 million tons) was produced from federal land, while only 4.7 percent (801,000 tons) was from state-owned land. The remainder was produced from private (7.9 percent, 1.3 million tons) and county (4.4 percent, 742,000 tons) lands.

Existing Utah mines face steady reserve depletion and difficult mining conditions. In addition, the demand for Utah coal has sharply decreased over the past few years as power plants have
switched to natural gas over coal-fired generation. In particular, several cogeneration plants in California, once a significant market for Utah coal, are converting to natural gas to comply with California’s strict air quality standards. The California market is also starting to influence Utah’s in-state demand since the IPP is mostly owned by the city of Los Angeles. The city has already stated that it will no longer purchase power from IPP after its current power purchase agreement expires in 2027, unless IPP converts to natural gas or implements carbon capture and storage technology. Thus, the average annual production total for Utah will likely be in the 15- to 20-million-ton range for the foreseeable future.

The total amount of Utah coal distributed to market in 2012 (the most recent year for which data are available) totaled 16.1 million tons, slightly less than the total coal produced for the year. The vast majority of Utah’s coal, 79 percent, goes to the electric utility market. As a result of the slowed U.S. economy and new regulation limiting coal-fired generation, demand for coal to produce electricity decreased, resulting in a 41 percent drop in the demand for Utah coal at electric generating facilities, from 21.6 million tons in 2008 to 12.8 million tons in 2012. The economic recession and low natural gas prices also slowed demand for Utah coal in the industrial sector, with deliveries dropping to 2.2 million tons in 2012, the lowest level since 1987. Coal deliveries in 2013 are expected to have remained in the 17-million-ton range, correlating with lower overall production. However, the last few years have seen an uptick in the amount of Utah coal being exported to other countries, in particular the Asian coal market. Overseas exports of Utah coal doubled between 2008 and 2012 to 1.1 million tons. Demand for coal in Asia is strong, but Utah operators will need increased access to port facilities to allow this market to replace slowing domestic demand.

For detailed statistics on Utah’s coal industry, please refer to the abundant data tables located on the UGS’s Utah Energy and Mineral Statistics website: geology.utah.gov/emp/energydata.

Exploration and Development Activity

**UtahAmerican Energy, Incorporated / Murray Energy Corporation – Lila Canyon mine:**
The Lila Canyon mine is located south of Horse Canyon in the Book Cliffs coalfield in Emery County. In spring of 2010, the company finished construction on 1,200-foot rock slopes and began development work in the Sunnyside coal bed, producing 72,000 tons of coal in 2010. Development work continued in 2011 and 2012, with total coal production reaching 157,000 tons and 304,000 tons, respectively. Coal production is expected to remain at the 300,000-ton level until longwall mining commences, possibly in 2015. At full capacity, the exact timing of which depends on the future coal market, the mine could employ up to 200 people and produce up to 4.5 million tons of coal per year. Coal will be mined from federal leases where the merged upper and lower Sunnyside bed is about 13 feet thick. Up to 46 million tons of recoverable coal is under lease. Approximately 32 million tons of additional reserves on 4,200 acres of federal land to the south has recently been nominated for leasing by UtahAmerican.

**West Ridge Resources, Incorporated – West Ridge mine:**
The West Ridge mine began operation in 1999 in the Book Cliffs coalfield with production from the lower Sunnyside bed. The West Ridge mine produced 2.6 million tons of coal in 2012, down from 3.6 million tons produced in 2011, due mainly to difficult mining conditions and a weak coal market. Production in 2013 increased by only 50,000 tons. UtahAmerican estimates that the West Ridge mine has 3.4 million tons of recoverable coal under lease, which will accommodate longwall production only until 2015.
Canyon Fuel Company – Dugout Canyon mine: The Dugout Canyon mine, located in the Book Cliffs coalfield, produced 1.6 million tons of coal from the Gilson bed in 2012, down significantly from the 2.4 million tons produced in 2011. Dugout Canyon’s longwall was shut down in December 2012 due to a weak coal market. Consequently, production in 2013 reached only 561,000 tons with one continuous miner. Canyon Fuel estimates that the Dugout Canyon mine has 12.8 million tons of recoverable coal remaining under lease.

Canyon Fuel Company – Skyline mine: Canyon Fuel Company’s Skyline mine, located in the Wasatch Plateau coalfield, is currently mining in the Lower O’Connor “A” bed on their North lease (Winter Quarters lease) in Carbon County. Production from this bed decreased significantly in 2012 to 2.0 million tons as longwall equipment was moved to the North Lease, but rebounded to 3.1 million tons in 2013. Canyon Fuel estimates that 15.0 million tons of coal can be recovered from current leases. Future production at the Skyline mine could come from the unleased Flat Canyon tract, which is estimated to contain 25 to 30 million tons of reserves.

Canyon Fuel Company – SUFCO mine: SUFCO is Utah’s largest coal producer and the eighth-largest producing underground coal mine in the United States (2011 data). It is also the only active coal mine in Sevier County. SUFCO produced 5.7 million tons of coal in 2012 from the upper Hiawatha bed, 15 percent less than in 2011 and 40 percent less than record high production of 7.9 million tons achieved during 2006. Demand for SUFCO coal diminished in 2012 due to a six-month outage at the coal-burning IPP. With IPP back online, production at SUFCO increased slightly to 5.9 million tons in 2013. Canyon Fuel estimates that roughly 32.1 million tons of reserves remain under lease in the upper and lower Hiawatha beds. On a separate note, the new Quitchupah road will significantly reduce coal haulage time for trucks heading for the Emery County power plants.

Canyon Fuel Company – Greens Hollow tract: Canyon Fuel has nominated the federal Greens Hollow tract for leasing, located northwest of the already acquired Quitchupah lease. A draft Environmental Impact Study (EIS) was issued in the spring of 2009 and the record of decision, favoring the lease of the tract, was made in December 2011. A National Environmental Protection Act (NEPA) plan is currently being formulated. The Greens Hollow tract is thought to contain approximately 73 million tons of reserves within the lower Hiawatha bed.

CONSOL Energy – Emery mine: CONSOL Energy’s Emery mine, its only mine in the western United States, produced about 1 million tons annually from the Ferron Sandstone I bed from its opening in 2005 through 2010. CONSOL idled the mine in December 2010, citing lack of coal demand. The mine reopened in 2013 with fewer than 4,000 tons produced in the third quarter.

Rhino Energy – Castle Valley mines: Rhino Energy purchased the Bear Canyon mines, formerly owned by C.W. Mining (Co-Op), in 2010, and during bankruptcy proceedings renamed the mines Castle Valley. No coal was produced from the property in 2010, but Rhino produced 592,000 tons in 2011 using continuous miner machines in the Tank bed. Full-scale production with two continuous miners increased production in 2012 to 1.0 million tons. Production slowed in 2013 to 875,000 tons. Rhino estimates that 6.9 million tons of reserves still exist on leased land, but roughly 50.6 million tons of recoverable reserves could be available in the Tank, Blind Canyon, and Hiawatha beds in the surrounding area.
Energy West Mining Company / PacifiCorp – Deer Creek mine: Production at the Deer Creek mine increased to 3.3 million tons in 2012 but decreased in 2013 to 2.8 million tons. From the inception of mining on the Mill Fork lease to July 2011, this tract was state-owned; however, its reversion back to federal ownership will greatly decrease Utah’s production of state-owned coal. Production in the Blind Canyon bed at Mill Fork was completed in mid-2010, and shifted back to the Hiawatha bed. There are roughly 14.4 million tons of coal remaining in the Hiawatha in this area.

Fossil Rock Fuels / PacifiCorp – Cottonwood tract: On December 31, 2007, SITLA held a sale of the Cottonwood Competitive Coal Leasing Unit. The tract was awarded to Ark Land Company, which is a subsidiary of Arch Coal, Inc., also the owner of Canyon Fuel Company. Two coal leases were issued, one for 8,204 acres covering lands within the 1998 land exchange Cottonwood Coal Tract and the other for 600 acres within an adjacent SITLA section. In mid-2011, the Cottonwood lease was transferred to Fossil Rock Fuels, a subsidiary of PacifiCorp and Rocky Mountain Power, as part of a settlement of litigation between the two companies. The Cottonwood tract is adjacent to PacifiCorp’s existing, but inactive, Train Mountain federal lease. Total recoverable coal in the Hiawatha bed for the combined leases is estimated to equal 49 million tons. Fossil Rock Fuels is currently conducting a three-year exploration program on the newly acquired Cottonwood lease.

America West Resources, Incorporated / Hidden Splendor Resources, Incorporated – Horizon mine: The Horizon mine, located approximately 11 miles west of Helper in the Wasatch Plateau coalfield, was idled in July of 2012 after producing 210,000 tons of coal for the year. The mine was idled after MSHA required extensive changes to the mine plan and a portion of the operation sealed. In February 2013, the company filed for bankruptcy with a subsequent bankruptcy sale in April. The mine failed to sell, but Bowie Resources, who just recently acquired the Canyon Fuels Company, expressed interest in purchasing America West's coal supply contracts. In addition, a Rhino Resource Partners affiliate bought some of the mining equipment. Before the mine closed, America West estimated that 16 million tons of coal remained on leased land.

Alton Coal Development – Coal Hollow mine: In 2011, Alton Coal Development began production at a new coal mine in the Alton coalfield in southern Utah’s Kane County. Surface-mining production on the company’s private property totaled 403,000 tons for 2011 and increased to 570,000 tons in 2012 and 747,000 tons in 2013. Full production at the Coal Hollow mine could total 2.0 million tons per year, but depends on the acquisition of surrounding federal lands. The BLM is currently preparing a draft EIS for the proposed federal leasing action. Alton’s private lease, as well as two recently leased state sections, are estimated to contain about 20.0 million tons of recoverable coal, while reserves on the surrounding federal mining areas are estimated between 35 and 40 million tons. The Coal Hollow mine produces subbituminous Dakota Formation coal from the Smirl bed, which averages about 10,000 btu/lb, about 1 percent sulfur, and 9 percent ash. As overburden increases, the company eventually plans to switch to underground mining.
8.1.3 Uranium

Production and Value

Energy Fuels Resources was responsible for all uranium produced in Utah during 2012, having acquired Denison Mines Corporation during the year, including its producing Daneros, Beaver, and Pandora mines. Energy Fuels Resources produced approximately 553,000 pounds of uranium oxide (U₃O₈) having a value of about $30.9 million, at an average realized price of $55.83/lb (Energy Fuels, 2013). The uranium and byproduct vanadium ore was shipped to Energy Fuel's White Mesa mill (Figure 8.7), located about 6 miles south of Blanding in San Juan County, and processed into U₃O₈ and V₂O₅. The value of uranium produced in Utah in 2012 increased about 4.7 percent over the value in 2011, and was due to an approximate 8.9 percent increase in production over 2011, despite a slightly lower selling price. Uranium spot prices peaked at about $52/lb early in 2012, reached a low of around $41/lb late in the year, but recovered at year's end to about $45/lb (Energy Fuels, 2013).

Exploration and Development Activity

Historically, Utah is the third most productive uranium state, with the majority of its production from the Colorado Plateau. The spot price of U₃O₈ has been especially volatile over the past decade with spikes to $136/lb in June 2007 and lows of under $45/lb in 2009–2010. The spot price rebounded to $73/lb in early 2011, only to fall below $50/lb again following the Fukushima nuclear power plant disaster in March 2011. Uranium exploration and development in Utah has waxed and waned with these spot price fluctuations. Long-term contract U₃O₈ prices, in contrast, have remained relatively constant at approximately $60/lb. In the last few years of low prices, the uranium industry in Utah has undergone a period of property/company consolidation with Energy Fuels acquiring most of the promising uranium mines and prospects in Utah. Energy Fuels, Incorporated and Denison Mines Corporation announced on April 16, 2012, that they had signed a letter agreement for Energy Fuels to acquire the U.S. assets of Denison Mines in exchange for Energy Fuels shares.

The continuing low U₃O₈ prices (under $45/lb) resulted in a halt to all production from uranium mining operations in Utah in early 2013. The White Mesa mill is continuing operations on ore from higher grade uranium breccia pipe deposits across the state line in the Arizona Strip, north of the Grand Canyon.

The following paragraphs report the major uranium events in Utah in 2012.

Energy Fuels, Incorporated

Energy Fuels, Incorporated owns six permitted uranium mines in Utah as well as the 2000 ton-per-day, dual-circuit (uranium-vanadium) White Mesa mill near Blanding. The mill processes both uranium-vanadium ore and an alternate feed waste material. The mill began operating on stockpiled ore from Energy Fuels-owned mines in 2008, and began accepting ore from other companies for toll milling in 2009. The mill has the capacity to produce about 3 million pounds of U₃O₈ and 4.5 million pounds of V₂O₅ annually. Uranium recoveries typically average over 90 percent.

In late 2006, the Pandora mine, in the eastern La Sal mining district (Figure 8.8), San Juan County, became the first Utah uranium producer since 1991. Energy Fuels’ Pandora mine shipped about 120 tons per day 70 miles south to the White Mesa mill, until it was put on standby in 2013. In 2012, the Pandora mine produced about 30,695 tons of ore.
In 2009, the Beaver mine, 2 miles west of the Pandora mine was reopened. The Beaver mine was also producing about 160 tons per day until its closure in October 2012. The La Sal district uranium ores are hosted in the Upper Jurassic Salt Wash Member of the Morrison Formation. In 2012, the Snowball and connected Beaver Shaft is credited with about 44,646 tons of ore.

The Daneros mine in the White Canyon mining district (Figure 8.8), San Juan County, was permitted in May 2009, development began in July, and production started in December 2009. Denison acquired the mine in June 2011, and it was sold to Energy Fuels in April 2012. The Daneros ore body had an estimated resource of 143,000 tons at 0.26 percent U₃O₈ hosted by the basal Shinarump Conglomerate Member of the Upper Triassic Chinle Formation and also contains about 1 percent copper (Peters, 2012). The mine is accessed by twin declines, developed by room and pillar methods, and had ramped up production to 140 tons day. Ore is shipped 62 miles to the White Mesa mill. In 2012, the Daneros produced 39,538 tons averaging about 0.22 percent U₃O₈.

Energy Fuels’ Henry Mountains Complex (Tony M mine and Bullfrog properties) in the Shootaring Canyon district, Garfield County, and Rim mine in the Dry Valley (East Canyon) district of San Juan County, are both on standby awaiting higher uranium prices. Both the Shootaring and Dry Valley district ore bodies are hosted in the Upper Jurassic Salt Wash Member of the Morrison Formation.

Energy Fuels acquired the Energy Queen mine in the La Sal district (Figure 8.8), San Juan County, and began rehabilitation. The mine has an estimated resource of 96,250 tons of ore averaging 0.32 percent U₃O₈ and 1.24 percent V₂O₅, with access via an existing 750-foot-deep lined shaft (Peters, 2011a). The Whirlwind mine on Beaver Mesa straddles the Utah-Colorado border about 28 miles northeast of Moab in Grand County. The property began limited production in 2009, but has been on standby since then. The Whirlwind mine has a measured resource of 147,798 tons of ore averaging 0.27 percent U₃O₈ and 0.88 percent V₂O₅ (Peters, 2011b). Both the Energy Queen and Whirlwind uranium ores are hosted in the Upper Jurassic Salt Wash Member of the Morrison Formation.

In 2012, Energy Fuels obtained a 100 percent interest in the Sage Plain project in the Ucolo uranium district (Figure 8.8), San Juan County. Sage Plain has calculated a measured and indicated resource of 642,971 tons at 0.22 percent U₃O₈ and 1.39 percent V₂O₅ (Peters, 2011c). This project encompasses the historic Calliham and Sage mines.

Uranium One, Incorporated
Uranium One, Incorporated acquired the uranium assets of the U.S. Energy Corporation in 2006 and Energy Metals in 2007. These assets in the Lisbon Valley district (Figure 8.8) included the Velvet mine with an indicated resource of about 70,850 tons averaging 0.41 percent U₃O₈ and 0.57 percent V₂O₅ (Beahm and Hutson, 2007). The Velvet has the highest grade uranium resource known in the state and is hosted in the Lower Permian Cutler Group sandstone. Other Uranium One assets include the large, albeit low-grade, Frank M underground uranium resource
and nearby inactive 750-ton-per-day Shootaring Canyon (Ticaboo) uranium mill, both in the Henry Mountains, Garfield County.

**Laramide Resources Limited**

Laramide Resources is working to develop the La Sal deposit in the Lisbon Valley mining district (Figure 8.8), the largest uranium-producing district in Utah. The La Sal deposit was initially developed by Homestake Mining Company in the Permian Cutler Formation sandstone beneath the Triassic-hosted ores of the main Big Indian uranium belt. The estimated La Sal resource is approximately 800,000 tons of 0.17 percent \(U_3O_8\).

### 8.1.4 Base and Precious Metals

**Production and Values**

Base and precious metals produced in Utah during 2012 have an estimated value of $2.53 billion, which accounts for 68 percent of the total value of all nonfuel minerals produced in Utah. Overall base and precious metal production values decreased 24 percent from 2011. Base metal production value in 2012 is estimated at $2.12 billion, which was the largest contributor to the total value of all nonfuel minerals produced in Utah, accounting for 57 percent (Table 8.4 and Figure 8.6). Utah’s base metal production value decreased by 19 percent from 2011, because of decreases in the production of copper and molybdenum. Of the total base metal value, copper (65 percent), magnesium (13 percent), and molybdenum (13 percent) together constitute 91 percent, and iron, beryllium, and vanadium account for the remaining 9 percent.

#### Table 8.4

**Utah Estimated Energy and Mineral Production Values, 2002–2012**

(Millions of Constant 2012 Dollars)

<table>
<thead>
<tr>
<th>Year</th>
<th>Base Metals</th>
<th>Industrial Minerals</th>
<th>Precious Metals</th>
<th>Energy Minerals</th>
<th>Oil</th>
<th>Gas</th>
<th>Total Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>2002</td>
<td>$781</td>
<td>$721</td>
<td>$220</td>
<td>$587</td>
<td>$420</td>
<td>$698</td>
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<td>$470</td>
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<td>$192</td>
<td>$446</td>
<td>$705</td>
<td>$1,771</td>
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<tr>
<td>2005</td>
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<td>$892</td>
<td>$246</td>
<td>$540</td>
<td>$1,058</td>
<td>$2,536</td>
<td>$7,732</td>
</tr>
<tr>
<td>2006</td>
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<td>$924</td>
<td>$456</td>
<td>$648</td>
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</tr>
<tr>
<td>2007</td>
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<td>$357</td>
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<td>$851</td>
<td>$685</td>
<td>$662</td>
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<td>$1,925</td>
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<tr>
<td>2011</td>
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<td>$1,180</td>
<td>$726</td>
<td>$703</td>
<td>$2,214</td>
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<tr>
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<td>$406</td>
<td>$644</td>
<td>$2,500</td>
<td>$1,330</td>
<td>$8,214</td>
</tr>
</tbody>
</table>

*Note: Energy minerals consist of coal and uranium; sulfuric acid has been included in industrial minerals since 2011.*


Precious metal production value for Utah in 2012 is estimated at $405.9 million, or 11 percent of the total value of all nonfuel minerals produced in Utah, and is distributed between gold (84 percent) and silver (16 percent) (Table 8.4 and Figure 8.6). Precious metal production value decreased by 43 percent from 2011 to 2012, due to significantly decreased production for both gold and silver.
The vast majority of Utah’s copper, gold, and silver, and all of the molybdenum, is produced from KUC’s Bingham Canyon mine, located about 20 miles southwest of Salt Lake City in Salt Lake County (Figure 8.7). The combined value of metals produced by KUC in 2012 at average prices is estimated at $2.01 billion, about a 31 percent decrease from 2011, and was approximately 54 percent of the total value of all nonfuel minerals produced in Utah. KUC’s Bingham Canyon mine was the second largest copper and molybdenum producer in the U.S. in 2012.

**Copper**

In 2012, copper was the largest contributor to the value of nonfuel minerals in Utah, having an estimated value over $1.38 billion, about a 23 percent decrease from 2011. KUC’s Bingham Canyon mine produced the majority of copper in Utah in 2012 at approximately 180,000 tons, a significant decrease of about 35,000 tons from 2011 (Rio Tinto, 2013). The average copper price decreased about 9 percent from 2011 to $3.70/lb (USGS, 2013a), and KUC’s production for 2012 has an estimated value of $1.33 billion, which is a decrease of about 24 percent from 2011.

Lisbon Valley Mining Company operates a copper mine and processing facility about 30 miles southeast of Moab in San Juan County (Figure 8.7). About 5,700 tons of copper was produced by the company in 2012, slightly less than in 2011, with an estimated value over $42 million at the 2012 average copper price (USGS, 2013a). C.S. Mining, LLC produced approximately another 565 tons of copper in 2012 from its Hidden Treasure mine in Beaver County. Copper is combined with a number of metals to create alloys for a wide variety of applications, and is used to produce a wide range of products including electrical wiring, electronic components, and pipe for plumbing, refrigerator, and heating systems.

**Magnesium**

The only facility producing magnesium from a primary source in the United States is located about 60 miles west of Salt Lake City at Rowley in Tooele County (Figure 8.7), and is operated
by U.S. Magnesium, LLC. Magnesium chloride concentrate is produced from Great Salt Lake brines through evaporation and converted to magnesium metal by an electrolytic process. USGS (2013a) reports that annual magnesium production capacity at U.S. Magnesium's plant is 70,000 tons. The price for magnesium metal increased slightly from 2011, averaging $2.20/lb in 2012 (USGS, 2013a). Utah's 2012 magnesium production is valued around $308 million, assuming production at full capacity, ranking it second as a contributor to Utah's base metal values in 2012. Significant quantities of U.S. Magnesium's production are used by a nearby plant, operated by Allegheny Technologies Inc., to produce titanium sponge. Nationally, other markets for magnesium include use as a constituent of aluminum-based alloys (43 percent), structural use in castings and wrought products (40 percent), and for desulfurization of iron and steel (11 percent) (USGS, 2013a).

Molybdenum
Utah's molybdenum production in 2012 came solely from KUC's Bingham Canyon mine, where it was recovered as a byproduct from the copper operation. Approximately 10,362 tons of molybdenum was produced in 2012, a large decrease of about 31 percent from 2011 (Rio Tinto, 2013). Molybdenum's average price dropped about 14 percent from 2011 to $13.24/lb (USGS, 2013a). Utah's molybdenum production in 2012 is valued at approximately $274 million. Molybdenum production value was about 41 percent lower than in 2011, due to the decrease in production and price. Molybdenum ranked third as a contributor to Utah’s base metal values in 2012. In 2012, molybdenum concentrate in the U.S. was produced by 12 mines, as either a primary product or byproduct, and was valued at about $1.7 billion. Molybdenum is primarily used in alloys with other metals by iron, steel, and other producers that account for about 76 percent of the molybdenum consumed (USGS, 2013a).

Iron Ore
Iron ore in Utah is produced solely by CML Metals, Incorporated from their Iron Mountain project, which is a redevelopment of the Comstock/Mountain Lion iron mine located about 19 miles west of Cedar City in Iron County (Figure 8.7). In 2012, CML produced approximately 1,583,400 tons of mostly run-of-mine iron ore up to 54 percent iron and lesser amounts of concentrate up to 67 percent iron (CML Metals, 2012). Iron ore production increased about 11 percent from 2011 to 2012. Estimated value of the iron ore at approximately $100/ton is around $158 million, which is an increase of about 32 percent from 2011. Iron ore production ranks fourth in contribution to Utah’s 2012 base metal production values. Iron ore from the Iron Mountain project is transported by rail to a port in Southern California and shipped overseas.

Beryllium
Utah remains the United States’ sole producer of beryllium ore from the mineral bertrandite \((\text{Be}_2\text{Si}_2\text{O}_7\cdot(\text{OH})_2)\). Materion Natural Resources, Inc. mines bertrandite from the Spor Mountain area about 42 miles northwest of Delta in Juab County (Figure 8.7). Materion operates a mill 11 miles north of Delta in Millard County, which is the nation’s sole source of beryllium concentrate, where bertrandite ore and imported beryl are processed into beryllium hydroxide. Materion's parent company (Materion Corporation) operates a refinery and finishing plant in Ohio where the beryllium hydroxide concentrate is shipped and converted into beryllium-copper master alloy, metal, and oxide (USGS, 2013a). About 80,500 tons of bertrandite ore was mined in 2012 from the Topaz mine at Spor Mountain. Beryllium concentrate production from Utah in 2012 is estimated to be 228 tons, roughly the same as 2011, having a value of approximately $20 million. The average beryllium price for 2012 was slightly higher than in 2011 at $209/lb (USGS, 2013a), which resulted in an increase of about 3.5 percent in value over 2011. Beryllium ranked
fifth as a contributor to Utah’s 2012 base metal values. Beryllium is used in various telecommunications and consumer electronics products, defense-related applications, industrial components, commercial aerospace applications, appliances, automotive electronics, energy applications, medical devices, and other applications.

Vanadium
Vanadium, in the form of vanadium pentoxide ($V_2O_5$), is a byproduct of uranium mining and milling at Energy Fuel’s White Mesa mill about 6 miles south of Blanding in San Juan County (Figure 8.7). In 2012, Energy Fuels produced approximately 1,811,200 pounds of $V_2O_5$ having a value of approximately $12 million, from the Beaver and Pandora mines uranium ore. The average vanadium price in 2012 was $6.52/lb (USGS, 2013a), remaining steady from 2011. Vanadium production value increased significantly in 2012 by about 43 percent over the value in 2011, and was due to an approximate 40 percent increase in production over 2011. Vanadium ranked sixth as a contributor to Utah’s 2012 base metal values. Metallurgical use by the steel industry as an alloying agent is responsible for about 93 percent of domestic vanadium consumption (USGS, 2013a).

Gold
In 2012, approximately 201,000 troy ounces (oz) of gold was produced in Utah, which was about a 48 percent decrease (185,000 troy oz) from 2011 (Rio Tinto, 2013). KUC mines most of this gold at its Bingham Canyon mine, where it is recovered as a byproduct from the copper operation. About 1,000 troy oz of the total gold produced came from residual leaching of existing heaps at KUC’s Barneys Canyon mine, which ceased active mining in 2001 after ore exhaustion, and is located 2.5 miles north of the Bingham Canyon operation. The average gold price in 2012 was $1,700/troy oz, an increase of about 8 percent from 2011 (USGS, 2013a). Utah’s gold production at the 2012 average price has an estimated value of $342 million, about a 44 percent decrease in value from 2011. Small quantities of gold and silver may have been produced by other small Utah mines, but production may not be reported and would not make any significant impact on the total amount of gold and silver produced in Utah.

Silver
KUC produced most of Utah’s silver in 2012 from the Bingham Canyon mine, where it is also recovered as a byproduct from the copper operation. Total silver production in 2012 amounted to approximately 2,126,680 troy oz, which was about a 28 percent decrease (849,320 troy oz) from 2011 (Rio Tinto, 2013). In 2012, C.S. Mining produced approximately 40,680 troy oz of silver from its Hidden Treasure mine in Beaver County. The average silver price in 2012 was $30/troy oz, a decrease of about 15 percent from 2011 (USGS, 2013a). Utah’s silver production at the 2012 average price has an estimated value of $64 million, about a 40 percent decrease in value from 2011.
Figure 8.7
Base and Precious Metals, Selected Industrial Minerals, and Uranium Production Locations in Utah During 2012

Explanation
- Base and Precious Metals
- Industrial Minerals
- Uranium


Exploration and Development Activity
Metals had an off year in 2012 with copper, molybdenum, and silver prices slipping, compounded by significantly decreased Utah production. Base metal exploration in 2012 was dominated by major companies doing brownfield exploration in the Bingham, Tintic, and Drum (Detroit) mining districts.
The escalating gold price in 2012 prompted renewed exploration activity for that metal in Utah. Precious metal exploration was also driven by recent important sediment-hosted gold discoveries in the Basin and Range of eastern Nevada (e.g., Long Canyon and Kinsley Mountain, Elko County). Gold-silver exploration is being carried out by major gold-silver producers and junior exploration companies, as well as local prospectors.

**Bingham Canyon**

KUC’s Bingham Canyon porphyry copper-gold-molybdenum-silver mine (Figure 8.7), Salt Lake County, produced its 3 billionth ton of porphyry ore in 2012, continuing a remarkable run of over 100 years of open pit copper mining. Bingham remained the second largest annual producer of both copper and molybdenum in the U.S. In June 2012, the $660 million Cornerstone push-back was approved to extend the Bingham Canyon mine life from 2018 to 2029. This project involves pushing back the south pit wall about 1,000 feet to access an additional 568 million tons of 0.79 percent copper equivalent ore.

Copper, molybdenum, gold, and silver production from Bingham were all down in 2012 from 2011 due to lower ore tonnages mined. Furthermore, copper, molybdenum, and silver prices were also down while only gold prices rose. Consequently gross sales revenue was down to $2.4 billion in 2012.

KUC began construction of a $340 million molybdenum autoclave process (MAP) facility in 2011. The new MAP facility will have the capacity to produce 30 million pounds of molybdenum products and an additional 9,000 pounds of rhenium per year. The MAP facility was due to come online in mid-2014 followed by a one-year shakedown period to reach full capacity. Ultimately the plant could produce 10 percent of the world’s molybdenum.

Although KUC’s Barneys Canyon gold mine ceased mining in 2001, the operation continues to recover minor amounts of gold from the old heap leach pads. In 2012, production was approximately 1,000 oz.

Kennecott Exploration Company (KEC) continued an aggressive brownfield, near-mine exploration drilling program in the Oquirrh Mountains in 2012. An additional 11 deep core holes (including deflections) totaling 40,335 feet were completed in the Bingham area (Russ Franklin, KEC, written communication, May 2013).

**Lisbon Valley Copper**

The Lisbon Valley Mining Company operates a sediment-hosted, open pit, heap leach, solvent extraction and electrowinning (SX-EW) copper operation situated in the Lisbon Valley mining district, San Juan County. The company began copper mine (Figure 8.7) development in 2005 with plant construction completed in 2006. Following some startup problems, Lisbon Valley Mining Company successfully restarted mining operations in 2009. Mine production in 2012 was similar to 2010 and 2011, holding steady at about 2.65 million tons averaging 0.46 percent copper delivered to the heap leach pads (Lantz Indergard, Lisbon Valley Mining Company, written communication, April 2013).

**Iron Springs**

The CML mine (formerly the Comstock-Mountain Lion) at Iron Mountain, Iron County (Figure 8.7), was acquired by Palladon Iron Corporation in 2005, and restructured into CML Metals Corporation in early 2010. The iron ore occurs as massive magnetite skarn/replacement deposits.
adjacent to Miocene laccoliths. Open pit mining was initiated by Palladon in 2008, but ceased in 2009 due to instability in the iron ore market and logistical problems. In 2009, Palladon completed a Canadian NI 43-101 compliant resource estimate on the CML deposit showing a resource of 31.4 million tons averaging 48.6 percent iron (SRK Consulting, 2009). Mining was restarted by CML in July 2010 and run-of-mine ore was shipped out of the new rail load-out facility at the mine by the Union Pacific Railroad. The concentrator was completed in early 2012 and operated in break-in capacity throughout 2012, suffering through concentrate dewatering difficulties. CML mined approximately 1.6 million tons in 2012 and in 2013 was still optimizing the concentrator to produce a high-grade iron concentrate at a rate in excess of 2 million tons per year.

CML also completed nine drill holes in 2012, twinning old U.S. Steel holes in the Rex deposit to verify the historic resource of approximately 80.9 million tons of 39 percent iron. The completion of a feasibility study on the Rex deposit was planned for 2013.

**Drum Mountains**

The Drum Mountains (Detroit mining district) became the most competitive metal exploration area in the state in 2012. Freeport-McMoRan Exploration Corporation acquired about 1,020 acres of SITLA land, roughly 1,000 acres of patented mining claims, and staked an additional 395 lode claims in the copper-gold heart of the old mining district. The Steele family also has about 70 claims in this area.

Newmont Mining Corporation signed an earn-in agreement with Renaissance Gold, Incorporated on the Wildcat sedimentary rock-hosted gold property in the northern Drum Mountains, Juab County (Figure 8.8). The property consists of over 200 unpatented mining claims. The property was explored by Gold Fields Mining Corporation in the early 1990s. Gold Fields’ drilling cut intervals of up to 75 feet of 1.27 ppm gold (hole DM-27). Newmont completed four reverse-circulation holes in 2011 and approximately 12 more in 2012 totaling 9,025 feet (Rendy Keaten, Newmont Mining Corporation, written communication, May 2013). Golden Dragon Capital also holds about 38 claims in this area.

Anglo Gold Ashanti USA (184 claims), C.S. Mining (226 claims), Golden Dragon (44 claims), and North Exploration (10 claims) have acquired land positions in the southern part of the Detroit district near the historic Drum distal disseminated silver-gold open pits in Millard County.

**Rocky and Beaver Lake Districts**

C.S. Mining controls a series of small copper deposits in the Rocky and Beaver Lake mining districts (Figure 8.8) in Beaver County. These properties host seven partially delineated prograde copper skarn and copper breccia pipe deposits. In 2009, a flotation mill was completed and open pit mining started on the Hidden Treasure copper skarn. The mill began production at 1,200 tons per day in May 2009 and produced a very limited amount of copper concentrate. A separate magnetite concentrate was also produced and sold to a coal wash plant in the fall of 2009. However, the mill experienced less than 20 percent copper recovery due to the mixed oxide-sulfide nature of the skarn ore and operations were halted near the end of 2009. The mine and mill were restarted in September 2012 and 206,527 tons of ore was mined from the Hidden Treasure copper skarn in 2012. C.S. Mining produced roughly 20 tons of concentrate per day for shipment in 2012 to the Bingham smelter. The concentrate is estimated to average about 25 percent copper, 600 ppm silver, and 3 ppm gold.
**Tecoma District**
In 2010, the TUG distal disseminated silver-gold deposit in the Tecoma district (Figure 8.8) of westernmost Box Elder County was optioned by West Kirkland Mining (USA) Limited from Newmont. The TUG deposit has a historic open-pitable resource of about 1.5 million tons averaging 1.71 ppm gold and 100 ppm silver, but recent drilling has increased the size to an inferred resource of approximately 30 million tons at 0.49 ppm gold and 15.9 ppm silver (Selway et al. 2012).

**Goldstrike District**
Cadillac Mining Corporation acquired 3,800 acres covering the historic mining area of the Goldstrike sedimentary rock-hosted gold-silver mining district, Washington County (Figure 8.8). Production from Goldstrike in the 1980s and 1990s totaled approximately 210,000 oz of gold and 198,000 oz of silver. Cadillac compiled and digitized the historic exploration/mining data on the district in 2011 and drilled three holes from a single pad on the Hamburg Extension target later that year. Two of these three initial reverse-circulation holes (GS11-02 and 03), totalling 1,860 feet, intersected 1.08 ppm gold over 240 feet and 1.25 g ppm gold over 270 feet. Several follow-up holes in 2012 also intersected mineralization including GS12-07, which cut 99 feet of 1.56 ppm gold and 3.8 ppm silver, and GS12-08, which intersected 101 feet of 2.05 ppm gold and 4.3 ppm silver.

**Confusion Range**
In 2012, Pine Cliff Energy Limited acquired 100 percent interest in the 2,300-acre Kings Canyon sedimentary rock-hosted gold-silver property in western Millard County (Figure 8.8). The property was explored in the early 1990s, primarily by Crown Resources. The property contains several known gold zones; the largest defined resource is in the Crown zone, about 7.9 million tons averaging roughly 0.93 ppm gold (Krahulec 2011).Geomark is continuing drilling to expand Kings Canyon and a more poorly defined Royal resource, with intersections including KC12-17 in the Royal zone of 110 feet of 1.09 ppm gold.

**Gold Springs District**
The Gold Spring mining district is located in extreme western Iron County, southwestern Utah (Figure 8.8). The district is a small historic low-sulfidation, epithermal, gold-silver quartz-adularia-calcite vein/stockwork district. High Desert Gold Corporation controls a 6000-acre block of ground in the Gold Springs district. High Desert Gold announced an initial inferred resource on the Jumbo gold-silver stockwork of 10,353,079 tons at 0.57 ppm gold and 12.90 ppm silver (Katsura and Armitage 2012). A follow-up four- to eight-hole reverse-circulation drilling program on the Jumbo zone was scheduled to begin in April 2013.
Gold Hill District
Clifton Mining Company and Desert Hawk Gold Corporation agreed in 2009 to jointly develop Clifton’s mineral properties in the Gold Hill district (Figure 8.8) in western Tooele County. Desert Hawk plans a heap leach operation at the Kiewit low-sulfidation, quartz-carbonate-adularia stockwork gold deposit. The Kiewit deposit is known to contain a crudely estimated 1.7 million tons averaging about 1 ppm gold. Permitting of the Kiewit open pit and cyanide heap leach operation is underway.
Tintic District
Andover Ventures, Incorporated purchased 78.5 percent of Chief Consolidated Mining Company in 2008. Chief Consolidated’s main assets are properties in the East Tintic district (Figure 8.8), Utah County. Andover has released an indicated resource for the Burgin Extension deposit containing 920,000 tons at 0.86 ppm gold, 249 ppm silver, 9.3 percent lead, and 3.5 percent zinc with an additional inferred resource of 1,357,000 tons at 0.45 ppm gold, 299 ppm silver, 14.4 percent lead, and 5.2 percent zinc (Tietz et al. 2011).

In addition, KEC, through a joint venture with Andover, acquired a porphyry copper lithocap target on Big Hill near the center of the East Tintic district. KEC began work in 2010 by running a magnetotelluric grid, six lines of induced polarization (IP), and a high-resolution aeromagnetic survey along with geologicalteration mapping and collection of about 200 geochemical samples. Four reverse-circulation holes, totaling 4,311 feet, were precollared in 2011 and two of these holes, totaling 5,159 feet, were core drilled to completion in 2012 (Russ Franklin, KEC, written communication, May 2013).

Quaterra Resources, Incorporated acquired about 3,200 acres of patented and unpatented mining claims encompassing the Southwest Tintic porphyry copper system, Juab County, in 2007. The property hosts a known historic resource of approximately 400 million tons of 0.33 percent copper and 0.01 percent molybdenum (Krahulec and Briggs 2006). This property was joint-ventured with Freeport-McMoRan Exploration Corporation in 2009, and Freeport began an integrated program of geological mapping, geochemical sampling, geophysical surveying, and drilled seven holes in 2010–11. No additional drilling was completed in 2012.

Star District
Firestrike Resources Limited acquired a property position in the eastern Star Range, Beaver County in 2012 (Figure 8.8). Following an initial dump rock sampling program they drilled 19 shallow, close-spaced holes totaling about 6,542 feet. The best hole (FSRC12-19) cut 44 feet of 0.72 ppm gold beginning at a depth of just 13 feet apparently in a ferruginous fissure zone in the Oligocene Vicksburg quartz monzonite stock.

Spor Mountain
Avalon Rare Metals controls 383 unpatented lode claims (7,900 acres) on a Spor Mountain rare metal prospect, Juab County (Figure 8.8). Geologic and ground magnetic surveys were completed in 2011. In 2012, Avalon completed four core holes totaling 4,055 feet at Spor Mountain. All four holes reportedly encountered intense alteration, brecciation, and faulting typically found near hydrothermal mineralization.

IBC Advanced Alloys Corporation acquired 371 claims adjacent to Materion’s (Brush-Wellman’s) Spor Mountain beryllium mine, the largest beryllium producer in the world. IBC completed a 4,657-line-mile airborne magnetic and radiometric survey in 2010, which defined several potential targets. In 2011, IBC began drill testing these targets, completing an east-west fence of 35 reverse-circulation holes totaling 18,040 feet south of Materion’s property. Preliminary analytical results released in mid-2012 appeared unfavorable, with the best intercept being just 617 ppm beryllium.

Miscellaneous Base Metal and Precious Metal Developments
Newmont Mining Corporation drilled five holes for gold at the Cina mine in north-central Iron County in 2011. The Cina mine is a high-level, epithermal mercury-sulfur system. Analytical re-
sults showed very little gold and the property was dropped. Newmont also has two additional sedimentary rock-hosted gold claim blocks in the northern Pilot Range and Goose Creek Mountains of extreme western Box Elder County.

In 2012, Kinross Gold USA, Incorporated staked 305 claims in the Fortuna mining district, Beaver County. The Fortuna district hosts Miocene low-sulfidation, epithermal, gold-silver quartz-adularia-calcite veins. Kinross also acquired a core block of 25 lode claims and a block of patented mining claims covering an additional 260 acres to the south. Drilling was anticipated in 2013.

During 2012, Eurasian Minerals (Bronco Creek) staked 238 lode claims at the Sand Pass distal disseminated silver-gold prospect in the northern House Range, Juab County. Eurasian also acquired a small patented claim block in the northern Ophir mining district, Tooele County.

Grand Central controls a large 4,779-acre Cave mine property position in the Bradshaw silver-gold-lead district of the southern Mineral Mountains, Beaver County. The Cave mine targets include copper-gold skarns and high-grade, precious metal-rich, polymetallic carbonate replacement deposits, like the old Cave mine itself. Initial work included surface and underground geological mapping and geochemical sampling along with a 93-line-mile ground magnetometer survey and some IP surveying.

The Coyote Knolls low-sulfidation silver-gold deposit, Juab County, was acquired by Amnor Energy Corporation in 2012. Coyote Knolls hosts a small, partly drill-defined resource estimated at about 50,000 tons averaging roughly 150 ppm silver and 1 ppm gold developed on a narrow, steeply dipping, high-grade vein/pebble dike that is open at depth. Amnor Energy Corporation began mining operations and built a small, off-site gravity mill west of Eureka. The mill operated by fine crushing and using shaker gravity concentrating tables to produce a concentrate. The whole operation was shut down after only a few weeks of operation due to high levels of mining dilution.

8.1.5 Industrial Minerals

Production and Values

Industrial minerals production in Utah in 2012 had an estimated value of $1.2 billion and was second, at 32 percent, in contribution to the total value of nonfuel minerals produced in Utah (Table 8.4 and Figure 8.6, above). Industrial minerals value in 2012 was approximately equal to the record-breaking value set in 2011. Industrial minerals production value remained steady from 2011 due to continued higher prices and production for some commodities.

The largest overall contributors to the value of industrial minerals production in Utah during 2012 were the brine-derived products of potash, salt, and magnesium chloride, having a combined value of $421.2 million. This value represented 35 percent of total industrial mineral value in 2012, and was an 8 percent increase over 2011. The sand and gravel, crushed stone (including limestone and dolomite), and dimension stone commodity group was the second-largest contributor to the value of industrial minerals production at $201 million. The value of this commodity group accounted for 17 percent of total industrial mineral value in 2012, and decreased 5 percent from 2011. The third-largest overall contribution to the value of industrial minerals production came from Portland cement and lime products, having a combined value of $194 mil-
lion that accounts for 16 percent of total industrial mineral value in 2012, an increase of 10 percent in value over 2011. These three commodity groups contributed 68 percent of the total value of industrial minerals produced in Utah during 2012. The remaining 32 percent of Utah’s total industrial mineral value came from, in decreasing order of value, phosphate, sulfuric acid, gilsonite, clays, expanded shale, and gypsum.

**Potash, Salt, and Magnesium Chloride**

The brine-derived commodities produced from Great Salt Lake and other deposits were important contributors to the value of Utah’s industrial mineral production in 2012, and consisted of salt, magnesium chloride, and potash (in the form of potassium sulfate). Potash in the form of potassium chloride, along with significant amounts of magnesium chloride and lesser amounts of salt, were produced by operations in other parts of the state. Small amounts of concentrated magnesium brine for use in nutritional supplements were produced by Mineral Resources International, Incorporated (NorthShore Limited Partnership).

Potash production in Utah was over 450,000 tons in 2012, and was the largest contributor to the value of the brine-derived commodities group. The 2012 value of potash produced in Utah was approximately $233 million, an increase of about 6 percent from 2011 that was due to increases in production of potassium sulfate and increases in the price of potash. Great Salt Lake Minerals Corporation produces the potassium sulfate variety, whereas Intrepid Potash–Wendover and Intrepid Potash–Moab produce the potassium chloride variety (Figure 8.7).

Utah’s salt production in 2012 was approximately 3.18 million tons, an increase of about 10 percent from 2011. This salt production was valued at approximately $154.5 million, an increase of about 8 percent over 2011 that was due to higher production in 2012, since prices remained steady from 2011. Some 84 percent of this salt was produced from Great Salt Lake brine by four operators who were, in descending order of production, (1) Great Salt Lake Minerals Corporation, (2) Cargill Salt Company, (3) Morton International, and (4) U.S. Magnesium (Figure 8.7). The remaining 16 percent came from another three operators who were, in descending order of production, (1) Redmond Minerals, Incorporated near Redmond in Sanpete County, (2) Intrepid Potash–Wendover near Wendover in Tooele County, and (3) Intrepid Potash–Moab near Moab in Grand County.

Magnesium chloride production in Utah was approximately 850,000 tons in 2012, about a 25 percent increase from 2011. Magnesium chloride prices remained steady from 2011, and production value of magnesium chloride was estimated at $34 million, an increase of about 25 percent from 2011 to 2012. Great Salt Lake Minerals Corporation on the east side of Great Salt Lake and Intrepid Potash–Wendover produced the magnesium chloride.

**Sand and Gravel, Crushed Stone, and Dimension Stone**

Sand and gravel, crushed stone, and dimension stone are produced by commercial operators as well as various county, state, and federal agencies. Due to the large number of producers in this commodity group, it is not practical for the UGS to send annual production questionnaires to all of the operators. However, the UGS does compile data from selected operators to track these commodities, and uses USGS data for production and value figures. In Utah during 2012, approximately 6.8 million tons of sand and gravel was produced, valued at $146 million (USGS, 2013b). About 7.56 million tons of crushed stone having a value of $54.3 million (USGS, 2013b), and an estimated 9,000 tons of dimension stone having a value of approximately $0.7 million, was produced in 2012. Production value for the commodity group in 2012 is approxi-
mately $201 million, about a 5 percent decrease from 2011. Unit price for sand and gravel and crushed stone remained steady from 2011, and the value decrease resulted from slightly lower production of these two commodities.

**Portland Cement, Lime, and Limestone**
Two companies, Ash Grove Cement Company and Holcim, Incorporated, produced Portland cement in Utah during 2012, which amounted to over 1.1 million tons having a value over $100 million. Ash Grove Cement Company operates the Leamington quarry and plant located east of Leamington in Juab County, and Holcim operates the Devils Slide quarry and plant located east of Morgan in Morgan County (Figure 8.7). Portland cement production in 2012 increased about 3 percent over 2011, resulting in a slight value increase for 2012 as well. However, production still remained below the combined potential capacity of the companies’ plants of 1.5 million tons of cement annually. Along with limestone, Ash Grove Cement and Holcim also mine small amounts of sandstone, clay, and shale that are used in cement manufacturing.

Lime in 2012 was produced solely by Graymont Western U.S., Incorporated. In the past Lhoist North America has produced dolomitic lime, but their quarry and plant in Tooele County have been idle since 2008. Lime production increased approximately 3 percent from 2011 to 2012. Graymont Western U.S. produces high-calcium quicklime and dolomitic quicklime from their quarry and plant in the Cricket Mountains about 35 miles southwest of Delta in Millard County (Figure 8.7). The annual production capacity when both plants are in operation is over 1.0 million tons.

Limestone production for 2012 amounted to approximately 3.6 million tons. The three operators responsible for most of this production were, in decreasing order of production, (1) Graymont Western U.S., Incorporated, (2) Ash Grove Cement Company, and (3) Holcim, Incorporated. Cotter Corporation in San Juan County produced a lesser amount of limestone for flue-gas desulfurization in coal-fired power plants. Limestone is primarily used in the manufacture of cement and lime products, with lesser amounts used in various aspects of the construction industry, for flue-gas desulfurization in coal-fired power plants, and as a safety product for the coal mining industry as “rock dust.”

**Phosphate**
Simplot Phosphates continues to be the only active phosphate producer in Utah. The company’s phosphate operation is located 12 miles north of Vernal in Uintah County (Figure 8.7). In 2012, the mine produced approximately 3.9 million tons of ore, about 7 percent less than in 2011. The ore yields roughly 1.3 million tons of phosphate concentrate (P₂O₅) after processing. The concentrate is then transported in slurry form through a 96-mile underground pipeline to the company’s fertilizer plant near Rock Springs, Wyoming. More than 95 percent of the phosphate rock mined in the U.S. was used to manufacture phosphoric acids to make ammonium phosphate fertilizers and animal feed supplements (USGS, 2013a).

**Sulfuric Acid**
In 2012, KUC’s Bingham Canyon mine generated approximately 800,000 tons of sulfuric acid (H₂SO₄), slightly less than in 2011, as a byproduct of the copper-gold-silver smelting process. Although sulfuric acid has been recovered at the Bingham copper smelter since 1917, this is just the second year its dollar value is included in the UGS production survey, now ranking it 5th in contribution to the value of Utah industrial minerals. In 2012, sulfuric acid prices averaged about $138/ton, suggesting a very approximate total value of about $110 million. Sulfuric acid is used
in the production of fertilizer and by some gold, copper, uranium, and beryllium producers, as well as in chemical manufacturing, power plants, steel companies, farming, and water treatment.

**Gilsonite**

Gilsonite is a shiny, black, solid hydrocarbon that forms a swarm of laterally and vertically extensive veins in the Uinta Basin. It has been mined since the late 1880s in Utah and Colorado. In 2012, American Gilsonite Company (Figure 8.7) and Ziegler Chemical and Mineral Company both mined and processed gilsonite at their operations in southeastern Uintah County. Gilsonite production has remained steady from 2011 to 2012 at about 82,000 tons, with American Gilsonite Company responsible for most of that production. Gilsonite production in 2012 is valued at approximately $88.9 million, at an average price of $1087.61/ton (Office of Natural Resources Revenue, 2013), an increase of about 35 percent from 2011 to 2012 due to the significant price increase. Utah is the only place in the world that contains large economic deposits of gilsonite, and it has been shipped worldwide for use in a large number of diverse products ranging from asphalt paving mixes and coating, inks and paints, to oil and gas well drilling (Boden and Tripp, 2012).

**Bentonite, Common Clay, and High-Alumina Clay**

Production of bentonite, common clay, and high-alumina clay in Utah during 2012 amounted to approximately 273,600 tons, about the same production as in 2011. These commodities are produced by many small and large mines, often on an intermittent basis. Bentonite was produced by two companies, Western Clay Company and Redmond Minerals, Incorporated, which together produced about 70 percent of the total production. Uses for bentonite include well drilling and foundry operations, various civil engineering applications, and as litter-box filler. The largest producers of common clay and high-alumina clay were Interstate Brick Company, and Holcim, Incorporated, respectively, which together produced the remaining 30 percent of the total production. The manufacturing of bricks was the primary use for common clay, and high-alumina clay was used for manufacturing of Portland cement.

**Expanded Shale**

Expanded shale in Utah is solely produced by Utelite, Incorporated at their quarry and plant near Wanship in Summit County (Figure 8.7). The company produced approximately 119,000 tons in 2012, a decrease of about 14 percent from 2011 production. Expanded shale is a lightweight aggregate, sometimes referred to as “bloated shale,” mainly used by the construction industry. It is produced by heating high-purity shale from the Cretaceous Frontier Formation to about 2000º F, causing it to expand and vitrify. The resulting aggregate is durable, inert, uniform in size, and lightweight, having a density about one-half that of conventional aggregates. Their material is used as aggregate in roof tile, concrete block, and structural concrete, and in other ways in horticulture, highway construction, and loose fill. Some of Utelite’s production is used locally along the Wasatch Front, but much of it is shipped out of state.

**Gypsum**

Four operators reported combined Utah gypsum production of about 271,000 tons in 2012, an increase of approximately 20 percent over 2011. This production had an estimated value of roughly $3.2 million, also a 20 percent increase over 2011 because 2011 prices remained unchanged (USGS, 2013a). In descending order of production, the four producers were (1) Sunroc Corporation, (2) United States Gypsum Company, (3) Diamond K Gypsum, Incorporated, and (4) Nephi Gypsum. Two wallboard plants are located in Utah, both near the town of Sigurd in Sevier County. The plant operated by United States Gypsum was active in 2012 (Figure 8.7), but
the plant operated by Georgia Pacific remains idle due to economic considerations. Utah gypsum is primarily used in the manufacturing of wallboard. Lesser amounts of raw gypsum are used by regional cement companies as an additive to retard the setting time of cement, and by the agriculture industry as a soil conditioner.

**Exploration and Development Activity**

Industrial minerals exploration and development in Utah follows two separate paths. High-value-per-ton commodities like potash respond to the strength of the world economy because of their ability to withstand shipping charges, and the demand for these products has grown over the past decade. Low-value-per-ton commodities like sand and gravel are developed and used locally and are more reflective of the vigor of the regional market.

**Potash**

In 2012, industrial minerals exploration activity increased in Utah, principally for potash. Potash exploration has focused on such diverse sources as deep evaporites in the Paradox Basin, and shallow brines in the Sevier Lake playa and in the Great Salt Lake Desert, and alunitized [K\(_3\)Al\(_2\)(SO\(_4\))\(_2\)(OH)\(_6\)] volcanic rocks. The numerous Utah potash projects currently in exploration and development are briefly summarized in Table 8.5.

**Table 8.5**

<table>
<thead>
<tr>
<th>Property</th>
<th>Deposit Type</th>
<th>County</th>
<th>Company</th>
<th>Progress</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blawn Wash</td>
<td>Alunite alteration</td>
<td>Beaver</td>
<td>Potash Ridge Corporation</td>
<td>In-place measured and indicated resource of 620 million tons of about 30% alunite; completed 84 drill holes with more planned for 2013; completed preliminary economic assessment</td>
</tr>
<tr>
<td>Bounty Potash</td>
<td>Great Salt Lake Desert, shallow brine</td>
<td>Box Elder</td>
<td>Mesa Exploration Company</td>
<td>Acquired 66,048 acres; historic resource of 5.14 million tons KCl; seeking exploration permits</td>
</tr>
<tr>
<td>Crescent Junction</td>
<td>Paradox Basin, deep evaporites</td>
<td>Grand</td>
<td>Pinnacle Potash International</td>
<td>Acquired 13 state leases, completed 1 hole</td>
</tr>
<tr>
<td>Green River</td>
<td>Paradox Basin, deep evaporites</td>
<td>Grand</td>
<td>American Potash LLC (Magna Resources Ltd.)</td>
<td>Project area 50,950 acres; received drilling permits on state leases; drilling planned for early 2013</td>
</tr>
<tr>
<td>Paradox Basin</td>
<td>Paradox Basin, deep evaporites</td>
<td>Grand</td>
<td>Universal Potash Corporation</td>
<td>Applied for 29,000 acres</td>
</tr>
<tr>
<td>Salt Wash</td>
<td>Paradox Basin, deep evaporites</td>
<td>Grand</td>
<td>Mesa Exploration Company</td>
<td>Applied for 21,184 acres</td>
</tr>
<tr>
<td>Whipsaw</td>
<td>Paradox Basin, deep evaporites</td>
<td>Grand</td>
<td>Mesa Exploration Company</td>
<td>Applied for 17,968 acres</td>
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<tr>
<td>White Cloud</td>
<td>Paradox Basin, deep evaporites</td>
<td>Grand</td>
<td>Mesa Exploration Company</td>
<td>Applied for 35,510 acres</td>
</tr>
<tr>
<td>Sevier Lake</td>
<td>Sevier (Dry) Lake, shallow brine</td>
<td>Millard</td>
<td>Peak Minerals Inc. (EPM Mining Ventures Inc.)</td>
<td>124,221 acres under lease; 426 exploration holes in 2011 and 2012; in-place measured and indicated resource of 32.5 million tons of potassium sulfate; working on preliminary feasibility study</td>
</tr>
<tr>
<td>Hatch Point</td>
<td>Paradox Basin, deep evaporites</td>
<td>San Juan</td>
<td>K2O Utah LLC (Potash Minerals Limited)</td>
<td>90,190 acres in Hatch Point area; completed 3 deep holes on SITLA tracts in 2011; seeking federal exploration permit</td>
</tr>
<tr>
<td>Lisbon Valley</td>
<td>Paradox Basin, deep evaporites</td>
<td>San Juan</td>
<td>Potash Green Utah LLC (North American Potash Developments Inc.)</td>
<td>State leases and federal prospecting permit applications totaling 31,061 acres in Lisbon Valley, completed 1 hole</td>
</tr>
<tr>
<td>Monument</td>
<td>Paradox Basin, deep evaporites</td>
<td>San Juan</td>
<td>Paradox Basin Resources Corp.</td>
<td>Holdings include 104,467 acres of federal land under application, state leases, and private land</td>
</tr>
</tbody>
</table>

Halloysite
The Dragon mine is situated in the southern Main Tintic mining district of Juab County in central Utah (Figure 8.8). The Dragon mine had historic production of approximately 1.3 million tons of halloysite, at least 500,000 tons of iron ore, and an uncertain tonnage of oxidized silver-gold ore. Halloysite \( \text{Al}_2\text{Si}_2\text{O}_5(\text{OH})_4 \) is a specialty kaolinite-group clay with a unique micro-tubular structure. The iron ore is an exceptionally pure goethite-hematite gossan, probably developed after a massive pyrite vein, and the halloysite is an unusual hydrothermal replacement of susceptible dolomite beds in the adjoining Upper Cambrian Opex Formation. The Dragon open pit has been closed since the last halloysite production in 1976.

Applied Minerals, Incorporated owns the Dragon property (38 patented lode claims) including the Dragon pit, has a large mine permit, and is working toward reopening the mine as an underground operation to produce halloysite and possibly an iron-oxide pigment by-product. Recent drill results from 80 shallow holes in the Dragon pit indicate a measured resource of about 552,500 tons of 64.8 percent halloysite (Applied Minerals, Incorporated 2011). Underground mine development is currently in progress.

Gilsonite
Gilsonite is experiencing increased interest from the oil and gas industry due to its use as a lost circulation additive in well drilling fluids and cementing slurries. Gilsonite sales to the oilfield market have increased over 150 percent since 2009. In response to increased demand, American Gilsonite Company has initiated a significant investment program to open new mines, explore new mine development methods, and develop strategic long-term reserves. The American Gilsonite Company expects to double its current production capacity in the near future (O’Driscoll 2012).

8.1.6 Mineral Resources of Wilderness Study Areas
When the Bureau of Land Management recommends a Wilderness Study Area for wilderness designation, by law a mineral assessment report must be prepared. According to the BLM, there are currently about 3.2 million acres in 95 WSAs in Utah. What follows are excerpts from the mineral assessments conducted for 49 recommended WSAs and excerpts from the EIS for the King Top WSA, which the BLM recommended not be designated wilderness. These materials are taken verbatim from the published reports.

Definitions of Mineral Resource Potential and Certainty of Assessment
The U.S. Geological Survey (USGS) uses a standard classification scheme to estimate mineral resource potential and to characterize the level of certainty behind those estimates. Below is the explanation provided with each mineral assessment conducted for WSAs.

LOW mineral resource potential is assigned to areas where geologic, geochemical, and geophysical characteristics define a geologic environment in which the existence of resources is unlikely. This broad category embraces areas with dispersed but insignificantly mineralized rock as well as areas with few or no indications of having been mineralized.

MODERATE mineral resource potential is assigned to areas where geologic, geochemical, and geophysical characteristics indicate a geologic environment favorable for resource occurrence, where interpretations of data indicate a reasonable likelihood of resource accumulation, and (or) where an application of mineral-deposit models indicates favorable ground for the specified type(s) of deposits.

HIGH mineral resource potential is assigned to areas where geologic, geochemical, and geophysical characteristics indicate a geologic environment favorable for resource occurrence, where interpretations of data indicate a high degree of likelihood for resource accumulation, where data support mineral-deposit models indicating presence of resources, and where evidence indicates that mineral concentration has taken place. Assignment of high resource potential to an area requires some positive knowledge that mineral-forming processes have been active in at least part of the area.

UNKNOWN mineral resource potential is assigned to areas where information is inadequate to assign low, moderate, or high levels of resource potential.

NO mineral resource potential is a category reserved for a specific type of resource in a well-defined area.

Figure 8.9
USGS Resource Potential and Certainty Matrix

![Image of the USGS Resource Potential and Certainty Matrix]

Source: Dickerson, Case, and Barton 1988.

A. Available information is not adequate for determination of the level of mineral resource potential.
B. Available information suggests the level of mineral resource potential.
C. Available information gives a good indication of the level of mineral resource potential.
D. Available information clearly defines the level of mineral resource potential.

(Reproduced from the appendix of Dickerson, Case, and Barton 1988.)
Westwater Canyon

In 1986 the U.S. Bureau of Mines and the U.S. Geological Survey conducted studies to appraise the identified mineral resources (known) and assess the mineral resource potential (undiscovered) of 73,937 acres of the Black Ridge Canyons (CO-Q70-113/113A; UT-060-116/117) and 31,160 acres of the Westwater Canyon (UT-060-118) Wilderness Study Areas in western Colorado and eastern Utah. Subeconomic placer gold deposits were identified along the Colorado River at the Pussycat claims in the Westwater Canyon study area. There is a high mineral resource potential for placer gold adjacent to the Colorado River and in terrace deposits above it. There is a moderate resource potential for gold, silver, copper, and barite in vein deposits in the southern part of the Westwater Canyon Wilderness Study Area. There is no resource potential for uranium occurrence due to complete erosion of the Morrison Formation. There is a low resource potential for gold, silver, mercury, copper, and uranium in the Chinle Formation, and for chromium, nickel, and cobalt resources in Precambrian rocks. Geological, geochemical, and geophysical studies indicate a low energy resource potential for undiscovered oil, natural gas, carbon dioxide, and geothermal energy, and a low mineral resource potential for the above-mentioned mineral resources where not specified differently. There is no potential for coal in the Westwater Canyon Study Area (Figure 8.10). (Dickerson, Case, and Barton 1988)

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²¹⁰ The Black Ridge Canyons WSA became Designated Wilderness as part of the Omnibus Public Lands Management Act of 2009, Public Law 111-11. Discussion of this WSA’s mineral resources has been omitted.
Figure 8.10
Mineral Resource Potential of the Westwater Canyon WSA

Source: Dickerson, Case, and Barton 1988.
Fish Springs Range

The Fish Springs Range Wilderness Study Area (UT-050-127) includes most of the Fish Springs Range and is located north of the House Range, about 50 miles northwest of the city of Delta, Utah. A mineral resource study of the 33,840-acre area was completed in 1987 by the U.S. Geological Survey (USGS) and U.S. Bureau of Mines (USBM). The northwestern and southeastern parts of the wilderness study area contain inferred subeconomic resources of high-purity quartzite. No metallic mineral resources were identified in the study area, but more than 17 million pounds of lead, 2.6 million ounces of silver, and minor copper, zinc, and gold have been produced from the Fish Springs mining district, which is immediately outside the northwest boundary of the wilderness study area. The potential for undiscovered deposits of these metals and molybdenum is high near the northern end of the study area, adjacent to the mining district, moderate near the southern end, and low in the remainder of the area. The resource potential for undiscovered deposits of high-purity limestone and dolomite is moderate throughout the study area except where quartzite is present; potential for undiscovered low-temperature geothermal resources and for oil and gas is low throughout the study area (Figure 8.11). (Lindsey et al. 1989)
Figure 8.11
Identified Resources and Mineral Resource Potential of the Fish Springs Range WSA

Source: Lindsey et al., 1989.
North Stansbury Mountains
In 1985, the USBM and the USGS appraised the mineral resources and assessed the mineral resource potential of the North Stansbury Mountains (UT-020-089) Wilderness Study Area. This area covers approximately 10,175 acres (15.9 square miles) near the northern end of the Stansbury Mountains in northwestern Utah. The area lies 45 miles west of Salt Lake City, about 20 miles west of the Oquirrh Mountains, and 55 miles northwest of the East Tintic Mountains. Both the Oquirrh and East Tintic Mountains are noted for large base- and precious-metal deposits.

A small area in the southeasternmost part of the study area has inferred subeconomic resources of limestone suitable for use in making cement. Inferred subeconomic resources of sand and gravel exist within Muskrat Canyon. These inferred subeconomic resources are not likely to be developed. There are no other identified resources in the study area.

Mineral occurrences and geochemical anomalies in and near the study area are similar to those observed near some of the deposits in the Oquirrh and East Tintic Mountains and provide evidence that hydrothermal mineralization has occurred within the eastern and southern parts of the study area. These parts are considered to have a moderate mineral resource potential for undiscovered lead, zinc, silver, gold, and mercury in vein and replacement deposits. The remaining parts of the study area are assigned a low mineral resource potential for lead, zinc, silver, gold, and mercury in vein and replacement deposits.

In the southwestern and eastern parts of the study area, some samples contain anomalous amounts of silver, bismuth, antimony, arsenic, and, in a few cases, mercury. This same geochemical suite is associated with some sediment-hosted disseminated gold deposits, such as the Mercury deposit in the adjacent Oquirrh Mountains. Based on this association, areas underlain by carbonate and fine-grained siliceous rocks in the southern and eastern parts of the study area are assigned a moderate potential for undiscovered sediment-hosted, disseminated gold resources. The remainder of the area has low potential for gold resources.

A small portion of the southwestern part of the study area may contain thermal waters and is assigned a moderate potential for undiscovered geothermal resources. The entire study area is assigned a low potential for oil and gas resources (Figure 8.12). (Foose et al. 1989)
Figure 8.12
Mineral Resource Potential and Pertinent Geologic Features of the North Stansbury Mountains WSA

Deep Creek Mountains
The Deep Creek Mountains Wilderness Study Area (UT-020-Q60/UT-Q50-020) includes most of the Deep Creek Range of west-central Utah. The area is near the Utah-Nevada State line, south of Wendover, Utah, and northwest of Delta, Utah. Eleven areas of mineralized rock in and near the study area were evaluated by the USBM. Four of these areas contain identified resources: (1) an indicated resource of 5,000 tons of 16.5 ounces silver per short ton, 4.1 percent lead, 4.6 percent zinc, and 0.25 percent copper, at the Willow Springs area, which is almost surrounded by the study area in the northeast corner although it is not part of the study area; (2) an indicated gold resource of 774,000 tons of 0.4 ounces per ton and an inferred gold resource of 5.7 million tons of 0.4 ounces per ton in the Goshute Canyon area immediately east of the study area; (3) an indicated gold resource of 75,000 tons of 0.22 ounces per ton in the Queen of Sheba mine just west of the study area; and (4) an inferred gold resource of 3,800 tons of 0.26 ounces per ton in the Gold Bond area immediately east of the study area. Gold resources at the Queen of Sheba mine and at the Gold Bond area are too low grade to warrant an economic evaluation. The small tonnage and thin vein width of the deposit at the Willow Springs area combine to make that deposit subeconomic.

Much of the study area is underlain by Late Proterozoic to Lower Cambrian quartzite and Middle Cambrian to Pennsylvanian carbonate rock and contains vast quantities of limestone, dolomite, and quartzite. The limestone and dolomite are suitable for agricultural uses, and the quartzite is suitable for use in the production of eighth- and ninth-quality amber glass. These commodities are not likely to be mined in the foreseeable future because the study area is so remote.

Most of the study area has moderate to high potential for undiscovered tungsten, mercury, gold, silver, lead, zinc, copper, molybdenum, tin, and (or) beryllium resources. The entire study area has low potential for undiscovered uranium, thorium, oil, gas, coal, and geothermal energy resources (Figure 8.13). (Nutt et al. 1990)
Source: Nutt et al., 1990.
Parunuweap Canyon

The Parunuweap Canyon Wilderness Study Area (UT-Q4Q-230) is in southwestern Utah adjacent to Zion National Park. A small part of the study area contains identified (known) resources of gypsum, and the study area also contains inferred subeconomic resources of sandstone, sand and gravel, and ornamental stone. The study area has a moderate resource potential for undiscovered oil and gas; a low potential for undiscovered uranium and silver resources, and for undiscovered geothermal energy and coal resources; and no potential for gypsum outside the small area that has identified resources (Figure 8.14). (Van Loenen, Sable, Blank, Barton, Cook and Zelten 1988)

Figure 8.14
Mineral Resource Potential of the Parunuweap Canyon WSA

Source: Van Loenen, Sable, Blank, Barton, Cook and Zelten 1988.
Spring Creek Canyon

The Spring Creek Canyon Wilderness Study Area (UT-040-148) is in southwestern Utah adjacent to the northern boundary of Zion National Park and covers about 4,433 acres. Inferred subeconomic resources of common variety sand, sandstone, and limestone occur in the study area. The study area has a moderate potential for undiscovered resources of oil and gas and low potential for all metallic resources (including copper, silver, and uranium) and geothermal resources (Figure 8.15). No potential exists for coal and gypsum resources. (Van Loenen, Blank, Sable, Lee, Cook, and Zelten 1989)

Figure 8.15
Mineral and Energy Resource Potential of the Spring Creek Canyon WSA

Source: Van Loenen, Blank, Sable, Lee, Cook, and Zelten 1989.
Fifty Mile Mountain

The Fifty Mile Mountain Wilderness Study Area (UT-040-080) is in south-central Utah in Kane County near the border with Arizona. No economic or marginally economic resources were identified in the study area. There are, however, inferred subeconomic resources of sandstone and sand and gravel. All or part of four lode and one placer claim blocks have been staked within the study area. All are located for either uranium or titanium. The mineral resource potential for undiscovered coal and titanium resources is high, except in the southwesternmost part of the study area, which has no potential for either commodity. The mineral resource potential for undiscovered uranium is high in the north-central part and southeastern tip of the study area and moderate elsewhere. The potential for undiscovered geothermal, oil, gas, gypsum, and carbon dioxide resources is moderate. The potential for undiscovered metals, excluding uranium and titanium, is low (Figure 8.16). (Bartsch-Winkler, Barton, Cady, Cook, and Martin 1988)
Figure 8.16
Mineral Resource Potential of the Fifty Mile Mountain WSA

Steep Creek and Escalante Canyons Tract V
The Steep Creek Wilderness Study Area (UT-040-061) and the Escalante Canyons Tract V (UT-040-077) are located in south-central Utah in Garfield and Kane Counties, respectively, west of Capitol Reef National Park. Inferred subeconomic resources of bentonite are present in the Steep Creek Wilderness Study Area; inferred subeconomic resources of decorative and dimension stone are present in both study areas. Petrified wood is present in the Steep Creek Wilderness Study Area, but does not constitute a resource. The mineral resource potential for undiscovered bentonite, oil, gas, and carbon dioxide is moderate in both study areas, and the mineral resource potential for undiscovered uranium is moderate in the northeastern part of the Steep Creek Wilderness Study Area and unknown in the western part of the Steep Creek Wilderness Study Area and in the Escalante Canyons Tract V. In both areas, the mineral resource potential for undiscovered iron, cobalt, nickel, copper, lead, molybdenum, tin, cadmium, strontium, and vanadium is low, as is the potential for geothermal energy. Low potential for undiscovered gypsum resources exists in the Escalante Canyons Tract V, and no potential for undiscovered gypsum resources exists in the Steep Creek Wilderness Study Area (Figure 8.17). (Bartsch-Winkler, Goldfarb, Cady, Duval, Kness, Corbetta, and Cook, 1988)
Figure 8.17
Mineral Resource Potential of the Steep Creek WSA and Escalante Canyons Tract V

Source: Bartsch-Winkler, Goldfarb, Cady, Duval, Kness, Corbetta, and Cook, 1988
Scorpion

The Scorpion Wilderness Study Area is in south-central Utah in Garfield and Kane Counties west of Glen Canyon National Recreation Area and Capitol Reef National Park. No mining claims or oil and gas leases or lease applications extend inside the study-area boundary. Demonstrated subeconomic resources of less than 30,000 short tons of gypsum are estimated to occur in the study area. The Navajo Sandstone could have industrial uses, but it is not considered an economic resource within the study area due to the distance from markets. Sand deposits in the study area are not unique, and similar deposits are closer to existing markets. The mineral resource potential for undiscovered gypsum in the Carmel Formation and the energy resource potential for geothermal resources is low. The mineral resource potential for uranium is low. The mineral resource potential for metals other than uranium is low. The energy resource potential for oil, gas, and carbon dioxide is moderate (Figure 8.18). (Bartsch-Winkler, Jones, Kilburn, Cady, Duval, Cook, Lane, and Corbetta 1989)
Figure 8.18
Mineral Resource Potential of the Scorpion WSA

Source: Bartsch-Winkler, Jones, Kilburn, Cady, Duval, Cook, Lane, and Corbetta 1989.
Cockscomb and Wahweap
The Cockscomb (UT-040-275) and Wahweap (UT-040-248) Wilderness Study Areas are in Kane County, Utah, west of the Kaiparowits Plateau. These study areas are underlain by gently folded sedimentary rocks: the eastdipping East Kaibab monocline in the western part of the Cockscomb study area, and relatively horizontal beds to the east and in the Wahweap study area. No identified resources of metals or nonmetallic minerals occur, but about 1.8 million tons of identified subbituminous coal resources are estimated for the Cockscomb study area, and about 350,000 tons for the Wahweap area. The mineral resource potential for all metals, including gold and uranium, is low in both study areas. Gravel deposits have been mined nearby, and the mineral resource potential is high for additional deposits of sand and gravel in the southern end of the Wahweap Wilderness Study Area. A moderate energy resource potential exists for coal in the Dakota Formation in both study areas, and for coal in the Straight Cliffs Formation in the Wahweap Study Area. The resource potential in both study areas is moderate for oil and gas, and low for geothermal energy (Figure 8.19). (Bell, Kilburn, Cady, and Lane 1990)

Figure 8.19
Mineral and Energy Resource Potential of the Cockscomb and Wahweap WSAs

Source: Bell, Kilburn, Cady, and Lane 1990.
Paria-Hackberry

The Paria-Hackberry Wilderness Study Area, in central Kane County, southern Utah, is a region of generally flat-lying, gently folded sedimentary rocks, bounded on the east by the east-dipping limb of the East Kaibab monocline and cut by sheer-walled, narrow canyons. The area selected for study by the U.S. Bureau of Land Management totaled 94,642 acres (148 square miles); because of uncertainty as to final boundaries, the U.S. Geological Survey studied an additional contiguous 41,180 acres (64 square miles). No identified resources of metals or nonmetallic minerals are present in the study area. An unsuccessful attempt to recover “flour” gold from the Chinle Formation was made at the now-abandoned townsite of Paria. The mineral resource potential for all metals, including gold, uranium, barium, silver, strontium, arsenic, antimony, mercury, copper, manganese, cadmium, and zinc, is low for the entire wilderness study area. The likelihood of occurrence of “decorative-use” gypsum and of sand and gravel is moderate in limited areas of the northern part of the Paria-Hackberry Wilderness Study Area and, for sand and gravel, in a few small occurrences along the Paria River valley. A moderate energy resource potential is assessed for oil and gas and a low potential for geothermal energy, for the entire study area. There is no energy resource potential for coal (Figure 8.20). (Bell, Bush, Turner, Cady, Brown, Hannigan, and Thompson 1991)
Figure 8.20
Mineral and Energy Resource Potential of the Paria-Hackberry WSA

EXPLANATION OF MINERAL RESOURCE POTENTIAL

- **M1/C**: Geologic terrane having moderate mineral resource potential for gypsum in the Carmel Formation, at certainty level C
- **M2/C**: Geologic terrane having moderate mineral resource potential for sand and gravel, at certainty level C
- **M3/C**: Geologic terrane having moderate mineral resource potential for oil and gas, at certainty level C—Applies to the entire study area
- **L/C**: Geologic terrane having low resource potential, at certainty level C, for geothermal resources and for all metals and nonmetals—Applies specifically to gold, uranium, silver, arsenic, antimony, barium, strontium, zinc, cadmium, mercury, copper, and manganese. Applies to the entire study area
- **N/D**: Geologic terrane having no energy research potential for coal, at certainty level D—Applies to the entire study area

**Level of certainty**
- **C**: Data indicate geologic environment and give a good indication of level of mineral resource potential
- **D**: Available data clearly define the level of resource potential

*Source: Bell, Bush, Turner, Cady, Brown, Hannigan, and Thompson 1991*
Swasey Mountain and Howell Peak

The Swasey Mountain (UT-050-061) and Howell Peak (UT-050-077) Wilderness Study Areas are in the northern House Range, Millard County, Utah. The Swasey Mountain Wilderness Study Area includes 34,376 acres, and the Howell Peak Wilderness Study Area includes 14,800 acres that were evaluated for this report. The House Range is about 40 miles west of the city of Delta. A mineral resource study of the areas was completed in 1987 by the USGS and USBM. No mineral production has been recorded for either the Swasey Mountain or the Howell Peak Wilderness Study Areas. Oil and gas leases cover most of both study areas. Inferred subeconomic resources in both study areas are high-purity limestone, quartzite, and sand and gravel. Fossils, especially trilobites, of interest to collectors are also present in both areas. The northern part of the Swasey Mountain Wilderness Study Area has moderate potential for undiscovered resources of lead, zinc, copper, molybdenum, silver, and gold, including disseminated gold deposits. The southwestern part of the Swasey Mountain Wilderness Study Area and the western part of the Howell Peak Wilderness Study Area have moderate potential for resources of these metals. Potential for undiscovered deposits of high-purity limestone and dolomite and for oil and gas is moderate for both study areas. The potential for undiscovered resources of geothermal energy is low in both areas. There is no potential for undiscovered resources of coal (Figure 8.21). (Lindsey, Zimbelman, Campbell, Duval, Cook, Podwysocki, Brickey, Yambrick, and Tuftin 1989)
Figure 8.21
Mineral Resource Potential of the Swasey Mountain and Howell Peak WSAs

Source: Lindsey, Zimbelman, Campbell, Duval, Cook, Podwysocki, Brickey, Yambrick, and Tuftin 1989.
Wah Wah Mountains

The Wah Wah Mountains Wilderness Study Area (UT-050-073/040-205) includes 36,382 acres in the northern part of the Wah Wah Mountains in western Utah. Identified resources in the Wah Wah Mountains Wilderness Study Area include two small iron occurrences on the southwestern boundary, consisting of less than 100 tons of inferred subeconomic iron-rich material. The study area also has millions of cubic yards of inferred subeconomic resources of limestone and dolomite suitable for industrial and agricultural uses; of sandstone and quartzite suitable for container glass and industrial use; and of limestone, sandstone, and volcanic rock suitable for construction purposes. The wilderness study area has moderate energy resource potential for undiscovered oil and natural gas, and low energy resource potential for undiscovered uranium and geothermal energy. Several areas in the southern half of the wilderness study area have moderate mineral resource potential for undiscovered zinc, cadmium, and antimony, and moderate resource potential for associated molybdenum, lead, arsenic, bismuth, tungsten and gold in several types of vein and replacement bodies and in concealed igneous breccia deposits. The metal occurrences are attributed to episodes of epithermal (low-temperature) mineralization originating with Tertiary igneous activity. Some of the metals occur within an alteration zone around Tertiary intrusions. The rest of the study area has low resource potential for undiscovered zinc, cadmium, antimony, tungsten, molybdenum, lead, arsenic, bismuth, and gold (Figure 8.22 and Table 8.6). (Cox et al. 1989)
Figure 8.22
Identified Resources and Mineral Resource Potential of the Wah Wah Mountains WSA

Source: Cox et al. 1989.
Table 8.6
Summary of Areas Having Mineral Resource Potential in and Adjacent to the Wah Wah WSA
(Commodities Listed in Order of Relative Importance)

<table>
<thead>
<tr>
<th>Area Name and Number (where applicable)</th>
<th>Resource Potential</th>
<th>Level of potential/level of certainty</th>
<th>Commodities</th>
<th>Type of Deposit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wah Wah Summit (west), 1</td>
<td>Moderate</td>
<td>M/B</td>
<td>Zn, Cd, Sb, Mo, Pb, As, Bi</td>
<td>Vein and replacement in carbonate host rock</td>
</tr>
<tr>
<td>Wah Wah Summit (east), 2</td>
<td>Moderate</td>
<td>M/B</td>
<td>Zn, Pb, W, Sb, Mo, Pb, As, Bi, Au</td>
<td>Vein and replacement in carbonate host rock</td>
</tr>
<tr>
<td></td>
<td>Moderate</td>
<td>M/B</td>
<td>Pb, Sb, Bi, As, Mo</td>
<td>Igneous breccia host</td>
</tr>
<tr>
<td></td>
<td>Moderate</td>
<td>M/B</td>
<td>Zn, Pb, W</td>
<td>Skam</td>
</tr>
<tr>
<td>Wah Wah Cove (south), 3</td>
<td>Moderate</td>
<td>M/B</td>
<td>Sb</td>
<td>Vein and replacement in carbonate or volcanic host rock</td>
</tr>
<tr>
<td>Wah Wah Cove, 4</td>
<td>Moderate</td>
<td>M/B</td>
<td>Sb, W</td>
<td>Vein and replacement in carbonate or volcanic host rock</td>
</tr>
<tr>
<td>Study area outside of areas 1-4</td>
<td>Low</td>
<td>L/C</td>
<td>Zn, Cd, Sb, W, Mo, Pb, As, Bi, Au</td>
<td>Vein and replacement in carbonate or volcanic host rock</td>
</tr>
<tr>
<td>Entire study area</td>
<td>Moderate</td>
<td>M/B</td>
<td>Oil and Gas</td>
<td>Subsurface sedimentary rocks</td>
</tr>
<tr>
<td>Entire study area</td>
<td>Low</td>
<td>L/C</td>
<td>Geothermal resources</td>
<td></td>
</tr>
<tr>
<td>Entire study area</td>
<td>Low</td>
<td>L/C</td>
<td>Uranium</td>
<td></td>
</tr>
</tbody>
</table>

Source: Cox et al. 1989.
Notch Peak

The Notch Peak Wilderness Study Area (UT-050-078) is located in the central House Range, Millard County, west-central Utah, about 43 miles west of the city of Delta. The geology of the study area consists of a Jurassic granite that intrudes gently dipping Cambrian and Ordovician limestone and shale. The northern part of the study area includes part of the Notch Peak mining district, which has produced tungsten from mines within and near the study area. Mining within the district, but outside the study area, included gold placer mining. Mineralization in the district is primarily related to the Notch Peak intrusive. A resource of 775 tons, which averages 0.47 percent tungsten trioxide was defined at the Brown Queen mine in the northern part of the study area. Limestone and sand and gravel occur within the study area. For the purposes of assessing mineral resource potential the study area was divided into five subareas: the granite (Notch Peak intrusive), the metamorphic contact zone of the granite, the area north of the contact zone, the area south of the contact zone, and a small drainage in the southwestern part of the study area. The Notch Peak intrusive has moderate mineral resource potential for undiscovered molybdenum, gold, copper, uranium, and thorium, and low mineral resource potential for undiscovered tungsten, silver, lead, and zinc. The metamorphic contact zone of the granite has high mineral resource potential for undiscovered tungsten, and moderate mineral resource potential for undiscovered molybdenum, gold, silver, copper, lead, zinc, uranium, and thorium. The area to the north of the contact zone of the granite has moderate mineral resource potential for undiscovered tungsten, molybdenum, gold, silver, copper, lead, zinc, uranium, and thorium. The area to the south of the contact zone of the granite has low mineral resource potential for undiscovered uranium and thorium. The area underlying a small drainage in the southwestern part of the study area has moderate mineral resource potential for undiscovered tungsten and molybdenum, and low mineral resource potential for undiscovered gold, silver, copper, lead, zinc, uranium, and thorium. The entire study area has moderate resource potential for undiscovered oil and gas. The entire study area has low resource potential for all other metals, coal, and geothermal energy (Figure 8.23). (Stoeser et al. 1990)
Figure 8.23
Mineral Resource Potential of the Notch Peak WSA

Source: Stoeser et al. 1990.
Horseshoe Canyon North

The Horseshoe Canyon North (UT -{}SQ--045) Wilderness Study Area is in Emery and Wayne Counties, Utah, about 30 miles south of the town of Green River. Investigations by the U.S. Bureau of Mines and the U.S. Geological Survey indicate that the study area has no known economic resources, has inferred subeconomic resources of common variety sandstone, and has occurrences of common variety sand and gravel. The entire study area has moderate mineral resource potential for uranium, vanadium, and copper and for oil and gas; the northernmost part of the study area has moderate resource potential for potash. The entire study area also has low mineral resource potential for all other metals and geothermal energy (Figure 8.24). (Soulliere, Lee, and Martin 1988)

Figure 8.24
Mineral Resource Potential of the Horseshoe Canyon North WSA

Little Rockies
The Little Rockies (UT-050-247) Wilderness Study Area comprises 38,700 acres in the Henry Mountains in Garfield County, Utah. Field and laboratory investigations were conducted by the USGS and the USBM from 1981 to 1984. These investigations indicate that a small part of the study area approximately 4 miles northeast of Mt. Ellsworth along Fourmile Canyon contains an identified subeconomic resource of uranium) in sandstone beds of the Shinarump Member of the Chinle Formation. The southern part of the study area has a high mineral resource potential (the likelihood of the presence of undiscovered occurrences) for uranium in sandstone beds of the Shinarump Member of the Chinle Formation, except for two small areas comprising the igneous stocks of Mt. Holmes and Mt. Ellsworth. These two areas have a low mineral resource potential for uranium. The northern part of the study area has a moderate mineral resource potential for uranium in sandstone beds of the Shinarump and Monitor Butte Members of the Chinle Formation. The entire study area has a low mineral resource potential for base (copper and lead) and precious (silver and gold) metals, nonmetals (sand, gravel, and stone), oil and gas, and geothermal energy (Figure 8.25). (Dubiel, Bromfield, Church, Kemp, Larson, Peterson, Pierson, and Kreidler 1987)
Figure 8.25
Mineral Resource Potential of the Little Rockies WSA

EXPLANATION

- **Area of identified uranium resource**
- **H/D** Geologic terrane having high mineral resource potential for uranium, with certainty level D
- **M/C** Geologic terrane having moderate mineral resource potential for uranium, with certainty level C
- **L/C** Geologic terrane having low mineral resource potential for uranium, with certainty level C

Source: Dubiel, Bromfield, Church, Kemp, Larson, Peterson, Pierson, and Kreidler 1987.
Bull Mountain
The Bull Mountain (UT-050-242) Wilderness Study Area comprises 11,800 acres in the Henry Mountains in Garfield and Wayne Counties, Utah. Field and laboratory investigations were conducted by the USGS from 1981 to 1984 and by the USBM in 1986. These investigations indicate that there are no identified resources in the study area. The northern part of the study area has a high potential for undiscovered gypsum resources, and the entire area has a low resource potential for undiscovered copper, lead, zinc, molybdenum, silver, gold, uranium and vanadium, coal, oil and gas, and geothermal resources (Figure 8.26). (Dubiel, Bromfield, Church, Kemp, Larson, Peterson, and Neubert 1988a)

Figure 8.26
Mineral Resource Potential of the Bull Mountain WSA

Source: Dubiel, Bromfield, Church, Kemp, Larson, Peterson, and Neubert 1988a.
Mt. Hillers

The Mt. Hillers Wilderness Study Area (UT-050-249) comprises 20,000 acres in the Henry Mountains, Garfield County, Utah. Field and laboratory investigations were conducted by the USGS from 1981 to 1984 and by the USBM in 1986. The area was studied for identified (known) resources as well as for mineral resource potential (undiscovered resources). These investigations indicate that small occurrences of uranium and vanadium are present near the northeastern and southern boundaries of the study area, and that copper, gold, lead, and zinc occur in the study area, but no identified resources of these commodities are present. Inferred subeconomic resources of the common variety materials, sand and gravel and stone, in the study area have no unique qualities and are not likely to be developed. The eastern part of the study area has a high mineral resource potential for uranium and vanadium and a low mineral resource potential for all other metals, and coal. The central part of the study area has a moderate mineral resource potential for base (copper, lead, and zinc) and precious (gold) metals, and a low mineral resource potential for uranium and vanadium, and coal. The western part of the study area has a moderate mineral resource potential for coal and uranium and vanadium, and a low mineral resource potential for all other metals. The entire Mt. Hillers Wilderness Study Area has a low mineral resource potential for oil and gas and for geothermal energy (Figure 8.27). (Dubiel, Bromfield, Church, Kemp, Larson, Peterson, and Neubert 1988b)
Figure 8.27
Mineral Resource Potential of the Mt. Hillers WSA

EXPLANATION OF MINERAL RESOURCE POTENTIAL.

Geologic terrane having high mineral resource potential for commodity 2, with certainty level C; geologic terrane having low mineral resource potential for commodities 3 and 4, with certainty level B; geologic terrane having low mineral resource potential for commodity 1, with certainty level C.

Geologic terrane having moderate mineral resource potential for commodity 3, with certainty level B; geologic terrane having low mineral resource potential for commodity 4, with certainty level B; geologic terrane having low mineral resource potential for commodities 1 and 2 with certainty level C.

Geologic terrane having moderate mineral resource potential for commodity 2, with certainty level C; geologic terrane having low mineral resource potential for commodities 3 and 4, with certainty level B; geologic terrane having low mineral resource potential for commodity 1, with certainty level C.

Geologic terrane having moderate mineral resource potential for commodities 1 and 2, with certainty level C; geologic terrane having low mineral resource potential for commodities 3 and 4, with certainty level B.

Commodities
1. Coal
2. Uranium and vanadium
3. Base (copper, lead, zinc) and precious (gold) metals
4. Oil and gas and geothermal energy

Levels of certainty
A Available information not adequate
B Available information suggests level of resource potential
C Available information clearly defines the level of resource potential
D Available information clearly defines the level of resource potential

Source: Dubiel, Bromfield, Church, Kemp, Larson, Peterson, and Neubert 1988b.
Mount Pennell
The Mount Pennell (UT-050-248) Wilderness Study Area comprises 25,800 acres in the Henry Mountains in Garfield County, Utah. Field and laboratory investigations were conducted by the USGS from 1981 to 1984 and by the USBM in 1988. The investigations indicate that subeconomic measured coal resources of approximately 1.3 million tons occur in the Emery Sandstone Member of the Mancos Shale within the western boundary of the study area. Several mines and prospects for base and precious metals are within the study area, and placer workings for precious metals are just outside the study area boundary; however, no resources are associated with any of these workings. The central portion of the study area underlain by igneous rocks has a moderate mineral resource potential for base (copper, lead, tin, molybdenum, and zinc) and precious (silver and gold) metals; the remainder of the study area has a low mineral resource potential for these metals. The central part of the study area has a low mineral resource potential for uranium and vanadium. The remainder of the study area has a moderate mineral resource potential for uranium and vanadium. The central part of the study area underlain by igneous rocks has a low mineral resource potential for coal; all of the study area outside of this central part has a moderate resource potential for coal in the Perron Sandstone Member of the Mancos, and the extreme western part of the study area additionally has a high resource potential for coal in the Emery Sandstone Member of the Mancos. The entire study area has a low resource potential for oil and gas and for geothermal energy (Figure 8.28). (Dubiel, Bromfield, Church, Kemp, Larson, Peterson, Pierson, and Gese 1990)
Figure 8.28
Subecononic Coal Resources and Mineral Resource Potential of the Mount Pennell WSA

Source: Dubiel, Bronfield, Church, Kemp, Larson, Peterson, Pierson, and Gese 1990.
San Rafael Swell Wilderness Study Areas

The San Rafael Swell wilderness study areas, including the Muddy Creek, Crack Canyon, San Rafael Reef, Mexican Mountain, and Sids Mountain Wilderness Study Areas, are in Emery County, south-central Utah. At least 4,100 current and historic mining claims have been located in or near the study areas, primarily for uranium. Vanadium is the most valuable byproduct of uranium mining, although minor copper, silver, lead, zinc, and gold also occur in some deposits. Past production totaled at least 7 million pounds of $U_3O_8$ (uranium oxide) from the entire San Rafael Swell area, and approximately 3 million pounds was mined from within and near the wilderness study areas. Mined ore bodies contained 100–10,000 tons of ore with an average grade of 0.2 percent $U_3O_8$ and less than 0.5 percent $V_2O_5$. Within and near the Crack Canyon Wilderness Study Area is about 221,000 tons of identified subeconomic uranium and vanadium resources (0.05–0.26 percent $U_3O_8$ and 0.3–0.5 percent $V_2O_5$). Within the Carmel Formation, inferred subeconomic resources of about 11 million tons of gypsum are in the Muddy Creek Wilderness Study Area, about 680,000 tons in the San Rafael Reef Wilderness Study Area, and about 103 million tons in the Sids Mountain Wilderness Study Area. An identified subeconomic resource of about 20 million tons of gypsum is in the Summerville Formation in the Crack Canyon Wilderness Study Area. Other commodities evaluated include geothermal energy, gypsum, limestone, oil and gas, sand and gravel, sandstone, semiprecious gemstones, sulfur, petrified wood, and tar sand.

The Crack Canyon Wilderness Study Area contains parts of the Delta, Temple Mountain, and Little Wild Horse mining districts. Between 1950 and 1973, about 472 tons of $U_3O_8$ were produced from 10 mines in districts within or adjacent to the study area, and about 414 tons were produced from two mines within the study area.

The mineral resource potential for localized, thin tar sands of variable grade in all wilderness study areas, except the Eardley Canyon area of the San Rafael Reef Wilderness Study Area, is high. The resource potential for gypsum on the surface in the western part of the Muddy Creek Wilderness Study Area, in the eastern and southeastern part of the San Rafael Reef Wilderness Study Area, in the northeastern part of the Mexican Mountain Wilderness Study Area, in the southern and southeastern part of the Crack Canyon Wilderness Study Area, and in the western part of the Sids Mountain Wilderness Study Area is high. The Sids Mountain Wilderness Study Area, Crack Canyon Wilderness Study Area, northeastern part of the Mexican Mountain Wilderness Study Area, eastern and southeastern part of the San Rafael Reef Wilderness Study Area, and western part of the Muddy Creek Wilderness Study Area have high resource potential for uranium and vanadium in the Chinle Formation. The resource potential for uranium and vanadium in the Morrison Formation is low in the southern part of the Crack Canyon Wilderness Study Area. The resource potential for oil and gas in all wilderness study areas is moderate. The resource potential for geothermal energy in the wilderness study areas is moderate. The resource potential for carbon dioxide and helium gases in the wilderness study areas is moderate. The resource potential in all wilderness study areas for metals other than uranium and vanadium, including gold and copper, is low. The resource potential for minor, localized sulfur deposits is low in the Mexican Mountain and San Rafael Reef Wilderness Study Areas. The resource potential for bentonite in the Chinle Formation on the surface and in the subsurface is low in the Sids Mountain Wilderness Study Area, Crack Canyon Wilderness Study Area, northeastern part of the Mexican Mountain Wilderness Study Area, eastern and southeastern part of the San Rafael Reef Wilderness Study Area, and western part of the Muddy Creek Wilderness Study Area, and is also low for bentonite with minor zeolite in the southernmost part of the Crack Canyon Wilderness Study Area.
Study Area (Figures 8.29 through 8.34). (Bartsch-Winkler, Dickerson, Barton, McCafferty, Grauch, Koyuncu, Lee, Duval, Munts, Benjamin, Close, Lipton, Neumann, and Willett 1990)

Figure 8.29
Index Map of the San Rafael Swell Region Showing Approximate Locations of the Five WSAs

Source: Bartsch-Winkler, Dickerson, Barton, McCafferty, Grauch, Koyuncu, Lee, Duval, Munts, Benjamin, Close, Lipton, Neumann, and Willett 1990.
Figure 8.30
Mineral Resource Potential of the Muddy Creek WSA

EXPLANATION
Muddy Creek Wilderness Study Area contains inferred subeconomic beds of gypsum; the Crack Canyon Wilderness Study Area contains ed subeconomic resources of uranium and vanadium in seven mines aspects in and near the wilderness study area; the San Rafael Reefness Study Area contains identified subeconomic resources of gypsum; and the western part of the Muddy Creek Wilderness Study Area contains subeconomic resources of gypsum.

Geologic terrane having high mineral resource potential for uranium and vanadium in the Chinle Formation on the surface and in the subsurface, with certainty level C—Applies to entire Sids Mountain and Crack Canyon Wilderness Study Area, the northeastern part of the Mexican Mountain Wilderness Study Area, the eastern and southeastern part of San Rafael Reef Wilderness Study Area, and the western part of Muddy Creek Wilderness Study Area.

Geologic terrane having high mineral resource potential for tar sand, with certainty level C—Applies to entire area of all study areas except Earlley Canyon in the San Rafael Reef Wilderness Study Area.

Geologic terrane having high mineral resource potential for gypsum in the Carmel and Summerville Formations, with certainty level D—Applies to the western part of San Rafael Reef Wilderness Study Area, the northeastern part of the Mexican Mountain Wilderness Study Area, the eastern and southeastern part of San Rafael Reef Wilderness Study Area, and the southwestern part of the Crack Canyon Wilderness Study Area, and the western part of Muddy Creek Wilderness Study Area.

Geologic terrane having moderate resource potential for carbon dioxide and helium gases and geothermal resources, with certainty level B—Applies to entire area of all study areas.

Geologic terrane having moderate resource potential for oil and gas, with certainty level C—Applies to entire area of all study areas.

Geologic terrane having low mineral resource potential for metals other than uranium and vanadium, with certainty level B—Applies to entire study areas.

Geologic terrane having low mineral resource potential for bentonite, with certainty level B—Applies to the entire Sids Mountain and Crack Canyon Wilderness Study Areas, the northeastern part of the Mexican Mountain Wilderness Study Area, the eastern and southeastern part of San Rafael Reef Wilderness Study Area, and the western part of the Muddy Creek Wilderness Study Area.

Geologic terrane having low mineral resource potential for sulfur, with certainty level B—Applies to the entire Mexican Mountain and San Rafael Reef Wilderness Study Areas.

Geologic terrane having low mineral resource potential for uranium and vanadium in the Morrison Formation on the surface and in the subsurface, with certainty level C—Applies to the eastern and southeastern part of the Crack Canyon Wilderness Study Area.

Source: Bartsch-Winkler, Dickerson, Barton, McCafferty, Grauch, Koyuncu, Lee, Duval, Mants, Benjamin, Close, Lipton, Neumann, and Willett 1990.
Figure 8.31
Mineral Resource Potential of the Crack Canyon WSA
(See Figure 8.30 for Explanation)

Source: Bartsch-Winkler, Dickerson, Barton, McCafferty, Grunew, Koyuncu, Lee, Duval, Munts, Benjamin, Close, Lipton, Neumann, and Willett 1990.
Figure 8.32
Mineral Resource Potential of the San Rafael Reef WSA
(See Figure 8.30 for Explanation)

Source: Bartsch-Winkler, Dickerson, Barton, McCafferty, Grauch, Kayuncu, Lee, Duwal, Munts, Benjamin, Close, Lipton, Neumann, and Willett 1990.
Figure 8.33
Mineral Resource Potential of the Mexican Mountain WSA
(See Figure 8.30 for Explanation)

Source: Bartsch-Winkler, Dickerson, Barton, McCafferty, Grauch, Keyuncu, Lee, Duval, Munts, Benjamin, Close, Lipton, Neumann, and Willett 1990.
Figure 8.34
Mineral Resource Potential of the Sids Mountain WSA
(See Figure 8.30 for Explanation)

Source: Bartsch-Winkler, Dickerson, Barton, McCafferty, Grauch, Keyunco, Lee, Duval, Munts, Benjamin, Close, Lipton, Neumann, and Willett 1990.
Coal Canyon, Spruce Canyon, and Flume Canyon

The Coal Canyon (UT-060-100C), Spruce Canyon (UT-060-100D), and Flume Canyon (UT-060-100B) Wilderness Study Areas are in the Book Cliffs in Grand County, eastern Utah. Demonstrated coal reserves totaling 22,060,800 short tons, and demonstrated subeconomic coal resources totaling 39,180,000 short tons are in the Coal Canyon Wilderness Study Area. Also, inferred subeconomic coal resources totaling 143,954,000 short tons are within the Coal Canyon Wilderness Study Area. No known deposits of industrial minerals are in any of the wilderness study areas. All three of the wilderness study areas have a high resource potential for undiscovered deposits of coal and for undiscovered oil and gas. There is a moderate resource potential for tar sand in the northwestern parts of the Spruce Canyon and Flume Canyon Wilderness Study Areas, and a low potential for tar sand in the rest of the wilderness study areas. All three wilderness study areas have a low potential for resources of oil shale, gilsonite, uranium and other metals, and geothermal energy (Figure 8.35). (Dickerson, Gaccetta, Kulik, and Kreidler 1990)
Figure 8.35
Coal Reserves and Resources and Mineral Resource Potential of the Coal Canyon, Spruce Canyon, and Flume Canyon WSAs

Source: Dickerson, Gaccetta, Kalik, and Kreidler 1990.
Desolation Canyon, Turtle Canyon, and Floy Canyon

In 1985, 1986, and 1988, the USBM and the USGS studied the Desolation Canyon (UT-060-068A), Turtle Canyon (UT-060-067), and Floy Canyon (UT-060-068B) Wilderness Study Areas, which are contiguous and located in Carbon, Emery, and Grand Counties in eastern Utah. The study areas include 242,000 acres, 33,690 acres, and 23,140 acres respectively. Coal deposits underlie the Desolation Canyon, Turtle Canyon, and Floy Canyon study areas. Coal zones of Late Cretaceous age occur in the Blackhawk Formation (west of the Green River) and Neslen Formation (east of the Green River). Identified bituminous coal resources in beds 3.5 feet or more thick and under 2,000 feet or less of overburden are estimated to be 22 million tons in the Desolation Canyon study area, 6.3 million tons in the Turtle Canyon study area, and about 45 million tons in the Floy Canyon study area. In-place inferred oil-shale resources are estimated to contain 60 million barrels of subeconomic shale oil in the Green River Formation underlying the northern part of the Desolation Canyon Wilderness Study Area. Minor occurrences of uranium have been found in the basal part of the Wasatch Formation in the southeastern part of the Desolation Canyon study area and in the western part of the Floy Canyon study area. Mineral resource potential for the study areas is estimated to be (1) for coal, high for all areas, (2) for oil and gas, high for the northern tract of the Desolation Canyon Wilderness Study Area and moderate for all other tracts, (3) for bituminous sandstone, high for the northern part of the Desolation Canyon Wilderness Study Area, and low for all other tracts, (4) for oil shale, low in all areas, (5) for uranium, moderate for the Floy Canyon study area and the southeastern part of the Desolation Canyon study area and low for the remainder of the areas, (6) for metals other than uranium, bentonite, zeolites, and geothermal energy, low in all areas, and (7) for coal bed methane, unknown in all three areas (Figure 8.36). (Cashion, Kilburn, Barton, Kelley, Kulik, and McDonnell 1990)
Figure 8.36
Identified Resources and Mineral and Energy Resource Potential of the Desolation Canyon, Turtle Canyon, and Floy Canyon WSAs

Indian Creek, Bridger Jack Mesa, and Butler Wash

The Indian Creek (UT-060-164), Bridger Jack Mesa (UT-060-167), and Butler Wash (UT-060-169) Wilderness Study Areas are located in San Juan County, southeastern Utah. Inferred subeconomic resources of sandstone and sand and gravel exist within all three wilderness study areas, but because of their abundance throughout the region, their distance from current markets, and their lack of unique properties, these materials have no current likelihood for development. Inferred subeconomic resources of potash and halite are present beneath the Indian Creek Wilderness Study Area, but the likelihood for their development is low. The potential for undiscovered resources of uranium and byproducts vanadium and copper is high for the north quarter of Bridger Jack Mesa Wilderness Study Area and is low for the Butler Wash, Indian Creek, and remaining parts of the Bridger Jack Mesa Wilderness Study Areas. The resource potential for undiscovered oil and gas is moderate in all three wilderness study areas. The resource potential for undiscovered placer gold and silver is low in all three wilderness study areas. The resource potential for undiscovered potash and halite is low for the Butler Wash and Bridger Jack Mesa Wilderness Study Areas. The resource potential is low in all three wilderness study areas for undiscovered geothermal energy, coal, and metals other than uranium, vanadium, and copper. The mineral resource potential for the rare-earth mineral braitschite is unknown in all three wilderness study areas (Figure 8.37). (Patterson, Toth, Case, Barton, Green, Schreiner, and Thompson 1988)
Figure 8.37
Mineral Resource Potential of the Indian Creek, Bridger Jack Mesa, and Butler Wash WSAs

Source: Patterson, Toth, Case, Barton, Green, Schreiner, and Thompson 1988.
Behind the Rocks
The Behind the Rocks Wilderness Study Area (UT-060-140A) consists of 12,635 acres in Grand
and San Juan counties, Utah. The study area has inferred subeconomic resources of potash and
halite in the subsurface, and sandstone on the surface. The study area has high potential for un-
discovered resources of oil and gas, low potential for undiscovered uranium, copper, vanadium,
gold, silver, other metals, and geothermal energy, and unknown potential for the rare-earth min-
eral, braitschite. There is no resource potential for potash or halite (beyond the previously men-
tioned inferred resources) or for coal (Figure 8.38). (Patterson, Toth, Case, Green, Barton, and
Thompson 1988)

Figure 8.38
Mineral Resource Potential of the Behind the Rocks WSA

Source: Patterson, Toth, Case, Green, Barton, and Thompson 1988.
Lost Spring Canyon

The Lost Spring Canyon (UT-060-131B) Wilderness Study Area is about 15 miles north of Moab, Utah, and covers 3,880 acres adjacent to Arches National Park. Investigations by the USGS and the USBM conclude that the study area has no economic mineral resources, but has inferred subeconomic resources of sandstone and sand and gravel. There is moderate energy resource potential for undiscovered oil and gas, potash, and halite, and low resource potential for undiscovered geothermal resources and all metals, including uranium and manganese (Figure 8.39). (Souliere, Lee, Case, and Gese 1988)

Figure 8.39
Mineral Resource Potential of the Lost Spring Canyon WSA

Negro Bill Canyon

The Negro Bill Canyon (UT-060-138) Wilderness Study Area is in southeastern Utah in Grand County southeast of Arches National Monument and covers 7,620 acres. No mineral resources are identified in the study area. Lode mining claims cover the western part of the Negro Bill Canyon Wilderness Study Area; there are no patented claims in the study area. The mineral resource potential for gypsum, potash, halite, and bentonite on the surface and in the subsurface beneath the wilderness study area is high. The energy and mineral resource potential for oil, gas, carbon dioxide, uranium and vanadium on the surface and beneath the wilderness study area is moderate. The potential for helium gas, geothermal sources, and metals other than uranium and vanadium is low (Figure 8.40). (Bartsch-Winkler, Case, Barton, Duval, and Lane 1990)

Figure 8.40
Mineral Resource Potential of the Negro Bill Canyon WSA

Source: Bartsch-Winkler, Case, Barton, Duval, and Lane 1990.
Mill Creek Canyon
At the request of the U.S. Bureau of Land Management, approximately 9,780 acres of the Mill Creek Canyon Wilderness Study Area (UT-060-139A) was evaluated for identified mineral resources (known) and mineral resource potential (undiscovered). Fieldwork was conducted in 1988 to assess the mineral resources and resource potential of the study area. No mineral resources were identified in the Mill Creek Canyon Wilderness Study Area. Placer gold is present in the eastern part of the study area but not in sufficient quantity to be considered a resource. Eolian sand and sandstone occur in the study area, but it is unlikely these will be developed. Oil and gas leases cover a small part of the study area; no geothermal resources are known to exist in the study area.

The entire study area has high potential for undiscovered mineral resources of potash and halite, and areas underlain by the Navajo Sandstone (Lower Jurassic) also have high potential for resources of flagstone. The top of Wilson Mesa also has high resource potential for small deposits of placer gold. The entire study area has moderate potential for resources of uranium, thorium, copper, vanadium, oil and gas, and carbon dioxide gas and has low potential for resources of helium gas and for geothermal energy (Figure 8.41). (Diggles, Case, Barton, Duval, and Lane 1990)
Figure 8.41
Mineral Resource Potential of the Mill Creek Canyon WSA

Source: Diggles, Case, Barton, Duval, and Lane 1990
Mancos Mesa
The USGS and the USBM conducted investigations to appraise the identified mineral resources (known) and assess the mineral resource potential (undiscovered) of 51,440 acres of the Mancos Mesa (UT-060-181) Wilderness Study Area, San Juan County, Utah. The wilderness study area has no identified resources. It has moderate mineral resource potential for uranium and moderate energy resource potential for oil and gas. Moderate mineral resource potential for uranium in channel-fill sandstones exists in the Shinarump Member of the Chinle Formation in the subsurface beneath Mancos Mesa. The wilderness study area has low mineral resource potential for other metals, coal, and geothermal energy (Figure 8.42). (Poole, Desborough, Barton, Hanna, Lee, and Kness 1989)
Figure 8.42
Mineral Resource Potential of the Mancos Mesa WSA

EXPLANATION

M/C
Geologic terrain having moderate mineral and energy resource potential for uranium and oil and gas, with certainty level C; and low mineral and energy resource potential for other metals, coal, and geothermal energy, all with certainty level C—Applies to entire study area

L/C

Level of certainty

C
Data indicate geologic environment and indicate level of resource potential

Fish Creek Canyon, Road Canyon, and Mule Canyon
At the request of the U.S. Bureau of Land Management the Fish Creek Canyon (UT-060-204), Road Canyon (UT-060-201), and Mule Canyon (UT-060-205B) Wilderness Study Areas, which comprise 40,160 acres, 52,420 acres, and 5,990 acres, respectively, were studied for their mineral endowment. A search of federal, state, and county records showed no current or previous mining claim activity, and with the exception of common-variety sand and gravel, no mineral resources were identified during field examination of the study areas. Sandstone and sand and gravel have no unique qualities, but could have limited local use for road metal or other construction purposes. However, similar materials are abundant outside the study areas. The three study areas have moderate resource potential for undiscovered oil and gas and low resource potential for undiscovered metals, including uranium and thorium, coal, and geothermal energy (Figure 8.43). (Bove, Shawe, Lee, Hanna, and Jeske 1989)
Figure 8.43
Mineral Resource Potential of the Fish Creek Canyon, Road Canyon, and Mule Canyon WSAs

Fiddler Butte (East)
The Fiddler Butte (East) Wilderness Study Area has inferred subeconomic resources of tar sands (oil-impregnated sandstones) in the northeastern part of the study area with in-place resources estimated to be 375–480 million barrels of oil. High-magnesium dolomite is present within the Navajo Sandstone within the study area. The dolomite would be suitable for various industrial uses, but the remote location of the deposit makes development unlikely. Common sand, gravel, and stone in the study area have no unique qualities and are not likely to be developed. Abundant petrified wood, suitable for collecting and polishing, is present in mudstones of the Chinle Formation within the study area. The southwestern part of the study area has a moderate mineral resource potential for undiscovered tar sands as localized deposits within the White Rim Sandstone. The entire study area has a moderate resource potential for undiscovered uranium and vanadium, for oil and gas, for small isolated occurrences of precious (silver and gold) metals, and a low potential for geothermal resources and other undiscovered metals (Figure 8.44). (Dubiel, Lee, Orkild, and Gese 1989)
Figure 8.44
Mineral Resource Potential of the Fiddler Butte (East) WSA

Dirty Devil, French Spring–Happy Canyon, and Horseshoe Canyon

Field and laboratory studies of the Dirty Devil, French Spring-Happy Canyon, and Horseshoe Canyon Wilderness Study Areas in Wayne and Garfield Counties, Utah, were conducted to determine the resource potential of these lands. The studies indicate a moderate potential for uranium resources in the Dirty Devil Wilderness Study Area and in the extreme southwestern part of the French Spring–Happy Canyon Wilderness Study Area and a low potential for uranium resources in the northeastern part of the French Spring–Happy Canyon Wilderness Study Area and in the Horseshoe Canyon Wilderness Study Area. All three wilderness study areas have a moderate potential for petroleum resources. The French Spring–Happy Canyon Wilderness Study Area has a high potential for tar sand resources. The potential for tar sand resources in the Dirty Devil and Horseshoe Canyon Wilderness Study Areas is unknown. The studies indicate a low potential for other metallic and nonmetallic resources in the study areas (Figure 8.45). (Dubiel, Larson, Peterson, Willson, and Schreiner 1985)

Figure 8.45
Mineral Resource Potential of the Dirty Devil, French Spring–Happy Canyon, and Horseshoe Canyon WSAs

Note: Entire map area has moderate potential for petroleum resources and low potential for both metallic and nonmetallic resources.

Mount Ellen–Blue Hills (Addition)
The Mount Ellen–Blue Hills (Addition) (UT-050-238) Wilderness Study Area comprises 7,324 acres in Wayne County, Utah. Field and laboratory investigations were conducted by the USGS from 1981 to 1985 and by the USBM in 1988. Field investigations disclosed no evidence of mineral occurrences, mining activity, or industrial commodities in the study area. The entire study area has a low mineral resource potential for oil and gas, coal, uranium and vanadium, metals, and geothermal resources (Figure 8.46). (Dubiel and Gese 1990)

Figure 8.46
Mineral Resource Potential and Geology of the Mount Ellen–Blue Hills (Addition) WSA

EXPLANATION OF MINERAL RESOURCE POTENTIAL

<table>
<thead>
<tr>
<th>L/B</th>
<th>Geologic terrane having low mineral resource potential for oil and gas, coal, uranium and vanadium, metals, and geothermal resources, with certainty level B</th>
</tr>
</thead>
</table>

Level of Certainty

B     Data indicate geologic environment and suggest level of resource potential

Source: Dubiel and Gese 1990.
King Top

The energy and mineral resource rating summary is given in Table 8.7. The WSA could contain deposits of beryllium, lead, zinc, and tungsten that are currently listed as strategic and critical materials. Industry evaluation indicates there is a high favorability for the occurrence of oil and gas in the WSA. However, several exploratory oil and gas wells have been drilled in the WSA, but no shows of oil or gas were reported. Based on somewhat favorable geologic structure and permeability, the favorability exists for small pools of oil or gas (f2) (less than 10 million barrels of oil or 60 billion cubic feet of gas), with a low (c2) degree of certainty. The area has slight (f1) potential for a low temperature geothermal resource with a very low (c1) degree of certainty. About 43 mining claims are in the WSA and cover an area of approximately 860 acres. The geologic favorability for Beryllium is f2 for potential small deposits, with a very low (c1) degree of certainty. The carbonate host rocks along with the Tertiary volcanics and block faulting provide a favorable geologic environment for small deposits of lead and zinc (f2), with a very low (c1) degree of certainty of occurrence. Associated minerals include gold, silver, and copper in minor amounts. Although the genetic source rocks for tungsten deposits are lacking at the surface, they may occur at depth. A very low (c1) degree of certainty is assigned for small (f2) deposits. There is a very low certainty (c1) that a geologic favorability exists for uranium resources within the WSA (f1). Salable minerals (sand, gravel, limestone, etc.) are present in the WSA, but there is no interest due to the abundance of other more easily accessible sources. (US BLM, Utah State Office 1990)

### Table 8.7

<table>
<thead>
<tr>
<th>Resource</th>
<th>Favorability</th>
<th>Certainty</th>
<th>Estimated Resource</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oil and Gas</td>
<td>f2</td>
<td>c2</td>
<td>Less than 10 million barrels of oil, less than 60 billion cubic feet of gas</td>
</tr>
<tr>
<td>Uranium</td>
<td>f1</td>
<td>c1</td>
<td>Little or none</td>
</tr>
<tr>
<td>Geothermal</td>
<td>f2</td>
<td>c1</td>
<td>Low-temperature resource</td>
</tr>
<tr>
<td>Beryllium</td>
<td>f2</td>
<td>c1</td>
<td>Less than 10 metric tons</td>
</tr>
<tr>
<td>Lead/Zinc</td>
<td>f2</td>
<td>c1</td>
<td>Less than 50,000 metric tons</td>
</tr>
<tr>
<td>Tungsten</td>
<td>f2</td>
<td>c1</td>
<td>Less than 500 metric tons</td>
</tr>
</tbody>
</table>

1. Favorability of the WSA's geologic environment for a resource (f1 = lowest, f4 = highest).
2. Degree of certainty that the resource exists within the WSA (c1 = lowest, c4 = highest).
3. One metric ton equals 1,000 kg or 2,204.6 pounds.

8.1.7 Unconventional Fuels

Oil Shale

The oil shale in Utah’s Uinta Basin may contain the equivalent of 1.3 trillion barrels of oil. A smaller portion of the full deposit has attributes that may eventually allow as much as 77 billion barrels of oil to be produced in an economically viable manner (Boden et al. 2013). Figure 8.47 shows the extent and density of the Basin’s oil shale resource.

Figure 8.47
Utah’s Oil Shale Resource and Federal Land Ownership

The relative magnitude of these numbers may go some way in explaining the persistent allure of oil shale. Consider, for example, that the current rate of conventional oil production in Utah is in the neighborhood of 35 million barrels per year; that only very recently has the cumulative volume of oil ever produced in Utah reached 1.5 billion barrels; and that 77 billion barrels of oil
represents 20 to 30 years of U.S. oil production at recent production rates, exceeds the sum volume of all oil produced in Texas since 1935, and would sustain the current rates of oil production seen in North Dakota for about 200 years.

Yet, in spite of the impressive numbers, oil shale has yet to prove itself as an economically viable resource given current technologies, and progress towards economic viability remains unclear. After all, oil shale is not the more-or-less conventional crudes historically produced in Utah and it is not the shale oil of North Dakota. In fact, though in volume the estimated 77 billion barrels of oil-equivalent contained in the most prospective oil shale deposits is roughly equal to one-fourth the reserves of Saudi Arabia, oil producible from oil shale is not considered part of U.S. reserves. “Reserves” is a technical term which connotes that the resource is not only available physically, but economically. Oil shale has not reached this threshold yet.

In recent years, a few prominent oil shale projects have shut down, a few others appear to be pushing ahead, and there may be new projects on the horizon. Chevron and Shell both withdrew from their in-situ oil shale projects on BLM-issued Research, Development and Demonstration (RD&D) leases in Colorado, while another RD&D holder—American Shale Oil Corp.—continues its work. ExxonMobil and Natural Soda Holdings have recently acquired RD&D leases in Colorado, both with plans to investigate proprietary in-situ production processes (Center of the American West 2014a).

In Utah, Enefit has access to over 30,000 acres of mixed federal, state, and private property, and has stated a plan to commence production at rates of 50,000 barrels per day (Enefit 2014). Red Leaf Resources has recently been granted a groundwater permit by the Utah Division of Water Quality that will enable it to move ahead on construction of an exhibition-scale oil shale plant utilizing its EcoShale technology (Red Leaf Resources 2014; Center of the American West 2014b). Another company, TomCo, with almost 3,000 acres on state lands, plans to license Red Leaf’s EcoShale technology (TomCo Energy 2014).

**Oil Sands**

Utah contains the largest oil sands deposits in the U.S., with approximately 32 billion barrels of resources-in-place (Institute for Clean and Secure Energy 2013). Figure 8.48 shows the locations of the major oil sands deposits in Utah.

Although large volumes of oil are currently being produced from oil sands in Canada, there are significant differences between the oil sands of Canada and those of Utah that bear on the relative economics of the two resources. Concerning this point, a 2013 report published by the Institute for Clean and Secure Energy notes:

> Utah oil sands occur in thin layers, so a relatively larger amount of overburden must be removed per unit of oil sands processed compared to Canadian opera-

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211 The similarity of the terms “oil shale” and “shale oil” is unfortunate since they are distinctly dissimilar resources (Chidsey 2012). See Appendix B for a comparison of the two resources.

212 The withdrawal of Shell is especially disappointing, as their In-Situ Conversion Process (ICP) has been considered one of the more promising oil shale technologies. In 2005 Shell stated that it expected production from this process to be economically competitive with oil prices in the mid-$20s per barrel (RAND 2005).

213 An in-situ process is one in which the oil shale is not mined, but heated in place, then brought to the surface as (synthetic) crude oil. An ex-situ oil shale technology is one in which the oil shale is mined, then brought to the surface where it is processed in a retort (a heat source that rapidly transforms the oil precursor found in oil shale—kerogen—into a product similar to conventional crude oil).
tions. These thin layers also mean that the economies of scale achieved by the enormous mining operations in Canada cannot be duplicated in Utah (Institute for Clean and Secure Energy 2013, p.29).

Regarding the prospects for production, the company U.S. Oil Sands has almost 6 thousand acres in the PR Spring Area (Figure 8.48) and has stated a plan to produce 2,000 barrels of bitumen per day, with production commencing in 2015 (U.S. Oil Sands 2014).

Figure 8.48
Major Oil Sands Deposits in Utah

Source: Institute for Clean and Secure Energy 2013, p. 22.

Cost Estimates for Oil Shale and Oil Sands Production
A 2013 report published by the University of Utah’s Institute for Clean and Secure Energy provides estimates of the supply price of oil produced from oil shale and oil sands, where the supply price is the oil price necessary to induce investment in oil shale and oil sands under particular production technologies. They represent a complete accounting of the financial costs of production, including royalties, various taxes, and the opportunity cost of capital.

For two particular ex-situ production technologies the supply cost of oil from oil shale ranges from $77 to $153 per barrel, as the hurdle rate of investment ranges from 0 percent to 12 per-
An in-situ process was also modeled, but the high estimates they provide for this process may not be reliable. Concerning this scenario, the authors note that, unlike the ex-situ oil shale scenarios, “This scenario is developed using commercially available reservoir simulation tools and equipment that can be purchased ‘off-the-shelf’ and does not necessarily represent what might be achievable using technologies currently under development.” Therefore, although the in-situ oil shale supply costs are provided in the following table, they should be read with caution.215 Lastly, for oil sands the estimated supply cost ranges from $76 to $122 for an ex-situ process, and from $84 to $161 for an in-situ process, as the hurdle rate ranges from 0 percent to 12 percent216 (Table 8.8).

<table>
<thead>
<tr>
<th>Process</th>
<th>Hurdle Rate</th>
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<tr>
<td></td>
<td>0%</td>
</tr>
<tr>
<td>Oil Shale (ex situ I)</td>
<td>$77</td>
</tr>
<tr>
<td>Oil Shale (ex situ II)</td>
<td>$78</td>
</tr>
<tr>
<td>Oil Shale (in situ)</td>
<td>$183</td>
</tr>
<tr>
<td>Oil Sands (ex situ)</td>
<td>$76</td>
</tr>
<tr>
<td>Oil Sands (in situ)</td>
<td>$84</td>
</tr>
</tbody>
</table>


Shale Oil

Since 2012 the Utah Geological Survey, in conjunction with the Energy and Geoscience Institute at the University of Utah and Eby Petrology and Consulting, has been conducting “reservoir-specific geological and engineering analyses of the emerging Green River Formation (GRF) tight oil plays in the Uinta Basin and the established, yet understudied Cane Creek shale (and possibly other shale units) of the Paradox Formation in the Paradox Basin. Recently, the USGS assessed the undiscovered shale oil resource in the Cane Creek shale of the Paradox Basin at 103 million barrels at a 95 percent confidence level and the undiscovered shale oil resource of the Gothic, Chimney Rock and Hovenweep formations at 126 million barrels with 95 percent confidence (U.S. Geological Survey Paradox Basin Assessment Team 2012, Utah Geological Survey 2014).

Shale Gas

Since 2010 the Utah Geological Survey had been conducting two studies of potential shale gas plays in Utah. These analyze the Mancos Shale in the Uinta Basin, the Manning Canyon Shale in central Utah, and the Paradox Formation in southeastern Utah. The final reports have not yet been released but a May 2014 Survey Notes article reported a potential estimated 6.5 trillion cubic feet of shale gas, as well as potentially more than 250 million barrels of shale oil in the Paradox Formation (Chidsey 2014).

214 The hurdle rate for an investment is the minimum acceptable rate of return on the investment given its risk/reward profile. For an oil shale or oil sands project the hurdle rate would almost certainly be higher than for investments in more conventional oil projects. A hurdle rate of 10 percent might be a reasonable lower bound.

215 For the in-situ oil shale scenario, supply costs were not provided for hurdle rates above 6 percent.

216 For North Dakota’s shale oil, one recent estimate has the break even oil price at $47/barrel (Energy Policy Research Foundation 2011). To the extent this estimate is commensurable with those provided in Table 8.8, it provides a useful comparison of the economics of the two resources.
8.2 RENEWABLE RESOURCES

8.2.1 Renewable Energy

Current Generation

In 2013 Utah generated a total of 1,577.0 Gigawatthours (GWh) of electricity from renewable sources (Table 8.9). This represented a 15 percent decline from 2012 but a 150 percent increase over 2003, when the state generated 624.9 GWh of electricity from renewable sources. Through 2009, geothermal, hydroelectric and biomass were the sole renewable energy sources in the state. Wind power came online in 2010 and the first solar came in 2012. The sources of generation in 2013 were 348.1 GWh of electricity from three geothermal facilities (two on federal land, representing 82 percent of capacity, and one on state land), 633.8 GWh from 64 hydroelectric facilities, 534.9 GWh from 11 wind farms, 57.3 GWh from four biomass facilities, and 2.8 GWh from 135 solar facilities. Note that the latter two cover utility-scale and commercial facilities, and as such include generation from solar panels and windmills installed at businesses, apartment buildings, museums, schools, etc.

Table 8.9
(Megawatthours)

<table>
<thead>
<tr>
<th>Year</th>
<th>Geothermal</th>
<th>Hydro</th>
<th>Wind</th>
<th>Solar</th>
<th>Biomass</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2003</td>
<td>198,465</td>
<td>421,339</td>
<td>-</td>
<td>-</td>
<td>5,083</td>
<td>624,887</td>
</tr>
<tr>
<td>2004</td>
<td>194,876</td>
<td>449,848</td>
<td>-</td>
<td>-</td>
<td>3,821</td>
<td>648,545</td>
</tr>
<tr>
<td>2005</td>
<td>184,802</td>
<td>784,463</td>
<td>-</td>
<td>-</td>
<td>3,948</td>
<td>973,213</td>
</tr>
<tr>
<td>2006</td>
<td>190,608</td>
<td>746,783</td>
<td>-</td>
<td>-</td>
<td>14,868</td>
<td>952,259</td>
</tr>
<tr>
<td>2007</td>
<td>163,925</td>
<td>538,782</td>
<td>-</td>
<td>-</td>
<td>31,030</td>
<td>733,737</td>
</tr>
<tr>
<td>2008</td>
<td>254,277</td>
<td>668,084</td>
<td>-</td>
<td>-</td>
<td>23,685</td>
<td>946,046</td>
</tr>
<tr>
<td>2009</td>
<td>279,121</td>
<td>835,257</td>
<td>-</td>
<td>-</td>
<td>47,878</td>
<td>1,162,256</td>
</tr>
<tr>
<td>2010</td>
<td>276,949</td>
<td>695,512</td>
<td>447,680</td>
<td>-</td>
<td>56,338</td>
<td>1,476,479</td>
</tr>
<tr>
<td>2011</td>
<td>330,188</td>
<td>1,230,165</td>
<td>572,790</td>
<td>-</td>
<td>58,007</td>
<td>2,191,150</td>
</tr>
<tr>
<td>2012</td>
<td>334,638</td>
<td>747,786</td>
<td>703,911</td>
<td>1,619</td>
<td>59,556</td>
<td>1,847,510</td>
</tr>
<tr>
<td>2013</td>
<td>348,093</td>
<td>633,830</td>
<td>534,896</td>
<td>2,822</td>
<td>57,334</td>
<td>1,576,975</td>
</tr>
<tr>
<td>Change</td>
<td>75.4%</td>
<td>50.4%</td>
<td>19.5%</td>
<td>74.3%</td>
<td>1027.9%</td>
<td>152.4%</td>
</tr>
</tbody>
</table>


The state continues to add geothermal, solar and wind generating capacity. As of January 2014, there were six proposed new solar facilities totaling 301.1 Megawatts (MW) (300 MW of that coming from a single project in Millard County), three proposed wind facilities totaling 239.5 MW (100 MW from Phase III of the Milford Wind Corridor and the remainder from projects in San Juan County), and two proposed geothermal facilities totaling 44.0 MW (30 MW from the Blundell expansion and 14 MW from the Thermo Hot Springs expansion) (Utah Geological Survey nd).

Potential Generation

There have been two recent evaluations of potential renewable energy generating capacity in Utah. The Western Renewable Energy Zones Initiative was a project of the Western Governors’ Association in collaboration with the U.S. Departments of Energy, Interior and Agriculture, the Federal Energy Regulatory Commission, and others. Their aim is to “facilitate the construction
of new, utility scale renewable energy facilities and any needed transmission to deliver that energy across the Western Interconnect” (Western Governors’ Association 2009, p. 2). The Utah Renewable Energy Zones Task Force was a concurrent effort commissioned by then-Governor Huntsman to “identify areas in Utah where utility-scale renewable energy development could occur; assess the electrical generation potential of wind, solar, and geothermal technologies; and identify new and existing transmission needed to bring renewable energy generation sources to market” (Berry et al. 2009, p. 1).

The WREZ Phase I report, released in June 2009, identified only one “qualified resource area” in Utah, spanning Millard, Beaver and Iron counties (Figure 8.49). This was based on “those resources that met a threshold potential for commercial development” (Western Governors’ Association 2009, p. 6). Candidate solar areas must receive at least 6.5 kilowatt hours per square meter per day of direct normal insolation217 (DNI) and have a terrain slope not greater than 5 percent (Western Governors’ Association 2009, p. 6). Candidate wind areas must have a National Renewable Energy Laboratory wind power class of 3 or greater at 50 meters above the ground and a terrain slope not greater than 20 percent (Western Governors’ Association 2009, p. 7). Given these constraints, the project identified a total of 10.6 GW of renewable renewable energy capacity: 7.2 GW of solar generating capacity, 1.7 GW of geothermal capacity (225 MW discovered, 1.5 GW undiscovered), 1.7 GW of wind capacity, and 91 MW of biomass capacity (Table 8.10).

Phase I of the UREZ project identified areas with the theoretical potential to be renewable energy zones. Solar areas must receive a DNI of at least 6.0 kWh/m²/day and have a slope of not more than 3 percent. Potential wind areas could not be higher than 9,500 feet, could not be within military operating airspace, and could not be on land “too rugged for development.” Wind sites were also subject to minimum wind resource requirements: drainage canyon sites must have at least 10 MW potential, other sites must have at least 50 MW potential, and there must be at least a 20 percent gross annual capacity factor.218 Environmentally sensitive areas such as national parks, wilderness areas and wetlands were excluded from consideration for any resource.

In Phase II, the resource areas identified in Phase I were refined to 27 renewable energy zones (Figure 8.50). In addition to the criteria in Phase I, zones were defined to be large enough to justify the construction of transmission lines to them and such that the resources in them could be feasibly collected and delivered to the transmission system (Black & Veatch 2010). These zones represent 24.0 GW of renewable energy resources: 14.7 GW of solar, 8.9 GW of wind and 437 MW of geothermal (Table 8.11). Whereas the WREZ process identified just one zone in west-central Utah, the 27 UREZ zones span most of the state, though there is a concentration in the western part of the state, from Millard to Iron counties.

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217 The rate of delivery of direct solar radiation per unit of horizontal surface.
218 Capacity factor is a measure of how often an electric generator runs for a specific period of time. It indicates how much electricity a generator actually produces relative to the maximum it could produce at continuous full power operation during the same period.
The UREZ Phase II report included five 15-year development scenarios for renewable energy in Utah. These were a reference case, low development, high development, “best projects” development and development timing. Detailed discussions of these scenarios can be found in chapter six of the Phase II report (Black & Veatch 2010).

Note that of the three main renewable energy sources discussed in these projects—geothermal, wind and solar—only geothermal is suitable for base load electricity generation. That is, it provides a constant, consistent supply of electricity. Wind and solar are intermittent sources that generate electricity only when the wind is blowing or the sun is shining. And the amount of energy they provide depends on how fast the wind is blowing and how intensely the sun is shining. As such, they are generally suitable only for contributing to daily peak load power provision.
Figure 8.50
Utah Renewable Energy Zones and Identified Resources

Map by John Downen, BBR | June 2014
Source: State of Utah, SGID.
8.2.2 Timber

Forests cover one-third of Utah. Among other values, they offer wildlife habitat, recreation opportunities, scenic landscapes, natural resources and watershed protection. The presence of commercially viable species varies by county, concentrated in mountainous areas. National forests contain 76 percent of the state’s timberland, including valuable Engelmann spruce, aspen, lodgepole pine and Douglas-fir.

Public and Private Forests by Ownership

Of Utah’s 54.3 million surface acres, 18.3 million acres are forested, 33.7 percent of the state. The Bureau of Land Management (BLM) and U.S. Forest Service each steward more than a third of the state’s forests. Most forests in Utah are not harvested. Tree species may not be suitable, the land may be managed for other priorities, or road access may be lacking.

Timberland, commercially viable forest, covers 3.8 million acres, which is one-fifth of the forest land and 7.0 percent of all land area in Utah. Very little of BLM’s forest land is classified as timberland. Otherwise, ownership patterns are analogous for forest land and timberland in Utah.
All landowners listed in Table 8.12 have at least a small amount of forest land, and all owners except the National Park Service, Fish and Wildlife Service, Department of Defense and Department of Energy have timberland. Of the 8.1 million acres of Forest Service lands, 6.3 million acres (78 percent) are forested and 2.9 million acres (35 percent) are timberland. As suggested earlier, 32 percent of BLM's 22.6 million acres in Utah is forested and 0.5 percent is timberland.

<table>
<thead>
<tr>
<th>Ownership</th>
<th>All Land</th>
<th>Forest Land</th>
<th>Timberland</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Acres</td>
<td>Share</td>
<td>Acres</td>
</tr>
<tr>
<td>Federal</td>
<td>34.7</td>
<td>64%</td>
<td>13.9</td>
</tr>
<tr>
<td>Forest Service</td>
<td>8.1</td>
<td>15%</td>
<td>6.3</td>
</tr>
<tr>
<td>National Park Service</td>
<td>2.0</td>
<td>4%</td>
<td>0.4</td>
</tr>
<tr>
<td>BLM</td>
<td>22.6</td>
<td>42%</td>
<td>7.2</td>
</tr>
<tr>
<td>Fish and Wildlife Service</td>
<td>0.1</td>
<td>0%</td>
<td>0.0</td>
</tr>
<tr>
<td>Defense, Energy</td>
<td>1.8</td>
<td>3%</td>
<td>0.0</td>
</tr>
<tr>
<td>State &amp; Local</td>
<td>6.0</td>
<td>11%</td>
<td>1.5</td>
</tr>
<tr>
<td>State</td>
<td>5.9</td>
<td>11%</td>
<td>1.5</td>
</tr>
<tr>
<td>Local</td>
<td>0.0</td>
<td>0%</td>
<td>0.0</td>
</tr>
<tr>
<td>Private</td>
<td>13.6</td>
<td>25%</td>
<td>2.8</td>
</tr>
<tr>
<td>Total</td>
<td>54.3</td>
<td>100%</td>
<td>18.3</td>
</tr>
</tbody>
</table>

1. Bureau of Land Management, Department of Defense, Department of Energy
2. State includes School and Institutional Trust Land Administration (SITLA), Forestry, Fire and State Lands (FFSL), Division of Wildlife Resources (DWR) and the Division of State Parks and Recreation.
3. Local ownership includes lands owned by municipalities and counties, about 49,320 acres, of which 36,725 are forested and 20,515 are timberland.
4. Private includes 7,309 forested acres of "other non-federal lands," of which none is timberland, as well as tribal lands not itemized in the FIDO source, but given as 535,872 acres of forest land per the 2010 survey of the National Association of State Foresters (NASF).
5. Forest land and timberland percentages do not add to 100% due to rounding.

Source: U.S. Forest Service, Forest Inventory and Analysis Program.

Only a small portion of federal timberlands are within national parks and wildernesses or otherwise officially closed to multiple-use access. Yet budget constraints, federal policy, timber prices, sawmill proximity and other factors limit access to federal timberland designated for multiple use, often precluding regular commercial harvests and active management for forest health objectives.

Forest Types

Figure 8.51 maps forest types contributing at least 1 percent of Utah’s timber harvest in recent years.219 Engelmann spruce, Douglas-fir, lodgepole pine and ponderosa pine are commonly used for conventional lumber or as logs for homes. Specialty wood, posts, firewood and excelsior are derived from a variety of forest types.

219 The map shows where Utah’s commonly harvested tree species were the dominant vegetation in 2001, the most recent year available. Forests commonly host a dominant tree species mixed with other varieties of trees and undergrowth.
Two noncommercial forest types shown in Table 8.13, pinyon-juniper and woodland hardwoods, make up 72.3 percent of Utah’s forests (Keyes, et al. 2003).

Utah’s pinyon-juniper forests thrive in dry conditions. They have encroached on lands that previously sustained sagebrush, grasses and other native plants (Keyes, et al. 2003, 12). Aspen forests are in decline (O’Brien 1999, 13). The leading causes are wildlife and livestock grazing and excessive fire suppression (Keyes, et al. 2003, 11). In addition, over the past few decades the health of most forest types in Utah has deteriorated due to drought, wildfire and beetle infestation in the absence of a vigorous and timely response by forest managers in most areas (Cottam and McNaughton 2014).
Table 8.13
Utah Forest Types by Land Area, 2012
(Thousands of Acres)

<table>
<thead>
<tr>
<th>Forest Type Group</th>
<th>Acres</th>
<th>Share</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pinyon-juniper</td>
<td>10,748</td>
<td>58.7%</td>
</tr>
<tr>
<td>Woodland hardwoods¹</td>
<td>2,482</td>
<td>13.6%</td>
</tr>
<tr>
<td>Aspen and birch</td>
<td>1,574</td>
<td>8.6%</td>
</tr>
<tr>
<td>Spruce, fir and mountain hemlock</td>
<td>1,472</td>
<td>8.0%</td>
</tr>
<tr>
<td>Nonstocked²</td>
<td>574</td>
<td>3.1%</td>
</tr>
<tr>
<td>Douglas-fir</td>
<td>553</td>
<td>3.0%</td>
</tr>
<tr>
<td>Lodgepole pine</td>
<td>427</td>
<td>2.3%</td>
</tr>
<tr>
<td>Ponderosa pine</td>
<td>347</td>
<td>1.9%</td>
</tr>
<tr>
<td>Cottonwood, elm and ash</td>
<td>62</td>
<td>0.3%</td>
</tr>
<tr>
<td>Other western softwoods</td>
<td>62</td>
<td>0.3%</td>
</tr>
<tr>
<td>Total</td>
<td>18,299</td>
<td>100%</td>
</tr>
</tbody>
</table>

1. Woodland hardwoods mainly consist of gambel oak.
2. Nonstocked forest is temporarily without tree cover from causes such as wildfire, harvests, and disease.

Source: U.S. Forest Service, Forest Inventory and Analysis Program.

Five tree species, most notably Engelmann spruce, constituted 94 percent of Utah’s 2007 timber harvest received by sawmills, with scarcely any pinyon, juniper or woodland hardwoods (Table 8.14).

Table 8.14
Utah Harvest Volume by Tree Type, 2007
(Thousands of Board Feet)

<table>
<thead>
<tr>
<th>Tree Species</th>
<th>Volume</th>
<th>Share</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engelmann spruce</td>
<td>12,607</td>
<td>41.6%</td>
</tr>
<tr>
<td>Aspen and cottonwood</td>
<td>8,730</td>
<td>28.8%</td>
</tr>
<tr>
<td>Lodgepole pine</td>
<td>3,989</td>
<td>13.2%</td>
</tr>
<tr>
<td>Douglas-fir</td>
<td>3,260</td>
<td>10.8%</td>
</tr>
<tr>
<td>Ponderosa pine</td>
<td>1,080</td>
<td>3.6%</td>
</tr>
<tr>
<td>True firs¹</td>
<td>648</td>
<td>2.1%</td>
</tr>
<tr>
<td>Other species²</td>
<td>6</td>
<td>0.02%</td>
</tr>
<tr>
<td>Total</td>
<td>30,321</td>
<td>100%</td>
</tr>
</tbody>
</table>

1. True firs include white, supalpine, and corkbark fir.
2. Other species include juniper and hardwoods.

Source: Hayes et al. 2007, Table U5.

Forests and Timberland by County

Timber resources are spread unevenly throughout the state. Figure 8.52 shows forest land acres and the percentage of forest that is timberland for the twelve counties with the largest timber harvest volumes in 2002 and 2007. These counties yielded more than 1.5 million board feet (MMBF) in average harvest for those two years. Wasatch County had just over 4 MMBF, followed by Summit and Garfield counties. Only three counties—Box Elder, Tooele and Juab—did not report any timber harvest in 2002 or 2007.
Figure 8.52
Forest Land and Timberland by County in Utah

Note: These are the twelve counties with the largest timber harvest volume in Utah during 2002 and 2007.

Source: U.S. Forest Service, Forest Inventory and Analysis Program

Counties with the most timberland in Utah are located between Salt Lake County and the Colorado border. These include Summit, Wasatch and Duchesne. Counties in central and southern Utah also have considerable timber resources, for example, Sevier and Garfield. Counties with 5 percent or more of Utah’s 3.7 million acres of timberland are Summit (12 percent), Duchesne (10 percent), Garfield (10 percent), Wasatch (8 percent), Uintah (5 percent) and Sevier (5 percent). While San Juan and Kane are among the top three counties in terms of forest land area, with over one million acres each, their timberland acreages are near the county average of 130,000 acres (Table 8.15).
Table 8.15
Utah’s Timberland and Forest Land by County, 2012

<table>
<thead>
<tr>
<th>County</th>
<th>Thousands of Acres</th>
<th>Share of State Totals</th>
<th>Rank of 29 Counties</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Timberland</td>
<td>Forest Land</td>
<td>All Land</td>
</tr>
<tr>
<td>Beaver</td>
<td>48</td>
<td>785</td>
<td>1,659</td>
</tr>
<tr>
<td>Box Elder</td>
<td>16</td>
<td>373</td>
<td>4,307</td>
</tr>
<tr>
<td>Cache</td>
<td>147</td>
<td>313</td>
<td>751</td>
</tr>
<tr>
<td>Carbon</td>
<td>135</td>
<td>521</td>
<td>950</td>
</tr>
<tr>
<td>Daggett</td>
<td>176</td>
<td>314</td>
<td>463</td>
</tr>
<tr>
<td>Davis</td>
<td>11</td>
<td>25</td>
<td>406</td>
</tr>
<tr>
<td>Duchesne</td>
<td>380</td>
<td>1,125</td>
<td>2,084</td>
</tr>
<tr>
<td>Emery</td>
<td>95</td>
<td>667</td>
<td>2,855</td>
</tr>
<tr>
<td>Garfield</td>
<td>370</td>
<td>1,652</td>
<td>3,333</td>
</tr>
<tr>
<td>Grand</td>
<td>103</td>
<td>951</td>
<td>2,364</td>
</tr>
<tr>
<td>Iron</td>
<td>139</td>
<td>913</td>
<td>2,113</td>
</tr>
<tr>
<td>Juab</td>
<td>36</td>
<td>483</td>
<td>2,180</td>
</tr>
<tr>
<td>Kane</td>
<td>113</td>
<td>1,367</td>
<td>2,629</td>
</tr>
<tr>
<td>Millard</td>
<td>38</td>
<td>693</td>
<td>4,370</td>
</tr>
<tr>
<td>Morgan</td>
<td>80</td>
<td>184</td>
<td>391</td>
</tr>
<tr>
<td>Piute</td>
<td>81</td>
<td>226</td>
<td>490</td>
</tr>
<tr>
<td>Rich</td>
<td>73</td>
<td>98</td>
<td>695</td>
</tr>
<tr>
<td>Salt Lake</td>
<td>44</td>
<td>171</td>
<td>517</td>
</tr>
<tr>
<td>San Juan</td>
<td>103</td>
<td>1,691</td>
<td>5,077</td>
</tr>
<tr>
<td>Sanpete</td>
<td>159</td>
<td>541</td>
<td>1,026</td>
</tr>
<tr>
<td>Sevier</td>
<td>192</td>
<td>672</td>
<td>1,228</td>
</tr>
<tr>
<td>Summit</td>
<td>456</td>
<td>715</td>
<td>1,205</td>
</tr>
<tr>
<td>Tooele</td>
<td>16</td>
<td>473</td>
<td>4,664</td>
</tr>
<tr>
<td>Uintah</td>
<td>197</td>
<td>995</td>
<td>2,879</td>
</tr>
<tr>
<td>Utah</td>
<td>145</td>
<td>685</td>
<td>1,370</td>
</tr>
<tr>
<td>Wasatch</td>
<td>318</td>
<td>495</td>
<td>774</td>
</tr>
<tr>
<td>Washington</td>
<td>22</td>
<td>751</td>
<td>1,555</td>
</tr>
<tr>
<td>Wayne</td>
<td>53</td>
<td>292</td>
<td>1,579</td>
</tr>
<tr>
<td>Weber</td>
<td>32</td>
<td>126</td>
<td>422</td>
</tr>
<tr>
<td>Total</td>
<td>3,779</td>
<td>18,299</td>
<td>54,335</td>
</tr>
</tbody>
</table>

Source: U.S. Forest Service, Forest Inventory and Analysis Program.
One way to express which counties of any size rely heavily on timber resources, or at least which have greater timber industry potential, is to note the percentage of county land area covered by forest or timberland. In Wasatch, Daggett and Summit counties, between one-third and one-half of the county is timberland (Figure 8.53 and Table 8.16), and more than half of the land area is forested (Table 8.16). In contrast, Box Elder, Millard and Tooele counties are less than 1 percent timberland and less than 20 percent forest land.

Common forest types in each county can be compared with harvested species in Utah: spruce, aspen, cottonwood, lodgepole pine, Douglas-fir, ponderosa pine and other firs (Table 8.17). For example, Wasatch County has the most aspen or birch forest land. Over 200 acres each of Duchesne and Summit counties are forests primarily containing spruce, true firs or western hemlock. Duchesne, Garfield, Cache and Uintah are leading counties for Douglas-fir forests. Few counties have lodgepole pine forests, 46 percent of which are located in Summit County. Ponderosa pine is distributed somewhat more widely, with Garfield County growing 35 percent of the state total. Of Utah’s nonstocked forest lands, 13.2 percent normally carry commercially har-
vested species that were depopulated or in early stages of recovery when surveyed during 2003–2012.

### Table 8.17

**Utah Forest Types by County**

(Thousands of Acres)

<table>
<thead>
<tr>
<th>County</th>
<th>Pinyon juniper</th>
<th>Woodland hardwoods</th>
<th>Aspen, birch</th>
<th>Spruce, fir...</th>
<th>Nonstocked Douglas-fir</th>
<th>Lodgepole pine</th>
<th>Ponderosa pine</th>
<th>Other softwoods</th>
<th>Cottonwood</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beaver</td>
<td>606</td>
<td>91</td>
<td>21</td>
<td>27</td>
<td>34</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Box Elder</td>
<td>288</td>
<td>47</td>
<td>5</td>
<td>–</td>
<td>17</td>
<td>15</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Cache</td>
<td>33</td>
<td>93</td>
<td>88</td>
<td>23</td>
<td>10</td>
<td>49</td>
<td>6</td>
<td>–</td>
<td>11</td>
</tr>
<tr>
<td>Carbon</td>
<td>314</td>
<td>39</td>
<td>76</td>
<td>38</td>
<td>2</td>
<td>30</td>
<td>–</td>
<td>–</td>
<td>8</td>
</tr>
<tr>
<td>Daggett</td>
<td>66</td>
<td>30</td>
<td>15</td>
<td>38</td>
<td>32</td>
<td>37</td>
<td>57</td>
<td>40</td>
<td>–</td>
</tr>
<tr>
<td>Davis</td>
<td>–</td>
<td>13</td>
<td>–</td>
<td>11</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Duchesne</td>
<td>503</td>
<td>8</td>
<td>140</td>
<td>254</td>
<td>14</td>
<td>75</td>
<td>95</td>
<td>29</td>
<td>7</td>
</tr>
<tr>
<td>Emery</td>
<td>555</td>
<td>7</td>
<td>26</td>
<td>49</td>
<td>12</td>
<td>11</td>
<td>–</td>
<td>–</td>
<td>6</td>
</tr>
<tr>
<td>Garfield</td>
<td>1,107</td>
<td>46</td>
<td>132</td>
<td>120</td>
<td>53</td>
<td>50</td>
<td>–</td>
<td>120</td>
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<tr>
<td>Grand</td>
<td>644</td>
<td>185</td>
<td>42</td>
<td>3</td>
<td>18</td>
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<td>–</td>
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<tr>
<td>Iron</td>
<td>671</td>
<td>61</td>
<td>63</td>
<td>78</td>
<td>30</td>
<td>8</td>
<td>–</td>
<td>2</td>
<td>–</td>
</tr>
<tr>
<td>Juab</td>
<td>294</td>
<td>80</td>
<td>–</td>
<td>17</td>
<td>68</td>
<td>19</td>
<td>–</td>
<td>–</td>
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<tr>
<td>Kane</td>
<td>1,143</td>
<td>72</td>
<td>19</td>
<td>39</td>
<td>22</td>
<td>16</td>
<td>–</td>
<td>56</td>
<td>–</td>
</tr>
<tr>
<td>Millard</td>
<td>402</td>
<td>202</td>
<td>19</td>
<td>24</td>
<td>45</td>
<td>2</td>
<td>–</td>
<td>–</td>
<td>–</td>
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<td>Morgan</td>
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<td>81</td>
<td>56</td>
<td>11</td>
<td>6</td>
<td>29</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Piute</td>
<td>119</td>
<td>22</td>
<td>56</td>
<td>18</td>
<td>5</td>
<td>6</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Rich</td>
<td>21</td>
<td>5</td>
<td>48</td>
<td>18</td>
<td>–</td>
<td>–</td>
<td>6</td>
<td>–</td>
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</tr>
<tr>
<td>Salt Lake</td>
<td>7</td>
<td>108</td>
<td>16</td>
<td>33</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>7</td>
</tr>
<tr>
<td>San Juan</td>
<td>1,406</td>
<td>138</td>
<td>30</td>
<td>19</td>
<td>31</td>
<td>6</td>
<td>–</td>
<td>52</td>
<td>–</td>
</tr>
<tr>
<td>Sanpete</td>
<td>236</td>
<td>137</td>
<td>68</td>
<td>100</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
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<tr>
<td>Sevier</td>
<td>356</td>
<td>116</td>
<td>100</td>
<td>78</td>
<td>11</td>
<td>11</td>
<td>–</td>
<td>–</td>
<td>1</td>
</tr>
<tr>
<td>Summit</td>
<td>16</td>
<td>109</td>
<td>155</td>
<td>209</td>
<td>15</td>
<td>10</td>
<td>197</td>
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<td>2</td>
</tr>
<tr>
<td>Tooele</td>
<td>371</td>
<td>34</td>
<td>6</td>
<td>18</td>
<td>34</td>
<td>10</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Uintah</td>
<td>694</td>
<td>68</td>
<td>35</td>
<td>48</td>
<td>27</td>
<td>48</td>
<td>66</td>
<td>2</td>
<td>–</td>
</tr>
<tr>
<td>Utah</td>
<td>162</td>
<td>324</td>
<td>74</td>
<td>74</td>
<td>14</td>
<td>35</td>
<td>–</td>
<td>–</td>
<td>2</td>
</tr>
<tr>
<td>Wasatch</td>
<td>13</td>
<td>120</td>
<td>227</td>
<td>75</td>
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<td>–</td>
<td>–</td>
<td>7</td>
</tr>
<tr>
<td>Washington</td>
<td>487</td>
<td>163</td>
<td>8</td>
<td>18</td>
<td>63</td>
<td>–</td>
<td>–</td>
<td>12</td>
<td>–</td>
</tr>
<tr>
<td>Wayne</td>
<td>233</td>
<td>–</td>
<td>22</td>
<td>20</td>
<td>–</td>
<td>–</td>
<td>7</td>
<td>7</td>
<td>4</td>
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<tr>
<td>Weber</td>
<td>–</td>
<td>81</td>
<td>27</td>
<td>11</td>
<td>1</td>
<td>6</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>10,748</strong></td>
<td><strong>2,482</strong></td>
<td><strong>1,574</strong></td>
<td><strong>1,472</strong></td>
<td><strong>574</strong></td>
<td><strong>553</strong></td>
<td><strong>427</strong></td>
<td><strong>347</strong></td>
<td><strong>62</strong></td>
</tr>
</tbody>
</table>

Notes: Several forest type groups merit clarification. “Woodland hardwoods” consist of gambel oak primarily, along with shrub oaks. The “spruce, fir...” forest type includes Engelmann and blue spruce, true firs (which Douglas-fir is not), as well as western hemlocks. “Nonstocked” indicates forest with less than 10% of its usual live tree stocking, usually a temporary condition due to fire, cuts, or disease. “Other softwoods” are western softwoods, such as bristlecone and limber pines. “Cottonwood...” includes elm and ash.

Source: U.S. Forest Service, Forest Inventory and Analysis Program.

In several counties more than 95 percent of the timberland is federally owned: Beaver, Garfield, Millard, Piute, Wayne and Daggett. The possibility of a timber industry in these areas depends greatly on federal forest management approaches. In six other counties—Tooele, Grand, Box Elder, Carbon, Morgan and Davis—at least half of timberland is in private or state ownership (Figure 8.54 and Table 8.18).
Figure 8.54
Federal Share of Timberland Acreage by County in Utah

Legend:
- Federal Share of Timber
  - 0.0% to 24.9%
  - 25.0% to 49.9%
  - 50.0% to 74.9%
  - 75.0% to 100.0%

Source: U.S. Forest Service, Forest Inventory and Analysis Program.
Table 8.18
County Timberland by Ownership, Utah, 2012
(Share of County Land Area)

<table>
<thead>
<tr>
<th>County</th>
<th>Federal Government</th>
<th>State and Local Government</th>
<th>Private</th>
<th>Total Acres</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beaver</td>
<td>100%</td>
<td>0%</td>
<td>0%</td>
<td>48,449</td>
</tr>
<tr>
<td>Box Elder</td>
<td>40%</td>
<td>0%</td>
<td>60%</td>
<td>16,458</td>
</tr>
<tr>
<td>Cache</td>
<td>87%</td>
<td>0%</td>
<td>13%</td>
<td>147,305</td>
</tr>
<tr>
<td>Carbon</td>
<td>25%</td>
<td>19%</td>
<td>55%</td>
<td>134,756</td>
</tr>
<tr>
<td>Daggett</td>
<td>96%</td>
<td>3%</td>
<td>1%</td>
<td>175,783</td>
</tr>
<tr>
<td>Davis</td>
<td>0%</td>
<td>100%</td>
<td>0%</td>
<td>11,447</td>
</tr>
<tr>
<td>Duchesne</td>
<td>73%</td>
<td>7%</td>
<td>20%</td>
<td>379,966</td>
</tr>
<tr>
<td>Emery</td>
<td>82%</td>
<td>0%</td>
<td>18%</td>
<td>95,108</td>
</tr>
<tr>
<td>Garfield</td>
<td>100%</td>
<td>0%</td>
<td>0%</td>
<td>369,845</td>
</tr>
<tr>
<td>Grand</td>
<td>41%</td>
<td>58%</td>
<td>2%</td>
<td>102,640</td>
</tr>
<tr>
<td>Iron</td>
<td>62%</td>
<td>5%</td>
<td>33%</td>
<td>138,750</td>
</tr>
<tr>
<td>Juab</td>
<td>69%</td>
<td>0%</td>
<td>31%</td>
<td>35,848</td>
</tr>
<tr>
<td>Kane</td>
<td>76%</td>
<td>0%</td>
<td>24%</td>
<td>113,351</td>
</tr>
<tr>
<td>Millard</td>
<td>100%</td>
<td>0%</td>
<td>0%</td>
<td>37,986</td>
</tr>
<tr>
<td>Morgan</td>
<td>16%</td>
<td>0%</td>
<td>84%</td>
<td>79,713</td>
</tr>
<tr>
<td>Piute</td>
<td>98%</td>
<td>2%</td>
<td>0%</td>
<td>81,033</td>
</tr>
<tr>
<td>Rich</td>
<td>63%</td>
<td>2%</td>
<td>35%</td>
<td>72,641</td>
</tr>
<tr>
<td>Salt Lake</td>
<td>68%</td>
<td>32%</td>
<td>0%</td>
<td>43,668</td>
</tr>
<tr>
<td>San Juan</td>
<td>80%</td>
<td>6%</td>
<td>14%</td>
<td>102,971</td>
</tr>
<tr>
<td>Sanpete</td>
<td>92%</td>
<td>0%</td>
<td>8%</td>
<td>159,458</td>
</tr>
<tr>
<td>Sevier</td>
<td>95%</td>
<td>0%</td>
<td>5%</td>
<td>191,699</td>
</tr>
<tr>
<td>Summit</td>
<td>75%</td>
<td>2%</td>
<td>23%</td>
<td>456,020</td>
</tr>
<tr>
<td>Tooele</td>
<td>45%</td>
<td>18%</td>
<td>36%</td>
<td>16,320</td>
</tr>
<tr>
<td>Uintah</td>
<td>85%</td>
<td>3%</td>
<td>11%</td>
<td>197,166</td>
</tr>
<tr>
<td>Utah</td>
<td>94%</td>
<td>5%</td>
<td>1%</td>
<td>145,024</td>
</tr>
<tr>
<td>Wasatch</td>
<td>82%</td>
<td>8%</td>
<td>11%</td>
<td>317,998</td>
</tr>
<tr>
<td>Washington</td>
<td>56%</td>
<td>0%</td>
<td>44%</td>
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</tr>
<tr>
<td>Wayne</td>
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<td>0%</td>
<td>2%</td>
<td>52,728</td>
</tr>
<tr>
<td>Weber</td>
<td>54%</td>
<td>0%</td>
<td>46%</td>
<td>32,201</td>
</tr>
<tr>
<td>State of Utah</td>
<td>78%</td>
<td>5%</td>
<td>16%</td>
<td>3,778,749</td>
</tr>
</tbody>
</table>

Source: U.S. Forest Service, Forest Inventory and Analysis Program

Utah Timber Harvest

The current timber harvest level suggests the available quantity of this renewable resource under present public land management policies. The Forest Service, BLM and SITLA reported 39.5 MMBF in harvested timber in Utah during FY2012, which should capture all activity on public lands.\(^{220}\) From private and tribal lands, Utah sawmills received 11.6 MMBF in harvested timber in 2007, 42.2 percent of the total received by mills that year, the most recent year for which data are available (Hayes, et al. 2012, 51).\(^{221}\)

The Forest Service accounts for most of Utah’s timber harvest. In FY2012 its harvest was 31.4 MMBF, valued at $854,000, the lowest value since FY1980, except for FY2010 and 2011.

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\(^{220}\) For BLM and the Forest Service, federal fiscal year 2012 ended September 30, while the state fiscal year used by SITLA ended June 30. Sources: Headwaters (2014) for Forest Service harvest, BLM 2012 Public Land Statistics, email communication from SITLA October 1, 2013.

\(^{221}\) The 11.6 MMBF estimate is conservative for two reasons. Some wood harvested from private and tribal lands, for example firewood, would not go to any mill. Also, as a net exporter of wood, more timber from Utah forests was likely sent to sawmills in other states than was processed by Utah mills.
(Headwaters 2014). By comparison, the 30.1 MMBF Forest Service harvest in FY2007 was worth $2.7 million in inflation-adjusted FY2012 dollars.

From all sources, sawmills in Utah received 30.3 MMBF in newly harvested timber in 2007, the most recent year of the mill census that documents the milled portion of harvests across all private and public land ownership (Hayes, et al. 2012, 50). Not all harvested timber is shipped to sawmills, depending on the intended final product. The counties with the highest timber harvest volumes in 2007 were Wasatch (4.3 MMBF), Sanpete (3.8 MMBF), Garfield (3.1 MMBF) and Summit (2.7 MMBF) (Hayes, et al. 2012, 49).

In 2002, on all types of land, sawlogs (conventional lumber) were 62 percent of the timber received by Utah sawmills, while house logs were 30 percent and fiber logs, wood for furniture, posts and poles amounted to 8 percent (DeBlander, et al. 2010).
REFERENCES


Cottam, Brian, and Geoffrey McNaughton, meeting with Levi Pace, Jan Stambro and John Downen. *Director and Forestry Programs Supervisor, respectively, Division of Forestry, Fire and State Lands, Utah Department of Natural Resources* Salt Lake City, Utah, (February 28, 2014).


8 – Utah’s Natural Resources


Cottam, Brian, and Geoffrey McNaughton, interview by Levi Pace, Jan Stambro and John Downen. Director and Forestry Programs Supervisor, respectively, Division of Forestry, Fire and State Lands, Utah Department of Natural Resources Salt Lake City, Utah, (February 28, 2014).


Patterson, Charles G., Margo I. Toth, James E. Case, Harlan N. Barton, Gregory N. Green, Russell A. Schreiner, and John R. Thompson, 1988, Mineral Resources of the Indian Creek, Bridger Jack Mesa, and Butler Wash Wilderness Study Areas, San Juan County, Utah, U.S. Geological Survey Bulletin 1754–A.


