

CASE STUDY

Soudan State Park Soudan, Minnesota

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**Prepared by
The Interstate Technology & Regulatory Council
Mining Waste Team**

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SOUDAN STATE PARK, SOUDAN, MINNESOTA

1. SITE INFORMATION

1.1 Contacts

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1.2 Name, Location, and Description

The Soudan mine is located in Soudan, Minnesota and is the oldest and deepest iron mine in the state. The mine began in 1884 as an open pit but switched to an underground operation in 1892. U.S. Steel operated the mine from the 1920s until 1962, when it closed. In 1965 the mine and surrounding land were donated to the State of Minnesota and are currently operated by the Department of Natural Resources, Division of Parks and Recreation (Figure 1-1).

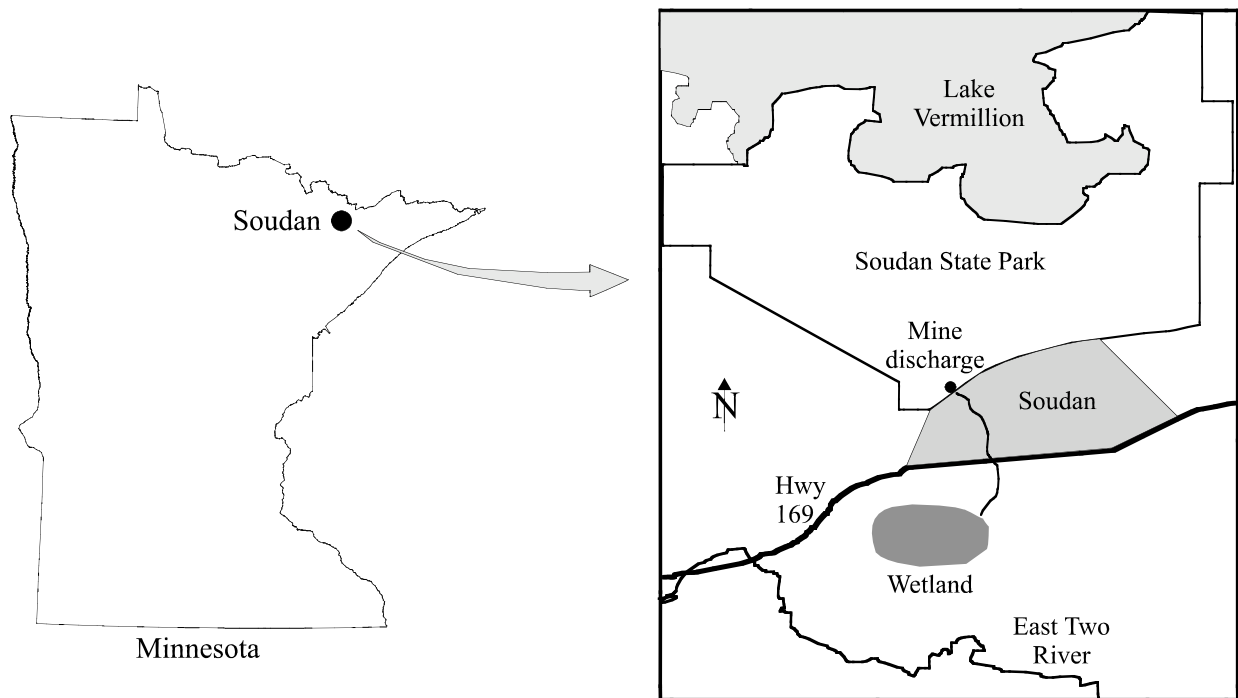


Figure 1-1. Soudan State Park map.

The park is in Breitung Township, on the shore of Lake Vermilion in northern Minnesota's Vermilion Range. The mine is close to Minnesota State Highway 169, about 20 miles east of Virginia and 20 miles (30 km) west of Ely, or about 1 mile from Tower. It has become a popular tourist site, often visited on the way to and from Ely and the Boundary Waters Canoe Area Wilderness. As the Soudan Iron Mine, it has been designated a U.S. National Historic Landmark. Underground tours are given of the lowest level of the mine, and two physics laboratories have

been established, where scientists from around the world have been working to answer basic questions about the universe. Water enters the mine through a series of open pits and fractures, with some flow occurring on all levels of the mine.

The average mine dewatering discharge is around 60 gallons per minute and, although circumneutral, contains copper and cobalt in excess of the permit standards of 0.020 mg/L copper and 0.005 mg/L cobalt. Annual average concentrations have varied 0.083–0.5 mg/L copper and 0.006–0.026 mg/L cobalt.

2. REMEDIAL ACTION AND TECHNOLOGIES

About 94% of the total copper and 44% of the total cobalt come from one area in the mine. The pH is around 4 with flow ranging about 1–10 gpm, copper 3–30 mg/L and cobalt 0.1–0.3 mg/L. In 2003 an ion exchange unit using a selective cation ion exchange resin from Simens Corporation was installed to treat the water. The discharge is being treated pursuant to the Clean Water Act and to mitigate the ecological risk.

3. PERFORMANCE

Both copper and cobalt are reduced to less than 0.01 mg/L, with concentrations generally on the order of 0.002 mg/L when the resin is new and working properly. Performance decreases as the resin loads with metal. With the current input concentrations, Siemens has estimated that copper removal should be on the order of 2 lbs/ft³ of resin.

4. COSTS

Annual estimated costs are around \$25,000.

5. REGULATORY CHALLENGES

None encountered.

6. STAKEHOLDER CHALLENGES

No information available.

7. OTHER CHALLENGES AND LESSONS LEARNED

As soon as the unit was installed, a white precipitate appeared in the inflow water, plugged the ion exchange units, and made consistent treatment impossible. Filter units comparable to standard household filters were installed to remove the precipitate, which was primarily an aluminum compound. This step has greatly increased the amount of maintenance.

8. REFERENCES

Eger, P. 2007. “Solving Mine Drainage Problems at Soudan State Park—One Step Forward, Two Steps Back,” *Proceedings, 24th Annual Meeting of the American Society of Mining and Reclamation*, Gillette, Wyo., June 3–8.