

CASE STUDY

Hartshorne/Whitlock-Jones Pittsburg County, Oklahoma

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

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HARTSHORNE/WHITLOCK-JONES, PITTSBURG COUNTY, OKLAHOMA

1. SITE INFORMATION

1.1 Contacts

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1.2 Name, Location, and Description

“The former Rock Island Coal Mining Co. Mine 7 is located immediately east of Hartshorne, OK and was one of a series of mines operated by the Rock Island Coal Mining Co. during the early part of the 20th century. The No. 7 mine was abandoned in the 1930’s and utilized three shaft entries and two parallel slope entries access the abandoned underground workings. An artesian acid mine drainage (AMD) discharge, ranging from the 19 to 76 L/min (5 to 20 GPM) of highly mineral-laden water discharges from a 55-m (180-ft) deep airshaft” (Behum, Meier, and Bohnenstiehl 2004). See Figure 1-1.



Figure 1-1. Hartshorne/Whitlock-Jones, Hartshorne, Pittsburg County, Oklahoma.
(N 34°, 50.7' [34.8450], W 95°, 33.4' [-95.5562]). *Source:* Google Earth 2009)

2. REMEDIAL ACTION AND TECHNOLOGIES

“Prior to construction, the mine discharge was sampled periodically for several years and showed considerable fluctuation in both water quality and quantity. Measured discharge rates ranged from <1 to approximately 75 LPM. Metal and anion concentrations varied with each sampling event, although temperature, pH, and DO remained relatively consistent. The acidic nature of the discharge, coupled with median concentrations of iron (Fe) and Mn (Manganese) of 765 and 18mg/L, respectively, warranted a plan for treatment.

An abandoned fan shaft (total depth approximately 56 m) from which the water discharged in an artesian manner was converted to the vertical anoxic limestone drain (VALD) and serves as the first process unit in the passive treatment system.... The VALD was designed to perform similarly to a traditional horizontally-oriented ALD. The shaft was first filled with approximately 34 m of local dolomitic stone (to provide long-term stability) which was then covered by 22 m of high calcite limestone (to provide alkalinity generation capacity). An effluent header pipe directs water from the VALD to the remainder of the passive treatment system, consisting of an alternating series of three oxidation ponds and two vertical flow cells, before discharging to a polishing wetland cell and then into an existing pond.... Because this study focuses solely on alkalinity generation in the VALD, performance of the remaining process units is not discussed” (Labar, Nairn, and Canty 2008).

3. PERFORMANCE

“Due to the design of the VALD [Figure 3-1], sampling of the original mine discharge is currently impossible. The VALD effluent is considered the best approximation of the discharge water quality. Water quality and quantity data collected from the VALD effluent from January 2007 through June 2008 demonstrate that this mine discharge remains highly mineralized, containing elevated metals, base cations, SO_4^{2-} , and Cl^- . Metal and anion concentrations and discharge rates were highly variable, remaining consistent with pre-construction data. However, temperature, pH, and DO remained relatively consistent over the sampling period. The maximum concentrations for all metals, all anions, alkalinity, and conductivity occurred in the first sampling event after the VALD first began to flow. Concentrations of metals and anions decreased for sampling events since then, with the majority of the minimum concentrations occurring in the last sampling event during the study.

“The purpose of the VALD is to generate alkalinity to sustain Fe oxidation in subsequent unit processes. In this regard, the VALD is performing effectively.... [A] typical anoxic limestone drain can be expected to add up to 150–300 mg/L as CaCO_3 of alkalinity. Alkalinity concentrations in the VALD effluent averaged 470 ± 49 mg/L (mean \pm standard deviation) as CaCO_3 during the period of study. The cause of these unusually high alkalinity concentrations is likely due to several factors, including the ionic strength of the mine water, elevated pCO_2 (~10-0.3 entering the VALD), and retention time (25 to 53 hours) of the water in the VALD.... As a result of alkalinity generation as well as decreases in metals concentrations, the net acidity of the discharge decreased from a pre-construction value of 1288 mg/L as CaCO_3 to 614 ± 498 mg/L as CaCO_3 .

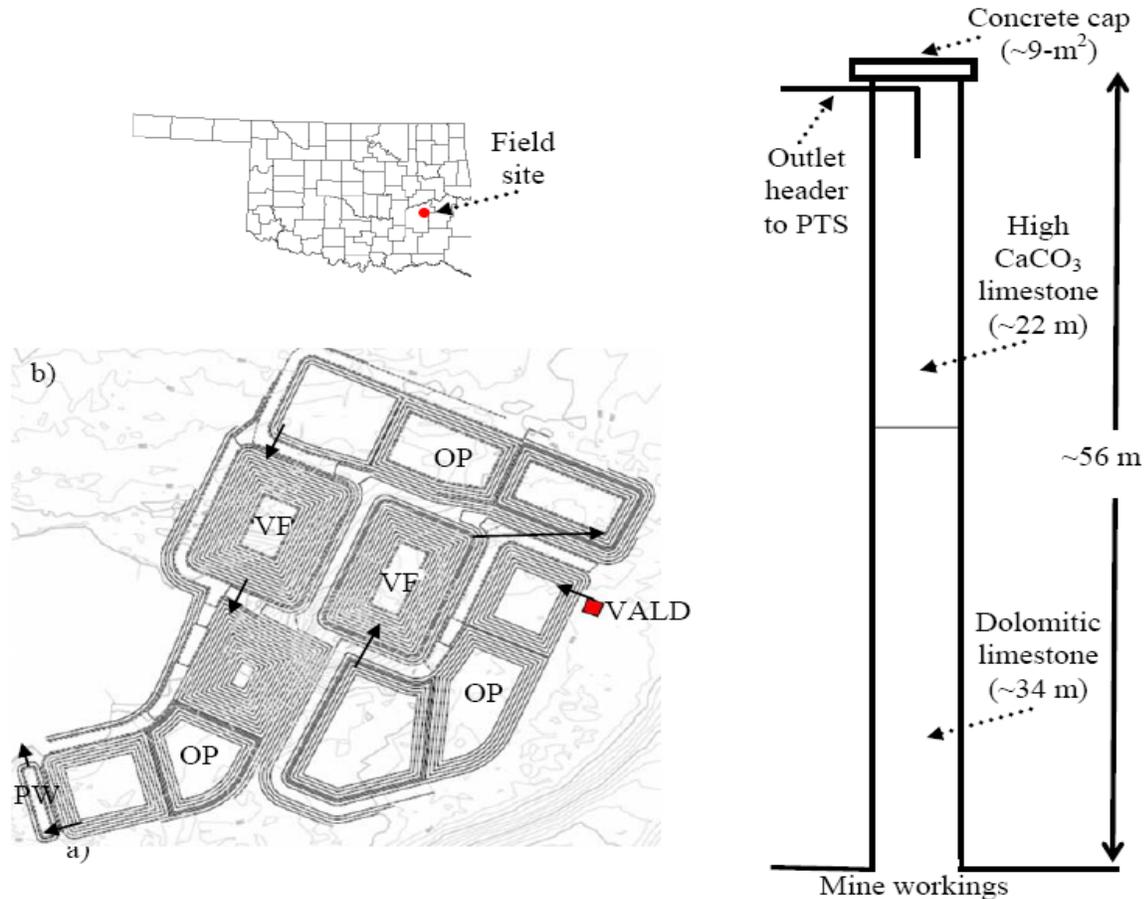


Figure 3-1. Rock Island #7 field site showing location in Oklahoma; schematic of passive treatment system with location of VALD (base drawing courtesy Burns and McDonnell 2004) showing general direction of flow (OP = oxidation pond, VF = vertical flow cell, PW = polishing wetland); and generalized diagram of VALD. (After Behum, Meier, Bohnenstiehl 2004. Note: Not to scale.)

“Although the Rock Island #7 passive treatment system was designed primarily for the removal of Fe from the mine discharge, it has been very effective at removing other metals as well. The system, on average, has exhibited Fe removal and alkalinity generation rates that compare well to those found in the literature. However, these rates fluctuate widely due to the highly variable water quality and quantity entering the system. In order to understand the system more fully, more information must be gathered on the retention time of the water in the system and the unit processes themselves. This will aid greatly in resolving the issue of location-event sample matching. Also, a thorough evaluation of the biotic processes occurring in both the oxidation ponds and vertical flow cells is necessary to gain a better understanding of how the system treats this unique mine discharge. Gathering a wider array of data on this system will help in further determining the efficacy of treatment. Despite these gaps in data, it is evident that the treatment system is discharging water with much higher quality than the original mine discharge” (Labar and Nairn 2009).

4. COSTS

No information was included with this survey.

5. REGULATORY CHALLENGES

No regulatory issues were encountered.

6. STAKEHOLDER CHALLENGES

There were no significant public or stakeholder issues associated with the project.

7. OTHER CHALLENGES AND LESSONS LEARNED

Learning to work with private landowners was critical, and there was a need to demonstrate how remedial technologies would benefit them.

8. REFERENCES

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- Labar, J. A., R. W. Nairn, and G. A. Canty. 2008. "Generation of 400–500 mg/L Alkalinity in a Vertical Anoxic Limestone Drain," in *New Opportunities to Apply Our Science, Proceedings, 25th National Meeting of the American Society of Mining and Reclamation*, Richmond, Virginia, June 14–19.