REMEDIATION OF ACID MINE DRAINAGE IN THE SUGAR CREEK WATERSHED, MISSOURI: TECHNOLOGY AND COSTS FOR USE IN TMDL ASSESSMENT[1]

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Abstract. The Sugar Creek Watershed is located north of Huntsville in north-central Missouri. Water quality in Sugar Creek has been affected by acid mine drainage (AMD) generated by underground mining and coal refuse disposal before the Surface Mining Control and Reclamation Act of 1977 and has been listed on Missouri's 303d list as an impaired stream. To support the state of Missouri's development of a Total Maximum Daily Load (TMDL) assessment and remediation efforts, the Office of Surface Mining (OSM), Mid-Continent Region in cooperation with the U. S. Geological Survey (USGS), Missouri Water Science Center - Kansas City Office has completed a technical evaluation and economic and logistical feasibility study for the AMD affected waterway. Utilizing a water-quality assessment completed in 2005 by the USGS, the OSM study proposes the construction of passive treatment facilities for three major AMD sources identified by the USGS in the watershed. Site-specific remediation costs are determined for each site using OSM's Technical Innovation and Professional Services software *AMDTreat*. The proposed treatment systems utilize state-of-the-art passive treatment technology, including anaerobic bioreactors and vertical flow wetlands. Treatment of the discharges from two of the AMD sources add alkaline effluent from public waste-water treatment facilities for neutralizing acidity, dilution of the AMD, and addition of nutrients into the proposed wetland treatment systems. This study will be used to develop costs and a plan for the remediation of the Sugar Creek discharges and can serve as a guide in TMDL assessments in Missouri and other coal mining areas.

Additional Key Words: passive treatment, aerobic wetland anaerobic bioreactor, and vertical flow pond.

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The Problem

The Sugar Creek Drainage is located in north-central Missouri near the town of Huntsville (Fig. 1). Water quality in Sugar Creek has been affected by acid mine drainage (AMD) generated by underground mining and coal refuse disposal before the Surface Mining Control and Reclamation Act of 1977 and has been listed on the Missouri's 303d list as an impaired stream. Elevated pH is the principle concern, but sub-watersheds are also affected by elevated iron, aluminum, sulfate and trace metals. Typical AMD discharges such as the Huntsville Gob Mine Pool Discharge (USGS # HG-2M, Fig. 2) are characterized by a low pH (median = 4.6), high acidity, dissolved iron, and sulfate [1,070 mg/L (non-Mn), 422 mg/L, and 3,245 mg/L (median values)]. Building on a USGS study (Christensen, 2005), OSM evaluated the economic and logistical feasibility of installing passive treatment facilities to remediate the AMD in the affected waterways.

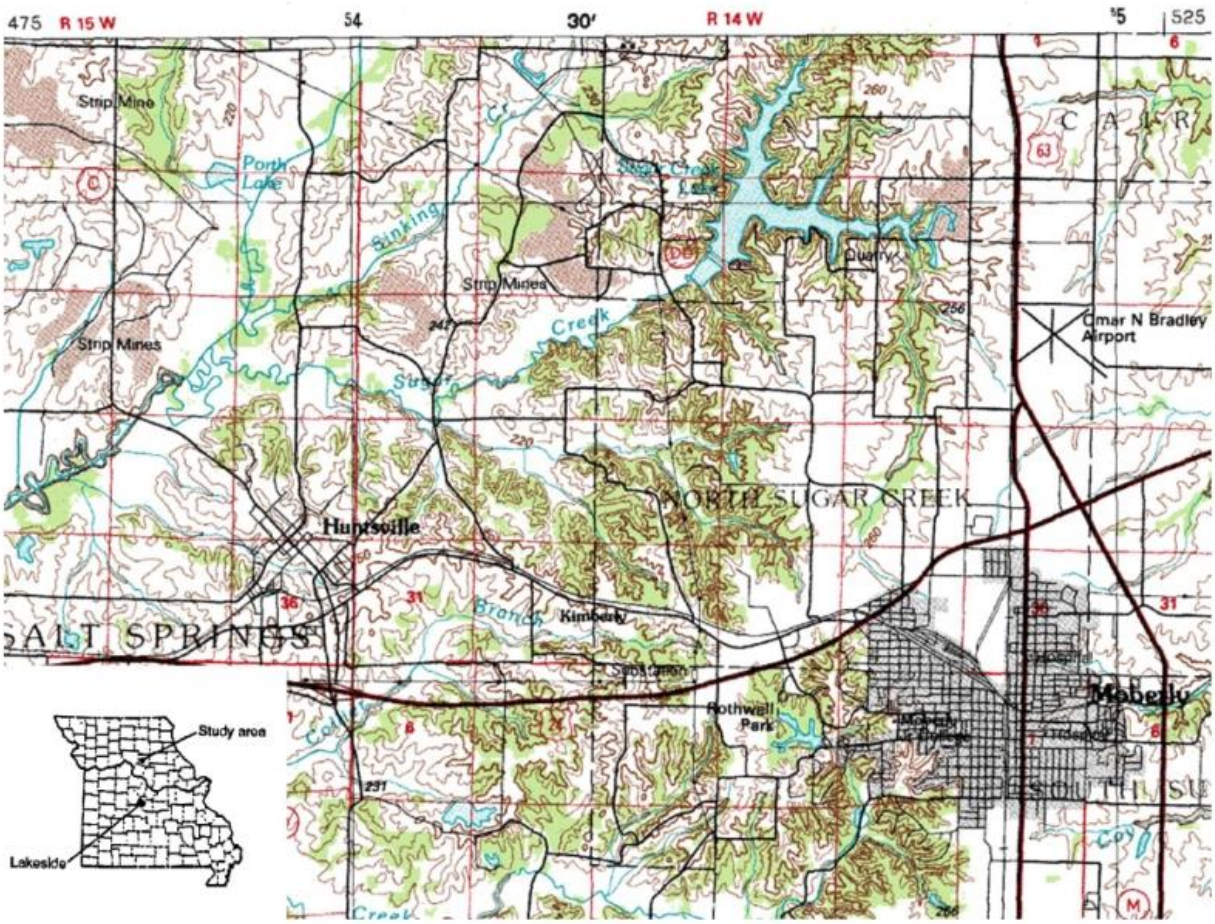

Figure 1. – Location map of Sugar Creek study area, Huntsville, Missouri.

Figure 2. - Huntsville Gob Mine Pool Discharge (USGS HG-2M).

Proposed Solution

To evaluate the cost of passive treatment OSM applied the TIPS freeware program *AMDTreat* (version 3.2; Means and others, 2003; available online at http://amd.osmre.gov/tt2/download.htm). Four discharges were evaluated:

1) Huntsville Gob Mine Pool Discharge (USGS #HG-2M).
2) Huntsville Gob Seep Collector Drain Discharge (USGS #HG-7S).
3) Calfee Slope Discharge (USGS #CS-5M).
4) Mitchell Mine Discharge (USGS #MM-3M).

Table 1 summarizes the preliminary cost estimates prepared by OSM and the pertinent design parameters used in the estimate.

Table 1 - Summary of Inlet Design Parameters and Preliminary Passive Treatment Costs.

AMD Discharge	Acidity (mg/L as $CaCO_3$)	Alkalinity (mg/L as $CaCO_3$)	Net Acidity (mg/L as $CaCO_3$)	Dissolved Iron (mg/L)	Flow (GPM)	Estimated Cost* ($ US)	Estimated Area* (acres)
HG-2M	1,070	20	1,150	422	4.5	$186,000	1.8
HG-7S	1,760	0.0	1,760	668	16.8	$410,000	5.0
CS-5M	1,030	38	992	551	30.0**	$365,000	5.0
MM-3M	291	164	127	165	66.6***	$120,000	2.1
Total:						$1,081,000	13.9

* Estimated costs are preliminary and do not include inflation allowances and geotechnical investigation, land and/or right-of-way acquisition, access development, security considerations, and bench and pilot treatment cell installation costs; results of the latter are likely to affect full scale treatment system installation costs; annual operation costs are also not included.

** The partially treated AMD discharge will be commingled with a public waste-treatment plant discharge (USGS #CS-8S) at a 1:1 ratio to yield a total discharge flow of 60 GPM.

*** The partially treated AMD discharge will be commingled with a public waste-treatment plant discharge (USGS #MM-6S) at a 1:1 ratio to yield a total discharge flow of 133.2 GPM.

The Huntsville Gob Mine Pool Discharge (USGS #HG-2M) and the Huntsville Gob Seep Collector Drain Discharge (USGS #HG-7S) are the most difficult discharges to treat because of the high acidity and the absence of an alkaline dilution water source. The collector drain discharge is a composite collection of a series of low-volume seeps from mine pool discharges and a previously reclaimed coal refuse facility. Fig. 3 and 4 show flow charts of the proposed passive treatment facilities. These systems are located in an area overlying a reclaimed coal fines impoundment and will require a geotechnical study to evaluate the site (Fig. 5). The Calfee Slope Discharge (USGS #CS-5M) and the Mitchell Mine Discharge (USGS #MM-3M) are located in sub-watersheds with existing public water treatment facilities discharging alkaline water. These discharges can be used to provide alkalinity and dilution water greatly reducing the passive treatment cost (Table 1, Fig. 6 and 7). Beneficial nutrients would also be added from the waste-water discharge. Figures 8 and 9 show the proposed location of passive treatment cells for the Calfee Slope Discharge, which are in part located adjacent to a waste-treatment facility. Figure 10 shows the proposed location of passive treatment cells for the Mitchell Mine Discharge, the drainage for which is also located adjacent to an existing waste-treatment facility.

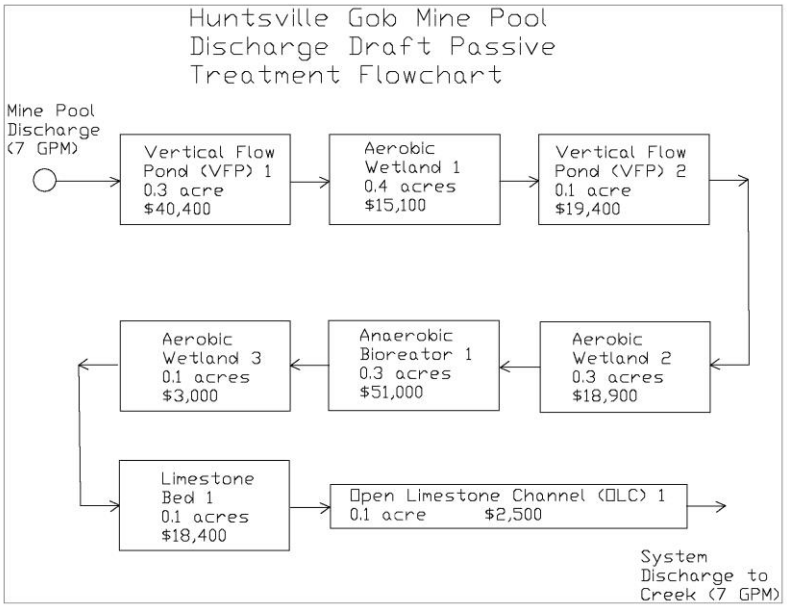

Figure 3 – Flow Chart of the Proposed Huntsville Gob Mine Pool Passive Treatment System.

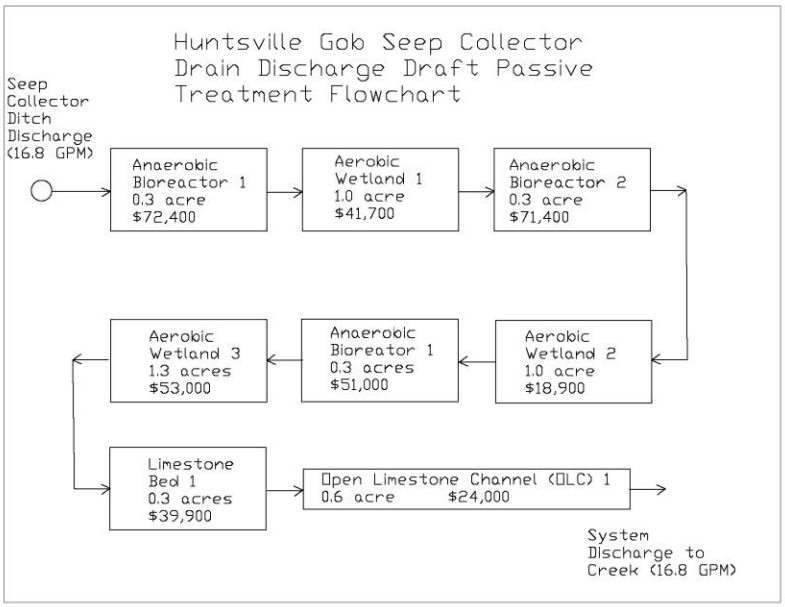

Figure 4 – Flow Chart of the Proposed Huntsville Gob Collector Ditch Passive Treatment System.

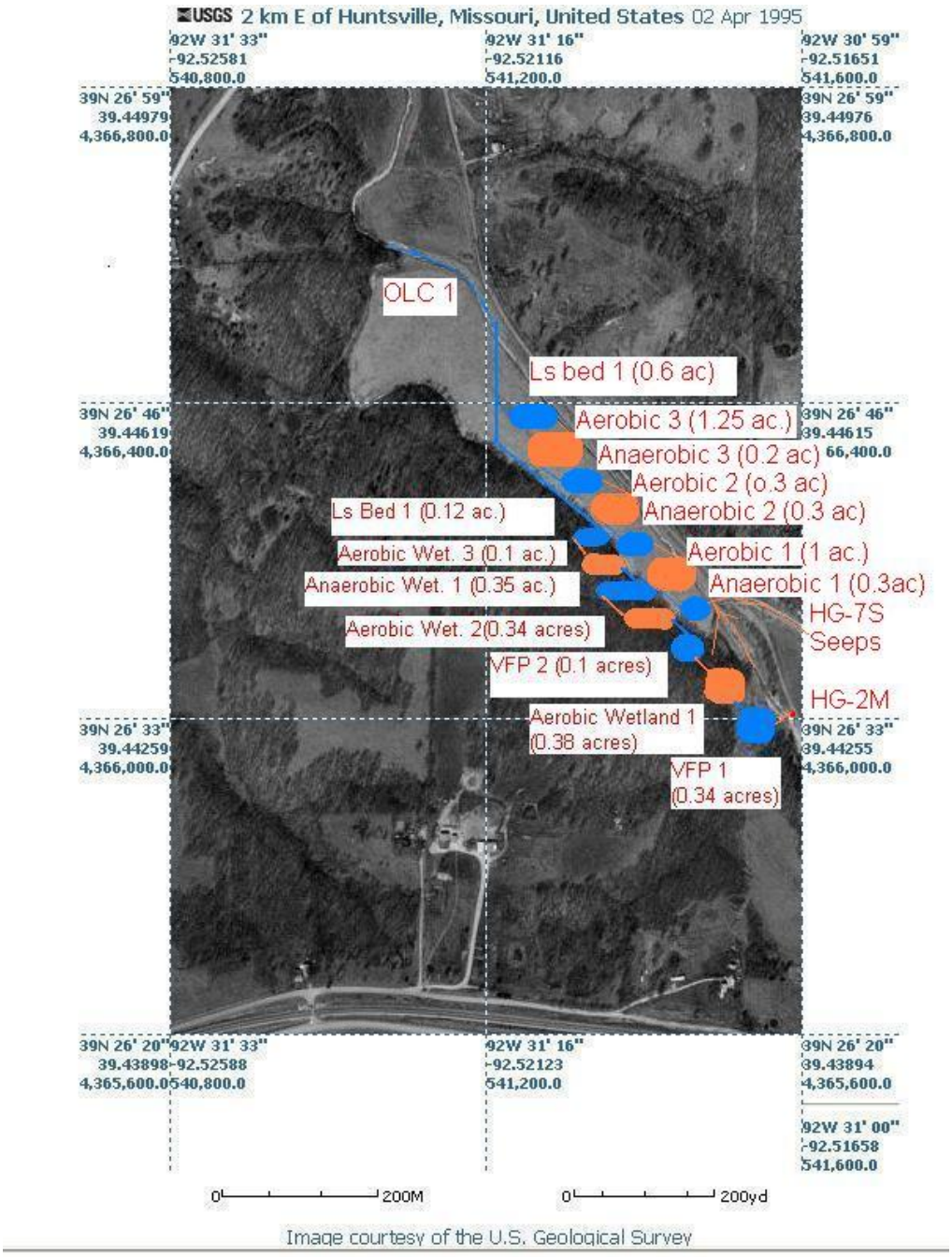

Image Source: TerraServer-USA (http://www.terraserver.microsoft.com/).

Figure 5 – Location Map for Huntsville Gob Area Discharge Treatment Systems.

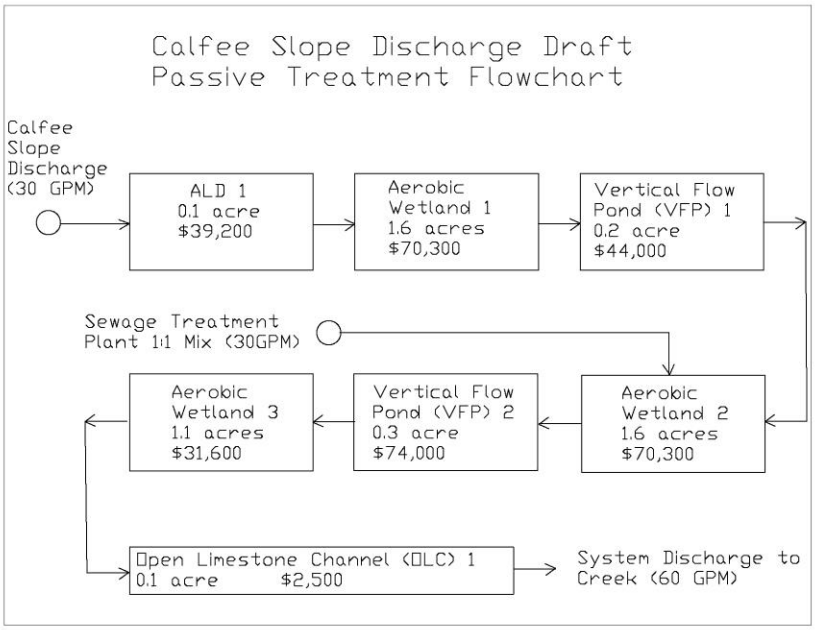

Figure 6 – Flow Chart of the Proposed Calfee Slope Discharge Passive Treatment System.

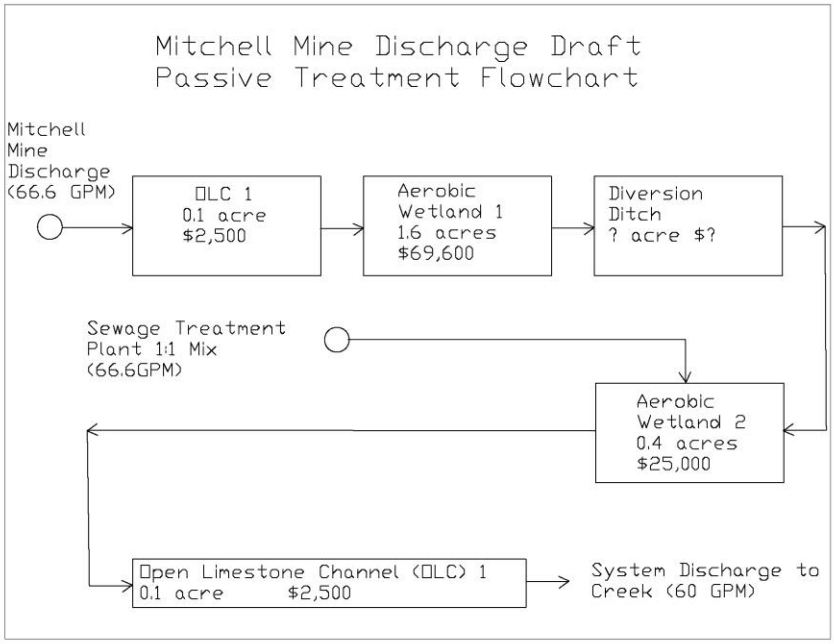

Figure 7 – Flow Chart of the Proposed Mitchell Mine Discharge Passive Treatment System.

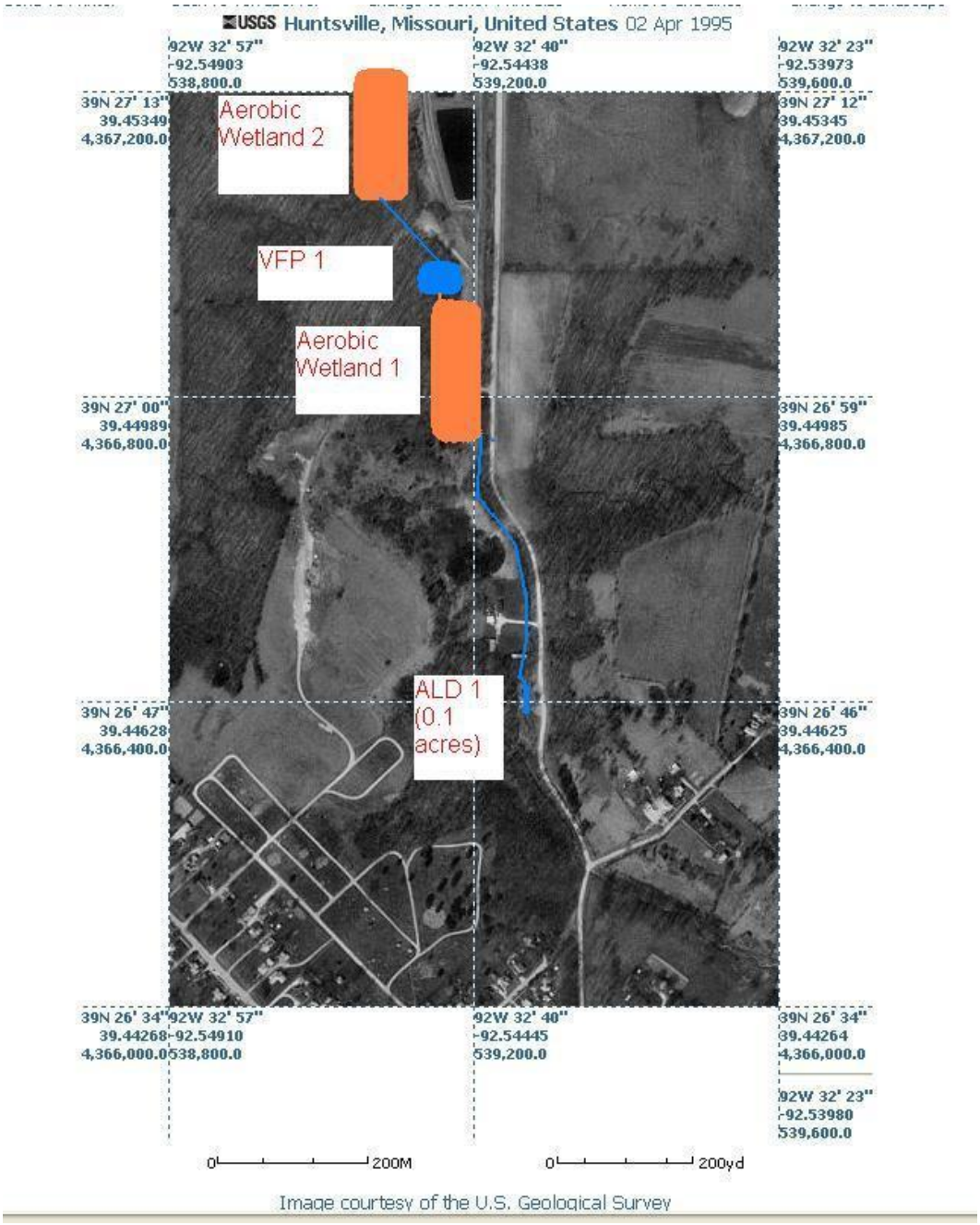

Image Source: TerraServer-USA (http://www.terraserver.microsoft.com/).

Figure 8 – Location Map for Calfee Slope Discharge Passive Treatment System: Southern Area.

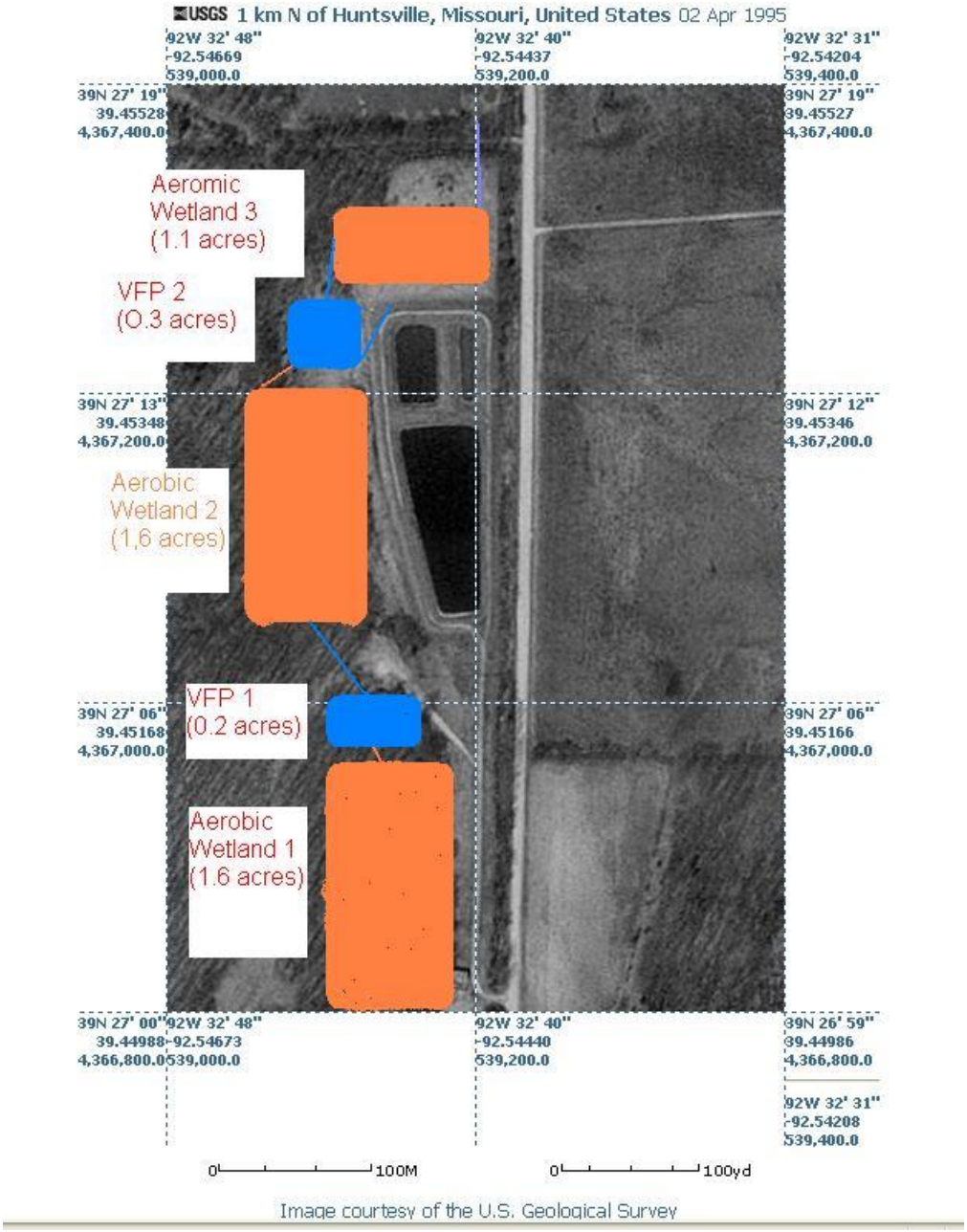

Figure 9 – Location Map for Calfee Slope Discharge Passive Treatment System: Northern Area.

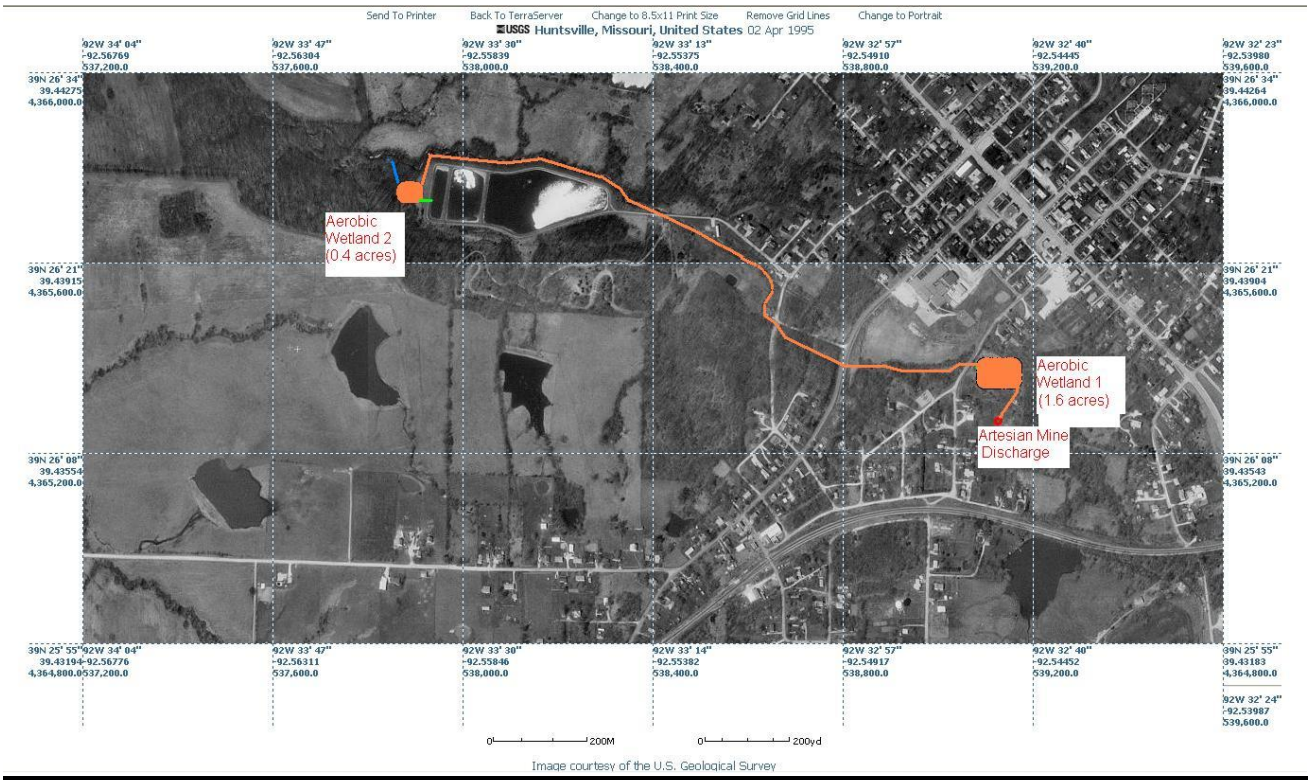

Image Source: TerraServer-USA (http://www.terraserver.microsoft.com/).

Figure 10 – Location Map for the Proposed Mitchell Mine Discharge Passive Treatment System.

References Cited

Christensen, E. D., 2005, Assessment, water-quality trends, and options for remediation of acidic drainage from abandoned coal mines near Huntsville, Missouri, 2003-2004, U.S. Geol. Survey, Scientific Investigations Report 2005-5202, 84 pp.

Means, Brent, Bob McKenzie, and Tiff Hilton, 2003, Computer-based model for estimating mine drainage treatment costs, *in* Proceedings of the 2003 National Meeting of the America Society of Mining and Reclamation and the 9th Billings Land Reclamation Symposium, Billings MT, June 3-6, 2003, published by AMSR, 3134 Montavesta Rd., Lexington, KY 40502.

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Abstract, hence there isn't a link to the original paper.
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