Interstate Mining Compact Commission

Benchmarking Workshop

"Developing A Defensible CHIA"

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Methods Used To Predict Postmine Water Quality

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Introduction

- CHIA Requirement (30 CFR §780.21, emphasis added)

(g) *Cumulative hydrologic impact assessment.*

(1) The regulatory authority shall provide an assessment of the probable cumulative hydrologic impacts (CHIA) of the proposed operation and all anticipated mining upon surface- and ground-water systems in the cumulative impact area. The CHIA shall be sufficient to determine… whether the proposed operation has been designed to prevent material damage to the hydrologic balance outside the permit area….

[almost verbatim from SMCRA, Section 507(b)(11)]

Scope

- Several methodologies available
- Won’t presume to know, let alone list, all of the various prediction methods in practice over past 30 years
- Two typical methods:
    1) Acid-Base Accounting (ABA)
    2) Chemical Mass Balance

Scope (cont.')

- Literature review

Kleinmann, Robert L. P., ed., 2000, *Prediction of Water Quality at Surface Coal Mines*, Acid Drainage Technology Initiative (ADTI), pub. by the National Mine Land Reclamation Center, West Virginia University, 241p.

Brady, Keith B. C., Smith, Michael W. and Scheuck, Joseph, eds., 1998, *Coal Mine Drainage Prediction and Pollution Prevention in Pennsylvania*, Pennsylvania Department of Environmental Protection.

Acid-Base Accounting

Net Neutralization Potential (NNP) =
Neutralization Potential (NP) –
Maximum Potential Acidity (MPA)

- NNP (sometimes referred to as the acid-base balance) is the net result of balancing the acid producers against the acid neutralizers in the overburden.

Acid-Base Accounting

- tons ($CaCO_3$ eq.)/1000 tons OB
- A variety of methods have been used to determine acid potential (MPA)
- NP can be somewhat subjective due to necessity of fizz rating -> need to standardize as best as possible
- Account for carbonates that do not contribute to alkalinity

Acid-Base Accounting

Evaluation, by individual mine, considering:

- overburden geology
  - sulfur forms (LECO analyzer)
  - OB strata/mineralogy (LS, siderite, ?)
- local hydrology
  - nearby minespoil aquifers
  - premining water quality (incl. adj. mines)
- mining method proposed
  - special handling proposed?

Acid-Base Accounting

General accepted guideline for defining strata as acid or alkaline

(from Skousen and others, in Kleinmann, R.L.P., 2000)

	Acid Tons/ 1000 Tons	Undetermined Tons/ 1000 Tons	Alkaline Tons/ 1000 Tons
NP	< 10	10 - 21	> 21
NNP	< 0	0 - 12	> 12

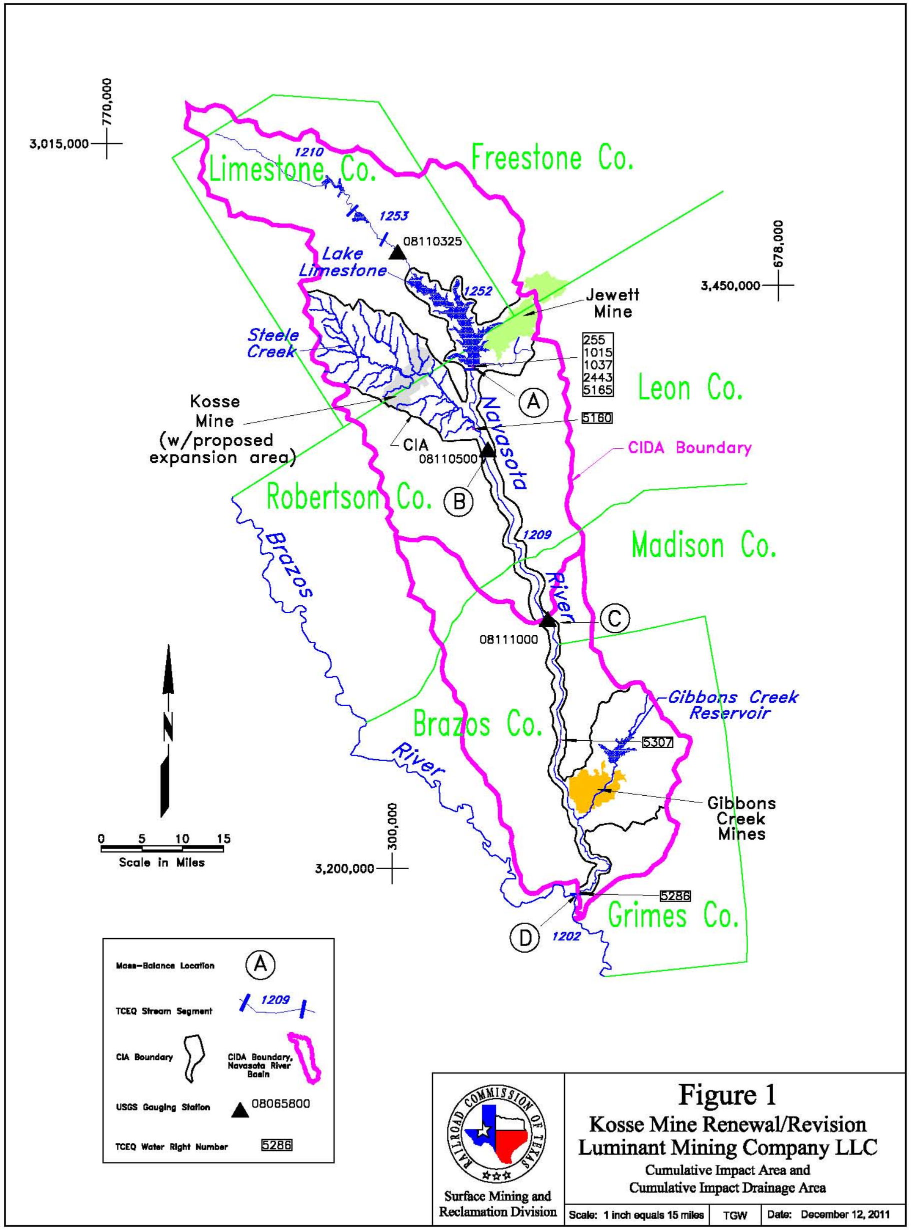
Acid-Base Accounting

Decision Matrix For Acid Drainage Potential - Pennsylvania

(after Brady and Hornberger, 1977)

	Low S	High S
Low NP	Evaluate Additional Data	Probable Denial
High NP	Probable Issuance	Possible Issuance or Denial

Mass Balance on TDS



Mass Balance on TDS

Table 3. Surface-Water Mass-Balance Estimate, Navasota River Basin

Location	Mine(s)	A_t, Total Drainage Area	B, Annual Unit Discharge (Runoff)	A_1, Unmined Drainage Area	Q_1, Average Annual Discharge Volume, Unmined Area	C_1, Average TDS, Runoff from Unmined Areas	A_2, Mined Drainage Area	Q_2, Average Annual Discharge Volume, from Spoils	C_2, Median TDS, Spoils-Area Water	Q_3, Average Annual Runoff Volume from Disturbed Areas	C_3, Average TDS of Mined-Area Surface Runoff	S, Average TDS at Mass-Balance Location	S-C_1, Change in TDS at Mass-Balance Location
End of Stream Segment No. 1252 at Lake Limestone	Jewett Mine	432,000	0.55	417,763	229,770	155	14,237	3,915	970	3,915	56	167	12
USGS Station Nos. 08110500 on the Navasota River downstream of Confluence with Steele Creek	Jewett and Kosse Mines	597,237	0.51	567,533	289,442	155	29,704	7,575	1,170	7,575	56	178	23
USGS 08111000 on the Navasota River near Bryan, TX	Jewett and Kosse Mines	917,366	0.65	887,662	576,980	132	29,704	9,654	1,170	9,654	56	148	16
End of Stream Segment No. 1209 at the Confluence of the Navasota River and the Brazos River	Jewett, Kosse, and Gibbons Creek Mines	1,437,270	0.56	1,397,321	782,500	421	39,949	11,186	1,170	11,186	56	426	5

Mass Balance on TDS

Table 2. Uses and Criteria, Navasota River Basin Stream Segment Standards

Segment No.	Segment Name	USES				CRITERIA						
		Recreation	Aquatic Life	Domestic Water Supply	Other	[1]Chloride, mg/L [Annual average not to exceed]	[1]Sulfate, mg/L [Annual average not to exceed]	[1]Total Dissolved Solids, mg/L [Annual average not to exceed]	[1]Dissolved Oxygen, mg/L	[1]pH Range, standard units	*E.Coli* /Fecal Coliform count/100 ml [30-day geometric mean not to exceed]	Temperature, ºF [not to exceed]
1210	Lake Mexia	CR	H	PS	--	100	50	400	5	6.0 - 9.0	126/200	91
1253	Navasota River Below Lake Mexia	CR	H	PS	--	440	150	1,350	5	6.5 - 9.0	126/200	93
1252	Lake Limestone	CR	H	PS	--	50	50	300	5	6.5 - 9.0	126/200	90
1209	Navasota River Below Lake Limestone	CR	H	PS	--	140	100	600	5	6.5 - 9.0	126/200	93

Regional Differences

- Mining methods
  - Surface
    - special categories e.g., MTM/VF
    - scale
    - special handling techniques
  - Underground
    - room and pillar, longwall
- Geology
  - Overburden
    - consolidated
    - unconsolidated
  - Coal rank

Regional Differences

- Hydrology
  - Climate
    - Class: Semiarid, Continental, Subtropical, Subarctic (Alaska)
    - Rainfall: Volume, Frequency
  - OB characteristics
    - stratigraphic continuity
    - structure, fracturing
  - Aquifer characteristics
    - hydraulic conductivity
    - confined, unconfined

Conclusions/Food for Thought

- Prediction of postmining water quality requires a thorough understanding of the geologic/hydrologic system for an accurate estimate; usually at more than one scale.
- Current approaches to prediction are robust and satisfactory.
- “Stream Protection Rule” will likely create an entirely new scenario in postmine water-quality prediction.
  - Mass balances for multiple parameters
  - Development of material-damage criteria for those parameters
  - Consider effects “during all phases of mining and reclamation and at all times of the year” and “variations in the amount and concentration of parameters of concern in discharges” → a change in scale of the CHIA analysis.