KY PEM 2021

Improving Subsurface Ventilation Efficiency

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Project Overview

- Multi-level, underground limestone operation
- Scope of Work:
  - Define the current ventilation circuit
  - Identify cost-reduction practices with the current ventilation
  - Provide suggestions for future ventilation requirements
- Operation Details:
  - 600,000 – 700,000 tons/yr of limestone production
  - 2 active mining levels
    - The lower level is accessed by a decline from the upper level
  - 18 ventilation fans on site
    - Primary ventilation provided by Three 8-ft diameter Jeffrey vane-axial fans

Conducting the Study

- Ventilation study conducted with the following tools:
  - Laser distance measurer – measures entry height and width
  - Sling psychrometer – measures air humidity
  - Vane anemometer/Smoke tube – measure airflow velocity
  - Altimeters – measures elevation to determine the air column

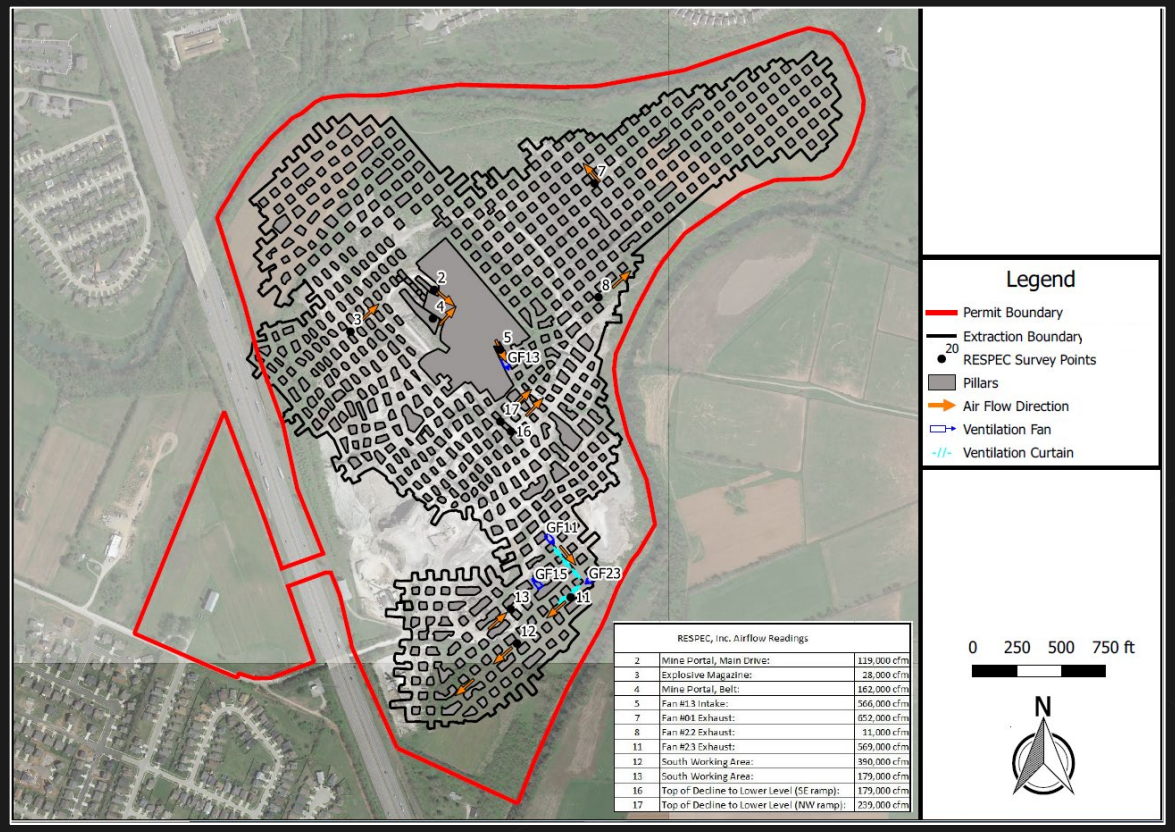
Velocity	Observable Characteristics	Recommended Tool
Less than 50 fpm	Airflow direction is difficult to discern. May feel as if there is no air movement within the drift. Air may be moving in two directions within the drift.	Smoke Tube 
50 to 100 fpm	Airflow direction may be somewhat apparent. Difficult to tell how much air is flowing by.	Smoke Tube or Anemometer
Greater than 100 fpm	Direction and flow is certain and measurable.	Vane Anemometer 

fpm = feet per minute.

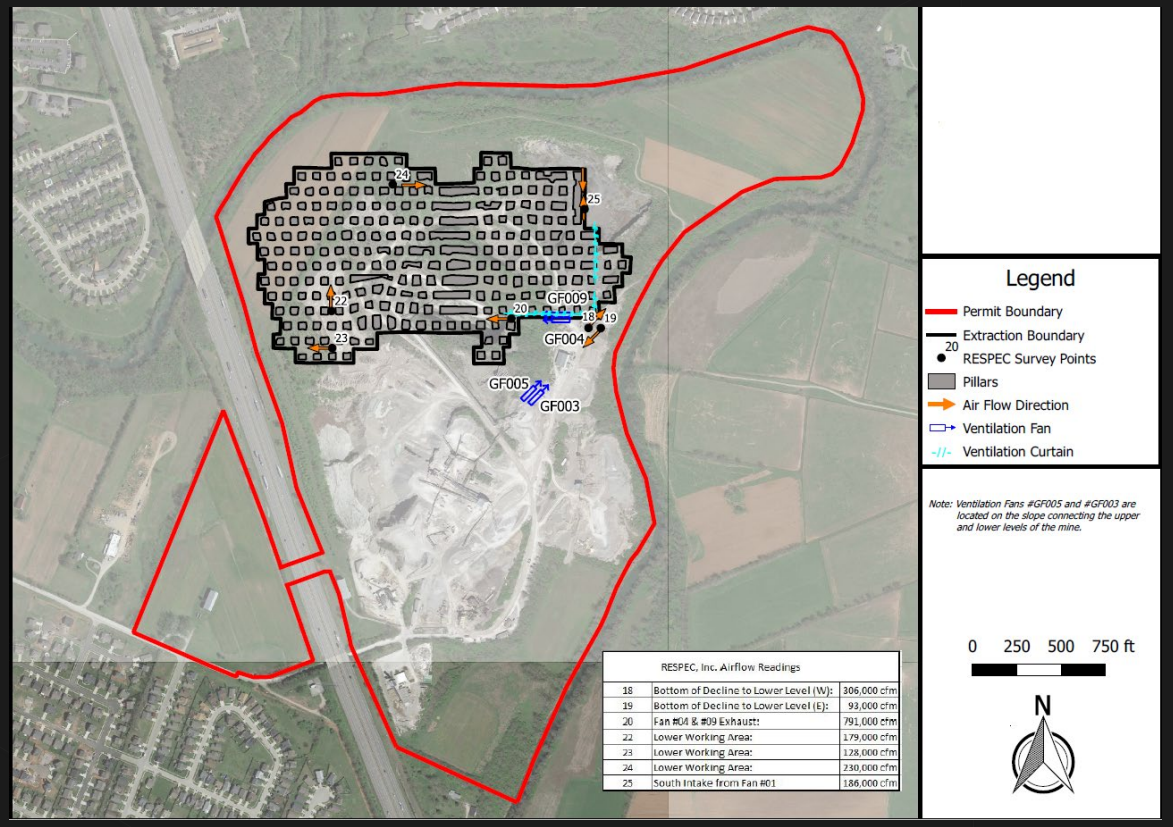
Note that both recommended tools require a correction factor for velocity readings at the low end of their respective ranges. Refer to the manufacturer documentations for applying the appropriate correction factors.

Survey Locations

Upper Level

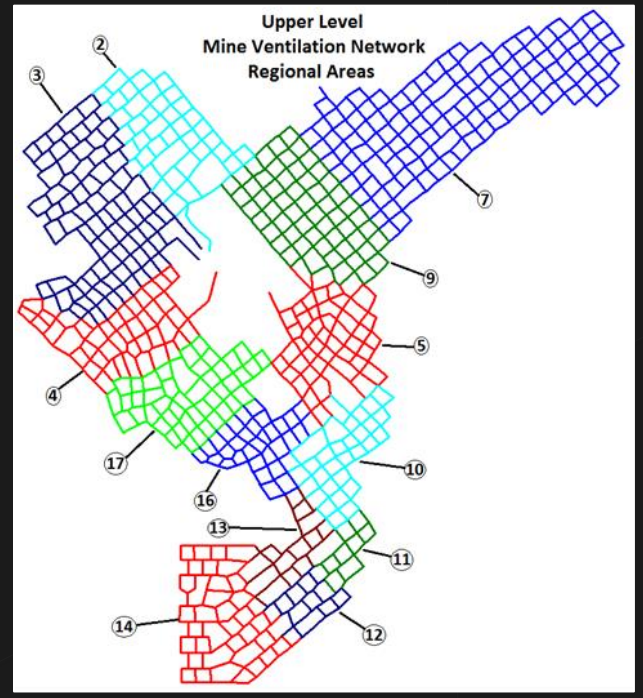


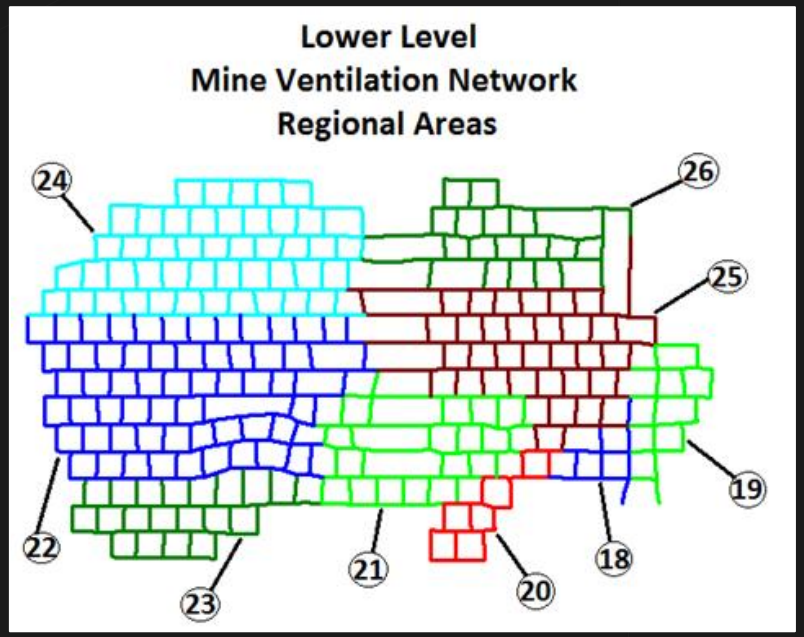
Lower Level



Creating the Ventilation Model

- A ventilation model of the operation was created using the VNet software
  - Differently numbered/colored regions represent "regions" of the mine workings that use a unique height, width, and airflow friction factor within the model
  - Fan performance characteristics were applied using operating and fan-curve data

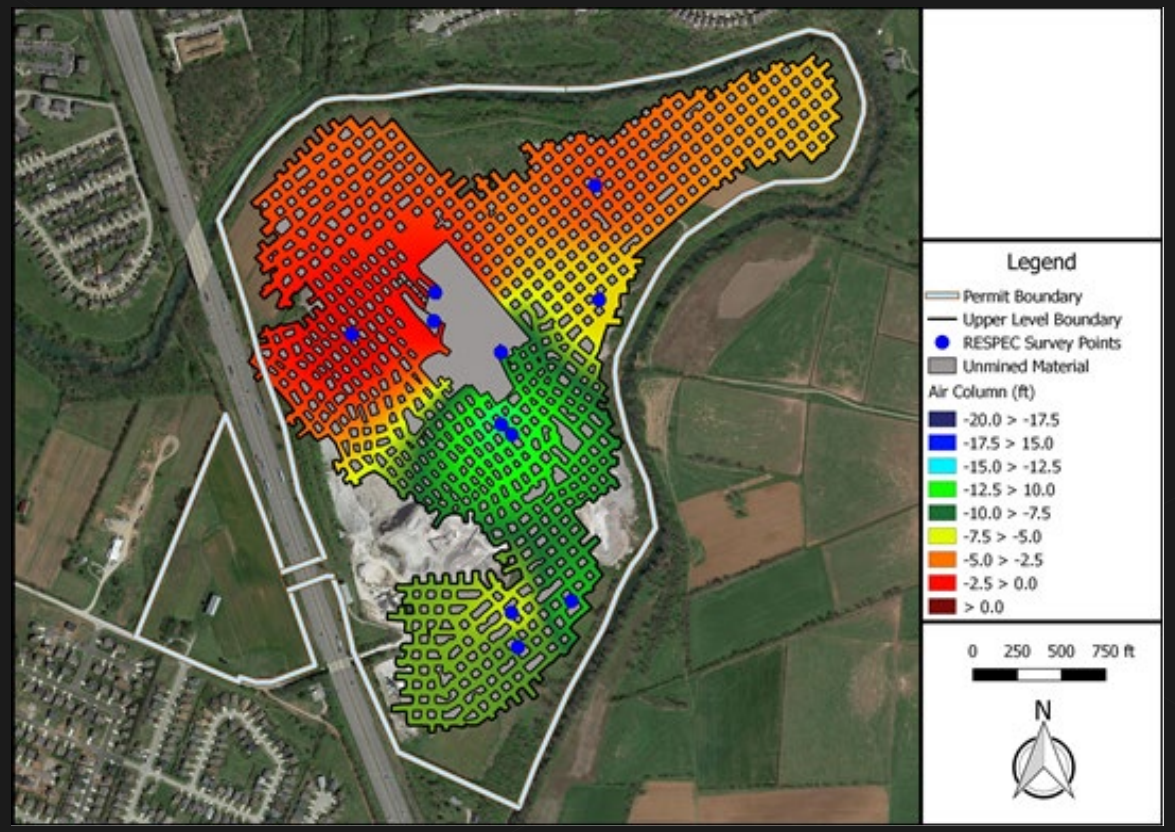




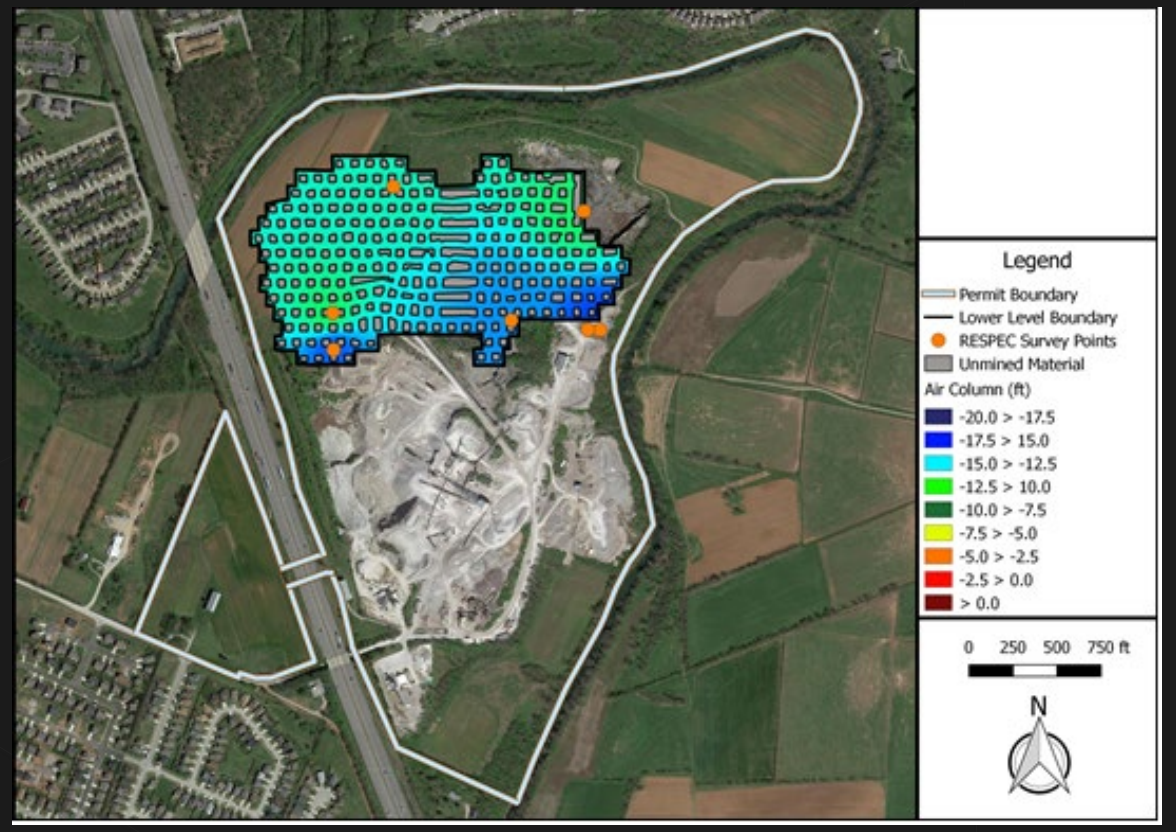
Air Column

- Where air column differences are greater (bluer), air is more likely to natural flow there

Upper Level



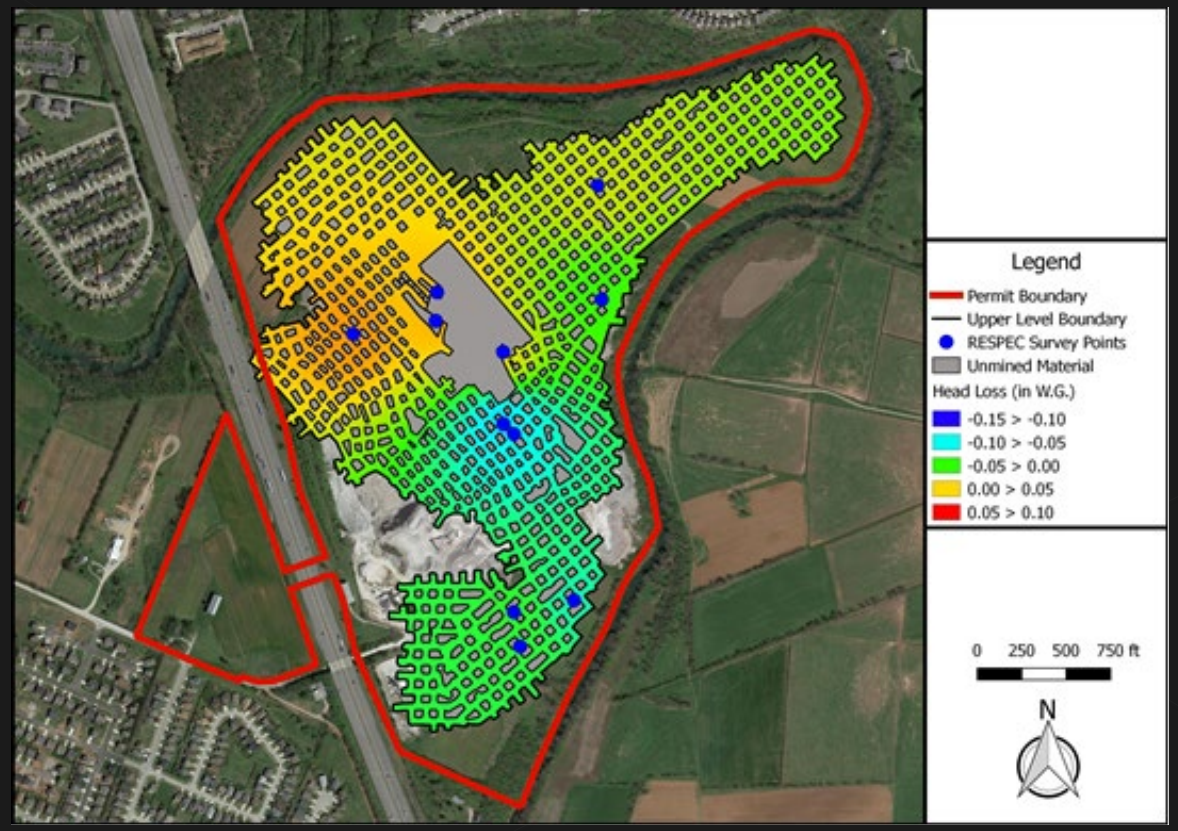
Lower Level



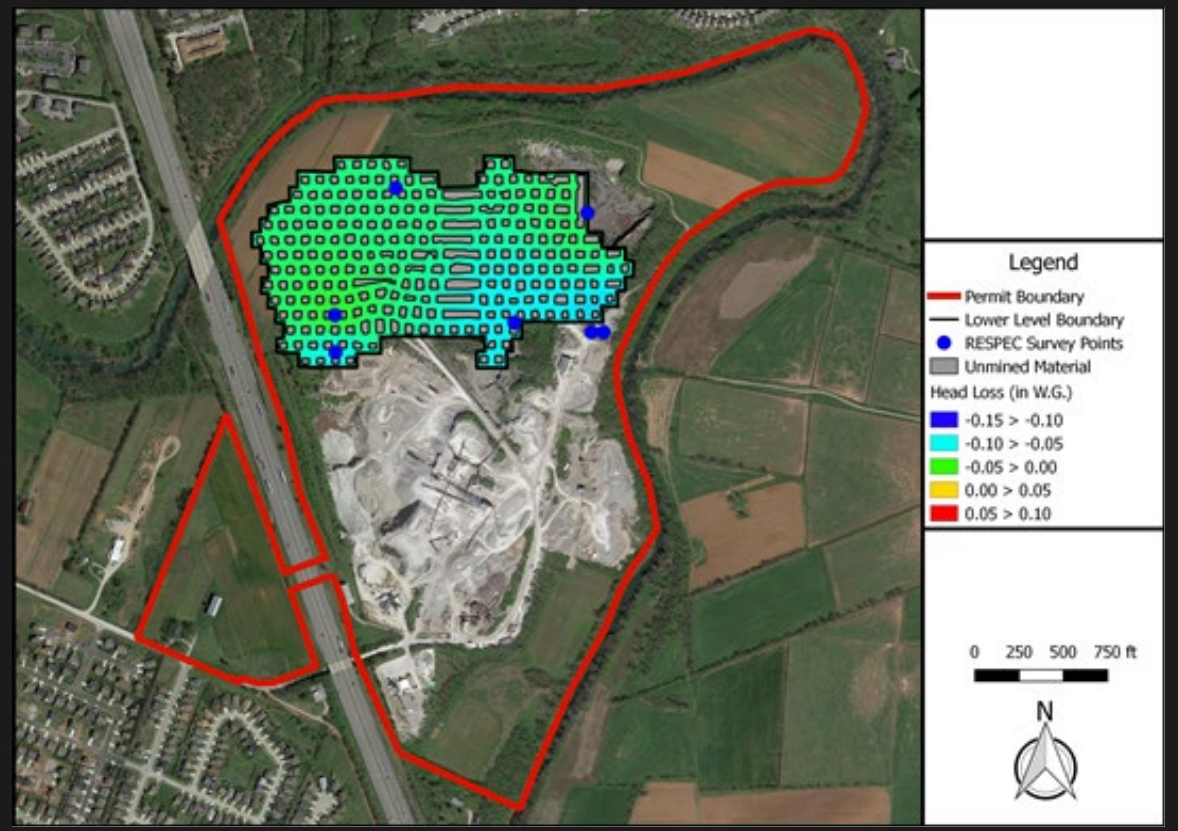
Head Loss

- Natural air flows will flow from higher pressure (red) to lower pressure (blue)

Upper Level



Lower Level



Current Opportunities to Improve Ventilation Effic

- Lower Cost
  - Hanging ventilation curtains
  - Operate one mining level at a time
  - Ensure proper use of booster fans
  - Open an airway for the south working area on the upper level

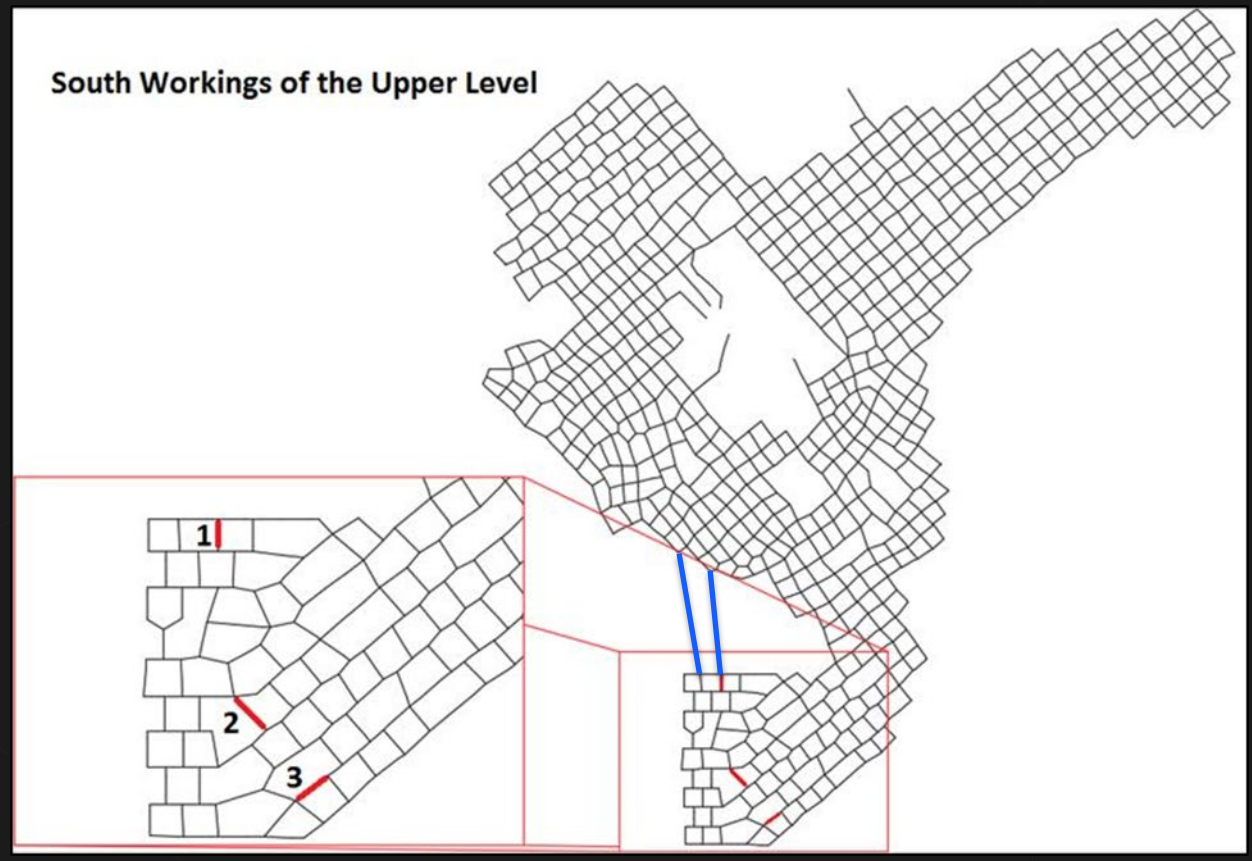
- Higher Cost
  - Install permanent stoppings/ventilation walls
  - Increase mine shaft diameter that connects the upper and lower level

Lower-Cost Approaches

- Hanging ventilation curtains
  - Used to channel air to different areas of the mine
  - Help prevent the recirculation of air.
  - Allow workers or equipment to pass through
- Operating one mining level at a time
  - Reduces the ventilation requirement for the entire mine
  - Can focus ventilation efforts

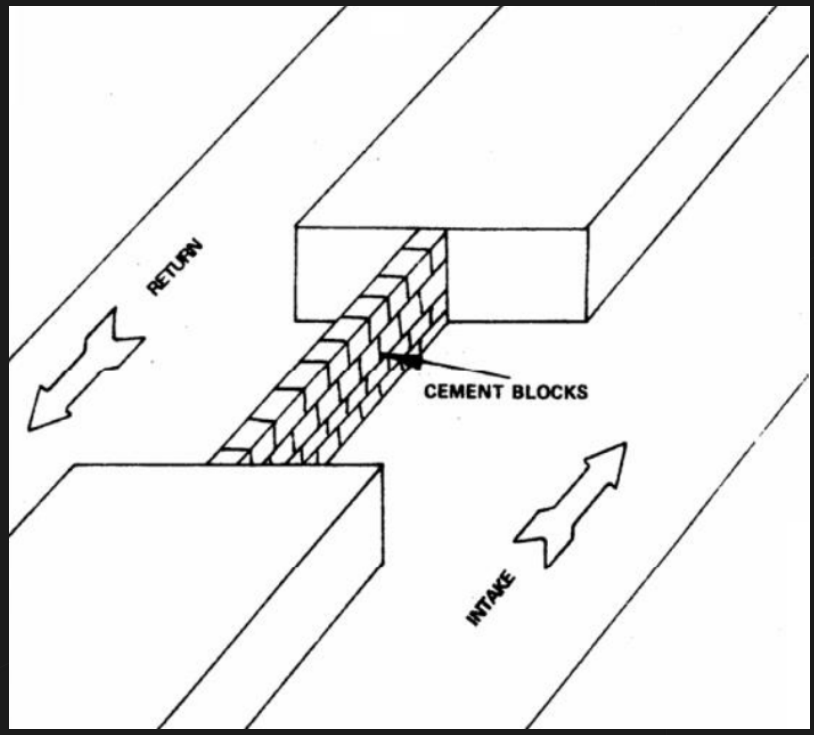
Lower-Cost Approaches Cont.

- Ensure proper booster fan location
  - Common practice of large-opening underground mines
  - Localized ventilation of the working area.
  - Should be in the direct intake air outside of the last open crosscut to allow directing of fresh air to the working face.
- Open airways to allow the circular flow of air
  - On the upper level of the operation, the southern working area has been worked into a bottleneck.
  - Additional airways allow the ventilation to flow in a circular direction, reducing recirculation and cross-contamination of the airflow



Higher-Cost Approaches

- Install permanent stoppings/ventilation walls
  - Can be installed in the same locations as ventilation curtains.
  - More expensive and prevent travel through the opening
  - Less airflow leakage and improve ventilation efficiency
- Increase mine shaft diameter that connects the upper and lower level
  - Is expected to increase the airflow quantities entering and leaving the mine
  - May not address the problem of directing air to the working areas.

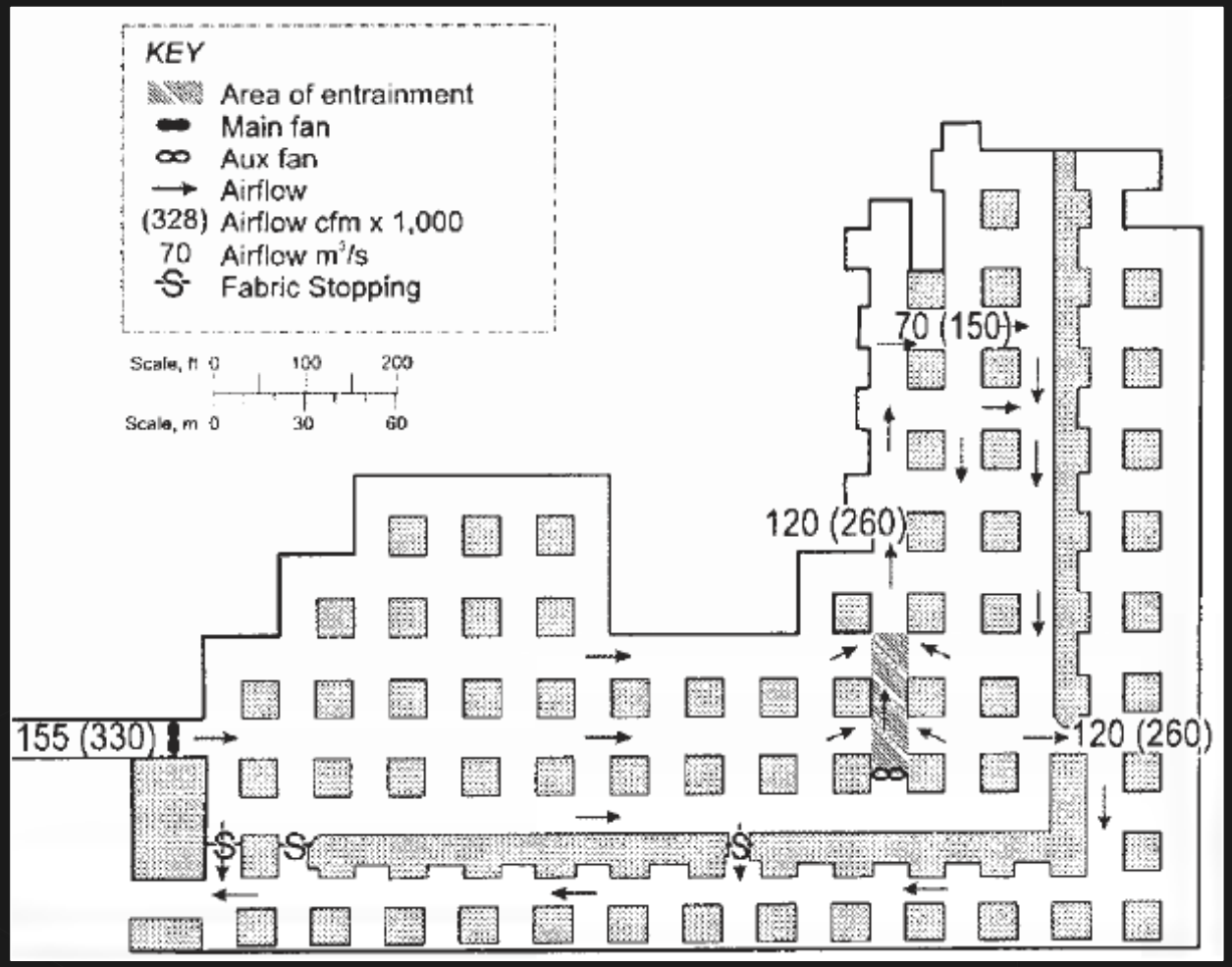


Future Opportunities to Improve Ventilation Effici

- The future opportunities identified include:
  - Leaving barrier pillars
  - Leaving low brows
  - Evaluating and using the appropriate primary main ventilation fans

Future Opportunities Cont.

- Barrier pillars are long rectangular pillars used to direct ventilation.
  - Often used in underground coal mines,
  - Occur where crosscuts have been purposefully not mined through.
  - Can often be mined later when they are no longer needed to direct airflow.



Future Opportunities Cont.

- Low Brows are crosscuts that are purposely mined at a lower height than the primary heading height.
  - Similar in nature to barrier pillars
  - Ventilation efficiency can be further improved if waste material is placed in the mined-out area where low brows occur
- When selecting the primary ventilation fan(s), there is no one size fits all approach.
  - High-pressure, vane-axial fans like the Jeffrey fans perform differently than low-pressure propeller fans
  - Vane-axial fans are better suited for small-opening underground mine (i.e. coal mines)
  - Low-pressure propeller fans used to ventilate large-opening mines are better suited for underground limestone operations

Questions?