



In-rush Protection and Water Management

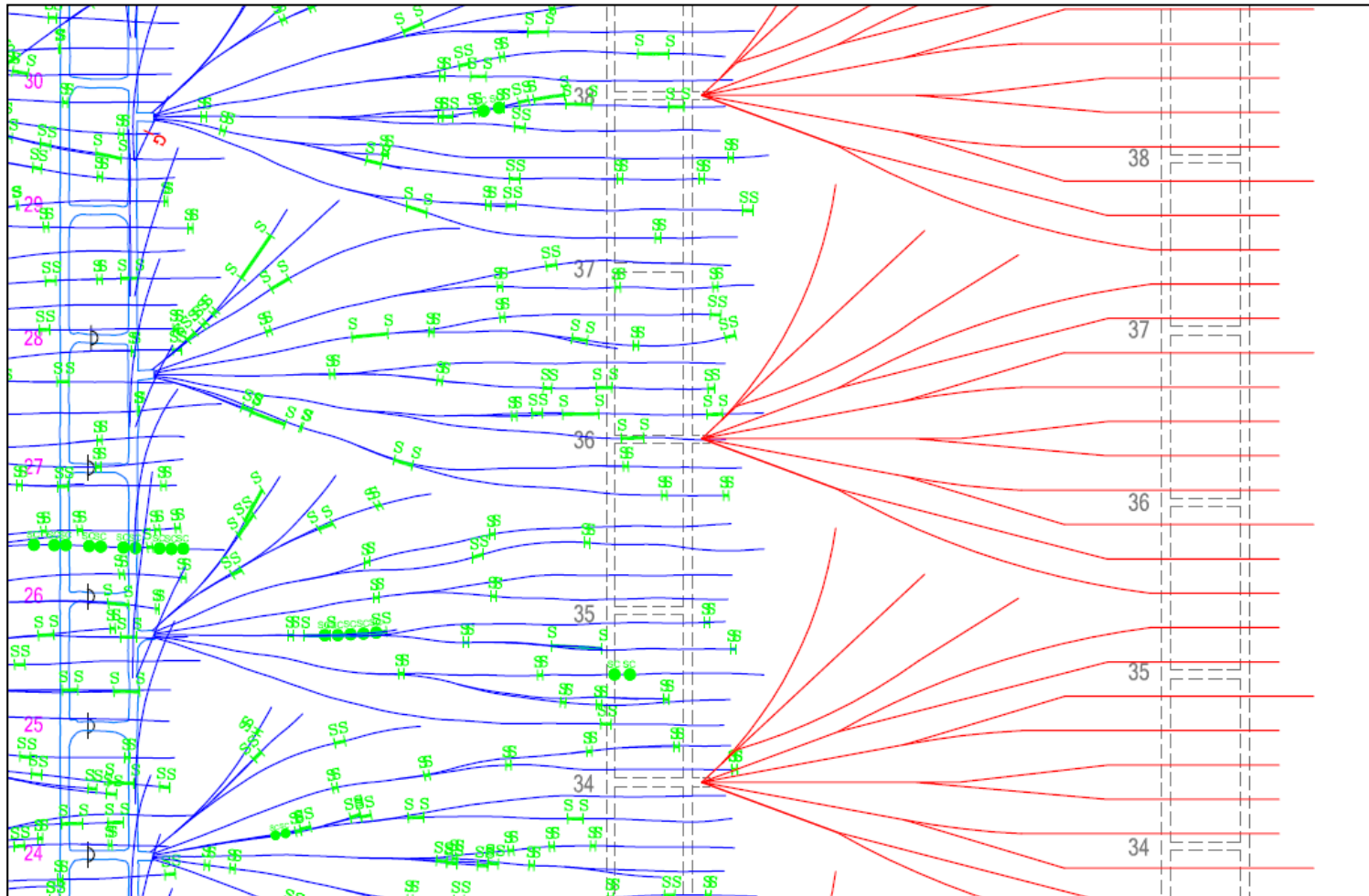
F Hungerford, T Ren

International Workshop on Mine Hazard
Prevention and Control, 19-20 Nov 2013

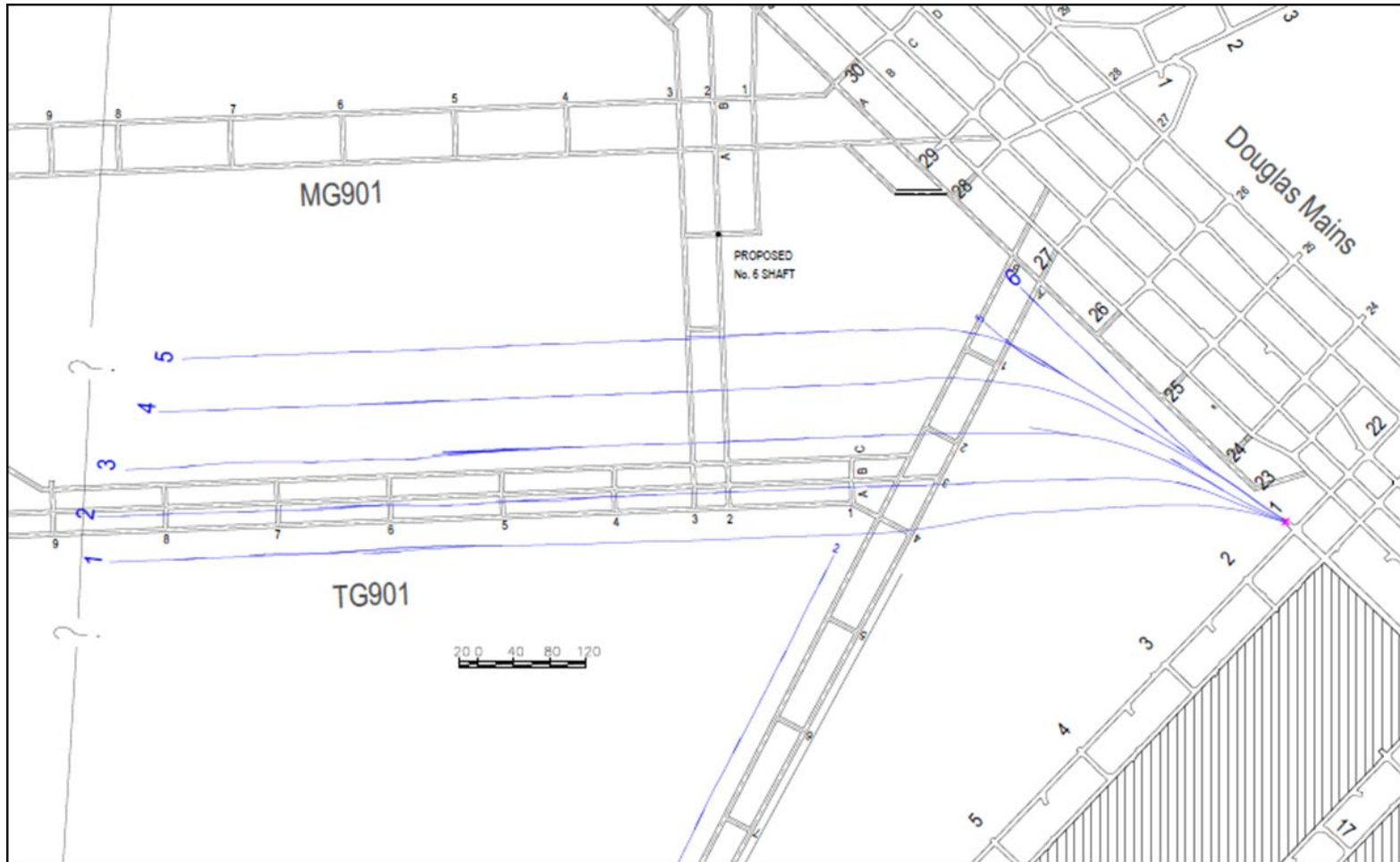
Directional Drilling for Gas Drainage

- **Directional Drilling developed in Australia in the mid 1980's for the requirements of gas drainage but initially limited by the survey systems available.**
- **Development of in-hole electronic survey instruments solved the surveying problems.**
- **Requirement for accurately placed boreholes and verified locations dictated that directional drilling become the industry standard.**

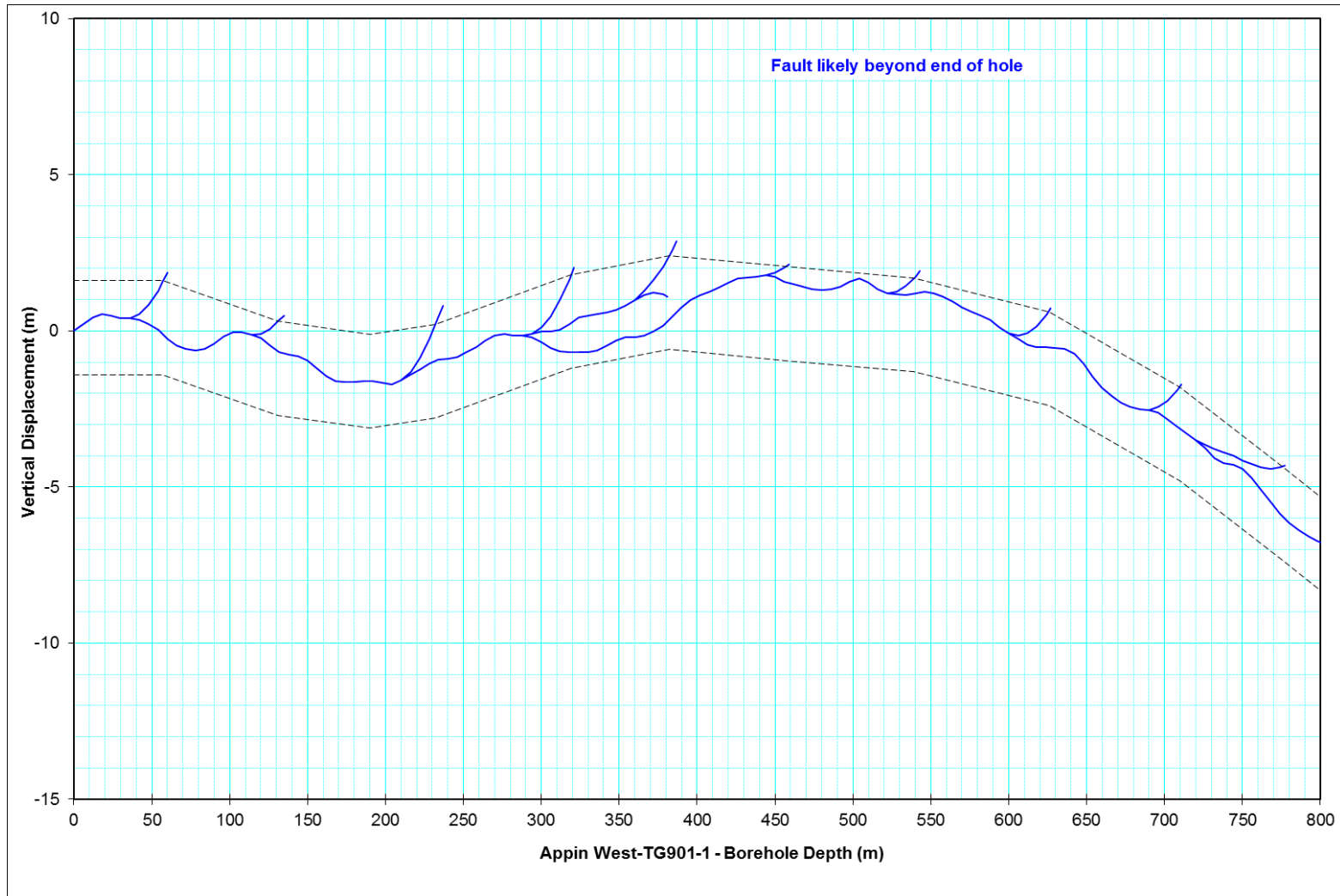
Directional Drilling Gas Drainage Layouts



Accurate Location of Long In-seam Boreholes



Gas Drainage and Exploration Drilling

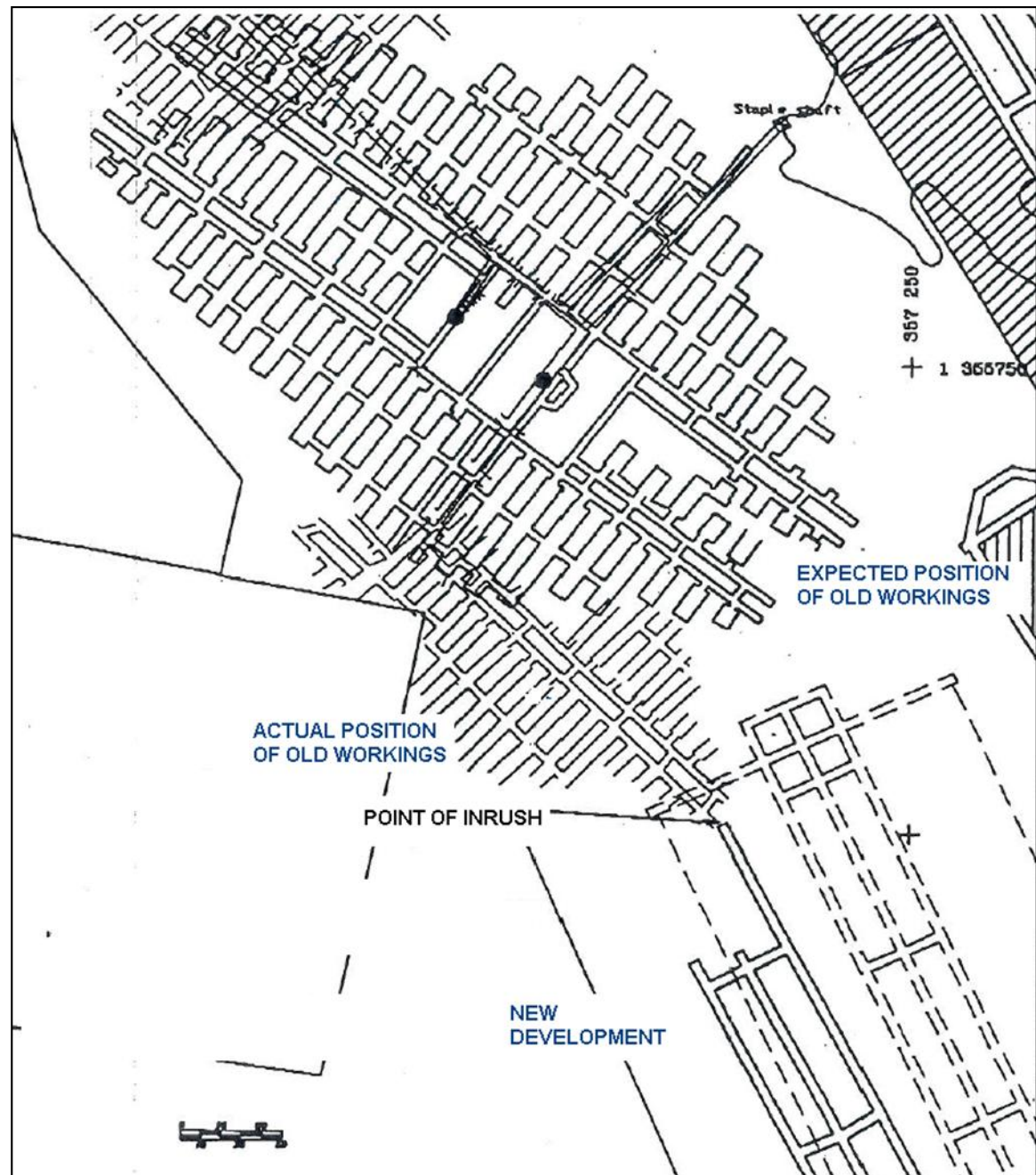


In-rush Event

- **In 1996, an inrush occurred at an Australian coal mine.**
- **The mine was developing towards known old workings likely to be filled with water.**
- **The location of the old workings was defined by old mine plans.**
- **A high pressure inrush occurred, pushing the 35 tonne continuous miner back.**
- **4 men working at the face did not survive.**

In-rush Event

- Old mine flooded
- Incorrect location displayed on plans
- Development mining intersected flooded old mine



Key Elements

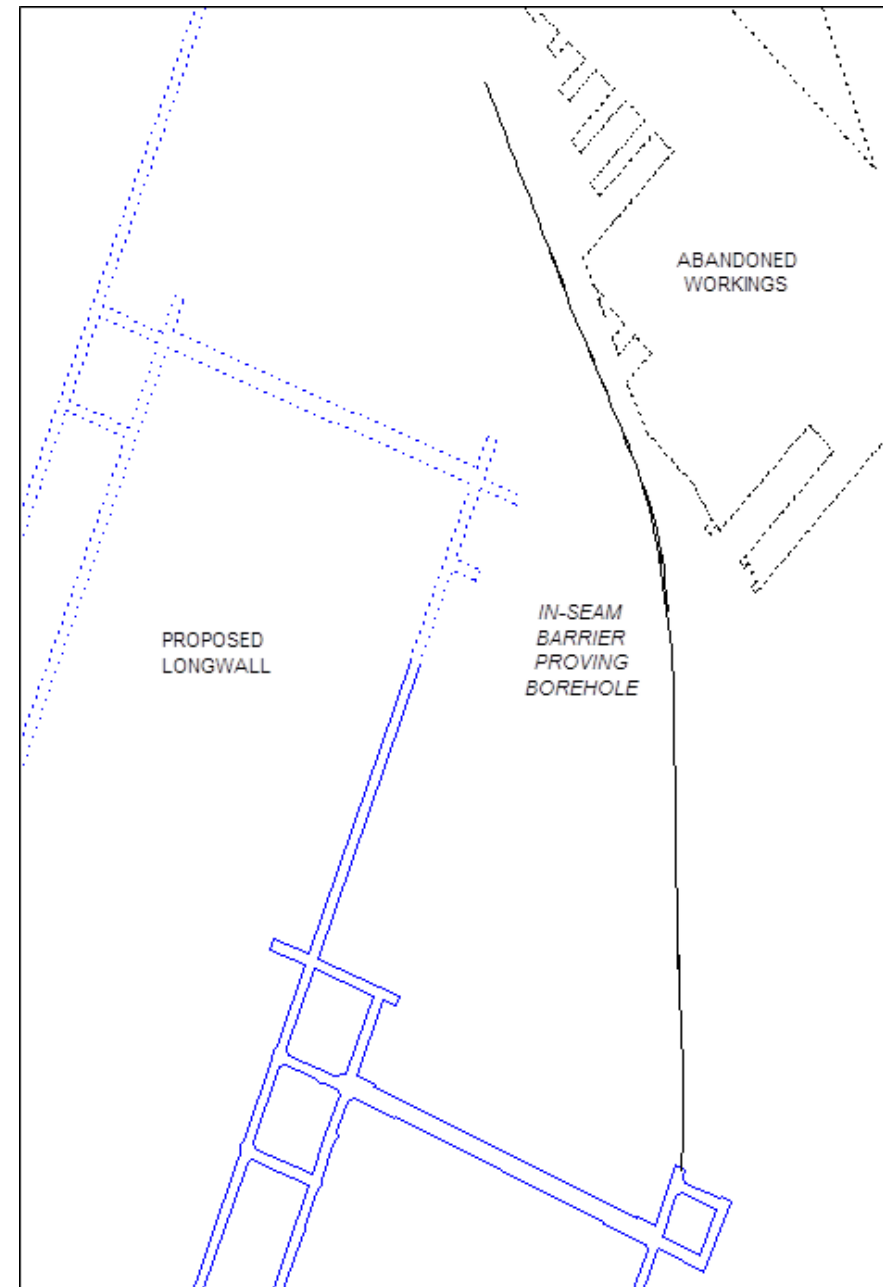
- **The plan showing the old workings was incorrect. The old workings were closer to the development than expected.**
- **Shafts connecting the old workings to the surface were full of water, thus increasing the water pressure substantially.**

Effects

- **The incident highlighted the dangers and adverse effects of inrush.**
- **Legislation was introduced requiring mines to ensure such an event is not repeated.**
- **Mines want to avoid injury to workers, potential damage to equipment and delays to production.**
- **Underground coal mines now conduct drilling programs ahead of development if old workings or structures are suspected.**

Inrush Protection

- **In-seam barrier proving borehole**

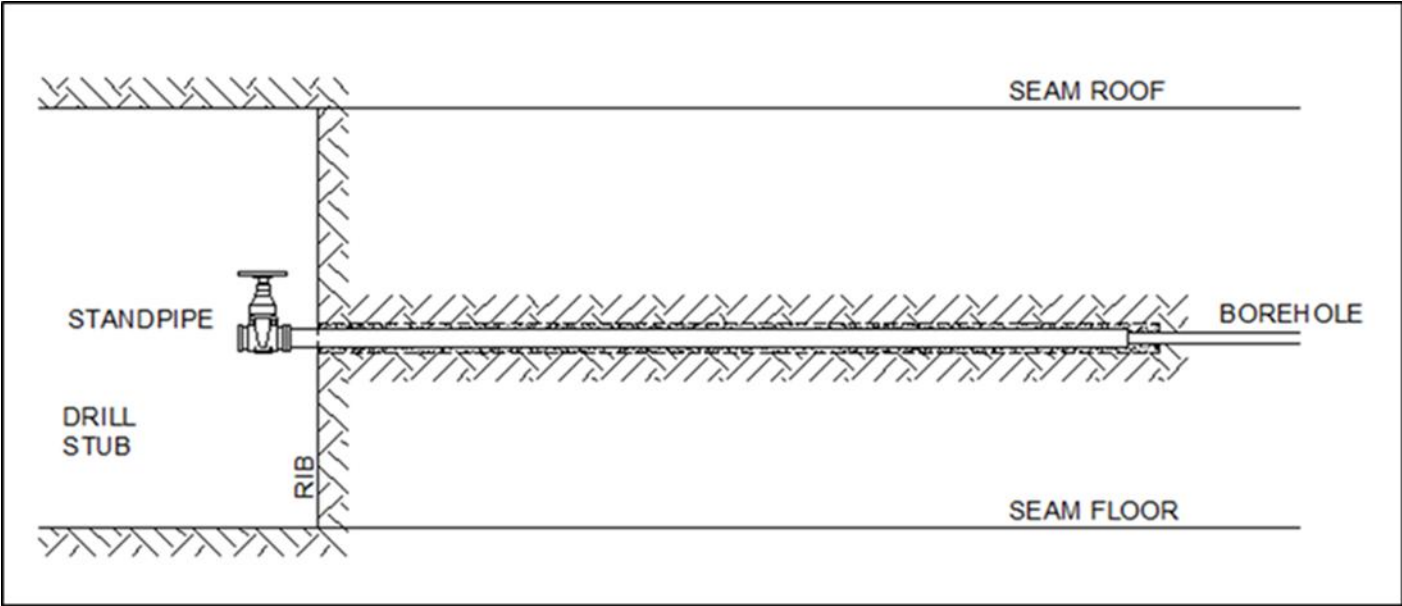




Drill Rig

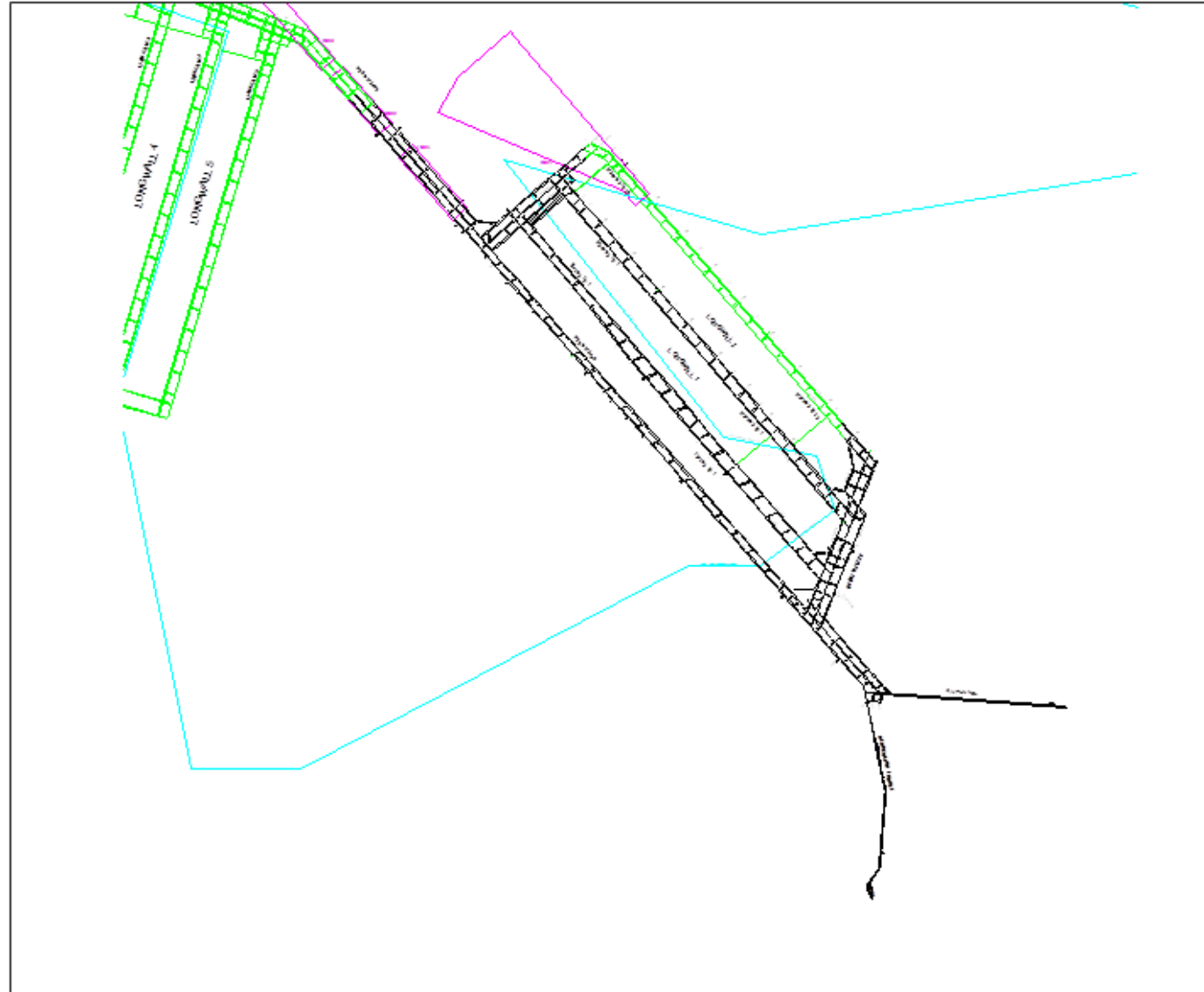


Standpiping



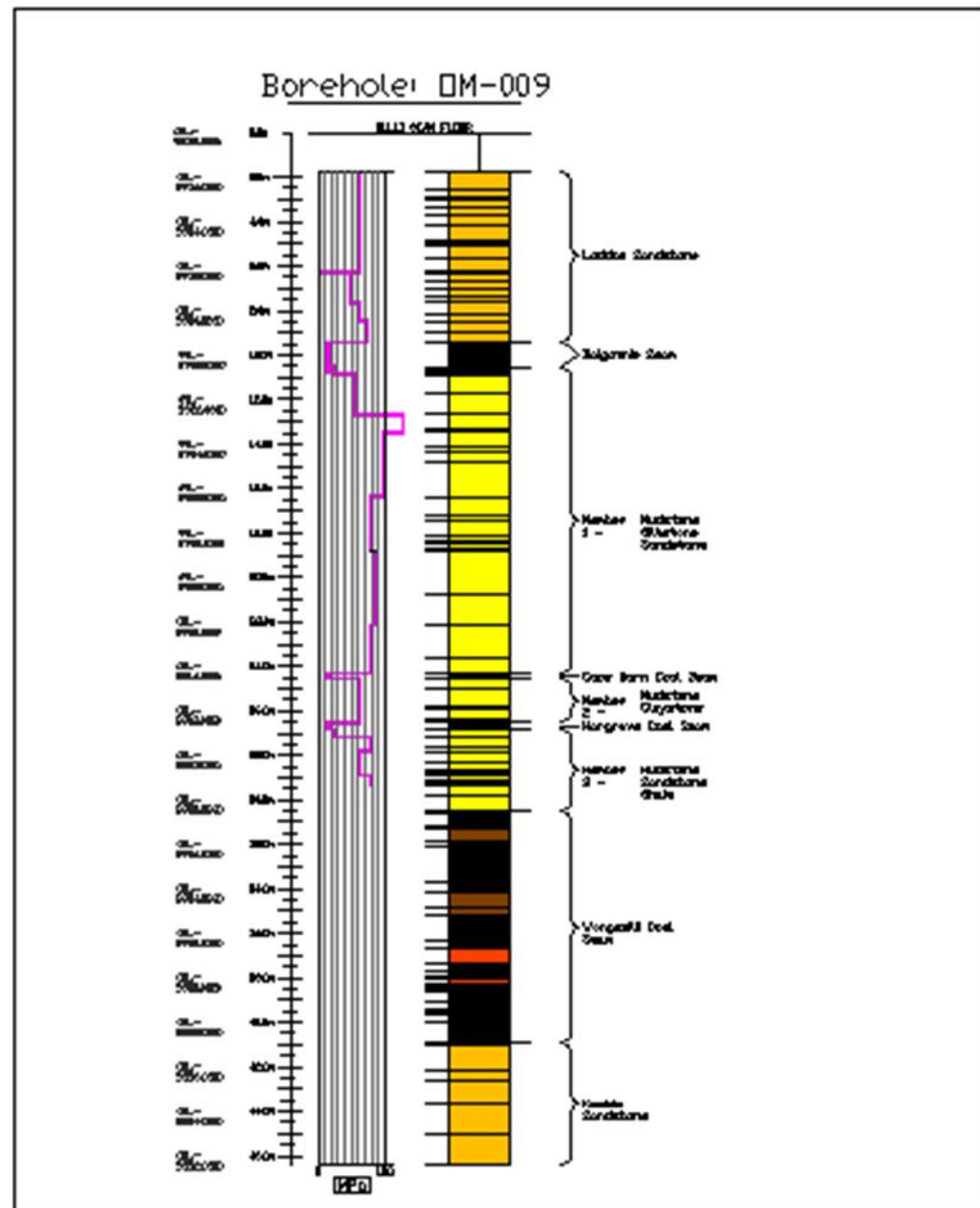
Inrush Protection

- **Mine plan without local features**



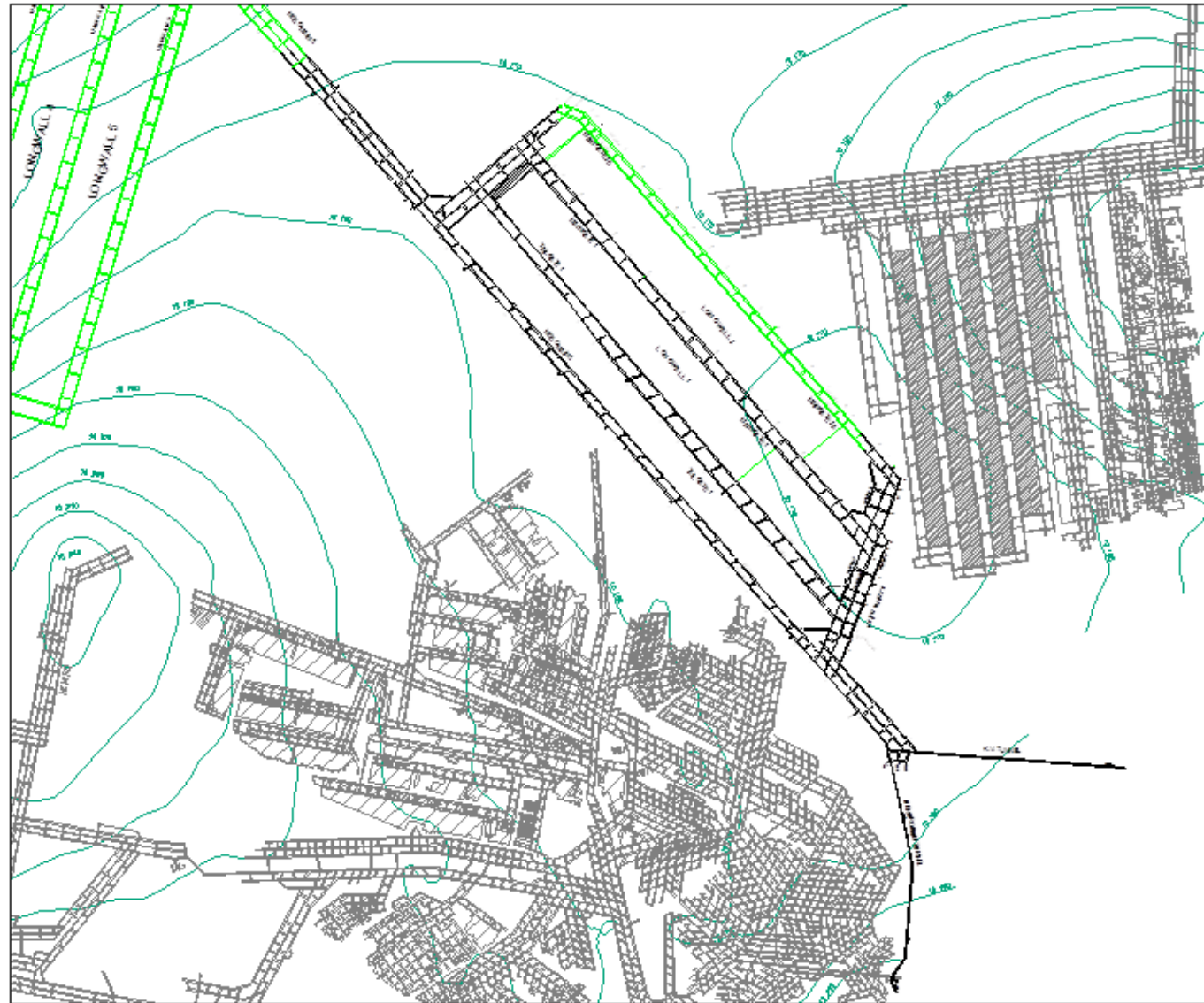
Vertical Section

- Adjacent workings in same mining section at bottom of the Wongawilli seam
- Overlying workings in the Bulli seam



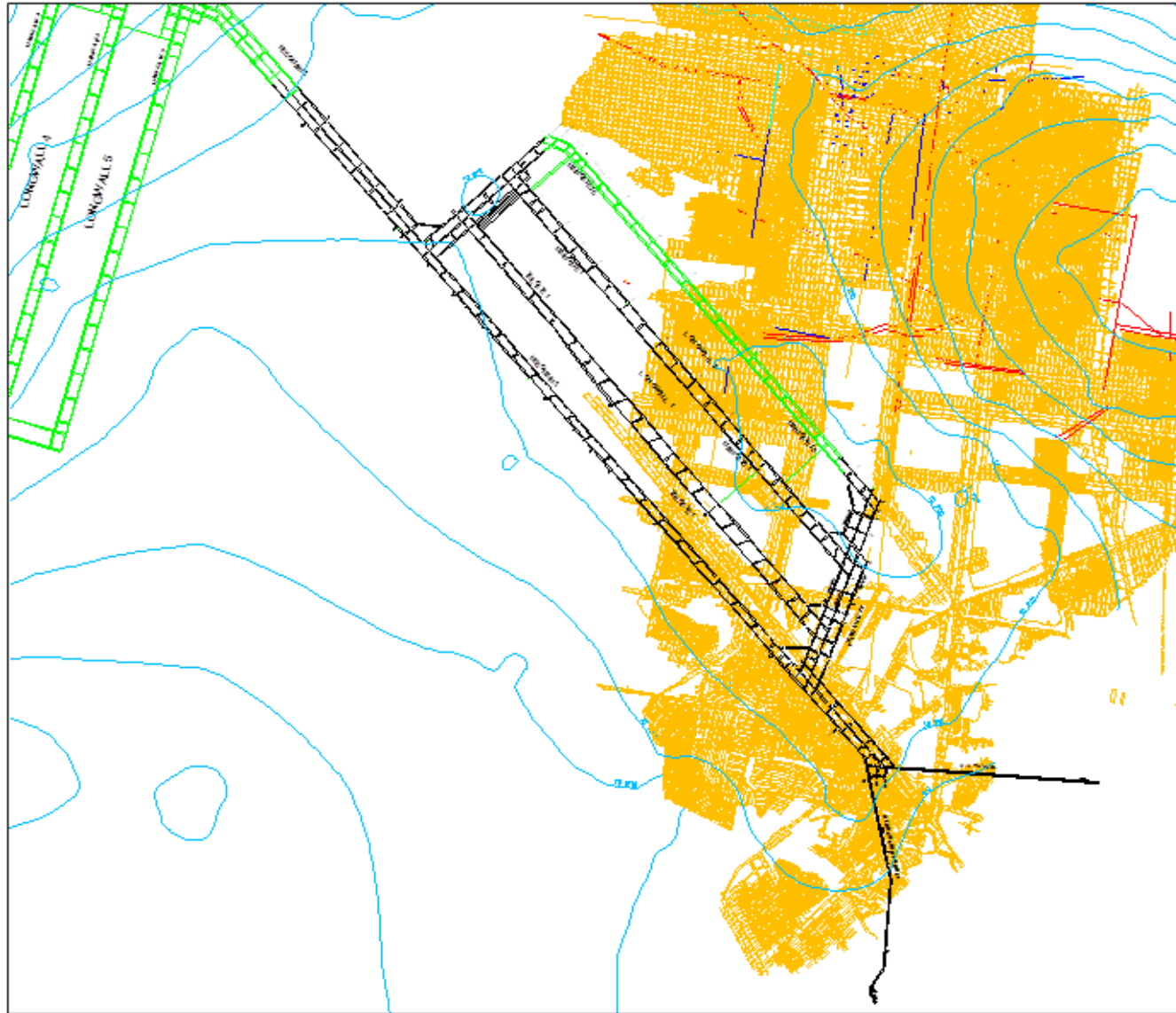
Inrush Protection

- **Mine plan with adjacent in-seam workings (flooded)**



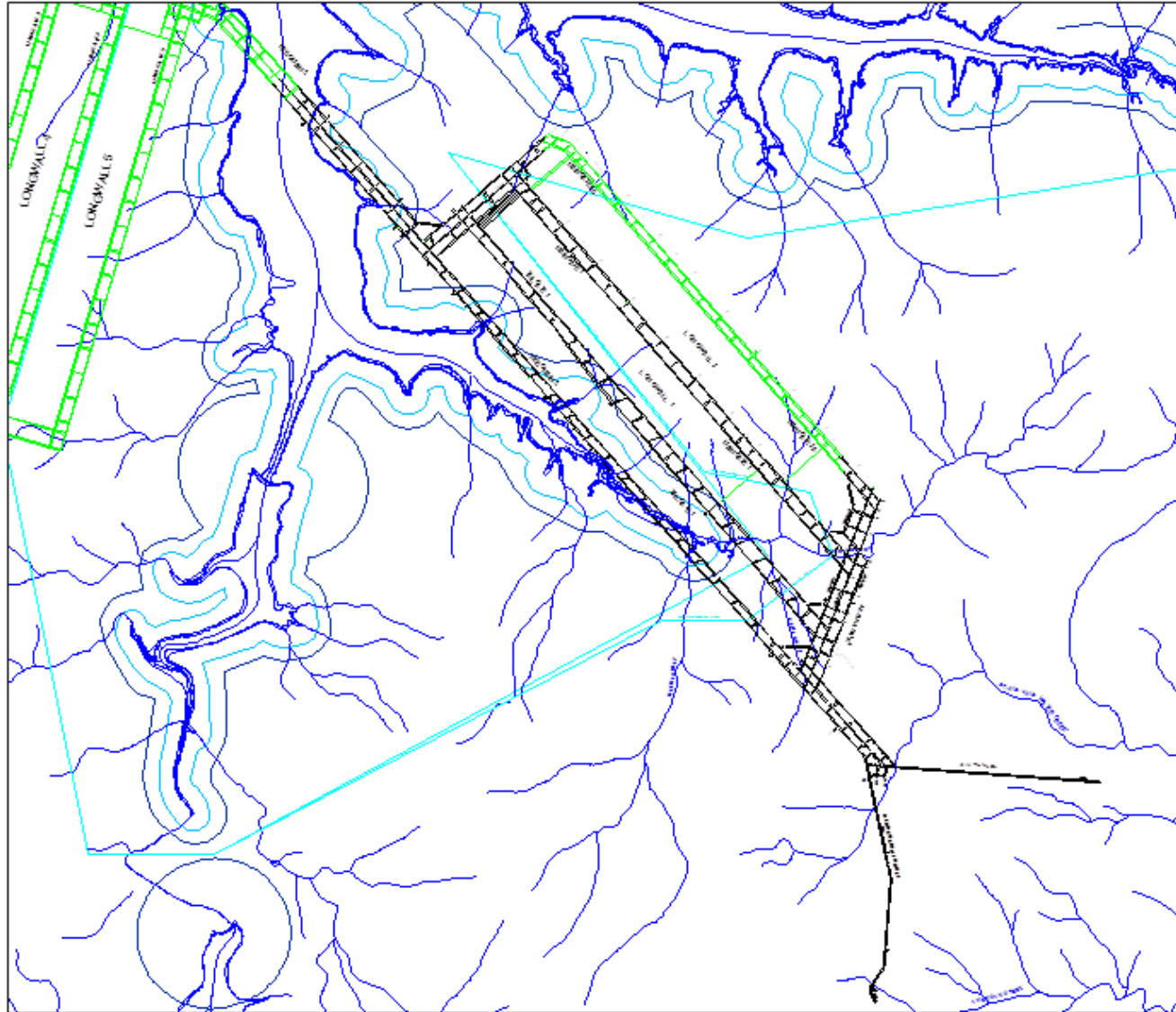
Inrush Protection

- **Mine plan with workings in overlying seam (partially flooded)**

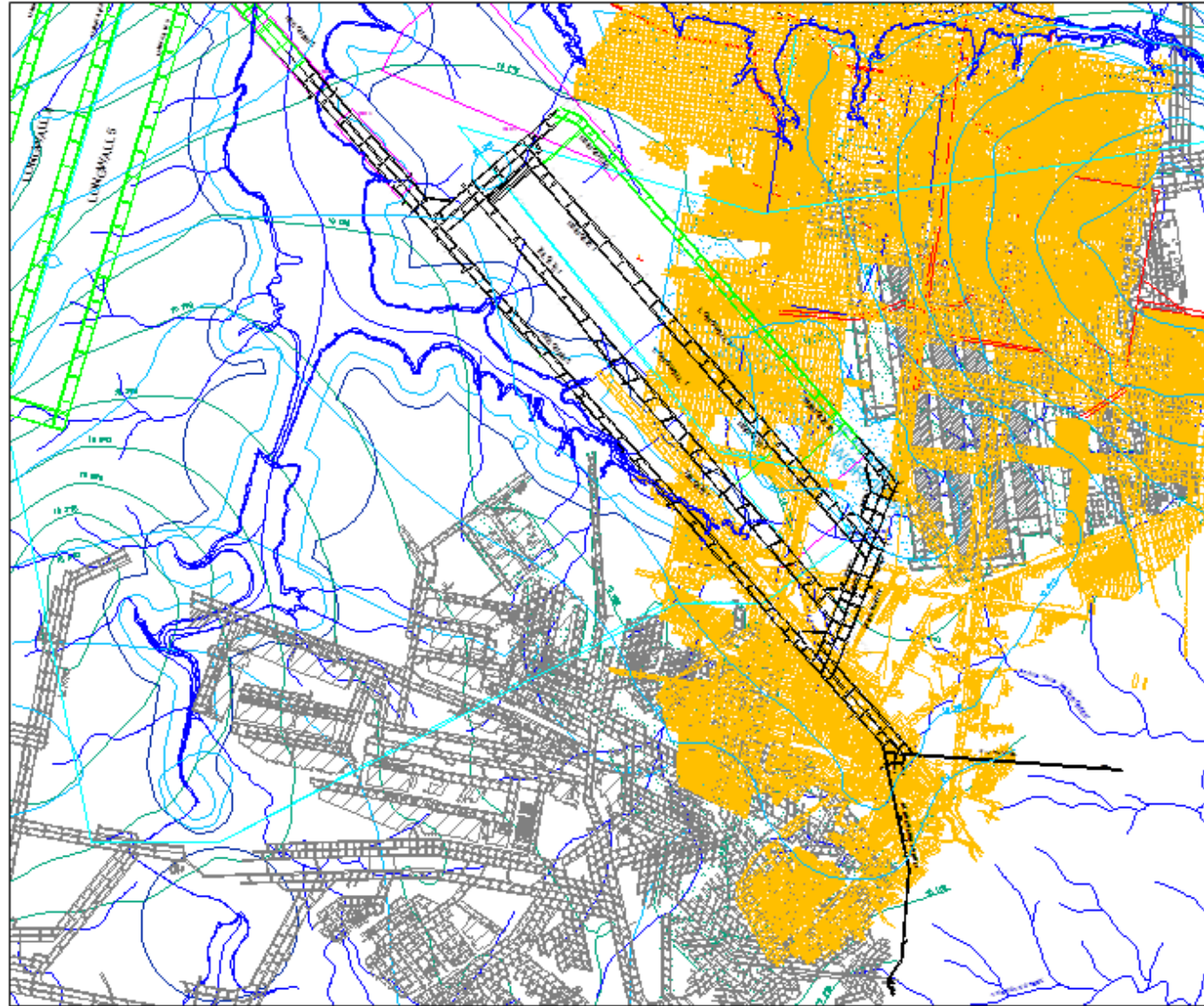


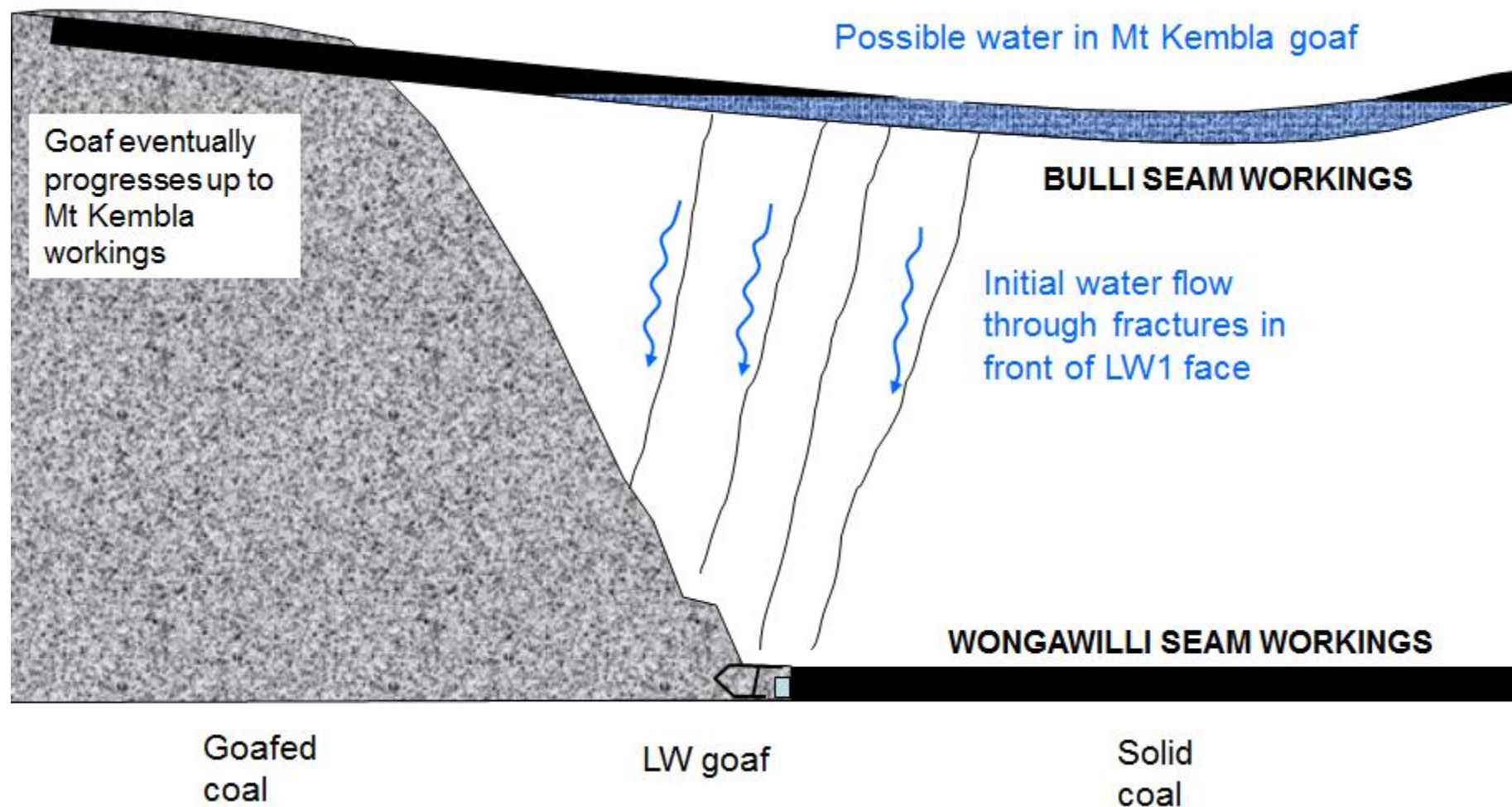
Inrush Protection

- **Mine plan with surface feature (water catchment dam)**



- Mine plan with all features





Vertical Rotary Drilling

- Drill sites set up in each cut-through
- Standpipe installed up through the tuff band
- Up-holes rotary drilled to intersect and test location and water status of over-lying workings
- Up-holes reamed to 96mm if found to make water
- Connected to the mine drainage system to remove water from the mine



Cross-measure drilling

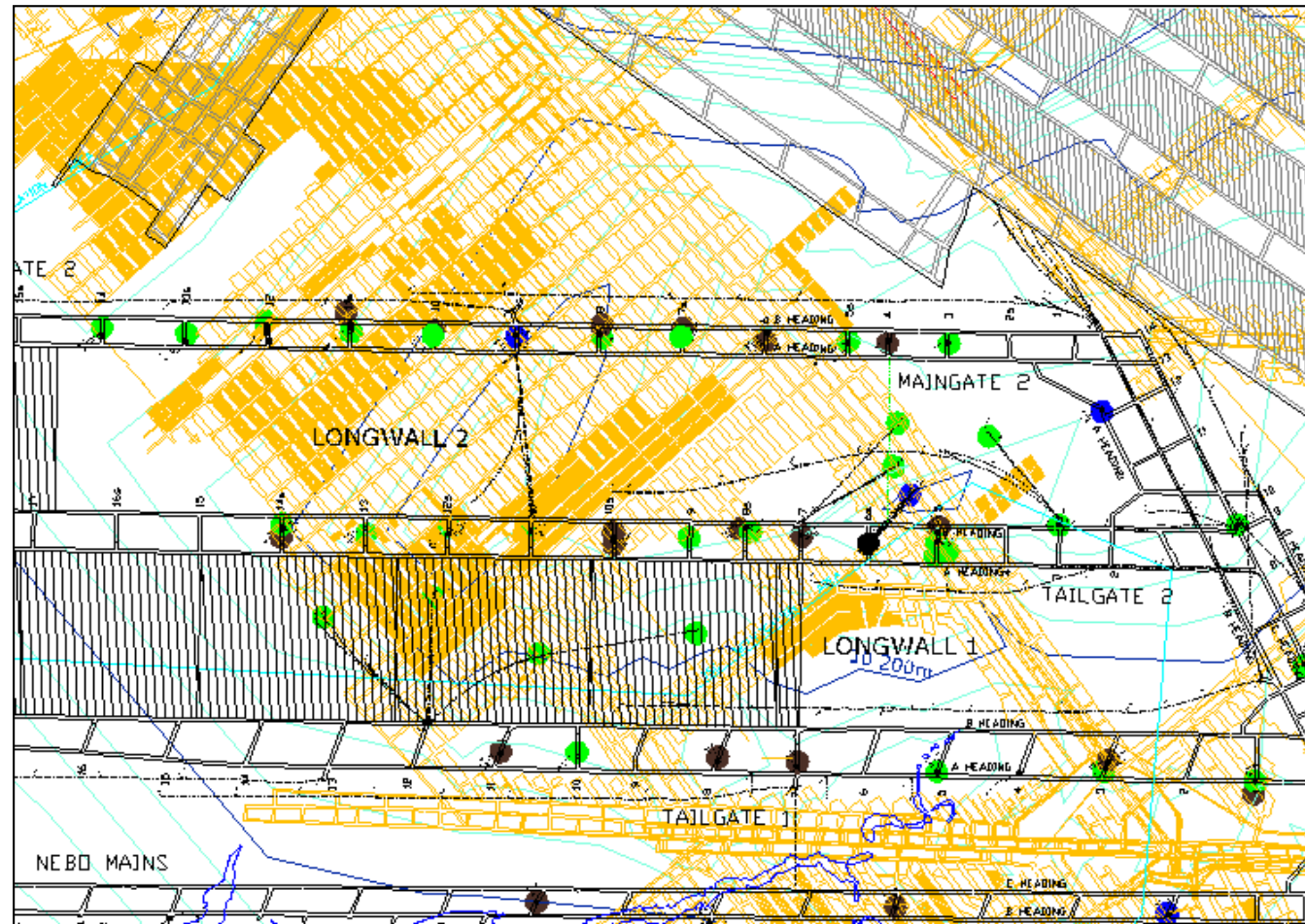
62 holes drilled in total.

17 Cross-measure holes

- All intersected open voids
- 7 intersected water

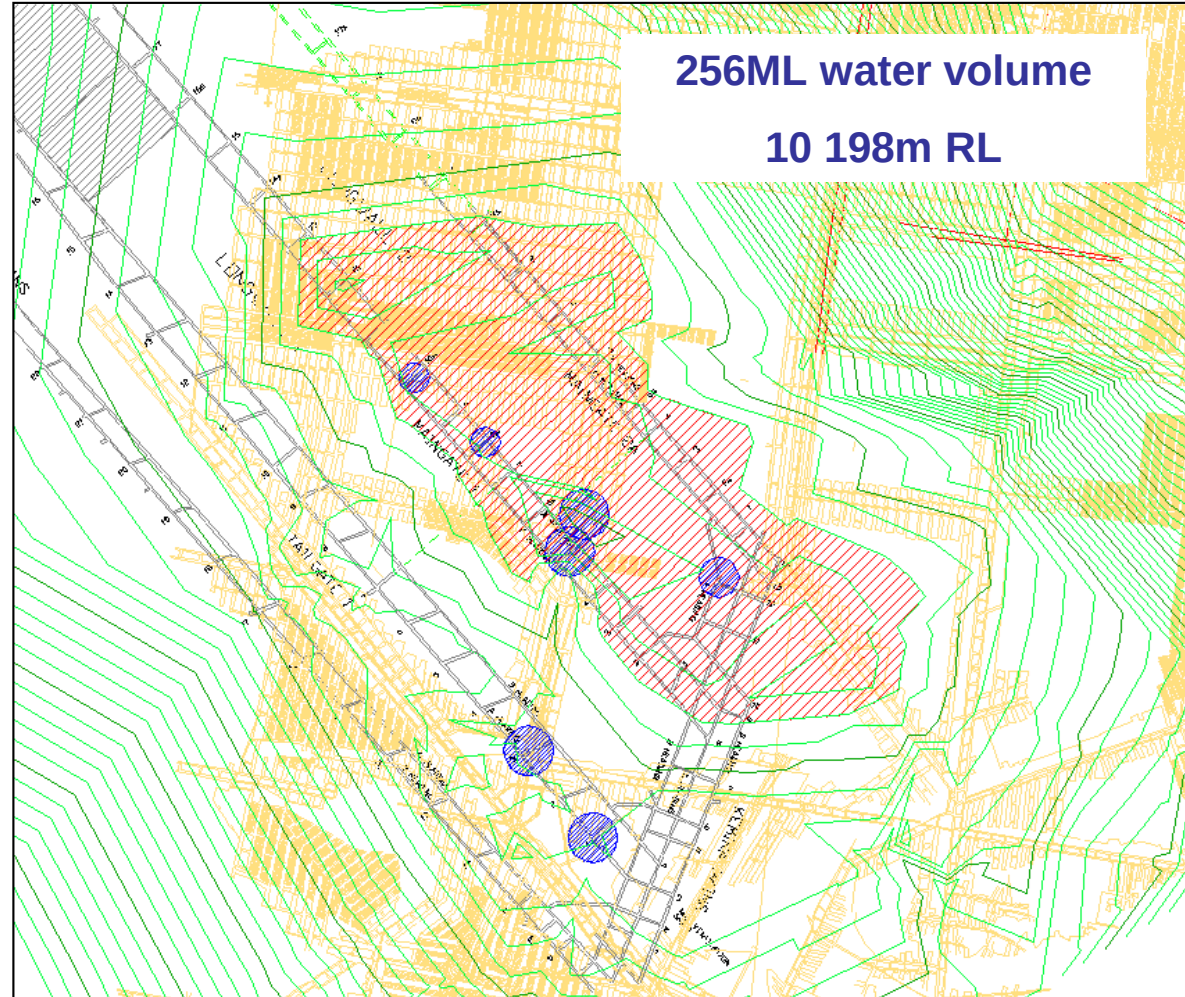
45 Vertical holes

- 25 intersected open voids
- 11 intersected coal pillar or goaf
- 9 intersected water of various volumes and flow rates



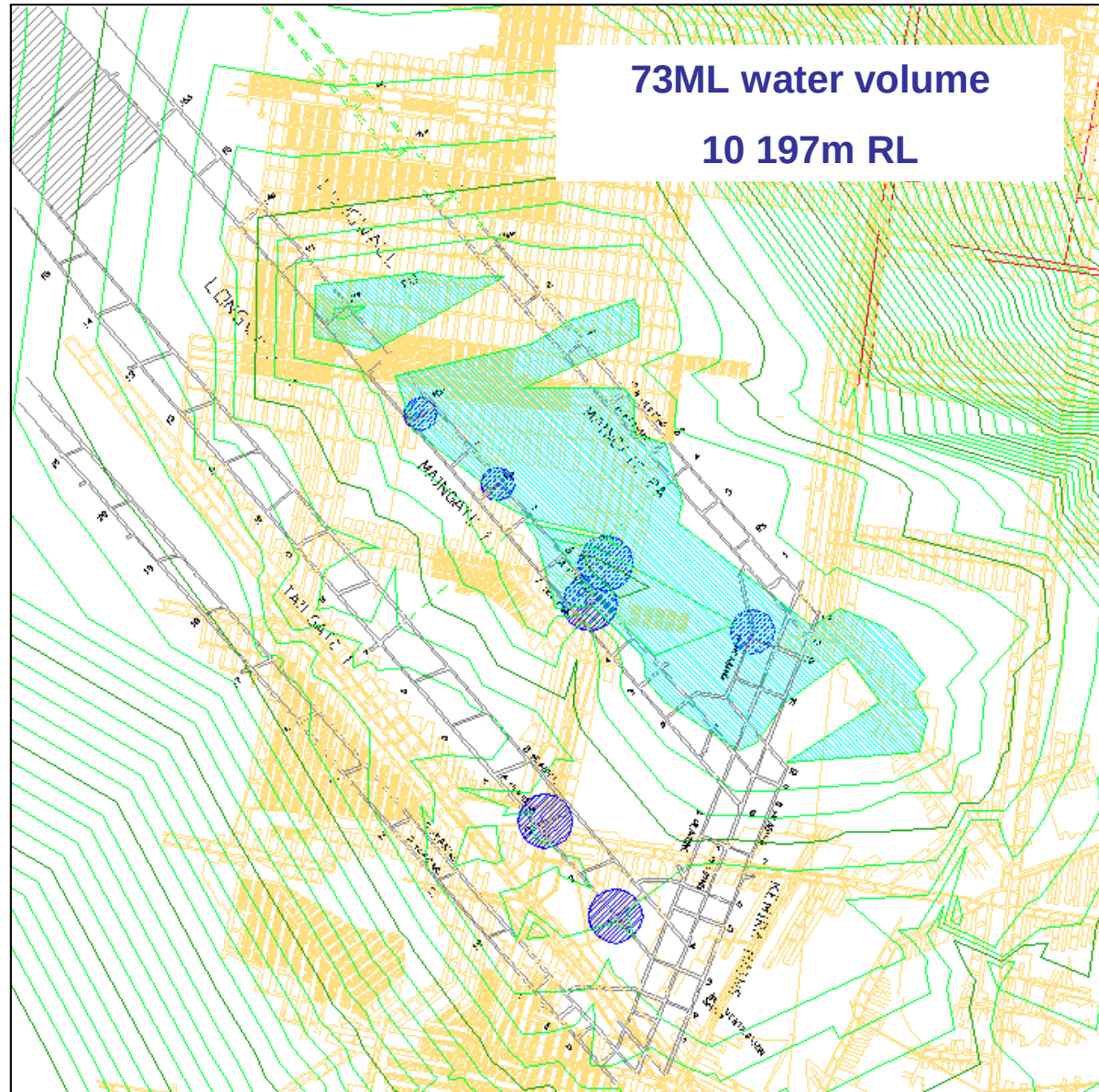
Water Volume in Overlying Workings

- Originally estimated at 900 ML
- Reduced to 256 ML by drainage by directional boreholes of adjacent working



Water Volume in Overlying Workings

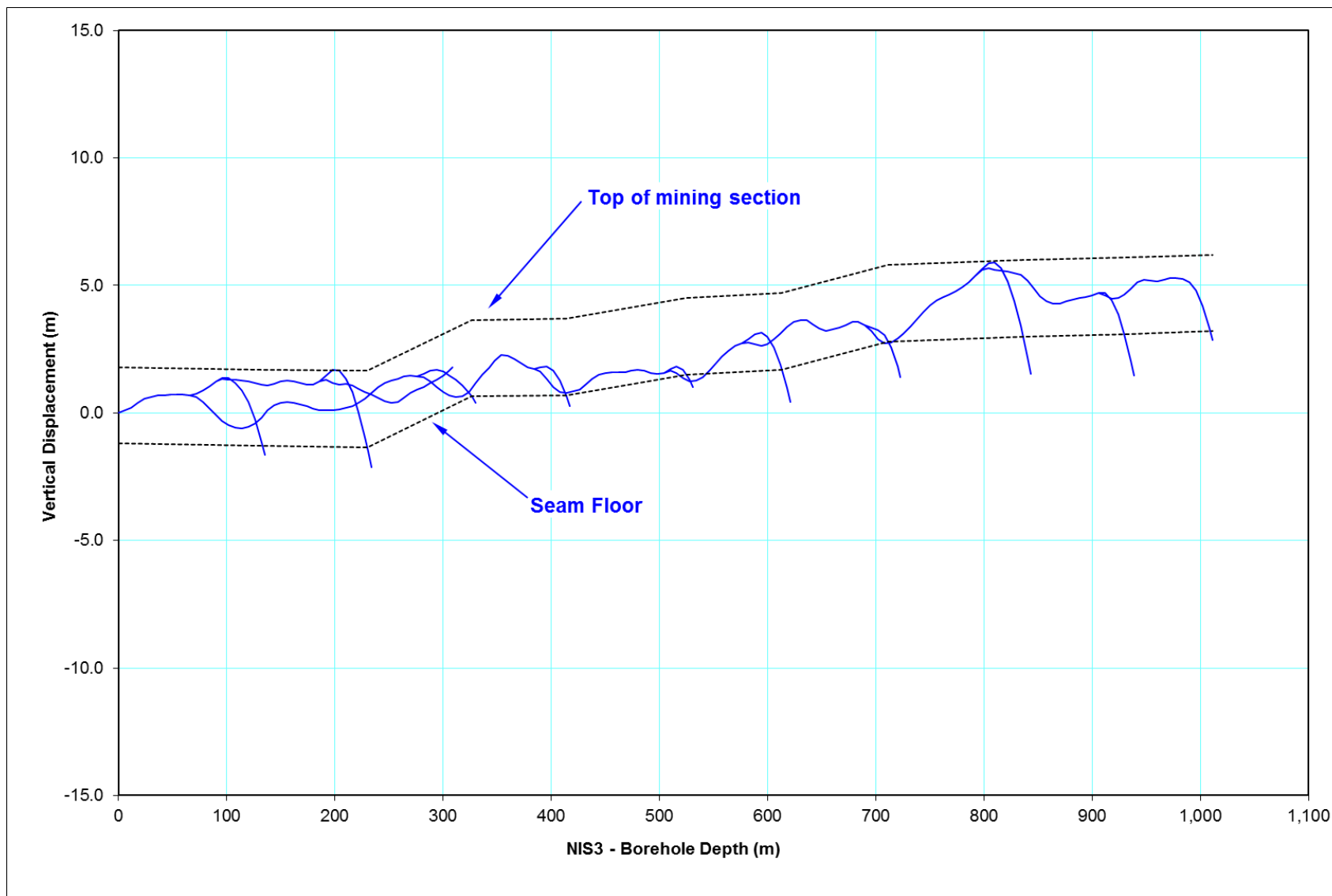
- **Reduced to 73 ML by drainage by vertical and cross-measure boreholes into overlying workings**



In-seam Directional Drilling

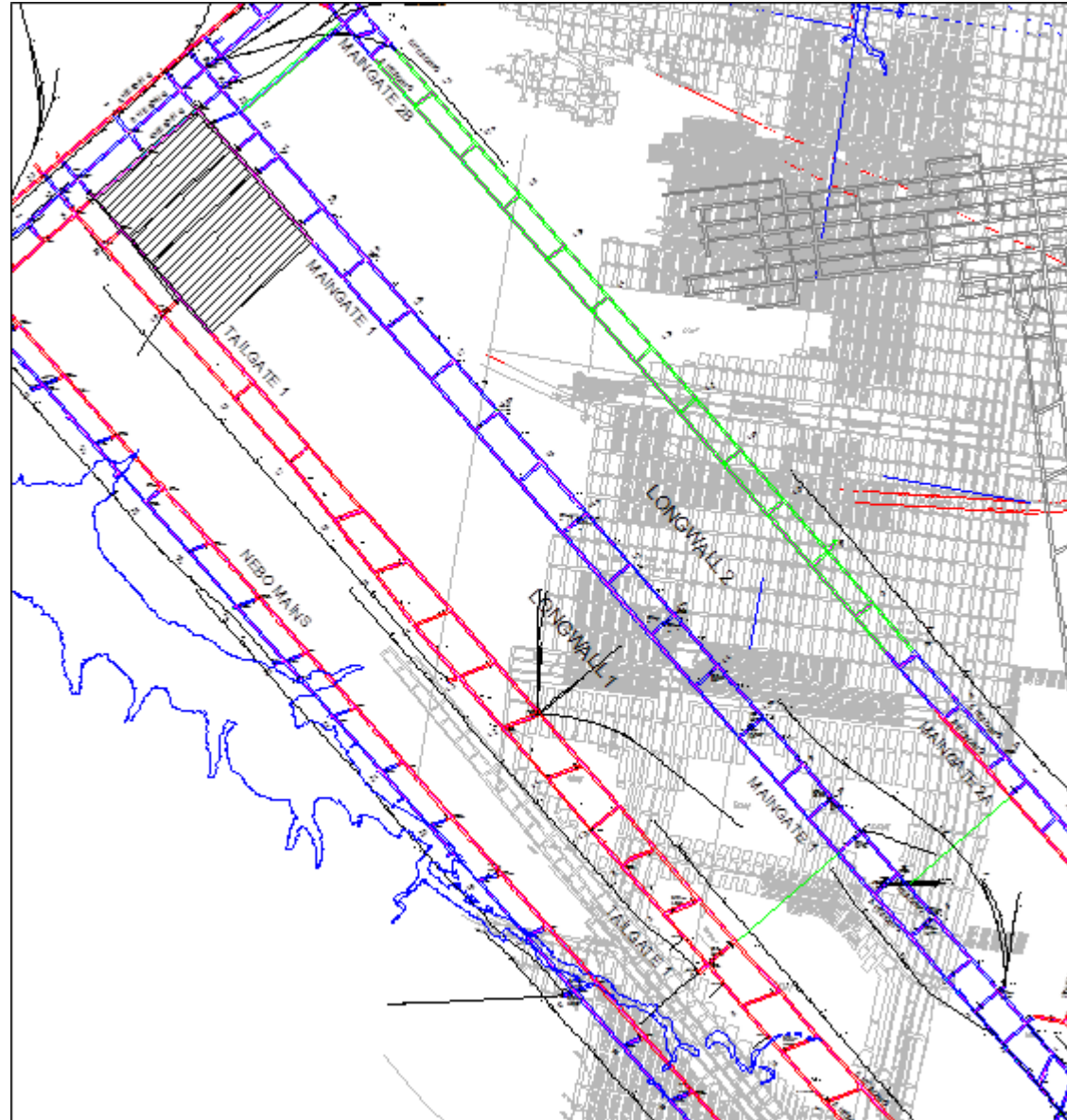
- **Flanking in-seam boreholes adjacent to old workings to ensure a safe barrier pillar to adjacent flooded old workings**
- **Boreholes ahead of development to identify structures which may:**
 - **Connect to the dam on the surface**
 - **Connect to the overlying or adjacent flooded workings**
 - **Be water bearing**
 - **Adversely affect mining**
- **Boreholes to intersect old workings to drain water**
 - **Reamed to improve water flow**
 - **Provide waste water disposal and recycling**

Thick Seam Definition

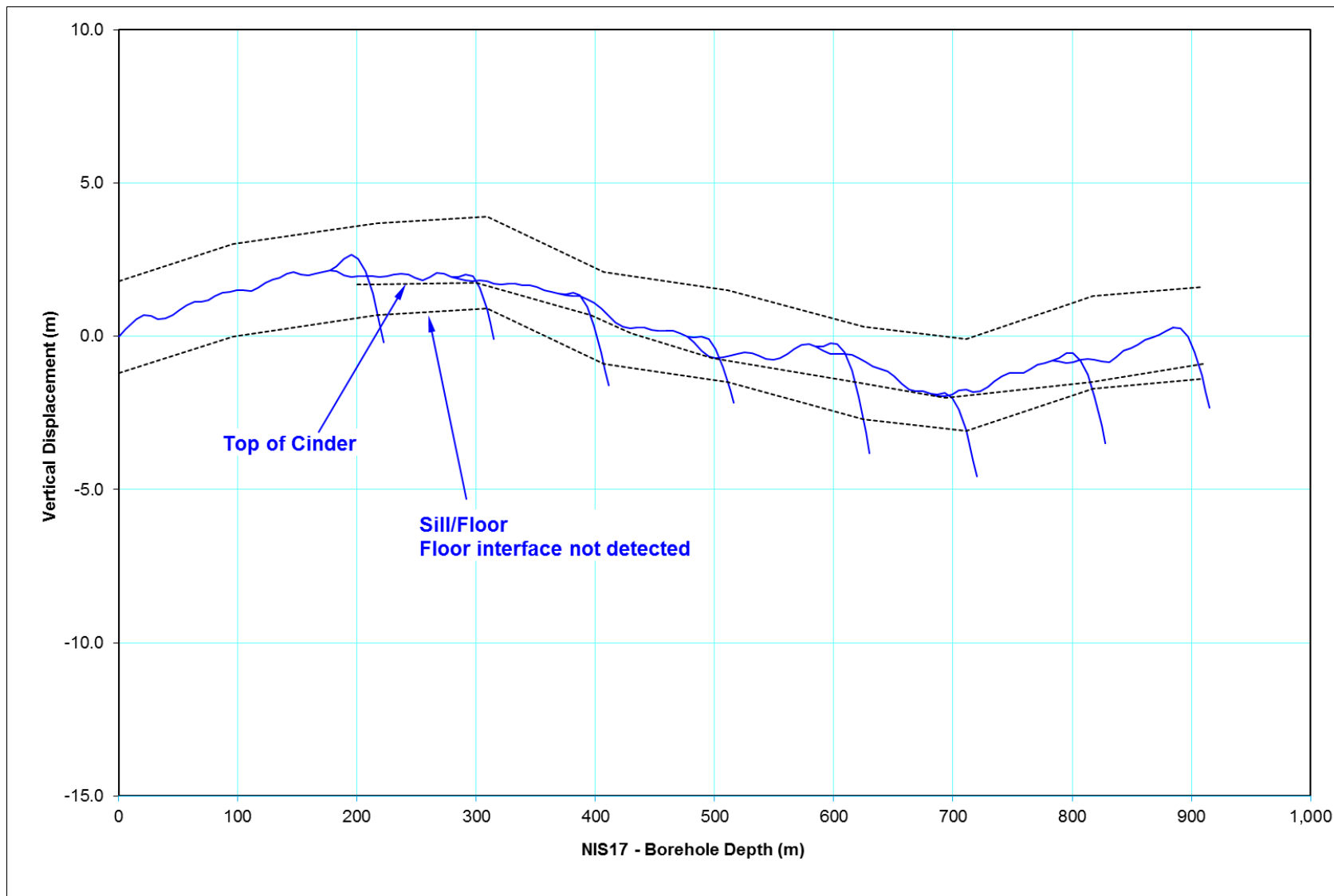


In-rush Event

- **Established**

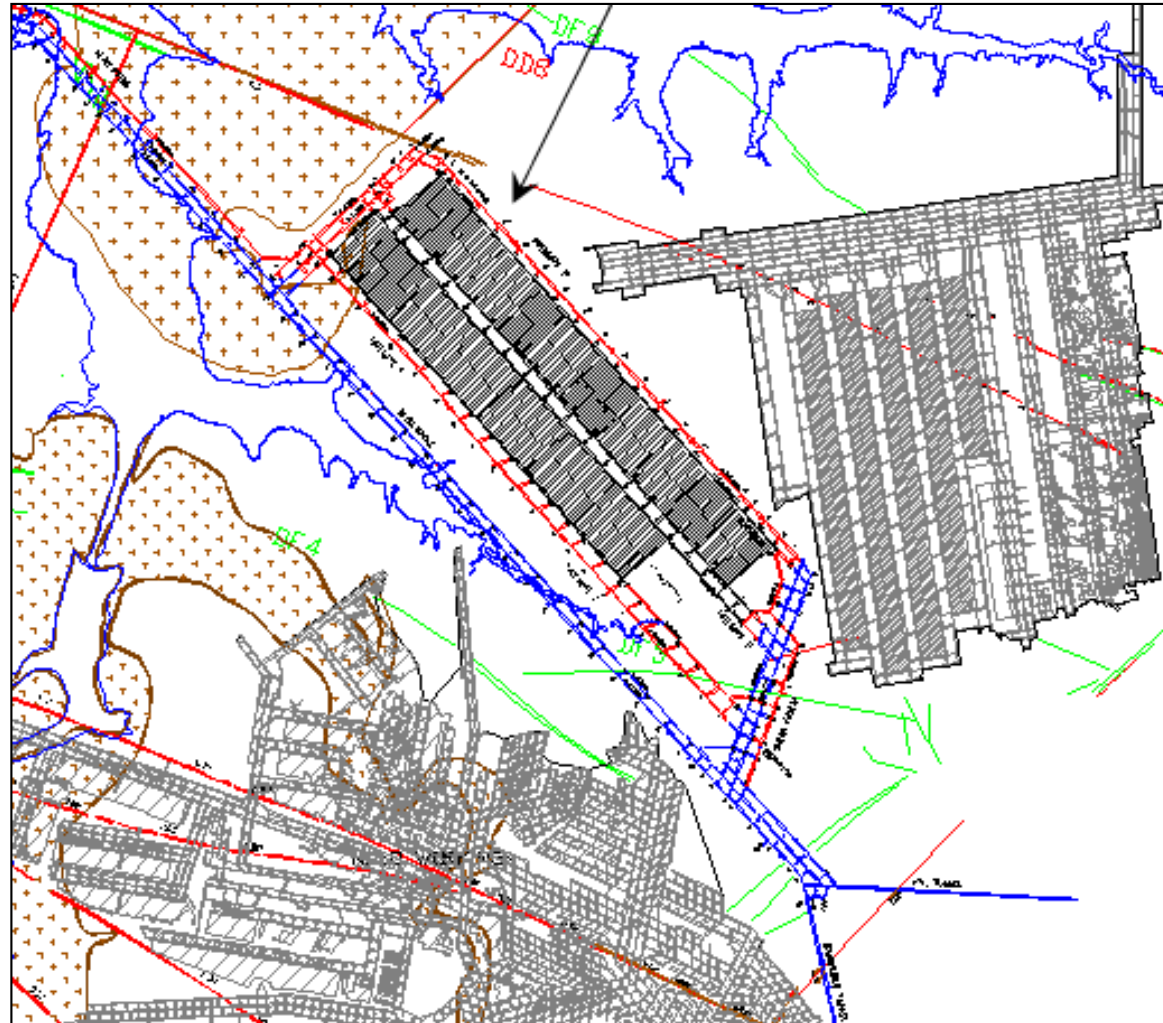


Cinder/Sill Definition on Seam Floor



Structures

- Small faults
- Line of dykes defined in previous workings
- Cuttings sampling every 6m to monitor for presence of igneous structures
- No displacements found
- Sill identified in floor
 - shortened LW
- Dyke location confirmed



Water Intersection



CONCLUSIONS

- **Legislation requires each mine to ensure there is protection against inrush.**
- **Sources of potential inrush need to be identified, assessed and managed.**
- **Directional drilling is now an established safe and reliable means to investigate ahead of mining**