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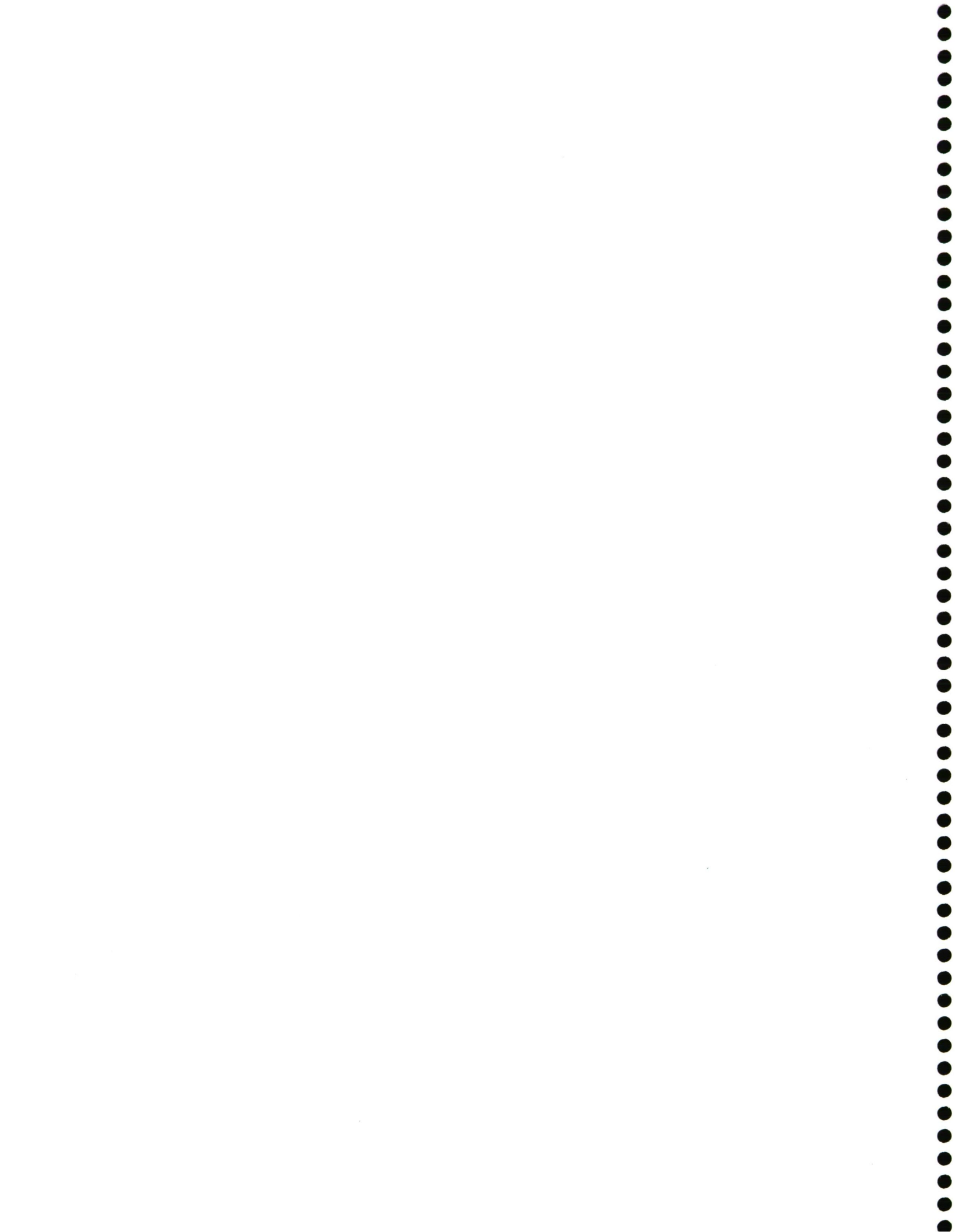
The Westray Story

A Predictable Path to Disaster

Report of the Westray Mine Public Inquiry
Justice K. Peter Richard, Commissioner

Reference





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Pre-explosion

Aerial view of the Westray mine site in Plymouth, Nova Scotia

Introduction

The subject matter of this Report is complex and will be unfamiliar to many readers. For that reason, it was decided to prepare a separate, spiral-bound volume to include the reference and visual material that readers will find useful: a glossary of mining terms, a key to abbreviations and measurements, photographs of equipment and of the mine after the explosion, a series of plans of the mine, and the bibliography. Readers then can consult a photo or a plan, or learn the meaning of a mining term, while reading the text relating to it.

Glossary

The glossary was prepared to assist the Inquiry, and the public, to understand the unique language used in the coal mining industry. Although the terminology is fairly consistent throughout the industry, each mining region – and each mine to some degree – develops a jargon of its own. Some of the terms in this glossary may be specific to the Westray mine, and to the legislation governing coal mining in Nova Scotia.

The glossary was compiled using various manuals, reports, studies, and textbooks relating to underground coal mining. The bulk of the definitions are based on a 1968 U.S. Bureau of Mines publication, *A Dictionary of Mining, Mineral, and Related Terms*. The glossary was reviewed by several coal mining engineers to ensure, as much as possible, that the terminology is accurate.

Abbreviations and Units of Measurement

Many of the abbreviations that readers will encounter in the Report have been gathered here for reference. To render the technical chapter a little more user-friendly, we also include a list of the more common units of measurement.

Photographs

The photographs of equipment were reproduced from photographs found in the documentation obtained from Westray Coal and Curragh Resources in 1992. These photographs show the various pieces of equipment used at Westray. Enlarged copies of most of these photographs were on display during the Inquiry hearings.

The photographs of post-explosion conditions underground were taken by the Royal Canadian Mounted Police during their 1992 visits underground. Most of these photographs were introduced as exhibits at the Inquiry hearings and were of great assistance to witnesses and to the Inquiry itself.

Maps

Maps 1 through 10 were prepared for the Westray Mine Public Inquiry in October and November 1995 from maps and documents obtained from the Inquiry's document database. These maps were prepared in consultation with Inquiry counsel, based on the information available before the hearings began. Maps 11 and 12 were prepared by Westray Coal in September and December 1991, respectively. All these maps were introduced as exhibits at the Inquiry hearings.

All maps have been resized for this Report and therefore the printed scales cannot be used with accuracy. Maps 2 and 10 have usable scale bars. Maps 2, 3, 10, and 11 have grids, which can be used to estimate distances. The circled numbers on map 1 are keyed to the quotations from Inquiry hearing transcripts in Appendix J.

Glossary of Coal Mining Terminology

A

abutment

The part of a mine that supports the strata above an opening in the mine. For example, (1) the weight of the rock above a narrow roadway is transferred to the solid coal along the sides, which act as abutments of the arch of strata spanning the roadway; (2) the weight of the rock over a longwall face is transferred to the front abutment (the solid coal ahead of the face) and the back abutment (the caved and settled material behind the face).

active workings

All places in a mine that are ventilated and inspected regularly.

adit

The entrance to a mine. See also **portal**.

afterdamp

1. The gases resulting from underground combustion, normally carbon monoxide. 2. A loose term implying any fatal gas in a mine after an explosion or fire.

airflow

The amount of air moving through a mine opening; usually measured in m³/s (cubic metres per second) or cfm (cubic feet per minute).

airlock

A pair of doors in an airway that permits the movement of equipment and personnel without affecting the ventilation airflow, since at least one door is kept closed at all times.

air shaft

See **ventilation shaft**.

airway

Any passage in a mine along which an air current moves. Some passages are driven solely for air; others, such as the mains at Westray, are all-purpose, to move air, personnel, materials, and coal.

anemometer

An instrument for measuring air velocity.

Ansul

A manufacturer of fire suppression systems and fire extinguishers.

anthracite

A type of coal characterized by high percentage of carbon and low percentage of volatile matter, providing a high heat value. Also referred to as hard coal.

aquifer

A water-bearing geologic formation.

ash

Non-combustible material contained in coal.

atmospheric monitoring system (AMS)

A system of sensors that continually sample the air at various locations underground and test for such constituents as noxious gases, oxygen, methane, smoke, and dust. The results are transmitted electronically to a remote monitoring station and recorder, usually on the surface. See also **environmental monitor**.

auxiliary fan

A fan temporarily required for the effective ventilation of a working place in the mine.

auxiliary ventilation

The process of bringing fresh air to individual working areas and exhausting contaminated air into the main return, usually accomplished by **fans** and **ducting** or by **brattice**. See also **main ventilation**.

axial-flow fan

A fan in which air flow is parallel to the shaft of the fan.

B

back

The roof or upper part of any underground mining cavity.

balance

1. A pair of passages, connected at the top, one of which is upcast and the other downcast for ventilation.
2. An inclined passage running up at right angles from a main level into the coal seam.

bank

The surface around the mouth of a shaft.

bankhead

1. The mouth and immediate environs of a coal mine.
2. A building at the entrance to a mine, into which the coal is dumped for processing and transportation.

bed

A separate layer of coal or other natural deposit, such as clay, rock, or shale.

belt road

A roadway in which a conveyor is located.

bifurcated duct

See **tee-jointed duct**.

bifurcated fan

A fan, commonly used in coal mines, in which the airflow is split into two separate flows that do not contact the fan motor.

bituminous coal

A common type of coal characterized by relatively high carbon and low volatile content; sometimes called soft coal. Most Pictou County coal is bituminous.

blackdamp

Carbon dioxide gas formed by mine fires and explosions; sometimes called **chokedamp** or **afterdamp**.

blind heading

The portion of a mine opening that has only a single entrance.

blower

Sudden emission of methane from a coal seam.

boom

1. A horizontally set wooden support of the mine roof.
2. A device for lifting.

boom truck

A flat-bed truck equipped with a hydraulic boom used for heavy lifting.

booster fan

A fan operated within a mine in conjunction with the main fan to assist in the ventilation of the mine.

bord

A road driven through coal; called a "room" in some coalfields.

bord-and-pillar

A method of coal mining similar to **room-and-pillar**.

borehole

A hole drilled in rock for any number of reasons, commonly loaded either with explosives to fragment the rock or with instruments for investigation purposes.

box

A mine vehicle in which coal is moved from the face to the surface.

box end

The tail (feed) end of a conveyor, onto which broken coal is loaded.

brake horsepower

A measurement of the actual power output delivered by the crankshaft of an engine.

brattice

A partition, often made from canvas or plastic, to direct airflow in the working areas of a mine. See also **line brattice**.

breakthrough

See **cross-cut**.

brusher

A miner who increases the height of mine passages and who keeps the roof, sides, and floor of a passage in repair.

brushing

1. Removing rock from the roof or floor to increase the height of a mine working. 2. Keeping the roof, sides, and floor of a mine passage in repair.

bull hose

A large flexible hose that attaches pump to pipes.

bump

Any dull, hollow sound produced in a coal seam or associated strata as a result of mining operations. See also **rock burst**.

butty

A miner's working partner (more likely "buddy" today).

C**cable reel**

A device on mobile electrical equipment that stores, winds, and unwinds trailing cable as needed.

cage

A mine elevator in which coal, personnel, and materials are transported in a shaft.

cap lamp

The battery-operated source of light that each person working underground carries.

carbon dioxide (CO₂)

A colourless, odourless, and inert gas that is a product of respiration and combustion of carbon. It also occurs naturally in some coal seams. It is heavier than air and causes breathing difficulties and asphyxiation at higher concentrations.

carbon monoxide (CO)

A colourless, odourless, toxic gas formed by the incomplete combustion of carbon; the main constituent of **afterdamp**.

cave

1. A deliberate collapse of the mine roof into mined-out areas; a common practice in **longwall** mining. 2. A partial or complete failure of mine workings. 3. A falling-in of the roof strata, sometimes extending to the surface and causing a depression there (see **subsidence**). Also called cave-in.

chainrunner

A person in charge of, and who accompanies, cars, trips, or trains in coal haulage, and whose signals direct the haulage operator.

chamber

The miners' working place; sometimes referred to as breast (British) or room.

checkweighman

The miners' representative, chosen by ballot, who in the interest of the miners checks the weight of coal recorded at the bankhead. This term is not relevant today.

chief engineer

The person having the control and supervision of all machinery and boilers at a mine.

chief inspector

In Nova Scotia, a person designated to fulfil certain functions under the *Coal Mines Regulation Act*.

chock

1. A hardwood block, two or more feet long, six inches or more square, used to build temporary roof support; also referred to as chuck or pack.
2. The structure built from individual chock blocks (see **cribbing**).

chokedamp

1. Atmosphere that causes choking because of insufficient oxygen.
2. In the United Kingdom, a loosely used term for **carbon monoxide** and **carbon dioxide**.

clearance

The distance from an object to the nearest point of roof, rib, or floor.

cleat

The main joint in a coal seam along which the coal breaks most easily.

coal

A combustible, carbonaceous rock formed by partial to complete decomposition of plant material that has been buried and compressed.

coalfield

A geographical area, the underlying rock of which contains workable coal seams. The Pictou coalfield refers to the entire deposit of coal in Pictou County, Nova Scotia.

coal gas

A flammable gas, consisting mostly of hydrogen and methane, derived from coal and obtained either in the destructive distillation of soft coal or as a by-product in the preparation of coke.

coal measure(s)

A succession of strata containing coal beds.

coal miner

A person employed underground in any coal mine to cut, shear, break, or loosen coal from the solid, whether by hand or machinery, and who has a certificate of competency as a coal miner.

coke

The residue of coal or petroleum after the gases have been driven off by heat.

coking coal

High-quality coal used in metallurgical applications.

collier

A coal miner.

colliery

A coal mine.

continuous miner

A machine that cuts or rips coal directly from the face, without the use of explosives, and loads it onto conveyors or shuttle cars in a continuous operation.

convergence

The squeezing inward of walls, floor, and roof to decrease the size of a mine opening.

conveyor belt

A moving belt that carries material, such as mined coal, from one part of a mine to another, commonly up the slope to the surface. See **main haulage**.

core

A cylindrical sample of rock obtained in **diamond drilling**.

creep

Slow downslope movement of surface material under gravity.

cribbing

A construction of timbers laid at right angles to each other, in log-cabin style; sometimes filled with earth or rock, as a roof support or as a support for machinery.

cross-cut

A passage driven to connect an **entry** with a parallel entry or air course.

crush

A settling of the strata overlying a portion of an excavated coal seam, generally accompanied by local falls of roof in mine openings. See also **gob**.

cut

1. To excavate coal. 2. A groove excavated in the coal face preparatory to using an explosive. 3. The advance by a continuous miner into the face during one mining cycle.

cutter roof

Longitudinal cracks in the roof of an entry caused by horizontal stresses.

D

datal

Day wage work.

degasification

1. Loss of gas from the coal. 2. The process of recovering gas via

boreholes from coal before, during, or after mining.

depillar

To remove a pillar by mining it.

deputy

A British term for the most junior official in the mine, equivalent to foreman. The term gradually died out in Pictou County pits after the terms "examiner" and **shotfirer** came into use in the early 1900s.

detonation

A violent and rapid explosion, producing shock waves and very high pressure; usually associated with explosives.

diamond drilling

Drilling boreholes with a rotating, hollow, diamond-studded bit that cuts a circular channel around a core, which can be retrieved to provide a columnar sample of the rock penetrated. The core is commonly used by geologists and engineers for prospecting and analysis.

dip

1. The angle at which a bed, stratum, or vein is inclined from the horizontal. 2. The direction of decline from the horizontal.

dolomite

A sedimentary rock similar to limestone; used for stonedusting in coal mines.

Dosco Corporation

A manufacturer of continuous miners and other mining equipment.

downcast

A shaft or passage through which fresh air is drawn or forced into a mine or part of a mine.

dozer

A small bulldozer used underground for grading roads and pushing material.

Draeger breathing apparatus

A type of long-service, self-contained, oxygen-supplied breathing apparatus used by mine rescue personnel during rescue operations. Draeger is the trade name.

draegerman

A mine rescue worker equipped with a Draeger breathing apparatus.

[Jeffrey] Dresser

A manufacturer of dozers.

drift

A common hard-rock mining term for a horizontal passage underground.

drill canopy

An overhead canopy that protects a miner operating a roof bolter from material that may fall from the roof.

drill platform

An elevated platform on which the driller stands during roof bolting operations.

dripping roof

A roof from which relatively small pieces of rock and coal are falling. The term is often seen in mine rescue documentation. See **working**.

drive

1. To excavate an underground passage horizontally or at an angle.
2. An excavated passage.
3. Machinery used to power a conveyor belt.

driveage

The process of excavating underground openings.

drum

A revolving cylinder on which the hoist rope is wound when hoisting a load up a shaft.

dry-bulb temperature

The temperature of air as measured by a standard thermometer, without regard to atmospheric humidity.

duct

A pipe or passage for ventilation in a mine.

ducting

A section of an air duct; also referred to as vent tubing.

ducting wire

Wire in the form of a spiral located inside, and providing support for, ventilation ducting.

Dywidag

A brand of roof-support system.

E

Eimco Jarvis Clark

A manufacturer of boom trucks, Jumbo drill rigs, and other mining equipment.

entry

An underground roadway or airway, usually providing access to working areas. See also **mains**.

environmental monitor

A device that monitors the atmosphere of the underground mine workings; it may detect methane and carbon monoxide and give an alarm if levels are too high. See also **atmospheric monitoring system (AMS)**.

exhaust fan

A fan that sucks used air from a mine or heading, thereby causing fresh air to enter by separate entries. An auxiliary exhaust fan uses ducting to ensure that used air is removed from the most advantageous point.

extensometer

An instrument used to measure small deformations, deflections, or displacements, as for downward movement in the mine roof.

extraction

The mining and removing of coal from a mine.

F**face**

1. Solid coal at the advancing end of a working place. 2. The place where a miner works to extract coal and rock.

fan

Any mechanical device used to circulate air through mine workings.

fan (performance) curve

A graphic representation of the operating characteristics of a fan.

fault

A break in a body of rock along which movement of the two sides relative to each other has occurred.

fault zone

1. A zone of numerous interlacing small faults, as opposed to a single clean fracture. 2. Broken ground along a fault plane.

feeder-breaker

A relatively mobile crusher into which coal is dumped. The feeder-breaker then loads the coal onto a conveyor.

finger pillar

A long, narrow pillar.

fire

See shoot.

fireboss

A foreman.

fire clay

Clay that is high in alumina or silica. Heat resistant and easily processed, it is invaluable for use as fire brick in furnaces. It often forms the base of coal beds.

firedamp

A common British term for a methane-air mixture or any explosive gas (usually methane) underground.

fissure

An extensive crack or break in rock, across the seam in coal.

flameproof

Enclosed and capable of withstanding, without damage, a methane-air explosion within the enclosure. This is to prevent ignition of the same methane-air mixture surrounding the equipment.

floor

The bottom of a mine excavation; in relation to the coal deposit, it is normally the upper surface of the stratum immediately underlying a coal seam. See also **pavement**.

fly ash

Very fine particles of incombustible ash resulting from the burning of fuels such as coal.

formation

In geology, any assemblage of rocks that have some character in common, whether of origin, age, or composition.

fresh-air base

An underground station located in the intake airway, used by rescue teams during underground fires and rescue operations.

friable

Easy to break, or crumbling naturally. Descriptive of certain rocks and minerals.

G

gate

An underground roadway. See **headgate** and **tailgate**.

gate end

The coal-face or **inbye** end of a gate.

gate-end box

A flameproof enclosure primarily used as a control board for electrical equipment at or near the coal face.

general body

A ventilation term to describe the body of air in a mine opening as opposed to the air immediately adjacent to a surface, which might not be representative of the whole.

goaf

A chiefly British term for **gob**.

gob

1. The void resulting from excavation of coal. 2. The area from which coal has been extracted and the roof permitted to fall in. Also called waste or **crush**. See **cave**, in reference to longwall mining.

grade

The angle of ascent or descent of a roadway.

ground cable bolt

A piece of wire cable used instead of a roof bolt to secure ground. Often used where long bolts would be impractical or in very narrow tunnels with limited clearance.

ground control

Any effort made to stop or reduce unwanted movement of rock surrounding mine openings, including installation of steel arches, rock bolts, etc. Also referred to as **strata control**.

ground pressure

The pressure to which a rock formation is subjected by the weight of the superimposed rock and other materials or by forces created by movements in the rocks forming the earth's crust. Such pressures may be great enough to cause rocks having a low compressional strength to deform and be squeezed into and close a borehole or other underground opening (see **convergence**) not adequately strengthened by an artificial support, such as casing or timber. Also called rock pressure.

grout

A cement mixture sufficiently fluid to be pumped into fissures, cracks, or holes in rock, thereby increasing the strength of a foundation, ceiling, or wall for an engineering structure, or for sealing against air movement.

gunitite

See **shotcrete**.

H

headframe

A wooden or metal frame erected over a shaft, which bears the hoisting wheels (headsheaves) from which the cages are suspended.

headgate

An entry or set of entries that provides access to a mining face, often acting as the intake airway and conveyor entry. Commonly used in longwall mining.

heading

Any road or passage driven in solid coal for the purpose of developing and working the mine.

hoist

A powered drum that hauls or hoists a **trip** or **cage** by winding a rope onto the drum.

holing

1. Cutting. 2. Working the lower part of a bed of coal in order to bring down the upper mass.

Huwood

A manufacturer of conveyor motors.

hydraulic mining

Breaking and extracting coal by a high-velocity water jet directed by a monitor (nozzle). Water jets are also used to impel the broken coal along the floor to a collection point.

I**igneous rock**

Rock formed by solidification from a molten state.

inbye

(Also "inby" or "in by") A commonly used coal mining term to denote locations or movement further into the mine (away from the mine entrance). Specific locations within the mine are often referred to as inbye or outbye a certain reference point. For example, "No. 3 North Main inbye North 2 Cross-cut" refers to a point on No. 3 North Main that is further into the mine than the cross-cut. Inbye is also used to describe working locations in some cases.

incline

A shaft that is not vertical and is often on the dip of a vein. See **slope**.

inspector

In Nova Scotia, a person appointed to perform certain functions under the *Mineral Resources Act*, the *Coal Mines Regulation Act*, or the *Occupational Health and Safety Act*.

Includes chief inspector and deputy inspector.

intake airway

Any heading through which fresh air flows as part of the ventilation system.

intrinsically safe

A term applied to equipment in which any spark or source of heat that may occur in normal use, or under any conditions of fault likely to occur in practice, is incapable of causing an ignition of a methane-air mixture.

J**J.H. Fletcher and Co.**

The manufacturer of the roof bolters used at Westray.

jib end

The head (delivery) end of a conveyor, from which coal is discharged.

joint

A fracture in rock along which there has been no movement of the two sides relative to each other.

Joy Technologies Inc.

The manufacturer of the continuous miners and shuttle cars used at Westray.

jumping the belt

Riding on a moving conveyor belt.

K**Kilborn Limited**

The engineering firm hired by Westray Coal to prepare a feasibility study.

L

lamp cabin

The place where cap lamps are stored, repaired, charged, and issued to personnel going underground.

layout

1. The design or pattern of the main roadways and workings for an underground mine. 2. The map of a mine or of part of a mine, usually including the arrangement of future workings.

Lefthander

The unnamed heading turned to the west from SW2-1 Road in the Southwest 2 section of the Westray mine.

level

A main underground roadway driven in the coal to afford access to workings and to provide ventilation and haulageways.

lift

1. A thickness of coal worked in one operation. 2. All the workings driven upward from one level in a steeply pitching seam.

lignite

A low-grade coal with high moisture content and minimum heat content; sometimes referred to as brown coal.

limestone

A sedimentary rock composed largely of calcium carbonate. Limestone or **dolomite** (calcium magnesium carbonate) is the main constituent of **stonedust**, which is used on exposed roadways to render coal dust inert.

line brattice

Brattice used to create temporarily both ventilation intake and exhaust paths within a single heading.

log

A written and graphic description of the geological characteristics of a vertical column of rock. The information is obtained from drill **core**.

longwall

A method of working coal seams believed to have originated in Shropshire, England, towards the end of the 17th century. A **panel** is removed in one operation by means of a working face, or wall, that may be several hundred metres long – hence, the name. The roof of the gob, or space from which coal has been removed, is usually allowed to collapse, or **cave**.

M

magnetometer

An instrument that detects bodies of rock that affect the earth's magnetic field; used mainly as an exploration tool.

main haulage

That portion of the haulage system that moves the coal from the secondary haulage system to the shaft or mine opening. The method employed is the same for either longwall or room-and-pillar mining. At Westray, this was accomplished with belt conveyors in **No. 2 Main**.

mains

The principal entry or set of entries driven through the coal bed from which cross entries, room entries, or rooms are turned.

main ventilation

The process of bringing fresh air from the surface atmosphere into the mine and exhausting contaminated air from the mine. See also **auxiliary ventilation**.

manager

In Nova Scotia, a person who has the control and supervision of a mine and who has a first-class certificate of competency as a mine official (mine manager) or a second-class certificate of competency as a mine official (underground manager).

manhole

1. A cubicle cut into solid strata for refuge. 2. Commonly a hole inset in the side of a roadway for personnel to stand in safety while equipment passes.

manway

A passage in or into a mine used as a footpath only. (A vertical manway may be called a ladderway.)

mesh

See **screen**.

metamorphic rock

Rock that has undergone change in texture and mineralogy through heat and compression.

methane (CH₄)

An odourless, tasteless, colourless, and non-poisonous gas formed by the decomposition of organic matter. The most common gas found in coal mines, it is also called **firedamp** and marsh gas. Methane is lighter than air and highly flammable.

methane monitoring system

A means of measuring the methane content of mine air continuously and, when the content reaches a predetermined concentration, cutting the electrical power automatically from each machine in the affected area. Continuous miners are equipped with **methanometers** for this purpose.

methanometer

A device used to measure the concentration of methane in the air.

mine examiner

In Nova Scotia, a person appointed to inspect the working places and other accessible parts of a mine to make sure they are safe before a shift is allowed to enter, and who has a certificate of competency as a mine examiner. The mine examiner also supervises the use and safety of explosives for breaking coal.

mineral oil

Any oil derived from mineral sources. Westray used mineral oil for hydraulic fluid in its underground equipment.

mine rescue crew

A crew consisting usually of five miners who are thoroughly trained in the use of mine rescue apparatus and techniques and are capable of entering a mine following an explosion or to combat fire. See also **draegerman**.

mine resistance

The resistance offered by a mine to airflow, caused by the friction of air against mine surfaces and other obstructions.

mining engineer

A person qualified by education, training, and experience in mining engineering.

mining engineering

That branch of engineering chiefly concerned with the discovery, development, and exploitation of coal, ores, and minerals.

mining geology

The study of geological structures and particularly the modes of formation and occurrence of mineral deposits and their discovery.

mouth

The opening at the surface of any passage into a mine. See also **portal**.

muck

Rock or ore broken in the process of mining.

N**natural ventilation**

The ventilation produced in a mine as a result of a difference in density of the air in the upcast and downcast shafts, brought about by natural causes. Natural ventilation is feeble, seasonal, and inconstant.

No. 1 Main

One of the two main slopes at Westray; used for intake air and transportation of personnel and materials.

No. 2 Main

One of the two main slopes at Westray; used as a return airway. The coal from underground was taken to the surface via a conveyor belt in No 2. Main.

O**opening**

Any excavation in or into a mine.

operator

1. The person, company, or corporation working a mine. 2. The person at the controls of a machine.

outbye

(Also "outby" or "out by") A commonly used coal mining term that refers to locations or movements towards the mine entrance. Specific locations within the mine are often referred to as outbye or **inbye** a certain reference point. For example, "No. 1 Main outbye No. 10 Cross-cut" refers to a point in No. 1 Main located between No. 9 and No. 10

cross-cuts. Outbye is also used to describe working locations in some cases.

outcrop

The portion of a geological stratum that appears at the surface.

output

A quantity of coal produced from a mine.

overburden

1. Loose material, such as soil, overlying the mineralized rock and varying in depth from place to place.
2. Material of any nature that overlies a deposit of useful materials, ores, or coal.

overcast

An enclosed airway that permits one airflow to pass another without interruption or mixing of the two, usually with solid ground separating the two airways. Also referred to as air passage.

overman

In Nova Scotia, a person who is in charge of a mine or any portion of a mine and who possesses a third-class certificate of competency as a mine official. Usually next in authority to the underground manager.

Oxy 60

The Oxy®-SR 60 B is a brand of **self-contained self-rescuer** manufactured by Draeger.

P**panel**

A large rectangular block or pillar of coal identified to be mined, usually separated from other panels by large pillars.

panic bar or panic button

A bar or button that, when pushed, will immediately deactivate the equipment to which it is connected.

parting

1. A line of demarcation between bedding planes. 2. A thin layer of dirt in a coal seam, or a band of waste separating coal bands.

passive barrier

An explosion suppression device consisting of a container of stonedust or water placed in an entry; when the stonedust or water is dispersed into the air by the shock wave preceding an explosion, it quenches the explosion.

pavement

The bottom or floor of any excavation.

peat

The dead and partly decomposed remains of marsh vegetation; this yellowish-brown to brown-black material precedes coal formation.

permissible

Electrical or diesel equipment that is certified for use in an explosive atmosphere.

pillar

An area of coal left to support the overlying strata in a mine. Pillars are often extracted later in the life of the mine (see **depillar**).

pillar-and-chamber

A pillar method of mining used to extract a portion of thick deposits where the value of the mineral, such as salt or gypsum, is less than the cost of setting artificial supports.

pit

1. The underground portion of a coal mine. 2. The mine shaft or slope.

pitch

See **dip**.

plan

A map showing features such as mine workings or geological structure on a horizontal plane.

plane

A roadway, generally inclined, used for transporting coal from one level to another.

portal

The entrance to an underground mine. At Westray, the portal is where No. 1 Main intersected the surface.

powder

A miner's term for any explosive used for blasting at the coal face to fragment coal.

prop

A wooden upright post used to support the roof, usually temporarily.

R

rake

A train of coal cars or boxes, also known as a **trip**. In the Pictou pits, rake generally meant a "riding rake," which carried the men into and out of the slope mines.

rebar

Steel rods used to reinforce concrete; often modified and adapted for use in roof bolting.

regulator

A ventilating device, usually an opening in a door or a wall and usually placed in the return of a **split** of air, to govern the amount of air flowing in that part of the mine.

resident superintendent

The general manager of a group of collieries operated by one company. The term is no longer used in Nova Scotia.

retreating system

A mining method in which supporting pillars of ore are left while the coal deposit is worked outward (away from the entrance) towards a boundary; the pillars are removed (robbed) as the work retreats towards the entrance, and the unsupported workings are abandoned and left to cave in.

return airway

Any portion of a ventilating system through which used or contaminated air flows, to be evacuated to the surface atmosphere.

rib

The side of a pillar or the wall of an entry.

Roadheader

A type of continuous miner made by Dosco.

roadway

Any underground passage capable of accommodating wheeled or tracked equipment. See also **cross-cut**, **entry**, **heading**.

rob

To extract coal from pillars previously left for support.

rock bolt

See **roof bolt**.

rock burst

The sudden yielding of a volume of rock into a mine opening, sometimes with explosive violence.

rock dust

See **stonedust**.

rock mechanics

A study of stress patterns in rock masses and the response of the rock to that stress.

rollerman

A worker who lubricates and maintains the rollers and pulleys over and through which haulage cables pass.

roof

The ceiling of any underground excavation. Also referred to as the **back**.

roof bolt

A steel bolt or cable secured into place in the roof or rib of a mine opening for the purpose of pinning layers of rock together. Roof bolting is a common form of roof control. See also **steel arches** and **steel sets**.

roof bolter

1. A machine used to place roof bolts. 2. A person who works underground placing roof bolts.

room-and-pillar

A system of mining coal in which the distinguishing feature is the extraction of 50 per cent or more of the coal in the first working. The coal is mined by advancing in parallel rooms connected by cross drives, leaving supporting coal as rectangular supporting pillars. The coal in the pillars may be subsequently extracted, usually allowing the roof to cave following the mining. This method is applicable to coal that occurs in relatively flat and shallow deposits.

run-of-mine

The raw coal as it is delivered from the mine, prior to treatment of any sort.

S

safety lamp

In coal mining, a lamp of an approved type, which is relatively safe to use in atmospheres that may contain flammable gas.

scabby roof

An unstable roof from which small- to medium-size rocks may fall.

scarp

A steep slope.

scoop

A large shovel attached to a tractor or a mining machine for lifting coarse material. Also a common name for a low-profile front-end loader used underground (referred to in this Report as a **Scooptram**).

Scooptram

A load-haul-dump unit (front-end loader) with a large shovel used to move coal, rock, and materials in the mine. A Wagner tradename. Also commonly referred to by miners as **scoop**.

screen

Either chain link or weld mesh (see **wire mesh**), used as wall and roof support in underground construction.

seam

A grouping of closely related bands of coal.

sedimentary rock

Rock, often in layers, formed by the accumulation of sediments in water or from air and later compacted.

seismic survey

An exploration technique that uses the reflections of small explosions or vibrations to delineate subsurface geological structures of possible economic importance, such as coal beds.

self-contained self-rescuer

A **self-rescuer** that has or is able to generate its own supply of oxygen. Generally good for 1 to 5 hours of use, depending on the type and how hard the wearer is working.

self-rescuer

A filtering device in a small canister with a mouthpiece directly attached to it. The wearer breathes through the mouth, the nose being closed by a clip. It will provide an underground miner with immediate protection against carbon monoxide and smoke in case of mine fire or explosion, as long as there is sufficient oxygen in the air. It is used for escape purposes only.

shaft

1. An approximately vertical excavation used to access ore or coal from the surface, and to hoist or lower personnel and materials, and to ventilate underground workings.
2. Another name for a slope or pit; at Westray, **shaft** and **slope** were used interchangeably.

shock losses

In ventilation, any loss in ventilating pressure caused by a change in direction of airflow or diversion of a passage through which the air flows. Shock losses commonly occur at obstructions in airways, splits, or junctions of two or more currents of air.

shoot

To detonate the explosive charge in the coal face. Also referred to as **fire**.

shortwall

A method of mining in which relatively small (compared to longwall) areas are mined using a combination of longwall and room-and-pillar equipment and methods.

shot

1. The explosive charge in the coal face. 2. Blasted.

shotcrete

A cement mixture sprayed onto the surfaces of mine openings with a pressure gun to prevent erosion by air and moisture and to provide a smooth surface for airflow. **Guniting** is a similar term.

shotfirer

A qualified miner who, before firing an explosive charge in a coal mine, examines the area for gas, examines the preparations made for blasting, and makes sure that all safety regulations have been complied with.

shuttle car

A rubber-tired electric-powered vehicle that carries coal from a continuous miner to a feeder-breaker or conveyor.

sinking

1. The process by which a shaft is driven. 2. An inside **slope**, without connection to the surface.

slabby roof

Where most of the planes of weakness of a rock mass run in one direction.

slope

An inclined passage or opening used for the same purpose as a shaft. At Westray, the slopes were called **No. 1 Main** and **No. 2 Main**.

slopeman

A person who patrols and keeps in repair the slopes of a mine.

split

In ventilation, any division or branch of the ventilating current, or the workings ventilated by that branch.

spoils

Accumulations of overburden and other non-ore material removed during mining and piled on the surface. Also called "waste."

sprag

1. The horizontal member of a square set of timbers running parallel to the axis of a heading. 2. Idiomatically used by miners to describe the practice of defeating safety devices, usually to prevent the automatic shutdown of equipment.

spreader bars

Bars that pull coal on a chain conveyor.

Stamler

An equipment-manufacturing company that manufactured the feeder-breakers used at Westray. The equipment itself was referred to as "the Stamler."

steel arches

Curved lengths of steel, usually of H-section, either rigid or yielding, used for long-term roof support in mine roadways and intersections.

steel sets

A traditional passive support system used in main entries of coal mines for ground support, usually consisting of I-beams for caps and H-beams for posts or wall plates. The term "passive" derives from the fact that steel sets and arches do not interact with the rock the way that roof bolts do.

stonedust

An incombustible dust (usually limestone) used to lessen the danger of potentially explosive coal dust. Stonedust is mixed with coal dust on mine roadways to create a non-flammable, non-explosive mixture.

stope

An excavation, usually in highly inclined or vertical veins, from which ore or coal has been excavated in a series of steps. It is frequently used (incorrectly) as a synonym for room in room-and-pillar mining.

stopping

A wall built across old headings, chutes, airways, etc., to confine the ventilating current to certain passages and to isolate gas in old workings. Permanent stoppings are commonly made of masonry or concrete; temporary stoppings may be made of such materials as plywood, plastic sheeting, and brattice cloth.

straps

Steel bands secured by roof bolts and used extensively to hold slabby ground between bolts or to prevent slabs from loosening.

strata

Sedimentary rock layers.

strata control

See **ground control**. Strata control is applicable to coal and other deposits in which the geological structure is organized in more-or-less horizontal layers, or strata.

strike

The direction of the intersection between a bedding plane or fault and the horizontal. (Strike is perpendicular to **dip**.)

stripping

1. Mining coal by first removing the covering overburden down to the coal bed. 2. Open workings, as in a quarry. 3. Sometimes used to describe a final mining operation such as robbing or drawing pillars.

structure

Geologically, the disposition of the rock formations: the broad dips, folds, faults, and unconformities at depth. In petrology, structure refers to any one of the larger features of a rock mass, such as bedding, flow banding, jointing, cleavage, or brecciation. It also refers to the sum total of such features.

subsidence

Lowering of the strata, including the earth's surface, due to underground excavations.

substation

An assemblage of equipment such as generators, transformers, and rectifiers through which electric energy is passed in bulk to change or modify its characteristics.

sulphur content

The percentage by weight of sulphides, sulphates, and organic sulphur compounds in coal.

sump

An excavation made underground to collect water, which can be pumped to surface or used as needed.

sump in

To begin a mining cut with the continuous miner by cutting while tramming forward.

Swellex bolt

A brand of rock bolt that is secured in the hole by inflation with high-pressure water.

T**tailgate**

An entry or set of entries that provides access to a mining face, often acting as the return airway and supply road to the face. Commonly used in longwall mining.

tailings

Waste rock material resulting from processing ores.

tee-jointed duct

A ventilation duct that splits the airflow into two parts to enable ventilation of two headings with one fan.

trailing cable

A flexible electric cable that connects portable equipment used near the face with a power source located at some distance from the face.

tram

To move a self-propelled piece of equipment.

transducer

A device that measures quantities – such as pressure, current, voltage, or gas concentration – in a system and converts them into related or proportional units. A sensor.

transfer points

Points at which coal is transferred from one conveyor to the next.

transformer

A device used in electrical systems to receive electrical energy and deliver that energy to some other device at altered values of voltage and current.

triggered barrier

An explosion suppression device consisting of water or stonedust dispersed into an airway when triggered by electronic or mechanical sensing devices at a working face.

trip

A small train of mine cars. See also **rake**.

Trojan horse

A term, used only at Westray, referring to a set of steel arches

constructed to provide protection for people working under a caved intersection in the North Mains.

tunnel

A horizontal connecting passage between two mines or systems of workings.

U

underground manager

In Nova Scotia, a person in charge of the underground workings of a coal mine (under the control and supervision of a manager) and who has a second-class certificate of competency as a mine official.

upcast

The passages from and in a mine from which air leaves the mine.

V

vent tube

See **ducting**.

ventilation

The provision of an adequate flow of fresh air along all roadways, workings, and service points underground. Ventilation is an essential factor in safety, health, and working efficiency; it dilutes and removes noxious or flammable gases and helps abate such problems as dust and high temperatures.

ventilation efficiency

One measure of the efficiency of a mine ventilation system is the ratio of the total airflow handled by the fan to the airflow actually getting to the working faces. For example, if 94 m³/s (200,000 cfm) are handled by the fan and only 47 m³/s (100,000 cfm) get to the working faces, the efficiency is 50 per cent.

ventilation planning

The calculation and description of airflows, velocities, and pressures – and the principal appliances, including fans, to control and distribute the air – in a proposed new mine or a new seam to be worked from an existing mine.

ventilation shaft

A vertical opening into a mine for the passage of fresh air to the mine or the removal of dust and gases from the mine.

ventilation survey

A quantitative survey to determine how much air is circulating through mine workings. Airflows are normally calculated from measurements of cross-sectional area and air velocity using an anemometer or smoke tubes. The ventilation survey provides and updates the data required for ongoing ventilation planning.

W

Wagner Mining Equipment Co.

The manufacturer of Scooptrams and utility vehicles.

wet-bulb temperature

1. A measure of the combined effect of temperature and humidity. 2. The lowest temperature that can be produced in given air by the evaporation of moisture into that air.

whip

A short extension electrical cable attached to the control box of an electrically powered machine, or from the gate-end box to the machine cable.

winch

1. A drum that can be rotated to exert a strong pull while winding in a line.
2. See **hoist**.

wire mesh

Steel wire welded to form a 4-by-8-foot or 6-by-12-foot sheet of mesh. Normally, a sheet with 4-by-4-inch openings was used at Westray. See also **screen**.

working

Rock or coal is “working” when it is being squeezed by pressure and emitting creaking noises and dropping small pieces into openings. This activity often serves as a warning to miners that additional support is needed or that a cave-in is imminent.

working face

Any face in a mine from which coal is being cut, sheared, broken, or loosened.

workings

A mine as a whole, or that part of a mine in which mining operations are going on.

Abbreviations

AC

alternating current

ACGIH

American Conference of
Government Industrial Hygienists

ACOA

Atlantic Canada Opportunities
Agency

AEP

Atlantic Enterprise Program

ASTMS

American Society for Testing
and Materials Specifications

(A)TRS

(Automatic) Temporary Roof
Support System (on roof bolters)

BHP

brake horsepower

BTU

British thermal unit – a measure
of energy

CANMET

Canada Centre for Mineral
and Energy Technology

CBDC

Cape Breton Development
Corporation (more commonly
known as Devco)

CBM

coalbed methane

cfm

cubic feet per minute – a
measurement of airflow in mine
ventilation

CFR

Code of Federal Regulations

CMD

Canadian Mine Development
(division of Hillsborough Resources
Limited; main contractor for Westray
Coal)

CSA

Canadian Standards Association

DC

direct current

DNR

Nova Scotia Department of Natural
Resources

DOL

Nova Scotia Department of Labour

EMR

Energy, Mines and Resources –
a Canadian federal department

IRS

internal responsibility system

kcfm

thousand cubic feet per minute

LHD

load-haul-dump – refers to an
underground front-end loader

LTA

lost-time accidents

MSHA

Mine Safety and Health
Administration – a U.S. government
(Department of Labor) body that
sees to the safety of mines and
equipment used in mines

NSPC

Nova Scotia Power Corporation
(NS Power)

NSR

Nova Scotia Reporter

ppm

parts per million – a measure
of chemical concentration

PVC

polyvinyl chloride (a plastic
often used to make pipes)

RCMP

Royal Canadian Mounted Police

ROM

run-of-mine

RSA Revised Statutes of Alberta	SOS start of shift
RSNS Revised Statutes of Nova Scotia	TLV threshold limit value
RSO Revised Statutes of Ontario	USBM United States Bureau of Mines
SBC Statutes of British Columbia	x-cut or XC cross-cut
SCSR self-contained self-rescuer	
SNS Statutes of Nova Scotia	

Units of Measurement

cfm cubic feet per minute
(0.0283) – a measure of airflow

ha hectare (2.47 acres)

Hz hertz (cycles per second) –
a measure of electrical frequency

kcfm thousand cubic feet
per second (28.3 m³/s)

kg kilogram (2.2 pounds)

km kilometre (0.62 miles)

kPa kiloPascal – a measure
of pressure

kW kilowatt (1.34 horsepower) –
a measure of power

m metre (3.28 feet)

m/s metres per second –
a measure of velocity

m³/s cubic metres per second
(35 cfm)

mm millimetre

MPa megaPascal (145 psi)

Pa Pascal

ppm parts per million

s second

t tonne

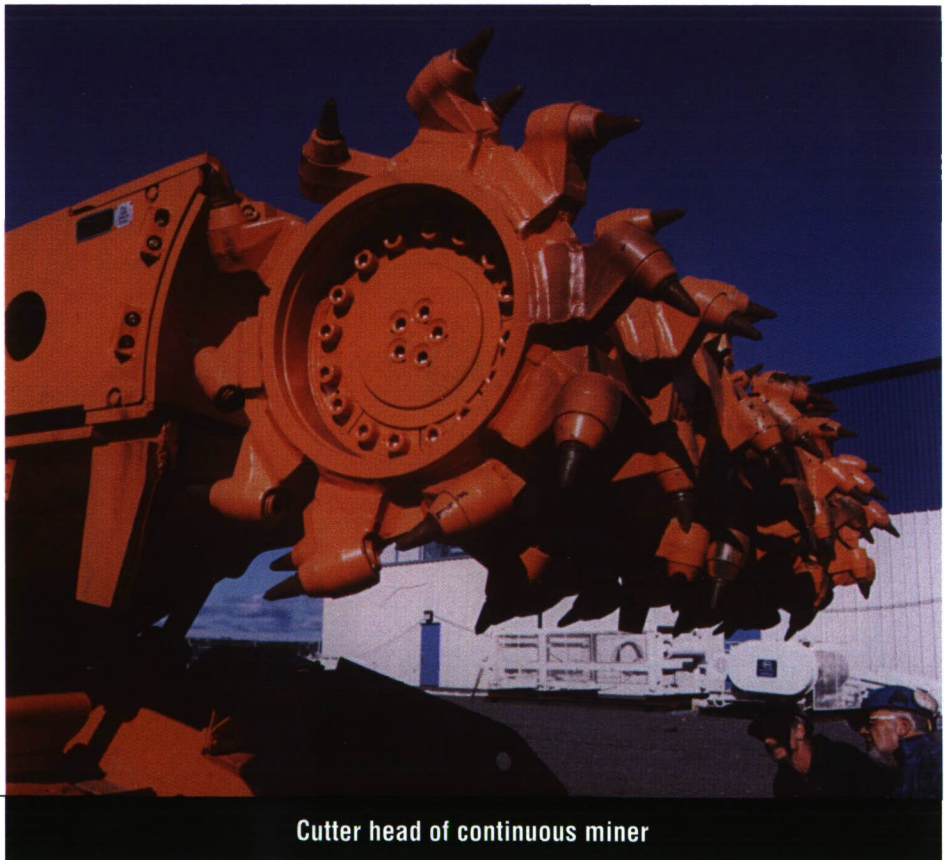
Photographs of Equipment Used at Westray

Photograph 1	Joy continuous miner 26
Photograph 2	Cutter head of continuous miner 26
Photograph 3	Joy shuttle car 27
Photograph 4	Stamler feeder-breaker 27
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Photograph 1

Joy continuous miner



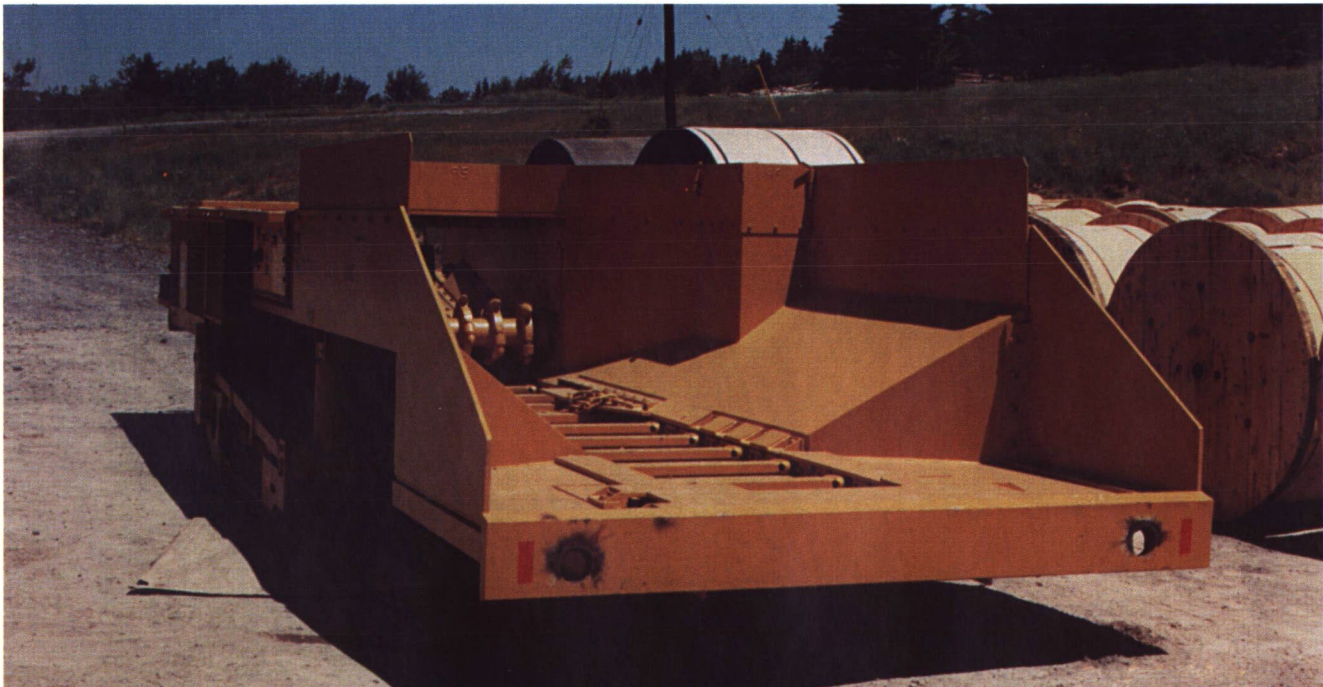
Photograph 2

Cutter head of continuous miner



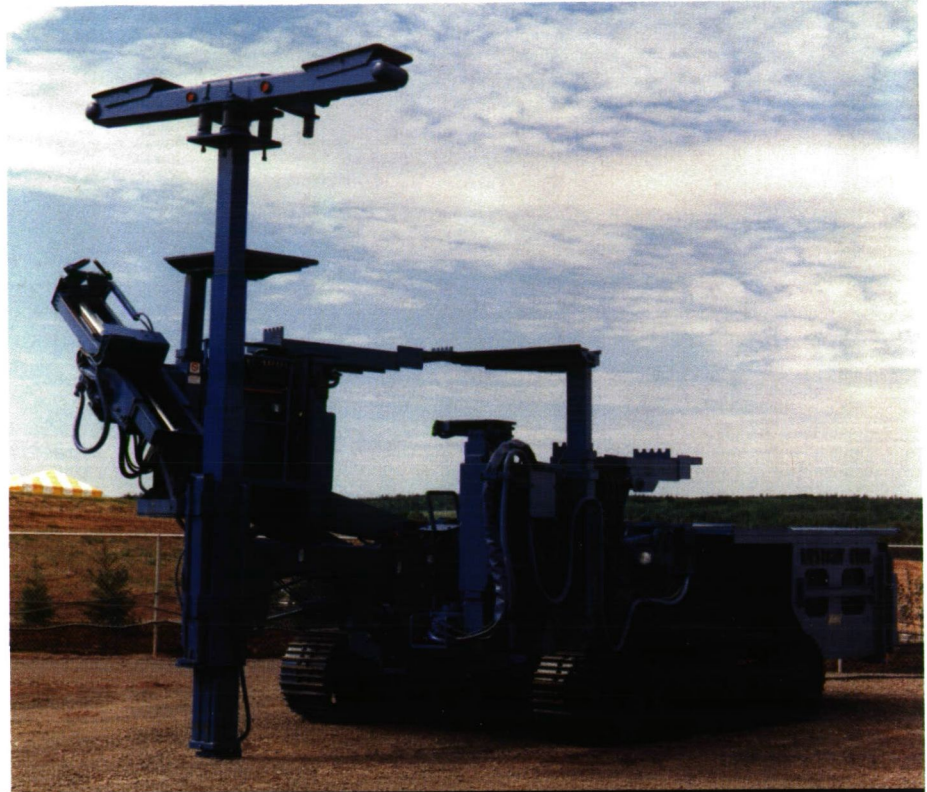
Photograph 3

Joy shuttle car



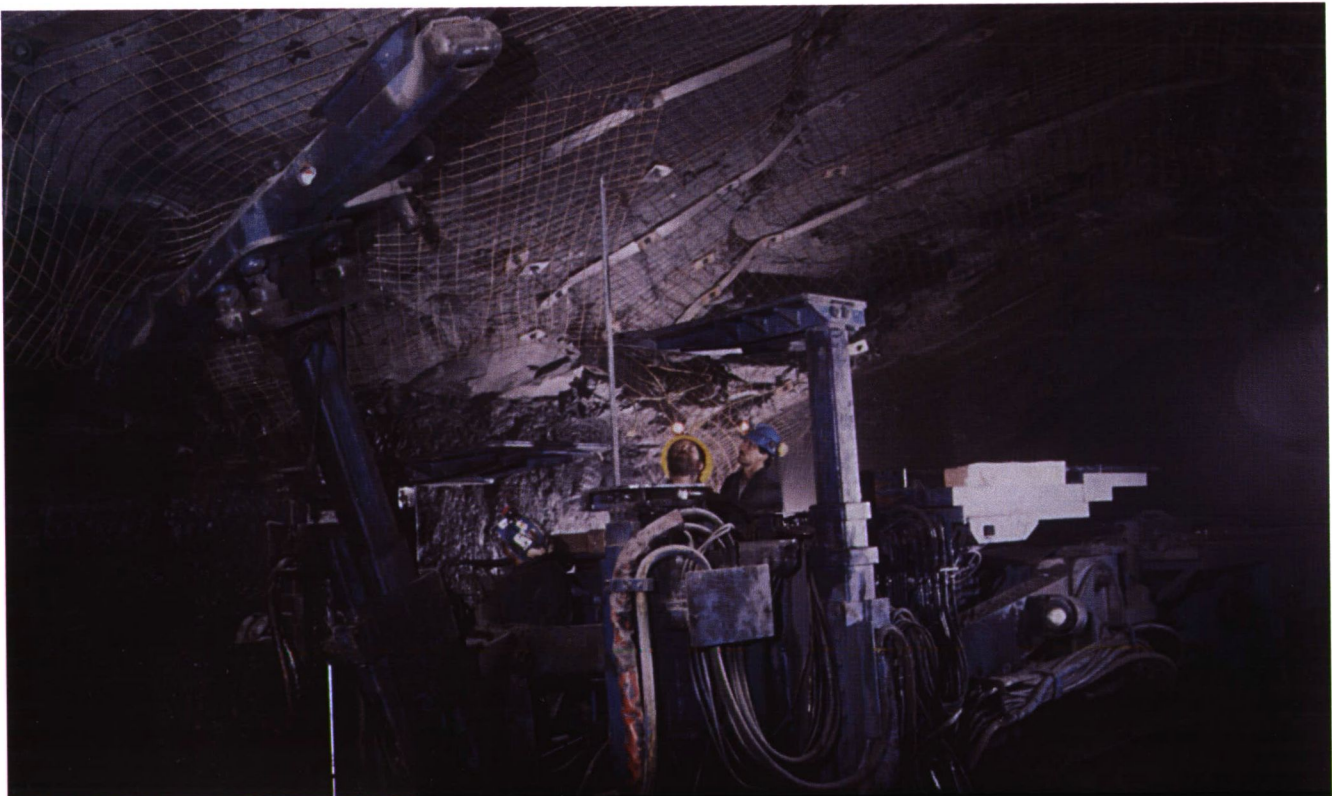
Photograph 4

Stamler feeder-breaker



Photograph 5

Fletcher roof bolter



Photograph 6

Roof bolter in operation underground at Westray



Photograph 7

Wagner Scooptram



Photograph 8

Draeger Oxy-SR 60 B self-contained self-rescuer
30 cm high x 22 cm wide x 14 cm deep



Photograph 9

MSA W65 self-rescuer
14 cm high x 10 cm wide x 8 cm deep



Photograph 10

MSA Spotter® hand-held methanometer

Post-Explosion Photographs

-
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- Photograph 27 Temporary stopping in No. 9 Cross-cut as seen from No. 1 Main **40**
-



Photograph 11

Damage to portal at No. 1 Main

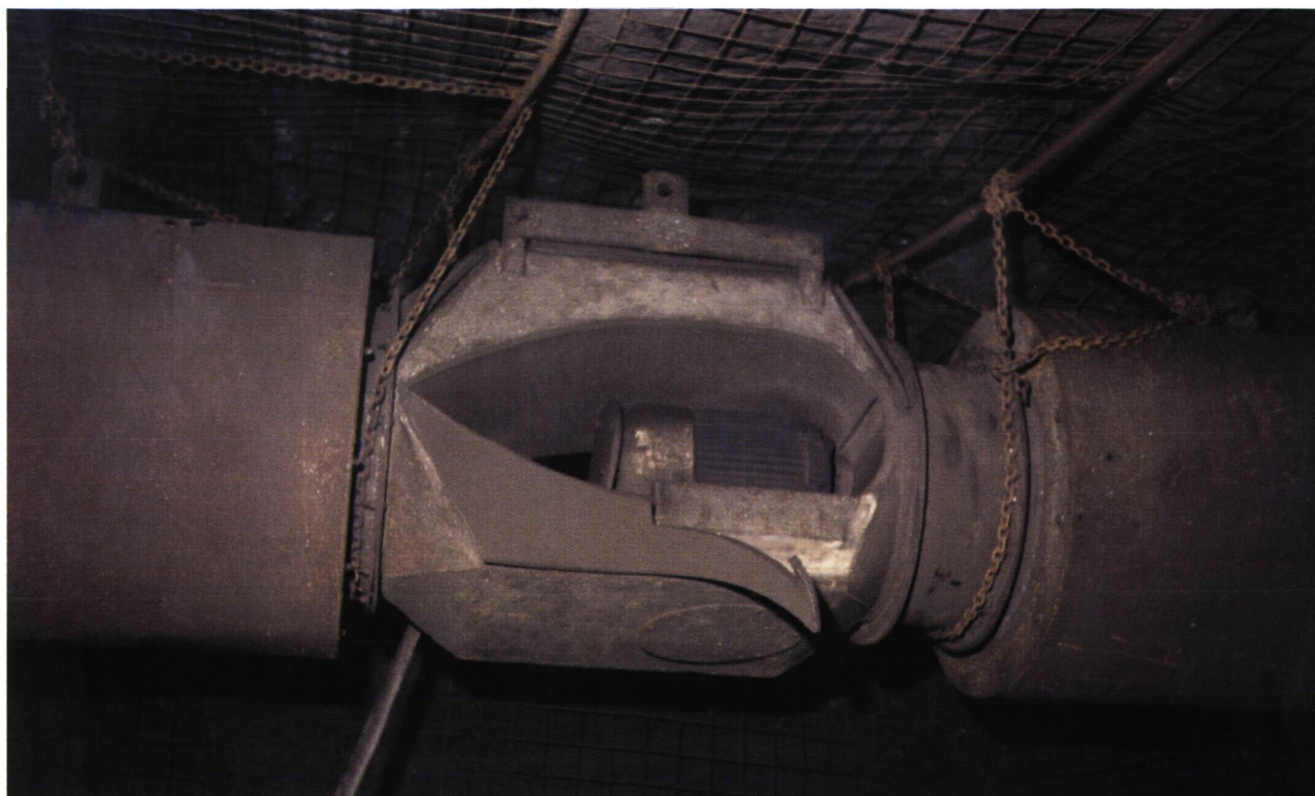
Exhibit 59, photo 1 (RCMP photo 15)



Photograph 12

Fallen arches at intersection of SW1-B Road and SW1-2 Cross-cut

Exhibit 59, photo 10 (RCMP photo 156)



Photograph 13

Ventilation fan on high side of SW2-2 Cross-cut

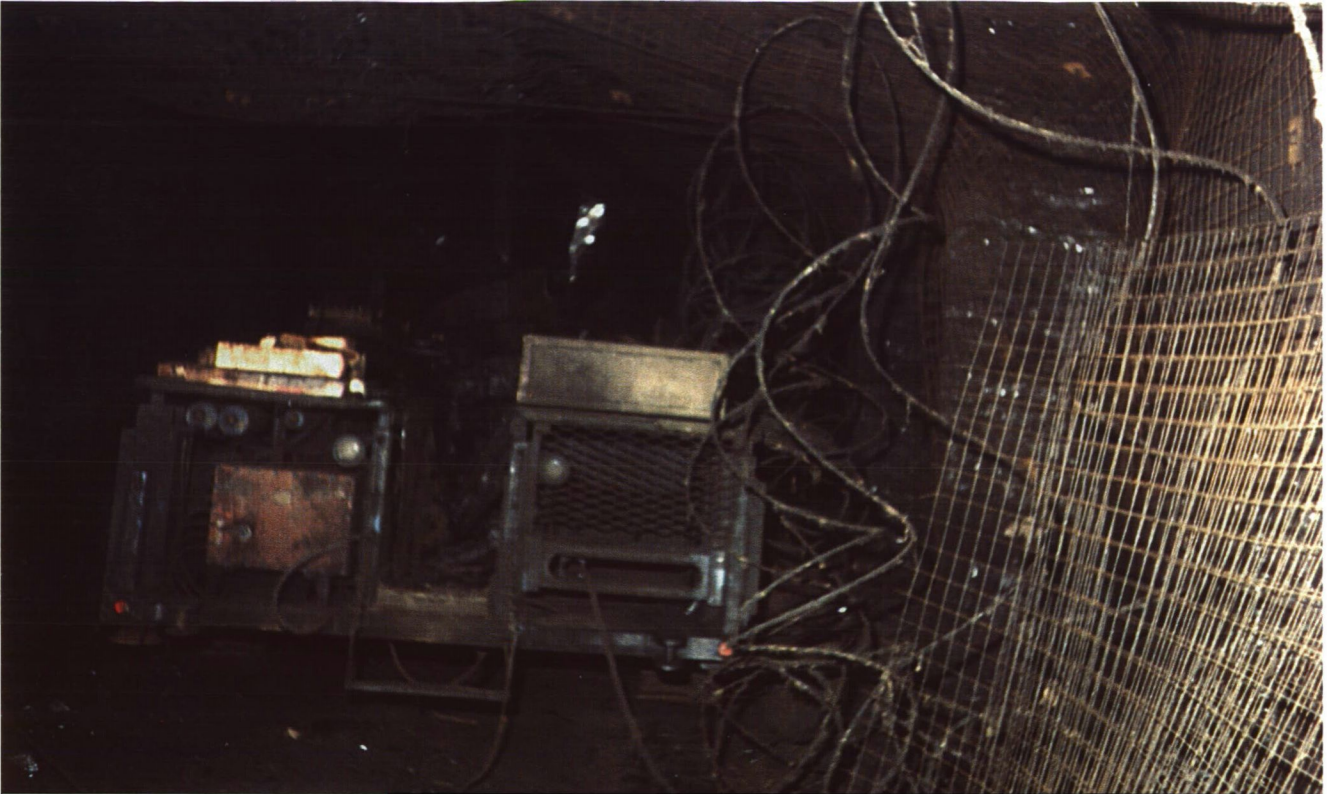
Exhibit 59, photo 15 (RCMP photo 194)



Photograph 14

Rock fall at top of SW2-A Road

Exhibit 59, photo 19 (RCMP photo 191)



Photograph 15

Roof bolter in Lefthander (west of SW2-1 Road)

Exhibit 59, photo 21 (RCMP photo 225)



Photograph 16

Working face of SW2-1 Road

Exhibit 59, photo 23 (RCMP photo 250)



Photograph 17

Continuous miner at working face of SW2-1 Road

Exhibit 59, Photo 24 (RCMP photo 245)



Photograph 18

Rear of shuttle car and continuous miner in SW2-1 Road

Exhibit 59, photo 25 (RCMP photo 236)



Photograph 19

Rear of shuttle car in SW2-1 Road, showing burned and unburned ventilation ducting
Exhibits 122.09, 73.07 (RCMP photo 234)



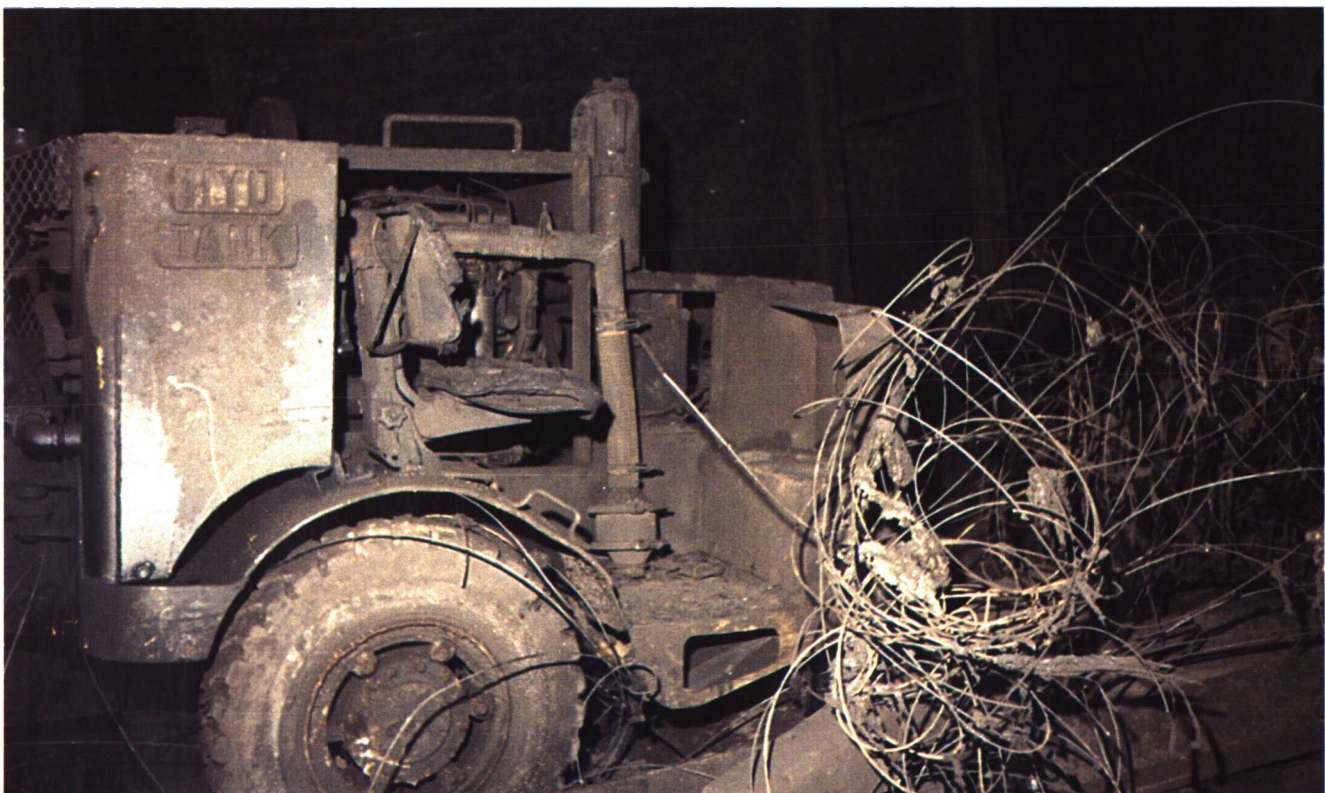
Photograph 20

SW2-1 Road towards face from intersection with SW2-B Road
Exhibit 59, photo 26 (RCMP photo 203)



Photograph 21

Boom truck at intersection of SW2-B and SW2-1 Roads
Exhibit 59, photo 27 (RCMP photo 196)



Photograph 22

Boom truck and ducting wire at the intersection of SW2-B and SW2-1 Roads
Exhibit 73.10.066A (RCMP photo 200)



Photograph 23

Lower side of roof fall in No. 2 Main between No. 7 and No. 8 Cross-cuts

Exhibit 59, photo 45 (RCMP photo 106)



Photograph 24

Remains of conveyor belt drive in No. 2 Main at No. 5 Cross-cut

Exhibit 59, photo 47 (RCMP photo 99)



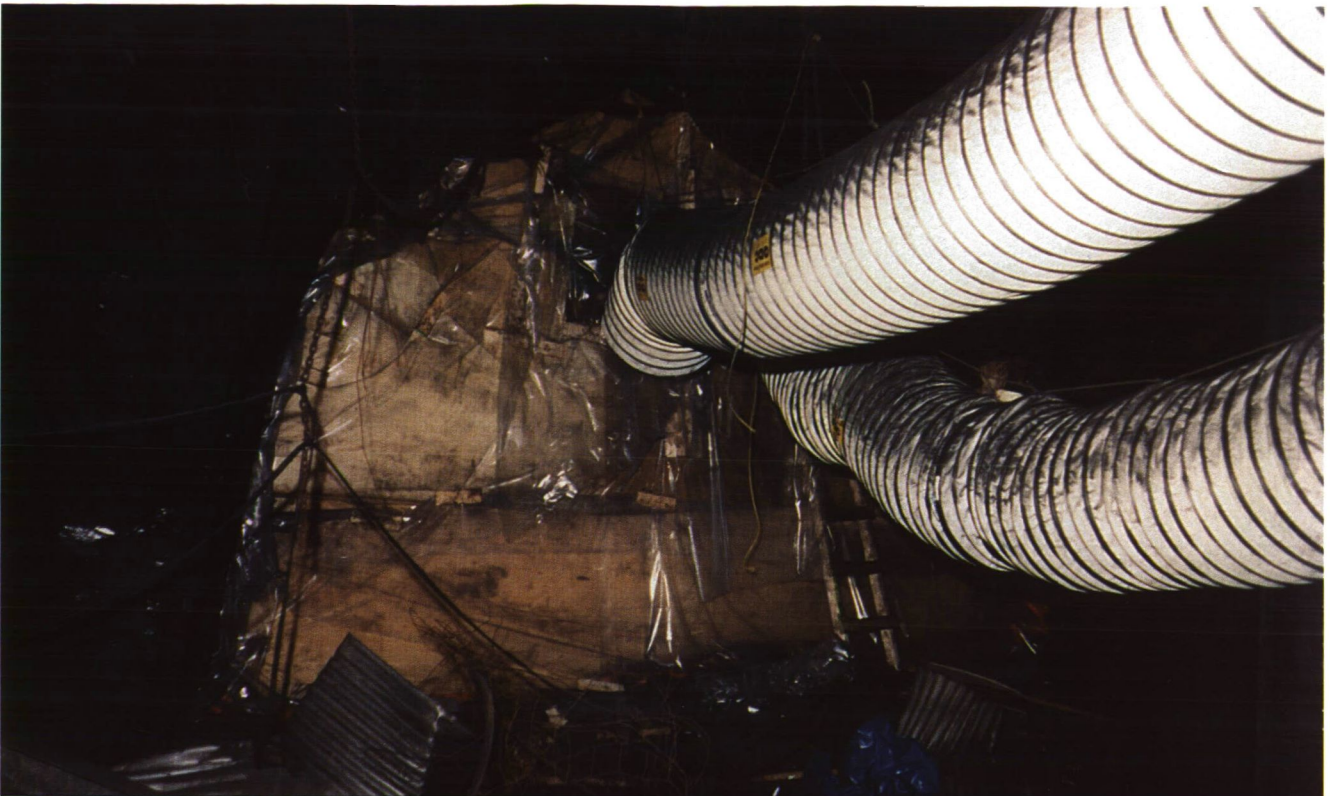
Photograph 25

Remains of conveyor in No. 2 Main outbye No. 5 Cross-cut
Exhibit 59, photo 49 (RCMP photo 93)



Photograph 26

Temporary stopping in No. 8 Cross-cut as seen from No. 1 Main
(RCMP photo 38)



Photograph 27

Temporary stopping at No. 9 Cross-cut as seen from No. 1 Main
(RCMP photo 43)

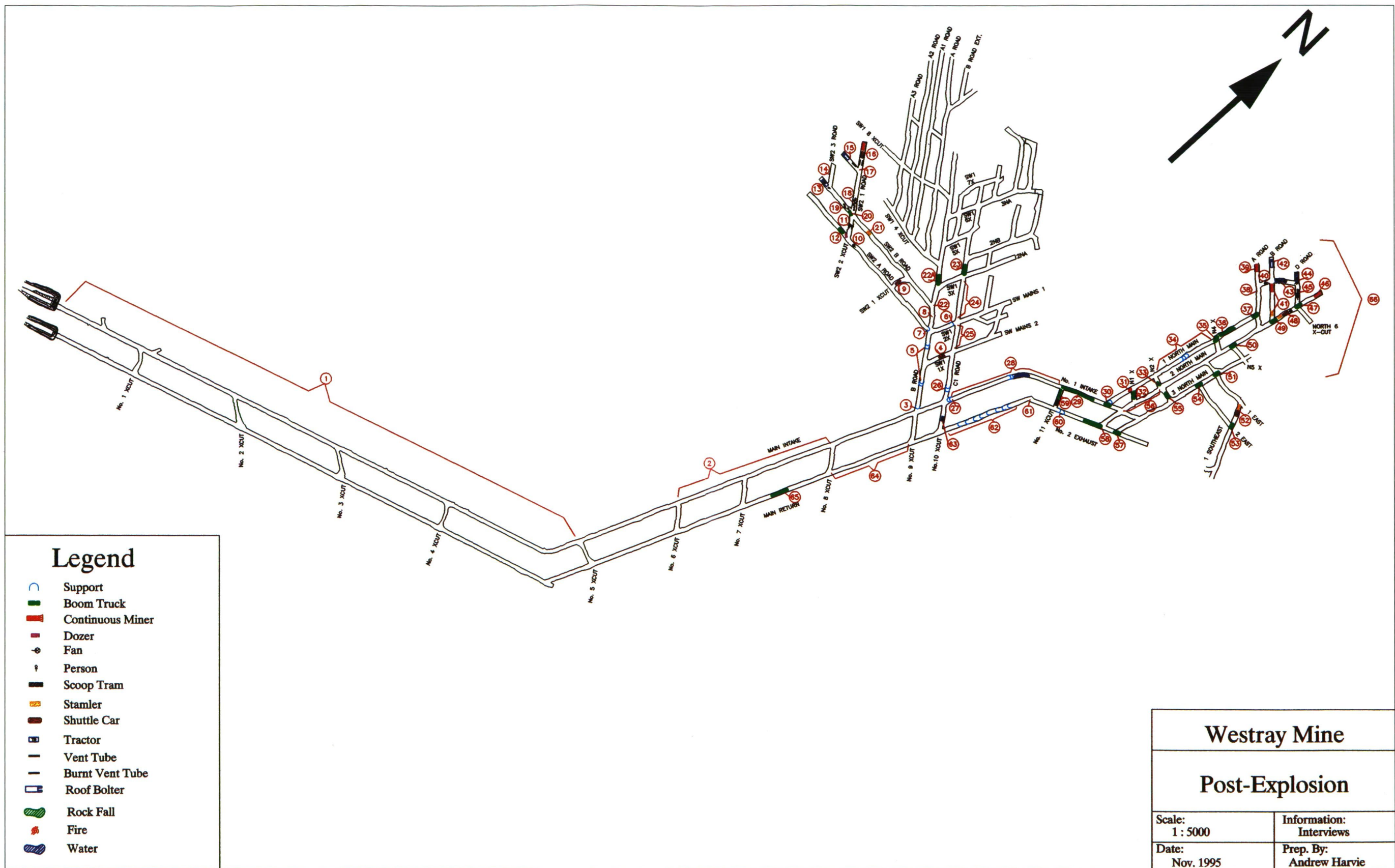
Maps

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Map 9	Geotechnical View of North Mains Section
Map 10	Approved Mine Layouts
Map 11	Proposed Mining Plan for Southwest Block
Map 12	Proposed Mining Plan for Southwest Panel (Alternative 2)

Map 1

The Westray Mine, Post-Explosion

Map 1

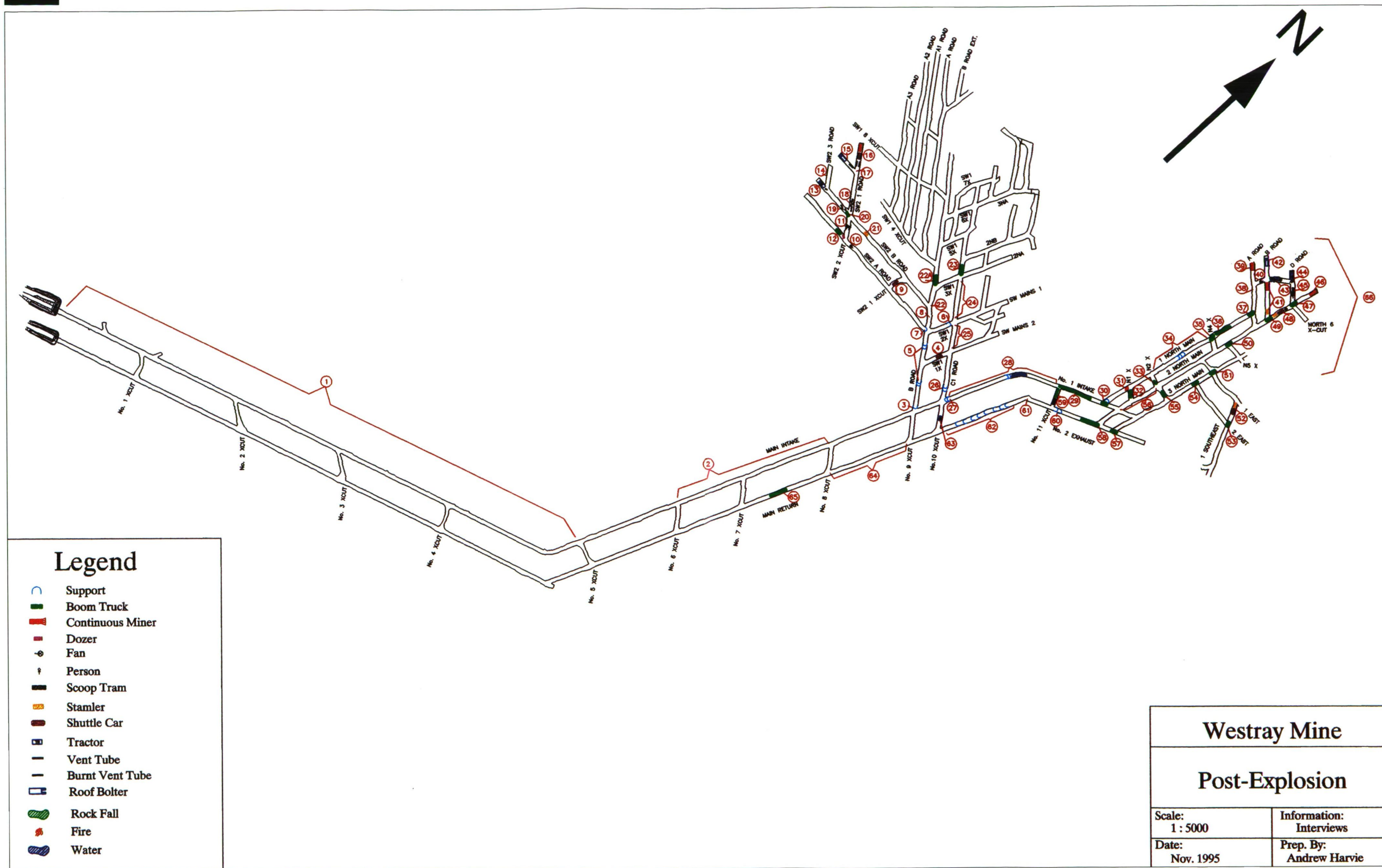




Map 1

The Westray Mine, Post-Explosion

Map 1

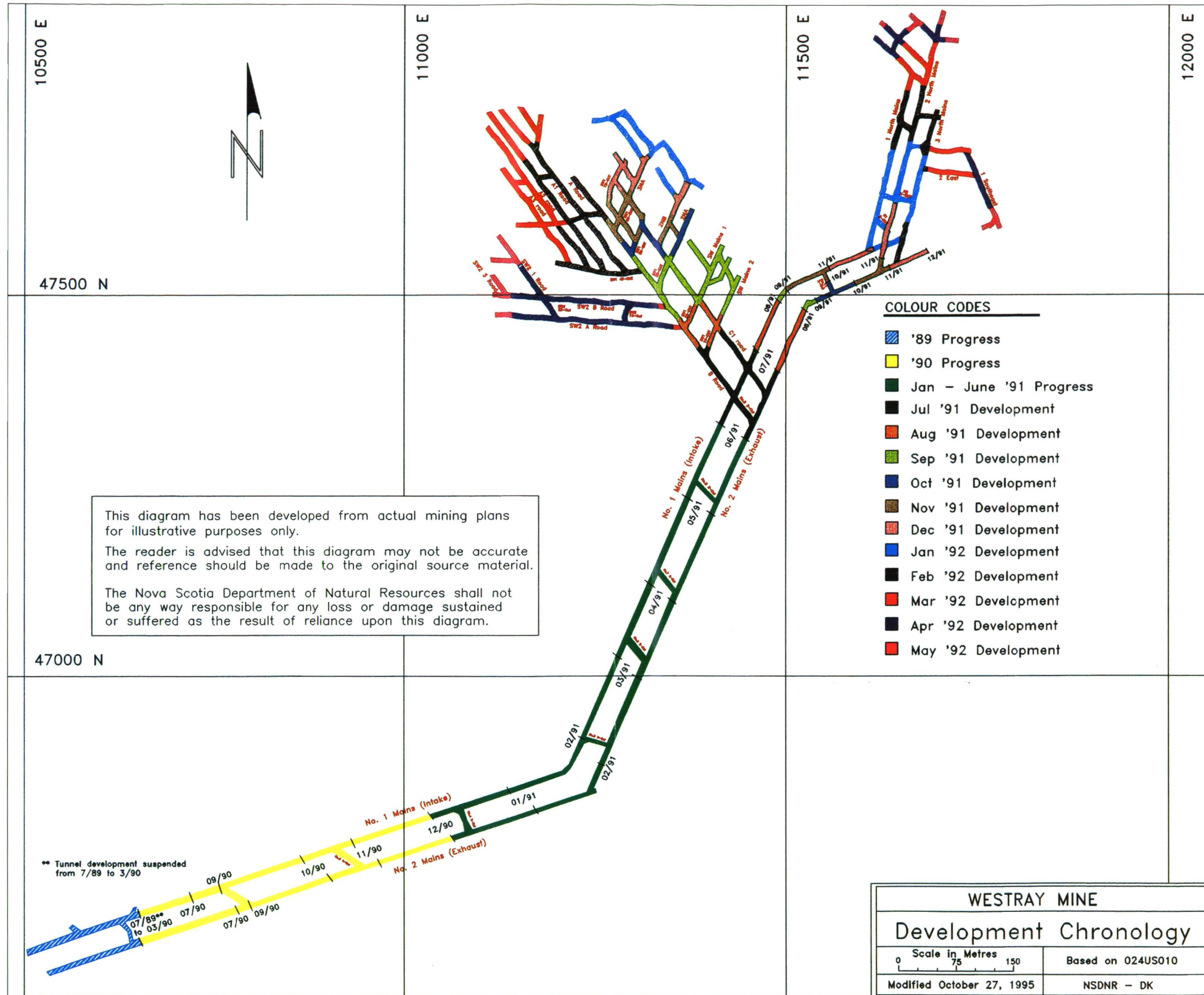


Source: Exhibit 74

Map 2

Development Chronology

Map 2





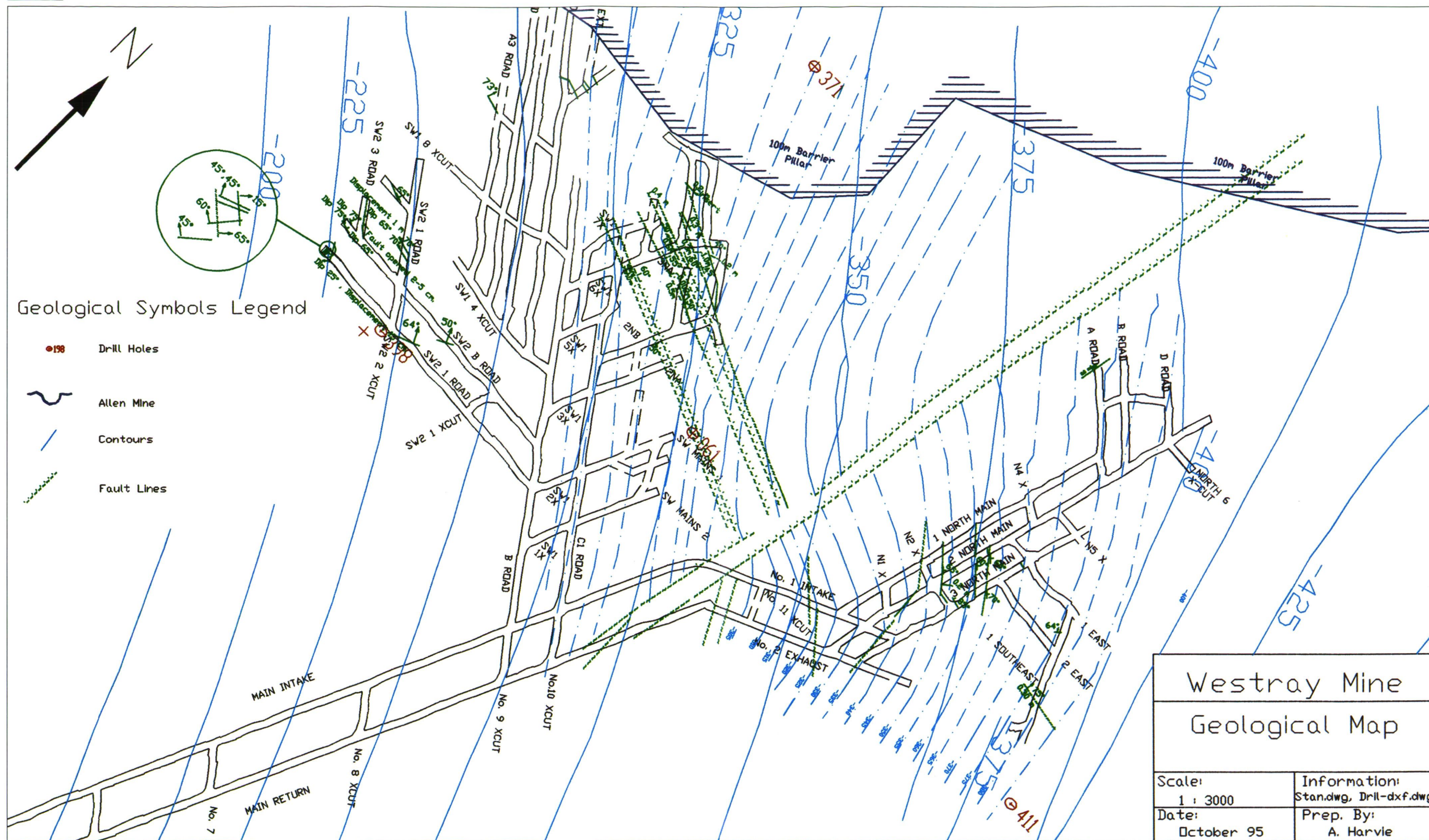
Map 3

Mobile Equipment Locations

Map 4

Geological View of Westray Mine

Map 4



Source: Exhibit 45.14

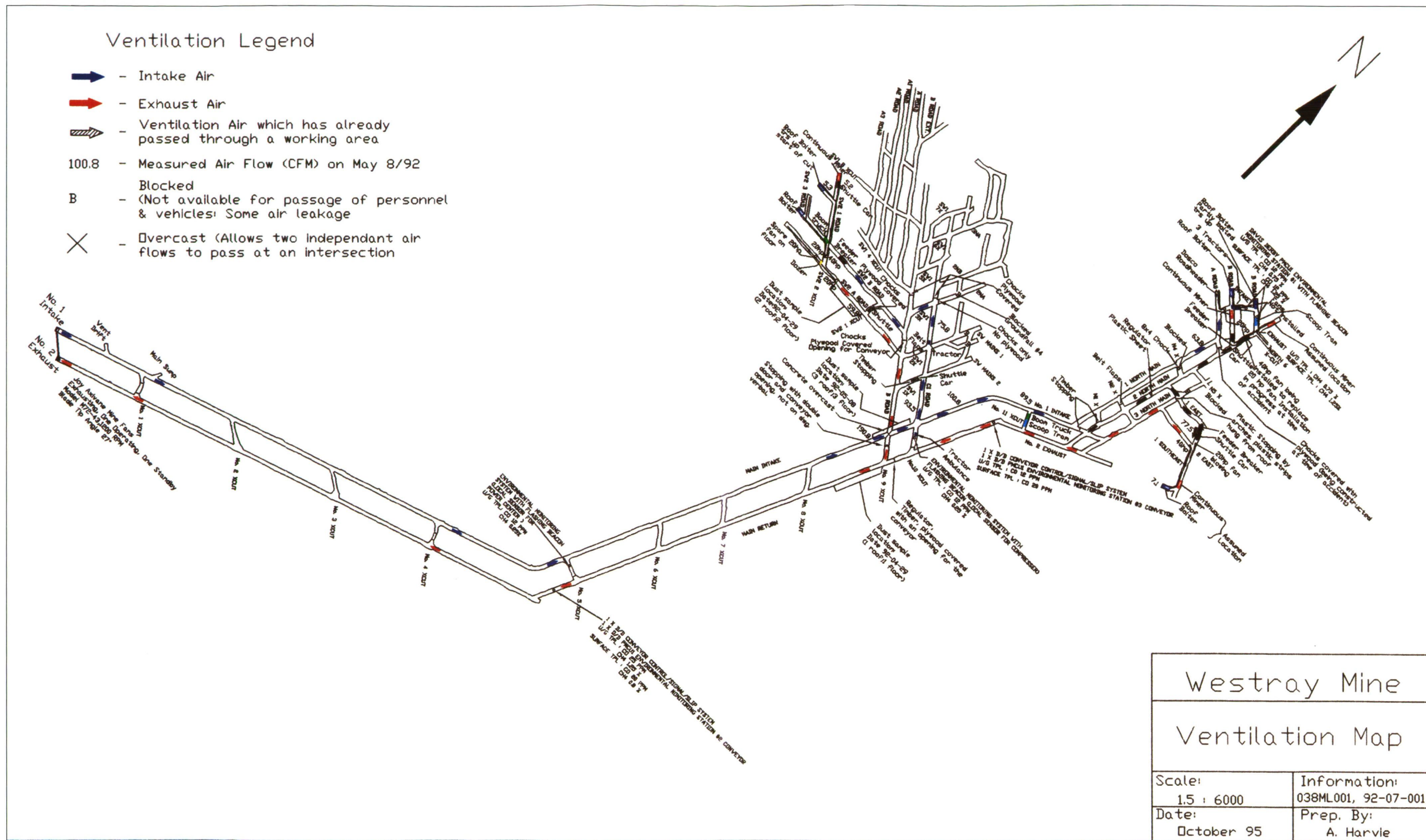


Map 5

Ventilation of Westray Mine



Map 5



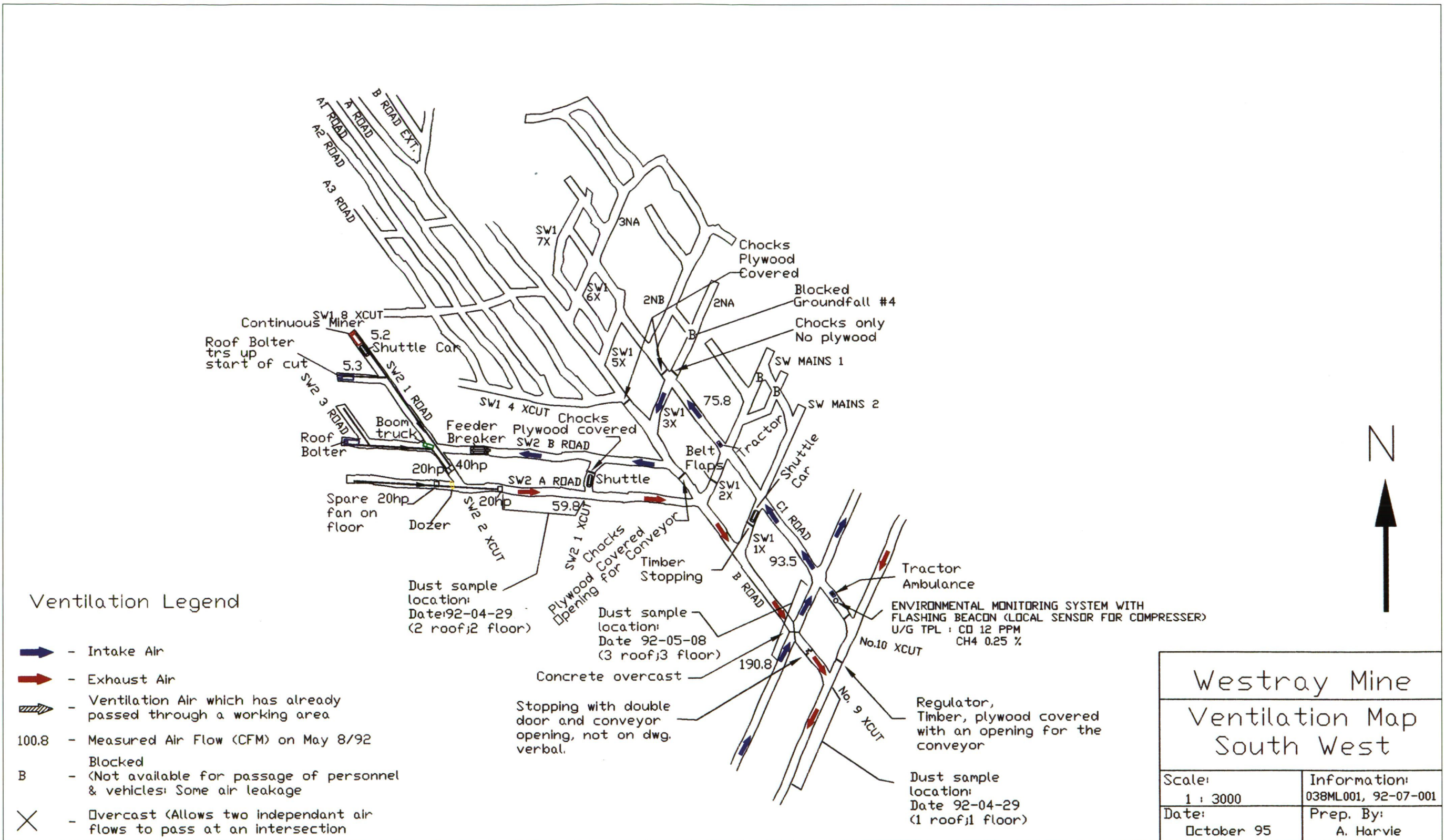
Source: Exhibit 45.11



Map 6

Ventilation of Southwest Section

Map 6



Source: Exhibit 45.11

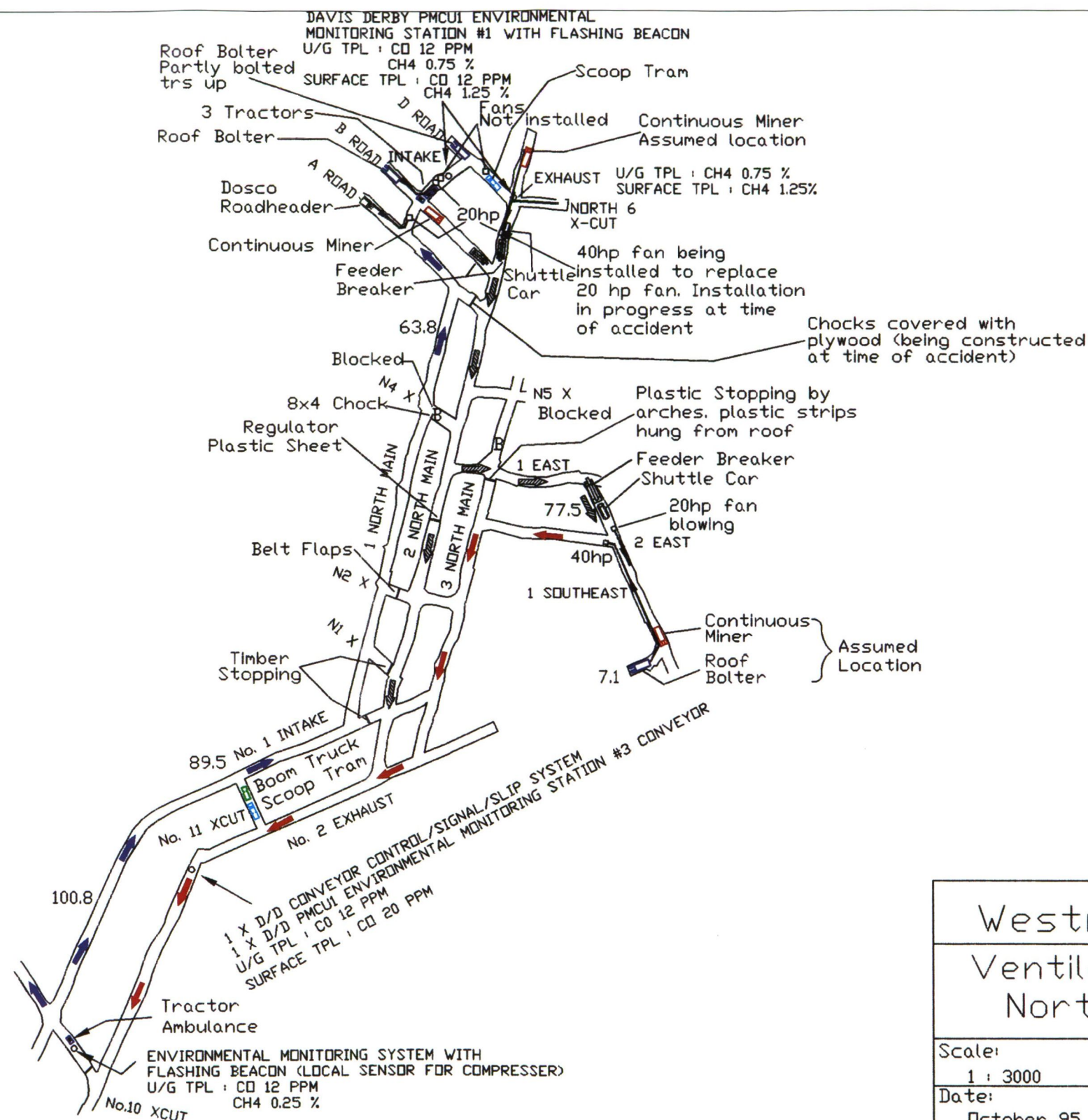
Map 7

Ventilation of North Mains Section

Map 7

Ventilation Legend

- ➡ - Intake Air
- ➡ - Exhaust Air
- ➡ - Ventilation Air which has already passed through a working area
- 100.8 - Measured Air Flow (CFM) on May 8/92
- B - Blocked (Not available for passage of personnel & vehicles; Some air leakage)
- X - Overcast (Allows two independant air flows to pass at an intersection)



Westray Mine Ventilation Map North Mains

Scale: 1 : 3000	Information: 038ML001, 92-07-001
Date: October 95	Prep. By: A. Harvie

Map 8

Geotechnical View of Southwest Section

Map 8

Cutter Notes

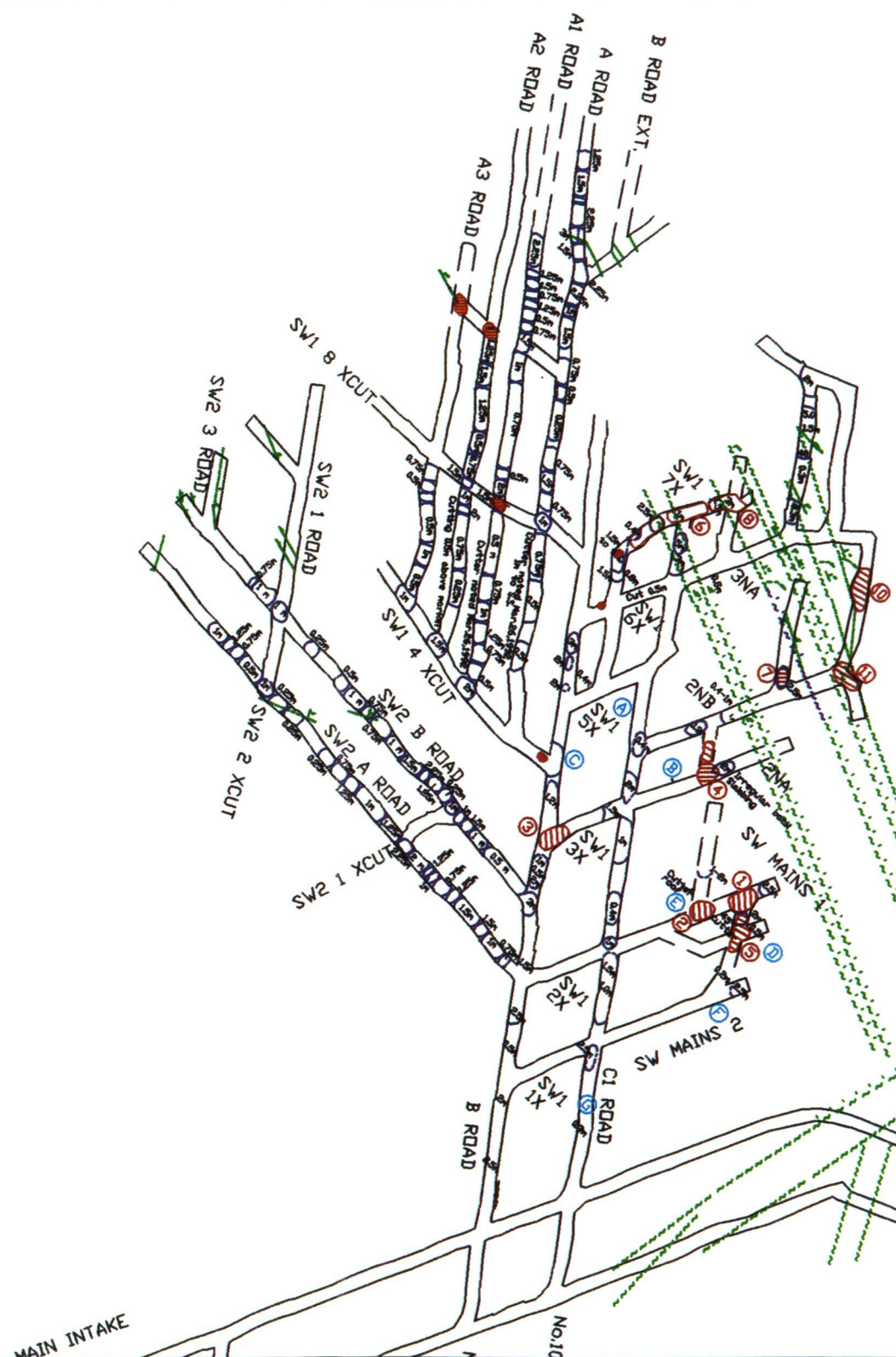
- (A) Cutter roof plates missing or def. Observed 9/11/10 9/11/25
Most 3rd row bolts (through cutter) missing plates over a 20m interval
- (B) Cutter roof first observed 9/11/09 9/11/16
- (C) Cutter roof bolts showing wgt. or missing plates along up dip rib Obs. 9/11/05 0.3-0.5m
- (D) Cutter roof, Bolts showing wgt. Some plates missing Obs 9/11/15
- (E) Cutter roof bolts showing wgt. on down dip edge
- (F) Bolts showing wgt. Back sagging and slabbing
- (G) Cutter roof Bolt plates showing wgt. Back sagging onto arches

Roof Falls

	Date	Height x Width
1	09-28-91	12m x 10m
2	10-02-91	8m x 8m
3	10-12-91	10m x 8m
4	12-02-91	8m x 8m
5	12-11-91	8m x 10m
6	12-11-91	3m x 6m
7	12-27-91	3m x 6m
8	12-27-91	10m x 8m
9	12-29-91	8m x 5.5m
10	01-22-92	12m x 9m
11	02-24-92	3m x ??
12	02-09-92	15m x 15m
13	02-22-92	3m x 5m
14	03-10-92	9m x 11.4m
15	04-06-92	5m x 6.1m
16	04-24-92	5m x 6m

LEGEND

- Pillar slabbing
- XXXX Cutter Roof
- ↓ Slickenside direction
- ~~~~~ Fault
- Roof Falls
- Cleat Separation
- Over Break



Westray Mine Geotechnical Map South-West

Scale:
1 : 3000

Information:
Stand.dwg

Date:
October 95

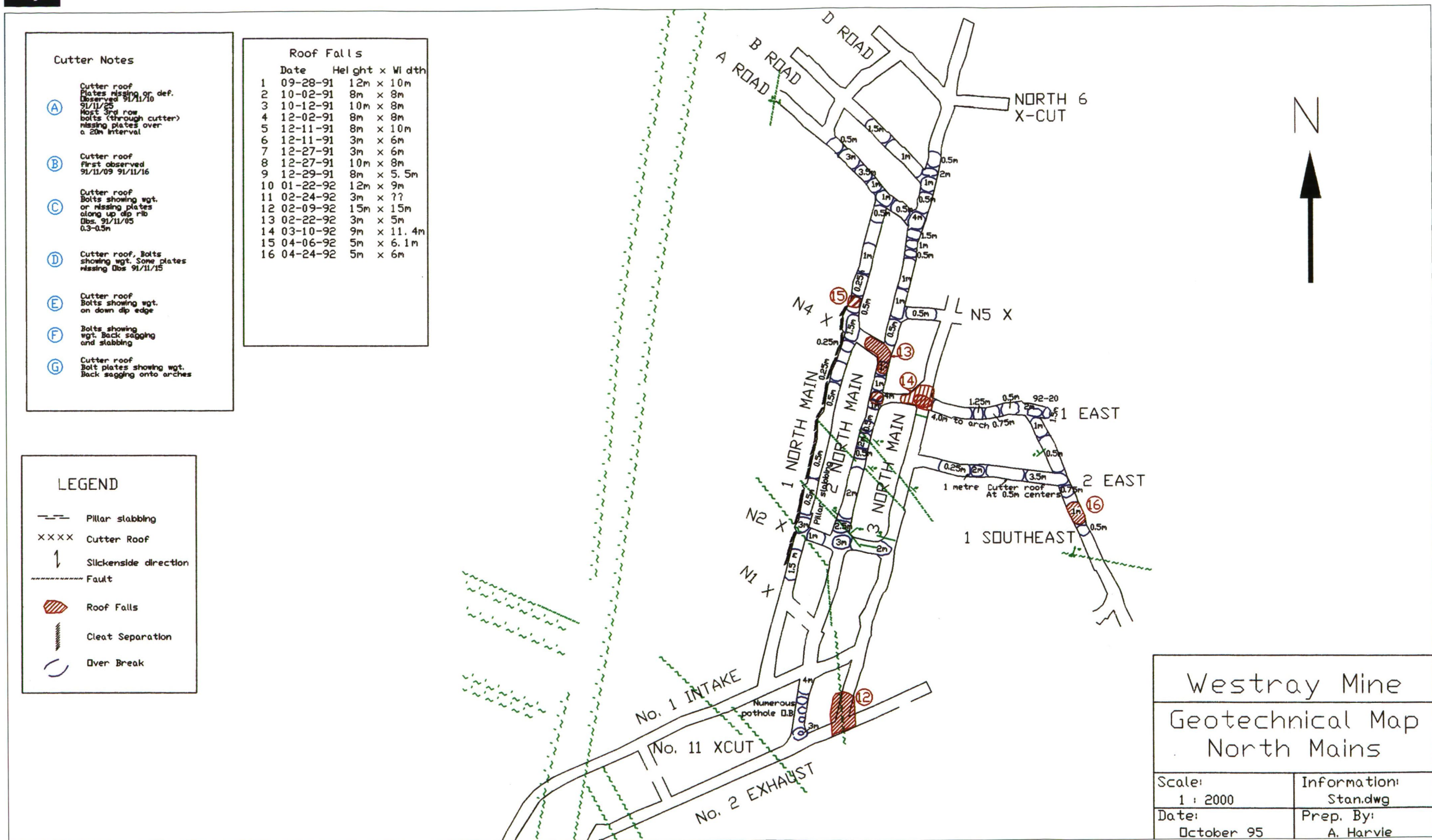
Prep. By:
A. Harvie



Map 9

Geotechnical View of North Mains Section

Map 9

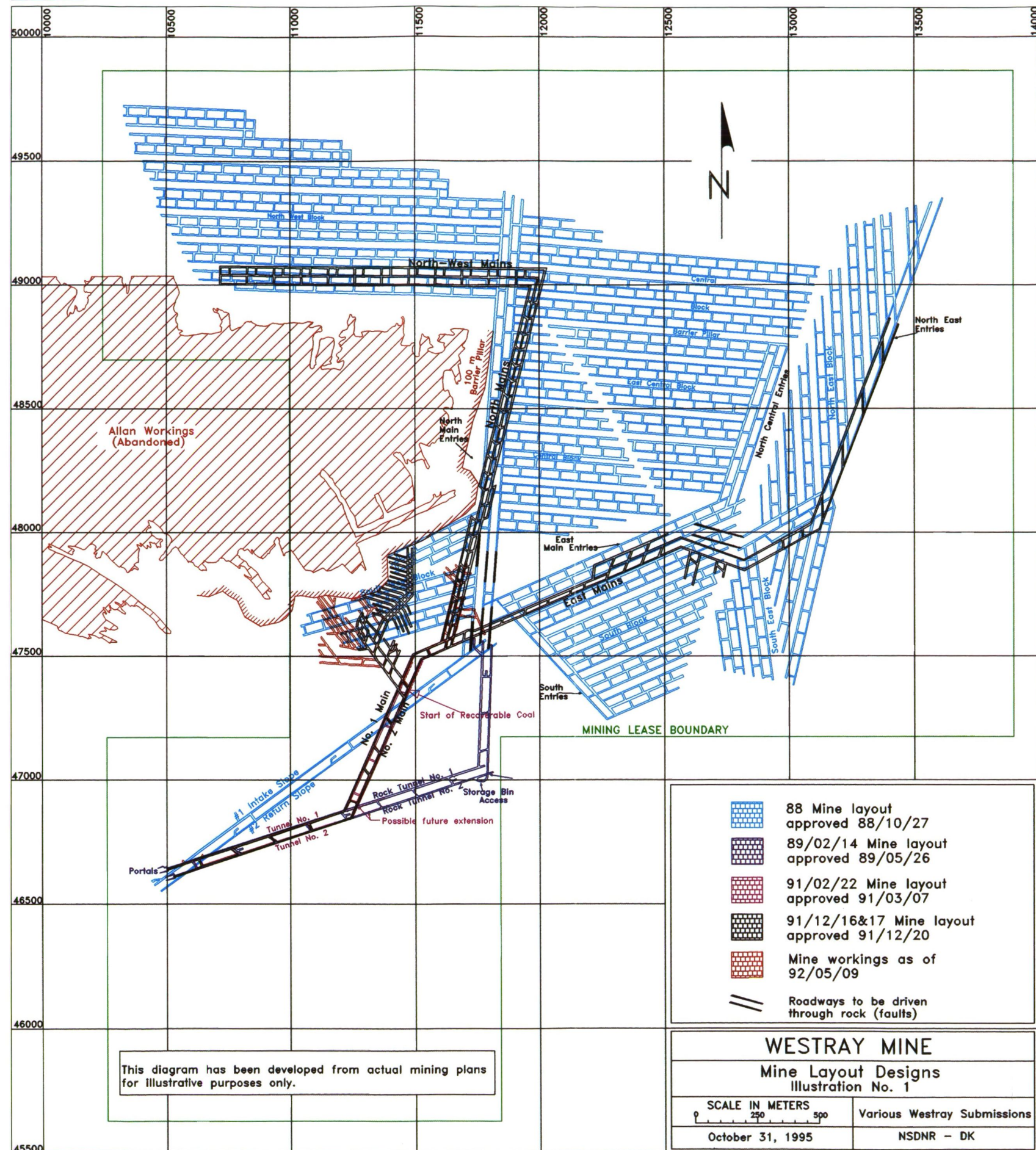


Source: Exhibit 45.15

Map 10

Approved Mine Layouts

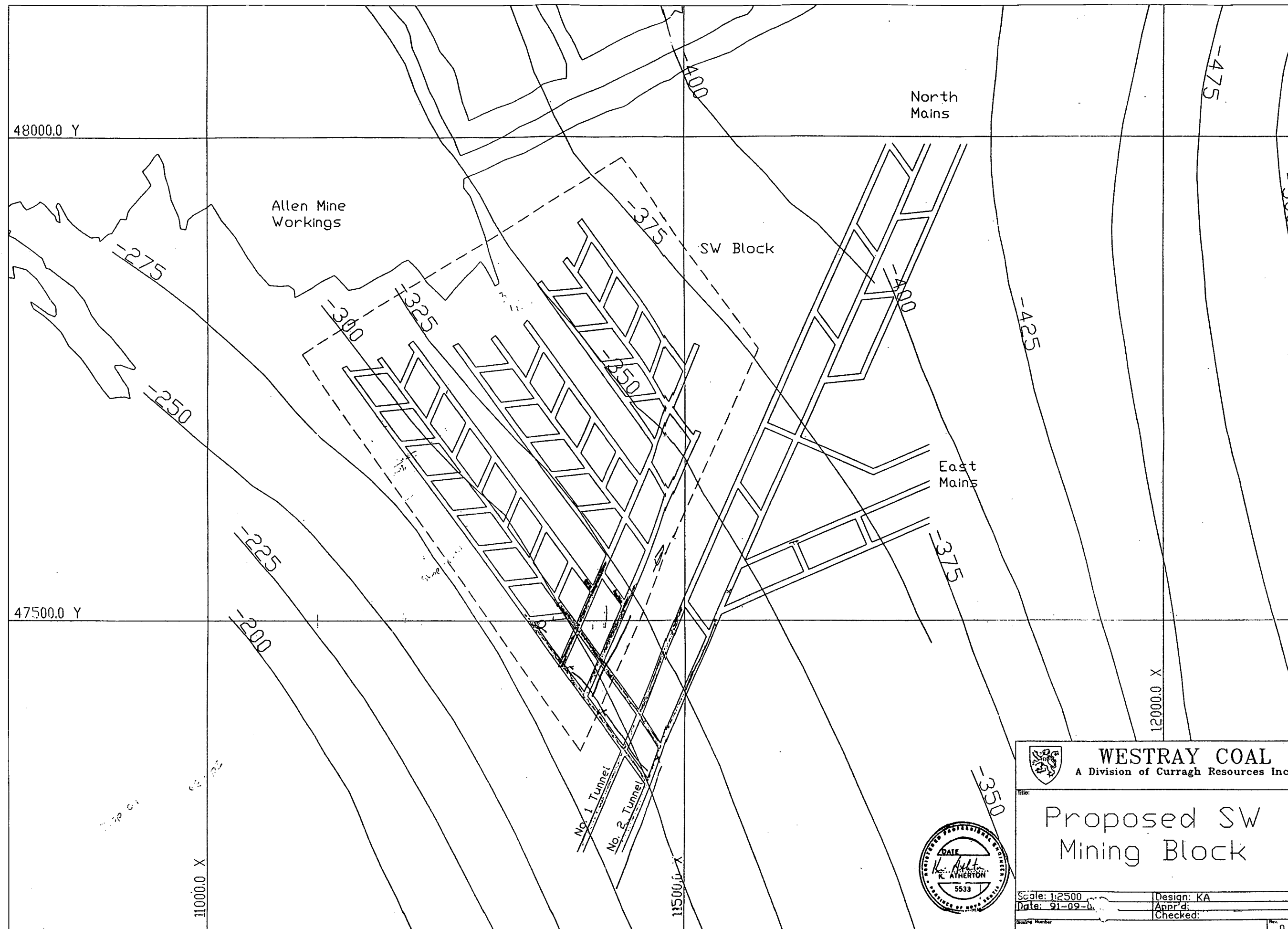
Map 10





Map 11

Proposed Mining Plan for Southwest Block



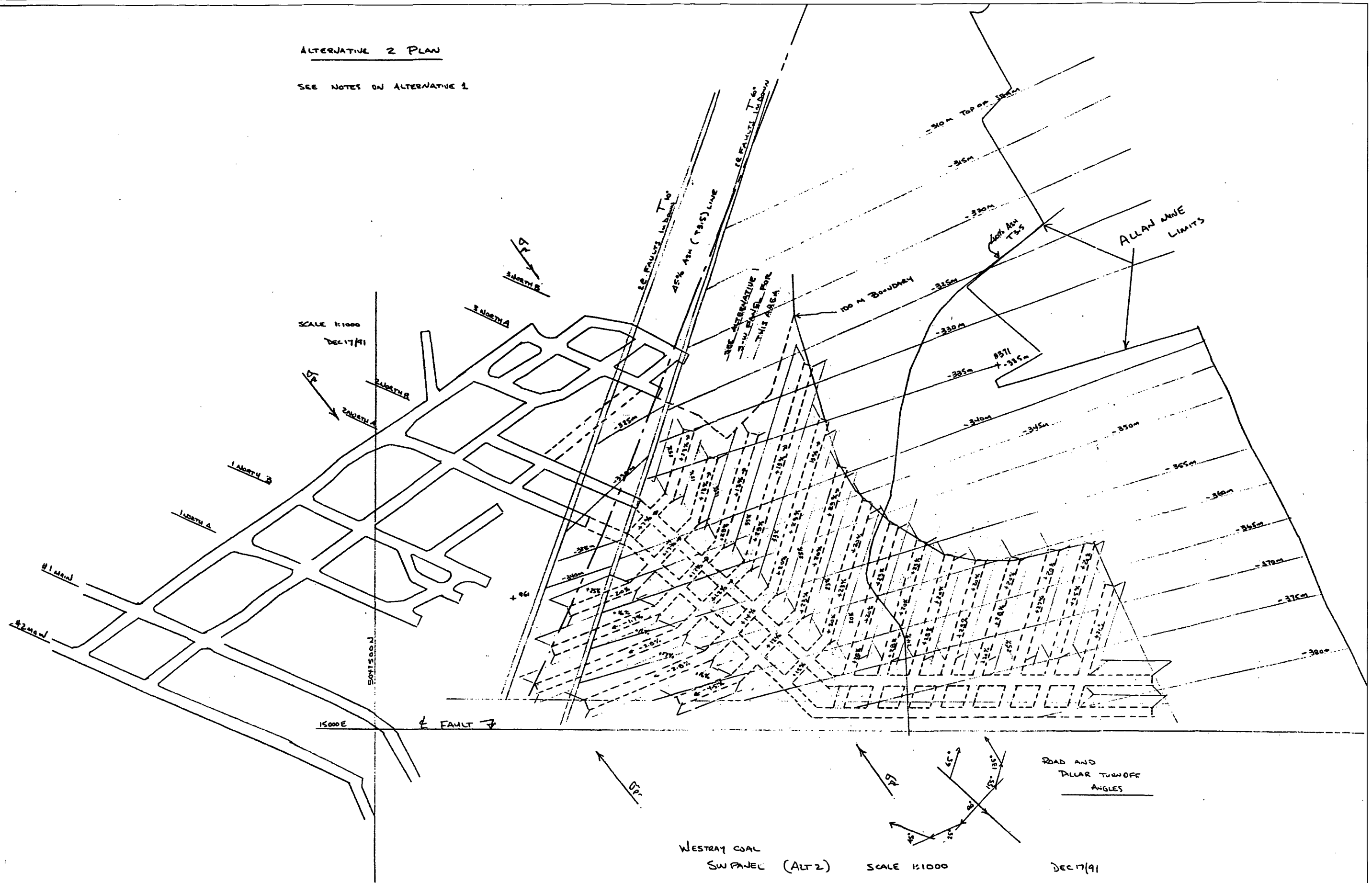


Map 12

*Proposed Mining Plan for Southwest Panel
(Alternative 2)*

ALTERNATIVE 2 PLAN

SEE NOTES ON ALTERNATIVE 1



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