

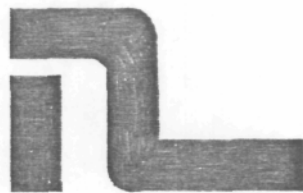
# MINE WASTE DUMP MANAGEMENT STUDY:

## A PROGRESS REPORT

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## BACKGROUND

STUDY FOR THE TECHNICAL AND RESEARCH COMMITTEE  
ON RECLAMATION,

FUNDED LARGELY BY THE CANADA-BRITISH COLUMBIA  
MINERAL DEVELOPMENT SUBSIDIARY AGREEMENT,

CONDUCTED BY: NORECOL ENVIRONMENTAL CONSULTANTS LTD

ASSISTANCE: WRIGHT ENGINEERS LIMITED  
THURBER CONSULTANTS LIMITED  
POLSTER ENVIRONMENTAL SERVICES

## OBJECTIVES OF STUDY

- O TO DEVELOP CRITERIA FOR WASTE DUMP MANAGEMENT FOR FUTURE AS WELL AS PAST DUMPS
- O EVALUATE THE MAJOR ENGINEERING (MATERIALS HANDLING, COST) STABILITY AND ENVIRONMENTAL FACTORS IMPORTANT FOR CONSIDERATION
- o CONSIDER THE NEED FOR AND WHEN RESLOPING MAY BE REQUIRED

## OBJECTIVES OF THIS PRESENTATION

- O STUDY IS IN PROGRESS AND RESULTS ARE NOT COMPLETE
- O PRESENT INTERIM RESULTS FROM LITERATURE SURVEY, INTERVIEWS AND INDUSTRY QUESTIONNAIRE
- O PRESENT SOME INITIAL FINDINGS AND OBTAIN FEEDBACK FROM AUDIENCE

## OVERVIEW OF PROBLEM

### LEGISLATION: GENERAL REQUIREMENT FOR RECLAMATION UNDER

- O MINES RECLAMATION ACT (1969) 11(1)
- O COAL MINES REGULATION ACT (1969) 8 (1)
- O MEMPR GUIDELINE (1984)
- O "ALL WASTE DUMPS SHALL BE RECLAIMED IN ACCORDANCE WITH THE LAND USE OBJECTIVES"
- O "WASTE DUMPS SHALL BE RECONTOURED SO THAT THE ANGLE OF REPOSE DOES NOT EXCEED 27 DEGREES, UNLESS PROVED THROUGH FIELD SCALE TRIALS THAT LAND USE AND PRODUCTIVITY OBJECTIVES CAN BE OTHERWISE ACHIEVED"

...CONT'D

COST:

O RESLOPING CAN BE LARGEST RECLAMATION COST  
ITEM

O OUTSTANDING RECLAMATION COSTS ON ACTIVE MINING  
SITES TOTAL MILLIONS OF DOLLARS -COSTS WILL BE  
GREATLY AFFECTED BY RESLOPING DECISIONS

...CONT'D

## ENVIRONMENTAL

- O BENEFITS DIFFICULT TO QUANTIFY
- O MUCH VARIABILITY IN CONDITIONS FROM MINE TO MINE
- O NEED TO PROVIDE GUIDELINES
  - REASONABLY SIMPLE FOR ADMINISTRATION, ETC
  - BUT, BY NATURE, CAN TEND TO BE:  
ARBITRARY AND INFLEXIBLE  
OR  
TOO VAGUE AND GENERAL
- O EXTREMES ARE LESS DIFFICULT: E.G.
  - LIFE OR PROPERTY ENDANGERED
  - VERY HIGH VALUE SPAWNING STREAM
  - REMOTE AREAS WITH ONLY LOW WILDLIFE HABITAT VALUES
- O IN BETWEEN CASES CAN BE PROBLEMATIC

## INSTITUTIONAL

- o TOO MANY INDIVIDUAL COMPANIES AND GOVT AGENCIES ACTING IN RELATIVE ISOLATION ?

## PROGRESS - WHAT HAS BEEN DONE ?

### O LITERATURE SEARCH

#### CAN MET DATA BANK

30,000 SOURCES

>200 "POTENTIAL" REFERENCES

116 REVIEWED

28 DIRECTLY RELEVANT REFERENCES

OTHER SOURCES LIBRARIES INFORMATION ON HAND  
(PROCEEDINGS, ETC)

... CONT'D



## QUESTIONNAIRES TO INDUSTRY

- 30 SENT

11 RESPONSES TO DATE

(EXPECT SOME MORE TO COME)

SOME VALUABLE DESCRIPTIVE DATA ( SEE

TABLE FOR EXAMPLE)

... CONT'D

	Mean	Standard Deviation	Range
% rock > 10 cm	41%	31%	2 - 95%
% hard durable rock	56%	34%	0 - 100%
Stack Angle (degrees)	36°	2.5°	26° - 37° (always 37° for coal)
Acid Producing (% of "yes" responses)	19%	-	-
Heavy Metals (% of "yes" responses)	0	-	-

	Mean	Standard Deviation	Range
Overall Height (m)	108m	86m	10 to 300m
Terrace Ht. (m) (when present)	28m	15m	10 to 58m
Terrace Width (m)	39m	16m	14 to 60m (2 mines no terrace width)
Slope Face Length (m)	74m	51m	16 to 200m (approx.)
Av. as built dump slope (degrees)	28°	8°	14° to 37°
Surface erosion (% yes)	25%	-	-
Stability problem	10%	-	-

## WASTE DUMP CLASSIFICATION

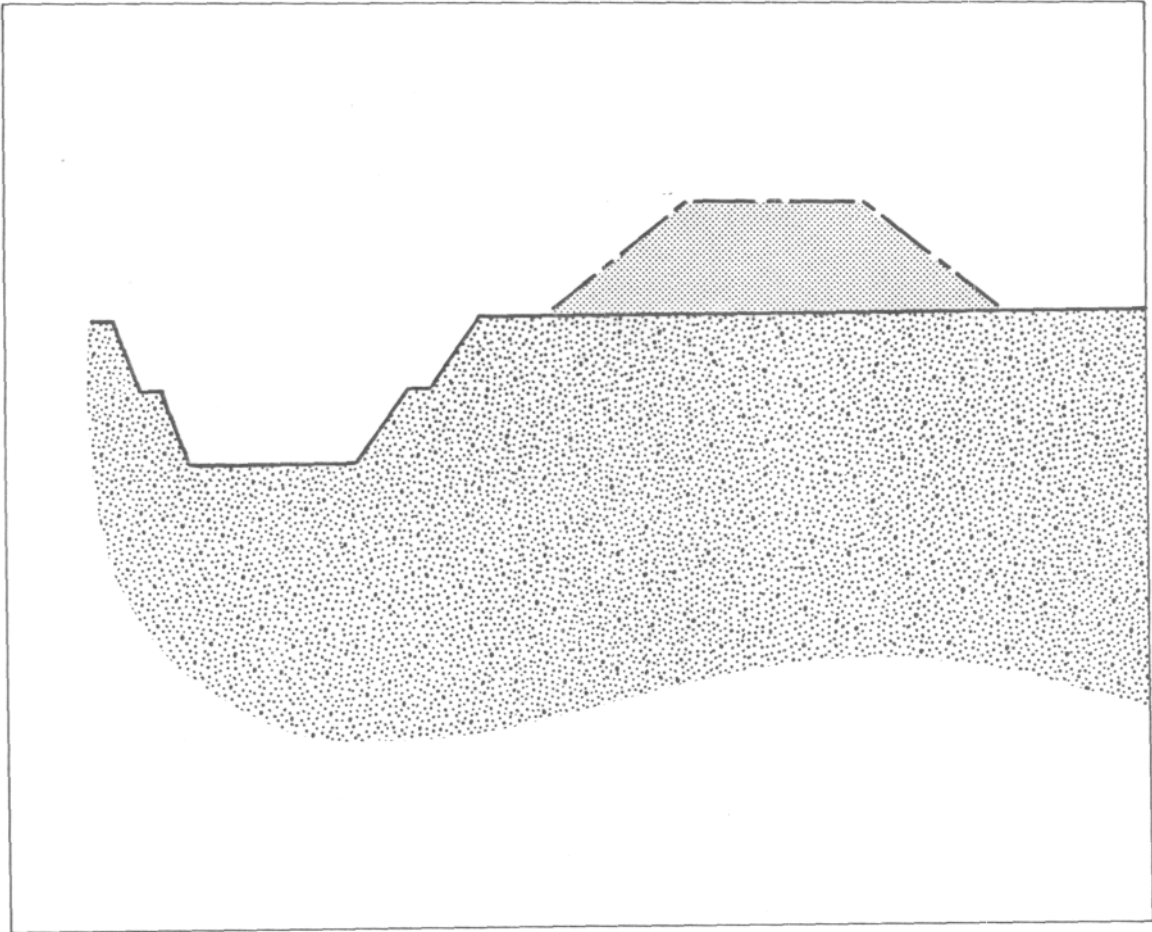
- 5 CONFIGURATIONS
- USEFUL FOR COST ANALYSIS
- MAY ALSO BE APPLIED TO OTHER CONSIDERATIONS
- EXAMPLES (FIGS, 1 - 5)

## COST ANALYSIS

- FRAMEWORK DEVELOPED
- NEEDS SOME REFINEMENTS
- NEED GOOD INPUT DATA FOR COSTS AND VALUES !
- SEE EXAMPLE

## CONCLUSIONS (INTERIM)

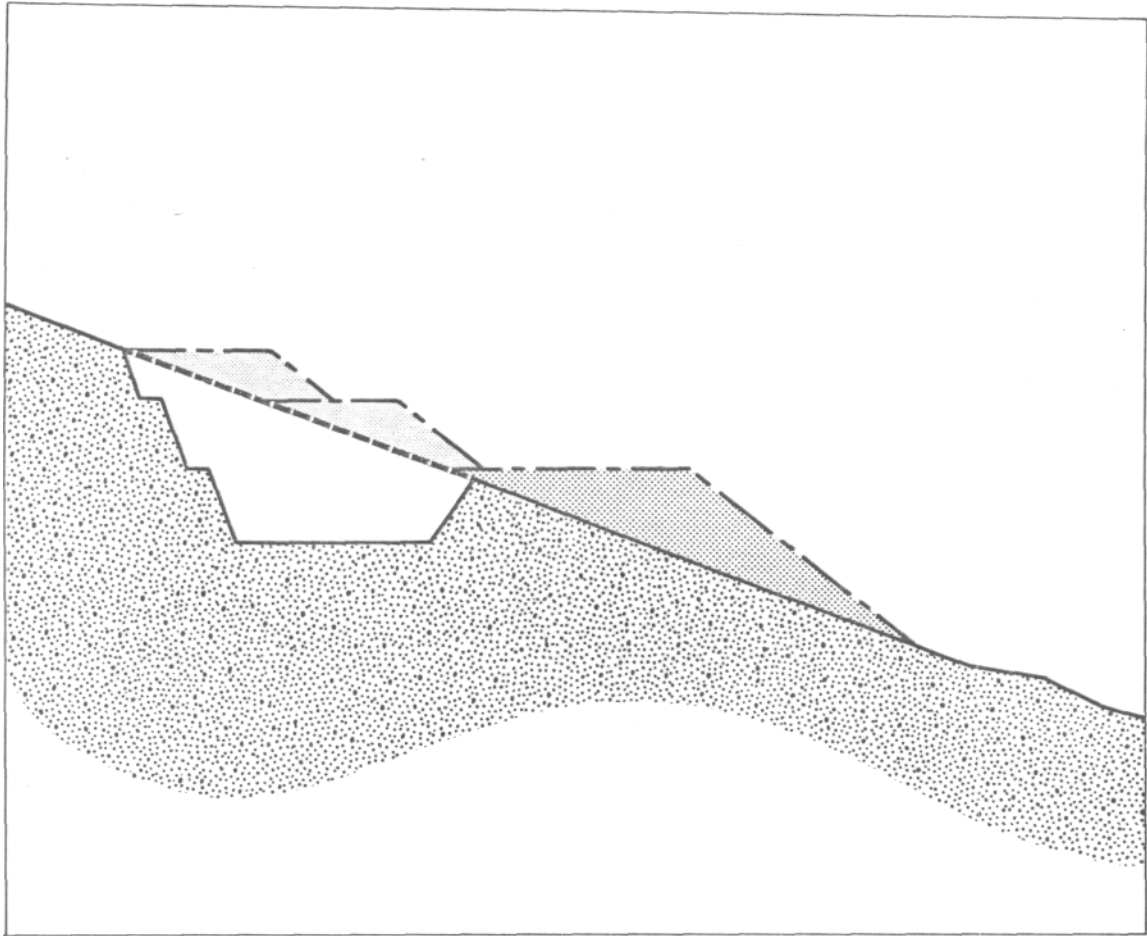
- O IN GENERAL, CRITERIA ARE WIDELY DOCUMENTED IN LITERATURE; NEED TO KNOW HOW TO WEIGHT VARIOUS CRITERIA IN VARIOUS SITUATIONS AND NEED A FRAME WORK FOR GUIDING DECISION MAKING
- O END LAND USE AND COSTS ARE COMMONLY THE MOST IMPORTANT CRITERIA IN DETERMINING WHETHER OR NOT AREAS SHOULD BE RESLOPED
- O SHOULD NOT LOOK AT WASTE DUMPS IN ISOLATION - CONSIDER LAND USE AND PRODUCTIVITY IN PERSPECTIVE OF THE TOTAL MINE AREA
- O ANY ONE, RIGID, BLANKET RULE SUCH AS - ALL DUMPS MUST BE SLOPED TO 26 DEGREES - MAY NOT BE JUSTIFIABLE
- o WASTE DUMP CLASSIFICATION AND COST ANALYSIS METHODS MAY BE USEFUL AIDS FOR RECLAMATION DECISION MAKING
- O RESLOPING CONSIDERATIONS REQUIRE ENGINEERING, COST AND GEOTECHNICAL CONSIDERATIONS AS WELL AS ENVIRONMENTAL



## I. Valley Bottom / Internal Pit Operation

- PIT AND WASTE DUMPS ESTABLISHED ON FLAT LAND
- DEVELOPMENT OF PIT RIMS
- HAULS BECOME MORE ADVERSE AS OPERATIONS MATURE
- DUMP CAN BE TERRACED ECONOMICALLY TO CREATE FLATTER ANGLES

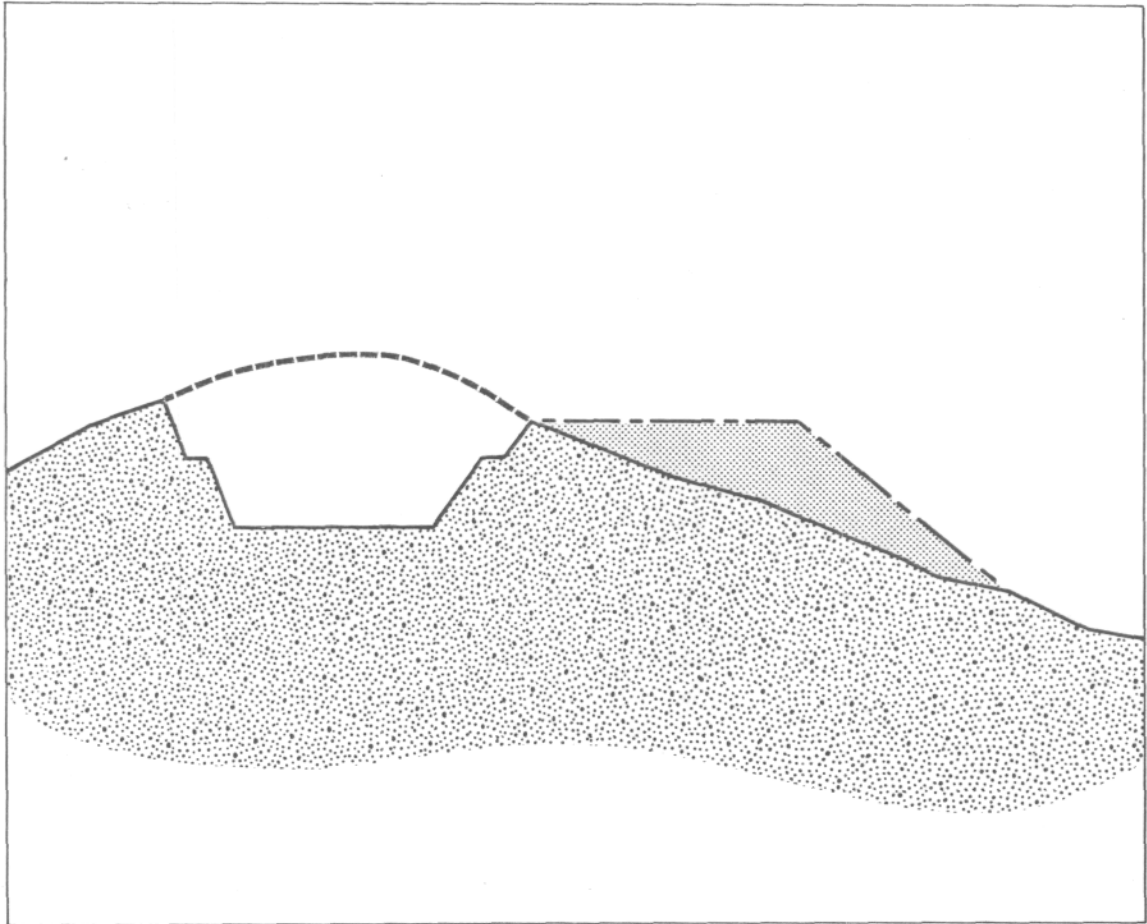
*EXAMPLE: COMINCO'S VALLEY COPPER OPERATION*



## 2. Mountain Bench / Daylighted Pit Operation

- OREBODY ON SIDE OF MOUNTAIN, SLOPE GRADIENTS 20 DEGREES APPROX.
- OREBODY SHALLOW AND IT'S PLUNGE PARALLEL TO SLOPE OF GROUND
- MOST OF BENCH DAYLIGHTED
- HAULAGE OF WASTE FLAT TO DUMP
- NECESSITY FOR MAINTAINANCE OF HAULAGE BERMS RESULTS IN DUMP FACE SLOPES 16-23 DEGREES

*EXAMPLE: ABANDONED DUMPS OF CRAIGMONT MINES*

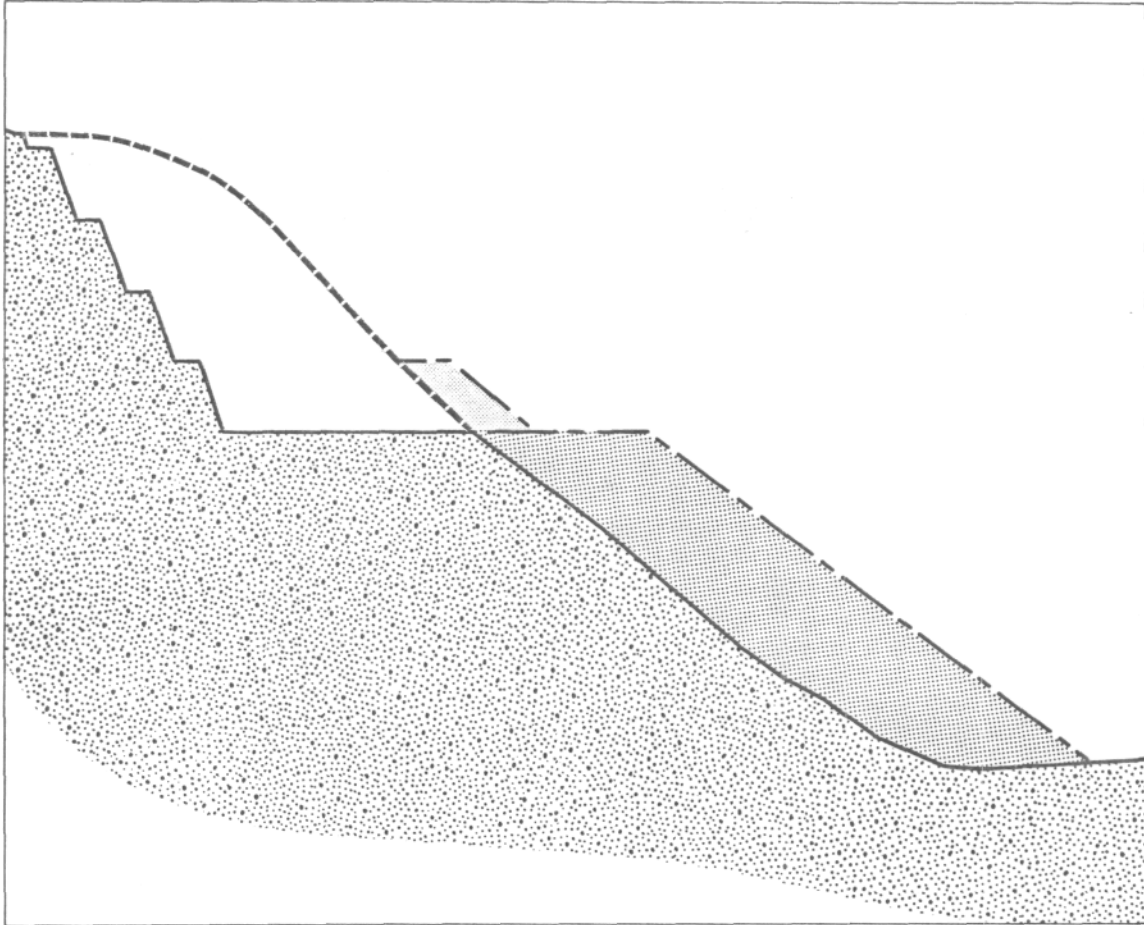


### 3. Mountain Bench/Internal Pit Operation

- SITUATION OF OREBODY EXCLUDES POSSIBILITY OF DAY-LIGHTING THE BENCHES
- PIT RIM ESTABLISHED EARLY
- WASTE HAUL IS ADVERSE TO PIT RIM THEN FLAT TO DUMP
- DUMP BERM ADVANCED BY END DUMPING, CREATING A 37 DEGREE SLOPE FROM DUMP CREST TO TOE
- TOO EXPENSIVE TO CONSTRUCT AT FLATTER ANGLES

*EXAMPLE: GIBRALTER MINES*

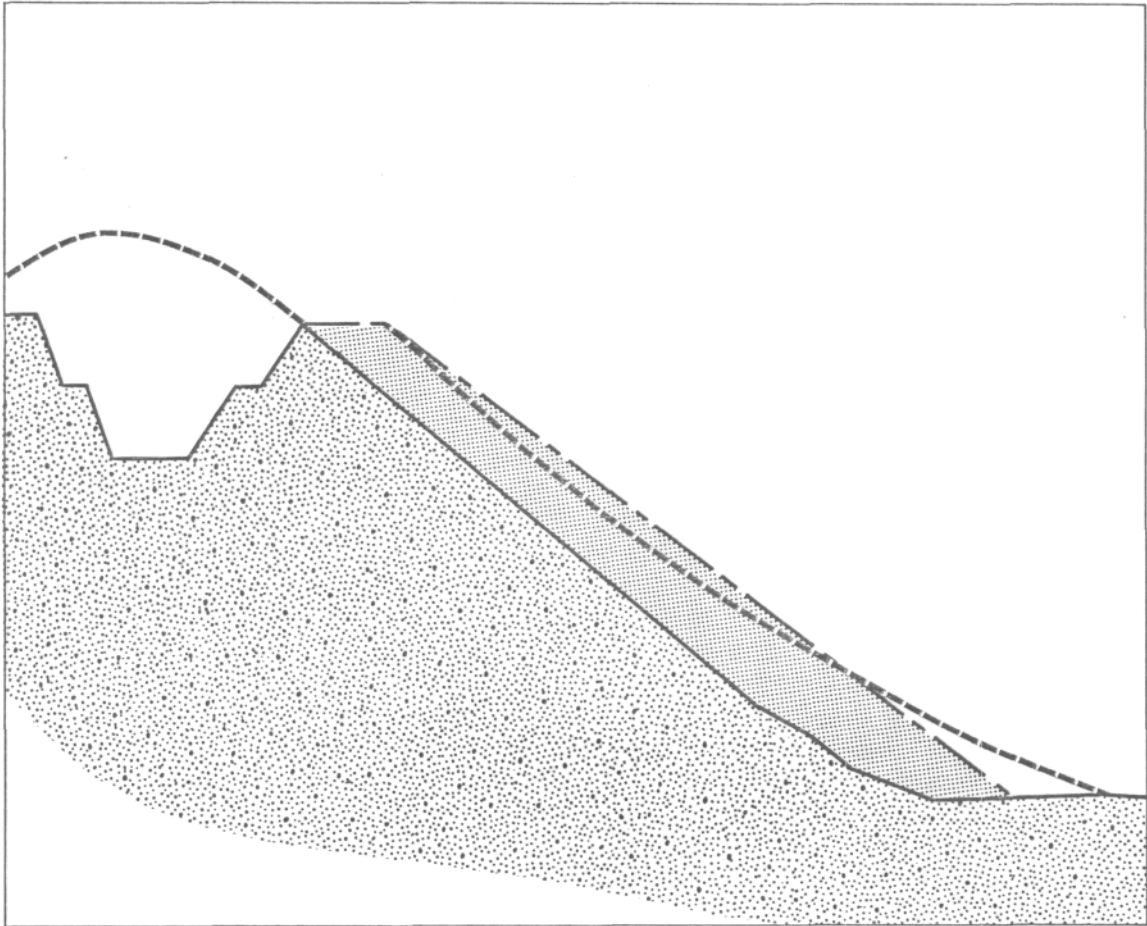




#### 4. Mountainous Terrain/Daylighted Pit Operation

- HIGH ON MOUNTAIN SIDES ( > 37 DEGREES, > 100 M)
- SHALLOW OREBODY ENABLING DAYLIGHTED BENCHES
- NEED CONSIDERABLE WASTE DUMPAGE TO ESTABLISH A CONTINUOUS SLOPE BACK FROM VALLEY FLOOR TO DUMP ELEVATION
- HIGH TENDENCY FOR CREEP IN UNSTABLE WASTES (EG. OVERBURDENS) WHICH SPILL ACROSS VALLEY FLOOR
- THUS, POSSIBLE NEED FOR TOE DYKES OR OTHER MEANS OF CONTAINMENT
- UPON ESTABLISHMENT OF DUMP BERM, DUMPS MAY BE BUILT AT A REDUCED SLOPE ANGLE

*EXAMPLE: FORDING COAL (EAST KOOTENAYS)*



## 5. Terraced Slopes

- IDENTICAL TO N0.4, ONLY BENCHES NOT DAYLIGHTED
- SINGLE DUMP ELEVATION AT PIT RIM
- SHALLOW OREBODY, NEED CONSIDERABLE WASTE DUMPAGE TO ESTABLISH A CONTINUOUS SLOPE AND UNSTABLE WASTES TEND TO CREEP
- TOO EXPENSIVE TO CONSTRUCT DUMP SLOPE AT FLATTER ANGLE
- POST-OPERATIONAL RESLOPING (ONCE DUMP INACTIVE)
- CONTAINMENT MAY BE PROVIDED BY TOE DYKES

*EXAMPLE: BETHLEHEM MINES*

## VARIABLES CONSIDERED IN COST ANALYSIS

- SLOPE ANGLE , CONTINUOUS OR TERRACED
- RESLOPING COST (\$/m<sup>3</sup> MOVED)
- REVEGETATION COST
- CONSTRUCTION COST (INCREMENTAL \$ / HA DUE TO \$/+ HAULED DURING CONSTRUCTION OF DUMP TO INITIAL 27°) NOT USED IN EXAMPLE
- DUMP HEIGHT
- GROUND SLOPE
- SLOPE LENGTH
- TOE LAND
- RESLOPE VOLUME (VOL. MOVED IN RESLOPING PER METRE LATERAL DUMP TO DISTANCE)
- REHANDLE (APPROX. % OF ABOVE THAT MUST BE REHANDLED IN RESLOPING THE DUMP)
- LAND VALUES

ORIGINAL	ASSESSED VALUE OR END USE OF LAND OCCUPIED BY DUMP
RECLAIMED	VALUE OR POTENTIAL LAND USE OF RESLOPED DUMP SURFACE
- NOTE  
(COST AND LAND VALUE DATA USED IN EXAMPLES ARE ORDER OF MAGNITUDE ESTIMATES)

# EXAMPLE

## COST ANALYSIS OF MINE WASTE DUMP RESLOPING\* (\$/HA)

	1	2	3	4	5
RESLOPING	-246	-1218	-1218	-947	-947
TOE COVER	-38	-227	-227	-104	-104
RECLAMATION	-3000	-3000	-3000	-3000	-3000
TOTAL COST	-3284	-4445	-4445	-4051	-4051
RECLAIMED LAND VALUE	2500	2500	2500	2500	2500
NET VALUE	-784	-1945	-1945	-1551	-1551

### ASSUMPTIONS\*

DUMP HEIGHT = 50m  
ORIGINAL LAND VALUE = WILDLIFE @ \$500 / HA  
RECLAIMED LAND VALUE = FORESTRY @ \$2500 / HA  
POST OPERATION, CONTINUOUS RESLOPE RECLAMATION  
DUMPS ORIGINALLY BUILT BY END DUMPING @ 37°  
RESLOPE ANGLE = 27°