Aggregate Operators Best Management Practices Handbook

PART II

Chapter 5 - 1: Planning Modules
EXTRACTION MODULE - EM

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EXTRACTION MODULE - EM

Common Concerns: Extraction

Extraction is a core activity for all aggregate operations. It is important that extraction be coordinated with processing in order to deliver material at an optimum size and rate from the working face into the processing stream (i.e., crushing or sizing facilities) or directly to the load-out facilities (Bowers et al. 1990). In additional, extraction should be coordinated with non-production considerations such as noise and dust reduction. Documentation of extraction planning in a formal extraction plan is also an application requirement for a *Mines Act* permit (Notice of Work & Reclamation for a Gravel Pit or Quarry) and may be required for local government soil removal permits.

The location of the working face and the extraction technique used will affect an operation's noise and dust emissions, visual impact and stormwater management, and may limit options for reclamation and post-extraction land uses. Adequate extraction planning may also help to avoid expensive and time-consuming problems once mine development proceeds.

This module focuses on coordinating extraction activities with the non-production considerations of an operation (refer to Table EM - 2), and will offer only general technical advice. Advice for the technical components of extraction is readily available from publications such as *The Aggregate Handbook* of the National Stone, Sand and Gravel Association in the USA, and various trade journals and magazines.

Extraction Planning

For extraction planning, aggregate operations may choose to have both long-term (mine-life) and short-term plans, and production related and non-production related plans as well.

Mine-Life Extraction Planning

Mine-life extraction planning details the overall extraction scheme for the entire deposit, and major events in the life of the mine. It describes the mining strategy and coordinates production with other components and activities such as noise reduction and processing activities. Mine-life planning may also include major capital expenditures or equipment purchases.

Short-Term Extraction Planning

Short-term extraction planning details expected activities over a one or two-year period. For example, phased extraction planning provides detail for one phase of a proposed operation. This type of planning can also specify operational direction on equipment selection, surface stripping areas, road developments and detailed extraction activities.

Production and Non-Production Related Planning

Production and non-production related extraction planning is discussed in Tables EM-1 & EM-2. Following these tables are some key pointers for both production and non-production related considerations. Table EM-3 relates extraction components to other modules and BMPs in this handbook.

Table EM - 1: Production related extraction planning considerations.

Production Related Considerations of Extraction Planning	
Pit/Quarry Size & Shape	• Pit/quarry width, length, extractable reserves and viability of phased mining will be determined by the deposit's shape and size, the topography and the quarry rock's structure.
Depth of Excavation	Factors which may limit the depth and shape of the excavation pit or face include: • depth to the top and bottom of the resource, • depth to the top of the groundwater table, • site steepness and lay of the land, and • the material competency or rock structure to maintain slope stability.
Phased Mining Option	• Some deposits can be mined in phases. • Determining factors may include: depth, thickness and shape of the deposit, the topography of the site, and the need to blend material (requiring a separate face for each type of product). • Phased mining can have numerous benefits for reclamation, environmental management and total project costs.
Clearing & Grubbing	• Clear only as much area as needed over the short term. • Clearing can start up to two years in advance. • Erosion control should be installed before clearing starts. • Byproduct & Waste Management Module provides advice on handling and storage of grubbed material.
Topsoil & Overburden removal	• The Stockpiling Module provides advice on topsoil storage. • Progressive mining allows for "Live Topsoiling."
Berms (landscape)	• Coordinate extraction (stripping) with berm construction.
Drilling & Blasting	• Refer to qualified professionals. • Note *Mines Act,* Health & Safety & Reclamation Code.
Location & Orientation of Working Face	• Strategic placement and orientation of the working face can significantly reduce visual, dust and noise impacts.
Loading and Hauling	• Match loading and hauling equipment to each other, the deposit characteristics and processing equipment. • Minimize or avoid double handling.
Equipment Selection	• Equipment selection can make a difference in extraction efficiency and noise and dust reductions.
Haul Roads	• Haul roads should be short, straight, with minimal hills and have sufficient stopping distances and good vision. • Keep roads both dry and dust free.
Primary/Secondary Processing Locations	• Processing can be continuous or intermittent. • Location of the processing plant or facility can significantly reduce visual, dust and noise impacts.
Water Management	• Coordinate extraction with location of settling ponds.
Stockpiling	• Coordinate extraction with stockpiling.

Table EM - 2: Non-production related extraction planning considerations.

Non-production Considerations of Extraction Planning	
Noise	• Locate and orient the working face to intercept and reflect noise away from sensitive areas. • Locate loading and unloading facilities in an area where noise will be absorbed and not broadcast (i.e., not on an exposed hillside). • Generators can be particularly noisy. Locate them in an area that will dampen their noise.
Visual Concerns	• Locate and orient the extraction working face and haul roads so that they are concealed from neighbours and roadways.
Dust	• Locate and orient the extraction working face and haul roads so that they are not in wind "chutes" or susceptible to strong winds.
Traffic	• Locate the extraction working face and haul roads so that they are concealed from neighbours and roadways and protected from strong winds.
Pollution Prevention	• Locate spill kits close to the working face and on equipment to handle upsets and spills. • Ensure good maintenance. • Ensure proper training plan in place. • Utilize blasting practices that minimize release of nitrogen compounds.
Erosion, Sediment and Stormwater	• Keep the extraction area and hauls roads free of ponding water from rainfall and upslope sources.
Environmental	• Consider/address special on-site or adjacent environmental features within the extraction plan.
Reclamation	• Coordinate extraction with reclamation plans. • Plan extraction to minimize reclamation work.

Extraction Planning: Key Pointers

Using Maps to Detail Extraction Plans

Maps are the best tool to show the location of the extraction face, how extraction will proceed and, if possible, phases of progressive reclamation.

Chapter 4 of this handbook, Mine Planning, has detailed advice on how to prepare maps for aggregate operations. That chapter refers to the maps (schedules) that should be included with a Notice of Work & Reclamation for a Gravel Pit or Quarry application. An "extraction plan map" is also commonly referred to by the name “mine development map.”

Matching Extraction Planning to Proven Reserves and Proposed Product

Before selecting equipment to work the face and move the material, an operator should know the grade, competency and quantity of the sand and gravel, or the hardness, lithology and rock structure of the quarry material and, in either case, potential production rates and volumes.

Sand and gravel deposits can be assessed using back hoe or excavator test pits, test holes drilled with a continuous flight auger or land form analysis (e.g., river terrace, delta, alluvial fan). For quarries, geological mapping, rock sampling and drilling can prove the extent of the extractable material. Operators should avoid areas with the potential for acid rock drainage, as discussed in Chapter 2.

The proposed mining sequence and pit or quarry shape will be largely determined by both the deposit characteristics and the lay of the land. For uniform deposits on flat land, a wide range of extraction sequences could be used to maximize operational and non-technical goals. In tight situations where the deposit is deep and the quality of the aggregate varies considerably, options for extraction sequences and pit configurations may be severely limited.

Start-up Space Problem

A sand and gravel pit or rock quarry requires a lot of space. Start-up can be one of the most difficult stages of an aggregate operation. During start-up, an operator must determine how much area should be cleared and grubbed, where top soil and overburden piles should be placed, where the extraction face should start, whether there is enough room for processing and when product can start to move, all in the shortest possible time frame. Other modules, such as stockpiling and processing, will help to solve these problems.

Without proper planning, the temptation to simply place the overburden pile somewhere convenient "until we get going” may be irresistible, but the time required for moving the pile a second time ("double handling") will far outweigh the time saved initially. Adequate up-front extraction planning will help an operation start up more smoothly and quickly, while minimizing double handling of materials once the operation is running in full swing.

Visibility

Where to begin the extraction face in order to minimize off-site impacts is an important decision. Commonly, an operator will start near the access point and work towards the back of the property.

This approach puts all activities where they are most visible right away, at a sensitive time for developing community relations.

A number of operations have found that starting extraction in a less visible part of the property, and away from neighbours, allows the property itself to act as a buffer. In this way, mitigation tools such as treed berms will have been established to control dust and noise and act as visual screens before the operation approaches neighbouring properties. Also, a less visible operation is far more conducive to establishing good community relations at an early stage.

Working Top Down

The conventional place to begin excavating a hillside gravel deposit is at the bottom of the slope. Consequently, the entire hillside may have to be exposed prior to reclamation and slopes may be cut too steeply, making them more prone to failure. Consider establishing the first excavation face at the top of a hillside and working down in benches or lifts. Reclamation can proceed on each bench as the next is opened up. In this way, the potential for slope failure is minimized

Starting at the top also allows for more control of the orientation of the face. A properly orientated face may be less visible from local residences and highways, act as a barrier for noise and reduce wind exposure and dust generation.

Straight Short Haul-Roads

The path between the working face and a primary processor (crusher) should be as short and straight as possible. Corners and hills require haul trucks to slow down, decreasing their operating efficiencies. If bends are required in the processing stream, then they should be at processing points. Grades should generally not exceed 10%, and road corridors should conform to the Health, Safety and Reclamation Code Section 6-8 specifications.

Both access and haul roads are further discussed in the Traffic Module and the Haul Roads BMP.

Keeping It Dry

Designing the extraction process to remain dry will benefit an operation in three ways. First, wet material is more difficult to process and requires drying once processed. Attempt to keep material dry until washing is required.

Secondly, wet working areas increase wear and tear on tires and equipment. Wet tires are five times as susceptible as dry tires to slashing from sharp objects like rocks. Some wetting may be required for dust control.

Thirdly, water collected from the excavation area requires treatment in settling ponds to remove sediment. Settling ponds require valuable space. If there is a risk of an oil or hydraulic fluid upset, runoff water may have to be treated in an oil/water separator.

The extraction area can be kept dry by using diversion ditches, back-draining benches, and well-drained, crowned and elevated haul roads.

Clearing & Grubbing

Clearing is the removal of trees and vegetation and grubbing is the removal of stumps and root systems. Local bylaws may regulate these activities. To cut down on dust, visibility and stormwater impacts, clearing and grubbing should be restricted to the areas that will be actively used for extraction, processing and stockpiling in the near future. If possible, these areas should be cleared and grubbed immediately prior to extraction.

The Ministry of Forests (MOF) has a mandate to regulate timber harvesting on Crown land. Thus, the MOF should be notified well in advance of tree removal, so that any possible resource conflicts can be settled and an appropriate Licence to Cut or Free Use Permit obtained, in accordance with the *Forest Act*.

Stumps and roots are normally burned or buried, subject to the *Waste Management Act* regulations. While chipping stumps is sometimes an option, it is generally prohibited by regulation because recent research has shown that stockpiled chips can leach acids. An alternative is to stockpile the stumps into berms or "beehives". The stumps can be later spread over the site during reclamation, if forestry is planned, or used for erosion control. Stumps can provide habitat for birds, small animals and insects, and may enrich the soil when decayed (Buchanan, 1999).

Blasting

Blasting can integrate extraction with processing by fragmenting rock into an optimal size for feed into the processing stream or for direct sale. In a blasting program, it is important to consider the structural discontinuities of the rock mass and the rock material strength.

While blasting expertise will not be discussed in this handbook, the Health, Safety and Reclamation Code for Mines in British Columbia has very specific requirements regarding explosives. *Mines Act* certification is required for all blasters at pits and quarries. Fisheries and Oceans Canada has published guidelines for the use of explosives in or near Canadian fisheries waters (Wright and Hopky, 1998). Suppliers of explosives can provide technical advice and valuable information.

Extract to Reclamation

Well-planned extraction can give reclamation a head start by reducing the amount of post-extraction work to be done. Final slope angles, shapes and grades can be established during extraction rather than as a separate operation (Norman et al., 1997), even if progressive reclamation is not an option.

Where the shape of the deposit and lay of the land allow for phased extraction, progressive or segmented reclamation may be an option. Progressive reclamation can reduce topsoil and overburden handling, reduce the need for large stormwater management areas, prevent dust generation, reduce the amount of reclamation security required as a permit condition, and allow post-mining land uses to begin earlier.

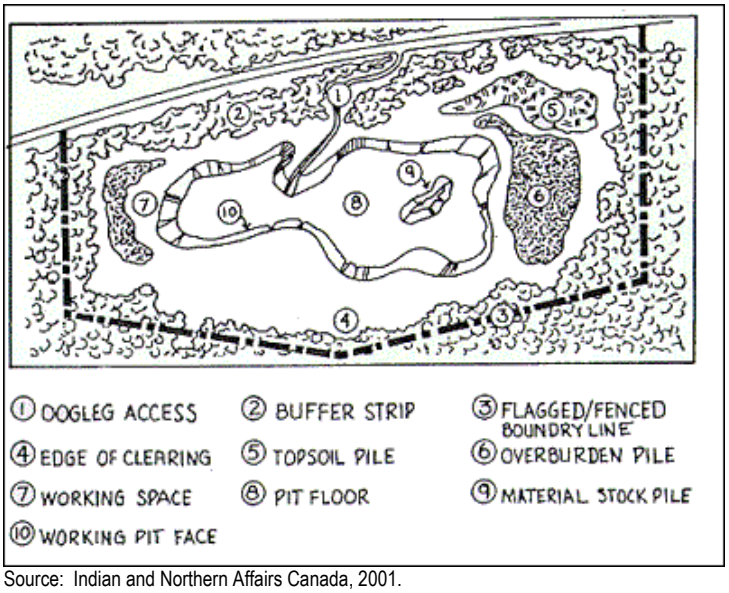
Benching

Benches are required where the working face in unconsolidated material would exceed the reach of loading equipment (refer to the Health, Safety and Reclamation Code Section 6.7.7). Benches are stable, can control stormwater runoff and are easily reclaimed. Back-sloping and crowning benches stop water from running over the face of the bench, and prevents sheet, rill and gully erosion and the entrainment of sediment into storm water. Benches should be maintained at a minimum width of 8 metres.

Table EM - 3: Extraction activities and related modules and BMPs.

Extraction Activities	Modules	Applicable BMPs
Clearing & Grubbing	SITE LAYOUT • Noise Section • Dust Section	• Berm • Silt Fence
Topsoil & Overburden	STOCKPILING	• Topsoil Management
Location & Orientation of Working Face	SITE LAYOUT • Visual Landscape Section • Noise Section	• Sinking the Plant
Haul Roads	TRAFFIC SITE LAYOUT • Visual Landscape Section • Noise Section • Dust Section	• Haul Road
Loading & Hauling	SITE LAYOUT • Noise Section • Dust Section	• Drop Height • Dust Skirt • Water Spray
Equipment Selection	SITE LAYOUT • Noise Section	• Equipment Selection
Primary/Secondary Processing Locations	PROCESSING	• Sinking the Plant
Washing	PROCESSING	• Settling Pond
Water Management	STORMWATER & EROSION CONTROL	• Ditches • Retention Basin • Silt Fence
Stockpiling	STOCKPILING	• Berm • Material Corrals • Tarps
Reclamation	EXTRACTION SITE LAYOUT	• Backfilling • Tillage

Figure EM - 4: Sample extraction map.



Source: Indian and Northern Affairs Canada, 2001.