Case Study

AT A GLANCE INDUSTRY:
Brownfields IPCC Case Study

COMMODITY:
Coal

CLIENT:
Confidential

LOCATION:
South Africa

PROBLEM SUMMARY:
Review possibility of the implementation of an IPCC transport system.

SERVICE:
Case Study

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In-Pit Crushing and Conveying Case Study

Review of the in-pit crushing and conveying (IPCC) system at a prominent Coal Mine in South Africa

Abstract:

Open pit material transport systems significantly affect the operating costs of an operation. IPCC offers and alternative material transport system that drives greater efficiency and cost saving. VBKOM used its expertise in integrated trade-off studies to deliver a successful Pre-Feasibility Study to its client, which the Board subsequently approved for entry into a BFS phase.

Keywords:

Pre-Feasibility Study (PFS), Bankable Feasibility Study (BFS), Base Case Analysis, Crushing, Conveying, Coal, Modular design, Financial Modelling, Evaluate Options, Simulation, Phased optimisation, System design, Funding

Problem Statement

The client is entering into a haul truck procurement cycle due to pit expansion, an increase in future mining tonnages, truck travel distance and replacement schedules. The client required a review of whether the implementation of an in-pit crushing and conveying (IPCC) material transport system at their coal operation in South Africa presented a viable alternative to a full truck handling base case.

To sustain future business competitiveness, it is imperative that the business determines whether the equipment and technologies it employs in delivering on the business and production plans supports the most suitable strategy within its future strategic intent, and whether alternative equipment strategies can be employed to minimize impacts from the increased future operational activities.

Options were determined and evaluated from a technical, funding, cost, and operational risk point of view that would adequately mine, transport and deliver identified material types to their respective destinations, to align the business in agreeing and approving a go-forward option for final design and implementation.

Project Objectives

A successful, technically feasible, and financially viable and approved Pre-Feasibility Study (PFS) was delivered to the client, which enabled its Board to approve the next BFS phase and ensure future implementation certainty.

Project Mandate:

Before the study it was not known how optimal and likely it would be that a substantial improvement might be realized when changing to a better alternative and implementing this solution. The project mandate was to:

- Determine whether a more feasible solution can be identified and proved to meet the future mining volume requirements compared to procuring additional haul trucks.
- Ensure a full understanding of the Base Case plan, the impact there-of, and the exact areas that will be influenced by a solution alternative.
- As the main differentiators, measure ideal solutions from a funding, cost, operation risk point of view that would adequately mine, transport and deliver identified material types to their respective destinations.
- Expand, quantify, and consider the opportunity to reduce carbon emissions, dust generation, secondary equipment requirements, and possible infrastructure constraints in the identification of the ideal go-forward solution.
- Ensure that the continuity of operations at tempo, least net present cost, acceptable/tolerable risk, sustainability targets and least peak capex are achieved.
- Reduce system complexity characterised by multi-faceted unplanned variables by designing for a predictable environment (although still complicated) facilitating higher levels of control.
- Identify all standards the project needs to adhere to, and deliverables required, considering the client's project life cycle guidelines and investment criteria.
- Deliver the study to the client in accordance to the agreed deliverables, on a Pre-Feasibility phase confidence level.

Method

The VBKOM team possess a unique skill set to assist clients in the optimisation and evaluation of mining operation alternatives and options of current and planned mining methods. VBKOM successfully demonstrated the progression of project scenarios and options, from ideation phase to prioritisation and selection. The complexity of the material planning and placement, with multiple destinations impacted by plant discard utilizing same resources, in time, was simulated using VBKOM's dynamic simulation approach in Simio software to support the configuration development and quantification of impacted KPI's. The option tradeoff and analysis were supported by various technical disciplines in the project, and the VBKOM team used all available information to propose the selected alternative for the BFS phase.

VBKOM followed an integrated approach by managing all related disciplines in the project, i.e., mining engineering, geotechnical, design and engineering (civil, structural, mechanical, electrical, process, systems), cost estimation, risk management, operational readiness, human resources, safety and health, legal and environmental, procurement, investment evaluation (finance), etc.

The VBKOM team's deep understanding of the application of mechanical and mobile mining equipment alternatives, configurations and application provided key evaluation criteria in identifying operable and techno-economically feasible solutions. This skill set involves the conceptualization, definition, configuration and system evolution of fit-for-purpose primary mining methods, especially the evaluation of mechanical alternatives to traditional truck and shovel mining operations, such as In-pit crush and convey alternatives in mining environments where increasing truck travel distances, pit space constraints, fleet size constraints and infrastructure limitations necessitate alternative primary mining systems.

The method to develop an extensive PFS were defined:

- Combine mine design, mine planning, equipment considerations and evaluations, system design and dynamic simulation, engineering design, OEM specification, investment and operating cost analysis and techno-economic evaluation.
- Develop a Base Case analysis, that included a route and cycle time analysis, fleet simulation according to OEM specification and mine constrains.
- Despite previous studies suggesting IPCC to be a suitable technology alternative, investigate and re-evaluate feasible technologies (alternative bulk material systems or equipment types).
- Develop and evaluate multiple full value chain (pit to plant) configurations of suitably matched technologies for multiple material flows, ensuring utilisation optimisation, risk redundancy, configuration flexibility for a continually changing environment, tolerance to future pit design and face advance changes.
- Confirm and incorporate previous learnings and study outcomes to reduce prolonged and duplicated investigations.
- Liaising with all stakeholders to incorporate the correct model inputs, such as assumptions, production volumes, etc.
- Capex and Opex estimations supported by engineering designs and associated material measurements.
- Develop construction and implementation schedules to inform cost flows and saving impacts over time.
- Develop the financial model with operating philosophy options and risk factor distributions.
- Conduct feasibility trade-offs to determine best material type and system configuration result for final material selection.
- Further testing of variables within the selected scenario for option improvement and final recommendation.

Project Results

A structured PFS evaluation approach ensure key trade-offs and decisions are made at the right point, to reduce unnecessary evaluation, and prevent the elimination of scenarios that may require future re-evaluation.

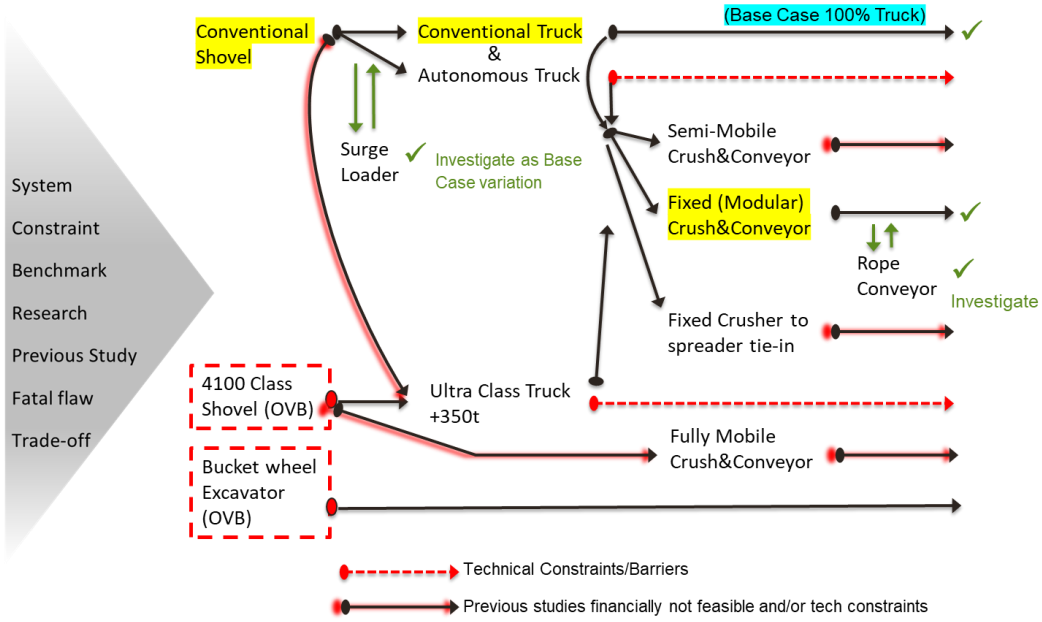
Relevant technology considerations:

Several technology applications are considered in order to determine the best fit to the client's operation.

Relevant and feasible mining technologies are benchmarked, investigated, and tested to determine constraints, operational complexity, system fit, alignment to the remaining mining fleet and implementation risks. For the client, truck fed modular, relocate-able IPCC proved to be the technology to most likely satisfy the success criteria. The following table highlights the suite of technologies that were considered

Technology **Mining**	**Technology** **Transport** **(to dump, backfill, plant)**
Loading Technologies: 1. Conventional Shovel 2. Ultra-Class Rope Shovel 3. Bucket wheel Excavator **Buffer Technologies:** 4. Shovel + Surge Loader 	**Trucking Technologies:** 5. Conventional Truck 6. Ultra-Class Truck 7. Autonomous Truck **Crushing & Conveying Technologies:** 8. Mobile crusher & relocatable conveyor (no truck) 9. Semi-Mobile crusher & relocatable conveyor (+ truck to crusher) 10. Fixed crusher & relocatable conveyor (+ truck to crusher) 11. Rope Conveyor Systems (with crusher)

The figure below indicates the system configurations and risk analysis:



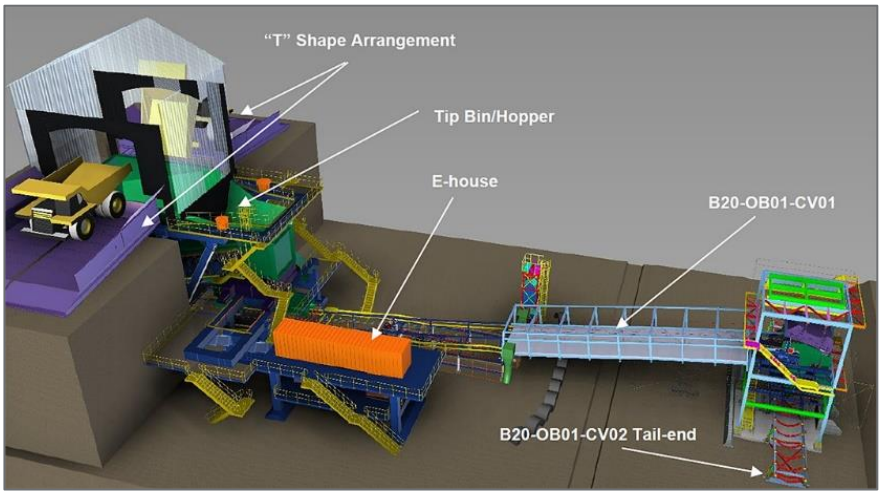
Solution Proposal – Technology choice:

A Modular IPCC System, with the option to relocate when necessary, proved to be the preferred technical solution. The value of the system is maximised by integrating this IPCC system with existing spreader systems for alternative placement compared to truck dumping:

- Replace hauling of waste material to different waste destinations, with an in-pit relocatable modular crushing station running at 6000tph, linked with an overland conveyor via transfer station into existing spreader systems.
- Second phase requires one re-location of the crusher system after 10 years of operation to maximise savings and investment value ensuring future utilisation whilst maintaining close proximity to the mining operations without being compromised by changing life-of-mine plans.
- Expand spreader capacity when current systems are fully utilised.
- OEM supplier of the total crusher station

Similar Installation (semi-mobile configuration):

Project Proposal (Modular, Relocate-able):

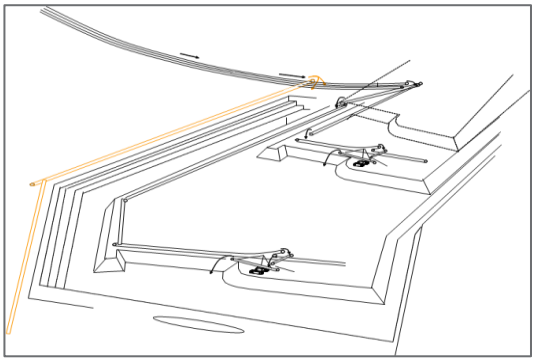


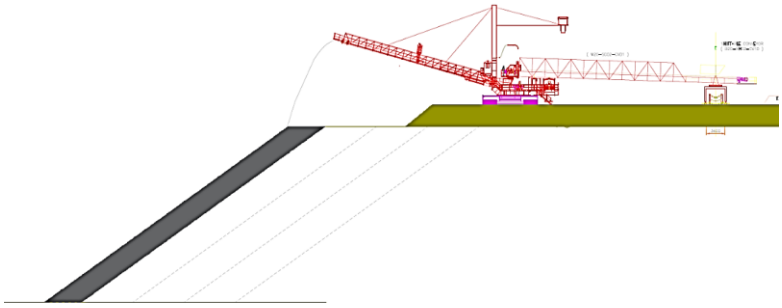
System design and utilization analysis:

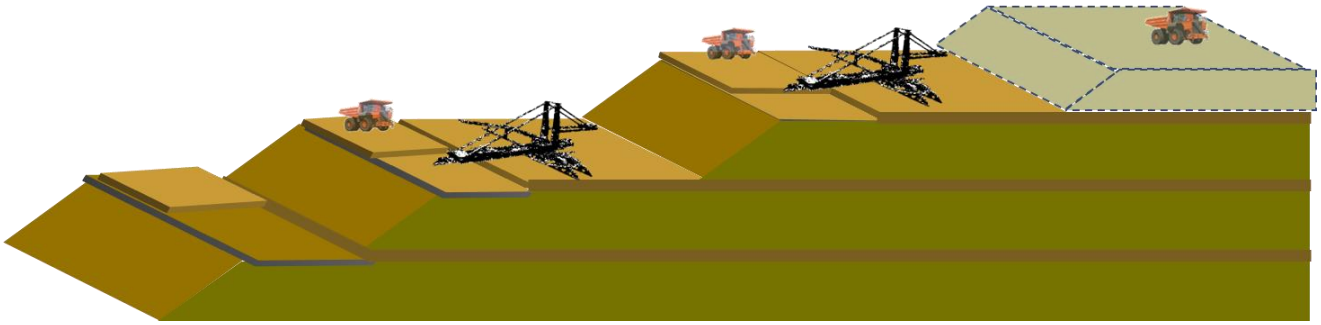
In most cases, the value of an IPCC system only materialises through efficient placing of the bulk material (ROM/Waste) at the allocated destination.

Detailed waste spreader system designs are conceptualised and modelled in SIMIO dynamic simulation software to determine operating schedules, availability and utilisation, and annual throughput potential, in order to provide the correct basis for determining savings and investment value.

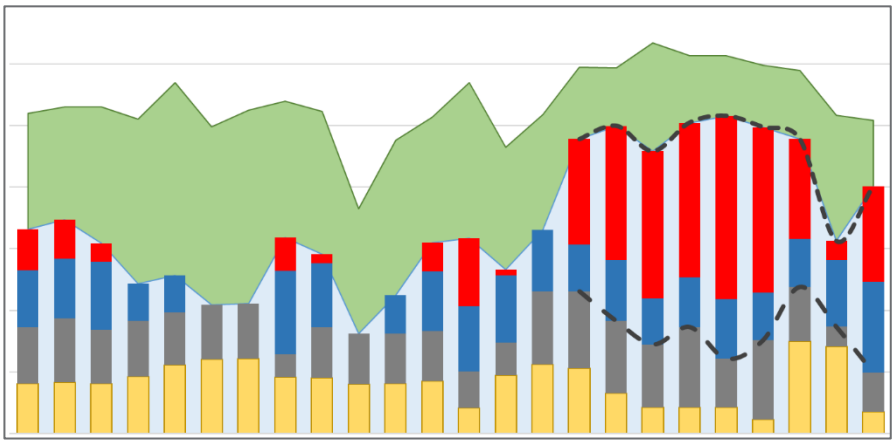
Waste dump design concepts:







System utilization and expansion analysis:



General arrangement

To support an estimate confidence on a PFS level, substantial engineering design is delivered to inform detailed bill of quantities and accurate cost estimates.

Business Case Impact:

Mine modelling with an IPCC truck destination, linked to the system throughput analysis, provide the key input into the investment business case – truck purchase, replacement, rebuild and operating savings:

The results of the analysis:

- Overall fleet size reduction
- Reduction in purchases of trucks for new and replacement capacity
- Improved fleet matching
- Reductions in truck mid-life rebuilds
- Secondary support equipment reductions
- Lower carbon emissions
- Less complexity

Customer Value

VBKOM's delivery of the PFS enabled customer value:

- Quality Pre-Feasibility Study financial model and study report to progress into the BFS and project implementation stage. This included all support provided in the assurance auditing processes to progress into the approval phases. In addition to the opportunity, technical and financial results reporting, the VBKOM team also managed and delivered key project discipline streams.

  Technical:
  - Mining analysis and proposals (Conducted by VBKOM)
  - Geotechnical evaluation (Managed by VBKOM)
  - Process and System engineering (Managed by VBKOM)
  - Dynamic Simulation modelling (Conducted by VBKOM)
  - Technology screening and evaluation (Conducted by VBKOM)
  - Infrastructure, Design and Engineering (Managed by VBKOM)
  - Control and Instrumentation (Managed by VBKOM)
  - Legal and Environmental screening (Managed by VBKOM)
  - Information Technology (Managed by VBKOM)

  Project Management:
  - Strategic fit analysis and executive report (Conducted by VBKOM)
  - Delivery standards and assurance (Conducted by VBKOM)
  - Next phase project and budget planning (Conducted by VBKOM)
  - Project execution methodology statements (Conducted by VBKOM)
  - Operational Readiness planning (Conducted by VBKOM)
  - Risk management (Managed by VBKOM)
  - Scheduling and controls (Managed by VBKOM)

  Financial:
  - Capex estimation (Managed by VBKOM)
  - Opex estimation (Managed by VBKOM)
  - Estimation basis (Conducted by VBKOM)
  - Financial modelling (Conducted by VBKOM)
  - Scenario analysis (Conducted by VBKOM)
  - Monte Carlo simulation (Conducted by VBKOM)
  - Investment proposals (Conducted by VBKOM)
  - Value engineering (Managed by VBKOM)