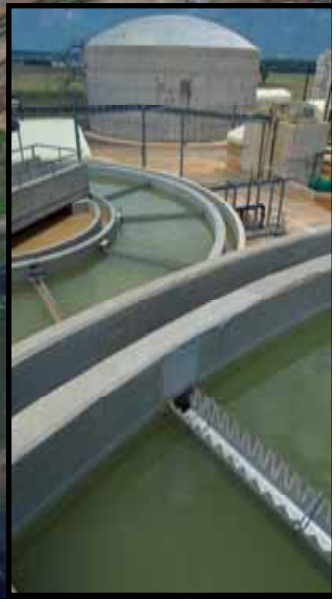
# eMalahleni Water Reclamation Plant



## “Towards Zero Disposal“
## 08 May 2009

# BACKGROUND

- Coal mining started in 1880's in South Africa – mostly underground methods
- Opencast mining started about 30 – 40 years ago
- Hydrological cycle affects both methods of mining in different ways
- Significant bodies of water have been collected
- Mines adopted Department of Water Affairs & Forestry (DWAF) hierarchy of water management to manage water

- **Not enough to solve all problems even when optimised – Mine water treatment of excess water required**

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# ANGLO COAL AND BHP BILLITON JOINT INITIATIVE

## Co-operative Water Management between Anglo Coal and Ingwe Collieries in the Olifants River Catchment

An initiative was started by Anglo Coal and Ingwe on 14 May 2002 to jointly develop and implement water management strategies that will contribute to the achievement of the in-stream and dam water quality, quantity and aquatic objectives, set or amended by DWAF for the catchment.

**The eMalahleni Water Reclamation Plant is a product of this initiative**

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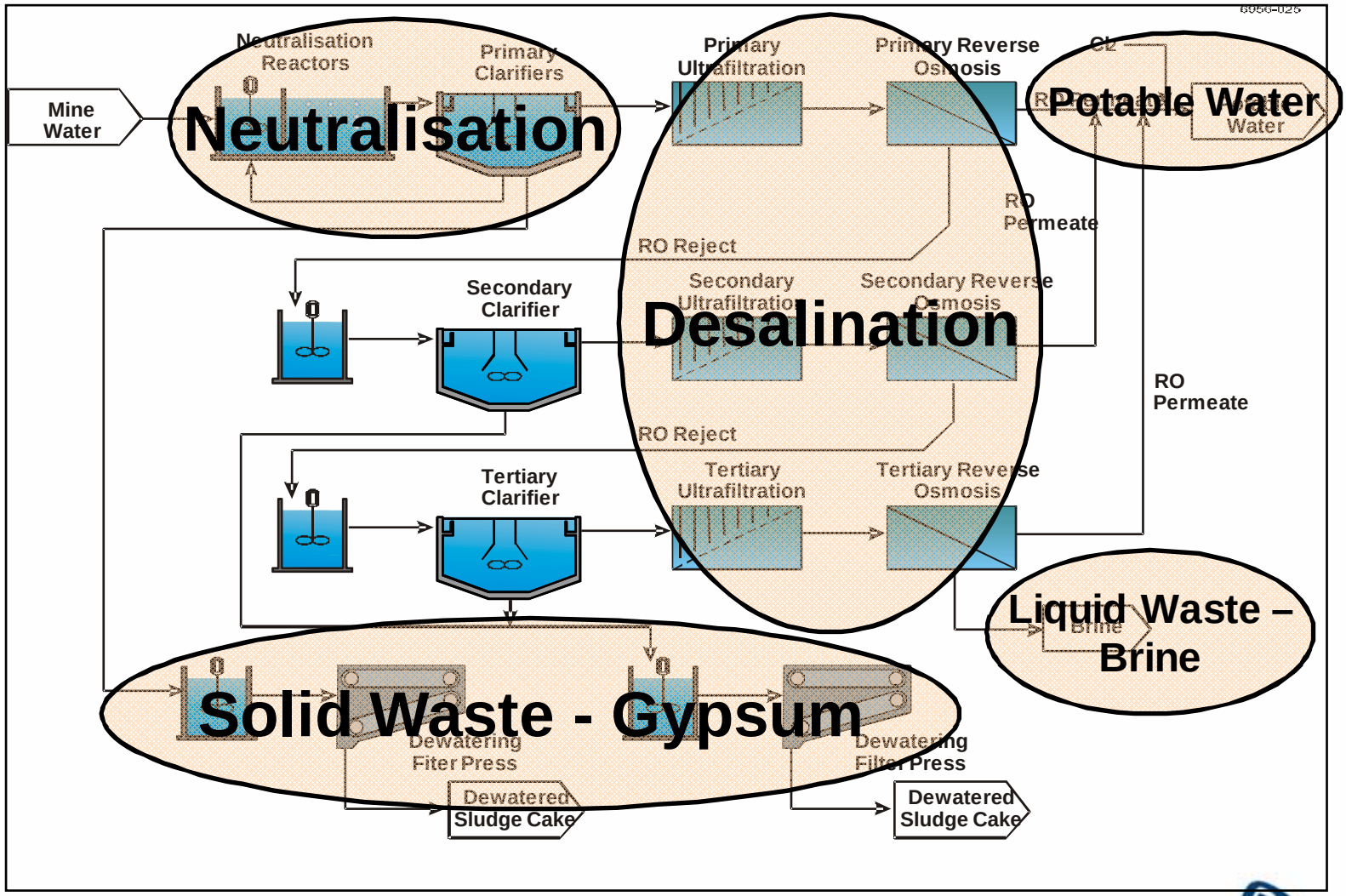
# SIMPLIFIED PROCESS FLOW DIAGRAM




**Source:** KeyPlan (Pty) Ltd

# OPERATIONAL PERFORMANCE

| KEY PERFORMANCE INDICATORS | | TARGET | ACHIEVED |
|---|---|---|---|
| SHE | LTI Free Production | - | 569 days |
| OPERATIONAL | Daily Peak Production | 25 Ml/day | > 26 Ml/day |
| | Water Recovery | > 95% | > 99% |
| | Engineering Availability | > 95% | > 98% |
| | Operational Utilization | > 95% | > 98% |
| | Energy Consumption | 3,031 kW/Ml | 2,500 kW/Ml |
| | Water Quality Compliance: Chemical* | 95% | > 96% |
| | Water Quality Compliance: Microbiological* | 99% | 100% |

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# WASTE PRODUCTION

- **Two wastes produced :**
  - Solid (Gypsum) waste ~ 150 – 200 tons/day
  - Liquid (Brine) waste ~ 60 - 100 $m^3$/day (design basis of 216 m3/day)

| | Stage 1 | Stage 2 |
|---|---|---|
| **Production (dry tons/day)** |  **40** |  **60** |
| **% Gypsum** | **30** | **86** |

- Disposal costs are still very high
- Investigations into waste remediation projects started

- **Objective of this presentation:**
  - Use of waste minimisation techniques
  - Criteria for selecting downstream technologies for waste remediation
  - Current status of research and development work on waste remediation

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# TYPICAL MINE WATER QUALITIES

- Water qualities in the northern part of the Witbank Coalfields :

| Water quality Parameter | Units | Feed Water (95 Percentile) | Treated Water |
|---|---|---|---|
| pH | - | 2.7 | 6.0 – 9.0 |
| Acidity | mg/ℓ as $CaCO_3$ | 1050 | 0 |
| Electrical conductivity | mS/m | 460 | < 70 |
| Total dissolved solids | mg/ℓ | 4930 | < 450 |
| Calcium, Ca | mg/ℓ | 660 | < 80 |
| Magnesium, Mg | mg/ℓ | 230 | < 30 |
| Sodium, Na | mg/ℓ | 130 | < 100 |
| Potassium, K | mg/ℓ | 13 | < 25 |
| Sulphate, $SO_4$ | mg/ℓ | 3090 | < 200 |
| Chloride, Cl | mg/ℓ | 70 | < 100 |
| Iron, Fe | mg/ℓ | 210 | < 0.01 |
| Manganese, Mn | mg/ℓ | 35 | < 0.05 |
| Aluminium, Al | mg/ℓ | 40 | < 0.15 |

- **What potential wastes could be produced :**
  - Metal hydroxides like iron, aluminium, manganese and magnesium
  - Calcium and magnesium sulphate
  - Low sodium based wastes like sodium chloride, sodium sulphate or sodium bicarbonate

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# MINE WATER TREATMENT INVESTIGATIONS

- **Principles :**
  - Solve process water problems
  - Another option in water management policy
  - Find suitable technologies to treat coal mine waters
  - Increase water recovery
  - Reduce capital and operating costs

| Technology Supplier | Type of Active Treatment Process | Water Recovery (%) | Nature of Waste |
|---|---|---|---|
| Debex | EDR | 65 | Solid & liquid |
| Keyplan | RO | 99 | Solid & liquid |
| CSIR | HDS (lime) | 99 | Solid only |
| | HDS (limestone) | 99 | Solid only |
| | BSR (CSIROSURE) | 98 | Solid only |
| Gyp-Cix | IX | 79 | Solid only |
| Savmin | Ettringnite | 95 | Solid only |
| Lektratek | Electrochemical | 95 | Solid only |
| IST Technik | BSR (Paques) | 99 | Solid only |
| Veolia | RO | 95 | Solid & liquid |
| Wren | Hydrothermal | 95 | Solid only |
| Bateman | RO & hydrothermal | 99 | Solid only |
| Weir-Techna | RO | 95 | Solid & liquid |






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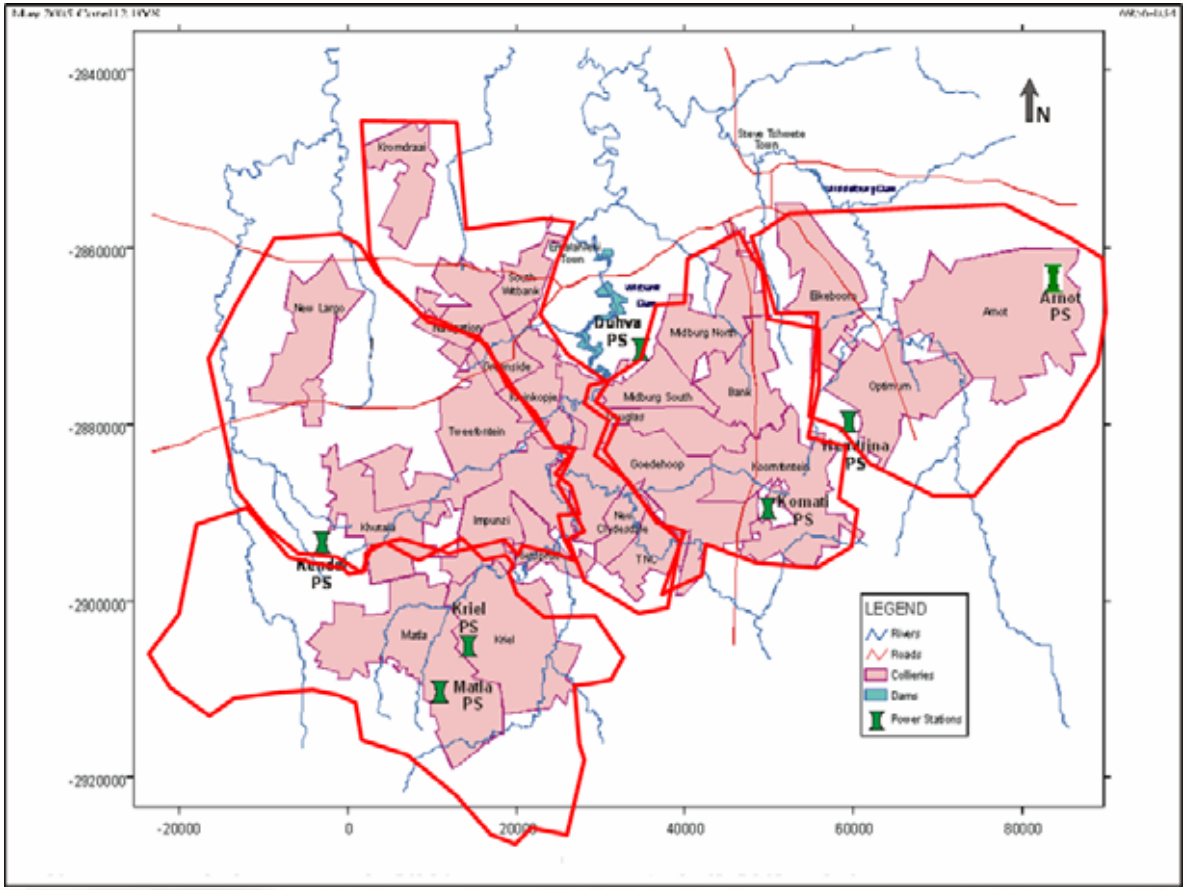
# REGIONAL MINE WATER RECLAMATION

- eMalahleni Water Reclamation Plant only treats water from 4 mines
- Potentially two other schemes under development
- Regional picture may have up to 4 or 5 regional plants in future
- What does this imply for waste generation from these facilities?

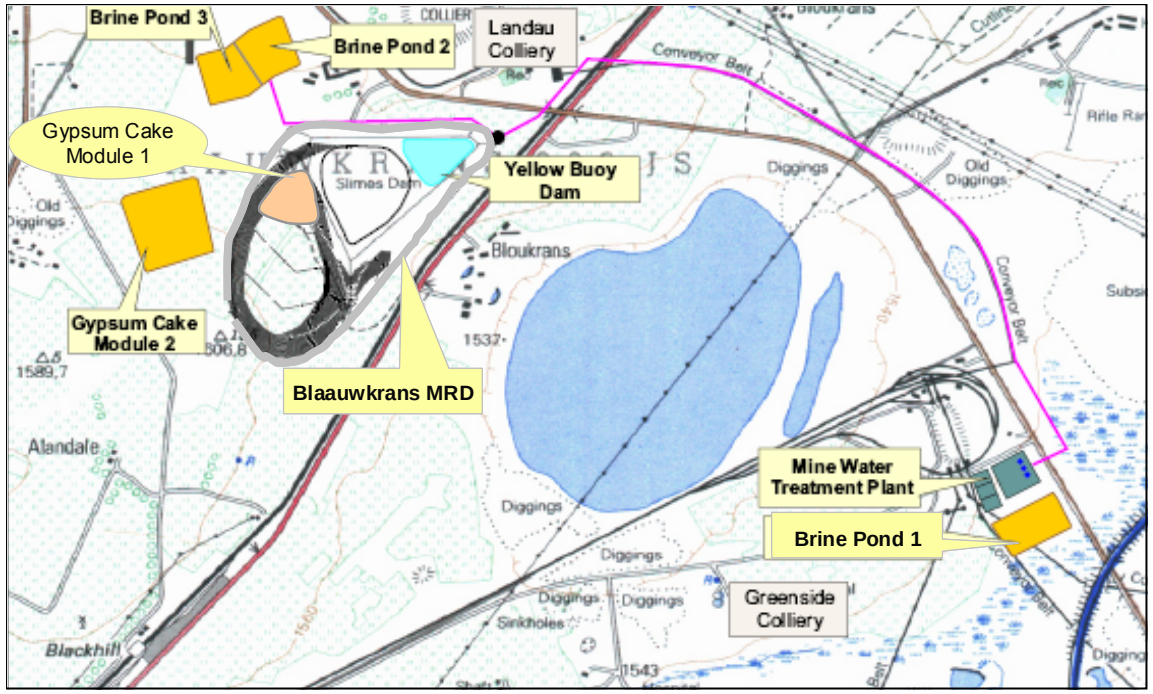


# WASTE MINIMISATION

- Tender process for eMalahleni Water Reclamation Plant required technology providers to focus of principles of waste minimisation
- Tender appraisal included cost of waste disposal
- Parallel to feasibility study – separate waste minimisation study conducted
- Main outcome was to separate solid and liquid wastes
- Wastes classified according to Minimum Requirements – could delist both wastes

# WASTE MINIMISATION

- Solid waste disposed of in separate landfill site on coal discards facility




- Liquid waste disposed of in H:H evaporation lagoon

# STRATEGY INTO WASTE MANAGEMENT

- Initial over-arching principle was to maximise water recovery to minimise waste
- Now principle is to aim to maximise water recovery but to produce waste that has downstream opportunities
- How much downstreaming is determined by how much value can be generated at acceptable risk and cost

- Four steps in identifying waste treatment processes :

  - Identification of waste products
  - Effective research relationships
  - Development of business plans
  - Regional collective collaboration in mining industry

# WASTE TREATMENT PROCESSES

- <u>Fours projects are currently targeted:</u>

- Solid (gypsum) waste :

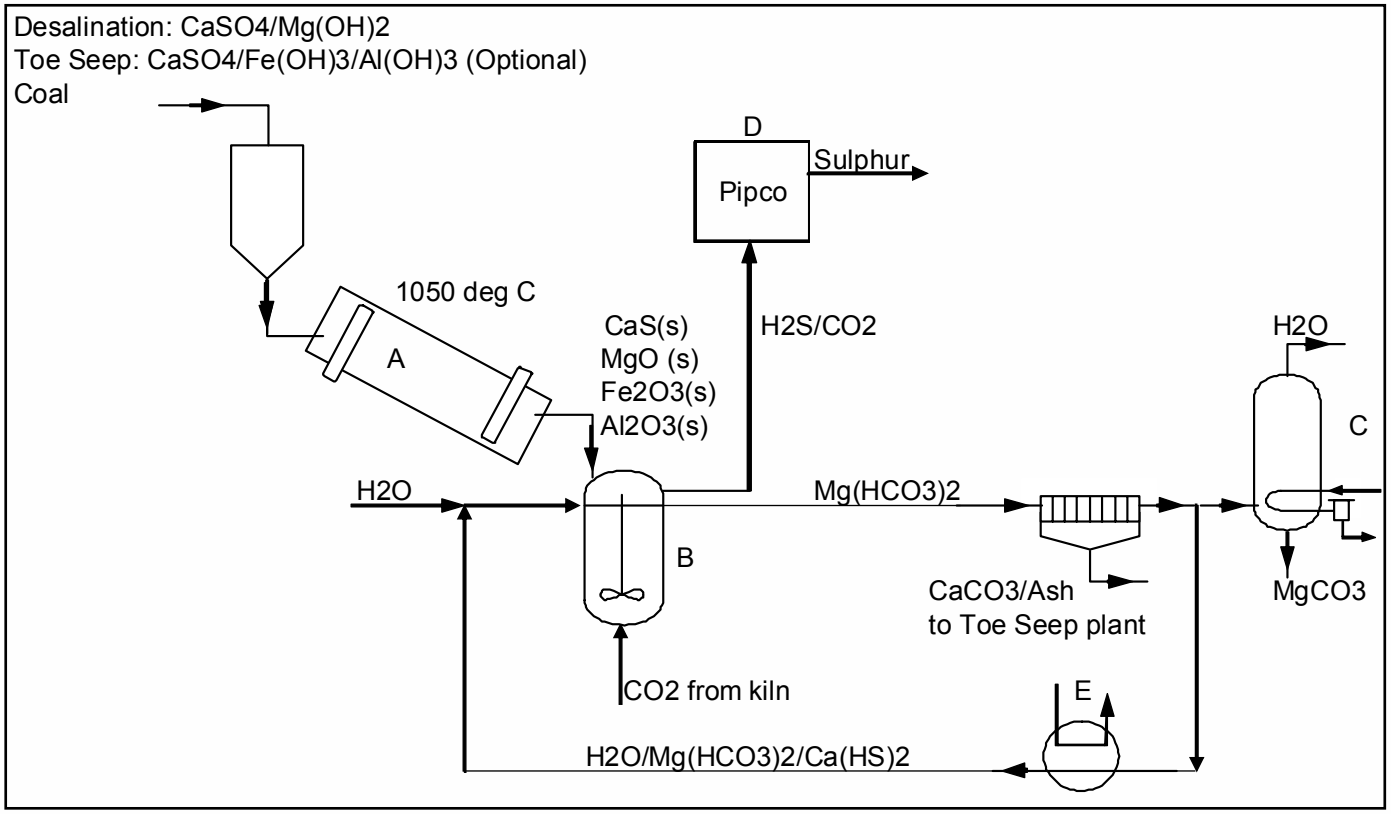
  - Gyp-SLiM – **Gyp**sum converted into **S**ulphur, **Li**mestone and **M**agnesite
  - Gyp-BuMP – **Gyp**sum converted into **Bu**ilding & **M**ining **P**roducts

- Liquid (brine) waste :

  - Algal brine remediation
  - Eutectic freeze cystallisation

# Gyp-SLiM PROJECT

- Convert waste **Gyp**sum into **S**ulphur, **Li**mestone and **M**agnesite
- Project is being conducted with CSIR and Keystructure Holdings



# Gyp-SLiM PROJECT

- Design, procure, construct & operate 1.2 ton per day pilot plant for 6 months
- Detailed design completed
- Piping & instrumentation drawings (P&ID's) completed & reviewed through HAZOP study
- Procurement of major equipment ~ June 2008,
- Commission in June 2009 and
- Operate for 3 - 6 months

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# Gyp-BuMP PROJECT

- Gyp-BuMP – **Gyp**sum converted into **Bu**ilding & **M**ining **P**roducts
- Project is being conducted with Tower Technologies
- Characterise waste gypsum physical & chemical properties
- Develop usable building and mining products
- Identify potential markets & target commercial opportunities
- Certify viable products to relevant product specification
- Engineer & cost processes to produce commercial products

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# Gyp-BuMP PROJECT

## Gypsum materials preparation:

Stage 1 Gypsum

Stage 2 Gypsum




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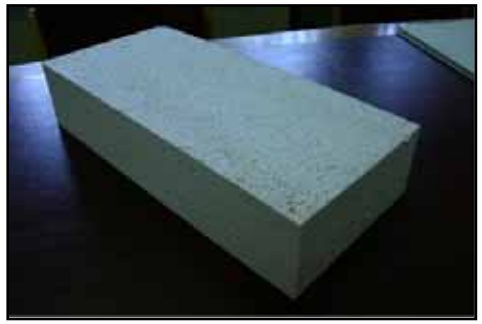
# Gyp-BuMP PROJECT



- **Product development :**

- **1. Building products**

- Matrix of 24 products from raw gypsum to high value products like boards, fillers, dental, etc.
- Value ranges from ~R450 per ton to ~R 4000 per ton
- Testing of products match or better building standards
- Optimisation of drying time & temperature for materials preparation

- **2. Mining products**

- Matrix of 5 products from ventilation seals, stone-dusting & extinguishing sponcom
- Value offsets costs but does not yield a profitable product
- Plan to do on-site trials

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# Gyp-BuMP PROJECT - Housing Development

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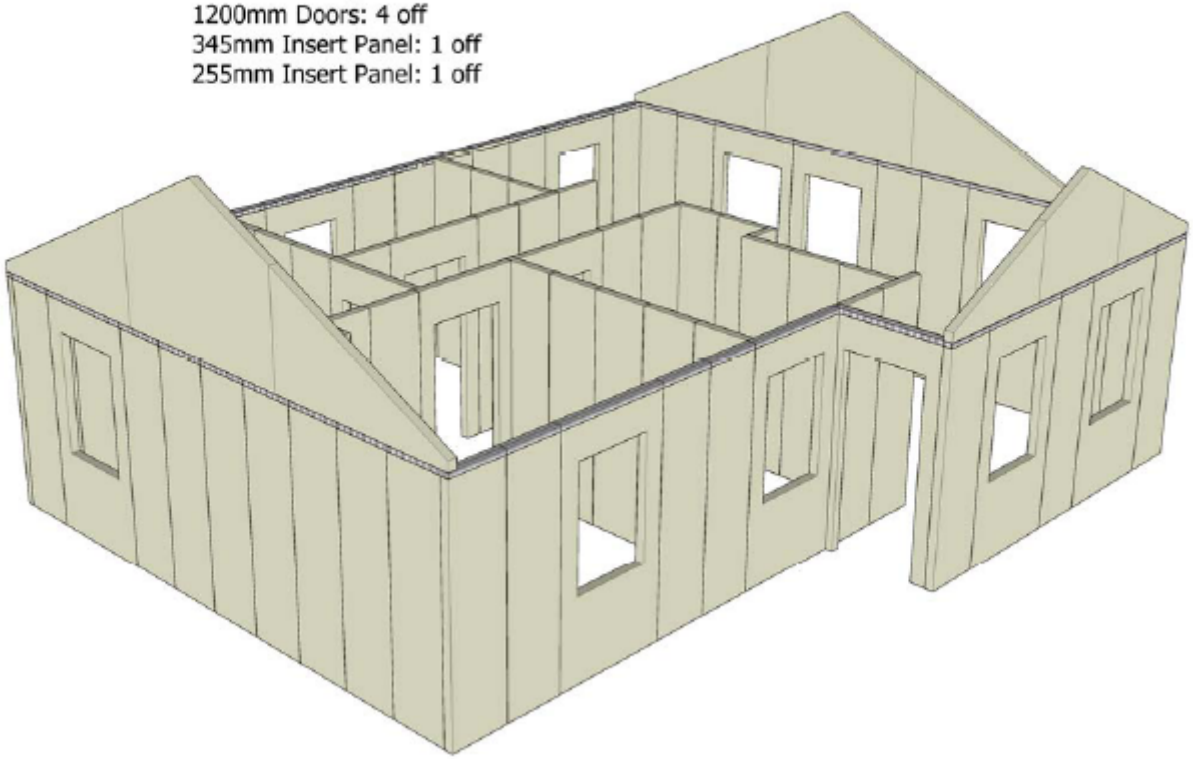
Exterior Panels, 600mm:32 off
1200mm Doors and Windows : 10 off
Long Gables: 2 off ( 3 panels each)
Short Gables: 1 off ( 3 panels each)

Interior Panels, 600mm:28 off
1200mm Doors: 4 off
345mm Insert Panel: 1 off
255mm Insert Panel: 1 off



# Gyp-BuMP PROJECT - Housing Development

# ALGAL BRINE REMEDIATION PROJECT

- Project being developed together with Environmental Biotechnology Research Unit (EBRU)
- Reduction of brine streams through algal bio-generation of *Spirulina* & *Beta-carotene*
- Successfully trialed at another Anglo Coal site but on sodium based brine over 2 years
- Use of High Rate Algal Ponds (HRAP's) used to grow & stress algal species by solar evaporation
- Seasonal weather patterns are critical drivers to production rates
- Can reduce brine stream by 90%, with remaining part being co-disposed or subject to forced evaporation

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# EUTECTIC FREEZE CRYSTALLISATION PROJECT

- Project being developed together with University of Cape Town and Delft University
- Freeze crystallisation been around since 1950's focusing on generation of ice as by-product
- Now focus is on both ice and salt generation as by-products
- Lower brine temperature to specific salt eutectic freeze point and both ice and salt precipitate out
- Brines are not homogeneous salt concentrations
- By manipulating salt concentration of undesired salts, targeted salt can precipitate out whilst other salts still in solution
- **Proposal is in hand to look at combined brine remediation project and draw from recent Water Research Commission and Coaltech projects**

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# CONCLUSIONS

- The eMalahleni Water Reclamation Plant is setting a benchmark
- Water recoveries of 99% can now be achieved but waste disposal costs are still high
- Waste minimisation and the separation of waste is essential
- Current waste remediation projects into conversion of solid (gypsum) waste into valuable by-products is progressing well
- Waste remediation projects into conversion of liquid (brine) waste have been identified and are ready to process to project phase
- **The high costs of mine water treatment may be offset in the future by the sale of valuable by-products developed from the wastes BUT more importantly the concept of ZERO WASTE DISPOSAL COULD BE REALISED**

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**Mining Legacy** → **Mining Heritage**

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