# The potential for uranium recovery at Nolans Project


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# Outline of this presentation

- Introduction to the Nolans Project
- Mineralogy and Processing Approach
- Uranium Distribution
- Alternative processes considered
- Optimal process for RE, P & Uranium Recovery

# Nolans Project Location

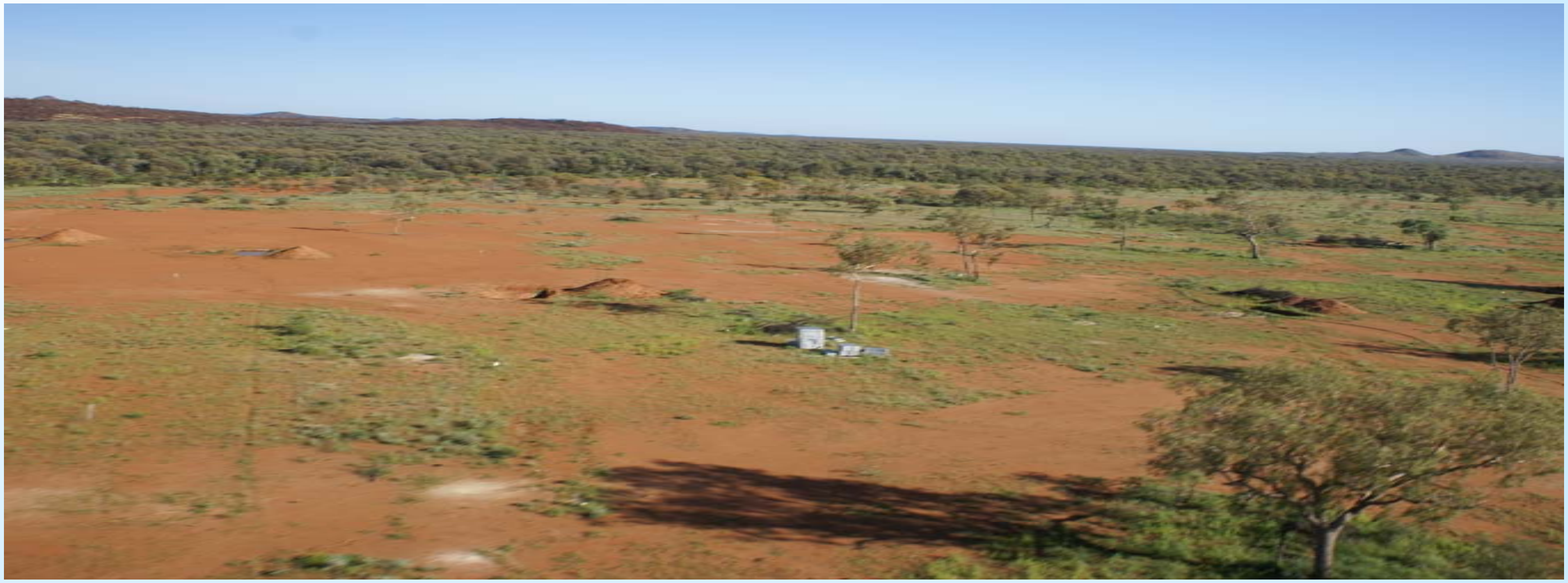

135 km north of Alice Springs

5km to gas

10km to road

60km to rail

15 km to Aileron Roadhouse

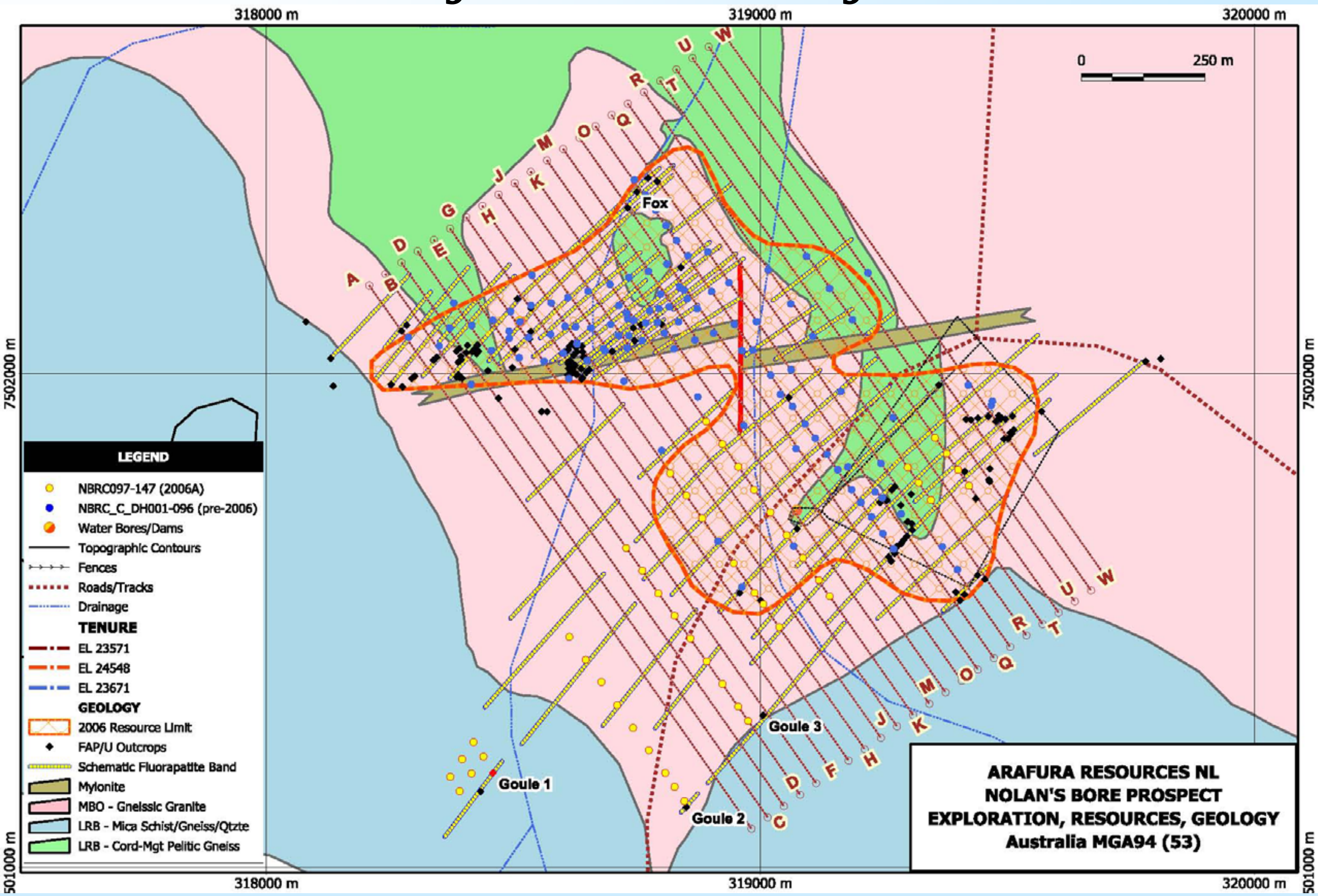


# Nolans – Mineral Resources

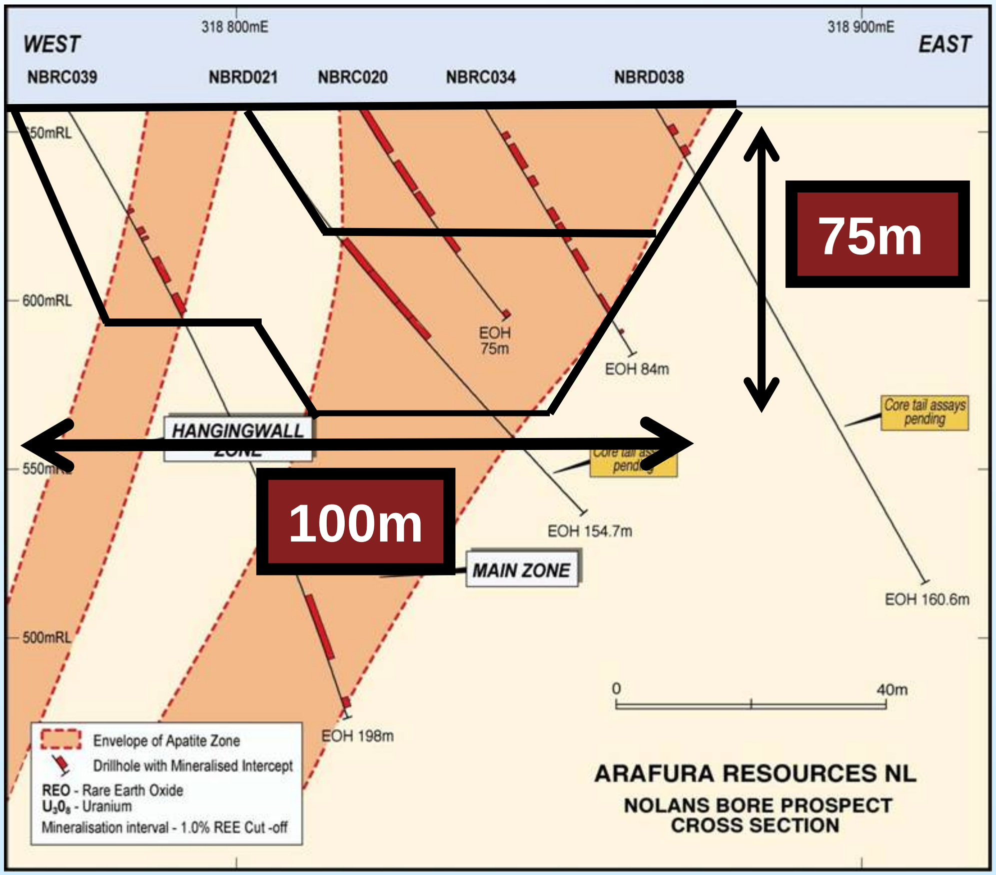
| | Mt | REO% | REO (kt) | $P_2O_5$% | $U_3O_8$lb/t |
|---|---|---|---|---|---|
| High grade | 3.9 | 4.4 | 174 | 18.3 | 0.70 |
| Medium grade | 6.6 | 2.4 | 158 | 11.1 | 0.37 |
| Indicated | 10.5 | 3.1 | 332 | 13.8 | 0.50 |
| Inferred | 8.1 | 3.0 | 245 | 14.3 | 0.43 |
| **TOTAL** | **18.6** | **3.1** | **577** | **14.0** | **0.47** |

Classification as at Nov 2005

# Nolans Project – a major resource

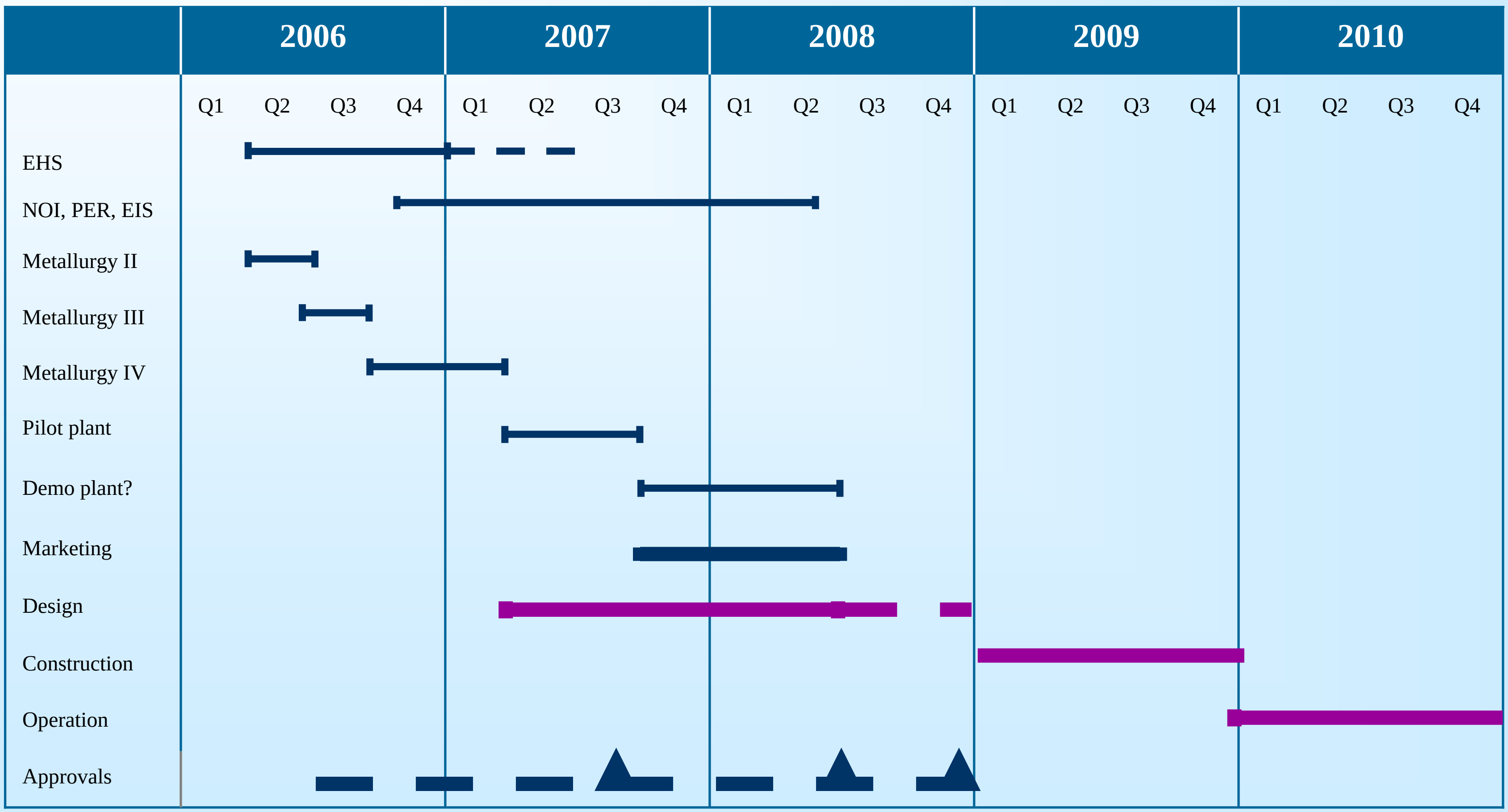


# Nolans – Shallow open pit




- **Mining rate @ 1mtpa**
- **Strip Ratio of < 1 : 1**
- **No overburden**
- **No waste in first 3 years**
- **Low cost mining**

# Development Timeline



# Mineralogy

- 82% fluorapatite

  $Ca_5(PO4)_3(F,OH)$

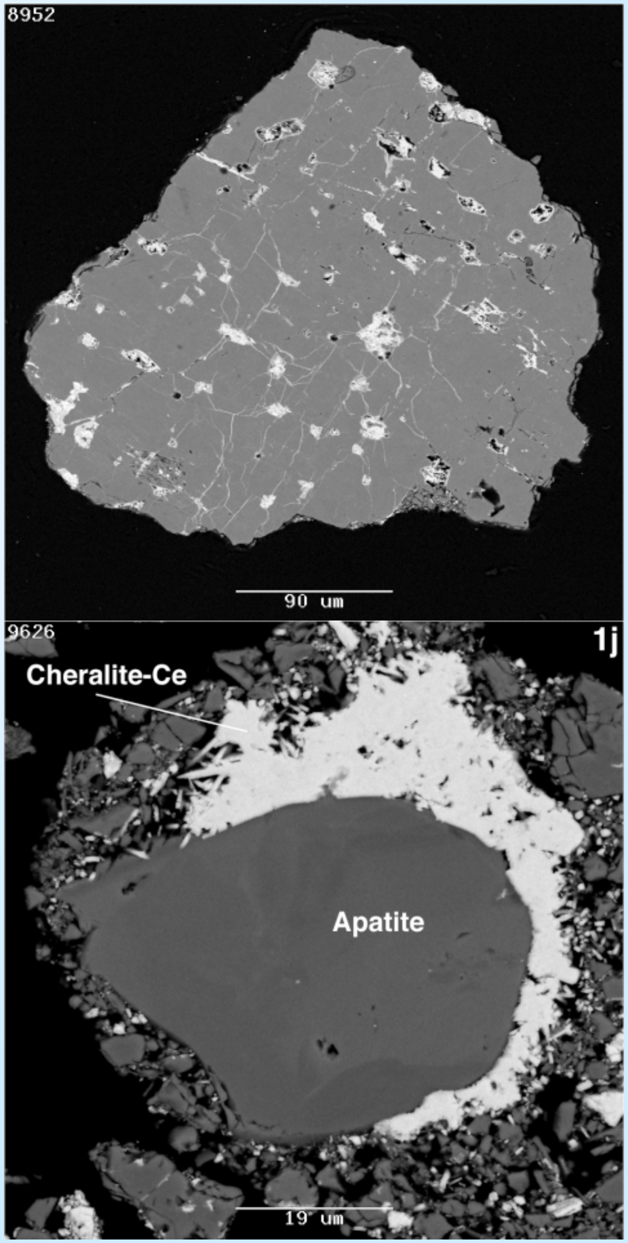
- 13% cheralite

  $(LREE,Ca)(P,Si)O_4$

- Clay (3 to 4%)

- Calcite, dolomite and quartz

  (1 to 2%)



# Nolans Mineralogy

| Nolans Bore Analysis | % |
|---|---|
| Rare Earths (La-Sm) | 5.7 |
| Al | 1.9 |
| Ca | 26 |
| F | 2.2 |
| P | 12 |
| Si | 7.8 |
| Th | 0.55 |
| U | 0.04 |

| **Apatites** | % REO | ppm U |
|---|---|---|
| Nolans Bore | 5-8 | 300-400 |
| USA - Florida | 0.3 | 130 |
| Morroco - Khoribga | 0.2 | 120 |
| Egypt - Abu Tartur | 0.1 | 25 |
| Russia - Kola | 0.9 | 4 |
| Russia - Khibili | 1.0 | low |
| **Rare Earths Concentrates** | | |
| Bastnasite | 75 | 0.4 |
| Monazite | 65 | 9 |
| Xenotime | 62 | |
| Australia - Mt Weld | 20 | 0.4 |

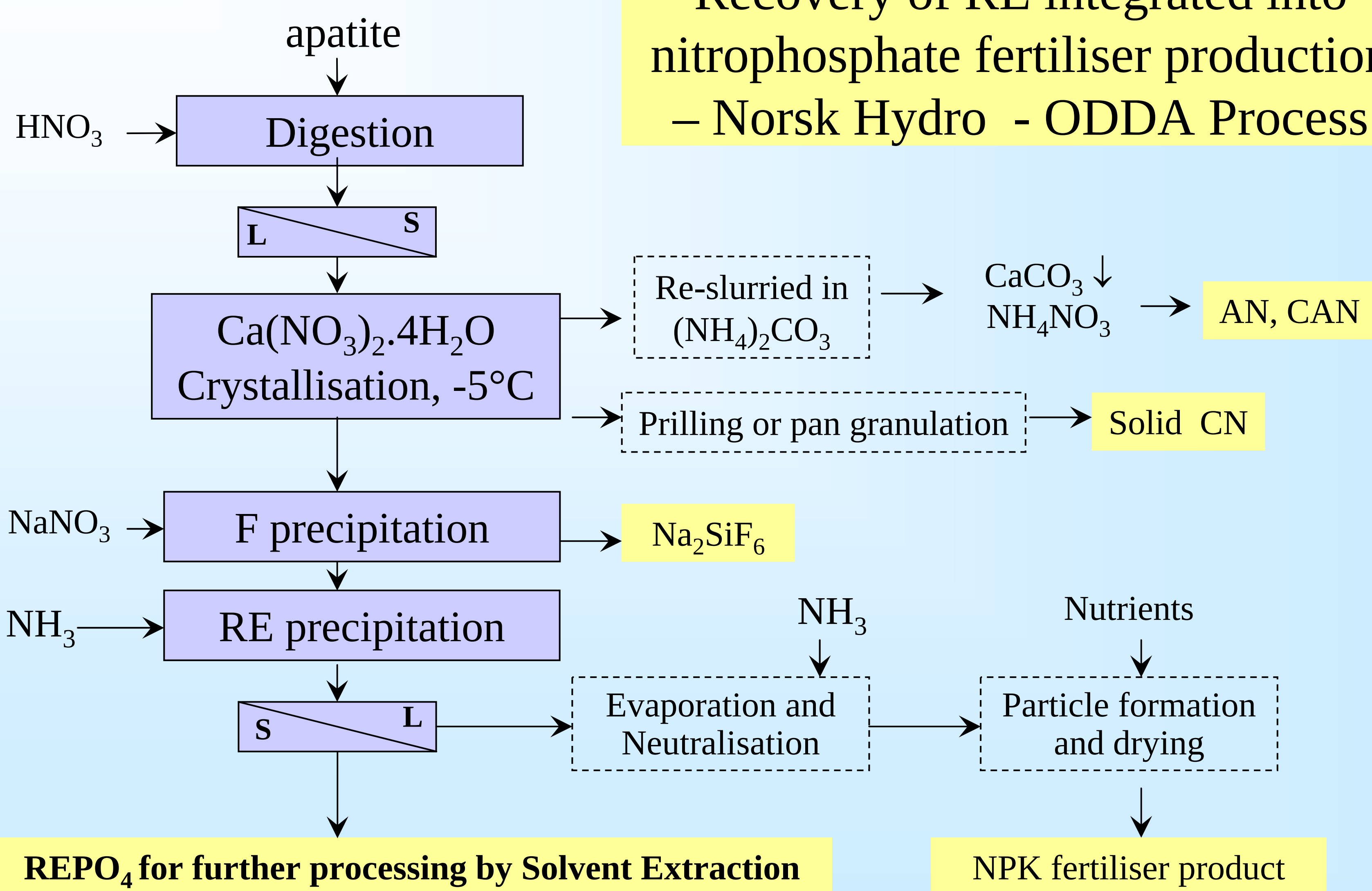
# Objective of Process Development

- Define process options for recovery of rare earths as primary driver with phosphate, uranium and calcium chloride as by-products
- Assess conventional process options for rare earths recovery from apatites
- Assess conventional options for rare earths recovery from rare earth concentrates

# Processing of apatite and phosphate rock

- Sulphuric acid attack for phosphoric acid production
  - Conventional, widely used
  - RE report with the gypsum, not recoverable
  - Uranium reports with the phosphoric acid, recovery is complicated
- Nitrate route for fertiliser production – RE recovery
  - Commercial process – not widely used
  - RE recovery by precipitation and solvent extraction
  - Uranium only present as impurity
- Chloride route
  - Niche market for high grade phosphoric acid

# Recovery of RE integrated into nitrophosphate fertiliser production – Norsk Hydro - ODDA Process

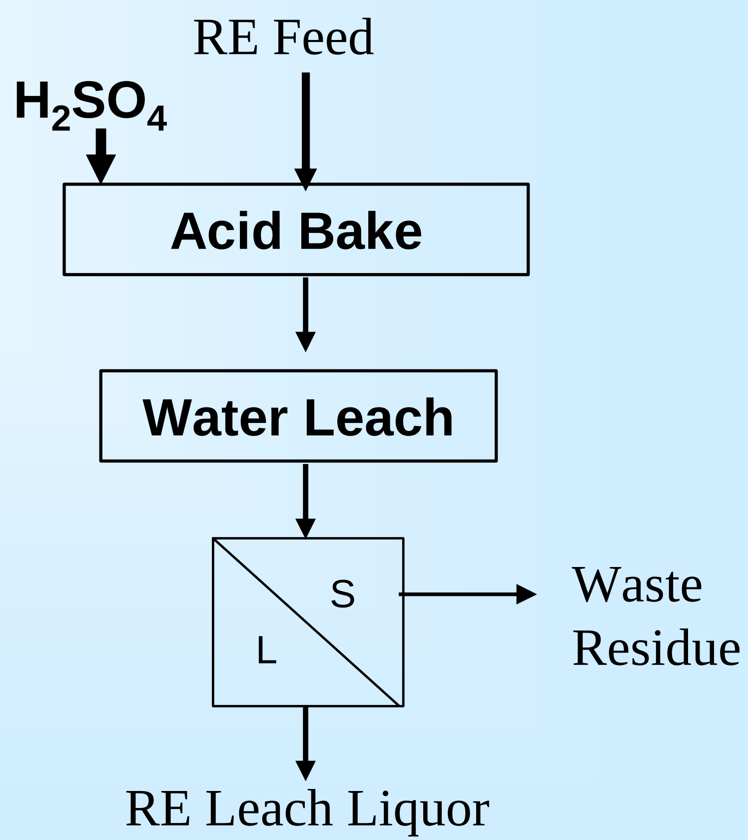


# Issues with Nolans mineralisation as feed to nitro-phosphate fertiliser ODDA Type Process

- Rare earth recovery within nitric digestion step is not very high
- High solids content from nitric digestion as opposed to apatite feed which is essentially dissolved
- Rare recovery requires precipitation and two additional solvent extraction circuits – not simple
- Main focus of this process is fertiliser product production with rare earths recovery as by-product. With Nolans mineralisation phosphate recovery is not the main driver – complicated flow sheet not justified.
- Nitric acid is not as readily available and relatively expensive
- Potential contamination of fertiliser products with U and Th

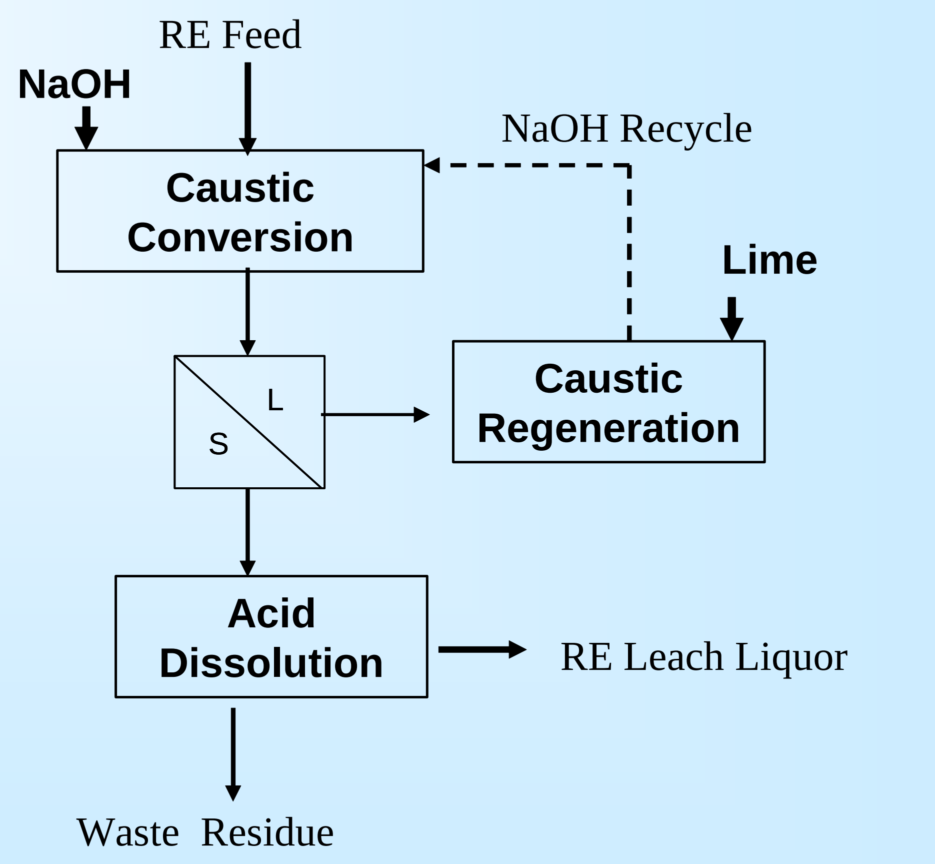
# Processing of rare earth concentrate – Acid Bake

- Conventional process
  - Used for rare earth phosphates
  - Relatively high temperature 250°C
- Not directly applicable to Nolans
  - High Ca content results in gypsum formation in water leach
  - High F content generates HF



# Processing of rare earth concentrate – Caustic Conversion

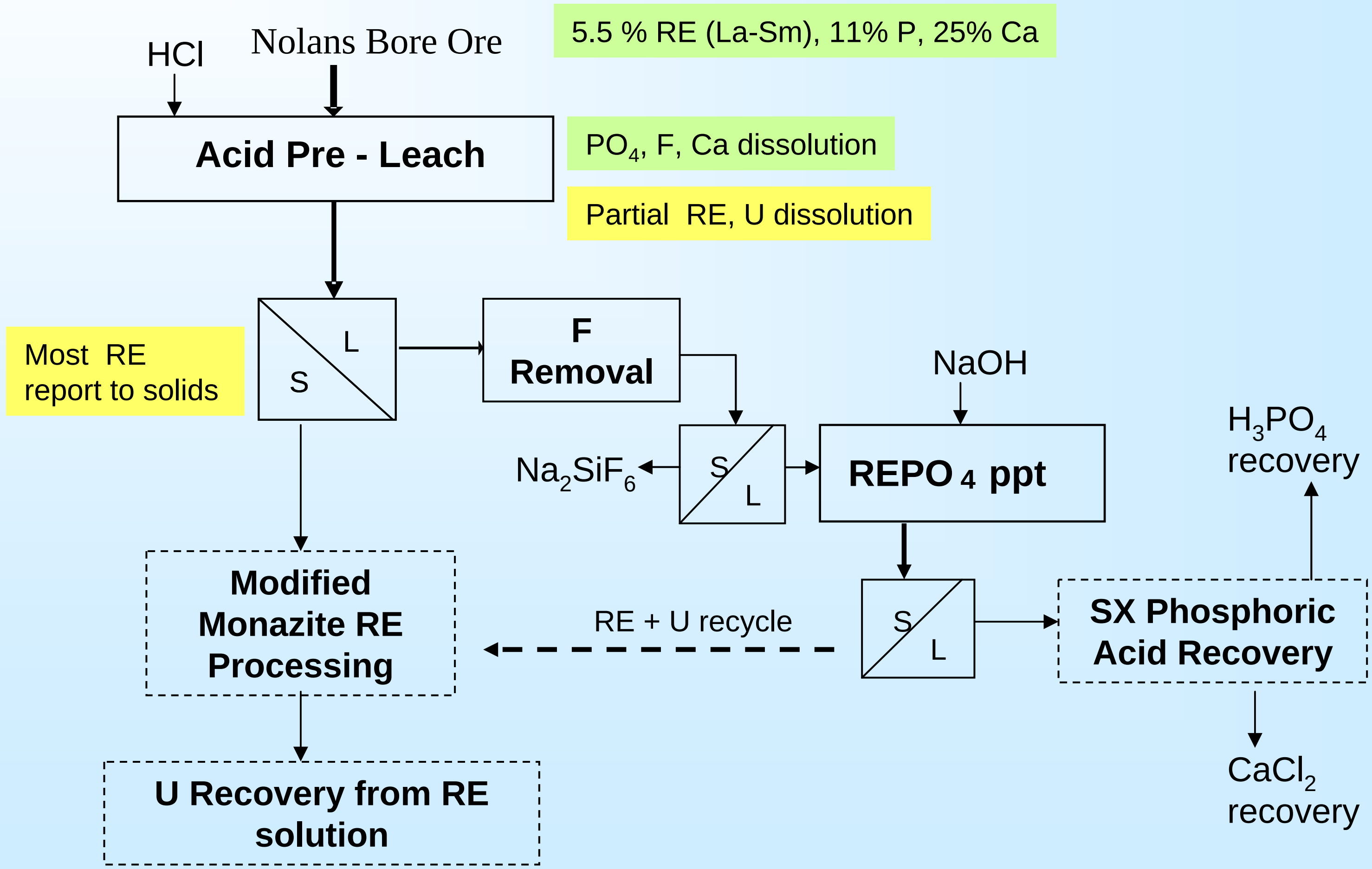
- Conventional process
  - Used for rare earth phosphates
  - Lower temperature 150°C
- Not directly applicable to Nolans
  - High Ca content results in poor phosphate conversion and low RE recovery
  - Have to remove Ca



# Processing philosophy for Nolans

- Separate apatite at early stage with an acid pre-leach step to remove as much Ca, F and P as possible – test work proved successful with nitric or hydrochloric acid under the appropriate stoichiometric conditions
- Recover any rare earths that are dissolved with the apatite – test work proved successful
- Pre-leach residue is significantly upgraded with respect to rare earths - modified conventional rare earth processing options of caustic conversion and acid bake are applicable – ongoing current test work to determine optimum process

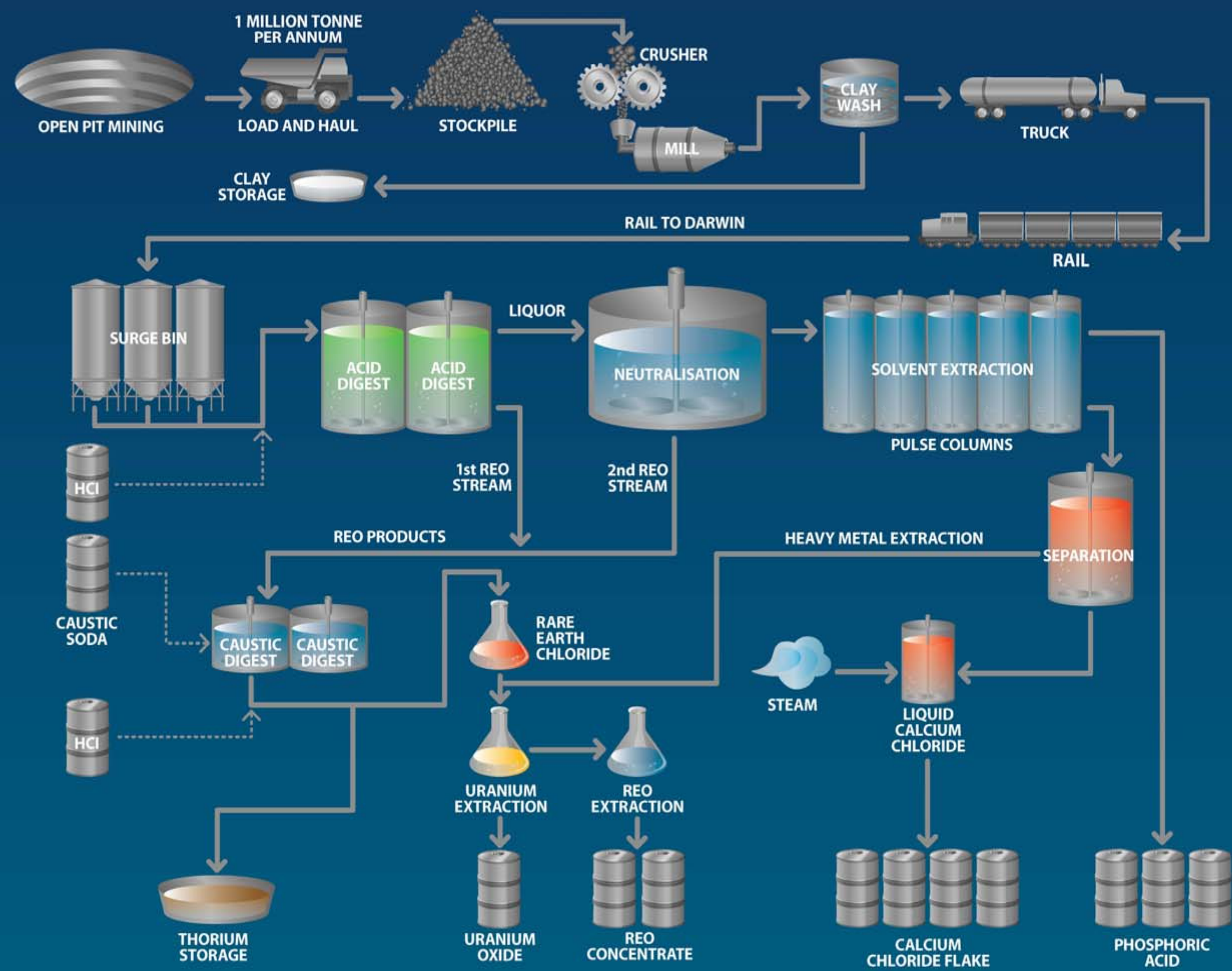
# Preferred Process for Nolans



# Approach to uranium recovery as by-product

- Partial dissolution of **uranium** in pre-leach
  - Some **uranium** is dissolved in pre-leach liquor
  - **Uranium** can be precipitated with rare earths in this liquor by the addition of metallic iron or by controlling neutralisation during rare earth phosphate precipitation if pH is extended
- **Uranium**
  - Is dissolved in the pre-leach & recycled with rare earths
- **Uranium**
  - Is recovered from rare earth liquor

# Nolans Project Flowsheet




Conceptual Flowsheet design as at 15 March 2007

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# Conclusions

- Comprehensive laboratory test work is underway to define a process to treat Nolans mineralisation for the recovery of rare earths as primary product with phosphoric acid and uranium as by-products.
- Conventional process routes have been tested and adapted to take into account the mineralogy specific to Nolans
- Pilot plant operation is planned for the last quarter of 2007.