

ISL mine Project and Planning - Feasibility Study -

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Introduction (1)

Bringing a uranium operation into production involves a sequence of interrelated steps. These are outlined in the simplified diagram presented below;

Very important step is detailed feasibility study, which :

- is required for permitting and licencing and for financing too;**
- will be the guide for all actions, and decisions leading to production.**

Introduction (2)



Introduction (3)

FEASIBILITY STUDY



PERMITTING AND LICENSING.



PROJECT PLANNING AND ENGINEERING



PROCUREMENT AND CONSTRUCTION



START-UP AND OPERATION



MINING AND PROCESSING WASTE MANAGEMENT



DECOMMISSIONING AND RECLAMATION

Introduction (4)

The Detailed Feasibility Study is the first step of designing ISL facilities.

The study or report provides an overview of the project and should address all significant issues pertaining to construction, operation, financing and final closure of the project.

The Feasibility Study gives a clear view of the scale of production, used technology, required power/heat/water resources, technical-economic parameters and economic effectiveness of the planned facility.

Typical table of contents (1)

1. INTRODUCTION

- Location and Site Description
- Historical Data
- Purpose and Scope of Study

2. CONCLUSIONS AND RECOMMENDATIONS

- Conclusions
- Recommendations
- Summary of Factors Affecting Cost

3. SUMMARY OF STUDY

- Conceptual Design
- Capital Costs
- Financial Analysis

Typical table of contents (2)

5. SUMMARY OF EXPLORATION AND INVESTIGATION RESULTS

- Geology, Hydrogeology
- Technological research
- Resource calculation
- Pilot plan

6. PRODUCTION CRITERIA

- Wellfields
- Processing Plant
- Conceptual Flow sheet

7. WELLFIELDS COMPLEX DESIGN

- Well construction
- Well patterns
- Drilling schedule
- Piping
- Access roads

Typical table of contents (3)

8. PROCESSING PLANT DESIGN

- **General Design Criteria**
- **Process Equipment List**
- **Plant Layout**
- **Process Control Concept**
- **Support Services and Facilities**

9. ENVIRONMENTAL PROTECTION

- **Atmosphere**
- **Water resources**
- **Land**

10. Restoration

- **Well Decommissioning**
- **Equipment and Building Dismantling**
- **Groudwater restoration**
- **Surface reclamatin**

Typical table of contents (5)

11. ENGINEERING MANAGEMENT

- **Project Execution Approach**
- **Preliminary Project Development Schedule**
- **Engineering Estimate**

12. DRAWINGS

- **Site Plan - Mine Conceptual Layout**
- **General Site - Building Location**
- **Processing Plant - Preliminary Flowsheets**
- **Storage, Shops, Warehouse - General Arrangement**
- **Office & Laboratory- General Arrangement**

Summary of exploration and investigation results (1)

The results of:

- **Geological exploration,**
- **U-reserves calculation,**
- **Hydro geological observation and measurements,**
- **Laboratory investigation of ore properties,**
- **Pilot plant testing,**
- **Mathematical modeling.**

Summary of exploration and investigation results (2)

Presents the main parameters characterizing:

- **Geotechnology of mining,**
- **Geological structure of the deposit,**
- **Confinement of the deposit to certain stratigraphic horizons,**
- **Location of ore bodies within the product horizon,**
- **Characteristics of ore bodies in plan and in section**

Parameters for ISL Mine

1. Geological ore reserves in categories, including geotechnological types
2. Recoverable reserves in categories, including geotechnological types
3. Leach field area
4. Average operational thickness
5. Workable reserves of ore mass including geotechnological types
6. Porosity, effective porosity of ores
7. Kinetics of leaching
8. Kinetics of reagent consumption
9. Determination of leading process (transport, chemistry)
10. Specific consumption of reagents (per 1 kg of ore, both mineralized and barren)
11. Leaching agent concentration in operational solutions (average)
12. Design time for block acidification
13. Design time for block leaching
14. Well pattern, recovery : injection wells ratio
15. Average design flow rate of operational wells
16. Total period of facility operation
17. Working period (days per year, shifts per day)
18. Below cut off U-reserves

Production criteria

- **Annual U-production** ⇒
 - ⇒ area of simultaneously working blocks
 - ⇒ number of simultaneously working wells
 - ⇒ volume of processed solution
 - ⇒ annual reagent consumption
- **Technology of leaching process (acid, alkaline)**
- **Technology of solution processing (ion exchange, extraction, etc.),**
- **Pumping technique (submersible pumps, air-lifts),**
- **Method for under balance of injected solution volume,**
- **Technology of restoration.**

Wellfields - Basic Design (1)

The wellfield complex is designated for:

- **Pre-conditioning and leaching the U deposit**
- **Leaching solutions injection into the ore bodies**
- **The production solution recovery to the surface**
- **Solutions transport from/to processing plant**

This chapter of FS includes:

- **Injection, recovery and monitoring wells**
- **Submersible pumps or airlift system for the recovery wells**
- **Associated control, piping and power systems**
- **Access and service roads**

Wellfields - Basic Design (2)

Requirements on wells:

- The arrangement of wells and their performance should provide maximum U recovery from the ore with a minimum loss of leaching solution.
- The wells should be designed to operate at the maximum possible productivity under the existing conditions at the site.
- The arrangement of wells should enable the movement of solutions underground to be controlled.
- The operating life of wells should last as long as required for complete extraction of the wellfield.

Wellfields - Basic Design (3)

Requirements on wells:

- **The number and cost of wells required for technical recovery of the ore should also be consistent with the economic parameters which are defined by the feasibility study.**
- **The standard quality attained during well installation should be sufficient to meet all expected operational requirements, including the specified equipment and instrumentation.**
- **The wells must not be allowed to become a source of environmental contamination.**

Wellfields - Basic Design (4)

Well pattern

- Hexagonal ($r = 15 - 30$ m)
- Tetragonal system (5-spot)
- Line system (20 x 50 m)
- Hexagonal with recovery well in centre, $r = 80$ m, distance of injection wells = 20 m
- Line system, distance of lines 60-120 m, distance of recovery wells cca 50-80 m, injection wells distance 10-15 m.

Wellfields - Basic Design (5)



Wellfields - Basic Design (6)



Wellfields - Basic design (7)

Parameters for the ISL mine design:

- **Well patterns, well density, ratio between recovery and injection wells,**
- **Annual total drilling (average for calculated year) including operational and monitoring wells,**
- **Total drilling for the development period (start-up) including operational and monitoring wells,**
- **Quantity of operational wells simultaneously working (both recovery and injection).**

Wellfields - Basic Design (8)

Parameters for the ISL mine design (cont.):

- Number of submersible pumps in simultaneous operation, including types
- Required number of submersible pumps annually replaced

or

- The air-lifts consumption of pressurized air
- Necessary capacity of pressurized air production, and
- Specific consumption of electrical power to pump one cubic meter solution from the well.







Processing Plant Design(4)

Parameters for the ISL mine design:

- The volume of solution to be treated is the major process parameter of each processing plant (10^6m^3 per year, m^3 per hour),
- Annual consumption of reagents and materials,
- Initial load of expensive agents and materials (adsorbents, extractants, etc.),
- Annual consumption of expensive agents and materials,
- Process water consumption,
- Steam consumption,
- Electric power consumption.

Environmental protection (1)

Atmosphere

This section gives characteristics of geographical and climatic conditions of the construction site, as well as the present background baseline concentrations of harmful impurities in the near surface layer of the atmosphere prior to the facility construction. Pollution sources are to be determined including estimates of harmful materials which may pose health hazards.

Environmental protection (2)

Water resources:

The natural pre-mine conditions of water resources are presented. The total water use is to be calculated considering both surface and underground sources.

Land

List of measures to be provided for protecting and utilizing the Earth's surface (removing and storing the fertile top layer of soil, followed with later utilization; prevention of acid spills, recultivation of disturbed land, and planting vegetation in the areas of production sites, etc.)

Restoration technology (1)

The chapter presents criteria for:

- **Decommissioning – wells, pipelines, equipment, buildings**
- **Surface reclamation – full/particular,**
- **Ground water restoration – after mining or starting parallel with operation,**
- **Waste materials management/technology.**

Restoration technology (2)

The main parameters for the ISL mine design:

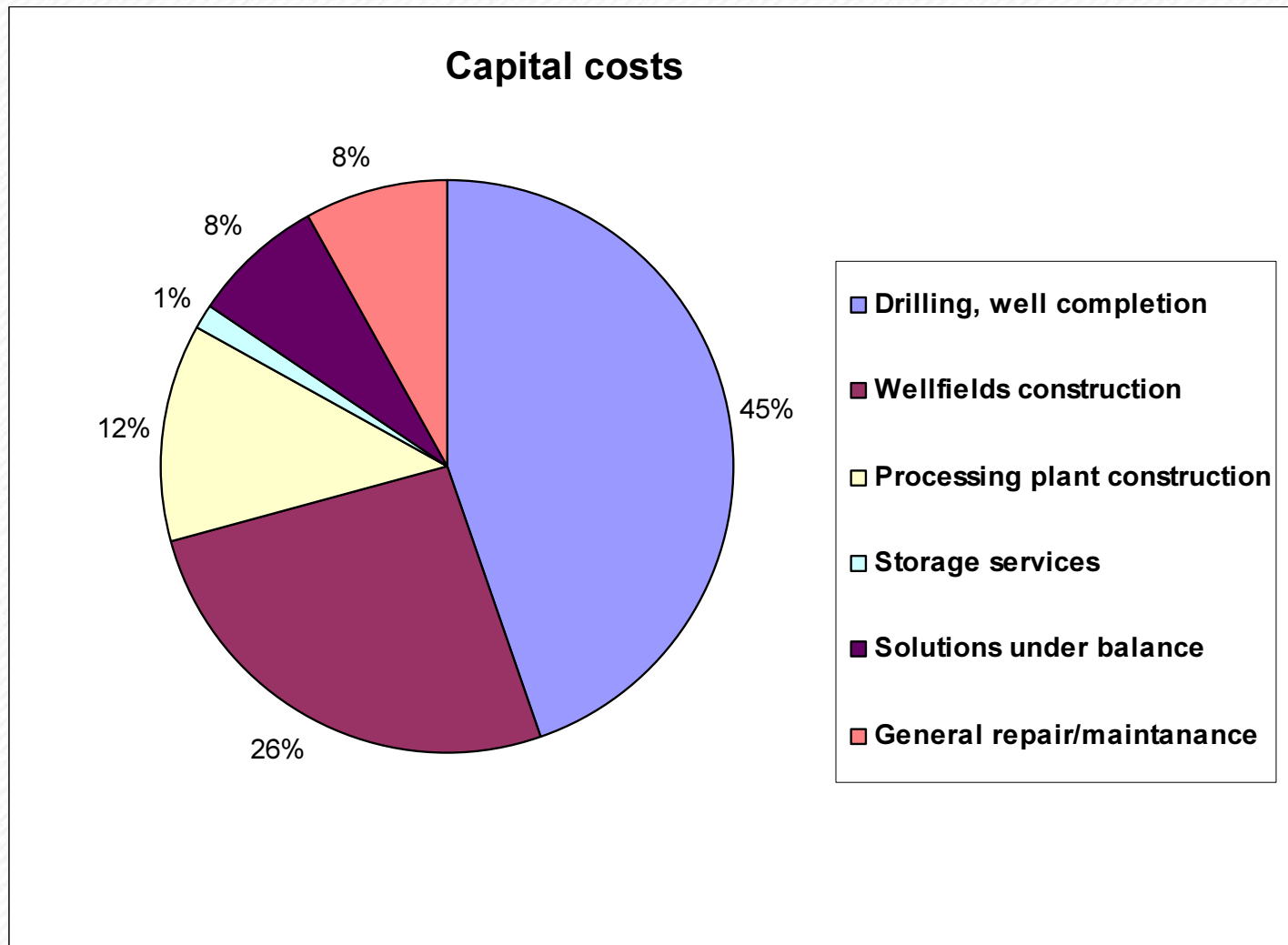
- **Technology of contaminated water treatment,**
- **Consumption of necessary reagents,**
- **Power consumption,**
- **Waste materials management.**

Cost analysis (1)

Supported by detailed schedules for:

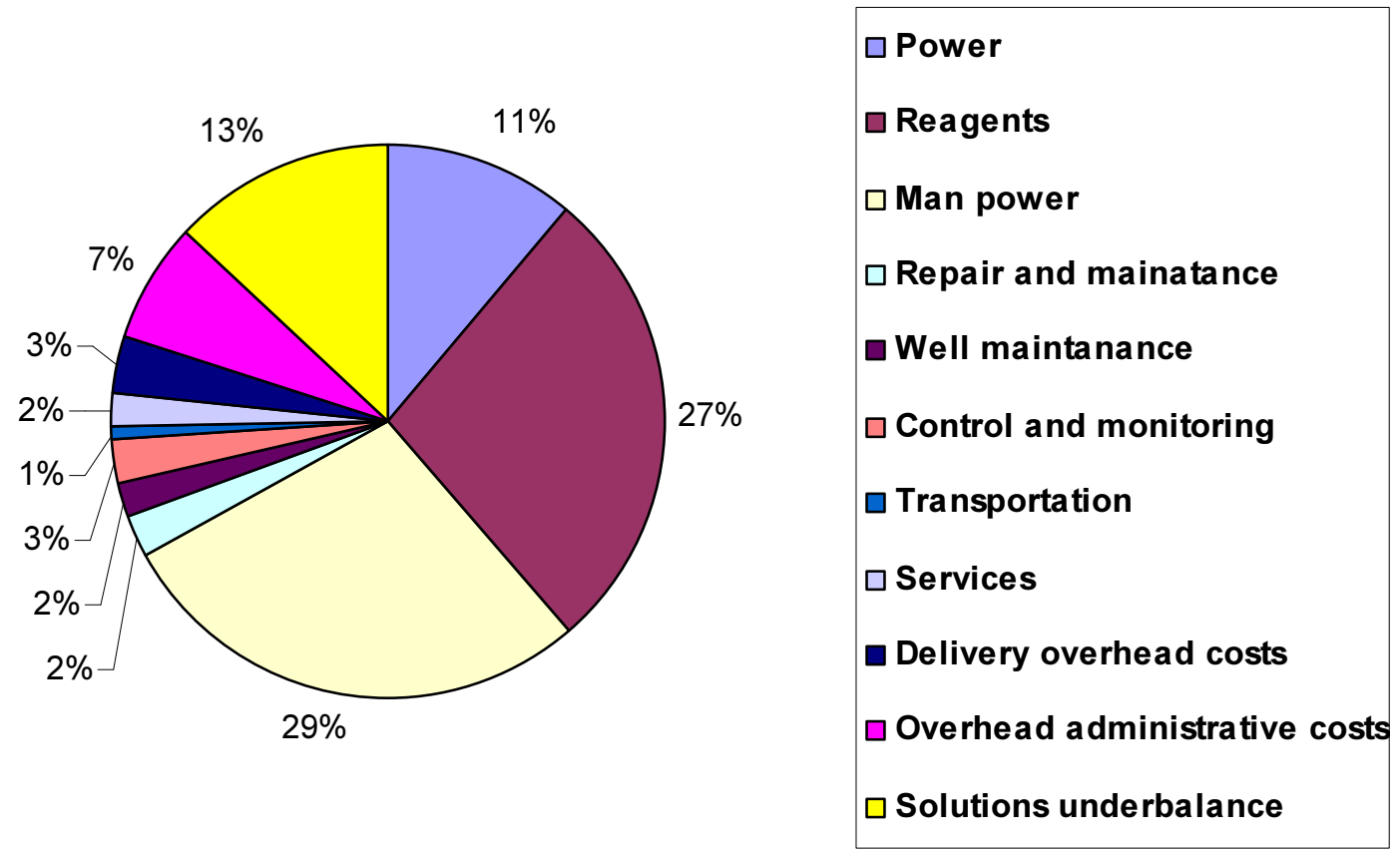
- **Initial capital equipment and costs,**
- **Annual drilling programmes and costs,**
- **Annual energy requirements and costs,**
- **Wellfield installation – material and labor,**
- **Annual manpower requirements and costs,**
- **Reagents consumption and costs,**
- **Sustaining capital requirements and costs,**
- **Decommissioning plans and costs,**
- **Surface reclamation plans and costs,**
- **Ground water restoration plans and costs, etc.**

Cost analysis (2)



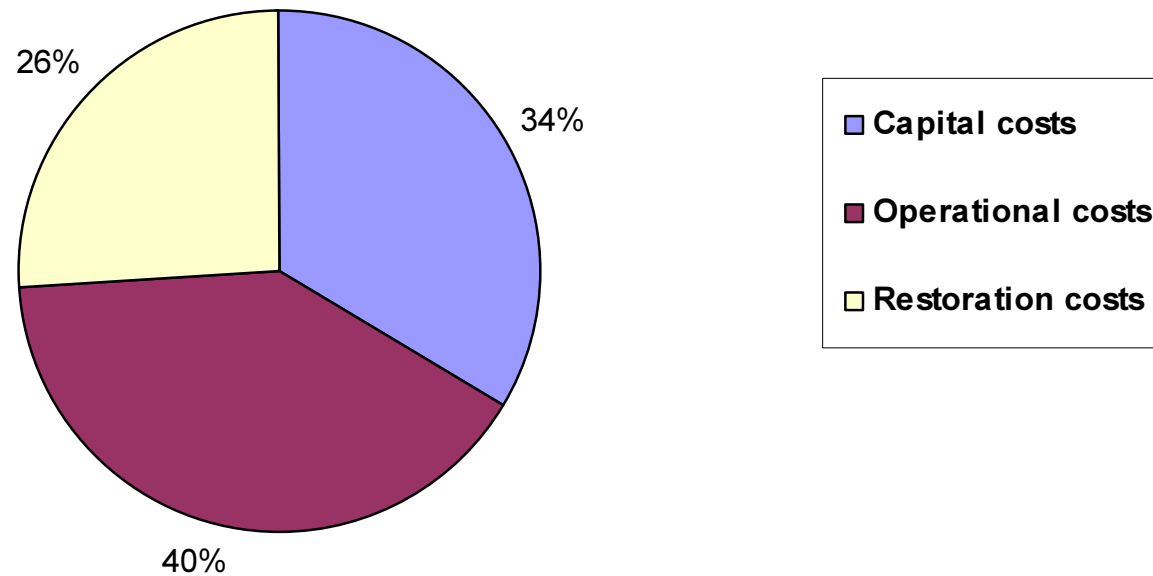
Cost analysis (3)

Operational Costs



Cost analysis (4)

Summary Unit Cost



Summary

Based on a comparison of experience between conventional and ISL uranium mining (both acid and alkaline), ISL was found to have the following advantages:

- low capital and operational project costs,**
- high cash flow within one year,**
- rapid payback of investment,**
- reduced length of project development,**
- low power consumption and less equipment required,**

Summary (cont.)

- **reduced labour per unit produced,**
- **reduced radiation exposure and lower environmental impacts (contamination, etc.),**
- **greatly reduced solid waste (no tails),**
- **economic recovery of low grade ores, thus increasing resource utilization,**
- **possibility of recovering uranium from deposit inaccessible by other extraction methods.**



Thank you for your attention