

Environment



Recycling of WTE Ash

for the Recovery of Ferrous, Non-Ferrous and Precious Metals

- RecuLAB™ NF for landfilled Ash
- RecuLAB™ Au for fresh Ash

Agenda

- RecuLAB™ NF: Recycling of landfilled ash
- RecuLAB™ Au: Recycling of fresh ash

Characterization of WTE ash

- After waste is incinerated in a municipal solid waste (MSW) incinerator, 20 – 25% of the incinerated waste volume remains as gravel-like bottom ash
- Major oxides (Al, Fe, Si, Ca) found in bottom ash sum up to about 45 – 55%. The glass and ceramic-like ash typically contains about 10% - 15% of ferrous and non-ferrous lumpy metals > 1mm
- In USA, air pollution control (APC) residues are jointly discharged with the bottom ash (combined ash)
- The dominant part of the heavy metal and salt contamination can be found in the combined ash particles sized < 1/12 “
- Grading of combined ash typically shows that 25% of the ash is < 1/12”, 95% < 2”
- Particle and bulk density of ash is typically 50 – 90% of natural gravel aggregates
- After storing and weathering, the ash can be processed in a repeatable manner to standardize the material and remove contaminants
- Ash can be used as an artificial aggregate in various application

State of the art in matured / landfilled ash recycling

- Typically, the treatment of matured / landfilled ash is performed offside the premises of a WTE plant
- Traditionally, the recycling processes for matured / landfilled ash is based on crushing and fractioning a suitable infeed for the usage of magnet and eddy-current systems for the recovery of ferrous and non-ferrous metals
- Since 2007, sensor-based sorting devices allow the recovery of alloyed steels and encapsulated metals, enabling another value creation
- Today, applying latest fractioning systems, a modern ash recycling systems can recover metal particles $> 1 \text{ mm}$
- The LAB Geodur RecuLab™ NF process for the treatment of matured / landfilled ash comprehends leading edge, best available technologies for the treatment of such ash material
- Sales revenues for non-ferrous metals are in USA in a range of 25.- - 30.- USD / to fresh ash

RecuLAB™ NF process focus

Metal recovery focus

- Quantity: Increased efficiency on recovery rate (>99%) and recovery bandwidth (> 1 mm)
- Quality: Sorting effectiveness and pureness of metals (all metals, even bound in mineral matrix)

Landfill focus

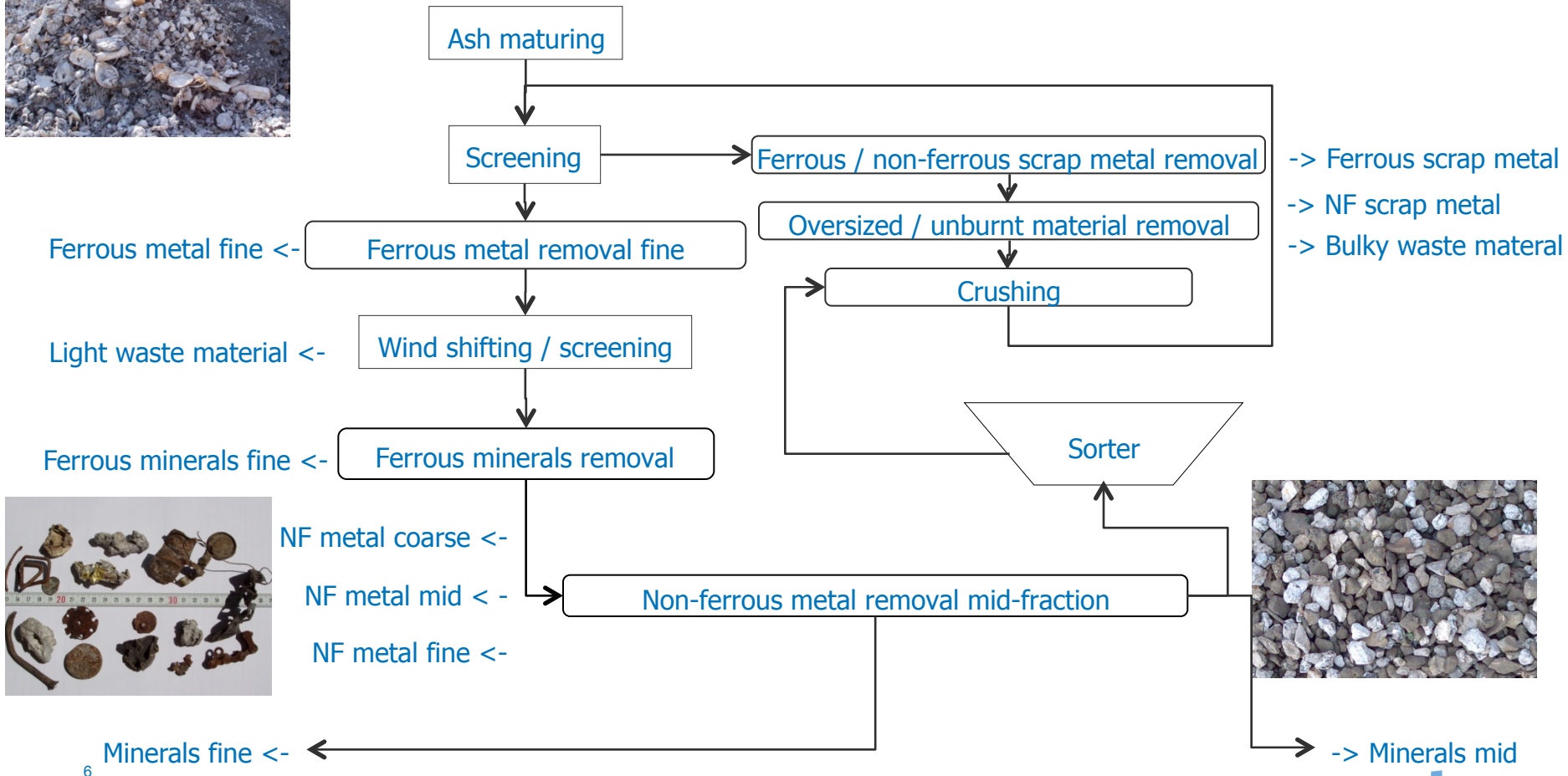
- Volume reduction: Sustainability and protection of landfill space (up to 100% re-use)
- Contamination: Reduction of chemical load in landfill (by up to 100%)

Construction material focus

- Chemical: Reduction of oxidation, carbonization, gas building and leaching
- Physical: Creation of visually attractive secondary construction material within defined construction material specifications

RecuLAB™ NF process flow

Removal of contamination, recovery of metals and proper grading



Advantages of RecuLAB™ NF process

- Maximum metal recovery > 1 mm (matured or landfilled ash)
 - Maximum value creation
 - Minimum leachate of residual minerals
 - Direct commercialization by LAB Geodur
- Minimum crushing of minerals
 - Maximum re-use potential as alternative construction material
 - Minimum dust building
 - Minimum wear
- Successful implementation in different ash treatment sites

Impressions of RecuLAB™ NF treatment site



Cornerstones of RecuLAB™ NF business model

- Base model BOO / JV; 10 years +5 years terms
- Minimum ash volume > 50.000 t / a per site
- Operations
 - Staff: 6-8 FTEs per shift
 - Power: 200 – 250 kW (base: 50 t/h per shift module)
 - IBA disposal cost: unchanged
- WTE plant owner typically manages ash supply to RecuLAB™ NF system and ash dispatch after treatment; operations and financing cost to be shared – as per business model (open book)
- LAB Geodur takes care of metals trading; metal revenues to be shared – as per business model (open book)

RecuLAB™ NF roles and responsibilities

	WTE plant	LAB Geodur
Engineering / permitting	Adaptations and permitting	Planning and integration
Installation / commissioning	Provision of space, connection of media and power	Installation, commissioning, training
Financing	BOO / JV model	
Operations	As per business model	Metal trading
Invoicing	Open book, distribution key as per business model	
Duration	10 years +5 years	

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- RecuLAB™ Au: Recycling of fresh ash

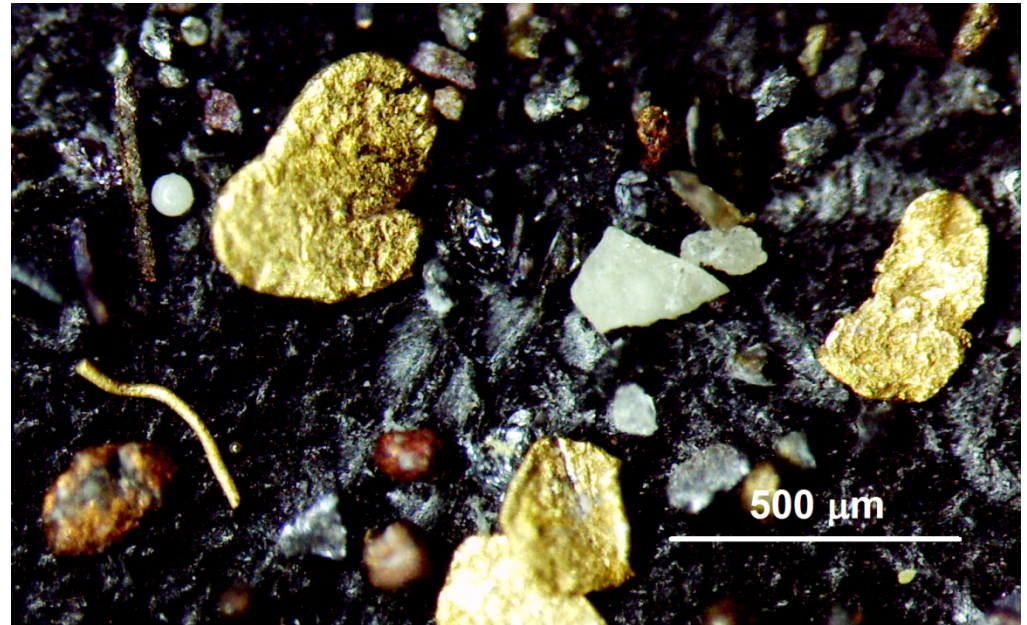
RecuLAB™ Au for treatment of fresh ash

- Fresh, wet discharged ash can not be treated easily:
 - High moisture content and large amount of adhesive fine particles hinders an effective recovery of metals and produces recovered metals with high mineral contamination
 - Non-continuous infeed (intermittent quenching process) produces complicated, irregular working conditions for metal recovery equipment
 - Space availability on WTE plant premises is typically limited
- BUT, if the precious and non-ferrous metals in the fraction $< 1/12$ “ could be recovered, the revenue potential from non-ferrous metals in fresh ash could be increased by another 25 – 50%
- => RecuLAB™ Au: LAB Geodur fine ash recycling module for wet discharge systems

RecuLAB™ Au for wet discharged ash

- Out of 100.000 to of fresh ash, the following volumes of non-ferrous and precious metals can be recovered in the fraction $< 1/12$ “

- Au: 25 – 40 kg
- Ag: 550 – 650 kg
- Cu: 140 – 180 to
- Zn: 120 – 200 to
- Other precious metals
(Pt, Pd, Cr, Ni, Mo, ...)

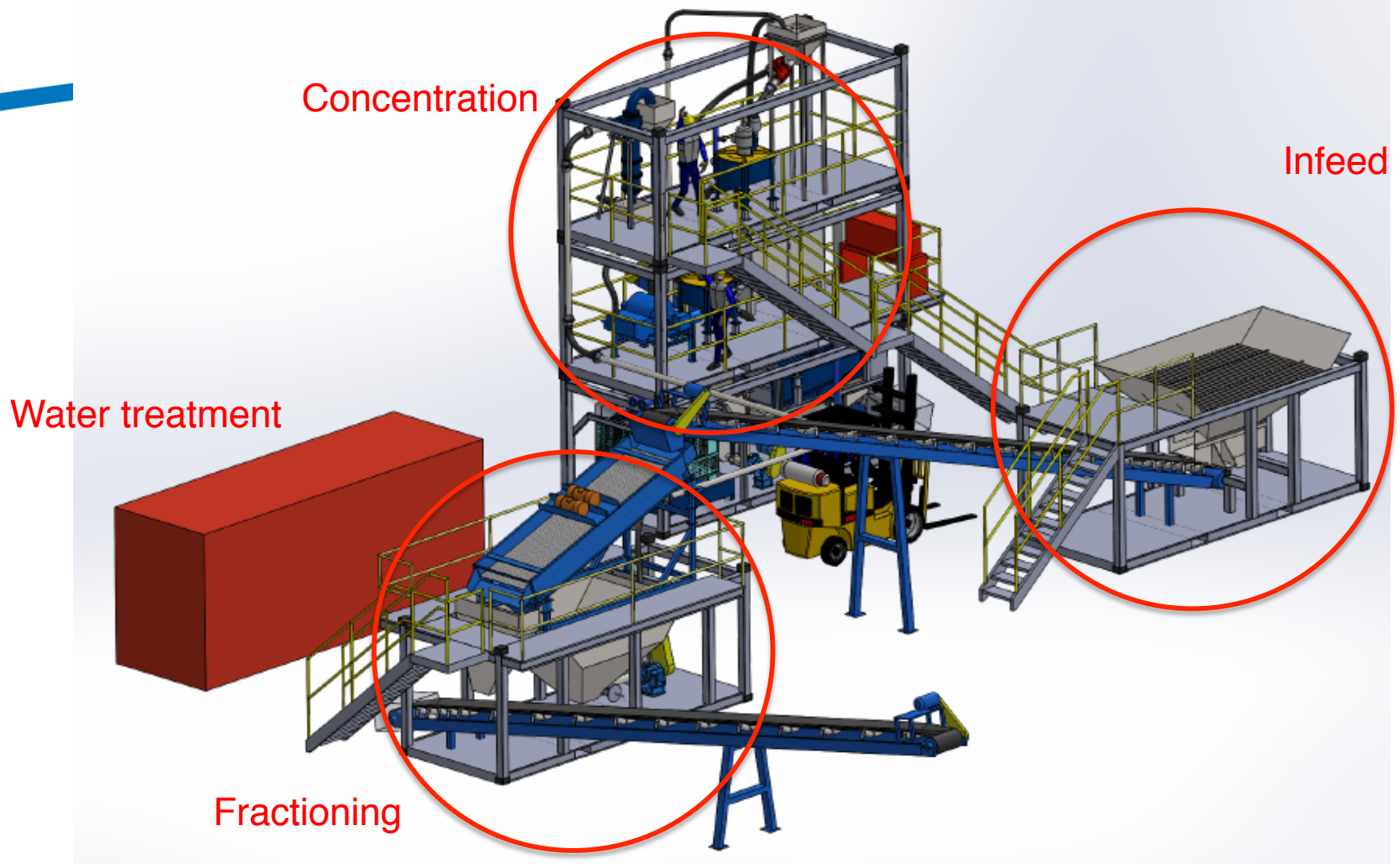


- RecuLAB™ Au patent application: PCT / EP 2013/075106 (EP 12 196 494.4/2012)

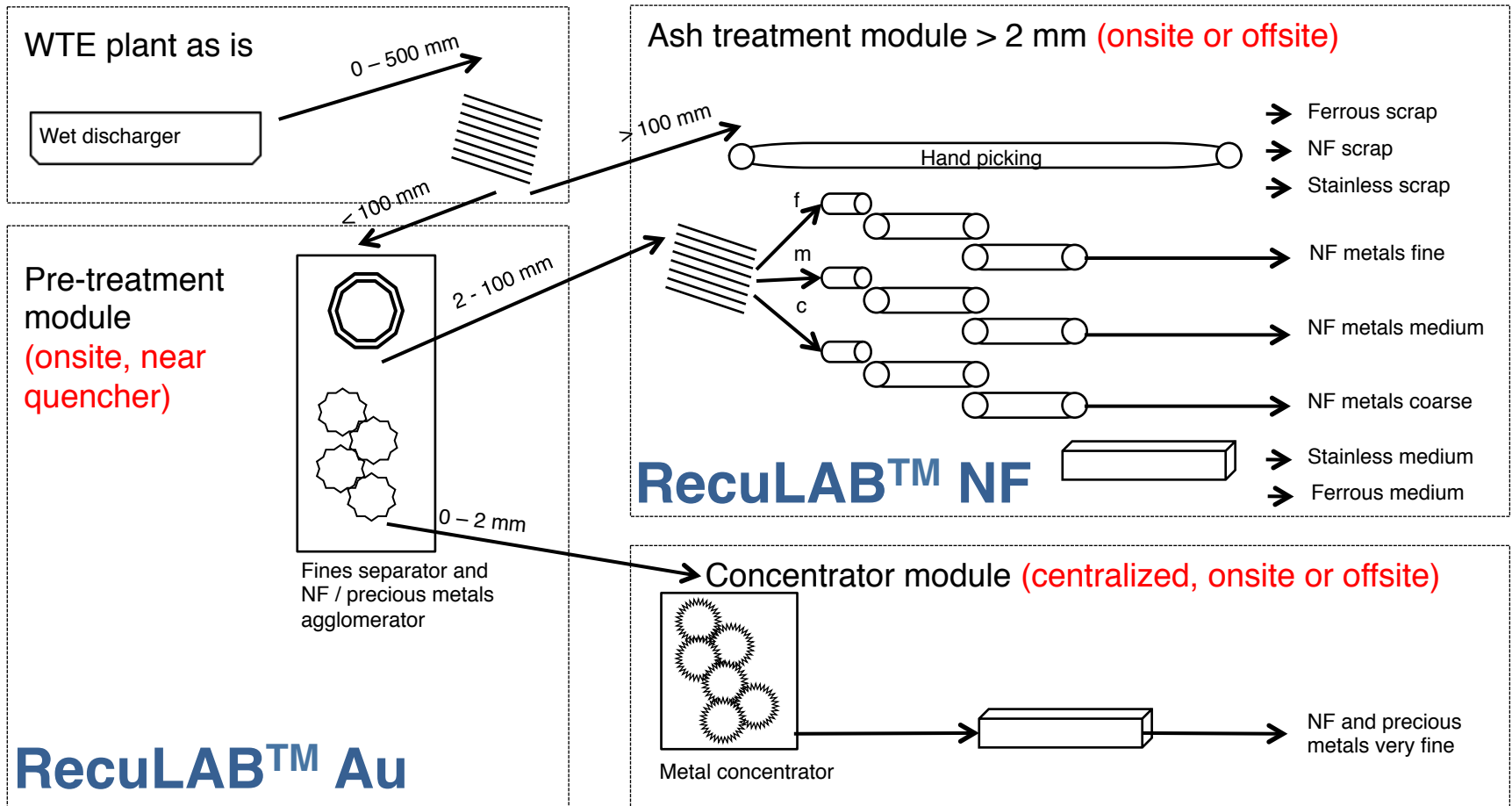
RecuLAB™ Au cornerstones

- **ONLINE, ONSITE, WET** pre-treatment of wet discharged, fresh ash, special processing technologies for the fraction $< 1/12$ “;
- **Modular** concept, e.g. easy integration into **existing ash recycling site**, **unchanged use** of installed ash recycling technologies for treatment of fraction $> 1/12$ “ (optionally updating);
- **Small footprint for infeed / outfeed storage** through timely processing of ash;
- **Massively reduced dust emissions**, also for subsequent conventional treatment of fraction $< 1/12$ “;
- **No additional residues expected**, closed-loop process water management;
- **Improved metal quality** in all fractions resulting in higher sales revenues;
- **Increase metal recovery rates** in fraction $> 1/12$ “ as better working conditions for eddy-current systems;
- **Further re-use of treated mineral fractions** as secondary construction materials if possible

RecuLAB™ Au main modules



RecuLAB™ Au integrated into RecuLAB™ NF



RecuLAB™ Au synergy effects for WTE plant

■ Operations:

- Regular operation of WTE plant not disturbed
- Operation with existing operations team
- Improved working conditions through dust reduction and simplified processing
- Omission of ash storage for maturation, with this reduced footprint requirements for ash treatment

■ Investments:

- Abandonment for retrofitting in aspiration and dedusting systems
- E.g. Leasing or JV model for RecuLAB™ Au treatment module
- Updating of modern metal recovery systems for ash fraction > 1/12 “

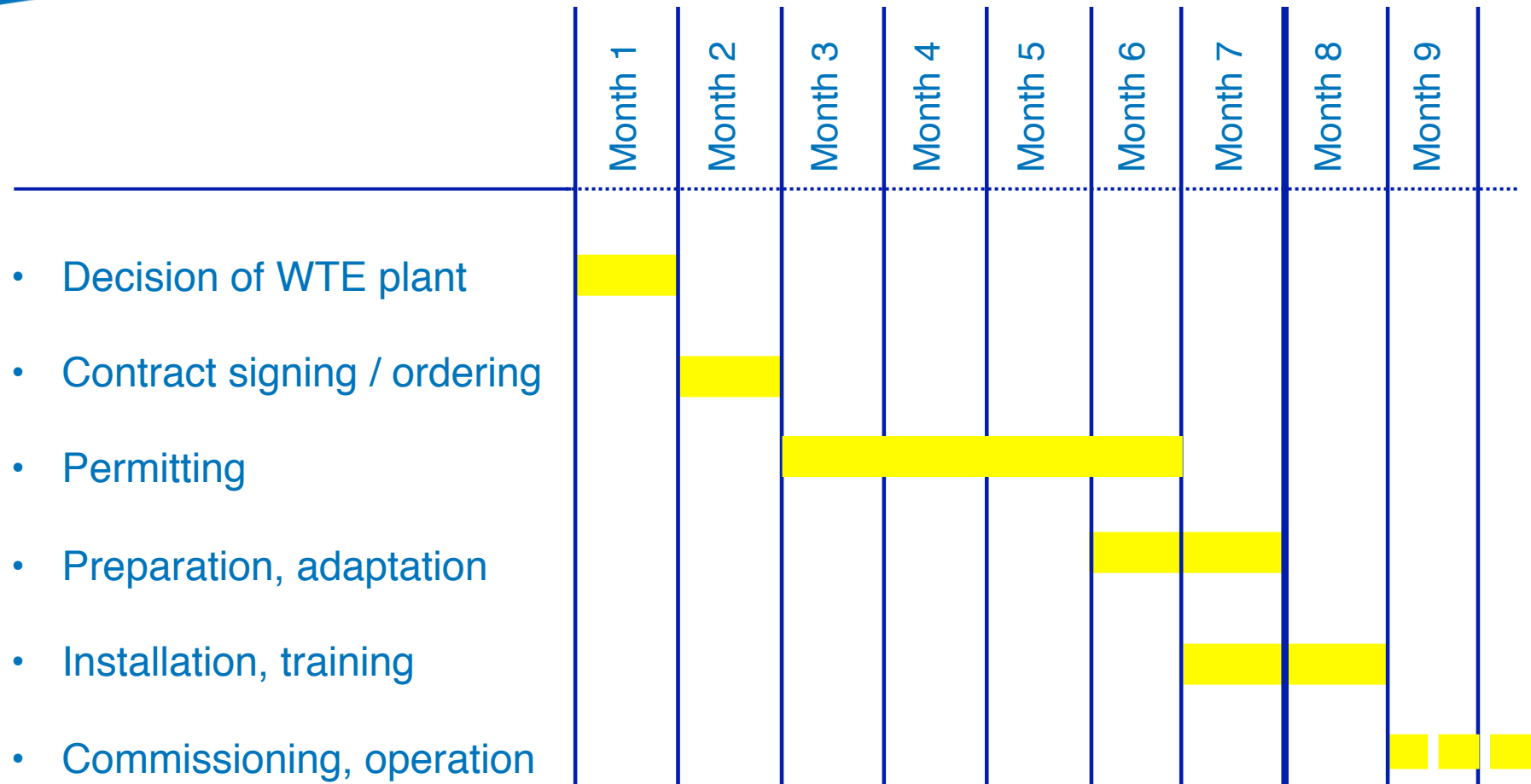
■ Revenues:

- Increased recovery volumes and qualities of existing ash treatment facility
- Higher metals sales revenues for NF fractions

RecuLAB™ Au roles and responsibilities

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Engineering / permitting	Adaptations and permitting	Planning and integration
Installation / commissioning	Provision of space, connection of media and power	Installation, commissioning, training
Financing	E.g. Leasing model or JV	
Operations	Operation with existing staff	Metal concentrate trading
Invoicing	Open book, distribution key for metal concentrate revenues	
Duration	10 years	

Timing for RecuLAB™ Au and NF modules



Contact information

LAB Geodur Zug
Riedstrasse 13
CH-6330 Cham / Switzerland

Telephone: +41 41 766 88 16

E-Mail: r.weippert@geodur.ch