Design of Sludge Treatment Facilities in Indonesia: Learning from the Past to Design a Better Future

FSM4 February 2017

MWH now part of Stantec

Authors / Acknowledgements

IUWASH PLUS Project

- Endro Adinugroho
- Foort Bustraan

MWH/Stantec

- Chengyan Zhang
- Michael McWhirter

Funded by United States Agency for International Development (USAID)

Significant input by Dave Robbins

Overview of Presentation

- Introduction
- Lessons learned
- Some themes and planned activities

Current Septage Treatment in Indonesia

- 85% of Indonesia's urban population create septage
- Government to construct 200 Septage Treatment Facilities over the next 5 years.
- An additional 150+ existing IPLTs are in need of replacement or rehabilitation

IUWASH (PLUS)'s Septage Management Work

- USAID's IUWASH (PLUS) program planning scheduled desludging

- Support regulations have been passed in many cities.

- This will cause a major increase in the sludge treatment facilities' flows

- Aim to identify lessons learned and develop knowledge to move forward

- Building training and education

Lessons Learned

Planning

Design

Construction

Operation

Planning

- Lack of standard methodologies/systems for planning
- Need Everyone Involved: Owner, Operator, Consultant, Contractor
- Lack of coordination between stakeholders (concept, design, construction, operation all separate activities)

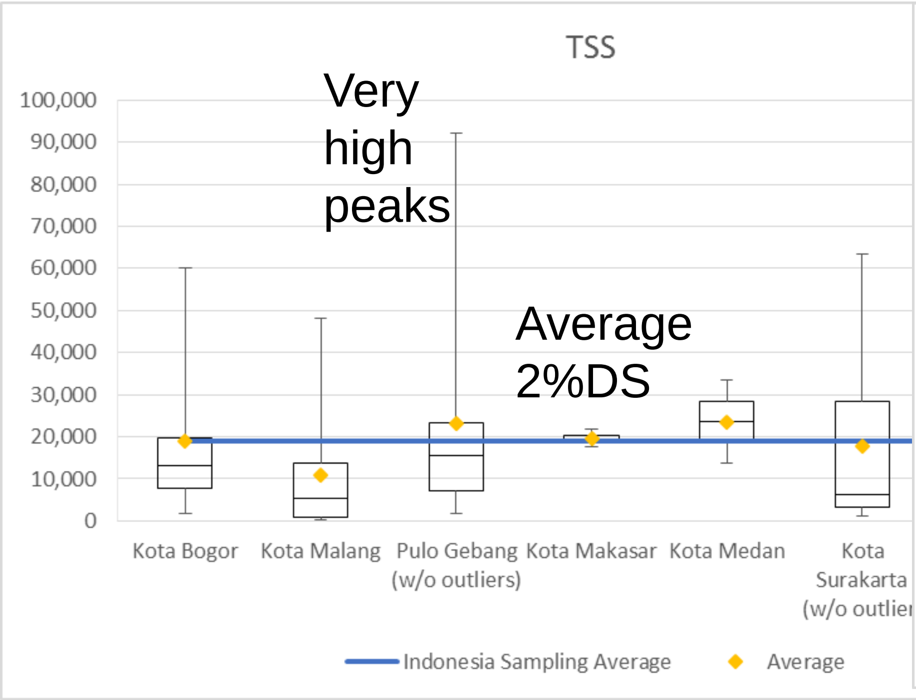
Design

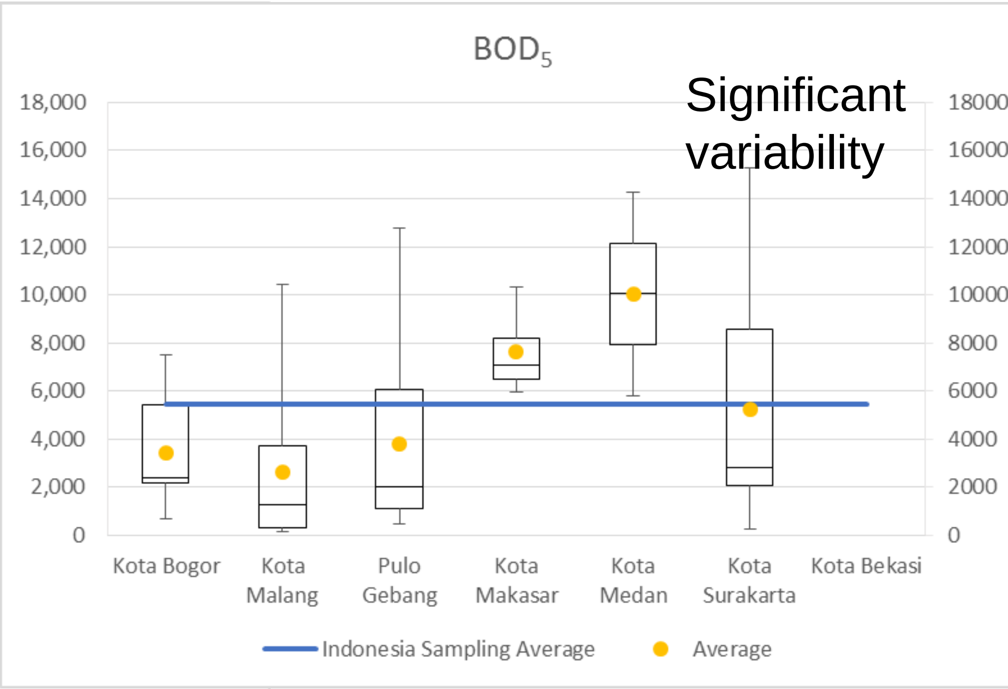
- No knowledge of septage quality
- No preparation of design narratives or calculations
- Lack of understanding of treatment processes
- Lack of consideration for hazards and ease of access and general practicality

Septage Quality

No real knowledge in country about strength of septage: The most important design parameter!

160 samples from 8 cities taken to get initial understanding





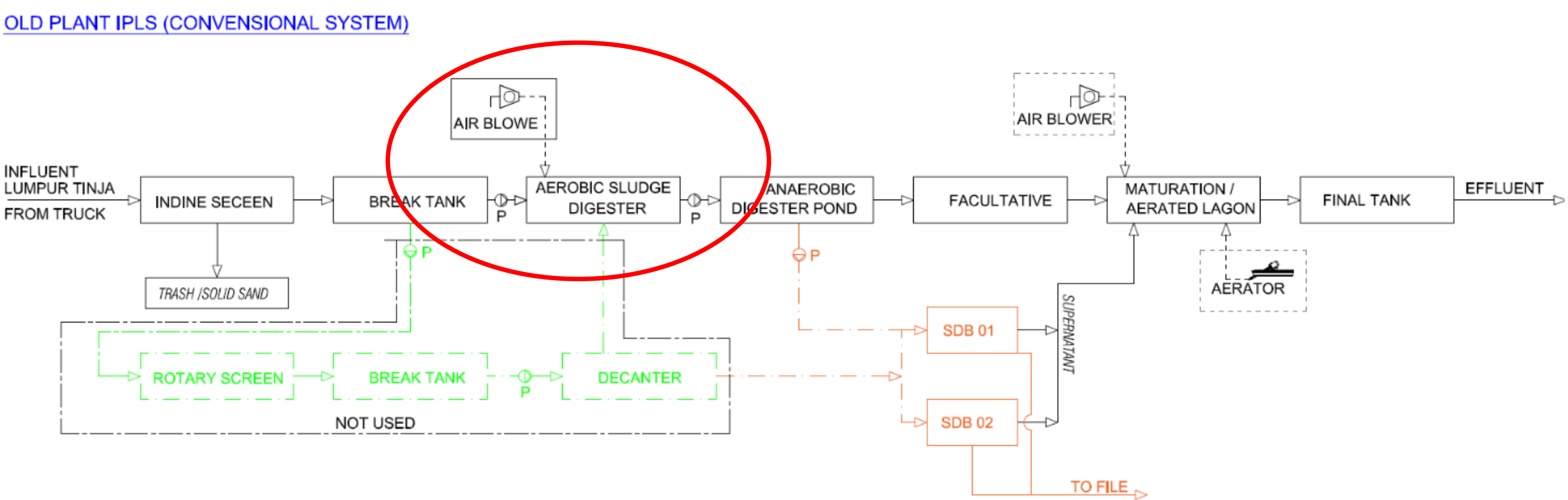
Design - Lack of Understanding of the Processes

- Sometimes Process Designs makes no sense **for septage**.
  - Pulo Gebang – Aeration as a first step
  - Medan – Imhoff Tanks overwhelmed with solids
  - Bekasi – ABR or single SBR proposed

- Process Flow chart makes sense, but is undersized or under utilized
  - Sludge Drying Beds – $1/5^{th}$ of needed size
  - Anaerobic Ponds – no consideration of desludging period

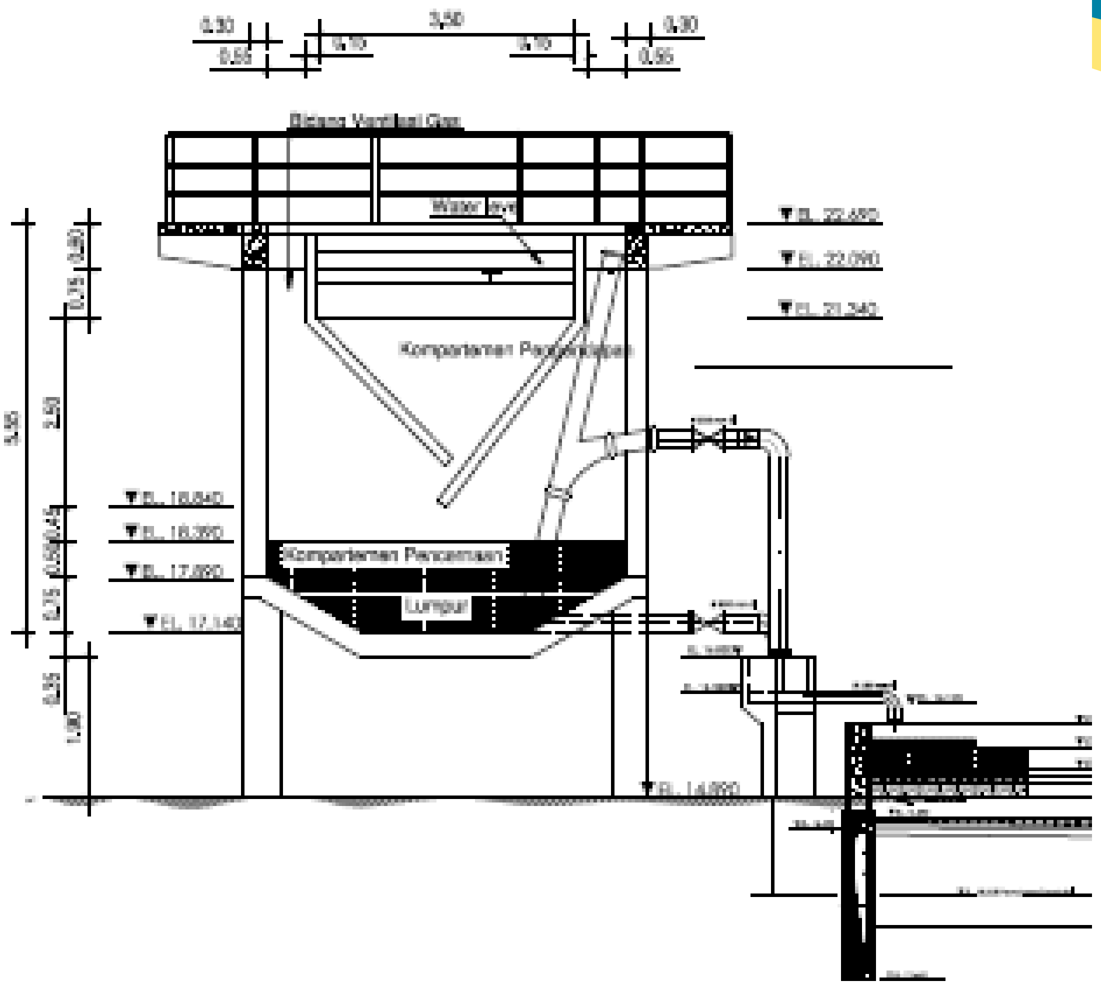
Aeration as a first step: seen at three facilities and quickly proposed for others…

- Septage contains 80 times “wastewater” solids concentration
- Aeration prior to solids liquid sepration is inefficient and costly
  - For 50% BOD reduction, 200m3/day, 135kW, $150,000 annual electricity

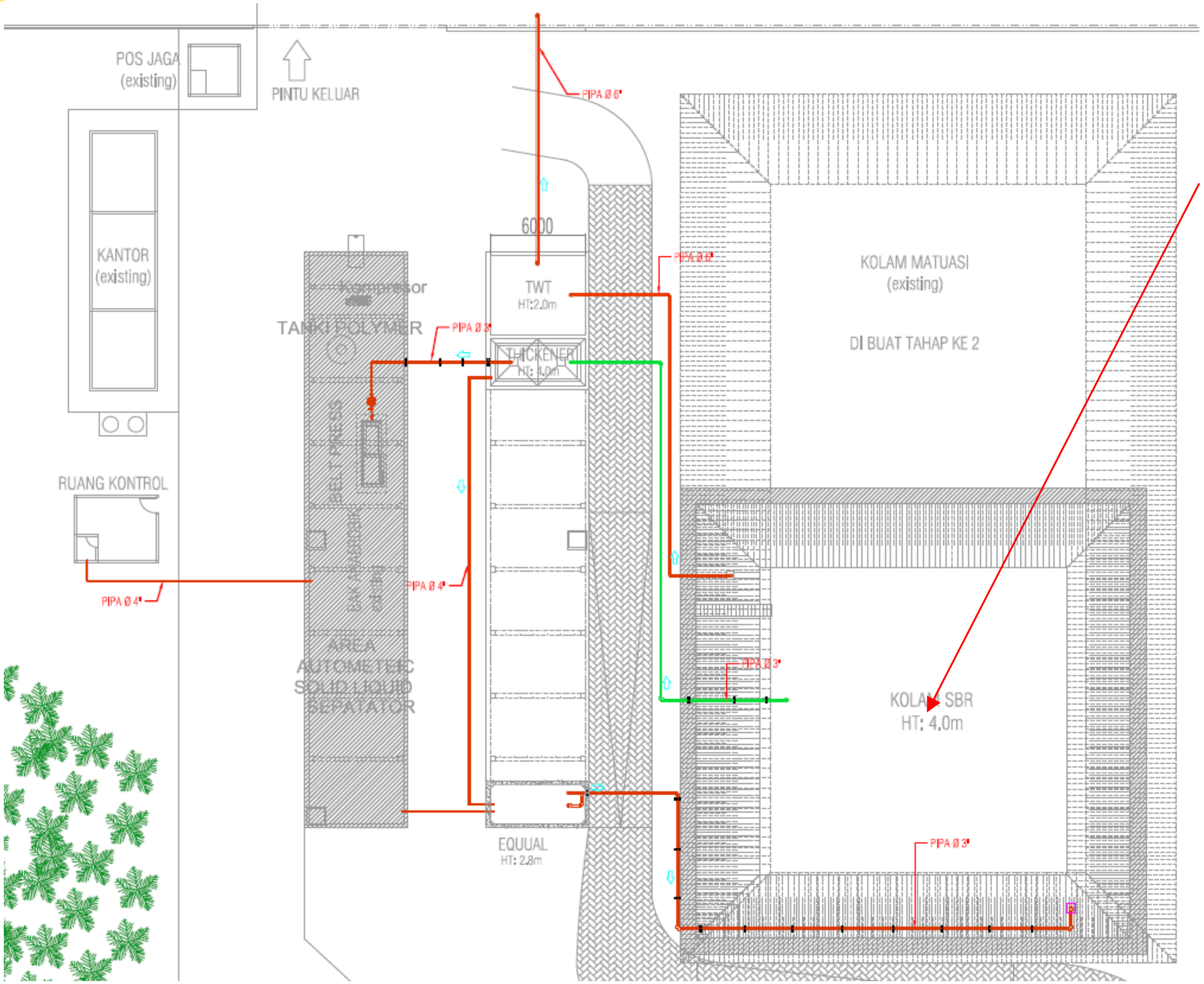


Medan – Imhoff Tank

- Imhoff tank aims to provide long solids retention time (>120days) for digestion.
  - For septage, design allows for 0.3 days solid retention time. Very little TSS removed.
- Also seen with ABR designs
- No understanding of hydraulics



Bekasi – A Design Proposed at One Stage



Only one "SBR" due to budget constraints.

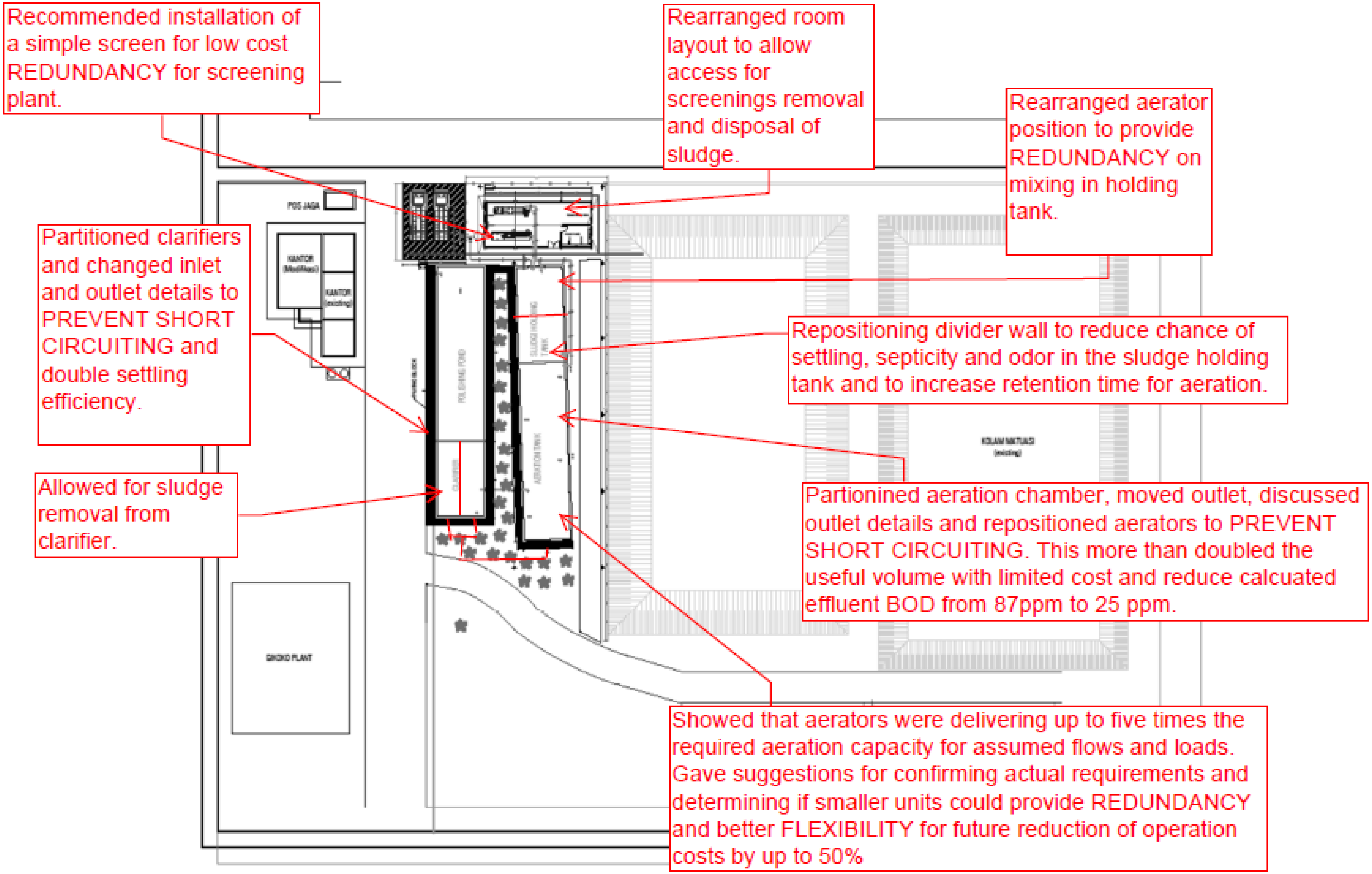
- Trucks fill from 8am to 10pm.
- 10pm to 4am react
- 4 to 5am settle
- 5-8 am decant

Lack of understanding of batch process

No clear operating description

No calculations

Size of tank way too large for good sludge removal at one point only



Recommended installation of a simple screen for low cost REDUNDANCY for screening plant.
Rearranged room layout to allow access for screenings removal and disposal of sludge.
Rearranged aerator position to provide REDUNDANCY on mixing in holding tank.
Partitioned clarifiers and changed inlet and outlet details to PREVENT SHORT CIRCUITING and double settling efficiency.
Repositioning divider wall to reduce chance of settling, septicity and odor in the sludge holding tank and to increase retention time for aeration.
Allowed for sludge removal from clarifier.
Partionined aeration chamber, moved outlet, discussed outlet details and repositioned aerators to PREVENT SHORT CIRCUITING. This more than doubled the useful volume with limited cost and reduce calcuated effluent BOD from 87ppm to 25 ppm.
Showed that aerators were delivering up to five times the required aeration capacity for assumed flows and loads. Gave suggestions for confirming actual requirements and determining if smaller units could provide REDUNDANCY and better FLEXIBILITY for future reduction of operation costs by up to 50%

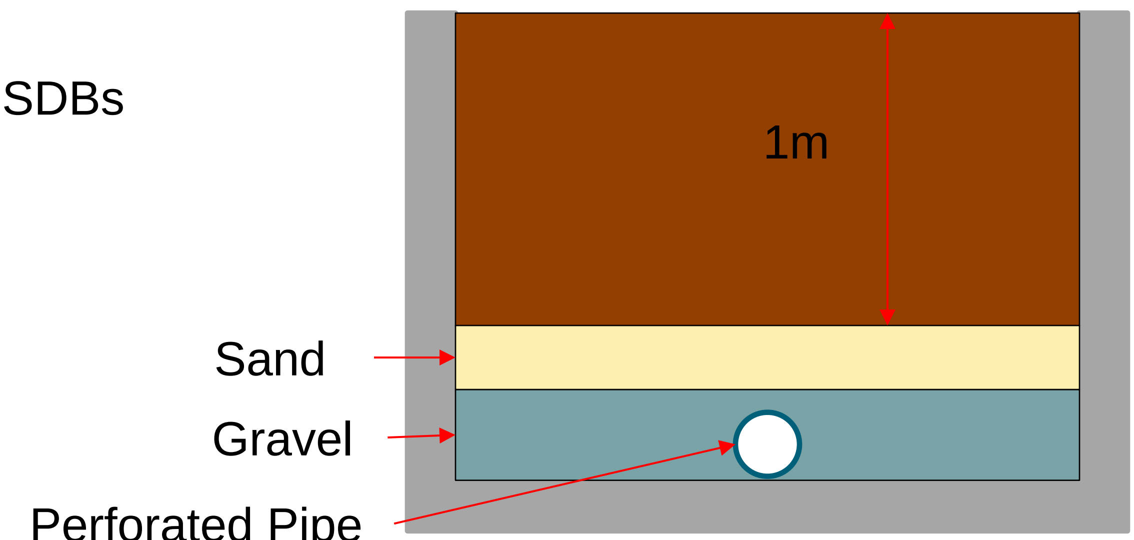
Undersized Sludge Drying Beds

- Sludge Drying Beds (SDBs) can separate liquids and solids
- SDBs must be designed to handle all the sludge
- Main Issues:
  - Undersized in general (annual loading)
  - Overloaded in short term (>20cm of sludge) – no understanding of operating strategy

Anerobic Pond at Pulo Gebang

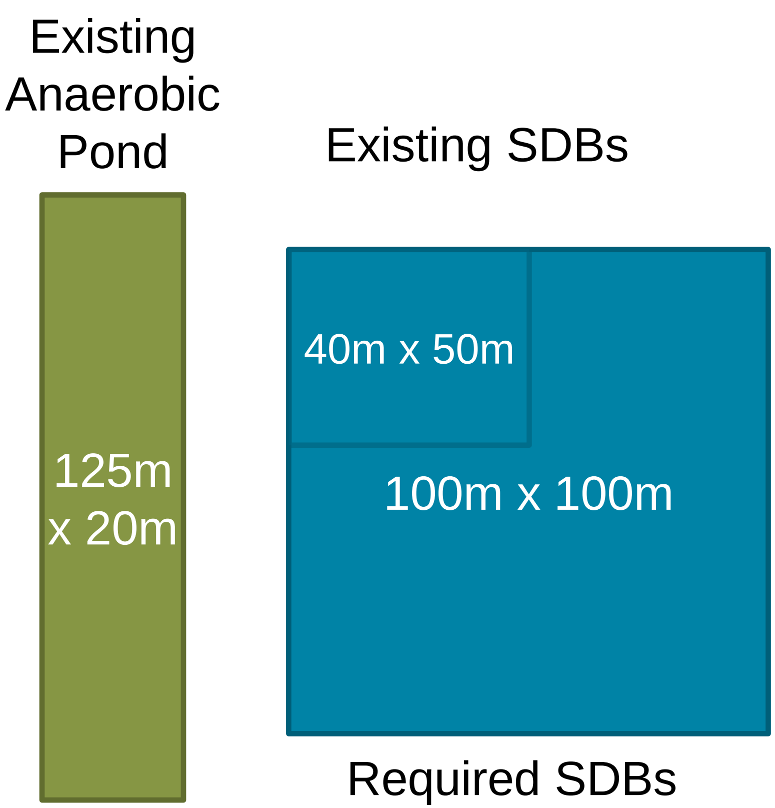
Pulo Gebang - Undersized Sludge Drying Beds For Anaerobic Pond Desludging

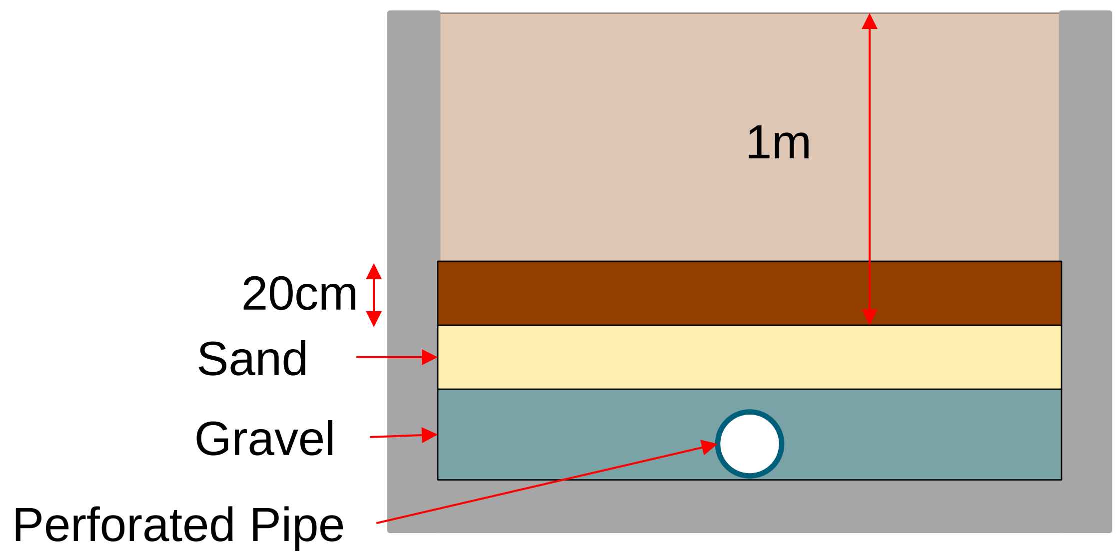
- **Current Anaerobic Pond is 125m x 20m and when the entire pond is desludged it will 2,000m^3 of sludge.**
- **There are two SDBs @ 20m x 50m (2,000m^2)**
- **When Sludge is emptied to SDBs it would create a 1m thick layer**
- **@ 1m the sludge will take a long time to dry**



Pulo Gebang - Undersized Sludge Drying Beds

- **To create a 20cm lift SDBs would need to be increased 5 times.**





We'd love to see a change in design attitudes

"Your opinions are a rephrasing of my opinions. I like that in a subordinate."

Construction

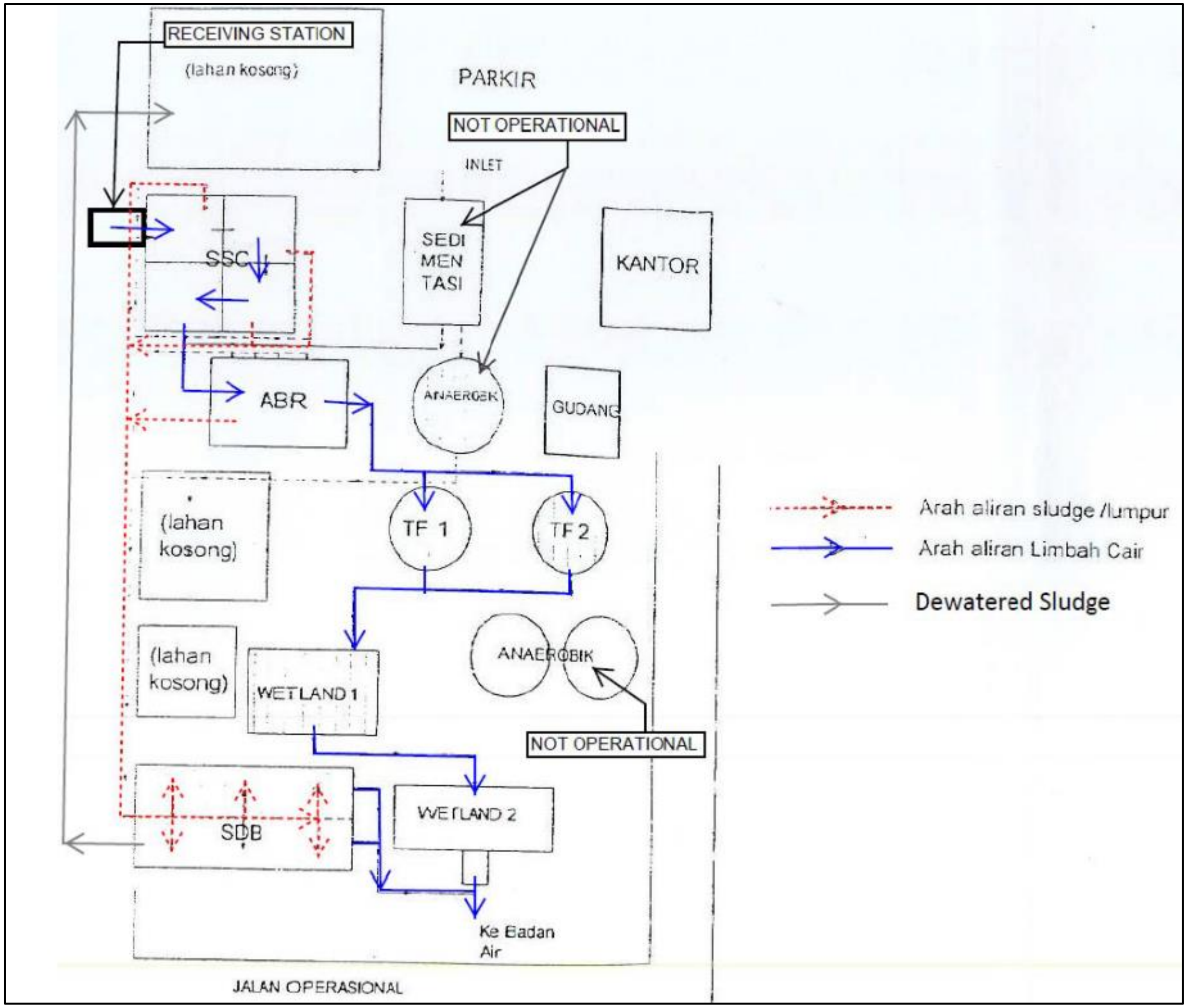
- Poor quality drawings
- Poor capacity contractors
- General lack of oversight likely
- No operations staff involvement
- Unclear responsibility after handover

Bogor

- Poor construction of Sludge Drying Beds
  - Poor quality wooden rafters
  - Cracking in Concrete
  - Poor quality plexi-glass roof material
  - “in warranty period” so no operator action

Malang – Pipe network

Solid/liquid separation occurs and due to incorrect pipe networks the split flows are then recombined in the ABR



Operation

- Lack of training for operators
- Lack of available spare parts and maintenance support for mechanical equipment
- Lack of understanding of the treatment process
- Reduction of cost at the expense of water quality
- Peripheral/Support Infrastructure Issues

Duri Kosambi & Pulo Gebang

- Operators hadn’t received training
- No users manual available
- No Spare Parts
- No local vendor support services

Bypassing Unit Processes Common

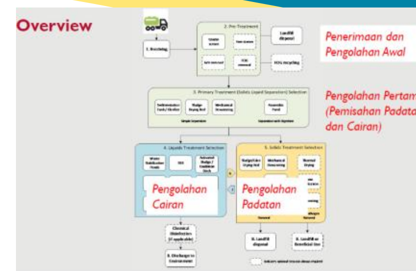
- **Operators are unable to solve problems and tend to bypass processes at the detriment to water quality.**

FOG on drying beds due to bypassing ABR

Bypassing initial grit removal due to lack of wash water

Bypassing initial grit removal due to broken mechanical equip.

Key Themes and Solutions



Septage is Strong, Needs Solid/Liquid Separation

Systematic method for process selection

O&M Manual Starts in Design!

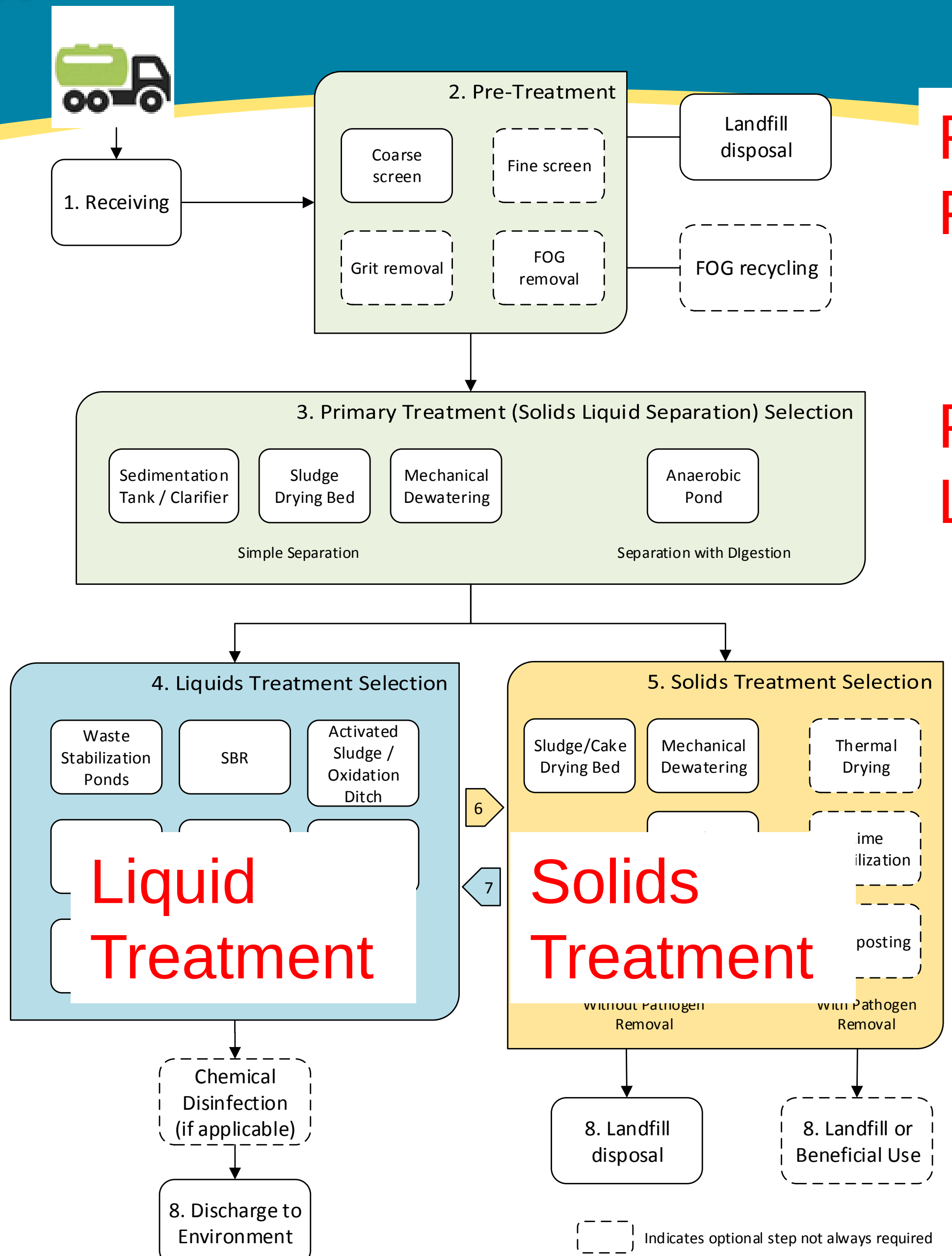
Redudancy in design. EVERYTHING must be redundant

Plan phasing of treatment facility

Stakeholder engagement through design and construction

Questions and Discussion

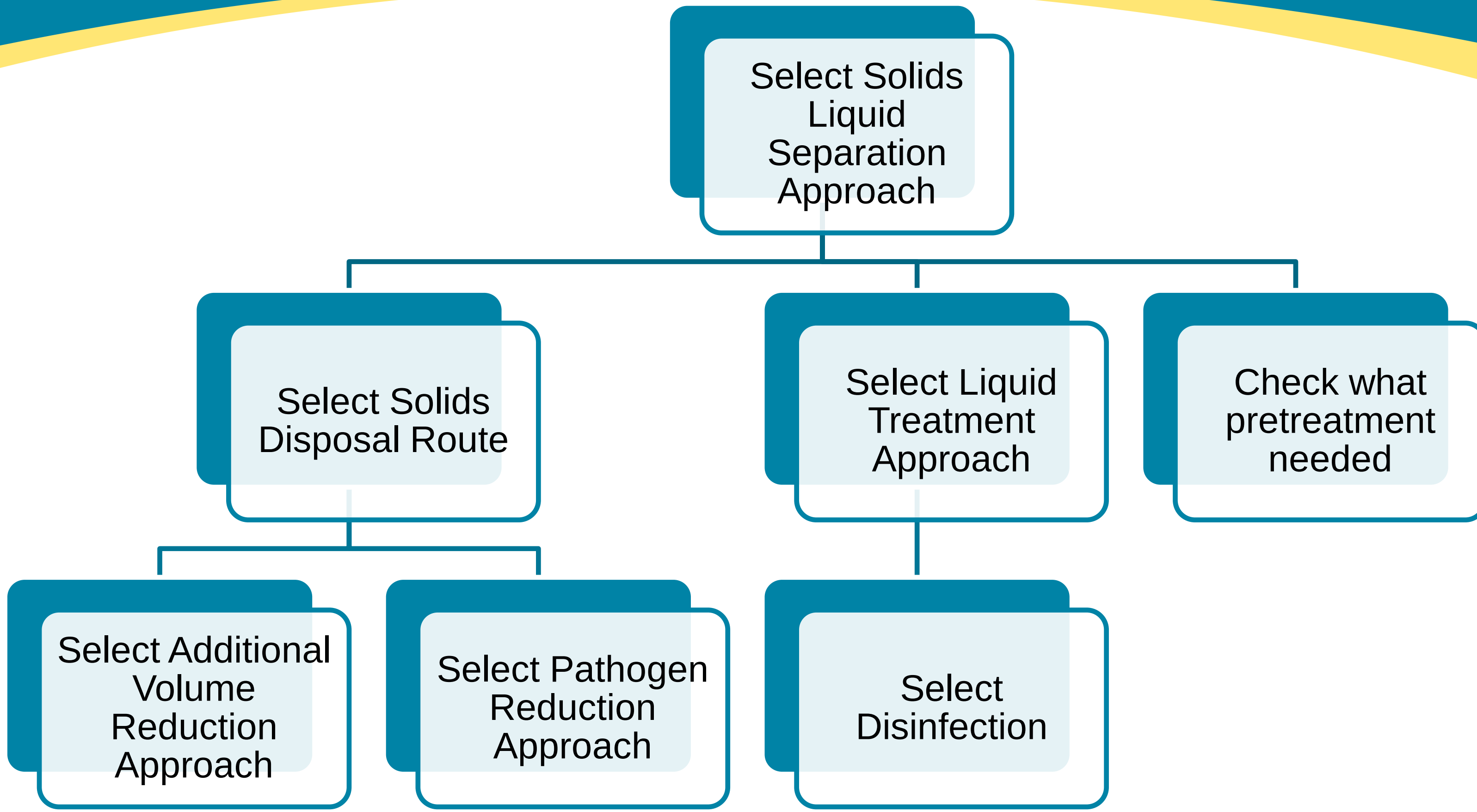
Overview



Receiving and Pre-Treatment

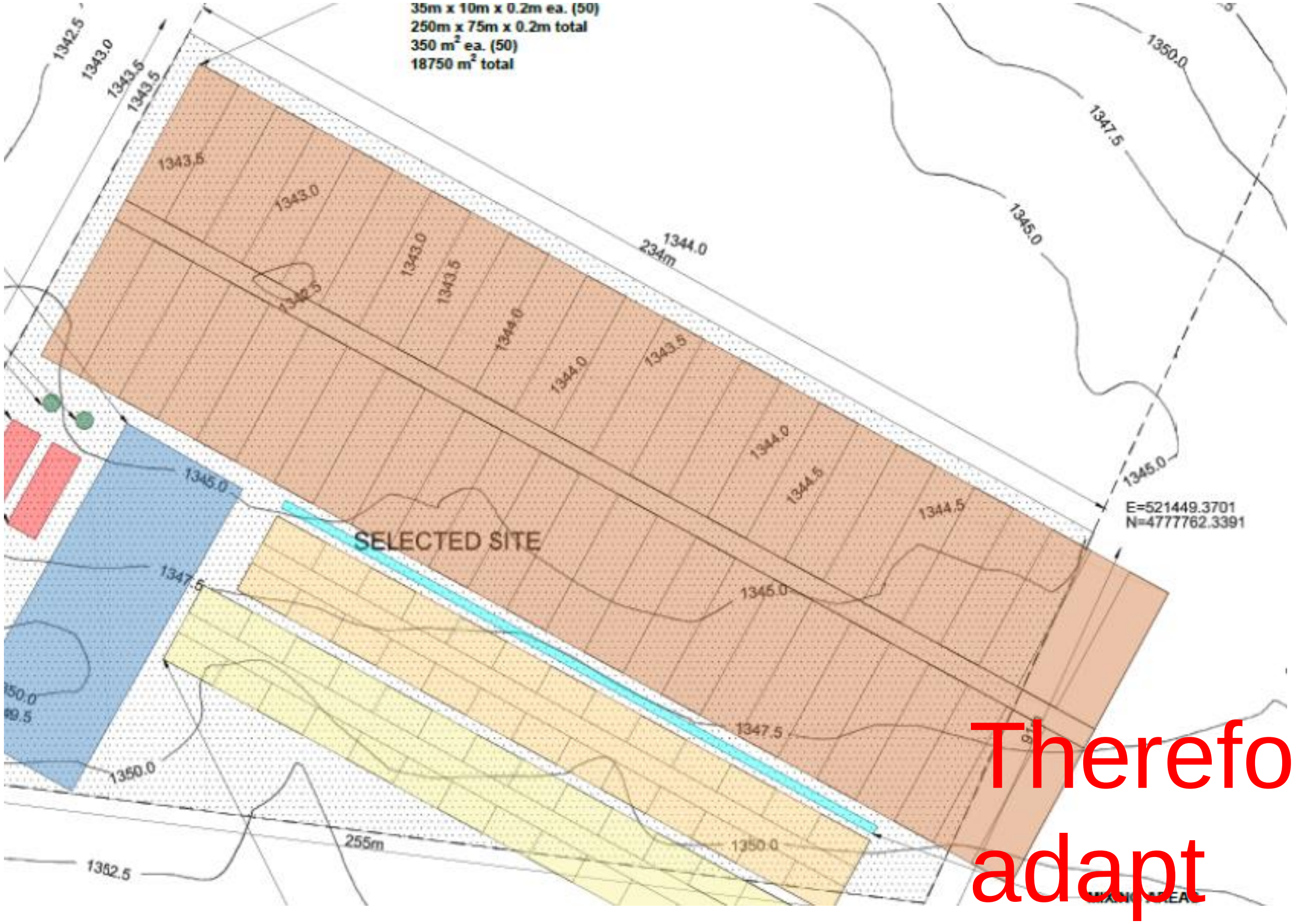
Primary (Solids Liquid Separation)

Sneak Preview



Then draw up treatment process and step through logically

Changes in Scale Can Prevent Modular



Therefore adapt technology

Technology Adaption: Dewatering Equipment

System Grows: More Money and Skill

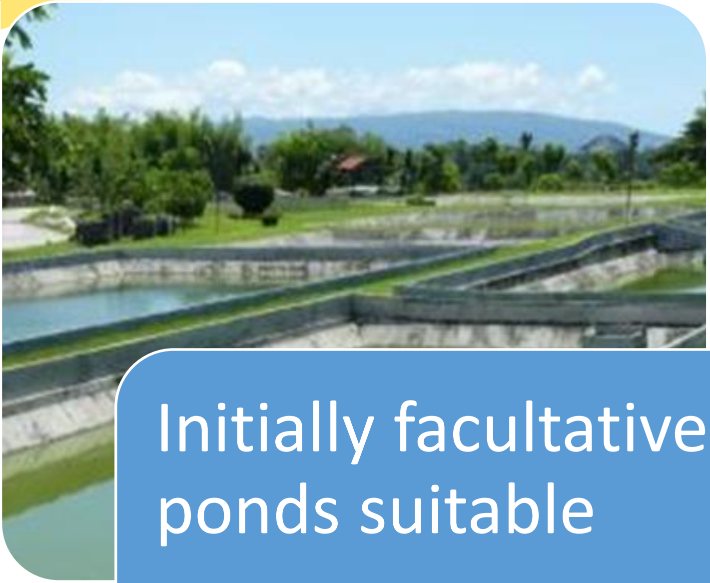
Initially Sludge Drying Beds Appropriate

- Low initial cost
- Simple to operate
- Suitable for small systems

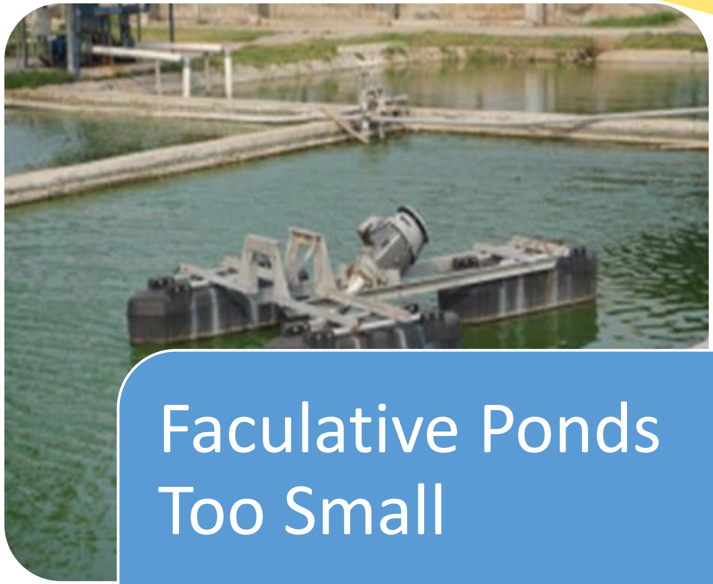
Sludge Drying Beds No Longer Appropriate

- Area needed too large
- Install mechanical dewatering
- Use SDBs for previously dewatered sludge

Technology Adaption: Pond Conversion



System Grows: More Money and Skill



Initially facultative ponds suitable

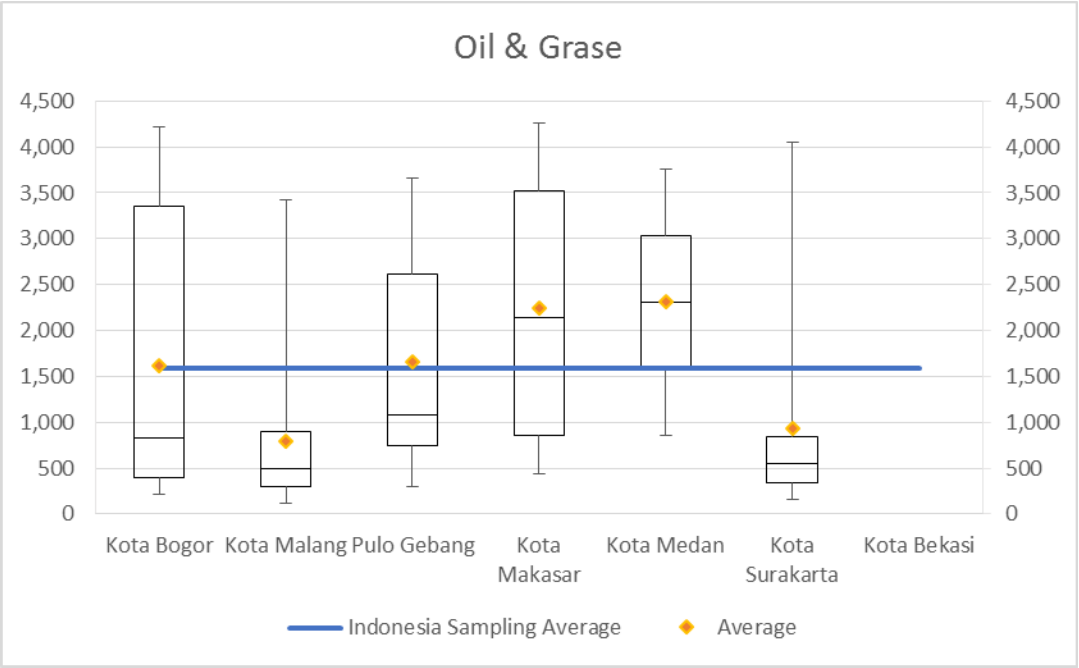
- Low initial cost
- Limited Operating costs
- Suitable for small systems

Faculative Ponds Too Small

- Area needed too large
- Install aerators
- Make sure pond initial design suitable

Water Quality: Oil and Grease

- Several consultants said “there is no oil and grease”
- Oil and Grease have a significant chance of wrecking facilities
- 500ppm is a “big number” when designing processes



Septage Quality in Different Nations

Parameter	Indonesia Samples		United States Septage	
	Average	Maximum	Average	Maximum
Oil & Grease	1,600	14,000	5,600	23,000
BOD5	5,500	15,000	6,500	79,000
TSS	22,000	18,000	13,000	93,000

Less FOG (but still a lot)

Similar BOD

More TSS

Pulo Gebang - Undersized Sludge Drying Beds

- **Besides creating massive SDBs what other options are there?**
  - **Divide Pond into smaller sections.**
  - **Add a mobile desludger**
- **Do need to still check the annual loading – good research question!**

Existing Anaerobic
Pond

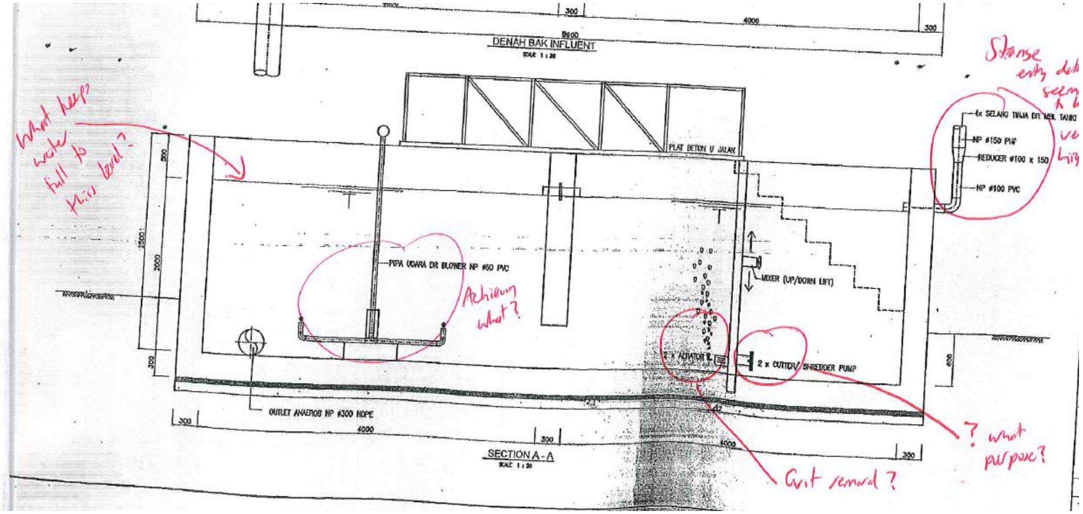
Aerators & Mixers

- Not Maintained
- Under utilized
- Located incorrectly

Aerators & Mixers

- Undersized – no sizing calculations
- Care with impact of high solids concentration on mixer design
- Located incorrectly

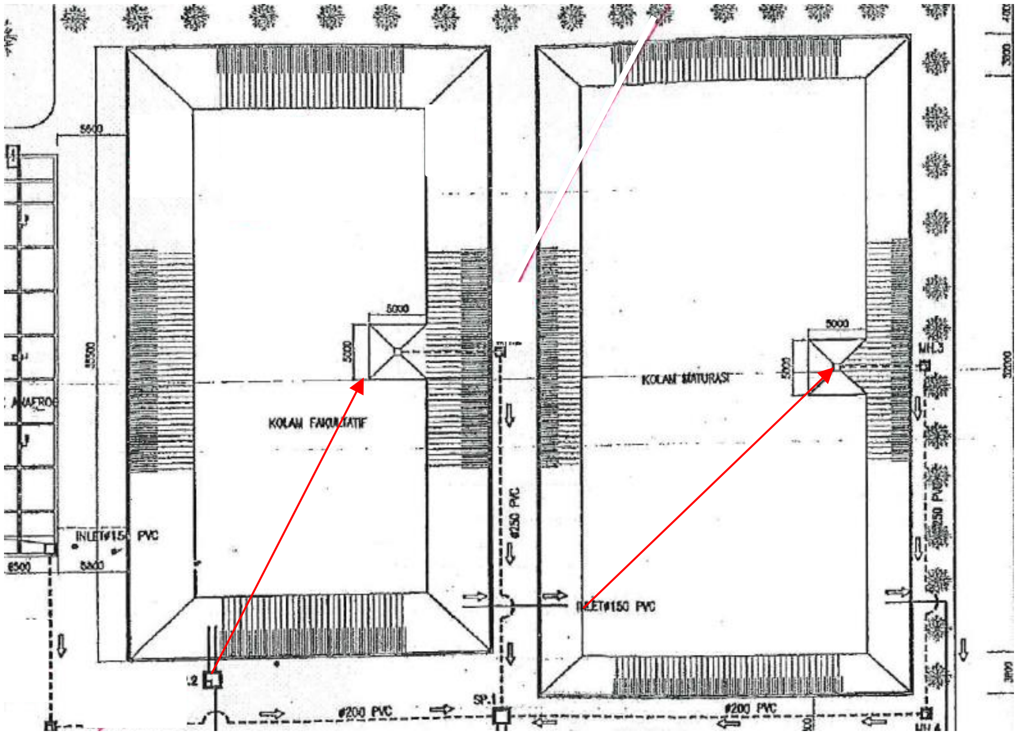
One Aerator for large pond



Pipe Networks

- Insufficient design. Pipes are not clearly shown in many designs e.g. Malang

- Pipes need to be designed to include:
  - Regular cleanouts
  - Scouring velocity
  - Minimum 3” for solids but keep scouring velocity if possible.
  - Built to withstand vehicle traffic (if applicable)
  - Ensure inlet/outlet locations to avoid short circuiting

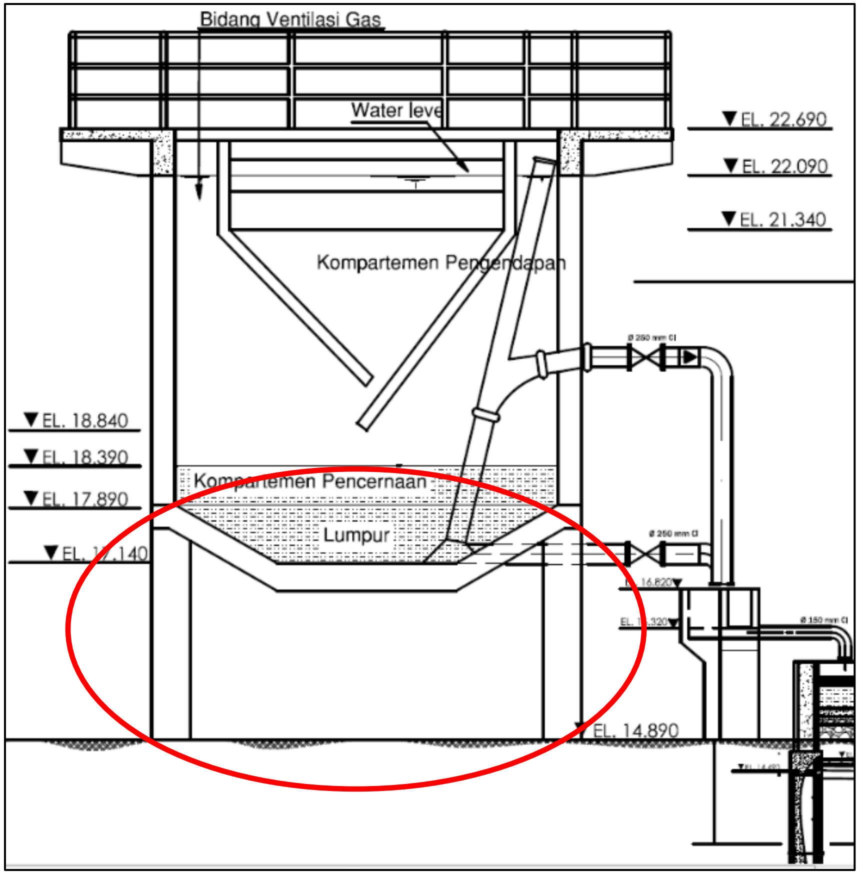


Pipe inlet and outlet will cause short circuiting

Site Hazards

- **Problems:**
  - **General Health & Safety Issues**
  - **Designs need to account for poor construction and seismic conditions**

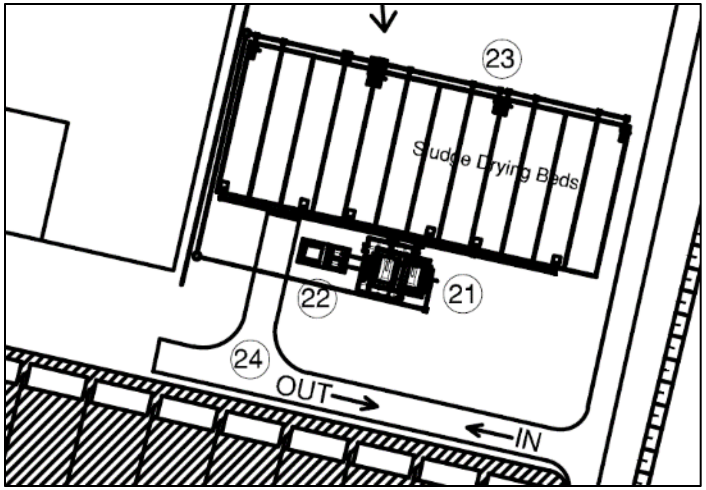
Elevated Imhoff Tank is an unnecessary hazard in a seismic prone region



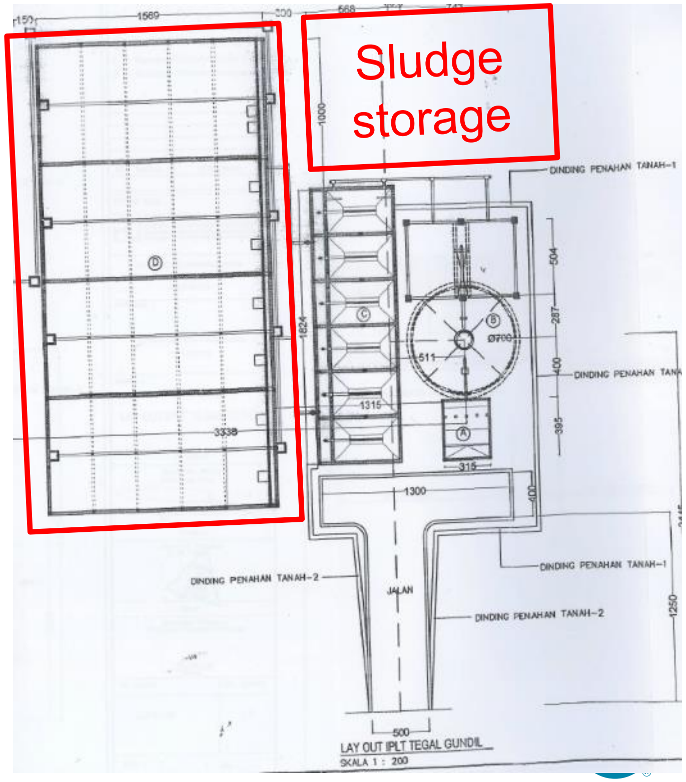
Site Hazards

– **Truck Access routes are not well thought out.**
– **Trucks reversing pose a hazard to plant operators.**

No vehicle access for removal of sludge. Currently dumped in the corner of lot. (Bogor and Malang)



Poor septic truck access routes



Duri Kosambi & Bogor – Receiving Stations

Receiving station inlet too high, prevents trucks from passively emptying truck.

Similarly receiving station is on a slope and this prevents trucks from passively emptying truck.

Peripheral Issues – water supply , power etc

- Washwater very important for screen operation but insufficient available.

Bekasi – Existing Treatment Plant

Anaerobic baffled reactor prior to liquid/solids separation will lead to rapid accumulation of solids and frequent desludging. Just like the Imhoff tank wont get digestion. Also seen at Bogor.