# 'Adaptive (Feedback) Environmental Monitoring for the Management of Dredging and Reclamation Activities' Panama – May 2018

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## Origins of Feedback EMMP (Monitor, Evaluate and Adapt!)



Singaporean / Malaysian Port Developments

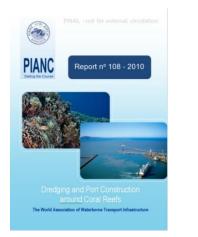


#### Images

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# **EMMP** Credentials

- Approach endorsed / recognized by
  - WODCON XVIII (2007) (Best Practice) —
  - UNEP, and \_
  - IFC's Environmental, Health, and Safety Guidelines for — Ports, Harbors, and Terminals www.ifc.org/ehsguidelines





nal methods for environmental ement of marine reclamation works o sensitive habitats have generally wided the level of control necessary are preservation of these habitats.	for using magnitudes and durations of sediment loading. Refinements to sodiment planne models ware undertaken to enhance their ability to hindcast impacts from the contraction' complex restantion schedules. Methods for segregation of impacts and	B Environment C) Pie Lot to this research. This paper was first presented at WOCCON XVIII in June 2007 and was published in the continence Proceedings. It is reprinted here in a slightly revised version with permission.
ing the level of control necessary to authorities and non-governmental attons (NGOs) of compliance with	assessment of cumulative impacts were also integrated into the hindcast procedures. Finally, the article describes the updating	INTRODUCTION
mantal quality objectives, requires lable compliance targets covering e temporal and spatial scales.	of tolerance limits and confirmation of spill budgets via targeted habitat monitoring.	The tropical waters in Singapore provide excellent conditions for marine IRe, owing to relatively condiant tropical water
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#### Applied in:

- Denmark •
- Sweden •
- Germany ۲
- Indonesia
- Singapore ۲
- Malaysia
- Brunei

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- Australia •
- New Zealand •



# Assessing Environmental Objectives (**Opportunities**/Impacts)



# Assessing Environmental Objectives (Opportunities/Impacts)

The project can cause socio-economic changes such as:

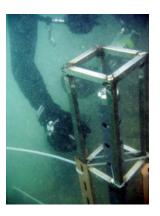
- general deviations from project objectives
- change in natural fisheries and aquaculture operations
- loss of operational efficiency and higher operational maintenance cost to powerplants and process water installations
- increased maintenance costs for port and harbours due to incremental sedimentation in channels and at berths
- impacts to recreational experiences and facilities, i.e. with corresponding economic losses to hotels and marinas, due to aesthetic changes in water quality, and in some rare cases...
- impacts to international relations arising from sediment plume / sedimentation intrusion across international borders.







# Traditional Environmental Monitoring and Management Plans (EMMPs)





- A traditional monitoring management program would typically include:
  - Static (i.e. fixed location) monitoring of turbidity
    - Typically at receptors predicted to be impacted according to the EIA
  - Static (i.e. fixed location) monitoring of habitats
    - Typically at receptors predicted to be impacted according to the EIA
  - Periodic Monitoring of water quality
    - Typically close to the work area / prescribed distance from activities
- Typical management criteria would be worded like:
  - Concentration 200m from the dredger shall not exceed 100mg/l
  - Reduction in live coral cover / eelgrass biomass shall not exceed 5%



# Traditional EMMPs: Why They Don't Work

- In general, the traditional approach tends to falter because it fails to recognize a number of key pieces of the puzzle, e.g.:
  - the importance between background vs. incremental spatial variability induced by the project
  - the linkage between operations and impact or change in operation and mitigation
  - response lag-times associated with habitat monitoring
  - The tools and 'language' needed to communicate with the Contractor generating the 'sources'
  - Inability to differentiate between sources within a work area or between one work area and another





# Feedback EMMPs

a 'Feedback EMMP':

• Speaks the language of a contractor



- Recognizes the spatial and temporal variability of works (e.g. sediment plumes and sedimentation)
- Isolates source contributions e.g. TSS / Sedimentation
- applies specific objectives for the project
- Addresses response lag-times
- Allows for a transparent (incl. stakeholders) proactive management process
- Provides comprehensive accounting of temporal achievements/impacts



## Feedback EMMP Includes All Pieces of the Puzzle

**Traditional "Reactive" EMMP** 

Fixed receptor monitoring stations (Physical and biological parameters)

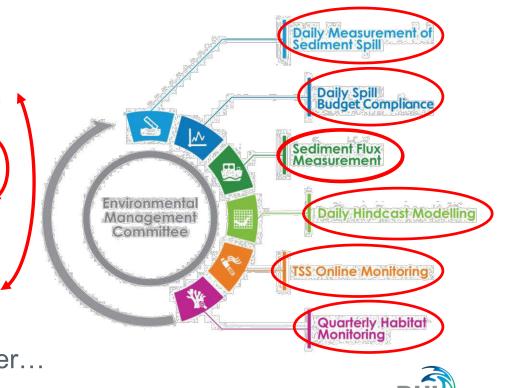
+ Trigger Limits + Respond when Trigger is Exceeded

Proactive "Feedback" EMMP All the features of Traditional EMMP **Spill Budget** +Hindcast Modelling / Dedicated **Trigger Limits** Feedback (Updating of spill control limits based on receptor monitoring)



# Feedback EMMP: A Tiered Approach for Dredging Works

- Provides 4 feedback tiers of Control
  - 1. Spill Budget Compliance
  - 2. Trigger / Tolerance limit (EQOs) Compliance
  - 3. Real time Monitoring to provide, validate or correct compliance analyses
  - 4. Habitat Monitoring to provide feedback on tolerance limits
  - The tiers reinforce each other...



#### © DHI Mobilization / EMMP Specifications

# Feedback EMMP: Stages

**Before** Start of Dredging / Reclamation (understand the environment):

- Deploy and calibrate Control Monitoring Instrumentation
- Establish baseline (3-12 months)
- Identify win-win opportunities/receptors (key species) for monitoring/Establish tolerance / alert limits and EQOs
- Calibrate & validate numerical models
- Assess impact of work plan (update of EIA) and determine draft spill budget based on contractors actual plan and equipment
- If non-compliant update overall work plan and finalize spill budget for start of works

#### **During Dredging / Reclamation (Control):**

- Daily spill **monitoring** and control against spill budget
- Daily **hindcast modelling** to document spatial extent of realized spill and control against EQO's at each receptor Daily
- Realtime / periodic control monitoring (alert limits)
- Identify mitigating actions, if required
- Review and **update spill** budget

#### After Completion of Dredging / Reclamation:

- Control monitoring continues for 3 6 month post-construction period
- Environmental Audit prepared to compare impacts to EIA



Monthly/Quarterly

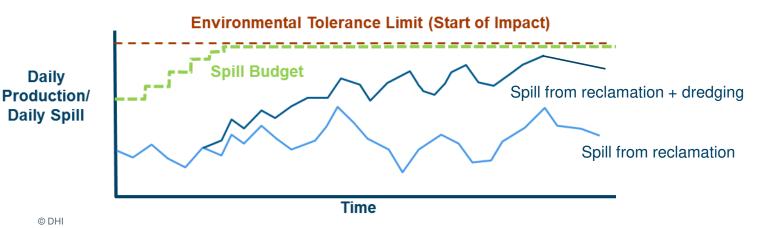
#### **Post Project Audit**

#### Feedback EMMP: Before the Start of Dredging / Reclamation

**Spill** = Portion of (fine) sediments that are released or mobilized at source from dredge or reclamation activities

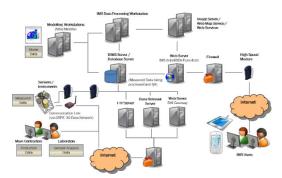
**Spill Budget** = Maximum amount of sediment spill (fine sediments) that can be released in the waters but still meet the EQOs for the project





#### Feedback EMMP: Before the Start of Dredging / Reclamation

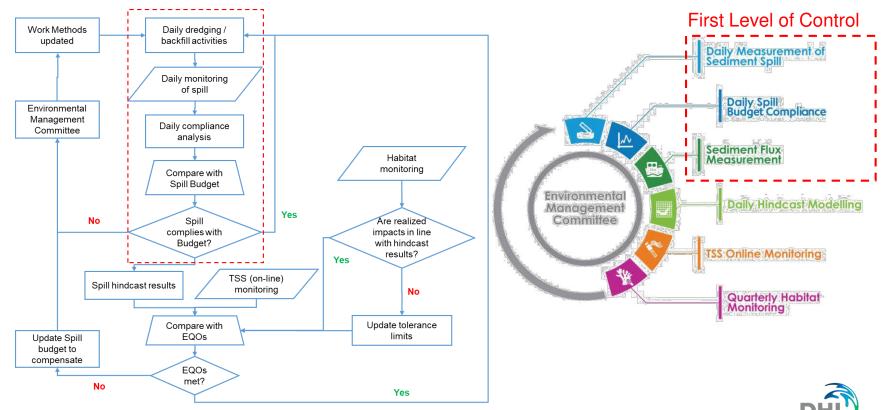




- Feedback EMMP mobilization also typically includes:
  - Review of Project Objectives/EIA findings and confirmation of appropriate Environmental Quality Objectives and Tolerance Limits
  - Establish an Environmental Management Committee (EMC)
  - Set-up of an EMMP document / data management system / portal
    - effectiveness depends on rapid access to information for all stakeholders throughout the EMMP
  - Engagement with dredge contractor / Client, authorities and stakeholders



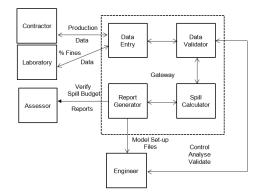
# Feedback EMMP: First Level of Control - Spill Budget

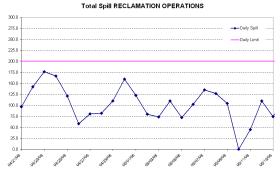


# Feedback EMMP: Spill Budget Compliance

- Daily sediment samples and work activity information is collected from the dredge contractor
  - This information undergoes / is used:
    - laboratory analyzes
    - to calculate actual daily sediment spill
- These results are used to determine Spill Budget compliance and generate a daily compliance report

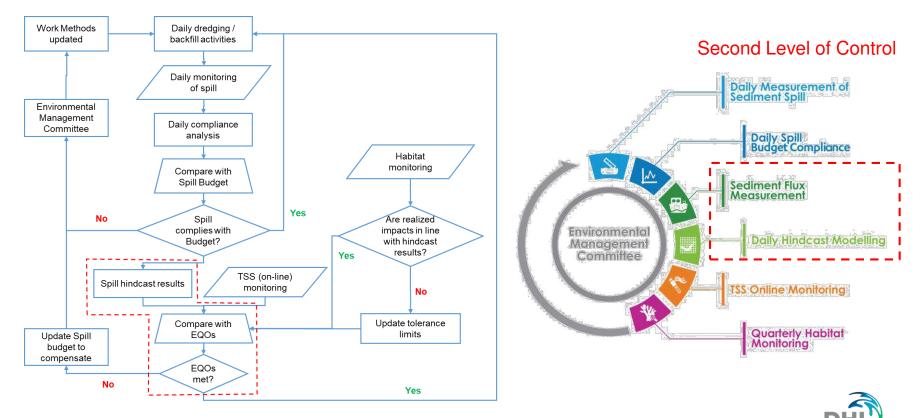
 Input also used for hindcast TSS and sedimentation modelling (2<sup>nd</sup> Tier)



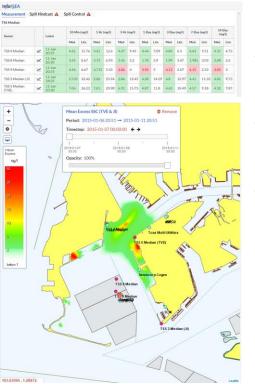




#### Feedback EMMP: Second Level of Control - Plume Hindcast

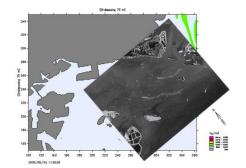


## Feedback EMMP: Second Level of Control - Plume Hindcast



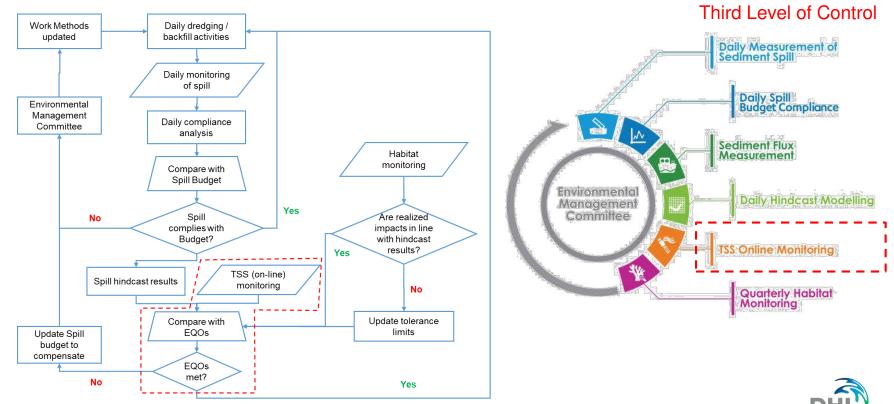
Hindcast modelling is a critical component for the Feedback EMMP

- The measured spill of fine sediments from every dredging trip is simulated using the numerical model
- The model results are compared against the receptor locations and site specific tolerance limits on a daily basis
- This highlights potential impacts to any of the receptors before they occur, allowing proactive management measures

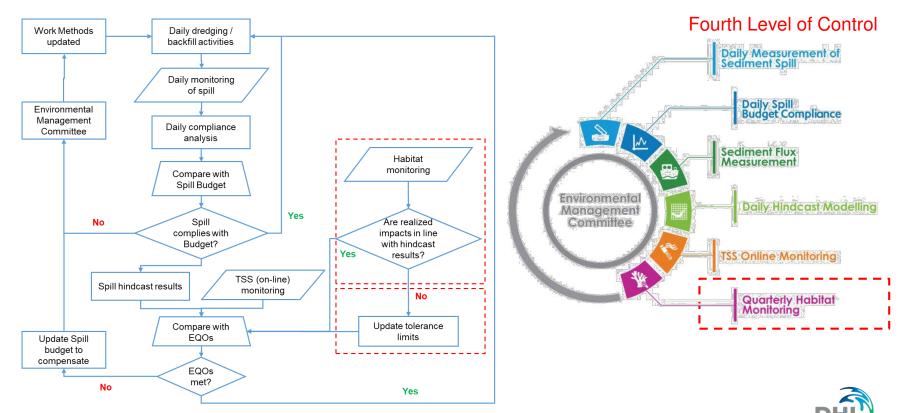




## Feedback EMMP: Third Level of Control - Real Time Monitoring



## Feedback EMMP: Update Tolerance Limits and Spill Budget



# Feedback EMMP: Non-Compliance Loop

#### **Possible Mitigation Responses**

- Stop works In extreme cases but mechanism (spill budget) available to justify recommencement
- Slow the dredging operations (reduce spill budget)
- Use of tidal windows, reduction in production
  - Dredging / reclamation operations during flood or ebb tides
  - Dredging / reclamation operations during spring or neap tides
  - Dredging / reclamation operations during day and night time
- Change in dredge location (if possible)
  - Migratory, spawning / breeding seasons
- **Deploy mitigation measures** (e.g. silt screens) that are assessed (quantifiably) to address the issue





# Feedback EMMP: Post - Construction

- Audit monitoring is carried out in line with baseline / control monitoring parameter to determine post-construction conditions
- Audits monitoring processing and analyses are carried out, to quantify:
  - Project objectives are met
  - net change to sensitive receptors (positive and negatives)
  - Conclude on tolerance limits, realized spill rates etc. to allow lessons learnt to be incorporated in subsequent projects





# Feedback EMMP: The Take away

- The **Feedback EMMP** is a <u>proactive</u> adaptive management approach not just about the identification of impacts and risks; it **provides information** on the overall ecosystem during and after project implementation.
- It is **highly flexible**, allowing for changes in the project if required e.g. timing, duration of the works, etc.
- It allows for segregation of changes/impacts from different components of the work, from adjacent projects and from natural events
- Traditional monitoring of e.g. turbidity, sensitive habitat health and water quality are still integral, but the data collection can be targeted at the right (and less) locations and is used to validate and / or update the working specifications and tolerance limits and less as direct operational triggers for environmental management



# Feedback EMMP: The Take away

- Because of the level of documentation Feedback EMMP significantly reduce developer (or Contractor depending on contract mechanism] environmental liability
- It allows a 'proactive' response before unexpected deviations or changes occur
- It allows a fully tiered response as you know what specific aspects of the work are causing the 'problem' and you can document that the response will be effective before you implement
- In general Feedback EMMP is <u>no</u> more expensive that traditional approaches as less sensors and less academic biological monitoring compensating for the cost of increased level of control afforded by the spill budget and hindcast controls



# Thank you

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