FACTS ABOUT

Environmental Monitoring

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What is Environmental Monitoring?

Dredging and maritime construction operations are a necessary element in the development of modern industrial society. Yet, at the same time, dredging activities will always create some change in the existing environment. Awareness of these changes, of their impacts on the coastal defences, on natural habitats and water quality are essential to ensuring that the improvements made by the dredging activities do not have unintended negative consequences. The main role of Environmental Monitoring is to examine changes in environmental conditions in areas where dredging is taking place, to ensure that impacts are acceptable, and that dredging methods are environmentally sound. Nowadays Environmental Monitoring methods are implemented for most major dredging operations.

Why is Environmental Monitoring necessary?

The value of Environmental Monitoring cannot be stated strongly enough. Environmental requirements and restrictions from governmental authorities, project owners and financial institutions are commonplace. As the environmental legislation, both local, regional and international, becomes stricter, and as the public's demand for information grows, implementation of environmental dredging techniques has become more widespread. Measuring the success of these methods is imperative.

Monitoring provides invaluable data for the Client and Contractor in order to minimise environmental impacts whilst simultaneously optimising the design. It also helps in communicating accurately with regulators, the public and other stakeholders who may doubt the dredging process for one reason or another.

When is Environmental Monitoring necessary?

Before, during and after dredging and maritime construction. The first step is usually an Environmental Impact Assessment (EIA), which is frequently mandatory. The EIA uses Environmental Monitoring to establish the environmental status at the start of a project and to predict how this will change as a result of the project and the construction techniques adopted. The degree to which environmental parameters are permitted to change are then defined by the appropriate regulator and an Environmental Monitoring and Management Plan (EMMP) is developed to ensure that parameter changes remain within the permitted ranges.

In some cases an EMMP is an integrated part of the EIA; in others the EMMP is an independent paper through which the environmental aspects of a dredging project are regulated. The EMMP will define the site-specific monitoring programme required as well as the role of the players involved. In some countries the EMMP /EIA will be a part of the permit to carry out the specific works; in others, the EMMP will be approved by the financing agency, for instance, the World Bank, before credits can be opened.

During the project, Environmental Monitoring is conducted to confirm that the EMMP is having the desired effect and no unforeseen disturbances are occurring. The continuation of monitoring after the project's completion guarantees that no long-term negative impacts are present. Or if they are, that interventions can be implemented in a timely fashion.

What type of information does Environmental Monitoring provide?

Environmental Monitoring records the state of the environment at a given locality. It establishes an environmental baseline, which recognises natural occurrences as well as human activities unrelated to dredging, such as shipping and fishing, and it establishes both seasonal and geographical variations before the start of a project.

By defining these various parameters, Environmental Monitoring can put into context such issues as spill rates, noise levels, accuracy, turbidity and such, and can help in the selection of the appropriate dredging plant. Over the years, the dredging industry has developed many dedicated environmental dredging vessels and technologies, e.g., the encapsulated bucket line, visor dredging heads, auger dredgers and the turtle deflecting draghead to name a few.

Monitoring during the lifetime of the project records the short- and long-term impacts caused by dredging

operations and can demonstrate the degree of recovery of the environment from temporary impacts versus long-lasting impacts. It thus ensures that the operations are carried out according to environmental requirements established by authorities, financial institutions and/or the project owner.

Finally, all the data accumulated can add to the body of knowledge of the participating parties and can be used for planning future projects. In the USA, the Environmental Protection Agency has initiated a comprehensive "Environmental Monitoring and Assessment Program" (EMAP). This research programme aims to develop tools to monitor and assess the status and trends of the nation's ecological resources and to develop scientific understanding for translating Environmental Monitoring data from multiple spatial and temporal scales into assessments of current ecological conditions and to forecast potential risks.

Are all Environmental Monitoring programmes the same?

Monitoring programmes can be categorised into three types depending on their objectives and are often the responsibility of three different groups: Surveillance or BACI Monitoring is usually the responsibility of local and/or central Authorities; Feedback or Adaptive Monitoring is conducted by the Project Owner or Contractor; and Compliance Monitoring is normally executed by the Contractor.

What is Surveillance or BACI Monitoring?

Surveillance or BACI (Before-After-Control-Impact) Monitoring assesses temporal and spatial changes to selected parameters between the prior condition (before dredging) and the current condition (during dredging). This type of monitoring is the most frequently used and the simplest to design.

The EIA study that precedes the dredging work will have identified and predicted the impact on the relevant parameters for the Surveillance/ BACI Monitoring programme. The objective of this monitoring programme is verification of the hypotheses developed during project preparation. These hypotheses can vary depending on the project, but in general relate to:

- oceanographic/ estuarial conditions at the dredging or relocation site (e.g. current, wind, waves, depth);
- environmental background conditions at the site (e.g. suspended sediments, salinity, existing contamination level); or
- operational parameters related to the dredging equipment (e.g. suspended sediments from overflow with the TSHD, accuracy of the selected dredging equipment, turbidity generation at the dredging site).

Verifying these parameters is critical, especially during the first phases of a project's execution, in order to check the validity of the assumptions used as a basis for the project planning. Surveillance/BACI Monitoring will allow the Contractor and Owner of the project to adapt the execution method or choice of dredging equipment should the project conditions change or if unexpected impacts are detected by the monitoring campaign.

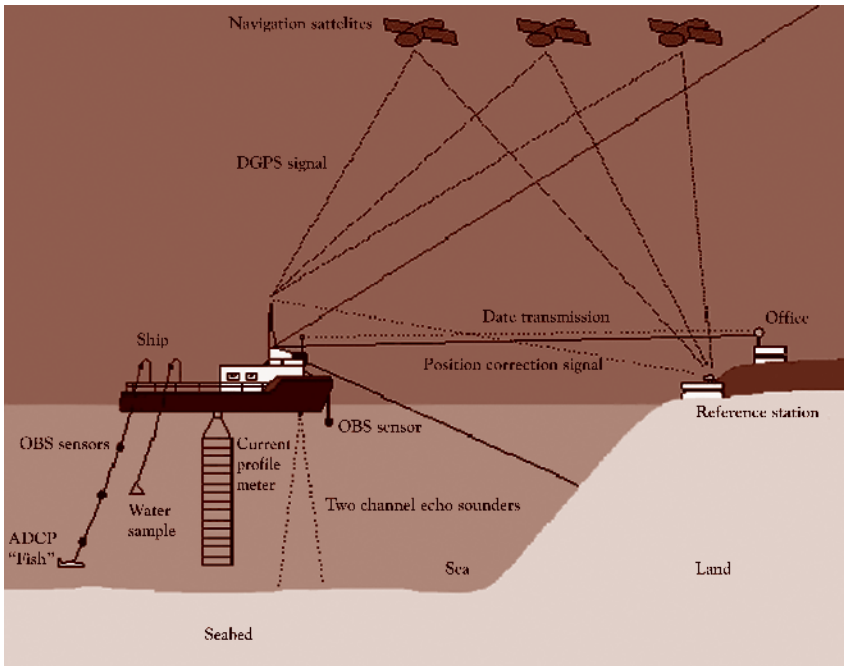
What is Feedback or Adaptive Monitoring?

Years ago traditional Environmental Monitoring used methods that needed a long period of observation before the Contractor and Owner could judge with statistical certainty whether an impact would result in a lasting change or whether it was an occasionally occurring natural variation. This has changed radically with the development of real-time monitoring techniques and fast data processing systems which allow a much quicker evaluation of impacts. This rapid evaluation in turn allows the Contractor to adjust the dredging operations when observed effects vary from predictions. This so-called "Feedback Monitoring" includes selected variables that over short periods of time show quantifiable changes as a result of impacts from the construction work.

Feedback Monitoring (as it is called in Europe) or Adaptive Monitoring (USA) is in fact a special form of surveillance monitoring where a few fast-reacting and predictable environmental variables are forecast by modelling and then monitored continuously during the dredging and filling operations. Computer models make it possible to assess early on whether intervention is necessary. Because possible exceedance of environmental criteria can be forecast so quickly, dredging plans can be altered immediately and environmental damage can more easily be avoided and/or limited, which also helps avoid costly downtime.

Is Feedback Monitoring always the right choice?

Although Feedback Monitoring is by far the most comprehensive, it is also the most expensive. Compliance and BACI Monitoring programmes normally are smaller and less of an investment. Given the financial consequences, Feedback Monitoring is primarily adopted for projects with very strict environmental criteria in highly sensitive environments where an extra level of caution and care is required or where legally binding limits for impacts must be observed. For instance, in Singapore, with its extremely



This schematic drawing shows an environmental monitoring vessel and the wide variety of survey equipment available, such as echo sounders, a current profile meter, OBS sensors and DGPS navigation satellites.

rich marine life in rather limited regional waters, authorities have established Environmental Quality Objectives (EQO) for marine construction activities. To document compliance with these EQOs, a pro-active EMMP based upon Feedback Monitoring principles is required for operations which are in close proximity to key environmental receptors.

What is Compliance Monitoring?

A major objective in planning a monitoring programme is to ensure that the dredging process complies with the restrictions that are either legally or contractually stipulated. Restrictions can vary markedly from one project to another depending on the prevailing human and ecological conditions at the site. They can be either physical (e.g., dredging depth, location or transport mode, limitation on turbidity or sedimentation rate at a vulnerable site nearby), seasonally related (e.g., special restrictions during breeding season) or quality oriented.

Given the costs of an extended monitoring campaign as well as of some mitigation measures, ensuring that a project's environmental restrictions are formulated accurately is critical. Keep in mind that most environmental parameters vary somewhat randomly. Therefore clarity and consistency in defining the thresholds which should not be surpassed during a predefined section of the execution period is highly recommended. If necessary, different thresholds can be defined with different allowable percentages by which these thresholds may be surpassed. In addition, the Environmental Monitoring requirements must also be clearly formulated (locations, frequency and duration) to prevent later discussions about "the manipulation" of monitoring results.

How is Environmental Monitoring implemented?

Monitoring can be done with either visual or physical sampling and in many cases with both. Means of measuring physical variables include: Point measurements of hydrographic parameters using moored buoys or bottom-mounted equipment like Acoustic Doppler Current Profilers (ADCP) and optical backscatter sensors (OBS). These should preferably be supplemented with area or line-covering ship-based measurements of hydrographic parameters. Radar-based area-covering measurements of surface currents and waves is now a well-proven technology, but only works in areas where the wavelength is sufficiently long (minimum 6 m) to reflect the radar waves. Satellite-based radar measurements are also a possibility, but this technique is also restricted to the open ocean with relatively large waves.

Visual samples may include surface and underwater photographs and videos. At the Port of Melbourne, monitoring videos used during and after dredging the bay helped to reverse negative public opinion as stakeholders could actually observe the subsea conditions.

All sampling, analysing, quality control and reporting of the results should be carried out by qualified professionals (e.g. analytical laboratories) or by the dredging contractors themselves. In fact, Environmental Monitoring is more and more often considered a standard task for the dredging contractor. When witnessed by experienced representatives of the Client, the results become contractual. By having the Contractor conduct monitoring, the results will be available instantaneously so that required response plans can be initiated within a minimal timeframe.

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How extensive should an Environmental Monitoring programme be?

Environmental Monitoring programmes must be specifically targeted towards variables that the EIA has identified as important for the particular local ecological system. They also need to target variables that are socially and economically important. At the same time, the scale of an Environmental Monitoring programme should be cost effective, reflecting the size of the dredging project and in reasonable proportion to the potential impacts caused by the project. Not all monitoring methods are applicable to smaller projects. For instance, radar and satellite based monitoring or ADCP may be unnecessarily expensive. In general, variables that should be identified are:

- depth of the sea- or riverbed;
- suspended sediment concentration;
- spilled sediment accumulation, especially for environmentally sensitive projects;
- hydrographic parameters;
- placement and post-placement leakage from CDFs; and
- chemical and biological parameters.

Monitoring programmes should be wary of being over-dimensioned. Too often to ensure that all possible impacts are detected, Environmental Monitoring plans contain non-relevant requirements. A flexible monitoring plan will be far more economical and achieve better results.

How is the Data and Information from Environmental Monitoring Applied?

A monitoring programme is not intended only as post-factum control of a dredging or maritime construction project. Nor is it to be used as a basis for applying penalties when parameters and criteria are not met during actual execution. To optimise effectiveness, a monitoring programme should provide as much direct information as possible to the project management team, operators and the crew onboard the dredger. These are the key people in the overall success of an environmental protection plan. The monitoring information will enable them to adjust their working procedures to achieve better environmental outcomes. For example, consider that the crew decides on the swing speed and the cutting depth or the trailing speed of the dredger. By providing the crew with a direct reading from a turbidity meter installed close to the cutting/trailing head, they can adapt the dredging process immediately to mitigate adverse environmental effects.

Who Benefits from Environmental Monitoring? The Contractor? The Client?

A well-planned monitoring programme can predict what impacts may occur and, if they occur, what mitigating measures can be enacted. These impacts should be considered in view of the benefits of the project and the benefits should be balanced against acceptable and non-acceptable impacts. Environmental Monitoring helps Owners and Contractors to make this evaluation. It helps them prepare a comprehensive dredging plan, respond to a potentially detrimental situation before it becomes a serious threat, weigh the advantages and disadvantages of a maritime construction project and establish a basis of trust and confidence in the project amongst all stakeholders.

For further reading and information

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This brochure is presented by the International Association of Dredging Companies whose members offer the highest quality and professionalism in dredging and maritime construction. The information presented here is part of an on-going effort to support clients and others in understanding the fundamental principles of dredging and maritime construction.