



# SPECIALISED SERVICES

**Kris Vlaeminck, Jan De Nul Group,  
Luxembourg**, explains the use of dredging  
vessels on the Macedon Project in Australia.

Figure 1. Shore approach for the Macedon project in Australia.



# IN AUSTRALIA

**S**pecialised services for the offshore oil, gas and renewable energy industries are a key part of the services provided by Jan De Nul Group. These works include pre-trenching for offshore pipelines, pre-sweeping of the sea bottom and backfilling of the trenches. The services also include shore approaches and possible related structures that might need to be installed, such as cofferdams.

Jan De Nul's large fleet of dredging and offshore installation vessels provides the necessary flexibility to execute these kinds of offshore services, as shown by its trenching works for the Macedon Project in Australia.

## General working methods

### Pre-sweeping

On the seabed, sand dunes often occur. To avoid over stressing and free spans of the offshore pipelines, the dunes need to be removed to prepare a smooth enough seabed before the actual trenching works and pipeline installation can start. The pre-sweeping is mostly done by means of trailing suction hopper dredgers.

### Pre-trenching

Defining the required equipment for a pre-trenching project depends on the water depth and the type of soil to be dredged. Jan De Nul Group uses three types of vessels to excavate an offshore trench: trailing suction hopper dredgers, cutter dredgers and backhoe dredgers. For shore approaches, land based excavation cranes or backhoe dredgers can be used. In order to meet the market demands, the Group can purchase, build or rebuild project specific equipment. For example, the Group invested in amphibious excavators Starfish I and Starfish II. Thanks to the raised location of the engine and cabin, Starfish I



**Figure 2.** The backhoe dredger Vitruvius can be equipped with buckets with a grab capacity varying from 15 - 40 m<sup>3</sup> and is often used to dredge land approaches.



**Figure 3.** One of the 28 hopper dredgers of Jan De Nul Group. These vessels are used to dredge loose material and are able to excavate trenches up to 155 m deep.

can work in water depths up to 10 m, while Starfish II even disposes of an excavator that can be placed on the seabed, while the control unit and cabin are connected with an umbilical and placed on a pontoon.

### Using trailing suction hopper dredgers

These dredgers are seagoing self-propelled vessels that are equipped with either one or two suction pipe(s), which are designed to trail over the side of the vessel on the sea bed. These vessels are mostly used for dredging loose material such as sand, clay or gravel, in deeper water depths.

Once the dredger approaches the trenching area, it reduces its sailing speed and hoists its suction pipe overboard, lowering it to the required depth. The vessels use a dynamic tracking system that allows the drag head to follow a predefined trench at low tolerances, resulting in minimum quantities being trenched at a lesser cost. Dynamic position and dynamic tracking systems are essential for such operations. Generally speaking, they allow working vessels to maintain position, course and track accurately. In addition, they often enhance safety considerably and indirectly reduce fuel consumption and emissions.

At the lower end of the suction pipe a drag head is attached, which ensures that the maximum amount of seabed material is drawn in via the suction pipe during the dredging process. Suction is provided by a dredge pump situated in the hull of the vessel. Some vessels have an underwater pump on the suction pipe in order to enable them to dredge at greater depths.

When in operation with its drag head on the sea bottom, the hopper dredger moves fairly slowly relative to the ground. The speed is varied depending on the material being dredged.

The trench is excavated by removing consecutive layers of the seabed material. The average minimum width of the trench depends on the width of the used drag head. With respect to the average trench dimensions, 1 m over width at each side is dredged as a result of positioning tolerances.

As soon as the dredger is fully loaded, she hoists the suction pipe onboard and sets course towards the discharge point. Once positioned the dredger opens its hull to unload, followed by a cleaning process making use of the jets inside the hopper, until the hull is completely empty and free of any dredge soil where after the bottom doors are closed. A new dredging cycle can commence by sailing back to the trench area.

The dredging process is controlled by a combination of sophisticated computerised automation and highly skilled operators. The navigator and the dredge pipe operators work in close co-operation during the dredging process. All important parameters are continuously controlled during the dredging process by computers and feedback systems.

The fleet of Jan De Nul Group includes 28 hopper dredgers. Using the largest of its kind in the world: Cristóbal Colón and Leiv Eiriksson, trenches up to 155 m water depth can be dredged.

### Using cutter suction dredgers

The large seagoing cutter dredgers can tackle the hardest and most difficult soil conditions during shore approach dredging.

These vessels are equipped with a rotating cutter head cutting hard soil into fragments. The cut soil is then sucked in by dredge pumps. Cutter dredgers are mostly stationary suction

dredgers that cut the soil according to pre-set profile. In other words, the vessel does not sail during dredging activities. The material is then pumped ashore using pumps and a floating pipeline or loaded into a split hopper barge moored alongside, which in turn can offload the dredge sediment at the set location. Large cutter suction dredgers are self-propelled which means they can sail autonomously.

Jan De Nul Group disposes of 14 cutter dredgers, including the most powerful cutter dredger in the world J.F.J. De Nul, with a total installed diesel powers of 27.240 kW.

### Using backhoe dredgers

A backhoe dredger is a spud barge, equipped with a hydraulic excavator, the main component, and three spuds: one spud is located in the centre of the pontoon at the stern in a spud carriage system. This spud can be lifted and moved along the centre line of the pontoon. The two other spuds can only be lifted/lowered.

The working method of the dredger is as such that it is towed into location and then fixed into position by its three spuds. Before lowering the spuds, the exact position as shown on the DGPS positioning system is checked in order to ensure that the spuds are lowered in the trench alignment. The dredger will then move into the exact starting position by using the spud carrier and the bucket. The dredger will excavate in steps of 6 m length. When one step has been completed, the dredger will release the front spuds from the sea bottom and raise them approximately 2 m above the seabed. The spud carrier then shifts the dredger 5 m backwards in the dredging lane and a new dredging cycle restarts.

The dredger typically operates backwards, i.e., it moves in the opposite direction of the excavator. Consequently, the material that falls down the slope created perpendicular to the centreline falls towards the bucket, leaving a levelled trench bottom. The dredger material can be side cast alongside the trench for reuse as backfill material or can be loaded into a self-propelled Split Hopper Barge and dumped at a designated dump location.

Jan De Nul Group disposes of six backhoe dredgers, of which five are self-propelled.

### Survey during pre-trenching

In order to be able to chart its offshore trenching projects in an accurate manner and to follow them up promptly and efficiently, Jan De Nul Group has set up its own survey division with experts and engineers deployed on various projects worldwide. The division has state-of-the-art, high-tech measuring equipment for hydrographical and topographical measurements at its disposal. The team also monitors closely all recent technological developments and tests them out in preparation for future challenges in the dredging and offshore industry.

When pre-trenching is executed survey works can be done by means of a single or a multi-beam echo sounding system, depending on the water depth. The system can be installed in the moon pool of the hopper dredger or in case of dredging with another type of vessel a separate shallow draft survey vessel equipped with a hydrographical survey system will be

used. The survey system provides online day-to-day survey information for the project team and client representatives.

### Cofferdam installation

When an open trench is not possible, a cofferdam will be installed at the beach area in the tidal zone. A cofferdam is a temporary enclosure and is a welded steel structure, with components consisting of sheet piles, walls and cross braces.

Once the installation of the sheet pile walls is complete, excavation between them can proceed. Normally, the trench of the seaside of the cofferdam is dredged by means of an elevated excavator or by a backhoe dredger. The area between the sheetpiles (i.e., the actual cofferdam) is excavated by means of shore equipment (excavator or crane). Cofferdam structures are dismantled after the ultimate work is completed.

### Backfilling

After pipeline installation, the trench will be backfilled with previously excavated materials. This can be done using a backhoe dredger, a split hopper barge or a trailing suction hopper dredger, depending on the water depth.

The backhoe dredger will position itself either alongside the trench. When side casting, it will install the excavated materials in the trench on top of the pipeline. When side casting is not allowed, the materials will be redredged and dumped in a barge which is moored alongside the dredger. The barge will split above the trench and the trench will be backfilled by dumping the materials in a controlled manner.

The hopper dredger will be loaded and position itself above the trench where the material will be dumped by opening the bottom doors. It is also possible to execute trench backfilling by pumping material reversely through the suction pipe. In that case, the dredge pipe will be positioned above the trench. By use of interim surveys, it is possible to avoid displacement of the pipelines from its as-laid position.

### Specific case in Australia

The Macedon and adjacent Pyrenees fields are located in offshore retention lease WA-12-R that is situated in the Northern Carnarvon Basin, approximately 100 km west of Onslow and 40 km north of Exmouth, Western Australia. The Macedon development included offshore services for the installation of



Figure 4. Simulation of a drag head used to dredge trenches for the installation of offshore pipelines.



Figure 5. A typical cofferdam construction.



Figure 6. The cutter dredger J.F.J. De Nul in front of a typical cofferdam construction.



Figure 7. Jan De Nul Group's cutter suction dredger Fernão de Magalhães and Starfish I executing trenching works.

a 75 km x 20 in. wet gas pipelines and a 75 km x approximately 120 mm OD umbilical from the subsea field to the onshore valve station.

Pipeline and umbilical were to be buried below the natural seabed and shoreline and ensures sufficient backfill on top of the pipe/umbilicals, with a minimum of 2 m cover on top at the shore crossing. The awarded dredging case included trenching and backfilling the pipeline and umbilical in a common trench.

The trench was excavated using two backhoe dredgers, one to execute the landfall dredging, and another one for the deeper sections.

Hard layers of calcirudite were found in a few sections along the trench alignment. These layers needed to be pre-treated using the backhoe dredger equipped with a hydraulic hammer. The hammer has been adapted to work underwater by connecting an air hose which creates overpressure preventing seawater from entering. After removal of the top soil by means of the conventional bucket, a layer thickness of 0.5 - 1 m was pre-treated. As the length of the hammer's chisel is about 50 cm, the layer it can fracture is normally limited to the same depth, but depending on the rock quality the layer could be broken up to 1 m. The typical working method with the hammer is as follows: after fragmentation of a certain area, the hammer is replaced with the bucket to remove the fractured layer. Once the fragmented rocks are removed, the hammer is re-installed and the next layer can be fragmented. The same process is repeated until the required trench bottom level and stable slopes have been reached.

The excavation was conducted with the aid of a digger-computer, calibrated previously in x, y, z values for both seabed and design BOT levels. The dredging depth and width control and the dredging operations were closely and frequently monitored by regular interim surveys. The material was side cast next to the trench and re-used for backfill.

The shore crossing was an open cut trench with a cofferdam. The termination point for the open cut shore crossing portion was approximately 150 m from the shoreline.

The cofferdam was constructed by land based equipment. The actual execution was done using a temporary causeway into the surf area. A specialised rig was used to install the sheet piles. During the installation operations the progress of the sheet piling was closely monitored. Daily surveys were done to enquire quick feedback on the results. This feedback allowed the superintendent to control and if applicable to adjust operations and improve the process. In order to allow excavation of the cofferdam without failure of the sheet piling, horizontal reinforcement was needed. This was done by placing horizontal struts connecting both sides of the cofferdam.

A hydraulic excavator (HEX) was used to dredge this part of the trench. The HEX was based on tracks and moved on and off its operational location. The dredged material was side casted and reused as backfill material afterwards. The overall project took 12 months to complete. 