Marine Engineering
An Introduction to the Consultancy

Dar Al-Handasah (Shair and Partners) is a leading international consultancy specializing in architecture, engineering, planning, environment and economics.

Founded in 1956, today the firm is ranked as one of the world's top international design consultants. With main operations in London, Cairo and Beirut, Dar is staffed with over 4,000 professionals located in 79 offices around the globe.

Our innovative plans, designs and successful implementations are attributed to:

- Half a century of global experience in all types of major large-scale developments in engineering and design
- A talented and dedicated staff professionals with multi-disciplinary, multi-cultural and multi-lingual experience
- Skills for developing, adapting and transferring state of the art planning, engineering and design techniques to indigenous and existing conditions in emerging economies
- A commitment to build long-term client-relationships and actively support our clients worldwide

Healthcare, Aug. 2004
Fields of Specialisation

Coastal and Marine Works Shore protection works; sand nourishment; ports; marinas; offshore facilities; coastal structures: breakwaters, trestles, quays, jetties, embankments, sea walls; causeways & airport runways extending into the sea; coastguard bases; coastal land reclamation; waterfront development schemes; environmental impact assessment studies related to offshore works; numerical models.

Geotechnical Engineering and Tunnelling Sub-soil investigations; foundations for major structures; dredging & reclamation; hydraulic & transportation tunnels; bored & cut-and-fill tunnels; dams.

GIS & Remote Sensing GIS data conversion management, needs assessment, database design, applications development & data integration; digital mapping; imagery acquisition, image rectification, mosaicing & processing.

Transport Planning and Transportation Engineering Transport & traffic studies; motorways; urban and rural roads & highways; causeways & river crossings; railways; automated people movers (APM); bridges; airports, seaports & harbours; car parks & garages.

Architecture Housing; residential & office buildings; hotels, tourist, recreation & sports complexes; banks; government offices (ministries, embassies, etc.); education facilities (universities, schools, etc.); hospitals & health-care facilities; terminals (ports, airports, railways, bus, etc.); commercial complexes (trade & shopping centres); military complexes; conference, exhibition & cultural centres (theatres, libraries, etc.); religious buildings; community facilities; laboratories; telephone exchange buildings.

Landscape Architecture Urban & regional landscape planning development; parks & recreational facilities; hotel & tourism complexes; streets, roads & motorways; military, airport & industrial sites; residential developments; educational centres; commercial complexes; governmental & civic facilities; research, scientific & medical institutions; corporate office parks; cultural & religious facilities; mixed-use developments; reforestation & site rehabilitation projects.

Structures Reinforced concrete, prestressed concrete, steel and composite constructions. Static, dynamic, linear and non-linear analysis of structures. Ultimate and serviceability design of structures including gravity, wind and seismic loads. Durability design including corrosion and fire. Retrofitting and repair of structures.

Bridges and Special Structures Bridges cable-stayed, post-tensioned, segmental (pre-cast, cast-in-situ), box-girder, incrementally launched, arch, steel; underpasses; river crossings; cable-supported roofs; silos; shelters.

Mechanical Engineering and Industry Heating, ventilation, air-conditioning & refrigeration; plumbing and fire protection; health-care facility infrastructure; building automation, energy management and control systems; environmental control and thermal modelling; manufacturing facilities (cement & building materials factories, food processing, chemical & pharmaceutical plants, light industry); fuel handling and storage facilities; tunnel ventilation; mechanical plants for water, sewerage & desalination; operation & maintenance management systems.

Power and Electrical Engineering Power generation; power transmission & distribution; electrical installations; building services; public lighting; security & surveillance systems.

Telecommunications Demand & traffic forecasts; network planning; switching; cable networks; radio systems; satellite systems; motorway networks; broadcasting systems & CATV; acoustics & sound systems; mobile radio; aeronautical systems; telemetry & control systems; intelligent buildings; security systems; telecommunication training centres.

Economics National & regional economic planning & development; institutional planning; macroeconomics & policy; industrial economic planning (estates & area planning, feasibility, national planning); transport planning; population & manpower; feasibility studies for projects & developments; commercial property development.

Town and Regional Planning Regional, metropolitan & town master plans; new towns; urban upgrading & rehabilitation of old quarters; town & district centres; treatment of urban spaces & streets; industrial parks; land use & parcelisation.

Resources & Environment Water resources, hydrogeology & groundwater; water treatment & supply; sewerage & sewage treatment; leak detection; solid waste collection & disposal; industrial waste; hydrology, stormwater drainage & flood protection; agricultural development; land resources, land reclamation, irrigation & drainage; erosion control, river training & shore protection; storage & diversion dams; water reuse & landscape irrigation; environmental protection & environmental impact assessment; rural infrastructure; diagnosis & rehabilitation of existing infrastructure.

Project and Construction Management in the aforementioned fields: conditions of contract; cost estimation; cost evaluation and control; risk analysis; contingency management; budget management; contractors’ prequalification; tender management; design management; value engineering; constructability review; contract administration; construction supervision; QA/QC formulation/implementation; project controls system establishment/operation; planning, scheduling and progress control; contract management; contractors’ interface/coordination; claims and disputes management; owner’s representation; technical assistance and training.

Services
- Preparation of Master Plans, Fundamental Planning, etc.
- Sector Studies, Institutional Reform, Manpower Plans, Tariff Studies, etc.
- Project Feasibility Studies (Technical, Financial, Economic)
- Detailed Engineering Design and Tender Documentation
- Pre-qualification of Contractors, Tendering, Tender Evaluation and Contract Negotiation
- Supervision of Implementation, Acceptance Testing and Commissioning
- Project and Construction Management
- Training, Technical Assistance and Transfer of Expertise
- Operations and Maintenance Management (Systems and Technical Assistance)
Dar Al-Handasah Consultants offers complete services in the field of marine works and port engineering. The firm provides services of different scale to projects ranging from commercial and industrial ports, marinas and small craft harbours, offshore structures including runways and coastal roads, to touristic developments with tidal lagoons, sand nourishment and shore protection works.

Its services are comprehensive and include:
- Port planning and sectoral reform;
- Site selection and harbour planning;
- Planning and supervision of bathymetric, hydrographic and topographic surveys;
- Planning and supervision of dredging and reclamation works;
- Specifying supervision, and review of physical modelling studies;
- Carrying out mathematical model studies;
- Determination of oceanographical/environmental conditions such as winds, waves and water levels;
- Design of breakwaters, quays, jetties, ship repair facilities, seawalls, embankments and other coastal structures;
- Sand nourishment for beaches;
- Environmental impact studies;
- Planning and supervision of shipwreck removal and salvage works.

Such services are carried out during the different design stages: conceptual, preliminary and detailed, tender preparation and evaluation, through the construction supervision stage.

Among the staff of the firm are specialists and experienced staff in the fields of port planning and design. The staff has good experience in the field of port planning and layout optimisation. This includes the determination of harbour size; width and depth of entrance channels; diameter and depth of turning circles; alignment and length of breakwaters; type, length, orientation and depth of quays; service and ship repair facilities; and planning of land areas, as well as sectoral and institutional reform. The firm also plans and supervises bathymetric, hydrographic and topographic surveys as well as geotechnical onshore and offshore investigations. It also plans and supervises specialised model studies, mathematical and physical to verify and complement the design.

Basic oceanographical/environmental conditions such as winds, waves and water levels are determined as the first step for the design of port and coastal structures. The firm determines the wind statistics; normal, extreme offshore, nearshore wave climate and waves inside the port. At a further stage, the firm then supervises the use of mathematical models to determine these values more accurately.

The Marine Division of Dar Al-Handasah has very good experience in the design of different types of breakwaters and quays, seawalls, revetments, dredging and slope protection for reclamation. For example, for rubble mound breakwaters, the staff carries out hydraulic stability analyses to determine the size and type of armour protection; underlayers and core; the stability, run-up and overtopping calculations; stability of crown walls and preparation of the specifications of materials. The design is usually verified by carrying out two-dimensional and/or three-dimensional physical model stability tests in specialised laboratories under the direct control and supervision of Dar Al-Handasah Consultants. Other coastal structures such as jetties, corniche embankments, seawalls, causeways, and sea runways for airports have been designed by this group of the Firm.

The Firm has also a very good experience with design and selection of nourished sand profiles, and design of coastal protection works.

The Firm also possesses a number of computer models for the study of wave propagation, wave agitation and morphological studies.
The firm also has a very experienced staff for the design of berths ranging from gravity-type for industrial and commercial ports to floating pontoons for marinas and coastguard bases. The Marine Division has also carried out detailed design for specialised terminals such as bulk, liquid, LNG and container terminals. The design of berths and terminals includes detailed structural design, selection and design of tendering and mooring systems.

The design of other offshore services and facilities such as the design of slipways, shiplifts, aids to navigation, lighting towers and fire-fighting systems is also undertaken as part of the comprehensive port/harbour design.

The capabilities of the Marine Division are enhanced by the full support provided by other specialised departments of Dar Al-Handasah Consultants, including the Structural, Environmental, Electrical, Urban Planning and Mechanical departments.
The Geotechnical Engineering Department of Dar Al-Handasah has been extensively involved in many large-scale civil engineering projects that require heavy construction activities. These projects include rock and soft-ground tunnelling, highway cuts and embankments, large excavations and side-support systems, dewatering operations, grouting and underpinning, dams, sewage treatment plants and pumping stations, foundations for bridges and high-rise buildings, coastal and marine works, etc.

The staff of the Geotechnical Engineering Department has diversified experience in all aspects of geotechnical engineering and engineering geology. The staff’s experience with the geotechnical conditions of the Middle East and the Gulf area is particularly strong due to the large number of projects undertaken by Dar in the area over the last 34 years. Besides the practical experience and academic background of the staff, the work in the Department is greatly enhanced by the availability of a most up-to-date library and computer facilities and programs, which provide a sound analytical background for solving different problems.

In spite of the diverse geographical extent of its work, the Geotechnical Engineering Department always provides strict supervision of all soil investigation works to assure the quality of the work carried out by the specialist soil investigation contractors. Based on the factual reports resulting from the site investigation, the staff carries out the necessary studies and analyses to produce interpretative reports including recommendations for all geotechnical aspects related to the project in question. The staff also gives continuous relevant technical support to other design disciplines within the Firm, e.g. highways, structures and town and regional planning. Follow-up and technical back up for site works also form a major component of the Department’s work.

The Geotechnical Engineering Department has been responsible for the design and supervision of numerous major projects in the region that included cuts, deep excavations, excavation support systems and slope protection works in both soil and rock formations. The designs were produced in accordance with the highest standards and codes using the most up-to-date software and analysis techniques to ensure they met both the requirements of the Client and international standards, and are cost-effective at the same time. The Firm always exercised strict supervision of the work during execution to ensure that the end product is constructed as designed thus guaranteeing that it performs as intended. Continuous follow-up and technical support are always provided by the design office during construction to provide uninterrupted work flow as problems arising from unforeseen circumstances and conditions are resolved without delay.
Doha Port Relocation
Master Study

Qatar

Main Features
Doha had experienced urban expansion and a huge growth in port traffic to the extent that the respective impacts and perceived incompatibility of land uses raised the question of port relocation.

We were hired to review the national long-term requirements for Doha Port and associated infrastructure, to develop and evaluate alternative short and long-term strategies for the port, and to assess commercial development opportunities attached to the existing port land.

The main question at hand was, “Would future demand be better met through a rehabilitation of the existing port, or at a series of alternative new port site locations?” To answer this, we initiated a master study.

The study considered the potential land use development of the port site, should all or part of it be relinquished, and how this could be used to offset the economic costs of port rehabilitation or port relocation. We took an in-depth look into the current port attributes and their use, shipping patterns in the region, and also competing overland transport.

Long-term projections were made of cargo and shipping demands, which were matched with road access, berth, channel, and quay storage requirements for the existing port and for a totally new port.

A new port layout was developed and cost to accommodate these requirements, together with a similar exercise for the upgrading of the existing Doha Port to similar standards.

A comprehensive review of potential new port locations was undertaken, taking into account basic criteria such as proximity to shipping lanes, water depths, proximity to road infrastructure and markets, avoidance of environmentally sensitive sites, etc.

Five new port locations were identified and, following further study and comparison, the two “best” options were retained. These were then compared with the option of port retention by upgrading the existing facilities.

Transport costs featured strongly in the evaluation process, as did the capital costs and incremental costs of construction. Port relocation released sufficient prime land for commercial development to indicate that the full economic incremental costs of port relocation could be recovered.
Client
Beirut Port Authority

Services provided
- Technical assistance
- Design review for the rehabilitation and extension works
- Operation and maintenance (O&M) services
- Tender documents.

Dates
1995 - 2001

Project Data
- Cargo area
- New container terminal
- Infrastructure
- Buildings, warehouses, administration, service and other buildings
- Miscellaneous works: fire-fighting vehicles, removal of ship wrecks and scrap, fuel station, container gantry cranes, etc.
- Traffic study and bus-shuttle system

Container Terminal
Design review, preparation of bid documents, tender analysis, and operation and maintenance services for the upgrading and rehabilitation of the existing cargo area and its extension into a new container terminal:
- Infrastructure: roads, utility networks, electrical, fire fighting, and telecommunications
- Buildings: structural steel framed warehouse (50 m span), administration, service and other buildings
- Cranes and handling equipments
- Marine works: rehabilitation of existing quays; construction of 2 new quay walls and marine protection structures

Traffic Study inside the Premises
Investigation of employees and agents movement inside the Port premises, and preparation of a study for a bus shuttle system inside the port.

Miscellaneous Works
Preparation of tender documents for various upgrading tasks, including:
- Purchase of fire fighting vehicles
- Removal of ship wrecks and bombs from the basins
- Removal of scrap, junk and destroyed equipment
- Renovation and upgrading of the fuel filling station
- Preparation works for the inspection halls; fence and pavement for the free zone area
- Design of quay, inspection of installation and training for four Post-Panamax container Gantry Cranes

Pavement of Open Yards
Inspection of materials and daily supervision.

Free Zone Buildings
- Tender analysis of the bids for construction of two buildings in the free zone area.
- Value of Works: US$ 10 million
Client
Comité de Gestion et Exploitation du Port de Beyrouth

Services Provided
- General Supervision
- Daily Supervision
- Design Office Support and monitoring progress
- Review of design by other independent consultants

Project Data
- Cargo area
- New container terminal of 150,000 m² including 2 870-m long quay walls
- 540-m detached breakwater
- 330-m long main breakwater extension infrastructure and civil works
- 5 new administrative buildings with total built-up area of 18,000 m²
- A 10,000-m² warehouse
- Parking area for 700 cars and 250 container trucks, 1.4-km fences, cranes, a 260-m long/5-m high retaining wall, one hangar
- Soft and hard landscaping, including a 2,000-m² park
- Container terminal value of works: US$ 150 million

Dates
1997 - 2000

Container Terminal
- Supervision of construction of 850-m long of concrete gravity quay walls
- Infrastructure and civil works: roads, utility networks, electricity, fire fighting and telecommunications
- Dredging for the foundations of the quay wall
- Reclamation from the sea of an area of about 150,000 m² including slope protection
- Buildings: Structural steel framed warehouse (50-m span), multi-storey administration, service and other buildings
- Rehabilitation of existing quay wall structures
- 330-m long extension to main breakwater
Beirut Port
Breakwater, Quay Wall and New Reclamation Area

Lebanon

**Detached Breakwater**
- Supervision of construction of 600 m of a rubble mound detached breakwater including dredging for the replacement of about 400,000 m³ of unsuitable foundation material
- Deepening of the port basin by dredging in soft and hard rock

**Design Office Support**
- Review of dredging and reclamation method statements for all aspects of construction
- Review and approval of materials submissions
- Checking and approval of contractor’s designs and shop drawings
- General technical and contractual back-up to the site supervision team
- Negotiation of rates for additional works and variations
Client
Saida Port Authority

Services provided
- Design
- Supervision of construction

Dates
1995 - 1998

Project Data
- Main and lee breakwaters with a total length of about 4 km
- Quaywalls with a total length of about 2 km
- Land reclamation area of about 1,200,000 m²:
  - container terminal: 44 ha
  - multipurpose terminal: 13 ha
  - reserved area: 5 ha
  - free trade zone: 8 ha
  - free industrial zone: 11.5 ha
  - services & customs area: 12 ha
  - landscaping: 3.5 ha
- Construction cost: US$ 200 million

Background
Dar was appointed to construct a new commercial port in Saida to serve the trans-shipment industry providing up-to-date services and including free trade and industrial zones.

Master Plan Finalisation
- Review and finalization of the port layout: requirements and dimensions for the access channel to the port (width and depth) and turning area
- Design of the onshore facilities including buildings, power plant, water tanks, waste treatment plant, fuel station, roads and all infrastructure

Environmental Assessment
Based on the World Bank Operational Directive OD4.01, it included analysis of the proposed port development, geographic location, geology and geomorphology, bathymetric survey, oceanography, seismicity, marine biology, coastal zone management planning and legislation, environmental legislation, feasibility study of the port development, type and quantity of construction work and materials, dredging, archaeology. The environmental management plan included the implementation analysis for the works, port operations, monitoring and reporting procedures, and establishing an environmental implementation unit.

Major identified impacts included economic downturn, loss of economic opportunities, loss of biological productivity, and port construction and operations.

Design
As pre-design requirements, the following studies were carried out:
- Topographic, bathymetric and hydrographic surveys covered the whole Port area extending about 500 m from all sides to identify the impact of the seabed topography on the design of the Port. ADCP techniques are used to measure wave, tide and current data
- Geotechnical studies: onshore and offshore surface investigations are conducted by drilling boreholes to a depth of 50 m below the seabed. Sampling and in situ testing are performed at regular intervals to assess the capacity of the seabed material and estimate the associated settlement
- Hydraulic studies: mathematical model studies are used to predict the inshore wave climates and wave agitation in addition to ship simulation and sedimentation in the vicinity of the port
Coastguard Headquarters and Facilities
Kuwait

Client
Ministry of Public Works

Services Provided
- Site selection
- Master plan
- Design
- Supervision of construction
- Environmental Impact Assessment

Dates
- Master plan study: 1989 - 1990
- Design: 1993 - 1997
- Supervision: 1998 - 2002

Project Data
- Base: Coastguard HQ, protected harbour, berthing and repair facilities, communication system, navigational equipment
- Main and lee breakwaters of 1.0 km and 0.6 km respectively
- 15-ha land reclamation
- 2,000 m of berths and 500 tonnes ship-lift and transfer system
- Cost: US$ 110 million

Main Features
We were hired to design and oversee construction of a new Coastguard Base at Al-Fintas, some 20 km south of Ras Al-Ard, along the eastern coast of the state of Kuwait. The base is comprised of headquarters and sports facilities built on reclaimed land, as well as a protected harbor. The harbor area provides berthing facilities for coastguard vessels, a communication system and navigation aids, and repair facilities for the in-service vessels.

Master Plan
Three different sites were evaluated during the master planning studies with Al-Fintas selected as the project site. A delicate balance was maintained between "high" and "low" buildings and their distribution on the site, particularly with respect to the soil condition and the area of reclaimed land.

Design
As pre-design requirements, the following studies were undertaken:
- Site Studies
  Topographic, bathymetric and hydrographic surveys were carried out covering the whole development site. We also tested onshore and offshore soil.
- Hydraulic Studies
  Mathematical and physical model studies were undertaken to predict offshore and near-shore wave climates, winds, and water levels as well as wave agitation inside the harbour. A two-dimensional physical model was carried out to verify the design of the most critical trunk cross-section of the breakwater, and a special mathematical model was performed to study the natural flushing performance of the harbour and sedimentation at the harbour entrance and its vicinity.
- Environmental Impact Assessment
  Our modeling studies provided some indication regarding the possible impacts of the project on shoreline evolution. Other impacts of the project on the local marine flora and fauna were investigated.
Ras Laffan Port

Qatar

Client
Condotte and Partners

Project Data

- Main and lee rubble mound breakwaters, 6.1-km and 4-km long
- Dredged basin approximately 2.2 km x 0.8 km in plan
- 3 berths, LNG trestles, 2 liquid product berths and a causeway
- 5 km long dredged approach channel
- 220 ha of reclamation
- Buildings totalling 10,000 m² and relevant infrastructure
- Construction cost: US$ 800 million.

Dates

- Design: 1990 - 1992
- Supervision: 1992 - 1997

Background

A new port is to be a key feature in the export of Liquefied Natural Gas (LNG) derived from Qatar’s major off-shore North Field.

The port forms the first stage of a master plan for the development of extensive hydrocarbon-related process, production and support facilities.

Master Plan: General

We prepared a comprehensive master plan with a new town and infrastructure to complement facilities directly associated with export of LNG.

Master Plan: Ports

Parallel with earlier production from oil and gas fields, an industrial complex and associated port had already been developed at Umm Said, on Qatar’s east coast to the south of Doha.

The on-shore portion of the North Field pipeline terminates at Umm Said. The master plan evaluated the merits of a major expansion versus constructing a new port and on-shore facilities.

Geotechnical studies

Studies were carried out for dredging, breakwater, foundations for extensive jetties and berths, and the selection of suitable sources of rock material for breakwater armour and core and concrete aggregate. Dredged and quarried rock were studied.

Hydraulic Studies

Comprehensive studies were undertaken, with the optimisation of the port layout carried out as a parallel exercise. European hydraulics institutes were involved in design parameters selection. The environmental impact of the port formed part of these studies.

Marine Studies

Simulation, using Danish facilities, permitted the arrival and departure of the larger vessels to be visualised and confidence gained in the port dimensions and operation.
Doha Port Development

Client
Ministry of Municipal Affairs and Agriculture

Services Provided
- Project management
- Redesign services
- Contract management and budget control
- Supervision of construction

Project Data

Dates
- Study: 1993
- Supervision: 1997-1998

Doha Port Dredging and Reclamation
- Value of works: US$ 100 million
- Widening and deepening of the approach channel and basin at the existing Doha Port; reclamation of 280,000 m² of land and associated rock-armouring works to form the future container terminal berth; and reclamation of 6 km² of land for future development of an international airport

Doha Port Container Terminal Quay Wall
- Value of works: US$ 13 million
- Construction of a 732-m quay wall, including a high berth, a ro-ro berth and all associated marine fittings, such as bollards and fenders, as part of the development of the new container terminal berth

Supply and Installation of Navigation Aids
- Value of works: US$ 4 million
- Supply, installation, testing and commissioning of a complete new system of navigation aids for the port

Doha Port Container Terminal, Infrastructure and Surfacing Works
- Value of works: US$ 16 million
- Construction of roads and hard standings for storage of containers, crane rails and foundations, foul and surface drainage, fire mains, lighting columns and electrical supply cables for lighting, refrigeration plants and container cranes

Doha Flour Mill Dredging & Reclamation and Construction of Quay Wall
- Value of works: US$ 13 million
- Dredging of an access channel from the main Doha Port channel, a new basin, reclamation of 100,000 m² of land and the associated rock-armouring works, construction of a 260-m quay wall and the supply and installation of navigation aids for the development of the flour mill import berth
Client
Ministry of Public Works

Services Provided
- Master plan
- Design
- Supervision

Dates
1973 - 1977

Project Data
- A navigable channel connecting the new Sea Wing basin with the deep waters
- A harbour with an adjoining camp for 840 sailors and officers
- Cost (1973): US$ 60 million

Main Features
The new Sea Wing is able to accommodate newly-acquired large vessels and is equipped to render services and repairs to all vessels with previously were carried out elsewhere. It is a residential and training centre for the growing navy.

The harbour is divided into two sections. The first section includes the existing Sea Wing jetty, which is used by the Royal Boats Squadron and their vessels. The second section - which covers a basin area of approximately 60,000 m² with 12,000 linear meters of quays and moles - is equipped to service the boats with water, electricity and fuel.

Covered boat-repair bays are installed on the hardstand adjacent to the quays for servicing major repairs. Adjacent to this structure are three speciality shops for further repairs. The camp in general is planned to house about 700 junior rating sailors, 100 senior rating sailors and 50 officers. There are training centres, administration and operation buildings, sick-bay stores complex, technical department offices, armoury, mosque and motor transport section. A large area for various sports activities is also provided.

The walls of quays and moles consist of anchored steel sheet piles with reinforced concrete waling beams.

The buildings are of reinforced concrete structures, except for the large-span high roofs of the workshops and boat-repair bays, which are of structured steel.
Multi-Purpose Harbour
Kuwait

Client
Ministry of Planning

Services Provided
- Site Selection
- Master Plan
- Design
- Environmental Impact Assessment

Dates
- Beginning: 1989
- Completion: interrupted by Gulf war

Main Features
Investigations and planning studies are undertaken for the selection of a site for a new multi-purpose harbour in Kuwait to accommodate about 1,000 vessels and to cater for the future needs of the fishing industry in Kuwait.

Three possible locations were to be studied and one location to be chosen.

The consultants’ task in this project are identified as follows:
- Optimum capacity for the proposed harbour
- Onshore and offshore surveys
- Identification of interrelations between spaces, buildings and activities
- Infrastructure requirements
- Geotechnical-oceanographic studies
- Comparative location analysis
- Preliminary and final design
- Preparation of tender documents
**Al-Mukalla Harbour**

**Yemen**

**Client**
Public Corporation for Fish Wealth, Yemen Ports Authority

**Services Provided**
- Feasibility study
- Engineering design
- Model testing
- Supervision of construction
- Environmental impact assessment

**Project Data**
- Construction of substantial breakwater and sea-wall protection
- Dredging and reclamation works
- Two 360-m long, 10-m deep quay walls for general cargo ships up to 10,000 dwt
- A 165-m long shallow-water quay for fishing vessels up to 200-ton capacity
- Construction cost: US$ 50 million

**Dates**
1974 - 1982

**Background**
In order to promote development, a new harbour was needed on the Gulf of Aden coastline for general cargo and fishing vessels. Because of the exposed nature of the coastline, particular attention to harbour layout and breakwater design was required.

**Model Testing**
Flume tests were made to determine the stability and behaviour of the original proposed breakwater section, and at a later stage additional flume tests were undertaken to estimate the efficiency of an alternative armouring scheme using precast concrete units known as “Accropods.”

Model tests were made to study the wave conditions in the harbour for various breakwater lengths and berth layouts. The primary requirement for satisfactory performance was that residual wave heights at the berth should not exceed 30 per cent of the offshore wave height.

**Project Components**
The construction on an exposed site near the town of Al-Mukalla consisted of two general cargo berths, a quay for fishing vessels and an auxiliary quay for lighters and small craft.

Extensive breakwater construction was necessary: the main breakwater, 500-m long was protected by concrete.

“Accropods” were built in a maximum water depth of 17 m at the breakwater head. Two quay walls were built from concrete blockwork, 360-m long for general cargo ships of up to 10,000 dwt; a 165-m long shallow-water quay and auxiliary quay provide berths for smaller vessels.

Extensive dredging was undertaken in soil and rock and reclamation was also necessary.
Fisheries Quay and Elf Quay
Phase Two

Soyo, Angola

Client
Sociedade Nacional de Combustiveis de Angola (SONANGOL)

Services Provided
- Master plan
- Parcellation
- Design
- Construction management

Dates
1984 - 1986

Project Data
- Site area: 700 ha
- Population: 30,000
- The fisheries and commercial quay will accommodate one 5,000 dwt vessel together with smaller coastal and fishing vessels
- The ELF Wharf is built to service oil field vessels
- Both quays consist of anchored sheet pile walls and paved reclaimed areas for hardstandings
- Construction Cost (1986) US$ 90 million

Main Features
Master plan for a 700-ha island housing bases for oil companies, including detailed design for architecture, site development and complete infrastructure, power and roads for the base and Soyo Town for a population of 30,000; detailed design and supervision of construction for 550 villas and all facilities; dredging, reclamation and construction of 2 quays (one for fishing and commercial vessels up to 5,000 dwt and one for oil field vessels).
MTBE/Methanol Jetty
Umm Said, Qatar

Client
Qatar General Petroleum Corporation (QGPC) / Overseas Bechtel

Project Data
- 2.3-km long steelwork trestle supporting pipework and road access, with piled foundations
- 3 jetties and associated loading arms, fire monitors and ancillary equipment
- Dredged channel and berths to provide a minimum water depth of 1.2 m.
- Construction cost: US$ 50 million

Dates

Background
A new trestle and jetty facility is to be introduced at the existing port of Umm Said, Qatar.

The jetty will permit the export of products arising from new process plants to be built within and existing industrial complex.

The entire facility represents a key development following the inauguration of the gas pipeline from the off-shore North Field to Umm Said in 1991.

Master Plan
The opportunity to optimise the existing facilities at Umm Said was recognised during the course of master plan studies associated with the development of the North Field off-shore gas reserves. Unfavourable dredging conditions near-shore has left this site undeveloped.

Geotechnical Studies
A comprehensive programme of geotechnical studies was implemented including a desk study, marine site investigation and bathymetric survey, laboratory testing, data interpretation and detailed design and analysis. Dredging conditions and piles for structures and dolphins were studied.

The scope of work included investigation, contract management and site supervision.

Port Studies
An optimum layout for the trestle and berths was derived despite the constraints of working in an operational port while establishing shipping channels.

Facilities were arranged so that new generation vessels could be accommodated. The integration of the new facility within the existing port operations was a key area of the studies.

Infrastructure Studies
In tandem with the structural studies data were obtained regarding the infrastructure to be supported by the new trestle and jetty system.

Pipeline configurations and support equipment were identified together with access requirements.

Structural Design
Structural design was carried out to American Petroleum Institute codes with span: weight ratios optimised for the proposed steelwork trestle and jetty construction. Design landings included fire monitors and loading arms, together with pumps and pigging equipment. Soil-structure interaction at mooring and berthing dolphins was examined.

Tender and contract documents
A full suite of specifications was prepared to support other documents associated with the contract for construction.
Ma Wan Port Development

Client
Shenzhen Municipality

Services Provided
- Preparation of a master plan for the first phase of port development
- Engineering design of the berths and quay included in the initial construction program

Project Data
- Cargo berths: 3 20,000-dwt berths
- Container berths: 6 50,000-dwt berths; 3 35,000-dwt berths.
- Length of quay, first stage: 3,300 m
- Construction cost, first stage: US$ 300 million

Dates
1984 - 1985

Background
We were commissioned to prepare a master plan for the first phase of the port, which is to serve the industrial development planned for the Nantoup Peninsula.

The proposed port includes a wide range of facilities to cater to both land-based development and activities in the off-shore oil fields.

Components
The scheme for the development of the port entails extensive reclamation works with Ta Ch’An Bay and offshore reclamation works to join two existing islands. Ship repair facilities will be included with the general cargo and container berths and berths for service ships for the South China Sea oil field. In the first stage, 12 berths will be built over a 15 year period to the south of Ta Ch’An Bay. This scheme will involve quay construction more than 3 km in total length; extensive installations for container handling; railway and road construction; service building and warehouse construction; power, water and sewage installations; and radar and telecommunications facilities.

Scope of Work
We were responsible for undertaking, in association with international hydraulic institutes, comprehensive studies involving mathematical and physical modelling in the development of the master plan and optimization of port layout.

A range of geotechnical, marine, and topographical surveys was also carried out in order to study dredging and breakwater requirements, foundations for jetties and berths, and the selection of suitable sources of rock material for breakwater armour and core concrete aggregate. Engineering design was undertaken for the initial phase of cargo and container berths including in the first stage of port development. The use of satellite imagery has increased with the improved availability of such data and LANDSAT imagery was used to study bathymetric and river training problems.
Maritime Sector Transport Study

Yemen

**Client**
Ministry of Transport, financed by KFAED

**Services Provided**
Study led by our experts, undertaken in association with MERC (Rotterdam) and consisting of:

- Appraisal of economic development trends & prospects and forecast trade flows
- Review of current shipping practices
- Assessment of facilities and performance at Aden and Mukalla ports
- Assessment of status and performance of Yemen Navigation Line
- Establishment of project shipping requirements and potential market share of the national line
- Inspection of competitiveness of coastal shipping in relation to alternative trucking routes
- Establishment and appraisal of proposals for the development of the national shipping line

**Date**
1990

**Sectors**
- Principal sector: transport shipping
- Associated sectors: transport: ports, trucking

**Principal Study Components**
- Macroeconomic development review
- Trade forecasts
- Shipping operations review
- Port operations and management review
- Modelling shipping movements
- Modal comparisons: coastal shipping/trucking
- Development plan for Yemen Navigation Line
- Financial evaluation of proposed developments

**Study Features**
- With a 1990 population of 2.3 million, real GDP growth for Southern Yemen is anticipated at around 3% p.a. in the decade to 2000. There is a high degree of dependence on imports
- Total non-oil trade handled by the ports was projected to increase from 1,113 to 1,750 thousand tonnes 1990-2000. Over 80% of the 2000 trade flow was projected for Aden Port
- The study highlighted shipping practices that inhibited efficiency
- Port facilities and operations were examined, and factors inhibiting performance and development identified. The status and performance of Yemen Navigation Line was reviewed
- The study indicated that shipping was unlikely to claim significant levels of coastal traffic
- Routes providing opportunities for the Line were identified.
- Proposals for the development of the Line were based on a linear programming model used to investigate optimal fleet, utilization and route configuration
Qatar Port Study

Qatar

Client
Ministry of Municipal Affairs and Agriculture

Services Provided
- Assessment of growth in port traffic and evaluation of shipping trends
- Preparation of master plans for first stage development at existing Port of Doha and at each of the three alternative port sites studies
- Recommendations on alternative solutions

Date
1992

Project Data
- Container berths: two of 17,500 dwt (1100 TEU berths)
- Multi-purpose berths: one of 20,000 berths
- Bulk grain berths: one of 30,000 dwt berth
- General cargo berths: nine of 15,000 dwt berths (in 3 of 4 options)
- Length of quay, first stage: 1,000 m (+1,800 m in 3 of 4 options)
- Estimated construction cost, first stage (1992): US$ 500 million

Background
We undertook a short study assisting the investigation that intended investment in the Port of Doha extension was consistent with expected future developments that would influence the requirements of Qatar’s ports.

Project Components
The study entailed a broad-brush assessment of the growth of port traffic, primarily in the public sector, including the possibility of the diversion of overland trade into sea-borne traffic. This was complemented by an evaluation of trends in shipping to the Arabian Gulf region, particularly in container services. These studies enabled the post service requirements to be defined.

Subsequently, master plans were prepared for the optimum development at the Port of Doha, and for the development of alternative new deep-water ports at Wakrah, Ras Abu Fantas, and Al-Jazirah Al-Alyah.

Two of the four port sites required dredged approach channels up to 19 km in length. If a new deep-water port were to be developed for the required new container, roll-on/roll-off, and bulk grain terminals, the further option of the possible transfer of the existing nine general cargo berths at the Port of Doha, together with the necessary administrative and other buildings, to the new port was also evaluated.

Estimated capital costs of the alternative port developments indicated that the case for extending the existing Port of Doha was very strong.
Client
Suez Canal Authority, Egypt
Financed by AFESD

Services Provided
Within the established consortium, our duties included:

- To appraise development of the global economy, review projections of development trends, and establish consensus long-term projections
- To analyze appropriate canal tolls
- To determine requirements for the relocation of non-Canal facilities
- To examine the viability of the proposed expansion schemes

Dates
1989 - 1991

Background
Following the review of the canal’s tolls, and projections in light of the global developments in shipping, an assessment of potential income was carried out, also a feasibility study was conducted for an alternative scheme for the widening and deepening of the canal.

Principal Sector:
- Transport - shipping

Principal Study Components
- Macro-economic: global development trends and prospects, macro-economic management policies, international economic relations
- Economic forecasts: “consensus” long-term GNP forecasts for individual countries and regions
- Specification of an appropriate toll “deterrent” function in a world shipping movement simulation model and analysis of appropriate toll regime and toll levels for the Canal
- Economic and financial feasibility analysis of alternative canal development proposals
**Main Features**

New runways, terminal and ancillary buildings were needed to improve air transport facilities at Rafic Hariri International Airport - Beirut (RHIAB):

**West Runway**

The west runway extends 2.3 km into the sea from the shoreline, with a 210-m wide strip. About 4.2 million m³ of rock-fill material is used to form the runway embankments.

**Breakwater**

A low-crested rubble mound breakwater protects the west runway from wave action and overtopping. Due to the height of the significant wave, large Antifer concrete units are chosen as armour protection for the breakwater. The breakwater extends 2,500 m parallel to the runway and 50 m beyond the northern end of the runway to ensure adequate protection.

The breakwater is spaced at 80 m to the west of the runway to reduce overtopping discharge to a safe limiting value at the edge of the runway strip yet meeting the navigation design requirements. Rock armour is used to protect the runway embankment from diffracted and transmitted waves.

**Model Studies**

Mathematical and physical model studies are carried out under Dar Al-Handasah’s supervision to forecast wave heights, water levels, and shore development; to verify the design section; and to optimise the breakwater length.
Rafic Hariri International Airport
Off Shore Runway

Beirut, Lebanon

Reclamation
About 500,000 m³ of reclamation material are dumped into the sea in the stretch, lying between the runway strip and the shoreline, and the area south of the west runway. Part of the new east runway is also on reclaimed land, as well as the re-routing of Ouzai Road. The slope protection for the southern reclamation area consists of rock armour and a special type of crown wall (recurved sea-wall) to minimize overtopping discharge to a safe value for the access of vehicular traffic during storms.

Guide Lights Dolphins
The guide lights are fixed on reinforced concrete pile caps/dolphins supported by raking steel piles 36-m long driven in the sea bed at 500 m from the shoreline with 12-m depth of water and subjected to open sea wave loads. The dolphins are accessed by precast concrete walkway beams.

Airfield Underpasses
Two airfield underpasses, 210-m and 430-m long, respectively cross under the west runway and taxiways. The tunnels consist of two 16.8 m wide cells of clear heights ranging from 5.0 to 8.5 m separated by a 200-m long open section.
Beirut International Airport
New West Runway Marine EIA

Beirut, Lebanon

Client
Council for Development and Reconstruction (CDR)

Dates
November 1994 - March 1995

Project Data
- New runway: 3,400 m x 300 m, projecting 2,500 m offshore
- Protection works in sea depths of 4-6 m for 100 storm/wave design
- Affected physical environments: terrestrial, coastal and marine ecosystems, and resources
- New west runway cost: US $ 80 million

Background
An EIA has been undertaken by Dar for the new west runway at Beirut International Airport on the marine and coastal environment to supplement the feasibility study, viz. reduction of aircraft noise on Beirut, alleviation of building height constraints.

Basis of Study
- Review of available literature
- Consultation with Government, NGO’s and potentially affected communities
- Specialist technical studies
- Geomorphological, biological and socio-economic surveys

Study framework, which was based on the World Bank guidelines, assumes a shift in decision making in favour of a bias towards safety and prevention.

Primary Impacts
Expected to be on the marine ecology, coastal morphology, local fisheries and recreational users:

- Probable reduction in water and beach quality in the bay formed to the east of the new west runway and in inshore coastal areas to the north
- Alteration to the adjacent shoreline possibly causing changes in the amenity value of recreational beaches and increasing erosion risks
- Loss of present anchorage facilities to local fishing boats
Second Manama-Muharraq Crossing

Bahrain

**Client**
Ministry of Works and Agriculture, Financed by AFESD

**Services Provided**
- Traffic, ground and marine surveys
- Traffic and marine modelling
- Economic evaluation
- Design of reclamation works, highways and structures
- Tender document assistance
- Supervision of construction

**Project Data**
- Dual 3-lane marine causeway with 260-m long navigation channel cable-stayed bridge
- 11 km of urban motorway link roads with four grade-separated interchanges
- 4 million m³ of reclamation
- Estimated cost: US$ 80 million

**Dates**
1989 - 1997

**Background**
Concerned about future traffic issues, Bahrain’s Ministry of Works hired us to design and oversee the construction of a bridge linking the two main islands of Manama and Muharraq.

**Feasibility Study**
The need for a second causeway was demonstrated by an area-wide traffic modelling using SATURN. Alternative causeway locations and interchange links were modelled to assess traffic impact and were evaluated taking into account reclamation, structural and road works costs. A study report was successful in attracting international finance.
Second Manama-Muharraq Crossing

Bahrain

Geotechnical Studies
Geotechnical investigations were carried out for the bridge, causeway sites and reclamation areas.

Bathymetric and topographical surveys helped us to develop a three-dimensional terrain model which defined shoreline, sea bed and foundation strata surfaces.

Marine Studies
Tidal flow models of the project area were set up to predict the impact of alternative causeway and reclamation configurations. Studies included navigation channel characteristics, scour of bridge foundations, dispersion of sewage outfalls and environmental impact on marine life.

Bridge Design
Structural concepts for the causeway and interchange bridges reflect the importance of the link. An unusual segmental concrete design with post-tensioned concrete “sails” was developed for the causeway bridge. We initiated concrete durability studies to address the aggressive marine environment.

Reclamation Design
Dredging, reclamation and coastal works factored in navigational concerns, tidal effects and marine ecology. Silt traps protected water quality during reclamation.

Highway Design
Highway and interchange alignments were developed using interactive MOSS to local and UK DTp standards. We included piped drainage systems with sea outfalls in the design, along with extensive utility relocations, landscaping, irrigation, signing and lighting. A staged construction plan was utilized to maintain access during construction.
San Stefano Company for Real Estate Investment

Services provided
- Design
- Supervision
- Project Management

Project Data
- A 30-floor high-rise building, with a total built-up area of 445,000 m² on a 28,000-m² site
- A multi-purpose complex comprising 5-star 125-key Four Seasons Hotel, 900 luxurious apartments, retail shopping mall, commercial offices, 10-screen cinema and a parking/service area over 3 basement levels
- Reclamation and protection of marine and beach facilities area with offshore structures: marina beach club, casino building, cabanas and lockers block
- Cost (2000): US$ 300 million

Dates
1999 - 2005

Complex Building
- Hotel: the 125-key, 5 star Four Seasons Hotel comprises a ballroom, conference halls, restaurants, coffee shop, tea lounge/bar, health club
- Residential Apartments: 900 apartments with areas ranging from 100 m² to 900 m². The built-up area amounts to 222,460 m²
- Commercial Offices: a total of 9,840 m² distributed between the 2nd, 3rd and 4th floors are allocated for commercial offices rental
- Retail/entertainment: a total of 31,000 m² are allocated for retail activities. This area includes 4,440-m² ten-screen cinemas totalling 1,590 seats
- Parking/storage/service: a total of 76,235 m² of parking space and other services are provided at 3 basement levels P1, P2 and P3

Beach Facilities and Pedestrian Passage
- 32,600-m² reclamation of a seaside part along with associated protection works
- A submerged offshore breakwater, 160-m long, to protect the newly established beach
- A 30-boat, 3,300-m² marina providing mooring and docking facilities
- Armored breakwaters for the necessary protection of the marina
- A 7,800-m² beach
- Cabanas, clubhouse, casino, lockers and showers amounting to 9,500 m²
- Pedestrian passage under the corniche road separating the Complex Building from the beach for access by the complex inhabitants and guests
Luanda Oil Service Centre

Client
SONILS, Angola & Integrated Logistic Services

Services provided
- Master plan & parcellation plan
- Design & tender documents

Dates
1996 - 2000

Project Data
- Area zoned for immediate use: 25.6 ha
- Land identified for future expansion: 18.8 ha
- Utility and maintenance facility with diesel and water supply for quay-side delivery, fuel pump station, maintenance and control and security buildings of some 8,400 m²
- Support facilities (7,666 m²): restaurant (100 seats), clinic (200 patients), offices and site security building

Background
Due to the growing importance of the Luanda Port as an on-shore support facility for the oil sector, rationalization and expansion of the present facility was necessary. The principal problems were the lack of sound land parcellation to suit individual users and a shortage of essential infrastructure such as roads, quay space, a fire-fighting system and support facilities.

Master Plan and Design
The master plan maximizes use of the site area through a rational system of land allocation to meet diverse user requirements and future demands for expansion. To achieve this, the area is divided into zones that are functionally related, directly accessible and have access to the quay where necessary. The phasing strategy accommodated immediate development on available land and provided for future allocations on adjacent areas.

Infrastructure
Utilities are provided according to the demands of the estimated growth. The infrastructure network will include a quay extension, roads, water supply, sewage collection and treatment, stormwater drainage, solid waste disposal, electricity and telecommunications.
Marsa Alam Tourist Development

Red Sea, Egypt

Client
Alexandria Company for Investment & Real Estate

Services Provided
- Master plan
- Parcellation
- Comprehensive design
- Infrastructure networks
- Tender documents
- Environmental impact assessment
- Land-Use plans

Dates
1997 - 1999

Project Data
- Location: Red Sea Coast, 245 km south of Hurghada
- Total site area: 250 ha:
  - 36 ha of lagoons
  - Marinas
  - 35 ha of landscaped areas
  - 16.6 ha of built-up area
- 5-star hotel: 150 rooms, 80 villas
- Four 100-room 4-star hotels
- 600 chalets
- Amphitheatre
- Commercial Centre
- Health Spa
- Recreational Islands
- Off-site area for staff housing and support facilities
- Estimated population: 5,000

Main Features
Located on an isolated and undisturbed stretch of the Red Sea Coast, the Marsa Alam site offers a unique opportunity for innovative development that capitalizes on the natural beauty of the area without compromising environmental integrity. This has been facilitated through the improvement of the existing highway as well as the establishment of a new airport.

Based on the rugged multilevel topography, Dar developed an innovative land-use plan with parcels centred around an aquatic area.

The low-lying areas are an ideal location for the man-made lagoons which include a number of small marinas and beaches extending the usable waterfront area and increasing the total area for development.

Complexes of villas and chalets are constructed around the lagoon while the hotels are located on the beach. The development will include one 5-star hotel and four 4-star hotels.

The road network provides vehicular access to and among the land parcels allowing for easy accessibility to individual buildings. Pedestrian movement is encouraged through a comprehensive network of landscaped footpaths and nine pedestrian bridges connecting the various areas and linking them with the principal open spaces.

Retail facilities are located in a small plaza at the town centre near the marina and the diving centre at a strategic point with convenient access from the road and pedestrian networks.

Infrastructure facilities comprising desalination, sewage treatment and power generation plants, and irrigation and potable water tanks, are accommodated in a secluded area located on the western side of the highway.

Stormwater and flood diversion has been ensured through a complete system of retaining ponds and discharge culverts.
**The Pearl**

**Qatar**

**Client**
United Development Company (UDC), Doha, Qatar

**Services Provided**
- Project management
- Construction management
- Supervision of construction

**Dates**
2004 - 2010

**Project Data**
- 400-ha mixed-use development built on a man-made island
- Location: offshore to the east of the West Bay Lagoon, about 20 km north of Central Doha
- Components: residential towers, villas and townhouses, three luxury hotels and community infrastructural facilities, roads, bridges, landscaping, and extensive marine works
- A causeway connection to the mainland
- Construction cost (2004): US$ 4,800 million

**Main Features**
Pearl of the Gulf, this man-made island is the largest real estate project in the State of Qatar and covers 400 ha of a reclaimed land offshore the coast.

The island is constructed by dredging and filling the offshore site to an elevation of approximately 3 m above mean sea level. The island’s shoreline is stabilized by seawalls, rip-rap revetments, and sandy beaches using marine sand.

The project is a four-phased mixed-use development comprising 10 precincts housing 20- to 40-storey residential towers, villas, townhouses, retail and restaurant spaces, and community facilities such as schools, mosques, retail shopping areas, community/entertainment centres.

The island is designed in a meandering beach front to maximize direct access to the sea, surrounded by several public parks, open spaces and recreational fields. Venetian-like canals add to the marine character of this resort.

Dar Al-Handasah scope of services covers:
- Overall project management
- Pre-Contract Inception Stage
- Design Stage:
  - selection of design consultants
  - design management and review
  - management of design contracts
- Tendering for Construction and Contract Award
- Construction Stage:
  - management of construction contracts
  - site supervision
Client
Ministry of Agriculture and Municipal Affairs

Services Provided
- Master plan
- Project management
- Design and supervision
- EIA and land-use

Project Data
- Site area: 340 ha
- 475 large villa plots, 100 condominiums, 200-bed hotel, marina for 200 boats, mosque, commercial centre, leisure centre
- 8,000 m² of public buildings
- Geotechnical/marine works:
  - investigation of wave and tidal conditions, flushing characteristics of the lagoon, and shoreline protection, pavements, foundations, breakwaters, groynes, retaining walls
- 14-km ring, main and secondary roads
- Total power demand 38 MVA

Dates
- Planning: November 1993 - March 1994
- Project management, design and supervision: 1994 - 1999

Main Features
West Bay Lagoon is an artificially created inland lagoon with reclaimed islands. Master planned, designed and supervised by Dar’s experts, the Lagoon extends into the sea to maximize the number of waterfront residential plots.

Our team carried out balanced dredging and reclamation work during the design stages to minimize cost and to ensure proper engineering, environment quality and aesthetic characteristics for the Lagoon.

The commercial and leisure uses have been allocated to the island facing the Gulf and include: hotel, residential housing, marina, shopping centre, leisure centre, a host of activity sites, and ample mooring and parking spaces for boats and cars.

The residential development is located within a well-controlled and managed estate of 340 ha, set around the lagoon with carefully-engineered and environmentally-enhanced bays and islands, which ensure residents’ privacy. Planning and building regulations have been established to control residential development, with options for future residents to custom-design or choose among the available villa types Dar’s architects designed.

Villa plots were master planned in varying size and locations: 115 plots along the shoreline, 240 plots in crescent gardens and 120 on islands. The area of villa plots range from 1,500 m² to 3,000 m² allowing for large 2-storey villas with built-up areas up to 900 m². All sites enjoy sea views and access to private jetties.
Nahr El-Kalb Motorway Realignment

Lebanon

Client
Council for Development and Reconstruction (CDR)

Services provided
- Engineering assessment
- Feasibility study
- Traffic study
- EIA
- Design and tender documents
- Supervision of construction

Dates
- Design: 1993 - 1994
- Supervision: 1994 - 2001

Project Data
- 8-km dual 4-lane freeway
- Realignment and upgrading
- Reclamation and sea protection works
- 3 grade-separated interchanges
- 2 railway bridges (one of 372 m)
- Service roads
- Street lighting
- Cost (1997): US$ 24 million

Background
Lebanon’s Northern Coastal Motorway carries a high volume of traffic. One of the critical bottlenecks is the twin-tunnel segment north of El-Kalb River. To relieve this congestion and accommodate future demand, the Council for Development and Reconstruction retained Dar Al-Handasah to design the widening and realignment of the motorway along the Nahr El-Kalb section.
Nahr El-Kalb Motorway Realignment

Lebanon

Scope of Work

- Traffic surveys and counts
- Topographic and bathymetric surveys
- Geotechnical and hydrological investigations
- Land reclamation
- Conceptual, preliminary and final design
- Environmental impact assessment
- Drainage, street lighting and realignment of utilities
- Widening of the motorway from 2 x 2 lanes to 2 x 3 and 2 x 4 lanes
- 2 overpasses, 2 underpasses, 1 highway river bridge, 2 railway river bridges and 1 pedestrian overpass
- Railway platform, 10 to 12 m wide, to accommodate dual-track high-frequency service at 80 km/h
- 6 frontage roads
- Improvement of an existing trumpet interchange
- Rehabilitation of existing tunnels and river bridge
- Reclamation and slope protection works for 1.4 km
- Street lighting and stormwater drainage networks
Coastal Boulevard in Saida

Client
Conseil Exécutif des Grands Projets (CEGP)

Services Provided
- Feasibility study
- Traffic surveys and forecasts
- Environmental impact assessment
- Land-use survey
- Corridor selection and route study
- Design and tender documents
- Supervision of construction

Dates
- Feasibility and Design Study: 1994 - 1996
- Supervision: 1997 - 2000

Project Data
- 7-km dual four-lane carriageway
- 2 grade-separated interchanges
- 12 bridges
- Connection of coastal boulevard to all the north/south arterials in Saida
- Main trunk sewer, stormwater drainage and flood protection
- Street lighting and signalized intersections and pedestrian crossings
- Hard and soft landscaping
- Shore protection/erosion control
- Cost (1996): US$ 65 million

Background
Following the inland expansion of Saida, the southern coastal motorway corridor reserved in 1965 was found to split the city in two parts funnelling traffic into the urban and city centre areas. To relieve congestion, a new corridor, bypassing the city, had to be developed.

Conceptual Design
- The first stage of the study compared two alternative routes for the coastal boulevard through Saida. The first passes along a reserved motorway corridor in the middle of Saida, while the second distributes traffic to the four main arterials crossing the city.
- Traffic surveys were undertaken inside the city and on the approaches. The results of the traffic surveys were analysed and used in traffic forecasts.
- Environmental assessment considered the environmental impact of each alternative alignment.
- Urban treatment of the sea front was undertaken with special emphasis on the area near the old city.
Coastal Boulevard in Saida

Lebanon

Preliminary Design, Final Design and Tender Documents

Design and tender documents cover:

- 7-km coastal boulevard in Saida with parking bays and wide sidewalks
- Two interchanges: Rmeileh in the north and Sianiq in the south
- Connections of the Coastal Boulevard to the north/south arterials
- 12 bridges: 4 river crossings, 5 viaducts and vehicular overpasses
- River crossings comprise precast prestressed concrete beams with cast-in-situ topping slab (max. span 30 m)
- Viaducts comprise continuous prestressed concrete box-girders (max. span 40 m)
- Railway and vehicular underpasses
- Main trunk sewer, for connection to proposed treatment plant
- Road signing, marking and traffic signals at intersections and pedestrian crossings
- Street lighting
- Soft and hard landscaping for the corniche including decorative lighting
- Slope protection
- Sea walls with stone facings, beach nourishment, offshore breakwaters and groynes
**Client**
Council for Development and Reconstruction (CDR)

**Services Provided**
- Surveys
- Identification and delineation of deposits of suitable materials
- Recommendations for landing sites and design of sand treatment plants
- Environmental Impact Assessment
- Concept design for coastal protection and beach nourishment
- Review and amendments to existing legislation
- Preparation of tender documents for potential concessionaires
- GIS/RS

**Dates**
1998 - ongoing

**Project Data**
- Lebanese coast length: 210 km
- Width of survey area: 2 to 10 km
- Total length of survey lines 6,500 km

**Background**
Dar undertook a study, to locate and delineate areas of sand accumulation on the Lebanese coastal waters for a proper exploitation in the construction industry.

**Survey Works**
- Bathymetric survey: on a coarse grid of 500 m x 500 m along the continental shelf over a width of up to 10 km
- Geophysical survey: boomer subbottom profiling to determine the geological features below the seabed depicting thickness of sediments, sand accumulation, depth to bedrock and geological structural features
- Hydrographic survey: deployment of wave and tide gauges, current meters distributed along and across the survey area
Lebanon

**Geotechnical Studies**
- Boreholes drilling, grab sampling and vibro-coring
- Characterisation of the material based upon laboratory testing
- Material conformity to international standards for various industrial uses
- Marine studies
- Appraisal of the shoreline evolution using satellite imagery
- Delineation of areas subject to erosion and accretion
- Establishment of recommendation measures for coastal protection and beach nourishment
- Review of extraction and dredging techniques
- Recommendations for the economic exploitation of sand deposits

**Market Study**
- Existing and forecast markets for sand
- Assessment of market volumes corresponding to the scale of construction activity including potential supply, and demand and prospects for the use of marine sands

**Environmental Impact Assessment**
- Based on the WB OD4.01, the EIA covers physical disturbance of the seabed, removal and dispersal of sediments, impacts associated with stockpiling large quantities of materials, water use and the disposal of waste materials
- Assessment of both negative and positive economic impacts for the development options with due consideration to future requirements for sand and available sources
- Comparisons of the economic costs of extraction from land-based (terrigenous), beach and offshore supplies
- Consideration of possible replacement costs of the environments and supporting ecosystems necessary under each scenario
- Recommendation of feasible and cost-effective mitigation measures, and cost effective Environmental Monitoring Programme, including training, identification of policy changes, and institutional strengthening or staffing changes.

**Control, Monitoring and Reinforcement**
- Comprehensive review of existing laws, leading to proposed amendments and drafts for new laws.
- Proposals for control measures and procedures for reinforcement, including procedures to minimize environmental impacts.