منتدى دبي العالمي لإدارة المشاريع
DUBAI INTERNATIONAL PROJECT MANAGEMENT FORUM

RTA

The Dubai Water Canal

Case study and lessons learnt

dipmf.ae

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Case study

1.1
About Dubai

Dubai is located on the eastern coast of the Arabian Peninsula, in the south west corner of the Arabian Gulf. It is well known for its warm hospitality and rich cultural heritage, and the Emirati people are welcoming and generous in their approach to visitors. With year round sunshine, intriguing deserts, beautiful beaches, luxurious hotels and shopping malls, fascinating heritage attractions and a thriving business community, Dubai receives millions of leisure and business visitors every year from around the world.

1.2 Dubai's history

Around 800 members of the Bani Yas tribe, led by the Al Maktoum family, settled at the mouth of the creek in 1833. The creek was a natural harbour and Dubai soon became a centre for fishing and pearl trading.

By the turn of the 20th century Dubai was a successful port.
The souk (Arabic for market) on the Deira side of the creek was the largest on the coast with 350 shops and a steady throng of visitors and businessmen.
When oil was discovered in 1966, the late Sheikh Rashid bin Saeed Al Maktoum utilised the oil revenues to spur infrastructure development in Dubai.

1.3 Dubai city and its attractions

Dubai is now a city that boasts unmatchable hotels, remarkable architecture and world-class entertainment and sporting events.

The beautiful Burj Al Arab hotel presiding over the coastline of Jumeirah Beach is the world's only hotel which offers seven star services. The Burj Khalifa is the world's tallest structure and reminds us of the commercial confidence in a city that expands at a remarkable rate. From the timeless tranquility of the desert to the lively bustle of the souk, Dubai offers a kaleidoscope of attractions for visitors. The Emirate embraces a wide variety of scenery in a very small area. In a single day, the tourist can experience everything from rugged mountains and awe-inspiring sand dunes to sandy beaches and lush green parks, from dusty villages to luxurious residential districts and from ancient houses with wind towers to ultra-modern shopping malls.

The Emirate is both a dynamic international business centre and a laid-back tourist escape; a city where the sophistication of the 21st century walks hand in hand with the simplicity of a bygone era. But these contrasts give Dubai its unique flavour and personality; a cosmopolitan society with an international lifestyle.

1.4 About RTA

The Roads and Transport Authority (RTA) emerged in November 2005 as a public entity with an independent corporate body and a full legal capacity to perform all business and actions needed to achieve its objectives. RTA is a government-owned entity and based in Dubai.

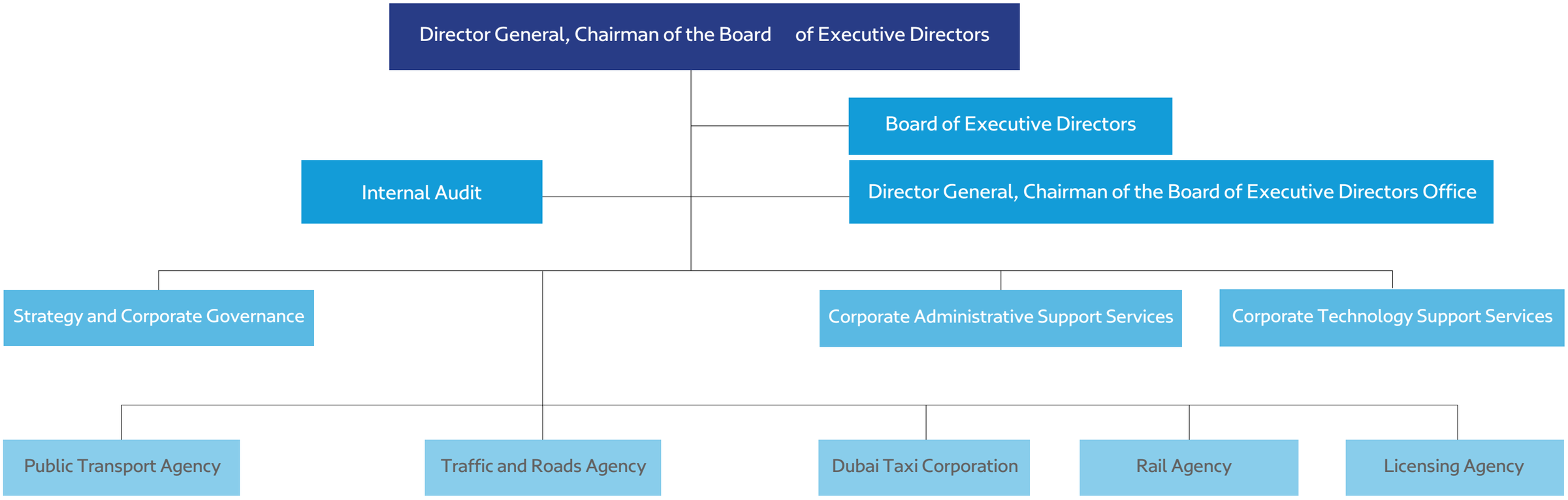
RTA plans and constructs transportation and road projects within Dubai, or between Dubai and neighboring emirates. It enacts rules and regulations and draws up comprehensive strategic plans for road systems, and land and marine transit networks to keep pace with Dubai's economic development plans according to highest international standards. Its roles include developing and implementing policies necessary for achieving optimal utilisation of existing transport and traffic elements. It attends to studying and endorsing the privatisation of related businesses, and establishing, managing and commissioning an integrated transport system that provides services customised to community needs. It sets up regulations, and administrative and operational systems relating to its core business.

It compiles and implements findings of studies conducted for fixing and implementing fees to traffic and roads including proposing fares for using roads network, licensing drivers and vehicles, and setting fare structure for mass transit routes. It attends to upgrading legislations and procedures of drivers and vehicles registration and licensing to realise the strategic objectives of transport system in Dubai, conducts licensing of mass transit routes and all RTA business-related activities.

Its Board of Directors oversees administrative, technical and financial affairs, develops the overall policy and project programs, prepares budget proposals for onward submission to Dubai's Executive Council for endorsement, sets up Organisation Charts, endorses fare structure for transportation, and appoints auditors.

RTA comprises five agencies: the Traffic and Roads, Public Transport, Licensing, Rail and Dubai Taxi Corporation and three support sectors: Strategy and Corporate Governance, Administrative Corporate Support Services and Technology Corporate Support Services.

1.5 RTA's organisational structure



1.6 RTA's strategic intent

Vision: Safe and Smooth Transport for All

Mission: Develop and manage integrated and sustainable roads and transportation systems at a world-class level, and provide pioneered services to all stakeholders for their happiness, and support Dubai's vision through shaping the future, preparing policies and legislations, adopting technologies and innovations, and implementing world-class practices and standards.

1.7 Objectives

1. Smart Dubai
- Foster connectivity, integration, collaboration and information management
- Enhance and sustain smart government solutions and services
- Develop smart solutions for transportation, roads and traffic

2. Integrated Dubai
- Enhance integration between transportation planning and urban planning
- Make roads and transport systems friendly for all
- Preserve national identity

3. People Happiness
- Pioneering people happiness
- Ensure harmony with customers
- Foster happiness and positive energy at work

4. Smooth Transport for All
- Encourage public transport
- Develop and enhance sustainable network and systems for roads and transportation
- Manage travel demand and congestion
- Improve effective policies and legislations for transport, roads and traffic

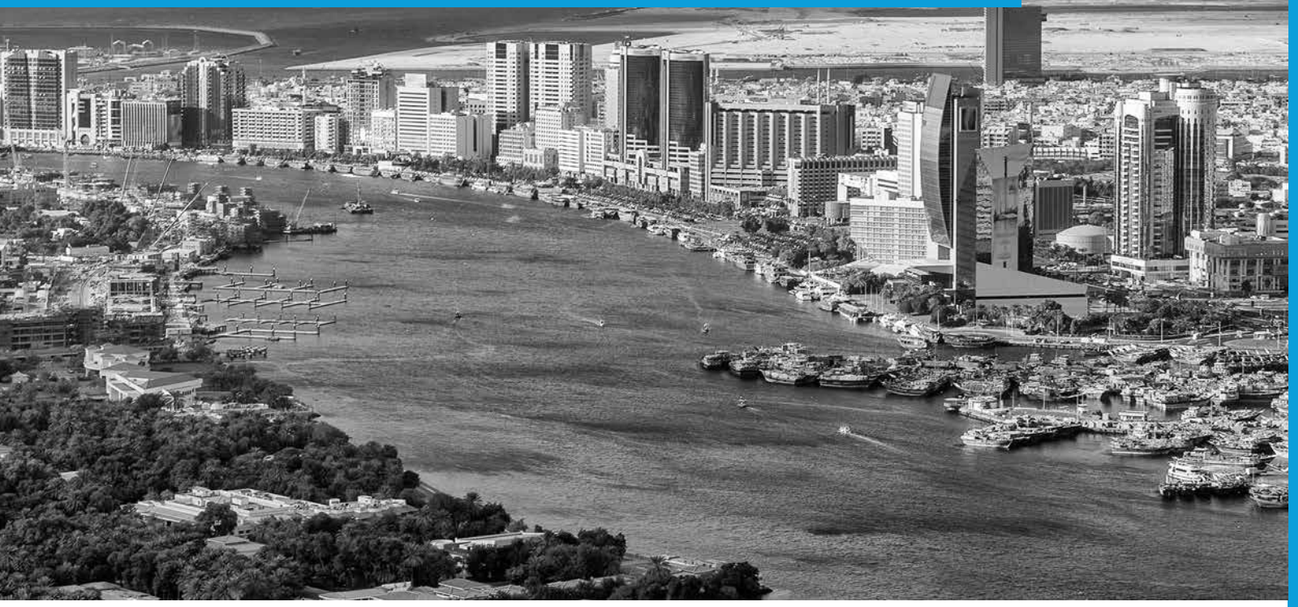
5. Safety and Environmental Sustainability
- Enhance transport and traffic safety to reduce accidents and fatalities
- Foster environment sustainability for transportation
- Ensure health and safety sustainability
- Foster security sustainability

6. Financial Sustainability
- Maximise and diversify revenues
- Foster partnership with private sector
- Enhance financial efficiency

7. Advance RTA
- Attract, develop and retain talents
- Foster excellence and knowledge management
- Enhance quality, process and corporate governance
- Ensure pioneering in creativity and innovation
- Improve relationships with partners and vendors

8. Assets Sustainability
- Enhance efficient and effective assets management
- Ensure optimal performing assets
- Maximise value of assets

1.8 Project background



Project introduction

Dubai grew around the natural creek from the Arabian Gulf where pearl trading and fishing were based. It became a landing point for dhows travelling from the subcontinent and Africa and was developed from the early 60s to accommodate vessels up to 500 tonnes.

Modern Dubai flourished from around the creek. More recently the vision to connect the inland end of the creek back to the sea, thus creating a u-shaped waterway was spawned. With the work to construct the waterway through Business Bay between 2006 and 2010 and in November 2016 the opening of the final 3 kilometres section to the Arabian Gulf, the waterway is now complete. His Highness Sheikh Mohammed bin Rashid Al Maktoum, Vice President and Prime Minister of UAE and the Ruler of Dubai officially opened the Dubai Canal on 09 November 2016. The AED 2.7 billion Dubai Water Canal, a 3.2 km-long tourist landmark development across the Business Bay to Safa Park, Al Wasl Road, Jumeirah 2, Jumeirah Road and opens out into the Arabian Gulf.

"The Dubai Water Canal is one of the ideas of His Highness Sheikh Mohammed Bin Rashid Al Maktoum to add a unique tourist and commercial showpiece offering a new style of living in Dubai city. His Highness is always keen to roll out creative and cracking visionary ideas that define new concepts for peoples' happiness and welfare."

The overall Dubai Water Canal Project includes the following 5 packages:

Package R999/1 – Elevating Sheikh Zayed Road involving the construction of the bridge crossing the proposed canal along Sheikh Zayed Road, modifications to IC-2, and the diversion of all required services under the canal

Package R999/2 – Elevating Al Wasl Street and Jumeirah Street includes the construction of the bridges along Al Wasl Street and Jumeirah Street, and the interconnections along Al Hadiqa Street and Al Athar Street, and all the associated diversion of services under the canal along these main roads

Package R999/3 – Canal and Coastal Works involves the construction of 3.2 km of the canal itself including the quay walls. Construction of coastal peninsular including rock revetments and coastal protection, and the construction of beaches and marina. This package also involves the works required for the roads and services diversions in the areas between Sheikh Zayed Road, Al Wasl Street and Jumeirah Street

Package R999/4A - Dubai Water Canal - Infrastructure Package involves the construction of all the infrastructure required specifically for the plots to be developed as part of the development, including all roads and utilities

Package R999/5 - Dubai Water Canal - Package 5 consists of the completion of all outstanding works within the Business Bay Canal, as required, to provide full navigation of the completed canal, including the following:

a) Complete remaining sections of the quay wall, constructed of precast mass concrete gravity type quay walls
b) Dredging of Business Bay lagoons to meet level - 4.00 DMD
c) Complete utilities diversions/relocations that conflict with the Canal route
d) Reduce/remove the salinity of the hyper-saline water in the Business Bay Lagoons to acceptable levels
e) Removal of redundant utility services from temporary bunds and surrounding areas
f) Removal of temporary bunds crossing the Canal
g) Flooding of the Canal between Dubai Creek and the Dubai Water Canal

In 2006, RTA drove forward the plan that has become the final part of this ambitious undertaking, to complete the 3-kilometre canal link from just east of Sheikh Zayed Road at Business Bay to the Arabian Gulf.
This required dredging the canal under three major road arteries, Sheikh Zayed Road, Al Wasl Street and Jumeirah Street and acquiring approximately 1.5 million square metres of high quality real estate GFA.

The plan included creating even higher quality canal-side real estate and in this regard the real estate developers Meraas and Meydan became partners in the project.

To further enhance the iconic nature of the project, three different structural bridge types were used for pedestrian bridge crossings of the canal and a spectacular waterfall was added to the Sheikh Zayed Road bridge.

1.9 Facts and figures

3.2 km
Length

80m - 120m
Width

7 knots
Max canal speed

4m - 6m
Canal depth

7.4m
Height of Dubai Water Canal from the Canal bed to the top of quay wall

3 million m³ Excavation volume

1,500,000 m³ Quantity of rocks that were paved in the marine area

7,800,000 m³ Water used for canal flooding

5,000,000 m³ Hyper saline water treatment

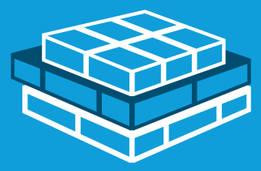
25,000 tonnes The amount of reinforcement used

150,000 tonnes The amount of cement used

20 million man-hours Number of working hours

4,650 Total number of workers in the project - Peak manpower

408,000 m² Reclaimed land area



12,500 concrete blocks

4 main contractors
70 sub-contractors

Project cost AED 2.7 billion

Cycle Track **12 km**

Jogging **3 km**

Boardwalk Smart LED lighting system **6 km**

Number of marine stations **9**

Number of marine riders/year by 2020 **1 million**

Bridge types and lengths

3.8 km Concrete road bridges

122 m Steel suspension pedestrian bridge

205 m Steel arch pedestrian bridge

122 m Steel vierendeel twisted truss pedestrian bridge

1.10 Benefits

- Constructing the canal has created opportunity to develop highly desirable waterfront living. Consequently land value in the immediate and surrounding area will be high

- The canal opens up water transport opportunities. Along the 12-kilometre length of the canal, nine water taxi stations have been opened, five of which are also used by the larger Dubai Ferry. Dubai residents and tourists can also testify to the increase in leisure opportunities. The boardwalk, a 6-kilometre long, high quality promenade along both canal banks, connects to the already constructed promenades in the developing Business Bay area and is already very popular even before the land on either side of the canal is developed. People are using the area as a running/walking track for exercise. Others use it as a viewing point to take in the canal itself as well as the unique Dubai skyline beyond

- Completing the link also means that a much-improved flow of water, particularly in the Business Bay area, is achieved which has significantly improved the quality of the water there

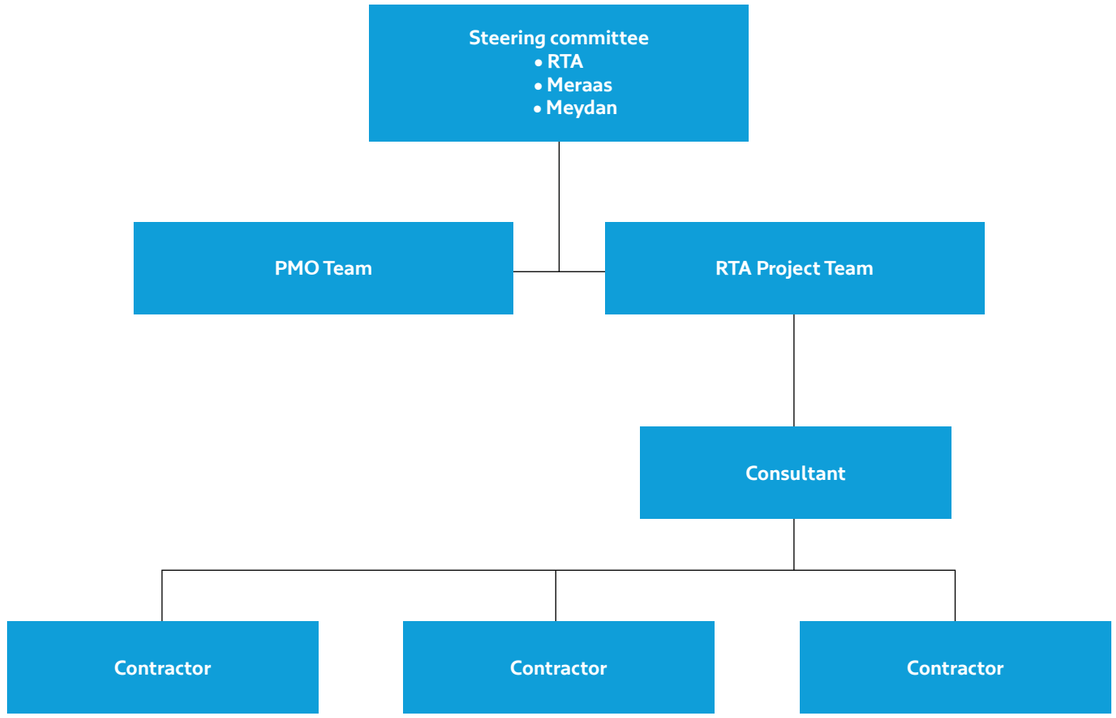
1.11 Leadership

His Highness Sheikh Mohammed bin Rashid Al Maktoum sponsored the implementation of the canal.

Due to the importance and sensitivity of the project combined with the inherent risks associated with a project of this nature RTA set up steering committees and teams led by higher management. These committees met regularly and the message that was thus permeated throughout the project was one of drive and commitment to success.

Success was defined as completing the project with the minimum of disruption to the public, on time, within budget and as safely as possible for all. By all of these measures the construction of the Dubai Water Canal was a great success.

1.12 Project team structure



1.13 Overall project implementation methodology

Project initiation

- Project brief
- Defining project scope
- Collecting available information
- Site visit
- Project initiation estimate
- Feasibility study, etc.

Preliminary and detailed design phase

- Technical studies/survey
- Geotechnical/Architecture/Landscape
- Design brief
- Cost estimates
- Preliminary design, detailed design
- Authorities submission etc.

Construction procurement phase

- Tender documentation
- Tender exercise
- Tender evaluation
- Tender award
- Contract agreement

Construction phase

- Construction drawings
- Physical construction and installations
- Contract management
- Authorities inspection
- Testing and commissioning
- Certificate of completion of the works

Handing over post-construction phase

- As-built drawings
- Operation and maintenance manuals
- Warranty certificates
- Defect liability period
- Snags completion/rectification works

1.14 Engineering and architectural diversity

Over just a 3-kilometre length of canal, the water is crossed by six bridges utilising four structural forms. The three road bridges are each of post-tensioned reinforced concrete construction and perform the vital function of keeping Dubai's road traffic moving. Three iconic pedestrian bridges cross the canal.

These bridges are what give the canal its unique look. Each bridge has a different structural form. There's a grand arch that's all curves, a low slung suspension bridge and a twisted truss. Although each of the bridges looks so very different, share steel as their main construction materials.

1.15 Excavation and reclamation

To create the canal's waterway required excavation of three million cubic metres of sand. To minimise construction cost and add greater value to constructing the project this material was used to create the Peninsula, some 408,000 square metres of reclaimed seafront, developable land at the point the canal meets the sea.

1.16 Sheikh Zayed Road bridges

Part way through construction of the first of the two decks of the bridge that takes Sheikh Zayed Road over the canal it became apparent that, because of unforeseeable issues with it, if the second bridge were constructed in the same way then it could not be finished in time for the planned opening.

Rather than delay the opening, the engineers working on the project considered options to build the second structure much faster.

By increasing the number of construction joints and redesigning the post tensioning system, it was possible to complete the second structure in just over five months, over four months faster than the first one and not delaying the opening.

1.17 Traffic

The scope of work included carrying out the Traffic Impact Study (TIS) for the Dubai Water Canal development. The objective of the study was to provide an assessment of the traffic's impact on the proposed development on the adjacent road network for the horizon years 2014 and 2020.

A survey was carried out on the traffic count survey on selected junctions and links within the study area. The total estimated trip generation based on land use details for the proposed development and the corresponding trip rates, as per Dubai Trip Generation and Parking rates Manual was also calculated.

Two scenarios were considered in the analysis. They were "Without Project" and "With Project" scenarios, and the analyses were carried out for two target years, 2014 and 2020. A detailed modelling process was carried out to update the RTA model within the study area and to obtain assignment plots in the future. Parking demand within the proposed development was calculated based on land use details and according to parking rates as per Dubai Trip Generation and Parking Rates Manual.

The proposed development with the planned access scheme was not expected to significantly impact any of the junctions within the study area.

Sheikh Zayed Road is Dubai's main artery and disrupting traffic on this route was not a possibility. So, engineers devised an efficient traffic management plan to keep traffic moving during the construction phase.

The ingenious part of the plan was to do it once without any future amends, in such a way that it was good for the entire duration of the construction phase.

As a testament to the design of the traffic management scheme, there were no major incidents and traffic flow was maintained at pre-construction levels throughout the construction of the canal project.

Modelling of the Water Canal

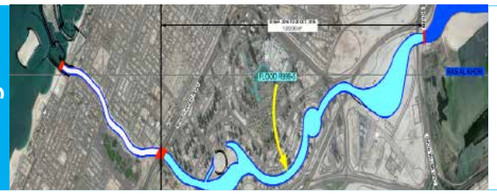
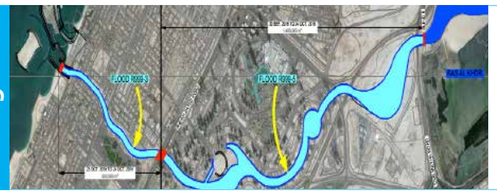
1.18 Environmental protection

To the east of Sheikh Zayed Road, where the canal meets Business Bay, because the canal had not been extended to the sea and thus water was not being flushed through, hypersaline conditions existed at the end of the Business Bay portion of the canal.

To avoid the potential adverse environmental effects, the removal required complex modelling. The removal operation resulted in discharging some six million cubic metres of diluted water and disposal of 400,000 cubic metres of salt.

1.19 Filling the canal

To complete the project, the canal was flooded in a complex six-stage operation to allow 7.8 million cubic metres of water into the canal. In total the operation was executed over a five-week period up to 8 November 2016.

Dubai Water Canal flooding sequence	Description	Flood rate	Water level
Stage 1 	Slow seawater fill of R999/5 Canal section 30 Sep 2016 to 20 Oct 2016	Cofferdam = ø	R999/3 = 0
		Bund 8 = 1,100 m^3/hr	R999/5 = 700 mm [0.7m]
Stage 2 	Flooding of R999/3 Canal Section to achieve water equilibrium with R999/5 23 Oct 2016 to 24 Oct 2016 Flood Vol. (R999/3): 300,000 m^3 Flood Vol. (R999/5): ~1,400,000 m^3	Cofferdam = 2,500 m^3/hr [Ave.]	R999/3 = 1,000 mm [1.0m]
		Bund 8 = 3,500 m^3/hr [Ave.]	R999/5 = 1,000 mm [1.0m]
Stage 3 	Removal of Bund 1 between R999/3 and R999/5 24 Oct 2016 to 25 Oct 2016 Volume: 2,500,000 m^3 [combined]	Cofferdam = 2,875 m^3/hr [Ave.]	R999/3 = 1,000 mm [1.0m]
		Bund 8 = 3,500 m^3/hr [Ave.]	R999/5 = 1,000 mm [1.0m]
Stage 4 	Opening of eight (8) Siphons at the Coastal Cofferdam and five (5) Siphons at the Creek end. A combined 1,000,000 m^3 per day of flooding. Flooding of Canal to achieve water equilibrium with sea 25 Oct 2016 to 31 Oct 2016 Volume: ~8,500,000 m^3 [approx.]	Cofferdam = 2,875 m^3/hr [Ave.]	R999/3 = +700 mm [0.7m] per day rise
		Bund 8 = 3,500 m^3/hr [Ave.]	R999/5 = +700 mm [0.7m] per day rise
Stage 5 	Removal of Cofferdam at the Coastal (Jumeirah) end and opening Canal to the sea 29 Oct 2016 to 05 Nov 2016 Volume: 9,000,000 m^3 [full]	Cofferdam = 0	R999/3 = 4,500 mm [4.5m]
		Bund 8 = 0	R999/5 = 4,500 mm [4.5m]

1.20 Project milestones

R999 Dubai Water Canal infrastructure packages

Serial no.	Contractual milestones	Date
	R999/1 - Infrastructure package 1	
01	Project commencement date	28/Sep/13
02	Project completion date	27/Sep/16
	R999/2 - Infrastructure package 2	
01	Project commencement date	4/May/14
02	Provide the design of additional bridge/ramp and other design modifications	3/Jul/14
03	Provide the details of expropriation and demolition of buildings to the contractor	3/Jul/14
04	Commence works on Jumeirah Road	4/Aug/14
05	Completion of bridge works	18/July/16
06	Project completion date	19/Oct/16
	R999/3 - Infrastructure package 3 - Canal	
01	Project commencement date	1/Jun/14
02	Completion of new jogging track and boundary wall at Al Safa Park	31/Aug/14
03	Demonstration of dwellings between Al Wasl and Jumeirah	31/Aug/15
04	Project completion date	31/Oct/16
	R999/4A - Dubai Water Canal Infrastructure	
01	Project commencement date	17/Jan/16
02	Safa B area boardwalk utilities and irrigation, Etisalat, EITUC-Du/ITS	30/Apr/16
03	Safa A area drainage line and electrical cable relocation/laying work	15/May/16
04	Relocation of substation at tower zone north	15/May/16
05	Safa A area boardwalk utilities and irrigation, Etisalat, EITUC-Du/ITS	30/May/16
06	Safa A area drainage line and electrical cable relocation/laying works	30/Jun/16
07	Jumeirah B area-55 Street, 49 Street, roads behind Jumeirah area A and area 2	15/Sep/16
08	Project completion date	15/Dec/16
	R999/5 - Infrastructure package 5 - Business	
01	Project commencement date	1/Jun/16
02	Relocate stockpile of pre-cast blocks	21/Feb/16
03	Pump water from lagoons to the sea within 180	21/Jul/16
04	Removal of final bund 8 within 225 days	4/Sep/16
05	Project completion date	31/Oct/16

1.21 Challenges

1 **Timely completion of south bound Sheikh Zayed Road Bridge, which was running behind schedule. To achieve this, the following innovative measures were implemented**

a) Simultaneous construction of foundation and superstructure

b) Re-arranging stressing sequence to suit the above method of construction

2 **Expediting the construction of the canal while the bridge was under construction**

a) Construction of the bridge foundation along with canal quay wall was carried to expedite the canal works after bridge construction

3 **Timely completion of huge micro tunneling works on Sheikh Zayed Road seaside and subsequent diversion of existing utilities in order to facilitate construction and timely opening of Sheikh Zayed Road detour, and subsequent commencement of bridge works**

a) To expedite works and save time, dry utilities (DEWA-ED, ETISALAT and DU/ITS) services were done via HDD works

4 **Implementing the Sheikh Zayed Road detour with minimum or no disruption to existing traffic**

a) Designed and arranged the detour geometry, capacity and speed limit for Sheikh Zayed Road, (one of the busiest) which served two stages on bridge construction (North and south bound).

b) It is noted that, the Sheikh Zayed Road detour functioned as good as original road without any traffic congestion issues

5 **The completion of micro tunneling works on Al Wasl landside and Jumeirah seaside for implementing traffic diversion and releasing area for construction of new bridges**

a) The traffic detour at Al Wasl was implemented in stages, and AWRD-1 Bridge (over Al Wasl Road) constructed in stages - landside and seaside, thus saving time and reducing impact of service diversions. The stage-1 of detour implemented in the restricted area with minimum or no impact on to existing traffic flow, while seaside bridge works commenced parallel with micro tunneling works on landside

b) The detour alignment at Jumeirah was designed/ arranged and changed from the earlier proposal taking it further into Jumeirah Park area (in coordination with R999/3 contractor) thus avoiding initially foreseen impact of service diversions on detour and bridge works

6 **Managing access for transportation of excavated materials along the canal alignment to the reclamation area in the sea, passing through the bridge construction areas with minimum disruption**

a) Excavation and hauling activities, and equipment and trucks, were planned and managed in such a way so as to have maximum hauling production during the night in order to reduce impact on traffic

b) Traffic lights designed and implemented at Al Wasl and Jumeirah detours in such a way so as to have no impact on existing traffic flow on detours and trucks crossing the same

7 **Managing the Traffic Detour stages, ensuring timely completion of bridges and removal of detours, thus allowing full access to Canal works under the bridges and the detour areas in all the 3 corridors**

a) Prioritising and scheduling construction and opening of Bridges at Canal area at Al Wasl and Jumeirah Streets, to allow early access to canal works

- Phased the construction and implemented detour in stages in order to prioritise the bridges construction in Canal area and release the same at the earliest to R999/3 contractor

b) Allow partial access at Sheikh Zayed Corridor allowing simultaneous construction of Bridge Piers and quay wall works

- The quay walls for more than 60% of the 120 metre Sheikh Zayed Road corridor were completed during the substructure works for South Bridge, thus saving time.

8 **Ensuring sufficient area for bridge construction, positioning of tower cranes, movement of construction vehicles and logistics**

a) Working adjacent to a live traffic/ Sheikh Zayed Road

- Strict compliance with local regulation in respect of traffic, safety, security and environment etc were ensured

b) Construction equipment was restricted to only one side (seaside) of the Sheikh Zayed Road Bridge due to metro on landside

- Operators/workers being trained to work carefully

9 **Environmental concerns - Full chemical and hydrodynamic water quality modelling done to establish the effect of the canal on the surrounding environment**

10 **Treatment through dilution and diffusion of 5 million cubic metres of hypersaline water. Telemetric real-time monitoring of disposal of treated water was carried out to ensure no environmental consequences**

11 **Coordination/interface communication with 5 major packages of the Canal project**

a) Developed interface programme to meet work schedule of all the 5 packages

b) It is noted that, there were 4 major contractors and around 70 subcontractors

c) Maintained excellent relationship with all the stakeholders for ease of progress activities and decisions

d) Maintained fair approach resulting in confidence building with the contractors

e) Resolving any disagreement on site on item before it turns in a dispute

f) Master programme incorporating major construction stages for each package, and agreed coordination and construction sequence in interface areas was developed and regularly monitored

g) In case of any lag, the programme was revised to incorporate the latest coordination and agreed revised construction sequence among the contractors

02

Lessons learnt

2.1 **Proposed Horizontal Directional Drilling (HDD) method in lieu of micro tunneling**

a) Discussion of Event/Issue
There was existing sewer line in with the proposed micro tunneling pit location, which was required to be diverted prior to pit construction and driving construction duration.

In addition, executing temporary relocation of the 1,000 mm sewer line was time consuming.

b) Solutions/Actions taken
To avoid interface, changed the method of non-disruptive crossing (NDRC) for relocation of dry services from micro tunneling (MT) to horizontal directional drilling (HDD).

c) Output and Lessons learnt
The new proposal also saved time that would have required in diverting the existing sewer line. Also, HDD works proved less time consuming and savings in cost compared to micro tunneling.

The proposed method might be used for other projects with similar issues, which can eliminate the potential risks to the project success.

2.2 **Appropriate traffic management plan**

a) Discussion of Event/Issue
Implementing the diversion of the 7-lane Sheikh Zayed Road, one of the busiest roads in the Emirate, while ensuring safe and smooth traffic was one of the major challenges in the project.

Timely implementation of diversion stages was driving and crucial for bridge construction.

However, managing the traffic flow to and from the Sheikh Zayed Road to the adjacent properties and internal roads or implementing the tie-ins from the detour to the existing roads during various stages of bridge construction was complex.

Added to the above was the challenge in ensuring sufficient area for Bridge construction – positioning of tower cranes, movement of construction vehicles/ logistics, as the construction equipment was restricted to only one side (seaside) of the Bridge due to Dubai Metro on landside.

b) Solutions/Actions taken
Designing and arranging the detour geometry, capacity and speed limit for Sheikh Zayed Road in one stage which served two stages on bridge construction (North andsouth bound).

Monitor and manage timely completion of utility diversions/protections ensuring successful completion of detour as planned.

c) Output and Lessons learnt
It is noted that, the Sheikh Zayed Road detour functioned as good as original road without any traffic congestion or safety issues. The primary function of temporary diversion road is to provide for the safe and efficient movement of traffic while reasonably considering the construction works. Appropriately designing based on the surrounding requirements with ease the traffic.

2.3 **Expeditious completion of South-Bound Sheikh Zayed Road. Bridge in a record time of 5.5 months**

a) Discussion of Event/Issue
As per project the original plan, the bridges elevating Sheikh Zayed Road were to be constructed in two stages, ensuring no/less impact on existing traffic on Sheikh Zayed Road. First stage included construction of the North Bridge and diversion of traffic into newly completed bridge in 10 months, and second stage included construction of the South Bridge, and diversion of traffic into newly completed bridge in another 10 months.

However, due to the major delays occurred for completion of North Bridge, the challenge was to expedite and reduce the construction duration for completion of South Bridge ensuring timely completion of subsequent canal works under the bridge as well.

b) Solutions/Actions taken

The original construction logic envisioned:

- 11 construction joints
- 14 stages of slab construction
- 6 stages of post tensioning and 5 post tensioning gaps, and required 10 months overall to complete the bridges. To expedite the work and achieve the target completion, the following measures were implemented

- Simultaneous construction of foundation and superstructure by introducing more construction joints to allow early construction of bridge decks
- Redesigning of post tensioning to reduce number of gaps and stages of stressing sequence
- Proposed method for grouting from top slab to expedite start of next stage

The revised construction logic implemented:

- 23 construction joints
- 26 stages of slab construction
- 4 stages of post tensioning and 3 post tensioning gaps
- Required overall 5.75 months to complete the bridges

The advantages by implementing the Revised Sequence were:

- Parallel working on piers and slab sections effectively reducing the overall duration for piers and slab completion to 4.5 months on the longest path
- Sequential stages (Pier P08 ~ Abutment A01) of post tensioning (PT), doing grouting from the top of the slab instead of from PT Gap face, thus allowing early casting of PT Gap, resulted in reduced duration of only 1.75 months (52 days) on longest path
- Consequent early removal of scaffolding allowing commencing bridge finishes after 4.5 months into construction
- In addition, alternate barriers on bridge slab were cast while grouting again reducing duration

c) Output and Lessons learnt

Implementing the revised construction logic with further efforts on site, like allowing grouting from top thus reducing further duration in post tensioning works and casting barriers while grouting, the bridge was completed and opened to traffic in 5.75 months.

Adopting similar approach would reduce the duration of the bridge considerably

2.4 Partial access at Sheikh Zayed Corridor allowing simultaneous construction of Bridge Piers and Quay Wall works.

a) Discussion of Event/Issue

The major challenge was timely planning, coordinating and executing the construction interfaces among the Bridges and the Canal works, while ensuring completion of the Dubai Water Canal within the stipulated duration.

The initial construction sequence for canal quay wall was as below:

- Construct and open north bound bBridge
- Construct and open south bound bridge
- Remove Sheikh Zayed Road detour
- Allow access for quay wall and canal excavation works in the Sheikh Zayed Road corridor

The duration foreseen for quay wall and canal extraction for the 120 m corridor was 6 months, thus extending the overall completion of the Water Canal project

b) Solutions/Actions taken

Immediate action taken was coordination to allow partial/early access to quay wall construction during construction of pier foundations for South Bridge in the corridor to expedite the canal works after bridge construction

c) Output and Lessons learnt

The proposed solution allowed saving of 2 months, and reduced the total duration of canal works, after opening of the South bridge

Extensive and effective coordination and management of interfaces among project packages from early stage

2.5 Reducing number of micro tunneling pits by 2 nos. each Al Wasl and Jumeirah Streets by proposing varied diversion for wet utilities

a) Discussion of Event/Issue

The diversion of existing water and irrigation lines under the canal on either side of Al Wasl and Jumeirah streets were proposed by micro tunneling on the respective side requiring total eight numbers MT pits and criticality on commencing bridge works

b) Solutions/Actions taken

The diversion of waterlines (300 mm dia. and 600 mm dia.) were proposed to be carried out via MT works on one side by providing larger diameter bores to accommodate the lines on both sides on one side. The seaside and landside waterlines at Al Wasl and Jumeirah streets were taken to the other side via road crossings. In addition, irrigation lines were diverted using HDD instead of micro tunneling

c) Output and Lessons Learnt

Due to the proposal:

- The structure works commenced earlier than anticipated avoiding criticality of MT works;
- Ease of logistic/construction vehicles movement for one side of road;
- Reduced cost of micro tunneling pits

Adopting similar approach would reduce the time/cost substantially

2.6 Adopting methodology of stressing from top, allowing change in post tensioning sequence and consequent savings in time

a) Discussion of Event/Issue

There were six bridges in one post tensioning sequence, which formed the longest and the critical path for the curved bridges on Al Wasl and Hadiqa Street

This posed a challenge/time constraint completing PT works, removing scaffolding and completing finishes on the bridges driving the implementation of diverting traffic underneath and over the constructed bridges on Hadiqa Street, to facilitate construction activities foreseen in the next stage for remaining bridges on Al Wasl Street

The hard-logic in the schedule posed a risk, as slippage at any stage would affect the overall opening of Al Wasl Street bridges and subsequent canal excavation works under the bridge in the Al Wasl corridor

b) Solutions/Actions taken

Top stressing proposed for the middle two bridges thus breaking the PT stages and sequence for bridges over Al Wasl and Al Hadiqa streets. This allowed parallel working on Exit bridges over Hadiqa Street and bridges on Al Wasl Street

c) Output and Lessons Learnt

Project gained one month duration in structure works completion and enabling early access to Canal excavation works.

Adopting similar approach would reduce the duration of the bridge considerably