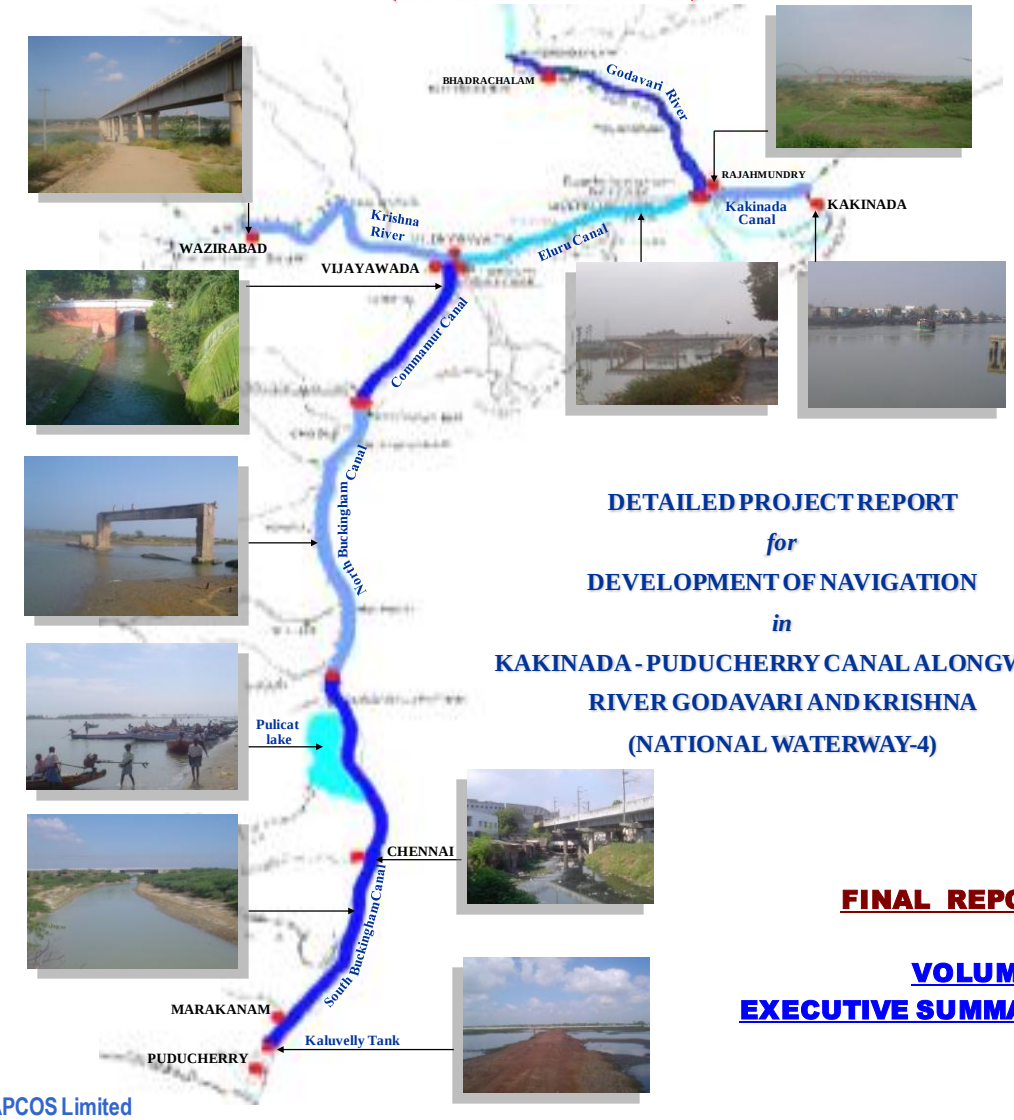
INLAND WATERWAYS AUTHORITY OF INDIA

MINISTRY OF SHIPPING, ROAD TRANSPORT & HIGHWAYS
(GOVERNMENT OF INDIA)



DETAILED PROJECT REPORT

for

DEVELOPMENT OF NAVIGATION

in

KAKINADA - PUDUCHERRY CANAL ALONGWITH RIVER GODAVARI AND KRISHNA (NATIONAL WATERWAY-4)

FINAL REPORT

VOLUME- I
EXECUTIVE SUMMARY

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EXECUTIVE SUMMARY

1 INTRODUCTION

Till 1975, there had been an active navigation in the integrated canal waterway viz. Kakinada Canal, Eluru Canal, Commamur Canal, Buckingham Canal interlinking the two major rivers Krishna and Godavari in Andhra Pradesh. In 1987-89, the studies for techno-economic feasibility on rivers Godavari and Krishna were carried out for development of Inland Water Transport. The navigation in isolation was not found promising due to in adequate cargo potential. Studies also revealed that if navigation was linked with the existing irrigation cum navigation canals connecting Chennai and Kakinada, there is possibility of increasing the cargo potential through the integrated canal system. Subsequently Irrigation and Command Area Development (CAD) department of Andhra Pradesh (AP) requested Inland Waterways Authority of India (IWAI) to explore the possibilities of development of IWT on the integrated waterway system canals alongwith rivers falling in the areas of A.P. and Tamil Nadu (T.N.). IWAI got the studies for development of IWT on integrated canal linking Kakinada and Chennai done during 1993-95.

Studies conducted by IWAI through RITES have also strongly emphasized the need to develop a viable and reliable Inland Waterway compared to the available modes of transport like rail and road, to carry the cargo from Kakinada to Markanam alongwith river Godavari and Krishna to serve the needs of Andhra Pradesh, Tamilnadu, Puducherry and hinterland and other consumer destinations as well as to support international trade with link to the seaport. The findings of the earlier studies have indicated technical viability in this stretch of Kakinada-Puducherry via Eluru Canal, Kakinada Canal, Commamur Canal, Buckingham Canal and Kalluvelly tank alongwith rivers Krishna and Godavari (Total length 1078 km). IWAI has therefore proposed that the waterway along this stretch of 1078 Km. would be declared as a National Waterway No. 4. IWAI simultaneously decided to get the DPR prepared for this National Waterway.

2 TERMS OF REFERENCE FOR DPR

IWAI has assigned the task of preparation of Detailed Project Report (DPR) to Water and Power Consultancy Services (I) Ltd. (WAPCOS) for development of navigation in Kakinada Puducherry canal alongwith river Godavari and Krishna, vide work order no. IWAI/HY/13(25)/2004 dated 26.10.2005 towards taking investment decisions and implement the project for execution.

The objective of the study are:

1. To conduct detailed investigations for the final design, to ensure a coordinated development to cover river and canal engineering works and structures, river and canal crossings, navigation structures, riverine ports and terminals, land and rail access.

2. To select and upgrade to preliminary engineering and cost standards of the structures with navigation by pass channel, locks and other structures

3. Identify the location and carry out preliminary designs of cargo terminals and river ports to handle the anticipated cargo as duly updated.

4. To suggest a phased programme of construction including river and canal terminals and ports which shall be fully integrated with the existing and planned irrigation and hydropower facilities so that navigation shall have priority;

5. To conduct a full economic and financial analysis of the costs and benefits of the alternatives indicated, independently as also in an integrated package in one stage or in phases. This analysis shall indicate the project parameters such as economic rate of return, cost/benefit ratios, cash flows and an assessment of the sensitivity of these parameters to changed inputs.

Detailed Terms of Reference has been given in Chapter 1 of Volume II : Main Report.

In pursuance of the studies, WAPCOS Ltd. has carried out detailed Hydrographic, topographic surveys and Traffic surveys and selection of Terminals locations. WAPCOS Ltd. have been constantly interacting with IWAI and also accompanied them in meetings with concerned State Governments.

The salient features of the Final Detailed Project Report prepared are explained here under in the executive summary.

3 BACKGROUND

In order to give a boost to inter state movement of various products a canal system was planned in the late 19th century. The canal system running between Kakinada in the state of Andhra Pradesh to Markanam in the state of Tamilnadu near Puducherry was looked upon as one of the greatest link in the total area linking Kakinada Port with Chennai Port. The canals covered in the portions are Kakinada Canal, Eluru Canal, Commamur Canal and Buckingham Canal. These canals integrated with rivers Godavari and Krishna provided uninterrupted navigational link till 1975. Out of these, the Kakinada Canal, Eluru Canal and Commamur Canal are irrigation-cum-navigational canals with interlinkage with rivers Godavari and Krishna; while Buckingham Canal is a tidal canal with sea confluences at many places and was constructed during Eighteenth Century exclusively for Navigation purposes. In this canal waterway, the major commodities used to be transported were rice, salt, sand, forest products, paddy, pulse, building materials etc. by country crafts of 30 to 40 tonnes capacity. Over the years, due to simultaneous development of railways and road network the canal system could not be utilised to the extent envisaged. This has resulted into canal system losing its existence.

Moreover, the irrigation canals are still being maintained by the State Government of Andhra Pradesh but Buckingham Canal is silted up heavily without any proper maintenance and usage. It was unable to pay for its own upkeep and maintenance

and started silting up badly and slowly went out of use. Obvious reasons for this condition can be traced out to then newly created alternative mode of cheaper transport infrastructure and technology available as compared to IWT, which was basically old. Though certain stretches of this integrated system of canals and rivers are still being used by people for movement of sand ,agricultural and other cargo alongwith passengers by country boats, most part of the canal and its control structures are commonly found out of use and need repair if the system is to be put back in use.

The Godavari river system which flows along the Bhadrachalam forests and coal deposits; and Krishna river system which flows along the limestone deposits and cement industries at Jaggayyapetta, however is navigable or can be made navigable without any effort for almost 8 months of the year. However, lean season navigation would have to be carried out after adoption of certain regulatory measures.

4 PROPOSED WATERWAY AND ITS PRESENT STATUS

The waterway under consideration comprises the canal section and the river section. The "river section "is combination of two rivers namely, Godavari and Krishna. The Godavari river portion is from Bhadrachalam to Dowleiswaram at Rajahmundry. The Krishna river portion is from Wazirabad to Prakasam Barrage at Vijayawada. The "canal section" is the combination of the Kakinada Canal, Eluru Canal, Commamur Canal and Buckingham Canal. The Kakinada canal runs from Dowleiswaram in Rajahmundry on the left bank of the river Godavari through a head sluice and lock to Kakinada (approx. 5 km downstream from Kakinada Port).The canal gets water from the river Godavari in Dowleiswaram barrage and thereafter connects Kakinada anchorage port. It connects the `River section' of Godavari from Bhadrachalam to Rajahmundry. The Eluru canal comprises two distinct irrigation-cum – navigation canals namely, Krishna Eluru Canal of Krishna Eastern Delta and Godavari Eluru Canal of Godavari western delta. The Krishna Eluru canal takes off from the 'River section' on the left bank of Krishna river on the upstream of Prakasam barrage through a head sluice at Vijayawada and meets Godavari Eluru Canal at east Tammileru lock at Eluru.The Godavari Eluru Canal takes off from the 'River section' of river Godavari at Vijjeswaram in Rajahmundry on the upstream of Dowleiswaram anicut through a head sluice and joins Krishna Eluru canal at East Tammileru lock. The Commamur canal takes off from 'River section' in river Krishna in Vijayawada on the right side upstream off Prakasam Barrage through a head sluice at Seethanagaram and joins Buckingham Canal at Peddaganjam Lock near Ongole. The Buckingham Canal is a tidal canal taking off from Peddaganjam lock and connecting to Chennai and further down South upto Markanam. It was constructed during 19th century along the Coromandal Coast. The main purpose of the canal was to have a lock-in-canal with extensive provision for passing upland discharge so as to retain a surface water level in the canal approximately upto the highest prevailing tide to facilitate inland navigation. The flood gates/locks were provided in various sea mouths to prevent silting caused by daily variation of tides. Locks serve another purpose of creation of impounding facility to retain high water level in the canal between low tides and also during the periods when sea bars are closed. The Buckingham canal from Peddaganjam lock to Chennai is called North Buckingham canal and from Chennai to Marakanam it is called South Buckingham canal. The

Kalluvelly Tank is an open swamp/tank connecting Markanam to the Sea at Puducherry. A key map of the waterway system is at Annexure-1.

The proposed waterway comprise of the following stretches:-

a)	Kakinada Canal(Kakinada to Rajahmundry)	50 km
b)	Eluru Canal (Rajahmundry to Vijayawada)	139 km
c)	Krishna river (Wazirabad to Vijayawada)	157 km
d)	Godavari river (Bhadrachalam to Rajahmundry)	171 km
e)	Commamur Canal (Vijayawada to Peddaganjam)	113 km
f)	North Buckingham Canal (Peddaganjam to Central Station of Chennai)	316 * km
g)	South Buckingham canal (Central Station of Chennai to Marakanam)	110 * km
h)	Marakanam to Puducherry through Kaluvelly tank	22 km
	Total length of waterway -	**1078 km**

***** It may be noted in earlier draft report that the North and South Buckingham canals were indicated for a length of 340km and 103km respectively.However after carrying out detailed analysis based on Delineation survey of Buckingham canal carried out by Government of TamilNadu during 2006-07,the corresponding lengths for the North and South Buckingham canals have been changed to 316km and 110km respectively.

A stretch of 50 km from Ennore South to Muthukadu [18km of North Buckingham Canal (Ennore South to Central Station of Chennai) and 32 km of South Buckingham canal (Central Station of Chennai to Muthukadu)] in Tamilnadu is not considered for waterway development. In this stretch multi-modal cargo transfer is proposed.

A stretch of approx. 2 km falls in Puducherry, out of the total stretch of 22 km from Marakanam to Kalluvelly tank.

A stretch of 258 km falls in Andhra Pradesh out of the total stretch of 316 km of North Buckingham Canal.

A stretch of 39 km of North Buckingham canal (excluding 18 km stretch from Ennore South to Central Station of Chennai) and 78 km of South Buckingham Canal (excluding 32 km stretch from Central Station of Chennai to Muthukadu) has been considered in Tamilnadu.

Thus the length of stretches of the waterway in the two States of Andhra Pradesh and Tamil Nadu are as follows:

State	Stretches	Total length (km)	Length included in the proposal for development (km)
Andhra Pradesh	Kakinada canal, Eluru Canal, Commamur canal, Godavari river, Krishna river and North Buckingham canal (Peddaganjam to Andhra Pradesh – Tamil Nadu border at Tada)	888	888
Tamil Nadu	North Buckingham canal (AP-TN border at Tada to Basin Bridge), South Buckingham canal and Kalluvelly tank	188	138
Puducherry	Southern portion of Kalluvelly tank – Puducherry link	2	2
TOTAL		**1078**	**1028**

* Excluding 50 km stretches of North and South Buckingham canals as explained earlier.

A detailed topographic and Thalweg survey was carried out for the entire length of the canals i.e. from Kakinada to Puducherry and river systems (Refer enclosed Index Map). The survey of the canal and the river indicated that the canals have been silted at many places due to lack of maintenance. The embankments on either bank of some of the canals are also leveled in some parts. Number of low level temporary bridges have been constructed over the canal at numerous locations owing to local requirements which have made navigation in canal difficult. The control structures are seen damaged except in Eluru Canal. In some places cross-drainage works have also seen developed. All these factors are carefully considered while proposing future development of Kakinada-Puducherry canals.

In so far as the river section is concerned, depth availability in the lean season from Wazirabad to Vijayawada (Krishna river)can be achieved by constructing a water retaining structure such as barrage or dam and by putting bed regulations. There is a dam being constructed at Pulichintala near Jaggayyapeta, 85km upstream of Vijayawada. The navigational locks will be provided for continuous uninterrupted navigation by Govt. of A. P. Similarly in Godavari river from Bhadrachalam to Rajahmundry, depth availability in the lean season can be achieved from the Pollavaram Dam (44km upstream of Rajahmundry) under construction. However, the existence of rapids between Bhadrachalam and Rajahmundry in river Godavari would have to be adequately taken care of before the navigation in the lean season is taken up.

Kalluvelly Tank is a vast lagoon situated near the eastern coast of the Tindivanam taluk of south Arcot District. It is about 10.5 km in width and about 12.80 km in length. It connects itself with Yedi Anthittu swamp, through a tidal creak about 8 km in length, which it turn links itself to the sea at about 10 km. north of Markanam. This swamp is full of water during rainy season and dry for the remaining part of the year. A further portion near sea for around 2.5 Km. is almost dry with high grasses and a causeway connecting villages of both banks. It ultimately ends at sea near "All India Institute of Medical Sciences" in Puducherry.

A brief description about different stretches of the proposed waterway is given in following paragraphs.

(a) Godavari River

The least available depth in Godavari river from Bhadrachalam to Rajahmundry (171 km) is between 0.5 to 1.5 m in the leanest period, marked by narrow and meandering condition near Pollavaram and wider reaches of 100 m to 500 m wide near Rajahmundry. The river bed consists of rock out crops and braided water flow. The river portion between Bhadrachalam and Rajahmundry is navigable by country boats and motor launches of about 40 tons capacity upto Tolagudem (31 Km. u/s of Venkatapuram). These crafts require a minimum of 1.2 m depth of water. The waterway depth available in the stretch from Bhadrachalam to Kunavaram is 1 m to 10.5 m and width is from 100 m to 900m. The waterway depth from Kunavaram to Pochavaram is from 1 m to 10 m with bed width of 100 m to 500 m. It is free from rock outcrops whereas the portion from Bhadrachalam to Kunavaram is full of rock outcrops. The portion from Pochavaram to Polavaram is having depth from 1 m to 15 m and bed width from 180 m to 500 m. At Polavaram a Dam is under construction. The dam is planned to have live storage capacity of 2100 million cu.m which is provided for between FRL +45.72 m and LWL of +41.15 m . The backwater effect of the dam is upto Bhadrachalam. The depth will increase to more than 2.5 m. The rock out crops which otherwise would have required dredging in hard rocks will also pose no navigational hindrance, once the Pollavaram Dam comes up. Thus a vessel of 500 t will easily ply in this stretch. Beyond Pollavaram upto Rajahmundry, the river width increases to 250 m to 850 m. and a depth of 0.5 m to 10.0 m is available with coarse sand at its bed.

The Pollavaram Dam will submerge the areas upstream of river in Kunavaram and Bhadrachalam. Water released from the Pollavaram Dam downstream will flow in to the right canal and left canal . The design discharge capacities of these canals are 2670 million Cu. m. (RBC) and 3090 Cu. m. (LBC) respectively. In the DPR for Pollavaram Dam, uninterrupted navigation from Rajahmundry to Bhadrachalam has been envisaged. The scheme provides for separate lock channel (navigational canal) on the left bank linking up the reservoir with the downstream side of the Dam through three high lift locks to negotiate the level differences from +41.0 m to +13.5 m. Since the DPR covers the required navigational aspects, no separate study on the effect of Pollavaram dam is considered necessary. The Dam is under construction but with many obstructions. For rehabilitation and environmental problems, the project is getting delayed. Once the construction of superstructure comes up, the Dam

construction authorities have to abide by the standards laid down by IWAI for uninterrupted continuation of navigation.

(b) Krishna River

The Krishna river in the portion between Wazirabad and Vijayawada (157 km) gets water from Nagarjuna Sagar Dam. This is a prime source of water for downstream navigation. This stretch runs through rocks and steep slope upto Pulichintala (at Chainage 71.20 Km) i.e. around 85 Km. upstream of Prakasam Barrage. A Dam is being constructed in Pulichintala by the Govt. of Andhra Pradesh exclusively for irrigation purposes and for generating power of 60MW.

The river stretch can therefore be categorized into two distinct regions i.e. Wazirabad to Pulichintala (62 Km.) and Pulichintala to Vijayawada (95 Km.)

The water requirement for the design channel depth of 1.8 m is 114 cumecs. This quantity is exclusive of water losses. If losses are added, the requirement will be 125 cumecs of water. The analysis of CWC records at Pondugala indicate that adequate discharge is available. Only small waterway improvement works (dredging and rock cutting) will be required for navigation by the designed vessel. However Nagarjuna Sagar Dam authorities should ensure daily uninterrupted supply of 125 cumecs. for smooth navigation exclusively. If discharge is less, the navigation through rocky reaches would call for elaborate river training and control measures. The temporary measures are bandalling, bottom paneling and maintenance dredging. The permanent measures are construction of spurs, groynes, bank revetment, capital dredging. The river training measures need careful scientific model study to provide required depth in the designed channel. In absence of the study, the only recommendation is to restrict to dredging and rock blasting.

The next reach between Pulichintala dam and Vijayawada is through plains and a number of secondary channels. Water spread area is more with exposed shoals and islands. The calculated discharge for existing channel with 1.5 m depth is 140 cumecs. Adding the losses (evaporation, seepage, runoff etc.),the required discharge is 150 cumecs. Pulichintala Dam is under construction. The Dam authorities should ensure 150 cumecs release downstream daily for ensuring un-interrupted navigation for maintaining 1.8 m depth. Besides they will be providing a lock arrangement for the purpose. IWAI may have to pursue and coordinate the matter.

(c) Kakinada canal

This canal runs from Kakinada to Rajahmundry for a length of 50 km. The depth required to be maintained is 1.6 m in Phase I and 2.0 m in Phase II. The Kakinada canal has adequate flow for navigational purposes excepting in some tail reaches. The water depth of 1.6 m will be available for a period of around 310 days in a year. The canal would remain closed for remaining days of the year for maintenance purposes. The dredging would be carried out in order to cater to the depth required for both phases.

(d) Eluru canal

From Vijayawada to Vijjeswaram lock at Sir Arthur Cottan Barrage the Eluru Canal runs for a total distance of 139 Kms. The canal comprises of two distinct irrigation cum navigation canals viz : Krishna Eluru Eastern Delta Main Canal, and Godavari Eluru Western Delta Main Canal

The Krishna Eluru Eastern Delta Main Canal takes off on the left bank of Krishna river on the upstream of Prakasam barrage through a head sluice. The Godavari Eluru Western Delta Main canal takes off from river Godavari at Vijjeswaram on the upstream of Dowleiswaram anicut through a head sluice. There are three locks, and many bridges (railway foot, road bridges, aqueducts) along the whole Eluru canal.

The required water depth of minimum 1.6 m will be available for a period of about 75 days in a year as estimated. The canal will be closed for maintenance works for about 55 days in a year. The tail reach of the canal also needs some manual excavation/dredging.

(e) Commamur canal

The 113 km long Commamur Canal from Vijayawada Seethanagram lock to Peddaganjam lock is totally dependant upon the release of water from Prakasam Barrage. The Canal is navigable at a depth of 1.6 m for a period of seven and a half months only. To make the whole canal navigable for 330 days in a year, the State Government of A.P. should release the water from Nagarjuna Sagar Dam (about 190 Km. upstream of Prakasam Barrage) during the remaining period. Alternatively, the depth of 1.6 m can be maintained by releasing the water from Pulinchintala Dam under Construction (85 Km. upstream of Prakasam Barrage).

(f) Buckingham canal

The Buckingham canal is a tidal canal. It was constructed during 19th century along the Coromandal Coast. The main purpose of the canal was to have a lock-in-canal with extensive provision for passing upland discharge so as to retain a surface water level in the canal approximately upto the highest prevailing tide to facilitate inland navigation. The flood gates/locks were provided in various sea mouths to prevent silting caused by daily variation of tides. Locks serve another purpose of creation of impounding facility to retain high water level in the canal between low tides and also during the periods when sea bars are closed. After various stages of improvements and construction of lock chambers, and surplus escapes for drainage, the canal carries only Salt Water. The canal has been divided into two portions, viz North Buckingham Canal, and South Buckingham Canal.

The North Buckingham Canal of a total length of 316km starts off after Peddaganjam Lock in A.P (where Commamur Canal ends) and ends at Central Station of Chennai in Tamil Nadu, from where the South Buckingham canal starts .The South Buckingham Canal of a total length of 110 Km ends at Kovalam North River lock in Marakanam.

North Buckingham canal from Ramperu lock has a bed width ranging from 15 m to 30 m. At present the condition of North Buckingham Canal is such that it remains almost dry. The banks have eroded. There are many salt pans all along the canal. During March to July every year, the canal remains totally dry. There are several confluences of rivers i.e. Paleru, Manneru, Musi and Pennar along the North Buckingham Canal. The range of the tide is about 0.7 to 1.0m.

The South Buckingham Canal is also a tidal canal. It has sea openings at seven places viz. Marina beach, Adyar, Muthukadu, Kalpakkam (Ediyuru), Palar, Paramankani Kuppam and Markanam. Locks are provided in the canal near sea openings to control the tidal flow and retain the desired water level in the canal. Sand bars have been provided at these openings due to which it remains closed for about seven months in a year. There are confluences of rivers Cooum and Adyar in Chennai city along the South Buckingham Canal. But as these rivers are rain fed rivers, and remain dry during non-monsoon periods. Hence the canal takes water from sea only. The canal in Chennai City is totally in abandoned condition. It has silted up heavily. Its banks have been heavily encroached where huts and houses have come up. The width of the canal is in the range of 10 to 15m. To add to it, T.N. Govt. has allowed Mass Rapid Transport System (MRTS), to construct Elevated Railway Stations right over the canal as per the recommendations of the Working Group appointed by the Planning Commission in 1976-77. In many places, the columns of MRTS flyover bridges are within the canal bed itself and in certain places, the pedestal foundation of column is exposed above the canal bed. Therefore, there is no navigation possible in the Chennai stretch. Alternative suggested by earlier consultants of constructing a Bye-pass canal in Chennai City is also ruled out because of non-availability of adequate water and high density population and space crunch in Chennai City. **It is therefore recommended that the Stretch inside Chennai City of approx 50 km should not be taken for IWT development**

(g) Kalluvelly tank

Kalluvelly tank is a vast lagoon in Sourth Arkot Distt of Tamil Nadu. It is about 10.5 km wide and about 12.8 km long. It is connected with Yidi Anthittu Swamp through a tidal creek of about 8 km long which in turn is connected with sea at about 10 km North of Markanam. This swamp is full of water during rainy season and dry for the remaining part of the year. During 2005 M/s. RITES had conducted a Detailed Feasibility Study for navigability of the stretch between Markanam and Puducherry including the Kalluvelly tank. They had assessed that with dredging and some other developmental works this stretch can be made navigable.

5 PHASEWISE DEVELOPMENT FOR NAVIGATION

In order to carry out economically sustainable navigation, the waterway is proposed to be developed in two Phases as per the TOR of IWAI as given below. However in Phase I it has been proposed to develop the waterway in two stages based on the request of Government of Andhra Pradesh (GoAP). Please see Annexure 2 of Volume III.

Phase – I - Buckingham canal 32 m wide and depth of 1.8 m Godavari and Krishna River 32 m wide and depth of 1.8 m. Other Irrigation Canals (Eluru, Commamur and Kakinada Canals) 14 m wide and depth of 1.6 m

Stage I : Kakinada canal from Kakinada to Rajahmundry, Godavari river from Polavaram to Rajahmundry, Godavari Eluru canal from Rajahmundry to Eluru, North Buckingham canal from Pedaganjam (A.P) to Basin bridge, South Buckingham canal from Basin bridge to Marakanam and Kalluvelly Tank upto Puducherry

Stage II: Godavari river from Bhadrachalam to Pollavaram, Krishna Eluru canal from Eluru to Vijayawada, Krishna river from Wazirabad to Vijayawada, and Commamur canal from Vijayawada to Peddaganjam

Phase – II - Width of 32 m and depth of 2.0 m for the entire stretch of canal/river systems

6 TRAFFIC STUDIES

The earlier traffic studies conducted in the techno economic feasibility for development of navigation on South Buckingham Canal including integration from Kakinada to Marakanam integrated with Godavari – Krishna rivers during the year 1999 have been reviewed. Further, WAPCOS appointed M/s A. F. Ferguson, an experienced firm in traffic studies, to carry out traffic survey for proposed waterway in 2005-06 . It involved an in-depth desk study through Trade Journals, Annual Reports, Statistical abstracts of the states, Cement Statistics, Fertiliser Statistics and in house database to assess the profile of hinterland that could be catered to by the proposed waterway, major industries in the hinterland, raw material and products consumed and manufactured by such industries, review of various government plans, trend in traffic at major ports etc. A field survey has also been carried out which involved discussions with various Government Authorities, Association of industries such as Cement Manufacturer's Association, Fertiliser Association, Sugar Mills Association and talking to the Marketing Departments of various industries in the hinterland of the waterway. The field visits were made to Kakinada, Guntur, Vijayawada, Kothagudem, Bhadrachalam, Ennore Port and Vishakhapatnam. The consultants met potential customers primarily Cement, Fertilisers, Rice Mills, Paper Industries, Ports etc. The data so obtained has been analysed and led to the cargo traffic projections for proposed waterway.

6.1 Existing Traffic

There is no appreciable traffic in any of the waterways except for movement of country boats which carry local produce. The main reason for lack of IWT movement being the absence of other infrastructure facilities and coordinated effort for improvements.

6.2 Potential Traffic

The hinterland of Kakinada-Puducherry Inland waterway could be divided into four major cargo belts viz. Kakinada belt, Krishna belt, South AP belt, and Chennai belt. Analysis of these cargo belts indicates that coal, cement, fertilisers and food grains account for majority of the total traffic in the hinterland. Based on the secondary survey and primary survey the cargo identified as relevant to the cargo belts under consideration are: Coal, Rice, Foodgrains, Cement, Fertilisers, Forest Products, Salt and Other Bulk Cargo.

Coal being abundantly available in the country, is extensively used in various industrial sectors. Singareni Collieries Company Ltd. (SCCL) is the only coal company in Southern India and caters to the needs of power, cement and all other coal based Industries spread over the Southern States. Rice is a major agricultural produce in Andhra Pradesh, It is the second largest producer of rice, termed rice bowl of India, it accounts for nearly 10% of the rice production in the country. The Godavari region is the major rice producing area in AP. Rice from this region is consumed by regions of Andhra Pradesh and sent to the southern markets of Tamil Nadu and Kerala. Since the region of AP is deficient of other food grains such as wheat, cereals etc., these are procured from the northern parts for distribution in the region. The traffic for other foodgrains from other states has a high potential.

Andhra Pradesh shows presence of large number of cement plants, totaling installed capacity of 23.33 Mn tonnes. The consumption in Andhra Pradesh was approximately 9 Mn MT in the year 2004-05 and has shown an increase of 7 % over the last year. The consumption of cement in Tamil Nadu and Puducherry was approximately 10 Mn MT. Fertiliser Industry is another important industry, which forms part of the hinterland of the inland waterways. The major fertiliser companies in the influence zone are Nagarjuna Fertilisers (NFCL), Godavari Fertilisers (GFL), Madras Fertilisers (MFL), etc. Andhra Pradesh produced approximately 1.4 Mn MT of fertilisers in the year 2004-05 and Tamil Nadu approximately 1 Mn MT.

Andhra Pradesh has many paper mills concentrated in the northern part, the major ones being ITC Bhadrachalam and Andhra Pradesh paper mills. Besides there are many small paper mills in the districts of East and West Godavari. The raw materials for these factories are mainly forest based wood products, waste paper and chemicals. Salt is an important cargo in the hinterland and forms potential for the inland water transportation. This is due to the proximity of the coastal regions as well as the salt producing areas to the waterway. Other cargo groups consist of vegetables, raw materials for ceramic tiles, marine products, iron ore, rice bran extractions, granite which move in the hinterland and can form part of the cargo. The total cargo potential for the hinterland is conservatively estimated to increase from 27.62 Mn. T. in 2014 – 15 when the waterway is assumed to start operations to 47.47 Mn. T. in 2039 – 40 in twenty five years and growing upto 78.09 Mn. T. in 2059 – 60. The total cargo potential is thus conservatively growing at a CAGR of 2% p.a. for the next fifty years. The snapshot of total cargo potential (by all modes) for the hinterland is summarized over the forecast period as under

S. No.	Cargo	2014-15	2019-20	2024-25	2029-30	2034-35	2039-40	2059-60
1	**Coal**	14409	15158	15985	16898	17906	19019	24756
2	**Rice**	5163	5985	6939	8044	9325	10810	19524
3	**Foodgrains**	1774	2057	2385	2765	3205	3715	6710
4	**Cement**	1694	2061	2507	3050	3711	4515	9893
5	**Fertilisers**	1412	1637	1897	2199	2550	2956	5339
6	**Forest products**	761	926	1127	1371	1668	2030	4448
7	**Salt**	455	554	674	820	998	1214	2660
8	**Other General Cargo**	1956	2160	2385	2633	2907	3210	4769
	Total Cargo Potential in 000Tonne	**27625**	**30538**	**33899**	**37781**	**42270**	**47469**	**78100**
	Total Cargo Potential in Million Tonne	**27.62**	**30.54**	**33.90**	**37.78**	**42.27**	**47.47**	**78.10**

Thus, the main cargoes identified to be moved on this waterway are coal, limestone, cement, fertilizers, iron and steel, building materials, paddy, tobacco, oil seeds, pulses and cotton, timber, bamboo, firewood, beedi leaves, chillies, general merchandise and civil supplies. The likely traffic for the proposed waterways is estimated to be 2.82 Mn. T. in 2014 – 15 to 12.39 Mn. T. in 2039 – 40 in twenty five years and growing upto 20.55 Mn. T. in 2059 – 60 under the realistic scenario. The snapshot of total cargo potential by IWT for the proposed waterway is summarized over the forecast period as under

S. No.	Cargo	2014-15	2019-20	2024-25	2029-30	2034-35	2039-40	2059-60
1	**Coal**	1441	2274	3197	4224	4476	4755	6189
2	**Rice**	516	898	1388	2011	2331	2703	4881
3	**Foodgrains**	177	309	477	691	801	929	1678
4	**Cement**	-	309	501	763	928	1129	2473
5	**Fertilisers**	282	409	569	770	892	1035	1869
6	**Forest products**	114	185	282	411	501	609	1334
7	**Salt**	91	139	202	287	349	425	931
8	**Other General Cargo**	196	324	477	658	727	802	1192
	Total Cargo Potential in 000Tonne	**2818**	**4846**	**7093**	**9816**	**11006**	**12386**	**20547**
	Total Cargo Potential in Million Tonne	**2.82**	**4.85**	**7.09**	**9.82**	**11.01**	**12.39**	**20.55**

The stretch wise cargo movement in canal and river sections of the waterway are described below:

(a) Krishna river (Wazirabad – Vijayawada)

The existing traffic moving along this stretch comprises agricultural produce, limestone, other minerals, cement, fertilizer, building materials, iron and steel and vegetable oils etc. Guntur is endowed with substantial resources of limestone, which are of use in cement blast furnace type, steel melting and chemical grades which are mainly consumed by M/s. ACC, Andhra Cement, Parthasarathy and Gauthami Cements as well as Visakhapatnam Steel Plant. The Krishna district is also endowed with limestone. Various cement plants have come up around river Krishna due to availability of limestones. They are producing bulk cement and are required to transport it by road through a lengthy and cumbersome route. The Inland Water Transport can definitely share the transport of a sizeable quantity of cement.

The total traffic movement in Million tonne and Million tonne –km projected in upstream as well as downstream direction for different years in the stretch of Krishna river from Wazirabad to Vijawada is summarized as under :

Year	Traffic							
	2014-15	2017-18	2022-23	2027-28	2032-33	2037-38	2042-43	2047-48
Downstream Traffic originating at Wazirabad and destinating to Vijayawada	-	0.619	0.973	1.434	1.692	1.998	2.360	2.789

Upstream Traffic originating at Vijayawada and destinating to Wazirabad	-	1.486	2.104	2.806	3.016	3.251	3.516	3.814
Total traffic movement in Million tonne	**-**	**2.105**	**3.077**	**4.240**	**4.707**	**5.248**	**5.876**	**6.604**
Total traffic movement in Million tonne - km	**-**	**330**	**483**	**666**	**739**	**824**	**922**	**1037**

(b) Godavari River (Bhadrachalam - Rajahmundry) stretch

The coal is abundantly available commodity in this stretch owing to its proximity to SCCL mines. There are existing coal fields in Kothagudam region comprising Manuguru, Kothagudem and Yellandu areas.

Coal in the downstream direction in Godavari river from Bhadrachalam can be very easily shifted to IWT mode as the distances through it get reduced by 70 to 100 km as compared to the road route. Rice has a traffic potential in this downstream route upto Rajahmundry. While in the upstream direction while coming back the vessels can bring forest products, wood pulp etc. and can unload it at Bhadrachalam.

The total traffic movement in Million tonne and Million tonne –km projected in upstream as well as downstream direction for different years in the stretch of Godavari river from Bhadrachalam to Rajahmundry is summarized as under.

		Traffic						
Year	**2014-15**	**2017-18**	**2022-23**	**2027-28**	**2032-33**	**2037-38**	**2042-43**	**2047-48**
Downstream Traffic originating at Bhadrachalam and destinating to Rajahmundry	-	2.557	3.639	4.869	5.229	5.633	6.086	6.595
Upstream Traffic originating at Rajahmundry and destinating to Bhadrachalam	-	0.277	0.416	0.599	0.717	0.857	1.026	1.228
Total traffic movement in Million tonne	**-**	**2.834**	**4.055**	**5.469**	**5.946**	**6.490**	**7.112**	**7.824**
Total traffic movement in Million tonne - km	**-**	**484**	**693**	**935**	**1017**	**1110**	**1216**	**1338**

(c) Canal Stretches

(i) Kakinada Canal

The main cargo to be transported by IWT in downstream direction from Kakinada to Rajahmundry is coal and fertilizer, and small quantities of Industrial salt, Rock Phosphate and Project cargo and drilling equipments. In the upstream direction the main cargo comprise of Rice bran extractions, Cement clinker and Fertilisers.

The total traffic movement in Million tonne and Million tonne –km projected in upstream as well as downstream direction for different years in the stretch of Kakinada canal from Kakinada to Rajahmundry is summarized as under.

		Traffic						
Year	**2014-15**	**2017-18**	**2022-23**	**2027-28**	**2032-33**	**2037-38**	**2042-43**	**2047-48**
Downstream Traffic originating at Kakinada and destinating to Rajahmundry	0.367	0.530	0.760	1.047	1.207	1.391	1.604	1.851
Upstream Traffic originating at Rajahmundry and destinating to Kakinada	0.070	0.264	0.409	0.598	0.706	0.835	0.989	1.175
Total traffic movement in Million tonne	**0.437**	**0.794**	**1.169**	**1.645**	**1.912**	**2.226**	**2.594**	**3.026**
Total traffic movement in Million tonne - km	**22**	**40**	**58**	**82**	**96**	**111**	**130**	**151**

(ii) Eluru Canal

At present, movement exists along Eluru Canal (both in Godavari Eluru canal and Krishna Eluru Canal) through country crafts, however the effect of which in working out the traffic potential is considered negligible. The important commodities forming potential for traffic on development of this waterway are Rice and other food grains, Rice bran extractions, Coal, Fertilizer and other General Cargo.

A summary of total traffic in Million tonne and Million tonne –km projected in upstream as well as downstream direction for different years in the stretch of Eluru canal from Vijaywada to Rajahmundry is tabulated below.

Year		Traffic						
	2014-15	2017-18	2022-23	2027-28	2032-33	2037-38	2042-43	2047-48
Downstream Traffic originating at Vijayawada and destinating to Rajahmundry	-	0.451	0.694	1.002	1.159	1.343	1.556	1.805
Upstream Traffic originating at Rajahmundry and destinating to Vijayawada	-	1.145	1.629	2.193	2.395	2.625	2.888	3.189
Total traffic movement in Million tonne	**-**	**1.596**	**2.323**	**3.195**	**3.554**	**3.967**	**4.444**	**4.994**
Total traffic movement in Million tonne - km	**-**	**222**	**323**	**444**	**494**	**551**	**618**	**694**

(iii) Commamur Canal

This stretch from Vijayawada to Peddaganjam in Ongole (113 km) is an important trade link linking Kakinada belt with south A.P. and Tamil Nadu. The major towns in the influence area are Vijayawada, Guntur and Ongole. It connects Prakasam Barrage to Peddaganjam Lock. The main traffic to move is of Rice & Foodgrains in downstream direction and Forest products in upstream direction.

The total traffic movement in Million tonne and Million tonne –km projected in upstream as well as downstream direction for different years in the stretch of Commamur canal from Vijaywada to Peddaganjam is summarized as under.

Year		Traffic						
	2014-15	2017-18	2022-23	2027-28	2032-33	2037-38	2042-43	2047-48
Downstream Traffic originating at Vijayawada, and destinating to Peddaganjam	-	1.343	2.042	2.920	3.353	3.856	4.437	5.111
Upstream Traffic originating at Peddaganjam and destinating to Vijayawada	-	0.490	0.727	1.033	1.221	1.444	1.711	2.030
Total traffic movement in Million tonne	**-**	**1.833**	**2.769**	**3.953**	**4.574**	**5.300**	**6.148**	**7.141**

Total traffic movement in Million tonne - km	**-**	**207**	**313**	**447**	**517**	**599**	**695**	**807**

(iv) North Buckingham Canal

The canal stretch is almost dry and has mainly salt traffic because of salt pans all along the canal. If developed in isolation, it has traffic potential of Rice & foodgrains, Fertilisers, Chillies, Tobacco Fish & Marine Products, Granite and Fruits & vegetables in the downstream direction from Peddaganjam to Chennai. In the upstream direction from Chennai to Peddaganjam, the main traffic consists of Fertilisers from Ennore, and Salt from Chennai for local consumption.

A summary of total traffic in Million tonne and Million tonne –km projected in upstream as well as downstream direction for different years in the stretch of North Buckingham canal from Peddaganjam to Chennai is tabulated below.

		Traffic						
Year	**2014-15**	**2017-18**	**2022-23**	**2027-28**	**2032-33**	**2037-38**	**2042-43**	**2047-48**
Downstream Traffic originating at Peddaganjam and destinating to Chennai	0.790	1.343	2.042	2.920	3.353	3.856	4.437	5.111
Upstream Traffic originating at Chennai and destinating to Peddaganjam	0.329	0.490	0.727	1.033	1.221	1.444	1.711	2.030
Total traffic movement in Million tonne	**1.119**	**1.833**	**2.769**	**3.953**	**4.574**	**5.300**	**6.148**	**7.141**
Total traffic movement in Million tonne - km	**333**	**546**	**825**	**1178**	**1363**	**1579**	**1832**	**2128**

(v) South Buckingham Canal and Kaluveli Tank including Puducherry

The canal stretch of South Buckingham Canal (103 km) starts from Basin bridge and runs upto Marakanam and is joined by Kalluvelly Tank, a huge open tank 22 km long, upto Puducherry. It has mainly traffic of salt and Fish & Marine Products because of salt pans and aquaculture shrimp farms all along the route. If developed in isolation, it has traffic potential of Iron scrap in the downstream direction from Chennai to Marakanam and Puducherry. In the upstream direction from Puducherry and Markanam to Chennai, the main traffic consists of Salt, Fertilisers and Timber from Markanam, Thiruvallur, Kanchipuram, Villipuram & Puducherry for local consumption.

The total traffic movement in Million tonne and Million tonne –km projected in upstream as well as downstream direction for different years in the stretch of South Buckingham canal from Chennai to Marakanam and Puducherry is summarized as under.

Year		Traffic						
	2014-15	2017-18	2022-23	2027-28	2032-33	2037-38	2042-43	2047-48
Downstream Traffic originating at Chennai and destinating to Markanam and Puducherry	0.092	0.131	0.191	0.268	0.320	0.383	0.459	0.550
Upstream Traffic originating at Marakanam and Puducherry and destinating to Chennai	0	0	0	0	0	0	0	0
Total traffic movement in Million tonne	**0.092**	**0.131**	**0.191**	**0.268**	**0.320**	**0.383**	**0.459**	**0.550**
Total traffic movement in Million tonne - km	**9**	**13**	**19**	**27**	**32**	**38**	**46**	**55**

7 WATERWAY DIMENSIONS PROPOSED

Considering the hydro-morpholical aspects of various stretches, the feasibility for development of Kakinada – Puducherry Canals integrated with Godavari and Krishna rivers waterway has been studied considering a channel of 14m width, and 1.6m depth (1:1 side slope) in Kakinada, Eluru and Commamur canals and 32 m width and 1.8 m depth (1:1.5 side slope) in Buckingham canal and river portions in Phase I and 32m width and 2 m depth in the entire waterway in Phase II. It may be noted that the Government of A.P. expressed that initially (till construction of Pollavaram dam and Pulichintala dams is completed) Kakinada, Eluru and Commamur Canals be developed with 14 m width and 1.6 m depth since they were of the view that if these dimensions are increased before the construction of these dams, this will adversely affect the irrigation purposes.

Accordingly the waterway dimension proposed along with the vessel size/capacity is as follows

a) Kakinada, Eluru and Commamur Canals

Bed width : 14 m
Depth : 1.6 m
Side slope : 1:1

Vessel capacity & size – 100 tonnes [30 m(L) x 4.25 m(B) x 1.2 m (draft)]

b) Rivers Godavari and Krishna, Buckingham canal and Kaluvelly tank

Bed width : 32 m
Depth : 1.8 m
Side slope : 1:1.5

Vessel capacity & size – 300 tonnes [40 m (L) x 9 m (B) x 1.5 m (draft)]

A key map of the waterway is given at Annexure-1. Sketch of these two cross sections are given at Annexure – 2.

8 VESSEL DIMENSIONS PROPOSED

The design vessel size for canal portion and river portion during Phase I and Phase II development has been worked out and given below:

	Phase-I 14m wide & 1.6m deep canal	**Phase-I 32 m wide & 1.8 m deep canal/river**	**Phase-II 32m wide & 2.0m deep river/canals**
Length	30m	40m	50m
B	4.25m	9.0m	11.0m
D	1.20m	1.5m	1.8m
DWT	100t	300t	500t

9. DEVELOPMENT WORKS PROPOSED

The project envisages land acquisition for 100 m corridor for waterway, dredging for widening & deepening of waterway and opening of sea mouths for free tidal flow into canals, marking the waterway with navigational aids, construction of terminals for loading / unloading of cargo, modification of locks, modification of low level bridges to facilitate movement of bigger barges and construction of cross drainage works for flow of flood water into/across the canals.

Further, as informed by IWAI, the Govt of Andhra Pradesh while giving concurrence to the proposal for declaration stated that till completion of construction of Polavaram dam on Godavari and Pulichintala dam on Krishna, sufficient depth for navigation will be available only for about 5 months in Eluru canal and Commamur canal. They suggested that the waterway be developed in two stages. Therefore, in Phase I, the waterway is proposed to be developed in following two stages.

Stage-I		**Stage II**	
(i) Polavaram-Rajahmundry Stretch of river Godavari	- 44 km	(i) Bhadrachalam - Polavaram Stretch of river Godavari	- 127 km
(ii) Kakinada-Rajahmundry Stretch of Kakinada Canal	- 50 km	(ii) Wazirabad-Vijayawada Stretch of river Krishna	- 157 km
(iii) Rajahmundry-Eluru stretch	- 74 km	(iii) Vijayawada – Eluru stretch	- 65 km

	of Eluru canal			of Eluru Canal	
(iv)	North and South Buckingham canal (excluding 50 km in Chennai city)	- 376 km	(iv)	Vijayawada-Peddaganjam Stretch of Commamur canal	- 113 km
(v)	Kalluvelly Tank including Puducherry	- 22 km		**Sub total Stage II**	**462 km**
	Sub total Stage I	**566 km**			
				Total Stages I & II	**1028 km**

9.1 Land Acquisition/Right of Way

100m wide corridor (Right of Way) is required for development of waterway of 32 m bottom width in canals (Kakinada, Eluru, Commamur, North and South Buckingham canals and Kalluvelly tank) which were in the possession of State Govts earlier at the time of construction of these canals. However, certain stretches are now under occupation by public. The State Govts were requested by IWAI to collect data on Land Acquisition. Govt. of Tamil Nadu completed the same but the details are yet to be received from States Govt. of Andhra Pradesh and Puducherry. Based on the information received from the States the abstract of requirement of land acquisition is given below:

a) Additional Area required to be acquired in Kakinada Canal - 227.55 ha
b) Additional Area required to be acquired in Eluru Canal - 524.3 ha
c) Additional Area required to be acquired in Commamur Canal - 497.85 ha
d) Additional Area required to be acquired in North Buckingham Canal (Andhra Pradesh Stretch – 258 km) - 129.90 ha
e) Additional Area required to be acquired in North/South Buckingham Canal (Tamilnadu Stretch) - 298.98 ha
f) Area required to be acquired in Puducherry - 27.00 ha

Govt of T.N has also indicated the extent of various types of land to be acquired (i.e. whether Patta land, Poramboke land or Encroachment) and the same is given below:

S. No.	Chainage (km)	Additional Area required to be acquired (ha)
North Buckingham Canal		
	Patta Land	4.256
	Poramboke Land	66.214
	Encroachment Area	5.156
	Total NBC	75.626
South Buckingham Canal		
	Patta Land	7.567
	Poramboke Land	175.271
	Encroachment Area	9.269
	Government Land	31.25

	Encroached by persons having Patta	
	Total SBC	223.357
	Total	**298.983**

However, such details have not been received from Govts of A.P and Puducherry. Moreover, the States also could not so for provide the cost of acquisition of these land areas. Therefore the cost of land acquisition was assessed by WAPCOS based on local circle area rates collected from the Revenue Departments or estimated based on local enquiries.

The State wise land acquisition requirement is summarized below:

(Area in Hectares)

	Tamil Nadu		A.P	Puducherry
Patta land	43			
Poramboke land –	242	300	1380	27
Encroachment –	15			

9.2 Dredging

Since the canals remained disused for navigation for many decades and the rivers do not have adequate depth for navigation during non-monsoon months, substantial quantity of dredging (both sand and rock dredging) is required to develop navigational channels of design dimensions. For constructing navigational channel in river and canal portions of the waterway of dimensions mentioned in item (7) above, dredging of 19 million cubic meter in Stage I and 0.80 million cubic meter (0.69 million cub m of sand and 0.11 million cubic meter of rocks) in Stage II is required. Thus total dredging required is 19.85 million cubic meter (19.74 million cubic meter of sand and 0.11 million cubic meter of rock). Stretch wise dredging quantities are given in Annexure -3 .

9.3 Modification/Reconstruction of Bridges

Since the waterway (particularly the canals) remained disused for navigation for many decades, several bridges/cross structures have come up thereon which are required to be either modified or reconstructed to provide desired horizontal and vertical clearances to allow passage of design size of inland vessels. There are a total of 190 such bridges out of which 47 require modifications. 105 bridges fall in the stretches of Stage I (out of which 34 requires modification) and 85 bridges fall in the stretches of Stage II (out of which 13 requires modification). Canal wise details of these bridges is given at Annexure 4 .

In addition, there are three bridges on river Godavari and two on river Krishna but these do not require any modification since they already possess adequate vertical and horizontal clearances.

9.4 Modification/Reconstruction of Navigational Locks

Since the canal portions of the waterway remained disused for a long time, the navigational locks (which are necessary to control water level during different seasons of the year) have also become defunct and most of these need to be modified. In most of these locks, the gates are also totally defunct. There is total number of 48 locks in the waterway and all these locks require modification. In stretches of Stage I, all the 36 locks falling in the stretch require modification while in Stage II all the 12 locks falling in the stretch require modification. Canal wise details of these locks may be seen at Annexure 5.

Since as of now there is no dam/barrage either on Godavari or Krishna rivers, there are no locks as of now on these. However, on Godavari river, Polavaram dam is being constructed by the Govt of A.P and IWAI and the WAPCOS had suggested to the State Govt to provide navigational locks of adequate capacity and size and the channel to allow navigation across the dam. Similarly, on Krishna river also, Pulichintala dam is being constructed by the State Govt of A.P and as per information collected by WAPCOS, initially there was no provision of navigational lock in the original scheme of the State Govt which would have made navigation up stream of the dam impossible. The WAPCOS and the IWAI had however, taken up the matter with the State Govt and it is learnt that the State Govt has agreed to provide a navigational lock across Pulichintala dam as well. Accordingly, cost of construction of locks across these two dams in A.P has not been included in the cost of project for development of the instant waterway as a National Waterway.

9.5 Terminals

The terminals are the gateway for the cargo and therefore should be strategically placed near high traffic concentration points in order to allow smooth and uninterrupted traffic between canal and hinterland. A total of 15 terminals have been proposed in the project, 11 in Stage I and 4 in Stage II. These terminals are proposed at Kakinada, Rajahmundry, Eluru, Kottapatnam, Maipadu, Durgarajupatnam, Muktiyala, Ennore(south), Muthukadu, Marakanam and Puducherry in Stage I and Bhadrachalam, Wazirabad, Vijayawada, and Tadepaligudam in Stage II. A brief description of each terminal is given below:

(i) **Kakinada :** At this terminal there would be cargo exchange from and to near the main Port to use the River Port Terminal. Therefore mechanical handling facilities for bulk and general cargo are proposed.

(ii) **Rajahmundry :** This terminal on river Godavari is to be developed for coal handling facilities primarily.

(iii) **Eluru** : Feeder cargo of Rice & foodgrains and other Bulk Cargo.

(iv) **Kottapatnam :** The terminal in canal section in Ongole to be developed for fertilizers, salt and fishery & Marine products.

(v) **Maipadu :** Feeder terminal for fishery products and finished goods .

(vi) **Durgarajupatnam:** Feeder terminal for fishery products and finished goods.

(vii) **Muktiyala :** Feeder terminal in river section for coal, cement, agro products and finished goods.

(viii) **Ennore(South) :** New fully mechanical handling facilities for handling fertilizers and industrial cargo are proposed in the terminal.

(ix) **Muthukadu:** A terminal on the Buckingham Canal proposed to be equipped with both bulk and general cargo handling facilities.

(x) **Marakanam :** The near end point in South Buckingham Canal to be developed for handling facilities for timber and industrial goods.

(xi) **Puducherry**: The final terminating point of the proposed waterway. The terminal will be planned for mainly general cargo in the hinterland of Puducherry state such as Cuddalore, Villupuram etc.

(xii) **Bhadrachalam :** This Probably is the most important terminal on the river and hence is to be equipped with both bulk and general cargo handling facilities.

(xiii) **Wazirabad:** This terminal on river Krishna is to be developed for cement and coal handling facilities primarily.

(xiv) **Vijayawada :** This terminal to be developed along Krishna river. The terminal is generally for agro products, cement, fertilizers and finished goods.

(xv) **Tadepaligudam** : Feeder terminal for rice bran extractions, agro products and finished goods.

A list of these terminals (waterway stretch wise) may be seen at Annexure –6.

The terminals are proposed to be provided with equipment and handling facilities suitable for bulk handling of coal/fertilizer and other general cargo with suitable adjustments and interchangeability. These arrangements can be carried out as per occurring cargo compositions. Along side berthing wharf on piles with pitched slopes on land side are planned. This is a flexible as well as economic system, which would allow easy future expansion. While planning the river port system, the following factors were considered:

- No. and length of berth for the throughput of cargo
- The length of the largest vessel and distance between two vessels for simultaneous berthing as would occur.
- Operation for 330 days a year
- Night navigation permitted
- Berth occupancy as permissible
- Waiting time (Tw) to Service time(Ts) not exceeding 1

9.6 Navigational Aids

Navigation in the waterway is generally associated with the risk of vessels going around. In order to prevent such incidences the channel has to be marked properly to make it navigable without risk. Since the present canal system is man made, the fairway is well defined. In order to have navigation for movement of barges round the clock, it has been proposed to provide a combination of shore beacon lights, lighted marks, FRP buoys and lights mounted on country boats in river/canal portion in Phase I.

The estimated quantity required for above mentioned navigational aids during Phase I is given below:

S.No.	Item Description	Quantity
1	FRP Buoys	240
2	Country Boats mounted with light system	240
3	Shore beacons with lights	158
4	Lighted marks on banks of canals	1545
5	Buoys laying vessel	2

As explained in para 5 and 7, the waterway is proposed in two phases.

10 ENVIRONMENTAL ASPECTS

Certain environment and environmental problems arise as a result of the development, exploitation and management of water resources projects. Due to execution of the dredging activity, certain effects may occur. However as it would be carried out at identified isolated locations, the resultant effect on river water quality would not be significant. In order to keep the environment free from pollution by dumping of dredged spoil, it is proposed that the spoil be disposed off in the low lying areas adjoining the river / canal course, without creating noticeable environmental degradation. The terminals are expected to handle materials like chemicals, cement, tea, food grains, fertilizers, coal, paper and paper products, stone, boulder and chips etc. Necessary care would be taken to minimize the adverse effect on the environment due to spillage/ handling of materials while loading/ unloading the same at terminal points. Effects on air and noise pollution shall be negligible. Overall, any significant negative impact on environment is not expected due to the implementation of IWT development on the entire waterway system. The advantages on the other hand are:-

- Considerable reduction in vehicular traffic when major portion of road traffic is diverted to IWT.
- Savings in cost of fuel, foreign exchange and energy savings.
- More employment generation
- Development of tourism.

However a separate report on environment impact analysis is being prepared by IWAI through a separate agency which also broadly agrees with the above points.

11. COST OF DEVELOPMENT WORKS

The phasewise cost estimate has been worked out for development of Phase I and Phase II. The Delhi Schedule of Rate, 2007 published by CPWD has been followed to arrive at the cost estimate of the project. It has already been discussed that Phase I development is proposed to be carried out in two stages i.e. Stage I & Stage II. Accordingly, the cost estimate for developing stretches of proposed waterway falling in these two stages i.e. Stage I & Stage II have been worked out separately. Further as informed by IWAI, when this project was submitted to the IWAI Board in its 126th meeting held on 27.11.08, the Board directed that a lump sum provision of Rs 25 cr may be further added to this cost for providing small facilities for local people (such as ferry ghats) etc so that the local people get involved in the project. Therefore a provision of Rs 15 cr in Stage I and Rs 10 cr for Stage II has been added for the purpose.

11.1 Cost estimate for Stage I of Phase I

To arrive at the total cost for Stage I development for the year 2009, an escalation of 7% p.a. has been assumed w.r.t. base year 2007. Accordingly, a summary of cost involved in various items for development of Stage I waterway for the year 2007 and 2009 is given below:

Cost Estimate for Stage I

S.No.	Item Description	Cost for year 2007 (Rs. In lakhs)	Cost for year 2009 (Rs. In lakhs)
1	Land Acquisition	19460	22280
2	Dredging	27174	31112
3	Cross Drainage Works	1290	1477
4	Locks	41010	46952
5	Bridges	4946	5663
6	Terminals	9193	10525
7	Navigational Aids	971	1112
8	Protection Measures	223	255
9	Facilities to local people for ferry service etc	1500	1500
	Total	**105767**	**120876**

11.2 Cost estimate for Stage II of Phase I

To arrive at the total cost for Stage II development for the year 2009, an escalation of 7% p.a. has been assumed w.r.t. base year 2007. Accordingly a summary of cost involved in various items for development of Stage II waterway for the year 2007 and 2009 is given below:

Cost Estimate for Stage II

S.No.	Item Description	Cost for year 2007 (Rs. In lakhs)	Cost for year 2009 (Rs. In lakhs)
1	Land Acquisition	14680	16807
2	Dredging	1891	2165
3	Cross Drainage Works	712	815
4	Locks	2588	2963
5	Bridges	1228	1406
6	Terminals	3369	3857
7	Navigational Aids	1087	1245
8	Protection Measures	242	277
9	Facilities to local people for ferry service etc	1000	1000
	TOTAL	**26797**	**30535**

11.3 Cost estimate for Phase I (Stage I + Stage II)

As the Phase I would be carried out in 2 stages i.e. Stage-I and Stage-II , accordingly the cost estimate for development of Phase I would be sum of the cost involved in Stage I and II as discussed above. Therefore, the cost estimate for Phase I is tabulated below.

Cost Estimate for Phase I

S.No.	Item Description	Cost for year 2007 (Rs. In lakhs)	Cost for year 2009 (Rs. In lakhs)
1	Land Acquisition	34140	39087
2	Dredging	29065	33277
3	Cross Drainage Works	2002	2292
4	Locks	43598	49915
5	Bridges	6174	7069
6	Terminals	12562	14382
7	Navigational Aids	2058	2356
8	Protection Measures	465	532
9	Facilities to local people for ferry service etc	2500	2500
	Total	**132564**	**151410**

Say 1515Crores

Therefore the total cost of **Phase I** of the project is estimated as **Rs 1515 Crores.**

11.4 Cost estimate for Phase II

In Phase II, the development proposed are mainly with respect to increasing the width and depth of all the portions of the waterways of river as well as canals to 32 m width and 2 m depth. While the extent of land acquisition, terminals and navigational aids proposed in Phase I would be sufficient for scope of Phase II also, for increasing the width and depth of the waterway stretches the important works to be undertaken under Phase II would be: dredging, cross drainage works, modification/re-construction of bridges and locks and up gradation of some terminals. Considering that in the optimistic scenario, the Phase I will be completed by 2016-17 it is proposed that after observing the utilization of the waterway developed under Phase I for a few years, the development works under Phase II may be started in 2024-25 and completed in about five years time i.e. by 2029-30.

To arrive at the total cost for Phase II development at 2009 price, an escalation of 7% p.a. has been assumed w.r.t. base year 2007. Accordingly, a summary of cost involved in various items for development of Phase II waterway for the year 2007 and 2009 is given below.

Cost estimate for Phase II

S.No.	Item Description	Cost for year 2007 (Rs. In lakhs)	Cost for year 2009 (Rs. In lakhs)
1	Land Acquisition	0	0
2	Dredging	46460	53192
3	Cross Drainage Works	1208	1383
4	Locks	25020	28645
5	Bridges	12491	14301
6	Terminals	2820	3229
7	Navigational Aids	0	0
	TOTAL	**87999**	**100750**

Say 1008Crores

Therefore the total cost of **Phase II** of the project is estimated as **Rs 1008Crores.**

12 ECONOMIC AND FINANCIAL EVALUATION

Economic analysis attempts to measure the overall impact of the project on improving the economic welfare of the citizens of the country. It would assess the project in the context of the national economy rather than the project entity.

Taking into account the traffic projections carried out for the entire stretch of waterway and cost of development works associated, two options have been broadly identified for economic and financial analysis as follows:

a) Option I: The option I consist of following stretches of waterway as given below:

Kakinada canal
Eluru canal
Godavari River
Krishna River

b) Option II: The option II consists of entire stretch of waterway as given below:

Kakinada canal
Eluru canal
Godavari River
Krishna River
Commamur Canal
North Buckingham Canal
South Buckingham Canal
Marakanam to Puducherry by Kalluvelly Tank

The results of EIRR for various selected options are given below :

S.No.	Options	EIRR
1.	Option I during Phase I	34.27%
2.	Option I during Phase II	25.84%
3.	Option II during Phase I	22.84%
4.	Option II during Phase II	29.48%

For the development of present waterway involving heavy investments, it becomes very important to analyse the benefits of the owner i.e. IWT/Govt. and the users i.e. barge operator who would use such IWT facility when compared to road. The FIRR has therefore been evaluated for IWT/Government and Users/Barge operator. The results of FIRR for Government/IWAI for all the options are summarised as follows.

S.No.	Weighted cost of capital	3%	6%	12%
	Options	**Levy charges (paise per Tonne - km) to earn an IRR equivalent to the weighted cost of capital**		
1.	Option I –Phase I	13	19	36
2.	Option I –Phase II	36	46	77
3.	Option II –Phase I	31	43	81
4.	Option II –Phase II	27	35	60

The results of FIRR for User/Barge Operator for all the options are summarized as follows :

S. No.	Options	Levy Charge (Rs. per Tonne - km) to earn an IRR of 12%
1.	Option I during Phase I	1.20
2.	Option I during Phase II	1.07
3.	Option II during Phase I	1.31
4.	Option II during Phase II	1.14

13 CONCLUSIONS AND RECOMMENDATIONS

The following conclusion are drawn from the above table as given below :

a. To earn FIRR of 3% by Govt./IWT, the levy charges work out to be minimum as 13 Paise per Tonne - km for Option I – Phase I and maximum as 36 Paise per Tonne - km for Option I – Phase II.

b. To earn FIRR of 6% by Govt./IWT, the levy charges work out to be minimum as 19 Paise per Tonne - km for Option I – Phase I and maximum as 46 Paise per Tonne - km for Option I – Phase II.

c. To earn FIRR of 12% by Govt./IWT, the levy charges work out to be minimum as 36 Paise per Tonne - km for Option I – Phase I and maximum as 81 Paise per Tonne - km for Option II – Phase I.

d. For user/barge operator, the cargo fare to be charged for earning 12% FIRR works out to be minimum as 107 paise per Tonne - km for Option I during Phase II development and maximum as 131 paise per Tonne - km for Option II during Phase I development.

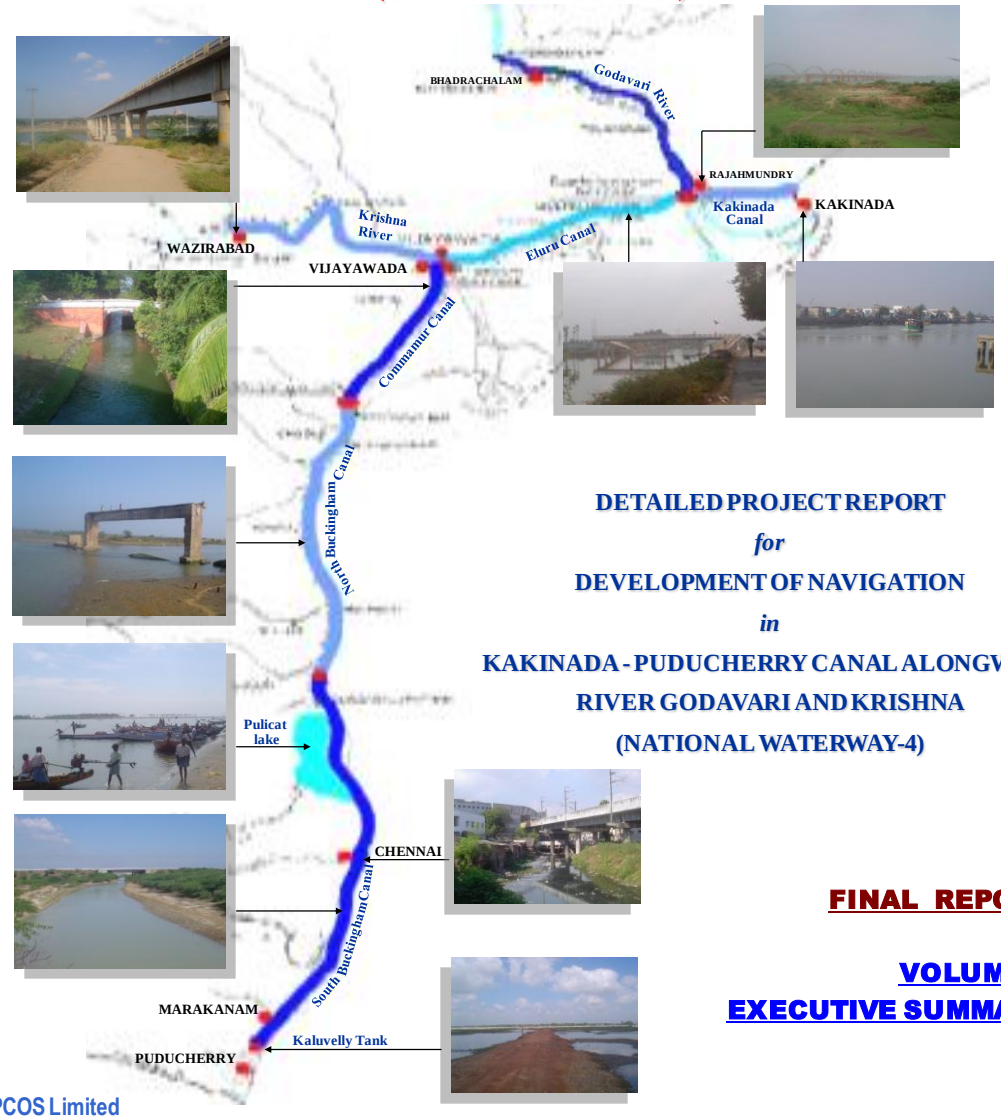
e. Taking into view of highly favorable EIRR for Govt./IWAI and levy charges exceeding Rs. 1.00 per Tonne-km for all the Options to earn an IRR of 12% by barge operator, it is concluded that the charges for using terminal and other infrastructural facilities may be absorbed so as to attract users to avail IWT facility.

f. Taking overview of all the activities associated with the development of proposed waterway, it is understood that the barge building facility is the activity that can be taken up under private sector participation/BOT/JV basis.

On the basis of conclusions discussed in previous para, it is understood and recommended that the Option I consisting of 14 m wide channel in Kakinada & Eluru canal and 32 m wide channel in Godavari & Krishna river during Phase I development is economically viable and most attractive as it is commanding an EIRR of 34.27% thus contributing to valuable national upgradation. Moreover, the user/barge operator has sufficient scope to use the recommended option of present waterway by charging 120 paise per Tonne - km in comparison to road. Taking into account the past experience of IWAI for not taking levy charges from barge operator in NW I and NW 2, it may be proposed that IWAI may not charge or charge on a nominal basis such as 5 paise per Tonne - km so as to attract the barge operator to use the proposed IWT facility.

INLAND WATERWAYS AUTHORITY OF INDIA

MINISTRY OF SHIPPING, ROAD TRANSPORT & HIGHWAYS
(GOVERNMENT OF INDIA)



DETAILED PROJECT REPORT

for

DEVELOPMENT OF NAVIGATION

in

KAKINADA - PUDUCHERRY CANAL ALONGWITH RIVER GODAVARI AND KRISHNA (NATIONAL WATERWAY-4)

FINAL REPORT

VOLUME- I
EXECUTIVE SUMMARY

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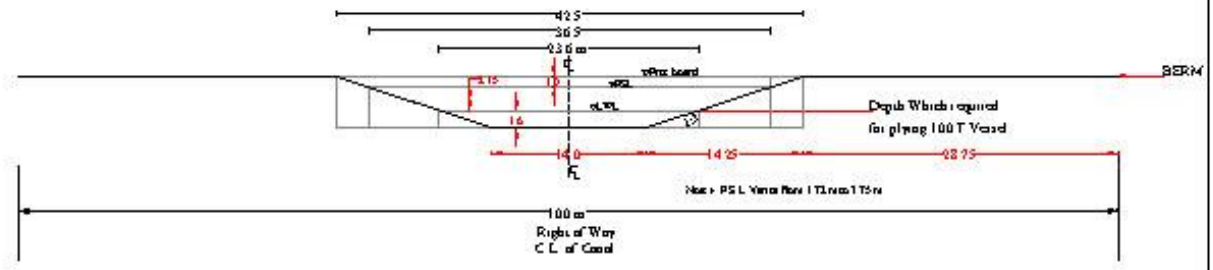
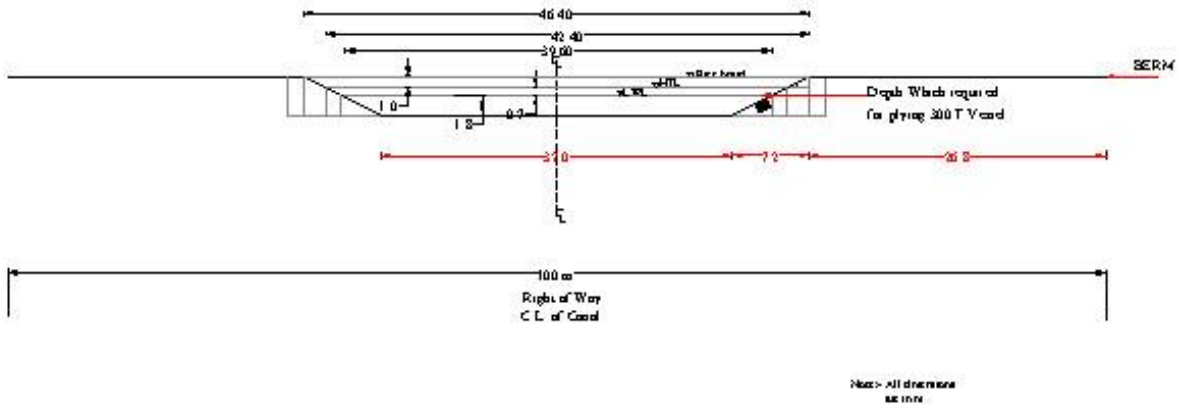
Annexure - 2

Proposed minimum Canal Section in Irrigation Canals
Kakinada Canal, Eluru Canal and Commamur Canal



Proposed minimum navigational Channel dimension in
Godavari & Krishna river and Buckingham Canal.



ANNEXURE-3

DETAILS OF DREDGING

Sl No.	Canal/River	Dredging Qty.
	Stage I	
1.	Kakinada Canal between Rajhmundry & Kakinada	362932 m^3
2.	Godavari Eluru Canal between Rajahmunadry & Eluru	1180391 m^3
3.	Godavari river between Pollavaram & Rajahmundry	95310 m^3
4.	Buckingham canal from Pedaganjam to Marakanam	16145210 m^3
5.	Marakanam to Puducherry (Kalapet)	1260904m^3
	Total	19044747 m^3 Say 19 million m^3
	Stage II	
1.	Godavari river between Bhadrachalam and Pollavaram	
	(a) Sand	267440 m^3
	(b) Rock	6440 m^3
2.	Krishna river between Wazirabad and Vijayawada	
	(a) Sand	205930 m^3
	(b) Rock	101210 m^3
3.	Krishna Eluru Canal between Vijayawada & Eluru	68718 m^3
4.	Commamur Canal between Pedaganjam & Vijayawada	151398 m^3
	Total Stage II Sand	693486 m^3 Say 0.69 million m^3
	Rock	107650m^3 Say 0.11 million m^3
	Grand total (Stage I+ Stage II) (Sand)	19738233 m^3 Say 19.74 million m^3
	(Rock)	107650m^3 Say 0.11 million m^3

ANNEXURE-4

DETAILS OF BRIDGES

Sl No.	Canal/River	Total number of Bridges	Bridges requiring modification
	Stage I		
1.	Kakinada Canal	19 nos	4 nos
2.	Godavari Eluru Canal	34 nos	2 nos
3.	North and South Buckingham Canal	52 nos	28 nos
	Total Stage I	**105 nos**	34 nos
	Stage II		
1.	Krishna Eluru Canal	47 nos	6nos
2.	Commamur Canal	38 nos	7 nos
	Total Stage II	**85 nos.**	13 nos
	Grand Total (Stage I + Stage II)	**190 nos**	47nos

Note: There are three and two bridges in rivers Godavari and Krishna respectively but these bridges do not require any modification.

ANNEXURE-5

DETAILS OF NAVIGATIONAL LOCKS

Sl No.	Canal/River	Total number of Locks	Locks requiring modification
	Stage I		
1.	Kakinada Canal	6 nos	6 nos
2.	Godavari Eluru Canal	1 nos	1 nos
3.	North and South Buckingham Canal	29 nos	29 nos
	Total Stage I	**36 nos**	36 nos
	Stage II		
1.	Krishna river	1 no	1 no
2.	Krishna Eluru Canal	4 nos	4 nos
3.	Commamur Canal	7 nos	7 nos
	Total Stage II	**12 nos**	12 nos
	Grand Total (Stage I + Stage II)	**48 nos**	48 nos