NIH/CS/13-14

# FLOW MODELLING IN GAUTHAMI GODAVRI RIVER


**National Institute of Hydrology**

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**Kakinada**

**2014**

## Preface

In order to understand the flow at river mouths during flooding, cyclonic surges etc, there is a need to take up detailed scientific study interaction due to hydrologic forcing of inland fluvial system as well as hydraulic-hydrodynamic forcing from marine system. This study will help understand the interaction between river flows from upstream and tidal forcing through river mouth. The results from the study are useful for various govt. departments that associate in hydrologic design of flood banks and tidal banks; planning flood plain zoning and disaster preparedness and flood, storm surge vulnerability mapping. In the present study, modelling of river flow at Gauthami Godavari river mouth has been undertaken by the Deltaic Regional Centre, National Institute of Hydrology, Kakinada. The Godavari delta is the second largest river delta and has an area of about 6322 sq.km with its head located near Rajahmundry, about 90 km from the mouth of its Gauthami Godavari branch and 96 km from the mouth of its Vasista-Vainateyam branch. The tidal effects can be felt upto a maximum of 42 km upstream from mouth.

This study on 'Flow modelling in Gauthami Godavari River', is part of work programme of the Deltaic Regional Centre, Kakinada and carried out under the supervision of Dr. J. V. Tyagi, Scientist F and Coordinator by Sri S. V. Vijaya Kumar, Scientist F as Principal Investigator. Sri V. S. Jeyakanthan, Scientist 'D', Dr. P. C. Nayak, Scientist 'D' and Shri B. Krishna, Scientist 'C' as other investigators with Shri P. R. Rao, R.A., as support staff.

**Abstract**

The surface water levels of a river, especially at its river mouth are required for planning and managing flood alleviation schemes and river engineering works. In lower reaches of a river flood plain inundation may occur from a high tide in combination with a high flood. Such studies will help understand the interaction between river flows from upstream and tidal forcing through river mouth. The results from the study are useful for various govt. departments that associate in hydrologic design of flood banks and tidal banks; planning flood plain zoning and disaster preparedness and flood, storm surge vulnerability mapping.

In this study, river flow is simulated using SWMM for the network of nodes that correspond to locations where cross-section data exists and links that identify stream portion between two nodes to represent the Gauthami River upto its mouth from just downstream of Dowlaiswaram. Two scenarios, the first one to simulate for the condition of original flood banks that existed and second one for scenario where flood embankment are raised to pass the peak flood studied. The impact of resistance to river flow due to tidal effect and rise in river level at upstream nodes is large and is about 1.5 m above flood water level in the river initially and gradually subsides with time as the tidal effect reduces. The head and depth at two last nodes located representing two outfalls is evaluated. It is observed that the head at Outfall-1 of the northern branch is well connected to the main river network compared to the Outfall-2, as the discharge of the river is peaking up and flows during ebb tide to sea. The complete output of simulation will help draw detailed information on the river flow and river levels.

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## 1.0 INTRODUCTION

The surface water levels of a river, especially at its river mouth are required for planning and managing flood alleviation schemes and river engineering works. In lower reaches of a river flood plain inundation may occur from a high tide in combination with a high flood. In many surface water flow related issues of practical engineering concern, the 3-D nature of the flow is of secondary importance, particularly, when width to depth ratio is large. River carrying sediments may form bays and spits together with the deltas either below or above the water at river mouths. The processes of erosion or accretion depend on the dynamics flow at mouth. The inter relationship between riverine factors like sediment load and discharge and marine factors such as depth at shore, waves, currents, tides, surges and long shore drifts influence the structure of delta. These conditions make it difficult to understand the laws of delta formation and destruction. According to Baydin(1970) the complete cycle include four stages. Many branched delta fan in the sea; lake-swamp delta; many branched interior delta; one branched or a few branched delta. The duration of each stage depends on the amount of sediment transport, on the possibility of sedimentation in a flood plain or on the possibility of sedimentation at the place where the river flows in to sea. The cycle of modern deltafication is different at different mouths. A knowledge of the recurrence interval of deltafication process and of long-term variation in river flows help to plan, to project and to build different constructions in deltas more correctly. Sea level lowering decreases the duration of many branched interior delta stage. A shallow coast decreases the duration of one branched delta and bay delta stages. Different engineering works such as construction of man made levees, channels dug for carrying water to fishery tanks, using channels for irrigation and similar works having deteriorating effect on hydrological regime may have influence on the deltafication. Construction of man made levees increases the danger of flushes and increases the speed of the transition to lake-swamp delta stage, since the interlevees sections and the height of the levees are found to be insufficient for flood discharges.

### Formations at Mouth

During course of development, deltas progress unevenly in different directions at the front. Egorov established in 1946 the laws governing the extension of deltas for the tideless water bodies. These laws were later verified for oceanic deltas (Tricart, 1956). Along the branches of the deltas, large accumulations of river sediment in the form of spits and extension of land into water body occurs first. Due to accumulation of fresh alluvium every year during flood

season the spits gradually become broader, which forms lower surfaces at the outer sides. Between deltas such lands are prone to water logging. In the deltas of rivers carrying large amount of sediment and discharging to shallow water bodies the spits can extend sometimes at a rate of several hundred meters a year (Egorov, 1970). During 1893 with a total length of 14 Km the sand spit of Kakinada bay at the front of Gauathami branch in Godavari delta was extending at a rate of 370 m/year (Prakash Agarwal, 1979). However, the delta extension is a very slow process and depends on number factors that influence topographical, riverine and marine forcing.

Extension of deltaic spits brings about formation of deltaic bays. Sometime later the distance to a bay shore for a water stream becomes shorter than the length of the main channel. During floods when rivers overflow banks and levees, part of the river flows to bay in the shorter direction and the gradient of flow increase, carrying water at a faster rate. Consequently the river bed becomes deeper and broader. The old bed below the outburst gets silted up and may discontinue as an active channel. Owing to change in the direction of water discharge, the bay will be filled up with alluvium and the spits will subsequently extend beyond the area of former bay into open water. Thus, the previous cycle will be repeated. The migration of the river bed in the vicinity of sea edge of a delta eventually ensures the final advance of the whole delta and deltas acquire their classic shape.

As the character of a deltaic land-scape is greatly determined by the quality and regime of ground water, special attention should be paid to the hydrogeological peculions of these surfaces. Being located close to the surface, ground water ensures almost uninterrupted water supply for the vegetations thus making it possible to obtain a large amount of organic produce on the deltaic lands. Some time ground water can have negative influence on the landscape. It may make the low lands water logged and under arid conditions it can accelerate the salinity of soils. In a sinking delta with cultivated deltaic lands groundwater is recharged both by the river water and partially by the intruding sea water. Besides an increased salinazation of soils, sinking deltas are characterized by an unusual predominance of chlorides in composition of salts. They demand specialized farming and increased amount of desalination works for the sustainable development. If conditions permit growing paddy is best in such situations. So, in deltas one should be cautious while deciding or changing the cropping pattern.

In an estuarine environment, contrary to common deltas, groundwater is less recharged by lateral seepage from river mainly because of smaller branching of river network and different texture of alluvium. As in the flood plains the aquifers are relatively more replenished by surface waters. Flooding is not always sufficiently complete and prolonged. Hence groundwater occurs at great depths. Continental groundwater inflows from watershed and slopes surrounding an estuarine valley are main source of groundwater recharge which is not characteristic of deltas. The quantity is not large but the significance can be given to quality if the water is mineralized.

**Salinity Ingress**

The laws governing hydro chemistry of river mouths are associated with the interaction of river and sea water, especially the formation of the salinity wedge and hydro-chemical and bio-chemcial processes. Simonov et al (1970) investigated the processes in two ways. The main characteristics resulting from the mixing are considered first. Hydro-chemical patterns arising from meteorological factors, from relatively small depths, from nearness to coast and from oxidising-reducing processes were considered next. According to them the discharge, exchange processes and climatic factors determine all the main characteristics of waters of river mouths. Sea water, unlike waters of mouth exhibit very large variations on characteristic with time and these variations diminishes from coast. The abundance of nutrient salts, carried out to the sea by river water creates favourable condition for the development of photosynthetic activity of green algae. The mouth has the highest index of photosynthesis compared with adjacent region of the sea.

During mixing, all physico-chemical characteristics of the river water are transformed until the individual patterns disappear. The most important pattern of river water is that its salt composition differs sharply from sea water composition. During mixing, the composition inherent to the river waters is transformed into the salt composition characteristics of sea water. Theory states that transformation of river water into sea water follows a hyperbolic low, so that the main qualitative discontinuity takes place in the salinity range 1-2% with mineralisation of river water to 250 mg/l. The content of suspended material in the river water is as a rule, higher than that in sea water. Turbidity variation at the mouth depends on the rate of sedimentation and of dilution of river water with sea water. Turbidity is directly proportional to the current velocity and decreases exponentially with distance from the shore. Sedimentation of suspended materials amounts to some 70-80% of their initial content in the

river water and explains protrusion of its delta into sea, 7-20% of the initial content of suspended material in the river water coagulates. So, the variation of all main physical and chemical characteristics at the mouth depends on the vertical velocity gradient in the river and on thermal and other mixing processes. Orlab et. al., (1970) presented a set of mathematical models which simulate the hydrodynamic and water quality behaviour of a variety of estuaries in the San Fransisco bay delta region, with particular emphasis on salinity intrusion problem as it is affected by division of fresh water inflows.

**Man's influence**

Since streamflow dominates the mouth offing formation in deltas, any long-term changes in the streamflow is reflected in the hydromorphology of the offing. According to Skriptunov (1970) man's influence at the river mouths takes place due to 1) the influence of different water resources development schemes within the river basin like, diversion of stream flow and seasonal regulations of stream flow etc. and 2) the influence of the local alteration at mouths like redistribution of runoff between branches, building canals, levees etc.

At deep offing, where surf is observed at the delta front removal of part of the runoff or its displacement in another channel front, results in disturbance of steady formation processes of the bar and delta front and their reformation by the sea waves and currents. This disturbance results in a sharp decrease in the rates of advance of delta front and bar and with a considerable reduction in runoff it results even in their erosion. The mouth prominence changes in form, the restoring influence of the river alluvium decreases and the transformation of the bar by waves results in development of a balanced profile, characteristics of a stable section of the sea shore.

Under the conditions of shallow offing, the removal of part of the river flow and its regulation doesn't change the direction of the process. In such shallow offing, only increase in the rates of sea front protrusion and variations in the offing depths occur, which results in the extreme case, in the complete stopping of extension of the delta front, but without its erosion.

Mouth bar is usually the natural obstacle for navigation and fish moving between river and sea and hence canals are formed for convenience of movement. At a deep offing the canals through the bay are usually of small length but, being crossed by long shore sediment flow, these are often generally silt prone. Hence protection measures such as dams from the offing,

permit a concentrated river flow out to sea and the area of sedimentation moves out into sea. At shallow offing, the canals are sometimes very long and are often filled by both river and marine sediment. During dredging, the branches are lengthened and above water canal edges are formed, which divides the offing into two parts. Such canals accelerate the rates of irregular protrusion of delta front making it more dismembered.

Since there are few methods of calculation of new mouth formation, only qualitative forecasts can be made either from the observational data available in the mouth analogue, which is determined from similar physical-geographical conditions and from the relation between river and sea factors or from the long term and seasonal variations of the river and sea factors at the mouth to arrive at possible values of erosion or accretion in future from the values of the runoff and sea factors.

**Godavari floods**

Due to cyclones and floods the coastal areas are frequently inundated, thus causing loss of crops, human lives etc. Approximately 25 km width of the east coast of India is vulnerable to the cyclones hazards and the risk is particularly severe at the mouths of rivers and estuaries. On an average, four severe cyclonic storms form in the Bay of Bengal every year, mostly from April to June (pre monsoon) and September to December (post monsoon). Cyclones are five times more frequent in the Bay of Bengal than in the Arabian Sea. The data for the last 100 years shows that the two stretches of the east coast from Nellore to Machilipatnam in Andhra Pradesh and Paradip in Orissa to the Indo-Bangladesh border are most frequently affected by cyclonic storms and surges. Also, the month of August is popular for heavy floods on the Godavari River. The flood of August 1986 recorded a record discharge of 36,00,000 cusecs near Rajahmundry at the head of Godavari river delta. Recently, a catastrophic flood occurred, during the first week of August 2006. The Godavari breached at two places on $6^{th}$ of August 2006. The first breach occurred around 20 00 hours at Sanaplli Lanka on the right flood bank of Gauthami Godavari branch. The second breach occurred at about 23 00 hours at Mondepu Lanka on left flood bank of Vasista Godvari branch. There was resistance to normal river flow at both sites due to high high tide of full moon days, that occurred on 9th August 2006 and the flood receded slowly. Things should have been even worse had the cyclone crossed at the mouth. Fortunately, as there was no storm surge as the cyclone crossed well north of the Godavari mouth.

In order to understand the flow at river mouths during flooding, cyclonic surges etc, there is a need to take up detailed scientific study interaction due to hydrologic forcing of inland fluvial system as well as hydraulic-hydrodynamic forcing from marine system. This study will help understand the interaction between river flows from upstream and tidal forcing through river mouth. The results from the study are useful for various govt. departments that associate in hydrologic design of flood banks and tidal banks; planning flood plain zoning and disaster preparedness and flood, storm surge vulnerability mapping. In the present study, modelling of river flow at Gauthami Godavari river mouth has been undertaken by the Deltaic Regional Centre, National Institute of Hydrology, Kakinada. The Godavari delta is the second largest river delta and has an area of about 6322 sq.km with its head located near Rajahmundry, about 90 km from the mouth of its Gauthami Godavari branch and 96 km from the mouth of its Vasista-Vainateyam branch. The tidal effects can be felt upto a maximum of 42 km upstream from mouth.

## 2.0 METHODOLOGY

A dynamic rainfall-runoff simulation model would be used for single event or long-term simulation of runoff quantity and quality for urban areas. The runoff component operates on a collection of sub-catchment areas that receive precipitation and generate runoff and pollutants load. The routing portion includes runoff through system of pipes, channels, storage/treatment device, pumps and regulators. Model tracks the quantity and quality of runoff generated within each sub-catchment and flow rate, flow depth and quality of water in each pipe and channel during a simulation period consisting of multiple time steps. Catchment information are built up in GIS/image processing software's like ERDAS/Arc View and the same are transformed for developing the necessary inputs for mathematical model to simulate surface runoff and routing through drains. The details on stream network map, Stream exit points are necessary. The model further routes the runoff collected from sub-catchments through the drainage network using St. Venant's equation (fully dynamic wave equation).

**Storm Water Management Model (SWMM)**

EPA-SWMM solves the conservation of mass momentum equation that governing the unsteady flow through drainage network of the channels and pipes. In the analysis dynamic wave method when used can take care of tidal effect for routing flows through system. This is an efficient but simplified approach that cannot deal with such phenomenon as back water effects, pressurized flow, flow reversal, and non-dendritic layouts. EPA-SWMM also includes a dynamic wave routing to solve the combined continuity and momentum equations known as Saint Venant equation.

$$\frac{\partial Q}{\partial t} + \frac{\partial Q}{\partial x} = 0 \qquad 1$$

$$\frac{\partial Q}{\partial t} + \frac{\partial (Q^2 / A)}{\partial x} + gA\frac{\partial H}{\partial x} + gAS_f + gAh_L = 0 \qquad 2$$

Where the $x$ is the distance along the conduit, $t$ is the time, $A$ is the cross-sectional area, $Q$ is the flow rate, $H$ is the hydraulic head of water in the conduit (elevation head any possible pressure head), $S_f$ is the friction slope (head loss per unit length), $h_L$ is the local energy loss per unit length of conduit and $g$ is the acceleration due to gravity.

The conceptual representation of the drainage system is based on the "link-node" concept which does not constrain the drainage system to a dendritic form. Links transmit flow from node to node. Properties associated with the links are roughness, length, cross-sectional area,

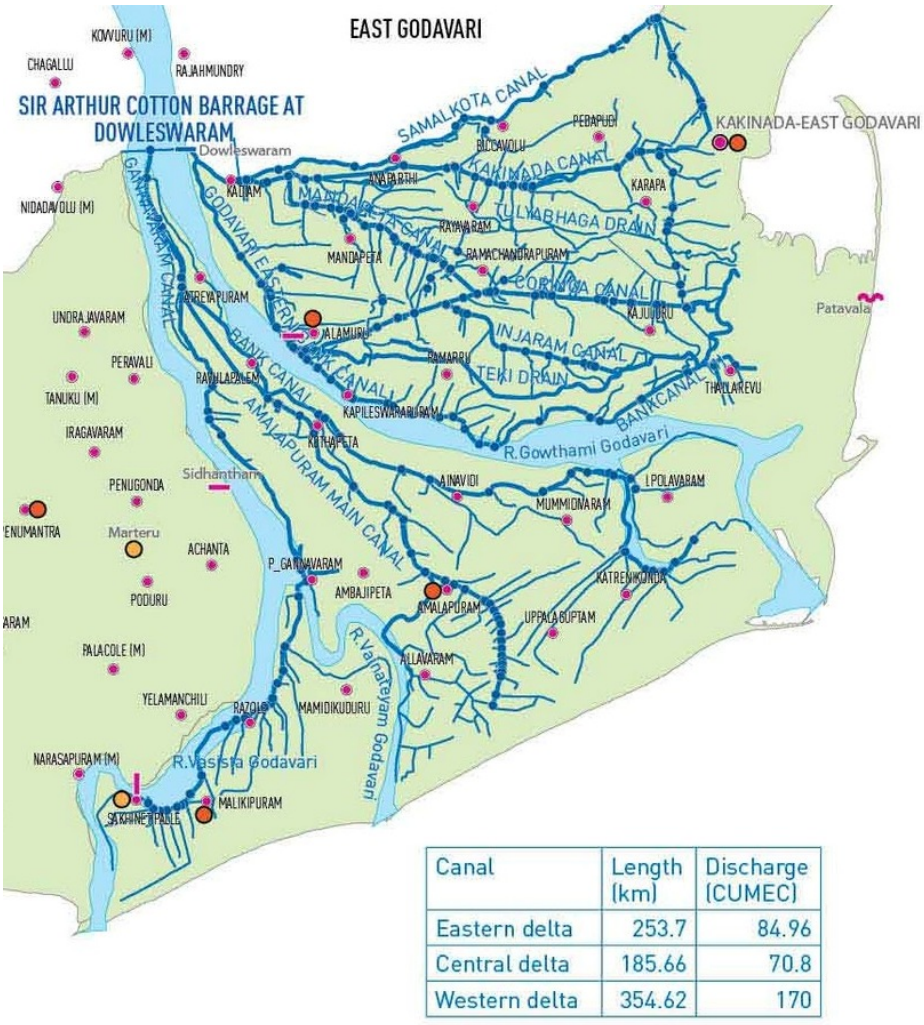
hydraulic radius, and top surface width. The primary dependent variable in the links is the discharge (Q). Nodes are the storage elements of the system and correspond to manholes or pipe junctions in the physical system. The variables associated with a node are volume, head, and surface area. The primary dependent variable is head (H), which is assumed to be changing in time but constant throughout any one node.

## 3.0 STUDY AREA

The Godavari is the second largest river in India and the largest in South India, with a catchment area of 3,12,812 sq. km. Godavari, after flowing for about 1,465 km falls into the Bay of Bengal near Yanam. The catchment area is nearly 10% of the total geographical area of India. The basin is a surplus basin as the utilization is less than the water resources potential. The Godavari originates at Triambakam near Nasik in Maharashtra in the Western Ghats, 1067 meters above sea level and journeys 692 km before entering Adilabad district in Andhra Pradesh. It then flows through the districts of Nizamabad, Karimnagar, Warangal, Khammam, East Godavari and West Godavari. It is fed by number of tributaries, notably Pranahita, the Penganga, Wardha, Waiganga, Kinnerasani, Manjira, Sabari and Indravti. The Pranahita contributes to 40 % of the Godavari waters, the Indravati to 20 %, the Sabari to 10% and the Manjira to 6%. Almost two thirds of the catchment of the Godavari flows into the bay of Bengal after traversing 1465 km. 22.62 % of the catchment area lies in Andhra Pradesh.

The river flows through Eastern Ghats at Polavaram in West Godavari district. At Dowlaiswaram near Rajahmundry in East Godavari district, Sir Arthur Cotton constructed a barrage; in the downstream the river divides into the two branches the Gauthami Godavari and Vasishta Godavari. The Vasishta Godavari again bifurcates into Vasishta and Vainateya Godavri. The Godavari delta is formed in between these rivers. The barrage water is used to irrigate about 4,10,000 hectares in both east and West Goadavari Districts.

The Godavari delta is the second largest river delta and has an area of about 6322 sq. km with its head located near Rajahmundry, about 90 km from the mouth of its Gauthami Godavari branch and 96 km from the mouth of its Vasista-Vainateyam branch (Fig. 1). The tidal effects can be felt upstream upto a maximum of 42 km upstream from mouth. The delta has a coast line of about 150 km with an average river width of about 2 km and a slope of 0.0004 and receives sediments predominantly from Deccan traps; Archean granites; unclassified crystallines; Gondwana and Recent formations. The mean annual sediment transport of the Godavari River, has been estimated to be 170 M Tonnes (Vaithiyanathan et. al., 1988). The total suspended material (TSM) load ratio in Godavari is 2:1 in wet and dry seasons (Ramesh and Subramanian, 1988).




| Canal | Length (km) | Discharge (CUMEC) |
|---|---|---|
| Eastern delta | 253.7 | 84.96 |
| Central delta | 185.66 | 70.8 |
| Western delta | 354.62 | 170 |

**Fig.1. Map of Godavari River Delta showing its branches**

Within the mangrove area, the Gauthami Godavari joins the Bay of Bengal at two places near Bhairavaplaem and near Kothaplalem. The Gauthami Godavari is connected to the Kakinada Bay by two major canals the Corangi canal at Yanam and the Gaderu canal, which has its origin at Bhairavapalem. Numerous other small canals such as the Chollangi creek and Matlapalem canal feed the mangrove areas and eventually flow into the Kakinada bay, which is very shallow (0-4 m depth). Vast areas of mudflats emerge during low tide in the Kakinada bay.

## 4.0 DATA

River flow data from 1973 to 2008 is analysed for understanding the river outflows down stream of Rajahmundry. Literature review has been undertaken on studies on river mouth processes and on modelling the fluvial marine interaction flow processes. Data availability on longitudinal and cross section data from previous studies about surveys has been is obtained.

A river flow modeling study was taken up by Andhra Pradesh State Development Planning Society (APSDPS) using the longitudinal and cross sectional data of the Gauthami Godavari in the year 1997 and the same has been obtained and analysed for 20 cross sections over a reach of 90 km from Dowlaiswaram to river mouth. Also, a study by NIO on a study to model tide induced currents in Gauthami-Godavari estuary has been conducted. In this study, the bathymetry is surveyed at a spatial resolution of 100 m and tide levels were monitored for Gauthami Godavari by NIO from Kotipalli to river mouth.

The objective of the study is to undertake modelling of river flow processes at Gauthami Godavari river mouth in order to understand the interaction between fluvial and marine environment. Since the bathymetry data at fine interval is not available, at present SWMM is applied for the Gauthami Godavari reach from Dowlaiswaram to its mouth using cross section data of APSPDS from 20 locations in the reach of 80 km (Fig. 2)

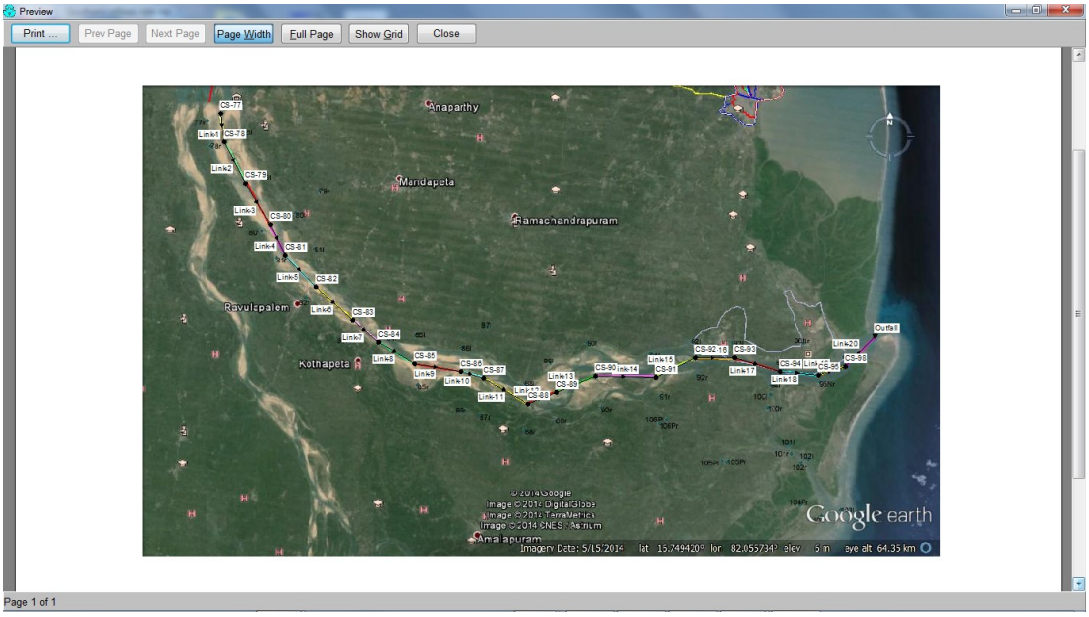



**Fig. 2. Cross sections of Gauthami River from Dowalaiswarm to mouth**

The network of nodes that correspond the locations where cross-section data exists and links that identify stream portion between two nodes to represent the Gauthami River upto its mouth from just downstream of Dowlaiswaram. The designed network forms the input to setup the SWMM model to simulate the flow of Gauthami Godavari river flow is shown in Fig. 3.

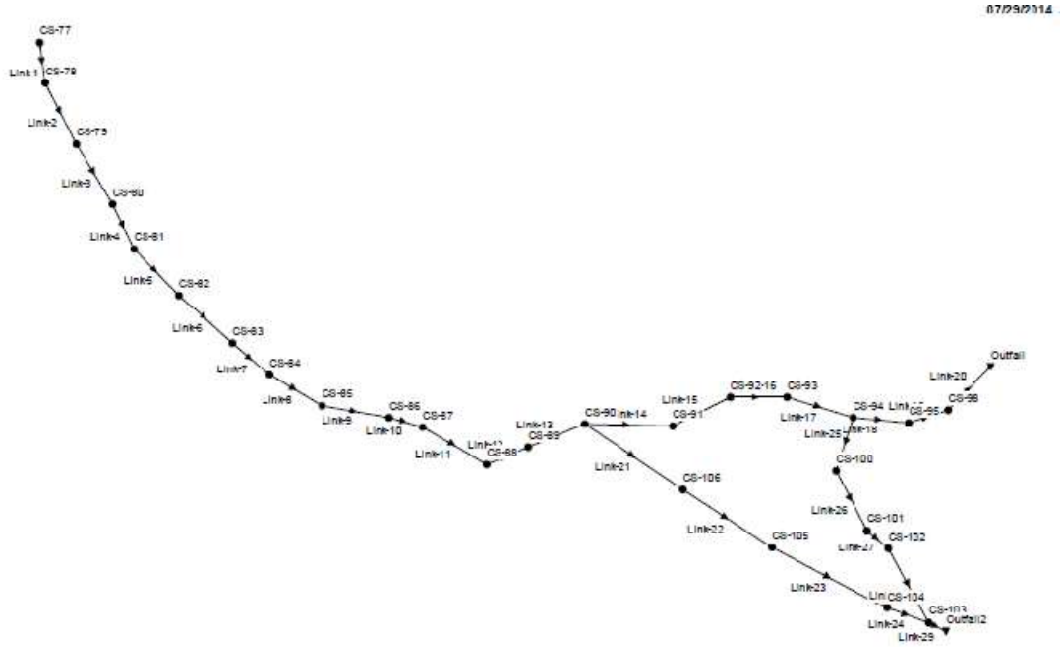



**Fig. 3. Designed network of nodes and Links representing the study area**

The downstream control from Bay that causes backwater effect are adopted from tidal observations recorded as shown in Fig. 4 (Sridevi et. al. 2013).

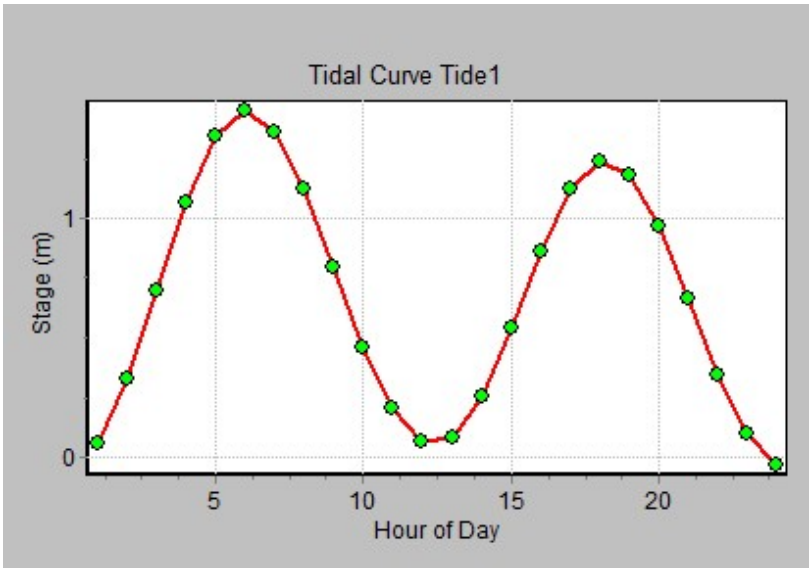



**Fig.4. Bay of Bengal Tidal observations adopted in the study**

For the upstream condition the hydrograph as observed during severe flood of August 1986 near Rajahmundry is considered and is shown in Fig. 5. The discharge is proportionately distributed for the Gauatami branch based on the releases from the Barrage near Dowlaiswaram and is used for simulation.

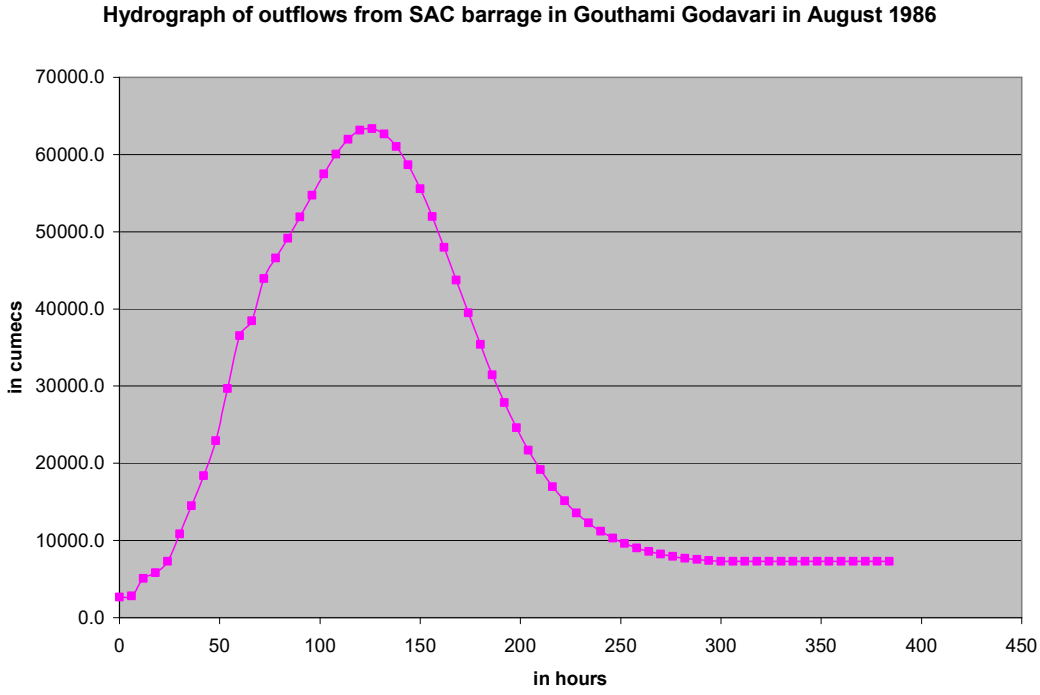



**Fig. 5. Observed flood hydrograph of August 1986 at Rajahmundry**

## 5.0 ANALYSIS AND RESULTS

River flow data from 1973 to 2008 is analyzed for understanding the river outflows down stream of Rajahmundry. Literature review has been undertaken on studies on river mouth processes and on modelling the fluvial marine interaction flow processes. Data availability on longitudinal and cross section data from previous studies about surveys has been is obtained. A river flow modeling study was taken up by Andhra Pradesh State Development Planning Society (APSDPS) using the longitudinal and cross sectional data of the Gauthami Godavari in the year 1997 and the same has been obtained and analysed for 20 C/S over a reach of 90 km from Dowlaiswaram to river mouth. The detailed cross-sections are input to the Model. The runoff hydrograph at the upstream end of the Gauthami river input the model is shown in Fig. 6.

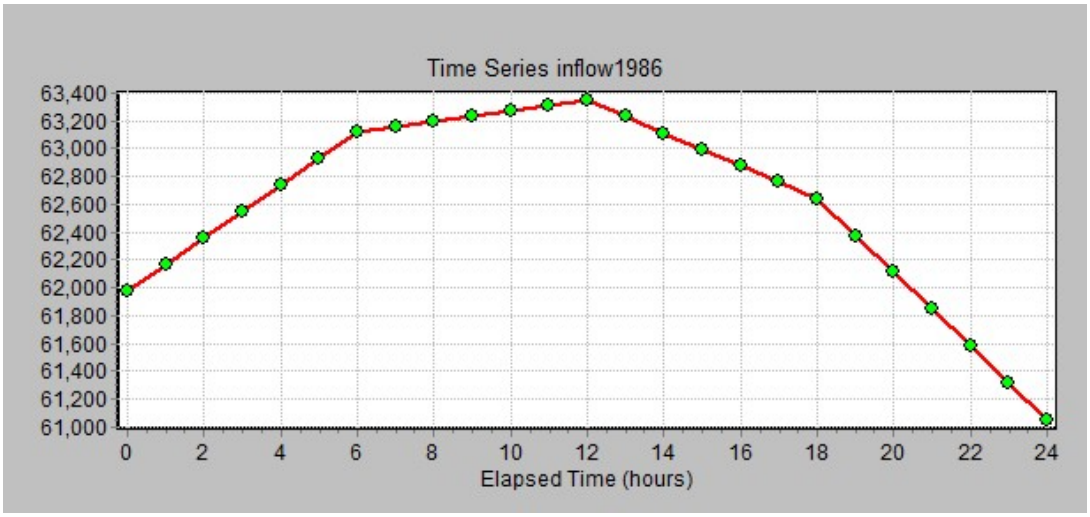



**Fig. 6. Input runoff hydrograph used in the SWMM simulation**

The SWMM model representing the Gauthami river is set up as a network of nodes and links as explained in previous section and as shown in Fig. 4. It is to be noted that there are 20 links from node at CS-77 to river mouth Outfall-1 to Bay of Bengal along the northern distributary. Also, there are two branches one at CS-90 flowing south east and at CS-94 flowing south with four links each and joining at Node CS-103 before plunging through link 29 into Bay of Bengal at Outfall-2.

The critical condition of river carrying large flood from the upstream and the highest high tide in the downstream end are considered as critical to simulate the flood water level in the stream network representing Gauthami Godavari. Also, the simulation is setup for two scenarios. The first scenario is for the condition of flood banks that existed then. The second scenario is for the raised flood embankment conditions. The input data along with simulation results as output reports from the SWMM runs for the two scenarios are shown at Annex-I and II. For the final run, the water surface elevation along the Gauthami river from node at CS-77 to Outfall-1 located to the north towards Yanam side is shown in Fig. 7. Similarly, the water surface elevation along the Gauthami river from node at CS-77 to Outfall-2 located to the north towards I. Polavaram side to the south east is shown in Fig. 8.

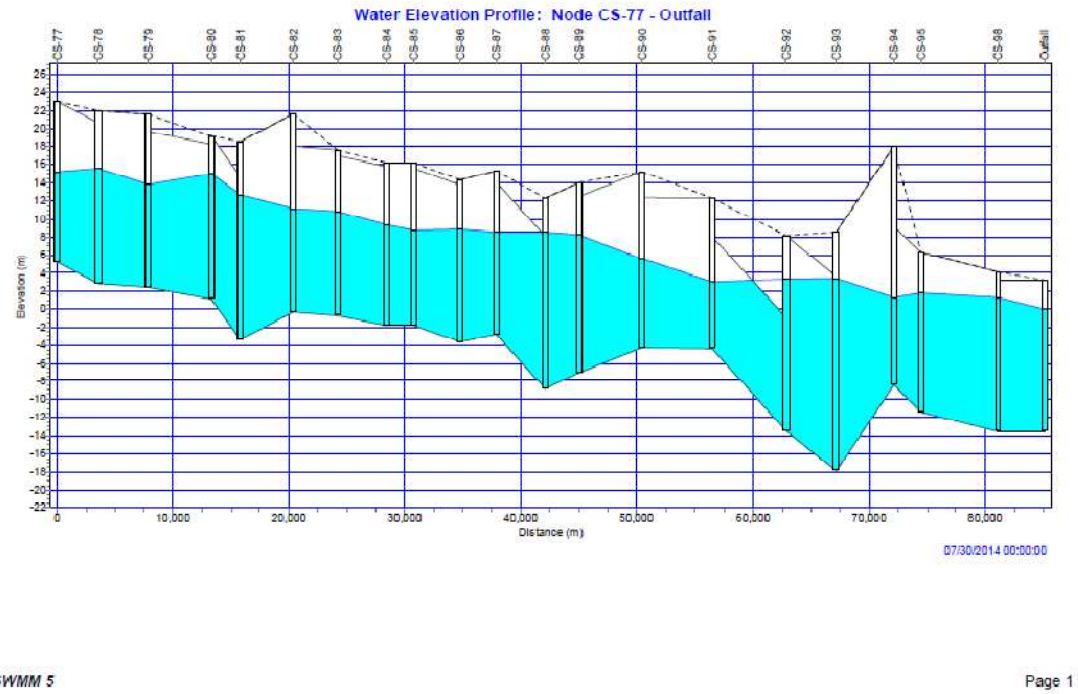



**Fig.7. Simulated river levels along links at node CS-77 to Outfall-1**

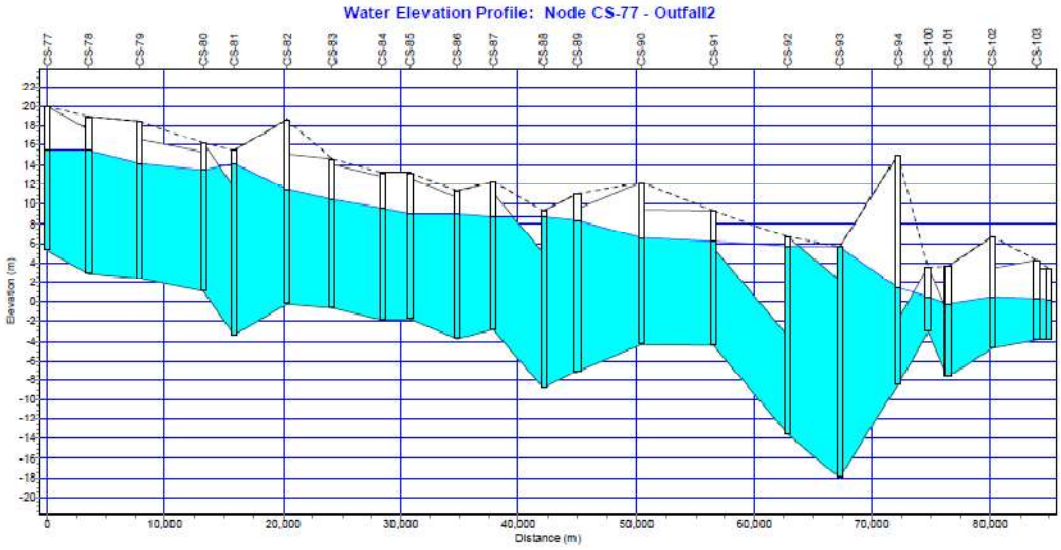



**Fig.8. Simulated river levels along links at node CS-77 to Outfall-2**

The simulated head at nodes at CS-80 in upstream to outfall-1 along the northern branch and to outfall-2 along southern branch is shown in Fig. 9 and Fig. 10 respectively.

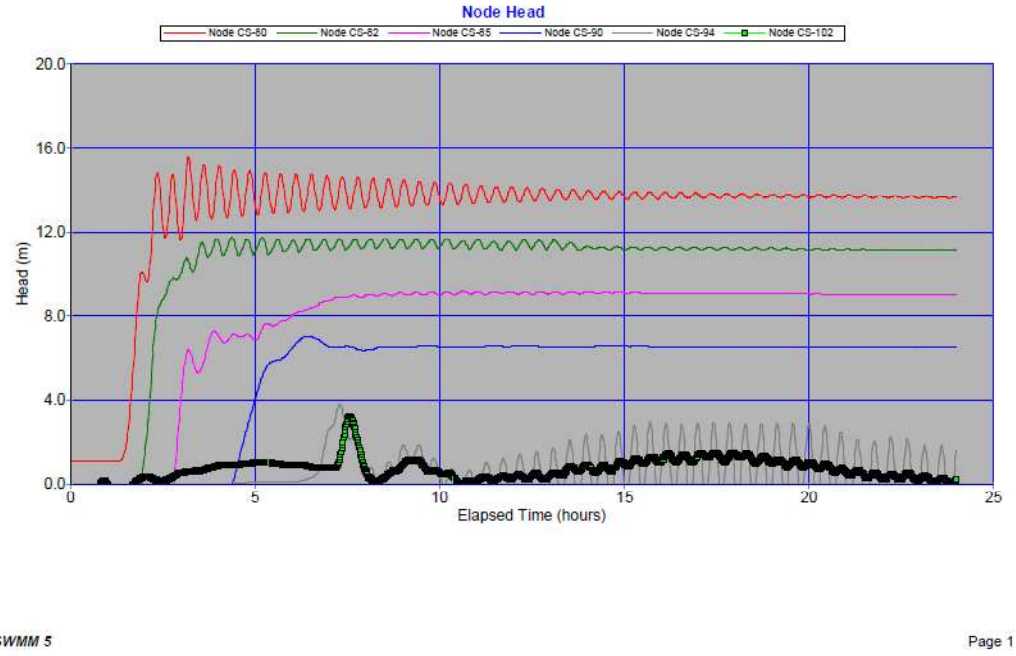



**Fig. 9. Variation of simulated head at some nodes from CS-80 to Outfall-1**

The impact of resistance to river flow due to tidal effect and rise in river level at upstream nodes is large and is about 1.5 m above flood water level in the river initially and gradually subsides with time as the tidal effect reduces.

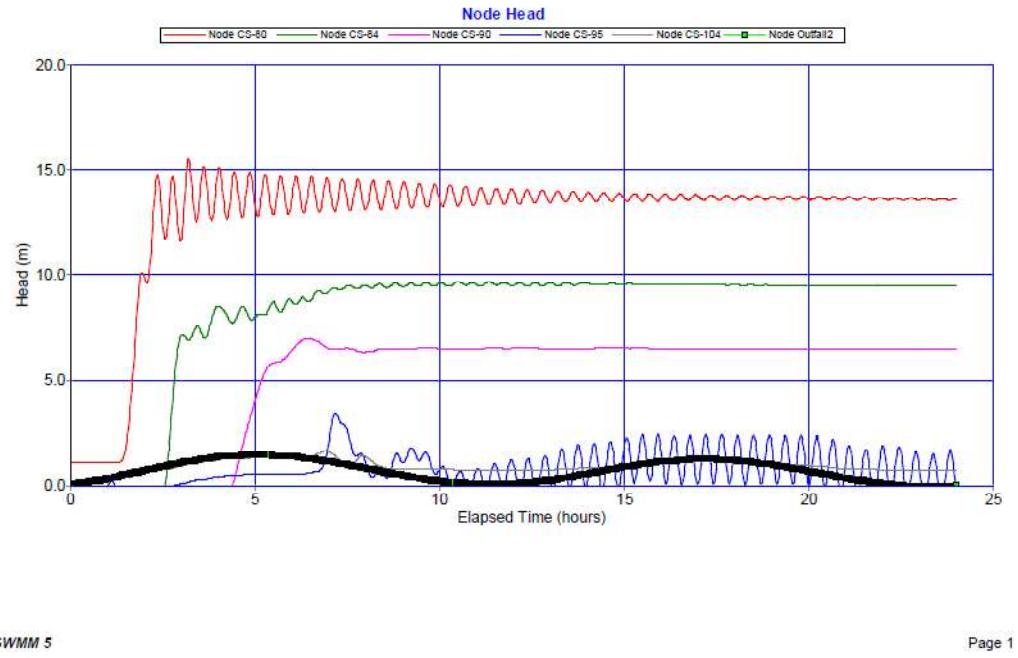



**Fig. 10. Variation of simulated head at some nodes from CS-80 to Outfall-2**

The head and depth at two last nodes located representing two outfalls is shown in Fig. 11 and Fig. 12 respectively. From Fig. 11, it can be observed that the head at Outfall-1 of the northern branch is well connected to the main river network compared to the Outfall-2, as we can see the discharge of the river is peaking up and flows during ebb tide to sea. The same can be ascertained form from Fig. 12 which shows the depth at Outfall-1 is large and is about 15 m compared to that of 5 m at Outfall-2. So, the Gauthami river predominantly flows in the Northern branch. Similarly, from the detailed output presented at Annexure more detailed information on the river flow simulated can be obtained.

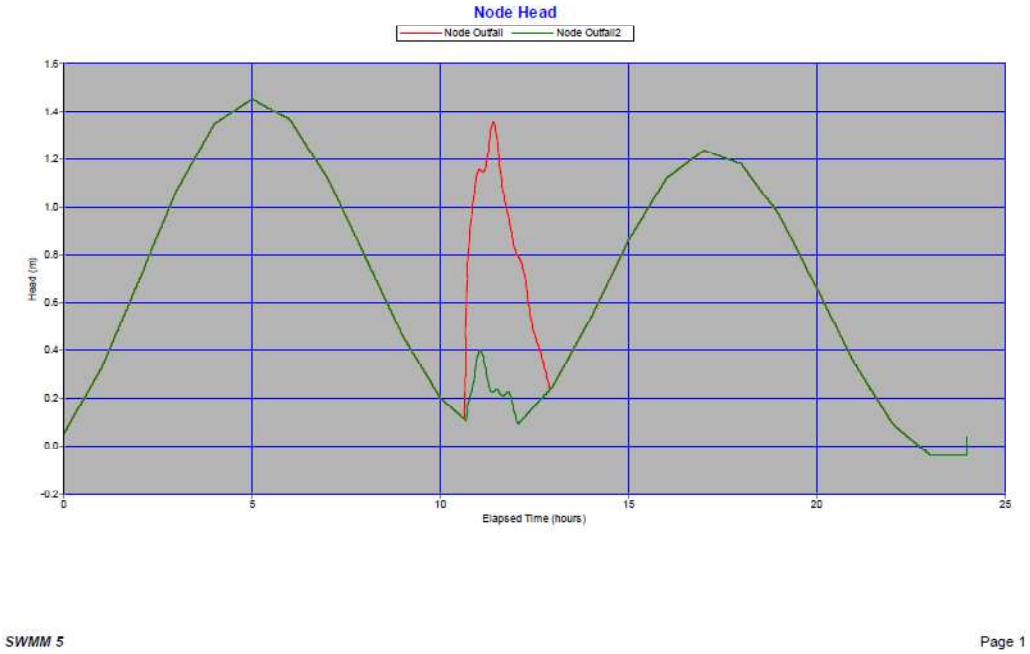



**Fig. 11. Variation of head at Outfall-1 and Outfall-2**

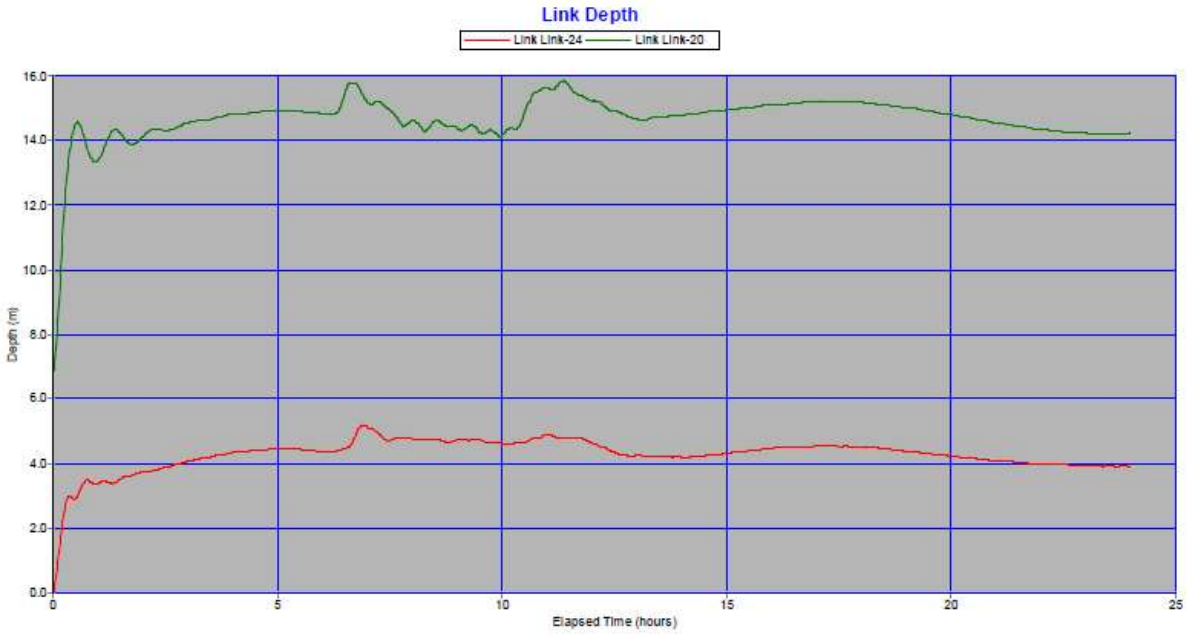



**Fig. 12. Variation in depth below water surface at Outfall-1 and Outfall-2**

## 5.0 CONCLUSIONS

The surface water levels of a river, especially at its river mouth are required for planning and managing flood alleviation schemes and river engineering works. In lower reaches of a river flood plain inundation may occur from a high tide in combination with a high flood. In this study, river flow is simulated using SWMM for the network of nodes that correspond to locations where cross-section data exists and links that identify stream portion between two nodes to represent the Gauthami River upto its mouth from just downstream of Dowlaiswaram. Two scenarios, the first one to simulate for the condition of original flood banks that existed and second one for scenario where flood embankment are raised to pass the peak flood studied.

The impact of resistance to river flow due to tidal effect and rise in river level at upstream nodes is large and is about 1.5 m above flood water level in the river initially and gradually subsides with time as the tidal effect reduces. The head and depth at two last nodes located representing two outfalls is evaluated. It is observed that the head at Outfall-1 of the northern branch is well connected to the main river network compared to the Outfall-2, as the discharge of the river is peaking up and flows during ebb tide to sea. The same can be ascertained form from the depth at Outfall-1 which is about 15 m compared to that of 5 m at Outfall-2. So, the Gauthami river predominantly flows in the Northern branch. Similarly, from the detailed output presented in the report more detailed information on the river flow and river levels can be obtained.

**Acknowledgements to**

1. APSPDS, Ministry of Planning, Govt. of Andhra Pradesh, Hyderabad for sharing data.

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Annexure I

Original conditions

EPA STORM WATER MANAGEMENT MODEL - VERSION 5.0 (Build 5.0.006a)

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**********

Analysis Options

**********

Flow Units ..... CMS

Flow Routing Method ..... DYNWAVE

Starting Date ..... JUL-29-2014 00:00:00

Ending Date ..... JUL-30-2014 00:00:00

Antecedent Dry Days ..... 4.0

Report Time Step ..... 00:01:00

Routing Time Step ..... 5.00 sec

**********

Element Count

**********

Number of rain gages ..... 0

Number of subcatchments ... 0

Number of nodes ..... 29

Number of links ..... 29

Number of pollutants ..... 0

Number of land uses ..... 0

**********

Node Summary

**********

| Name | Type | Invert | Depth |
|---|---|---|---|
| CS-77 | JUNCTION | 5.25 | 14.76 |
| CS-78 | JUNCTION | 2.85 | 16.08 |
| CS-79 | JUNCTION | 2.44 | 16.08 |
| CS-80 | JUNCTION | 1.07 | 15.11 |
| CS-81 | JUNCTION | -3.41 | 18.90 |
| CS-82 | JUNCTION | -0.26 | 18.90 |
| CS-83 | JUNCTION | -0.68 | 15.31 |
| CS-84 | JUNCTION | -1.84 | 15.05 |
| CS-85 | JUNCTION | -1.81 | 15.05 |
| CS-86 | JUNCTION | -3.76 | 15.08 |
| CS-87 | JUNCTION | -2.78 | 15.08 |
| CS-88 | JUNCTION | -8.82 | 18.10 |
| CS-89 | JUNCTION | -7.05 | 18.10 |
| CS-90 | JUNCTION | -4.36 | 16.53 |
| CS-91 | JUNCTION | -4.47 | 13.80 |
| CS-92 | JUNCTION | -13.48 | 20.18 |
| CS-93 | JUNCTION | -17.96 | 23.54 |
| CS-94 | JUNCTION | -8.50 | 23.54 |
| CS-95 | JUNCTION | -11.34 | 14.73 |
| CS-98 | JUNCTION | -13.58 | 14.73 |
| CS-106 | JUNCTION | -3.07 | 8.51 |

| | | | |
|---|---|---|---|
| CS-105 | JUNCTION | -4.22 | 8.51 |
| CS-104 | JUNCTION | -2.31 | 7.91 |
| CS-100 | JUNCTION | -3.06 | 6.60 |
| CS-101 | JUNCTION | -7.68 | 11.31 |
| CS-102 | JUNCTION | -4.69 | 11.31 |
| CS-103 | JUNCTION | -3.90 | 8.17 |
| Outfall | OUTFALL | -13.58 | 13.80 |
| Outfall2 | OUTFALL | -3.90 | 7.31 |

**********

Link Summary

**********

| Name | From Node | To Node | Type | Length | %Slope | N |
|---|---|---|---|---|---|---|
| Link-1 | CS-77 | CS-78 | CONDUIT | 3534 | 0.0678 | 0.0100 |
| Link-2 | CS-78 | CS-79 | CONDUIT | 4343 | 0.0095 | 0.0100 |
| Link-3 | CS-79 | CS-80 | CONDUIT | 5384 | 0.0254 | 0.0100 |
| Link-4 | CS-80 | CS-81 | CONDUIT | 2589 | 0.1730 | 0.0100 |
| Link-5 | CS-82 | CS-81 | CONDUIT | 4517 | 0.0696 | 0.0100 |
| Link-6 | CS-82 | CS-83 | CONDUIT | 3818 | 0.0109 | 0.0100 |
| Link-7 | CS-83 | CS-84 | CONDUIT | 4240 | 0.0274 | 0.0100 |
| Link-8 | CS-85 | CS-84 | CONDUIT | 2327 | 0.0011 | 0.0100 |
| Link-9 | CS-85 | CS-86 | CONDUIT | 4046 | 0.0481 | 0.0100 |
| Link-10 | CS-87 | CS-86 | CONDUIT | 3061 | 0.0320 | 0.0100 |
| Link-11 | CS-87 | CS-88 | CONDUIT | 4237 | 0.1425 | 0.0100 |
| Link-12 | CS-89 | CS-88 | CONDUIT | 2888 | 0.0613 | 0.0100 |
| Link-13 | CS-90 | CS-89 | CONDUIT | 5443 | 0.0494 | 0.0100 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Link-14 | CS-90 | CS-91 | CONDUIT | 6103 | 0.0017 | 0.0100 |
| Link-15 | CS-91 | CS-92 | CONDUIT | 6300 | 0.1432 | 0.0100 |
| Link-16 | CS-92 | CS-93 | CONDUIT | 4370 | 0.1024 | 0.0100 |
| Link-17 | CS-94 | CS-93 | CONDUIT | 4952 | 0.1909 | 0.0100 |
| Link-18 | CS-94 | CS-95 | CONDUIT | 2395 | 0.1186 | 0.0100 |
| Link-19 | CS-95 | CS-98 | CONDUIT | 6590 | 0.0339 | 0.0100 |
| Link-20 | CS-98 | Outfall | CONDUIT | 4000 | 0.0000 | 0.0100 |
| Link-21 | CS-106 | CS-90 | CONDUIT | 9101 | 0.0142 | 0.0100 |
| Link-22 | CS-106 | CS-105 | CONDUIT | 15655 | 0.0073 | 0.0100 |
| Link-23 | CS-104 | CS-105 | CONDUIT | 11049 | 0.0173 | 0.0100 |
| Link-24 | CS-104 | CS-103 | CONDUIT | 1700 | 0.0935 | 0.0100 |
| Link-25 | CS-100 | CS-94 | CONDUIT | 2586 | 0.2106 | 0.0100 |
| Link-26 | CS-100 | CS-101 | CONDUIT | 1645 | 0.2810 | 0.0100 |
| Link-27 | CS-102 | CS-101 | CONDUIT | 3823 | 0.0782 | 0.0100 |
| Link-28 | CS-103 | CS-102 | CONDUIT | 3761 | 0.0210 | 0.0100 |
| Link-29 | CS-103 | Outfall2 | CONDUIT | 1000 | 0.0000 | 0.0100 |

**********

Cross Section Summary

**********

| Conduit | Shape | Full Depth | Full Area | Hyd. Rad. | Max. Width | Full Flow |
|---|---|---|---|---|---|---|
| Link-1 | IRREGULAR | 14.76 | 31557.78 | 8.96 | 3505.00 | 354379.68 |
| Link-2 | IRREGULAR | 16.08 | 25238.82 | 7.22 | 3481.00 | 92044.40 |
| Link-3 | IRREGULAR | 14.20 | 24813.56 | 8.12 | 3040.00 | 159841.01 |
| Link-4 | IRREGULAR | 15.11 | 27739.53 | 8.11 | 3405.00 | 465705.17 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Link-5 | IRREGULAR | 18.90 | 22847.05 | 6.24 | 3645.00 | 204317.38 |
| Link-6 | IRREGULAR | 15.31 | 25218.10 | 9.63 | 2605.00 | 119473.41 |
| Link-7 | IRREGULAR | 14.69 | 23453.92 | 7.18 | 3250.00 | 144384.59 |
| Link-8 | IRREGULAR | 15.05 | 23374.31 | 9.49 | 2450.00 | 34356.37 |
| Link-9 | IRREGULAR | 14.42 | 45290.38 | 8.15 | 5535.00 | 402448.92 |
| Link-10 | IRREGULAR | 15.08 | 43677.21 | 7.89 | 5510.00 | 309534.74 |
| Link-11 | IRREGULAR | 13.86 | 56483.14 | 9.24 | 6090.00 | 938638.18 |
| Link-12 | IRREGULAR | 18.10 | 30569.21 | 8.21 | 3705.00 | 308092.37 |
| Link-13 | IRREGULAR | 16.53 | 33981.74 | 7.61 | 4445.00 | 292331.35 |
| Link-14 | IRREGULAR | 13.80 | 39738.50 | 6.80 | 5820.00 | 59159.01 |
| Link-15 | IRREGULAR | 10.00 | 21673.51 | 5.38 | 4010.00 | 251854.91 |
| Link-16 | IRREGULAR | 20.18 | 24319.34 | 8.59 | 2820.00 | 326388.82 |
| Link-17 | IRREGULAR | 23.54 | 16649.79 | 7.50 | 2205.00 | 278849.82 |
| Link-18 | IRREGULAR | 14.69 | 21241.06 | 9.87 | 2140.00 | 336583.45 |
| Link-19 | IRREGULAR | 14.73 | 14784.56 | 7.15 | 2060.00 | 101043.81 |
| Link-20 | IRREGULAR | 13.80 | 9214.70 | 7.04 | 1302.00 | 934.16 |
| Link-21 | IRREGULAR | 8.51 | 2094.82 | 4.62 | 450.00 | 6917.52 |
| Link-22 | IRREGULAR | 8.51 | 2094.82 | 4.62 | 450.00 | 4979.92 |
| Link-23 | IRREGULAR | 7.91 | 1351.24 | 4.47 | 300.00 | 4818.68 |
| Link-24 | IRREGULAR | 5.69 | 989.03 | 4.77 | 205.00 | 8570.55 |
| Link-25 | IRREGULAR | 6.60 | 4862.77 | 3.14 | 1540.00 | 47897.80 |
| Link-26 | IRREGULAR | 6.60 | 4862.77 | 3.14 | 1540.00 | 55325.20 |
| Link-27 | IRREGULAR | 11.31 | 2993.80 | 3.97 | 750.00 | 20998.31 |
| Link-28 | IRREGULAR | 8.17 | 3426.85 | 5.59 | 610.00 | 15637.86 |
| Link-29 | IRREGULAR | 7.31 | 5366.81 | 5.29 | 1010.00 | 899.49 |

**********

Transect Summary

**********

Transect Link-1a

Area:

| | | | | |
|---|---|---|---|---|
| 0.0056 | 0.0125 | 0.0216 | 0.0358 | 0.0562 |
| 0.0871 | 0.1235 | 0.1617 | 0.2013 | 0.2445 |
| 0.2903 | 0.3373 | 0.3845 | 0.4319 | 0.4796 |
| 0.5274 | 0.5755 | 0.6238 | 0.6723 | 0.7212 |
| 0.7711 | 0.8220 | 0.8743 | 0.9352 | 1.0000 |

Hrad:

| | | | | |
|---|---|---|---|---|
| 0.0576 | 0.1139 | 0.1579 | 0.1285 | 0.1766 |
| 0.1980 | 0.2154 | 0.2770 | 0.3194 | 0.3697 |
| 0.4206 | 0.4699 | 0.5331 | 0.5961 | 0.6588 |
| 0.7214 | 0.7836 | 0.8454 | 0.9070 | 0.9682 |
| 1.0276 | 1.0670 | 1.1154 | 0.9582 | 1.0000 |

Width:

| | | | | |
|---|---|---|---|---|
| 0.0969 | 0.1217 | 0.1562 | 0.2786 | 0.3788 |
| 0.5200 | 0.5760 | 0.5907 | 0.6397 | 0.6848 |
| 0.7102 | 0.7184 | 0.7218 | 0.7252 | 0.7286 |
| 0.7317 | 0.7351 | 0.7385 | 0.7418 | 0.7553 |
| 0.7666 | 0.7886 | 0.8209 | 0.9761 | 1.0000 |

Transect Link-2a

Area:

| | | | | |
|---|---|---|---|---|
| 0.0008 | 0.0030 | 0.0065 | 0.0113 | 0.0201 |
| 0.0392 | 0.0626 | 0.0866 | 0.1110 | 0.1364 |
| 0.1632 | 0.1911 | 0.2200 | 0.2502 | 0.2819 |

0.3201 0.3657 0.4177 0.4821 0.5617

0.6485 0.7357 0.8233 0.9115 1.0000

Hrad:

0.0447 0.0911 0.1362 0.1933 0.1223

0.1500 0.2346 0.3176 0.3990 0.4778

0.5522 0.6252 0.6948 0.7441 0.8141

0.8628 0.8970 0.9253 0.7946 0.5763

0.6615 0.7465 0.8310 0.9152 1.0000

Width:

0.0171 0.0326 0.0480 0.0584 0.1641

0.2614 0.2670 0.2726 0.2782 0.2955

0.3089 0.3197 0.3312 0.3512 0.3619

0.4924 0.5518 0.6161 0.8308 0.9748

0.9804 0.9856 0.9907 0.9959 1.0000

Transect Link-3a

Area:

0.0015 0.0071 0.0147 0.0255 0.0393

0.0572 0.0829 0.1140 0.1464 0.1801

0.2158 0.2537 0.2935 0.3350 0.3781

0.4233 0.4723 0.5261 0.5874 0.6553

0.7237 0.7923 0.8613 0.9305 1.0000

Hrad:

0.0243 0.0755 0.1186 0.1480 0.1815

0.1981 0.2155 0.2542 0.3152 0.3731

0.4261 0.4774 0.5291 0.5797 0.6292

0.6737 0.7143 0.7442 0.6550 0.6694

0.7358 0.8019 0.8676 0.9337 1.0000

Width:

| | | | | |
|---|---|---|---|---|
| 0.0637 | 0.0942 | 0.1298 | 0.1776 | 0.2218 |
| 0.3073 | 0.4280 | 0.4565 | 0.4743 | 0.4962 |
| 0.5285 | 0.5610 | 0.5842 | 0.6076 | 0.6310 |
| 0.6737 | 0.7357 | 0.8166 | 0.9631 | 0.9793 |
| 0.9839 | 0.9884 | 0.9930 | 0.9967 | 1.0000 |

Transect Link-4a

Area:

| | | | | |
|---|---|---|---|---|
| 0.0006 | 0.0024 | 0.0049 | 0.0080 | 0.0152 |
| 0.0446 | 0.0793 | 0.1143 | 0.1494 | 0.1847 |
| 0.2201 | 0.2557 | 0.2914 | 0.3272 | 0.3633 |
| 0.4029 | 0.4502 | 0.5084 | 0.5728 | 0.6397 |
| 0.7085 | 0.7800 | 0.8527 | 0.9260 | 1.0000 |

Hrad:

| | | | | |
|---|---|---|---|---|
| 0.0406 | 0.0801 | 0.1272 | 0.1807 | 0.1396 |
| 0.1006 | 0.1686 | 0.2419 | 0.3149 | 0.3876 |
| 0.4600 | 0.5321 | 0.6039 | 0.6754 | 0.7466 |
| 0.8082 | 0.8533 | 0.8616 | 0.7703 | 0.8171 |
| 0.8643 | 0.7998 | 0.8665 | 0.9326 | 1.0000 |

Width:

| | | | | |
|---|---|---|---|---|
| 0.0149 | 0.0295 | 0.0386 | 0.0442 | 0.2338 |
| 0.4571 | 0.4706 | 0.4726 | 0.4746 | 0.4765 |
| 0.4785 | 0.4805 | 0.4825 | 0.4845 | 0.4880 |
| 0.5816 | 0.7109 | 0.8366 | 0.8890 | 0.9144 |
| 0.9449 | 0.9753 | 0.9842 | 0.9930 | 1.0000 |

Transect Link-5a

Area:

| | | | | |
|---|---|---|---|---|
| 0.0016 | 0.0046 | 0.0080 | 0.0119 | 0.0163 |
| 0.0211 | 0.0264 | 0.0321 | 0.0402 | 0.0509 |
| 0.0633 | 0.0821 | 0.1067 | 0.1345 | 0.1745 |
| 0.2194 | 0.2728 | 0.3296 | 0.3925 | 0.4661 |
| 0.5510 | 0.6437 | 0.7601 | 0.8797 | 1.0000 |

Hrad:

| | | | | |
|---|---|---|---|---|
| 0.0707 | 0.1723 | 0.2634 | 0.3476 | 0.4268 |
| 0.5026 | 0.5756 | 0.6058 | 0.4843 | 0.5419 |
| 0.4973 | 0.4165 | 0.5037 | 0.4527 | 0.4998 |
| 0.5695 | 0.6294 | 0.7254 | 0.8051 | 0.8543 |
| 0.8990 | 0.9244 | 0.7688 | 0.8847 | 1.0000 |

Width:

| | | | | |
|---|---|---|---|---|
| 0.0227 | 0.0266 | 0.0304 | 0.0342 | 0.0380 |
| 0.0419 | 0.0457 | 0.0529 | 0.0829 | 0.0937 |
| 0.1271 | 0.1969 | 0.2117 | 0.2970 | 0.3490 |
| 0.4109 | 0.4587 | 0.4824 | 0.5548 | 0.6778 |
| 0.7316 | 0.8674 | 0.9887 | 0.9944 | 1.0000 |

Transect Link-6a

Area:

| | | | | |
|---|---|---|---|---|
| 0.0003 | 0.0014 | 0.0059 | 0.0198 | 0.0390 |
| 0.0602 | 0.0831 | 0.1085 | 0.1383 | 0.1729 |
| 0.2114 | 0.2566 | 0.3044 | 0.3531 | 0.4027 |
| 0.4534 | 0.5075 | 0.5665 | 0.6271 | 0.6882 |
| 0.7498 | 0.8118 | 0.8742 | 0.9369 | 1.0000 |

Hrad:

| | | | | |
|---|---|---|---|---|
| 0.0316 | 0.0609 | 0.0545 | 0.0827 | 0.1274 |

0.1763 0.2233 0.2519 0.2797 0.3059

0.3391 0.3581 0.4110 0.4637 0.5160

0.5679 0.5733 0.5944 0.6521 0.7093

0.7672 0.8259 0.8842 0.9422 1.0000

Width:

0.0105 0.0287 0.1583 0.2833 0.3223

0.3482 0.3757 0.4378 0.5030 0.5797

0.6430 0.7480 0.7627 0.7776 0.7926

0.8076 0.9035 0.9531 0.9617 0.9703

0.9774 0.9831 0.9887 0.9944 1.0000

Transect Link-7a

Area:

0.0029 0.0090 0.0160 0.0239 0.0328

0.0434 0.0612 0.0799 0.0993 0.1218

0.1502 0.1818 0.2174 0.2591 0.3040

0.3523 0.4042 0.4607 0.5269 0.5996

0.6764 0.7562 0.8374 0.9186 1.0000

Hrad:

0.0442 0.1105 0.1767 0.2322 0.2840

0.2560 0.2696 0.3451 0.4111 0.4611

0.5028 0.5303 0.5558 0.4741 0.5459

0.6136 0.6771 0.7334 0.7777 0.8260

0.8091 0.7597 0.8399 0.9200 1.0000

Width:

0.0664 0.0816 0.0908 0.1031 0.1157

0.1888 0.2272 0.2316 0.2539 0.3136

0.3679 0.4107 0.4681 0.5470 0.5590

0.6189 0.6550 0.7280 0.8739 0.9122

0.9637 0.9960 0.9974 0.9987 1.0000

Transect Link-8a

Area:

0.0008 0.0063 0.0181 0.0336 0.0514

0.0709 0.0937 0.1205 0.1520 0.1857

0.2252 0.2759 0.3273 0.3789 0.4307

0.4827 0.5350 0.5876 0.6408 0.6962

0.7543 0.8144 0.8753 0.9372 1.0000

Hrad:

0.0292 0.0442 0.0834 0.1359 0.1839

0.2196 0.2457 0.2675 0.3182 0.3667

0.3999 0.3393 0.4012 0.4628 0.5243

0.5842 0.6438 0.7031 0.7428 0.7826

0.8051 0.8610 0.9163 0.9660 1.0000

Width:

0.0311 0.1503 0.2256 0.2619 0.2970

0.3276 0.3841 0.4792 0.5166 0.5516

0.7502 0.8133 0.8161 0.8189 0.8216

0.8264 0.8311 0.8358 0.8626 0.8936

0.9457 0.9588 0.9719 0.9899 1.0000

Transect Link-9a

Area:

0.0011 0.0053 0.0110 0.0179 0.0271

0.0388 0.0544 0.0814 0.1124 0.1473

0.1863 0.2321 0.2808 0.3323 0.3851

0.4394 0.4952 0.5538 0.6139 0.6762

0.7399 0.8037 0.8680 0.9327 1.0000

Hrad:

0.0311 0.0735 0.1230 0.1703 0.1805

0.2344 0.2661 0.2541 0.2939 0.3260

0.3510 0.3932 0.4341 0.4859 0.5385

0.5680 0.6333 0.6846 0.7487 0.7496

0.8185 0.8846 0.9490 1.0131 1.0000

Width:

0.0355 0.0721 0.0899 0.1052 0.1554

0.1746 0.2968 0.4231 0.4709 0.5145

0.6150 0.6677 0.7210 0.7395 0.7580

0.7737 0.8173 0.8420 0.8624 0.9020

0.9039 0.9086 0.9146 0.9207 1.0000

Transect Link-10a

Area:

0.0006 0.0017 0.0039 0.0079 0.0126

0.0186 0.0265 0.0367 0.0481 0.0603

0.0736 0.0993 0.1534 0.2117 0.2721

0.3365 0.4034 0.4732 0.5474 0.6220

0.6970 0.7723 0.8480 0.9239 1.0000

Hrad:

0.0507 0.0920 0.1216 0.1413 0.1939

0.1957 0.2415 0.2927 0.3447 0.3965

0.4255 0.4108 0.3390 0.3620 0.4009

0.4063 0.4748 0.5080 0.5605 0.6340

0.7073 0.7803 0.8530 0.9248 1.0000

Width:

| | | | | |
|---|---|---|---|---|
| 0.0109 | 0.0181 | 0.0446 | 0.0562 | 0.0651 |
| 0.0951 | 0.1223 | 0.1439 | 0.1553 | 0.1666 |
| 0.1855 | 0.5798 | 0.7580 | 0.7779 | 0.8222 |
| 0.8618 | 0.8929 | 0.9684 | 0.9781 | 0.9829 |
| 0.9876 | 0.9922 | 0.9968 | 0.9992 | 1.0000 |

Transect Link-11a

Area:

| | | | | |
|---|---|---|---|---|
| 0.0004 | 0.0019 | 0.0043 | 0.0076 | 0.0122 |
| 0.0177 | 0.0247 | 0.0397 | 0.0786 | 0.1302 |
| 0.1836 | 0.2385 | 0.2951 | 0.3525 | 0.4102 |
| 0.4682 | 0.5263 | 0.5849 | 0.6439 | 0.7029 |
| 0.7621 | 0.8213 | 0.8807 | 0.9403 | 1.0000 |

Hrad:

| | | | | |
|---|---|---|---|---|
| 0.0287 | 0.0543 | 0.0940 | 0.1204 | 0.1477 |
| 0.1728 | 0.2038 | 0.1965 | 0.0956 | 0.1488 |
| 0.2071 | 0.2640 | 0.3079 | 0.3662 | 0.4240 |
| 0.4818 | 0.5405 | 0.5933 | 0.6523 | 0.7113 |
| 0.7699 | 0.8277 | 0.8853 | 0.9427 | 1.0000 |

Width:

| | | | | |
|---|---|---|---|---|
| 0.0159 | 0.0347 | 0.0455 | 0.0664 | 0.0852 |
| 0.1043 | 0.1422 | 0.3956 | 0.8289 | 0.8781 |
| 0.9034 | 0.9311 | 0.9585 | 0.9624 | 0.9675 |
| 0.9717 | 0.9738 | 0.9859 | 0.9871 | 0.9883 |
| 0.9898 | 0.9923 | 0.9949 | 0.9974 | 1.0000 |

Transect Link-12a

Area:

0.0005 0.0021 0.0058 0.0112 0.0182

0.0275 0.0390 0.0537 0.0700 0.0880

0.1071 0.1268 0.1470 0.1685 0.1949

0.2404 0.3129 0.3973 0.4820 0.5670

0.6525 0.7386 0.8252 0.9124 1.0000

Hrad:

0.0440 0.0689 0.1139 0.1586 0.2202

0.2704 0.2985 0.3393 0.3813 0.4108

0.4840 0.5572 0.6286 0.6823 0.6527

0.4954 0.3260 0.4122 0.4983 0.5839

0.6674 0.7503 0.8334 0.9160 1.0000

Width:

0.0107 0.0306 0.0506 0.0706 0.0969

0.1161 0.1499 0.1754 0.1951 0.2141

0.2211 0.2274 0.2337 0.2789 0.3400

0.6827 0.9600 0.9640 0.9674 0.9712

0.9779 0.9845 0.9903 0.9962 1.0000

Transect Link-13a

Area:

0.0015 0.0065 0.0128 0.0197 0.0270

0.0349 0.0434 0.0538 0.0669 0.0814

0.0970 0.1134 0.1307 0.1487 0.1831

0.2575 0.3340 0.4122 0.4938 0.5760

0.6596 0.7437 0.8282 0.9136 1.0000

Hrad:

0.0363 0.0955 0.1670 0.2402 0.3073

0.3707 0.4252 0.3945 0.4502 0.5109

0.5744 0.6347 0.6982 0.7610 0.7310

0.2912 0.3764 0.4562 0.5218 0.6065

0.6792 0.7629 0.8463 0.9158 1.0000

Width:

0.0403 0.0681 0.0766 0.0818 0.0878

0.0941 0.1046 0.1423 0.1589 0.1761

0.1840 0.1969 0.2032 0.2282 0.7337

0.8841 0.8875 0.9385 0.9464 0.9573

0.9711 0.9749 0.9786 0.9976 1.0000

Transect Link-14a

Area:

0.0005 0.0027 0.0056 0.0089 0.0125

0.0165 0.0210 0.0259 0.0335 0.0448

0.0740 0.1306 0.1948 0.2596 0.3246

0.3896 0.4548 0.5201 0.5856 0.6512

0.7170 0.7830 0.8491 0.9206 1.0000

Hrad:

0.0299 0.0832 0.1500 0.2132 0.2724

0.3286 0.3798 0.4271 0.4170 0.4201

0.2990 0.1664 0.2431 0.3235 0.4036

0.4837 0.5636 0.6434 0.7224 0.8012

0.8798 0.9582 1.0370 0.9584 1.0000

Width:

0.0185 0.0330 0.0383 0.0429 0.0474

0.0520 0.0574 0.0666 0.1114 0.2053

0.5221 0.7853 0.8012 0.8026 0.8041

0.8056 0.8070 0.8084 0.8106 0.8127

0.8149 0.8170 0.8188 0.9606 1.0000

Transect Link-15a

Area:

0.0010 0.0041 0.0102 0.0196 0.0330

0.0485 0.0674 0.0911 0.1174 0.1462

0.1764 0.2081 0.2415 0.2797 0.3267

0.3833 0.4479 0.5127 0.5776 0.6437

0.7110 0.7809 0.8532 0.9262 1.0000

Hrad:

0.0407 0.0716 0.1179 0.1458 0.1858

0.2360 0.2720 0.2753 0.3272 0.3883

0.4469 0.5032 0.5568 0.5902 0.6216

0.5914 0.5120 0.5848 0.6574 0.7284

0.7983 0.8040 0.8752 0.9373 1.0000

Width:

0.0249 0.0648 0.1064 0.1594 0.1980

0.2308 0.2830 0.3405 0.3767 0.3992

0.4186 0.4388 0.4663 0.5912 0.6789

0.8546 0.8750 0.8768 0.8810 0.9051

0.9154 0.9744 0.9802 0.9953 1.0000

Transect Link-16a

Area:

0.0007 0.0022 0.0041 0.0063 0.0089

0.0117 0.0148 0.0184 0.0252 0.0374

0.0546 0.0750 0.1000 0.1329 0.1815

0.2406 0.3029 0.3678 0.4470 0.5371

0.6290 0.7213 0.8138 0.9066 1.0000

Hrad:

0.0471 0.1200 0.1833 0.2450 0.3059

0.3639 0.4169 0.4373 0.2621 0.2462

0.3016 0.3486 0.3900 0.4160 0.3814

0.4256 0.4778 0.5364 0.4667 0.5558

0.6371 0.7294 0.8201 0.9103 1.0000

Width:

0.0142 0.0182 0.0221 0.0256 0.0287

0.0319 0.0352 0.0418 0.1052 0.1677

0.2002 0.2378 0.3007 0.4371 0.6031

0.6478 0.6790 0.7141 0.9564 0.9729

0.9856 0.9868 0.9900 0.9950 1.0000

Transect Link-17a

Area:

0.0029 0.0102 0.0220 0.0371 0.0541

0.0726 0.0928 0.1142 0.1365 0.1595

0.1831 0.2072 0.2318 0.2568 0.2821

0.3105 0.3463 0.3891 0.4394 0.4960

0.5713 0.6543 0.7519 0.8754 1.0000

Hrad:

0.0732 0.1417 0.1962 0.2883 0.3789

0.4715 0.5512 0.6512 0.7524 0.8543

0.9551 1.0582 1.1643 1.2724 1.3803

1.4690 1.5211 1.5517 1.5418 1.4567

0.8699 0.9533 0.7703 0.8779 1.0000

Width:

| | | | | |
|---|---|---|---|---|
| 0.0454 | 0.0719 | 0.1125 | 0.1290 | 0.1429 |
| 0.1543 | 0.1685 | 0.1756 | 0.1815 | 0.1867 |
| 0.1916 | 0.1957 | 0.1989 | 0.2014 | 0.2038 |
| 0.2508 | 0.3107 | 0.3694 | 0.4360 | 0.4738 |
| 0.6565 | 0.6861 | 0.9766 | 0.9976 | 1.0000 |

Transect Link-18a

Area:

| | | | | |
|---|---|---|---|---|
| 0.0007 | 0.0026 | 0.0073 | 0.0173 | 0.0327 |
| 0.0577 | 0.0892 | 0.1252 | 0.1629 | 0.2017 |
| 0.2421 | 0.2846 | 0.3282 | 0.3746 | 0.4255 |
| 0.4789 | 0.5342 | 0.5911 | 0.6486 | 0.7066 |
| 0.7650 | 0.8236 | 0.8824 | 0.9411 | 1.0000 |

Hrad:

| | | | | |
|---|---|---|---|---|
| 0.0355 | 0.0615 | 0.0731 | 0.0892 | 0.1103 |
| 0.1188 | 0.1651 | 0.2016 | 0.2510 | 0.3069 |
| 0.3572 | 0.3934 | 0.4385 | 0.4655 | 0.4825 |
| 0.5219 | 0.5639 | 0.6117 | 0.6662 | 0.7204 |
| 0.7743 | 0.8316 | 0.8898 | 0.9480 | 1.0000 |

Width:

| | | | | |
|---|---|---|---|---|
| 0.0209 | 0.0518 | 0.1205 | 0.2162 | 0.3006 |
| 0.4864 | 0.5779 | 0.6220 | 0.6502 | 0.6614 |
| 0.7099 | 0.7244 | 0.7496 | 0.8278 | 0.8833 |
| 0.9188 | 0.9487 | 0.9677 | 0.9749 | 0.9820 |
| 0.9892 | 0.9913 | 0.9922 | 0.9931 | 1.0000 |

Transect Link-19a

Area:

0.0026 0.0106 0.0220 0.0384 0.0574

0.0777 0.0995 0.1231 0.1479 0.1738

0.2007 0.2282 0.2563 0.2873 0.3213

0.3622 0.4163 0.4758 0.5366 0.6051

0.6813 0.7591 0.8382 0.9185 1.0000

Hrad:

0.0396 0.0917 0.1377 0.1727 0.2396

0.3059 0.3592 0.4160 0.4790 0.5411

0.6045 0.6760 0.7458 0.8005 0.8476

0.8788 0.5787 0.6525 0.7251 0.6595

0.7266 0.7940 0.8635 0.9322 1.0000

Width:

0.0655 0.1161 0.1675 0.2224 0.2398

0.2541 0.2770 0.2959 0.3089 0.3212

0.3320 0.3375 0.3586 0.3940 0.4390

0.5720 0.7192 0.7293 0.7529 0.9175

0.9376 0.9560 0.9707 0.9853 1.0000

Transect Link-20a

Area:

0.0066 0.0197 0.0369 0.0572 0.0807

0.1068 0.1358 0.1671 0.2003 0.2354

0.2722 0.3107 0.3516 0.3943 0.4391

0.4857 0.5338 0.5835 0.6345 0.6881

0.7440 0.8013 0.8619 0.9278 1.0000

Hrad:

0.0451 0.1009 0.1529 0.2014 0.2579

0.3152 0.3661 0.4193 0.4733 0.5277

0.5821 0.6345 0.6848 0.7353 0.7838

0.8333 0.8823 0.9323 0.9853 0.9959

1.0510 1.0934 1.0995 1.1127 1.0000

Width:

0.1462 0.1957 0.2417 0.2846 0.3173

0.3529 0.3881 0.4142 0.4383 0.4608

0.4825 0.5083 0.5368 0.5609 0.5869

0.6069 0.6269 0.6460 0.6632 0.7077

0.7248 0.7512 0.8038 0.8932 1.0000

Transect Link-21a

Area:

0.0006 0.0025 0.0056 0.0100 0.0160

0.0285 0.0510 0.0772 0.1050 0.1345

0.1660 0.2009 0.2392 0.2813 0.3322

0.3895 0.4506 0.5151 0.5810 0.6480

0.7161 0.7854 0.8558 0.9274 1.0000

Hrad:

0.0365 0.0730 0.1095 0.1407 0.1699

0.1624 0.1478 0.2095 0.2682 0.3255

0.3669 0.4026 0.4384 0.4412 0.4436

0.4824 0.5241 0.5778 0.6404 0.7022

0.7631 0.8232 0.8825 0.9413 1.0000

Width:

0.0169 0.0339 0.0508 0.0707 0.0951

0.2283 0.3460 0.3692 0.3924 0.4140

0.4535 0.5001 0.5467 0.6390 0.7508

0.8093 0.8616 0.8933 0.9088 0.9243

0.9398 0.9553 0.9708 0.9859 1.0000

Transect Link-22a

Area:

0.0006 0.0025 0.0056 0.0100 0.0160

0.0285 0.0510 0.0772 0.1050 0.1345

0.1660 0.2009 0.2392 0.2813 0.3322

0.3895 0.4506 0.5151 0.5810 0.6480

0.7161 0.7854 0.8558 0.9274 1.0000

Hrad:

0.0365 0.0730 0.1095 0.1407 0.1699

0.1624 0.1478 0.2095 0.2682 0.3255

0.3669 0.4026 0.4384 0.4412 0.4436

0.4824 0.5241 0.5778 0.6404 0.7022

0.7631 0.8232 0.8825 0.9413 1.0000

Width:

0.0169 0.0339 0.0508 0.0707 0.0951

0.2283 0.3460 0.3692 0.3924 0.4140

0.4535 0.5001 0.5467 0.6390 0.7508

0.8093 0.8616 0.8933 0.9088 0.9243

0.9398 0.9553 0.9708 0.9859 1.0000

Transect Link-23a

Area:

0.0047 0.0166 0.0317 0.0489 0.0690

0.0920 0.1178 0.1464 0.1783 0.2141

0.2541 0.2990 0.3458 0.3935 0.4419

0.4912 0.5412 0.5920 0.6436 0.6961

0.7508 0.8076 0.8661 0.9300 1.0000

Hrad:

0.0640 0.0799 0.1414 0.1844 0.2256

0.2656 0.3046 0.3428 0.3705 0.3974

0.4258 0.4534 0.5151 0.5758 0.6362

0.6958 0.7545 0.8125 0.8698 0.9261

0.9796 0.9784 1.0304 0.9368 1.0000

Width:

0.0732 0.2085 0.2247 0.2658 0.3066

0.3470 0.3874 0.4278 0.4820 0.5400

0.5980 0.6607 0.6726 0.6844 0.6955

0.7066 0.7177 0.7289 0.7400 0.7622

0.7938 0.8250 0.8400 0.9928 1.0000

Transect Link-24a

Area:

0.0090 0.0263 0.0516 0.0846 0.1210

0.1588 0.1977 0.2375 0.2785 0.3205

0.3637 0.4075 0.4516 0.4960 0.5406

0.5854 0.6305 0.6758 0.7214 0.7672

0.8133 0.8596 0.9061 0.9529 1.0000

Hrad:

0.0326 0.0626 0.0887 0.1128 0.1545

0.1967 0.2385 0.2794 0.3188 0.3571

0.3948 0.4397 0.4844 0.5287 0.5728

0.6166 0.6602 0.7035 0.7466 0.7894

0.8320 0.8744 0.9165 0.9583 1.0000

Width:

| | | | | |
|---|---|---|---|---|
| 0.2796 | 0.4237 | 0.5856 | 0.7552 | 0.7885 |
| 0.8131 | 0.8346 | 0.8560 | 0.8791 | 0.9032 |
| 0.9269 | 0.9321 | 0.9374 | 0.9426 | 0.9478 |
| 0.9530 | 0.9582 | 0.9635 | 0.9687 | 0.9739 |
| 0.9791 | 0.9843 | 0.9896 | 0.9948 | 1.0000 |

Transect Link-25a

Area:

| | | | | |
|---|---|---|---|---|
| 0.0008 | 0.0026 | 0.0064 | 0.0133 | 0.0217 |
| 0.0351 | 0.0520 | 0.0705 | 0.0903 | 0.1119 |
| 0.1339 | 0.1561 | 0.1787 | 0.2023 | 0.2276 |
| 0.2833 | 0.3589 | 0.4363 | 0.5144 | 0.5930 |
| 0.6722 | 0.7520 | 0.8334 | 0.9165 | 1.0000 |

Hrad:

| | | | | |
|---|---|---|---|---|
| 0.0617 | 0.0881 | 0.1111 | 0.1475 | 0.1699 |
| 0.1922 | 0.2385 | 0.3154 | 0.3534 | 0.4301 |
| 0.5066 | 0.5838 | 0.6471 | 0.6964 | 0.6432 |
| 0.3220 | 0.3886 | 0.4691 | 0.5490 | 0.6283 |
| 0.7070 | 0.7853 | 0.8393 | 0.9198 | 1.0000 |

Width:

| | | | | |
|---|---|---|---|---|
| 0.0136 | 0.0294 | 0.0579 | 0.0903 | 0.1279 |
| 0.1826 | 0.2181 | 0.2235 | 0.2556 | 0.2602 |
| 0.2642 | 0.2673 | 0.2761 | 0.2905 | 0.3537 |
| 0.8799 | 0.9235 | 0.9302 | 0.9370 | 0.9439 |
| 0.9508 | 0.9577 | 0.9930 | 0.9965 | 1.0000 |

Transect Link-26a

Area:

0.0008 0.0026 0.0064 0.0133 0.0217

0.0351 0.0520 0.0705 0.0903 0.1119

0.1339 0.1561 0.1787 0.2023 0.2276

0.2833 0.3589 0.4363 0.5144 0.5930

0.6722 0.7520 0.8334 0.9165 1.0000

Hrad:

0.0617 0.0881 0.1111 0.1475 0.1699

0.1922 0.2385 0.3154 0.3534 0.4301

0.5066 0.5838 0.6471 0.6964 0.6432

0.3220 0.3886 0.4691 0.5490 0.6283

0.7070 0.7853 0.8393 0.9198 1.0000

Width:

0.0136 0.0294 0.0579 0.0903 0.1279

0.1826 0.2181 0.2235 0.2556 0.2602

0.2642 0.2673 0.2761 0.2905 0.3537

0.8799 0.9235 0.9302 0.9370 0.9439

0.9508 0.9577 0.9930 0.9965 1.0000

Transect Link-27a

Area:

0.0032 0.0099 0.0194 0.0315 0.0463

0.0653 0.0890 0.1147 0.1420 0.1709

0.2009 0.2319 0.2638 0.2965 0.3299

0.3643 0.4026 0.4439 0.4907 0.5500

0.6168 0.6965 0.7893 0.8899 1.0000

Hrad:

0.0704 0.1379 0.2046 0.2676 0.3160

0.3441 0.4038 0.4899 0.5726 0.6576

0.7454 0.8334 0.9256 1.0161 1.1050

1.1302 1.1493 1.1461 1.0825 0.9807

0.9960 0.8886 0.9250 0.9592 1.0000

Width:

0.0460 0.0721 0.0949 0.1176 0.1465

0.1899 0.2203 0.2342 0.2481 0.2598

0.2694 0.2781 0.2847 0.2913 0.2980

0.3217 0.3496 0.3867 0.4527 0.5603

0.6189 0.7836 0.8531 0.9276 1.0000

Transect Link-28a

Area:

0.0042 0.0140 0.0275 0.0439 0.0632

0.0840 0.1066 0.1321 0.1624 0.1984

0.2377 0.2805 0.3269 0.3778 0.4323

0.4878 0.5435 0.5996 0.6559 0.7125

0.7694 0.8267 0.8841 0.9419 1.0000

Hrad:

0.0281 0.0710 0.1051 0.1422 0.1806

0.2305 0.2655 0.2863 0.2776 0.3056

0.3412 0.3687 0.3959 0.4169 0.4552

0.5108 0.5662 0.6213 0.6762 0.7307

0.7850 0.8390 0.8927 0.9462 1.0000

Width:

0.1501 0.1978 0.2618 0.3095 0.3502

0.3648 0.4020 0.4620 0.5860 0.6500

0.6977 0.7617 0.8267 0.9072 0.9509

0.9558 0.9608 0.9658 0.9707 0.9757

0.9807 0.9856 0.9906 0.9956 1.0000

Transect Link-29a

Area:

0.0025 0.0086 0.0181 0.0315 0.0487

0.0773 0.1114 0.1474 0.1852 0.2244

0.2655 0.3087 0.3569 0.4078 0.4598

0.5124 0.5655 0.6191 0.6730 0.7271

0.7813 0.8357 0.8903 0.9450 1.0000

Hrad:

0.0306 0.0689 0.0924 0.1198 0.1425

0.1306 0.1751 0.2195 0.2662 0.3074

0.3458 0.3708 0.3941 0.4340 0.4842

0.5340 0.5833 0.6340 0.6868 0.7395

0.7919 0.8442 0.8963 0.9482 1.0000

Width:

0.0830 0.1251 0.1963 0.2822 0.3421

0.5927 0.6368 0.6719 0.6963 0.7306

0.7685 0.8330 0.9061 0.9402 0.9503

0.9601 0.9700 0.9769 0.9802 0.9835

0.9868 0.9901 0.9934 0.9967 1.0000

**********

Control Actions Taken

**********

| ********** | Volume | Volume |
|---|---|---|
| Flow Routing Continuity | hectare-m | Mliters |
| ********** | --------- | --------- |
| Dry Weather Inflow ..... | 0.000 | 0.000 |
| Wet Weather Inflow ..... | 0.000 | 0.000 |
| Groundwater Inflow ..... | 0.000 | 0.000 |
| RDII Inflow ..... | 0.000 | 0.000 |
| External Inflow ..... | 609486.315 | 6094926.574 |
| External Outflow ..... | 129029.100 | 1290304.426 |
| Surface Flooding ..... | 290771.894 | 2907749.202 |
| Evaporation Loss ..... | 0.000 | 0.000 |
| Initial Stored Volume .... | 1252.832 | 12528.445 |
| Final Stored Volume ..... | 172419.935 | 1724217.296 |
| Continuity Error (%) ..... | 3.032 | |

**********

Node Depth Summary

**********

| Node | Average Depth Meters | Maximum Depth Meters | Maximum HGL Meters | Time of Max Occurrence days hr:min | Total Flooding ha-mm | Total Minutes Flooded |
|---|---|---|---|---|---|---|
| CS-77 | 9.62 | 11.36 | 16.61 | 0 01:36 | 0 | 0 |
| CS-78 | 11.93 | 13.03 | 15.88 | 0 03:05 | 0 | 0 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| CS-79 | 10.88 | 12.12 | 14.56 | 0 | 03:00 | 0 | 0 | |
| CS-80 | 11.68 | 14.47 | 15.55 | 0 | 03:11 | 0 | 0 | |
| CS-81 | 15.86 | 18.90 | 15.50 | 0 | 03:20 | 554993.31 | | 3 |
| CS-82 | 10.42 | 12.01 | 11.75 | 0 | 04:22 | 0 | 0 | |
| CS-83 | 9.94 | 11.47 | 10.79 | 0 | 10:21 | 0 | 0 | |
| CS-84 | 9.84 | 11.52 | 9.68 | 0 | 10:29 | 0 | 0 | |
| CS-85 | 9.24 | 10.98 | 9.16 | 0 | 10:37 | 0 | 0 | |
| CS-86 | 10.83 | 12.89 | 9.13 | 0 | 10:47 | 0 | 0 | |
| CS-87 | 9.44 | 11.58 | 8.80 | 0 | 11:45 | 0 | 0 | |
| CS-88 | 14.40 | 17.63 | 8.81 | 0 | 11:04 | 0 | 0 | |
| CS-89 | 12.57 | 15.49 | 8.44 | 0 | 11:14 | 0 | 0 | |
| CS-90 | 8.94 | 11.37 | 7.01 | 0 | 06:25 | 0 | 0 | |
| CS-91 | 9.04 | 11.03 | 6.57 | 0 | 06:20 | 0 | 0 | |
| CS-92 | 17.20 | 19.98 | 6.50 | 0 | 06:00 | 0 | 0 | |
| CS-93 | 21.79 | 23.54 | 5.58 | 0 | 05:48 | 208309526.35 | | 1092 |
| CS-94 | 8.77 | 12.33 | 3.82 | 0 | 07:17 | 0 | 0 | |
| CS-95 | 11.87 | 14.73 | 3.39 | 0 | 07:08 | 76497.76 | | 2 |
| CS-98 | 14.27 | 14.73 | 1.15 | 0 | 00:26 | 57157667.65 | | 451 |
| CS-106 | 6.63 | 8.51 | 5.44 | 0 | 06:37 | 8487287.01 | | 1043 |
| CS-105 | 7.03 | 8.51 | 4.29 | 0 | 07:02 | 15623912.71 | | 1018 |
| CS-104 | 3.17 | 3.91 | 1.60 | 0 | 06:55 | 0 | 0 | |
| CS-100 | 3.33 | 6.60 | 3.54 | 0 | 07:16 | 554426.52 | | 13 |
| CS-101 | 8.25 | 11.31 | 3.63 | 0 | 07:17 | 15475.31 | | 3 |
| CS-102 | 5.29 | 7.90 | 3.21 | 0 | 07:33 | 0 | 0 | |
| CS-103 | 4.62 | 5.43 | 1.53 | 0 | 07:36 | 0 | 0 | |
| Outfall | 14.26 | 15.03 | 1.45 | 0 | 05:00 | 0 | 0 | |
| Outfall2 | 4.58 | 5.35 | 1.45 | 0 | 05:00 | 0 | 0 | |

**********

Conduit Flow Summary

**********

| Conduit | Maximum Flow CMS | Time of Max Occurrence days hr:min | Maximum Velocity m/sec | Length Factor | Maximum /Design Flow | Total Minutes Surcharged |
|---|---|---|---|---|---|---|
| Link-1 | 95286.37 | 0 01:16 | 6.96 | 1.00 | 0.27 | 0 |
| Link-2 | 71664.86 | 0 02:20 | 8.49 | 1.00 | 0.78 | 0 |
| Link-3 | 82485.73 | 0 03:07 | 17.43 | 1.00 | 0.52 | 0 |
| Link-4 | 130304.25 | 0 03:16 | 7.05 | 1.00 | 0.28 | 0 |
| Link-5 | 74467.96 | 0 04:18 | 9.01 | 1.00 | 0.36 | 0 |
| Link-6 | 74996.43 | 0 05:16 | 12.30 | 1.00 | 0.63 | 0 |
| Link-7 | 68303.70 | 0 04:33 | 6.69 | 1.00 | 0.47 | 0 |
| Link-8 | 69693.07 | 0 04:14 | 38.53 | 1.00 | 2.03 | 1263 |
| Link-9 | 71822.83 | 0 04:04 | 30.59 | 1.00 | 0.18 | 0 |
| Link-10 | 66595.72 | 0 04:19 | 7.06 | 1.00 | 0.22 | 0 |
| Link-11 | 83371.40 | 0 03:57 | >50.00 | 1.00 | 0.09 | 0 |
| Link-12 | 65020.76 | 0 11:08 | >50.00 | 1.00 | 0.21 | 0 |
| Link-13 | 64181.18 | 0 11:17 | >50.00 | 1.00 | 0.22 | 0 |
| Link-14 | 57637.68 | 0 12:23 | 3.77 | 1.00 | 0.97 | 0 |
| Link-15 | 58295.63 | 0 07:18 | 2.69 | 1.00 | 0.23 | 1109 |
| Link-16 | 59964.58 | 0 07:01 | 8.03 | 1.00 | 0.18 | 0 |
| Link-17 | 32591.02 | 0 05:34 | 9.23 | 1.00 | 0.12 | 0 |
| Link-18 | 61226.34 | 0 17:31 | 4.81 | 1.00 | 0.18 | 0 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Link-19 | 46347.85 | 0 | 07:36 | 5.25 | 1.00 | 0.46 | 2 |
| Link-20 | 64875.58 | 0 | 00:18 | 9.03 | 1.00 | 69.45 | 1440 |
| Link-21 | 7914.19 | 0 | 06:36 | 3.88 | 1.00 | 1.14 | 1071 |
| Link-22 | 5640.85 | 0 | 07:02 | 2.79 | 1.00 | 1.13 | 1041 |
| Link-23 | 2555.07 | 0 | 07:52 | 3.23 | 1.00 | 0.53 | 0 |
| Link-24 | 2990.01 | 0 | 08:08 | 4.50 | 1.00 | 0.35 | 0 |
| Link-25 | 9943.11 | 0 | 07:19 | 2.94 | 1.00 | 0.21 | 13 |
| Link-26 | 9683.31 | 0 | 15:52 | 3.20 | 1.00 | 0.18 | 13 |
| Link-27 | 4429.37 | 0 | 05:17 | 4.84 | 1.00 | 0.21 | 0 |
| Link-28 | 5747.82 | 0 | 07:43 | 3.52 | 1.00 | 0.37 | 0 |
| Link-29 | 9302.67 | 0 | 07:43 | 4.61 | 1.00 | 10.34 | 1400 |

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Flow Classification Summary

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| | --- Fraction of Time in Flow Class ---- | | | | | | Avg. | Avg. |
|---|---|---|---|---|---|---|---|---|
| Conduit | Up Dry | Down Dry | Sub Dry | Sup Crit | Up Crit | Down Crit | Froude Number | Flow Change |
| Link-1 | 0.04 | 0.00 | 0.00 | 0.96 | 0.00 | 0.00 | 0.32 | 0.0001 |
| Link-2 | 0.04 | 0.00 | 0.00 | 0.93 | 0.03 | 0.00 | 0.78 | 0.0002 |
| Link-3 | 0.04 | 0.00 | 0.00 | 0.95 | 0.00 | 0.00 | 0.42 | 0.0003 |
| Link-4 | 0.05 | 0.00 | 0.00 | 0.94 | 0.01 | 0.00 | 0.32 | 0.0006 |
| Link-5 | 0.06 | 0.02 | 0.00 | 0.14 | 0.79 | 0.00 | 0.97 | 0.0002 |
| Link-6 | 0.08 | 0.00 | 0.00 | 0.92 | 0.00 | 0.00 | 0.50 | 0.0004 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Link-7 | 0.08 | 0.00 | 0.00 | 0.92 | 0.00 | 0.00 | 0.00 | 0.70 | 0.0001 |
| Link-8 | 0.09 | 0.01 | 0.00 | 0.89 | 0.01 | 0.00 | 0.00 | 0.52 | 0.0005 |
| Link-9 | 0.10 | 0.00 | 0.00 | 0.90 | 0.00 | 0.00 | 0.00 | 0.25 | 0.0000 |
| Link-10 | 0.10 | 0.02 | 0.00 | 0.83 | 0.05 | 0.00 | 0.00 | 0.35 | 0.0000 |
| Link-11 | 0.12 | 0.00 | 0.00 | 0.85 | 0.02 | 0.00 | 0.00 | 0.16 | 0.0000 |
| Link-12 | 0.10 | 0.00 | 0.00 | 0.90 | 0.00 | 0.00 | 0.00 | 0.28 | 0.0000 |
| Link-13 | 0.08 | 0.00 | 0.00 | 0.92 | 0.00 | 0.00 | 0.00 | 0.43 | 0.0000 |
| Link-14 | 0.08 | 0.00 | 0.00 | 0.92 | 0.00 | 0.00 | 0.00 | 0.31 | 0.0001 |
| Link-15 | 0.04 | 0.04 | 0.00 | 0.92 | 0.00 | 0.00 | 0.00 | 0.22 | 0.0000 |
| Link-16 | 0.02 | 0.02 | 0.00 | 0.94 | 0.02 | 0.00 | 0.00 | 0.28 | 0.0000 |
| Link-17 | 0.01 | 0.00 | 0.00 | 0.97 | 0.02 | 0.00 | 0.00 | 0.52 | 0.0001 |
| Link-18 | 0.00 | 0.01 | 0.00 | 0.99 | 0.00 | 0.00 | 0.00 | 0.28 | 0.0007 |
| Link-19 | 0.00 | 0.00 | 0.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.30 | 0.0005 |
| Link-20 | 0.00 | 0.00 | 0.00 | 0.99 | 0.01 | 0.00 | 0.00 | 0.24 | 0.0279 |
| Link-21 | 0.06 | 0.00 | 0.00 | 0.94 | 0.00 | 0.00 | 0.00 | 0.31 | 0.0001 |
| Link-22 | 0.01 | 0.05 | 0.00 | 0.94 | 0.00 | 0.00 | 0.00 | 0.25 | 0.0001 |
| Link-23 | 0.00 | 0.00 | 0.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.49 | 0.0001 |
| Link-24 | 0.00 | 0.00 | 0.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.55 | 0.0001 |
| Link-25 | 0.01 | 0.02 | 0.00 | 0.97 | 0.00 | 0.00 | 0.00 | 0.28 | 0.0007 |
| Link-26 | 0.00 | 0.03 | 0.00 | 0.97 | 0.00 | 0.00 | 0.00 | 0.34 | 0.0009 |
| Link-27 | 0.00 | 0.00 | 0.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.28 | 0.0003 |
| Link-28 | 0.00 | 0.00 | 0.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.24 | 0.0002 |
| Link-29 | 0.00 | 0.00 | 0.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.27 | 0.0112 |

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Highest Continuity Errors

**********

Node CS-92 (5.45%)

Node CS-91 (4.07%)

Node CS-90 (3.28%)

Node CS-102 (2.87%)

Node CS-98 (2.44%)

**********

Time-Step Critical Elements

**********

None

**********

Routing Time Step Summary

**********

Minimum Time Step : 5.00 sec

Average Time Step : 5.00 sec

Maximum Time Step : 5.00 sec

Percent in Steady State : 0.00

Average Iterations per Step : 2.00

Analysis begun on: Mon Aug 04 18:04:59 2014

Total elapsed time: 00:00:03

Banks rised

EPA STORM WATER MANAGEMENT MODEL - VERSION 5.0 (Build 5.0.006a)

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Analysis Options

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Flow Units ..... CMS

Flow Routing Method ..... DYNWAVE

Starting Date ..... JUL-29-2014 00:00:00

Ending Date ..... JUL-30-2014 00:00:00

Antecedent Dry Days ..... 4.0

Report Time Step ..... 00:01:00

Routing Time Step ..... 5.00 sec

**********

Element Count

**********

Number of rain gages ..... 0

Number of subcatchments ... 0

Number of nodes ..... 29

Number of links ..... 29

Number of pollutants ..... 0

Number of land uses ..... 0

**********

Node Summary

**********

| Name | Type | Invert | Depth |
|---|---|---|---|
| CS-77 | JUNCTION | 5.25 | 17.76 |
| CS-78 | JUNCTION | 2.85 | 19.08 |
| CS-79 | JUNCTION | 2.44 | 19.08 |
| CS-80 | JUNCTION | 1.07 | 18.11 |
| CS-81 | JUNCTION | -3.41 | 21.91 |
| CS-82 | JUNCTION | -0.26 | 21.91 |
| CS-83 | JUNCTION | -0.68 | 18.31 |
| CS-84 | JUNCTION | -1.84 | 18.05 |
| CS-85 | JUNCTION | -1.81 | 18.05 |
| CS-86 | JUNCTION | -3.76 | 18.08 |
| CS-87 | JUNCTION | -2.78 | 18.08 |
| CS-88 | JUNCTION | -8.82 | 21.10 |
| CS-89 | JUNCTION | -7.05 | 21.10 |
| CS-90 | JUNCTION | -4.36 | 19.53 |
| CS-91 | JUNCTION | -4.47 | 16.80 |
| CS-92 | JUNCTION | -13.48 | 21.61 |
| CS-93 | JUNCTION | -17.96 | 26.54 |
| CS-94 | JUNCTION | -8.50 | 26.54 |
| CS-95 | JUNCTION | -11.34 | 17.73 |
| CS-98 | JUNCTION | -13.58 | 17.73 |
| CS-106 | JUNCTION | -3.07 | 11.51 |

| | | | |
|---|---|---|---|
| CS-105 | JUNCTION | -4.22 | 11.51 |
| CS-104 | JUNCTION | -2.31 | 10.91 |
| CS-100 | JUNCTION | -3.06 | 9.60 |
| CS-101 | JUNCTION | -7.68 | 14.31 |
| CS-102 | JUNCTION | -4.69 | 14.31 |
| CS-103 | JUNCTION | -3.90 | 11.17 |
| Outfall | OUTFALL | -13.58 | 16.80 |
| Outfall2 | OUTFALL | -3.90 | 10.31 |

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Link Summary

**********

| Name | From Node | To Node | Type | Length | %Slope | N |
|---|---|---|---|---|---|---|
| Link-1 | CS-77 | CS-78 | CONDUIT | 3534 | 0.0678 | 0.0100 |
| Link-2 | CS-78 | CS-79 | CONDUIT | 4343 | 0.0095 | 0.0100 |
| Link-3 | CS-79 | CS-80 | CONDUIT | 5384 | 0.0254 | 0.0100 |
| Link-4 | CS-80 | CS-81 | CONDUIT | 2589 | 0.1730 | 0.0100 |
| Link-5 | CS-82 | CS-81 | CONDUIT | 4517 | 0.0696 | 0.0100 |
| Link-6 | CS-82 | CS-83 | CONDUIT | 3818 | 0.0109 | 0.0100 |
| Link-7 | CS-83 | CS-84 | CONDUIT | 4240 | 0.0274 | 0.0100 |
| Link-8 | CS-85 | CS-84 | CONDUIT | 2327 | 0.0011 | 0.0100 |
| Link-9 | CS-85 | CS-86 | CONDUIT | 4046 | 0.0481 | 0.0100 |
| Link-10 | CS-87 | CS-86 | CONDUIT | 3061 | 0.0320 | 0.0100 |
| Link-11 | CS-87 | CS-88 | CONDUIT | 4237 | 0.1425 | 0.0100 |
| Link-12 | CS-89 | CS-88 | CONDUIT | 2888 | 0.0613 | 0.0100 |
| Link-13 | CS-90 | CS-89 | CONDUIT | 5443 | 0.0494 | 0.0100 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Link-14 | CS-90 | CS-91 | CONDUIT | 6103 | 0.0017 | 0.0100 |
| Link-15 | CS-91 | CS-92 | CONDUIT | 6300 | 0.1432 | 0.0100 |
| Link-16 | CS-92 | CS-93 | CONDUIT | 4370 | 0.1024 | 0.0100 |
| Link-17 | CS-94 | CS-93 | CONDUIT | 4952 | 0.1909 | 0.0100 |
| Link-18 | CS-94 | CS-95 | CONDUIT | 2395 | 0.1186 | 0.0100 |
| Link-19 | CS-95 | CS-98 | CONDUIT | 6590 | 0.0339 | 0.0100 |
| Link-20 | CS-98 | Outfall | CONDUIT | 4000 | 0.0000 | 0.0100 |
| Link-21 | CS-106 | CS-90 | CONDUIT | 9101 | 0.0142 | 0.0100 |
| Link-22 | CS-106 | CS-105 | CONDUIT | 15655 | 0.0073 | 0.0100 |
| Link-23 | CS-104 | CS-105 | CONDUIT | 11049 | 0.0173 | 0.0100 |
| Link-24 | CS-104 | CS-103 | CONDUIT | 1700 | 0.0935 | 0.0100 |
| Link-25 | CS-100 | CS-94 | CONDUIT | 2586 | 0.2106 | 0.0100 |
| Link-26 | CS-100 | CS-101 | CONDUIT | 1645 | 0.2810 | 0.0100 |
| Link-27 | CS-102 | CS-101 | CONDUIT | 3823 | 0.0782 | 0.0100 |
| Link-28 | CS-103 | CS-102 | CONDUIT | 3761 | 0.0210 | 0.0100 |
| Link-29 | CS-103 | Outfall2 | CONDUIT | 1000 | 0.0000 | 0.0100 |

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Cross Section Summary

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| Conduit | Shape | Full Depth | Full Area | Hyd. Rad. | Max. Width | Full Flow |
|---|---|---|---|---|---|---|
| Link-1 | IRREGULAR | 17.76 | 41912.26 | 11.90 | 3505.00 | 568646.62 |
| Link-2 | IRREGULAR | 19.08 | 35527.30 | 10.16 | 3481.00 | 162713.25 |
| Link-3 | IRREGULAR | 17.20 | 33836.03 | 11.07 | 3040.00 | 267966.21 |
| Link-4 | IRREGULAR | 18.11 | 37786.57 | 11.04 | 3405.00 | 779427.67 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Link-5 | IRREGULAR | 21.91 | 33626.04 | 9.18 | 3645.00 | 389067.46 |
| Link-6 | IRREGULAR | 18.31 | 32911.60 | 12.57 | 2605.00 | 186166.20 |
| Link-7 | IRREGULAR | 17.69 | 33152.90 | 10.14 | 3250.00 | 256969.59 |
| Link-8 | IRREGULAR | 18.05 | 30557.83 | 12.41 | 2450.00 | 53698.73 |
| Link-9 | IRREGULAR | 17.42 | 61647.86 | 11.09 | 5535.00 | 672803.95 |
| Link-10 | IRREGULAR | 18.08 | 60123.23 | 10.86 | 5510.00 | 527238.47 |
| Link-11 | IRREGULAR | 16.86 | 74553.65 | 12.19 | 6090.00 | 1490730.45 |
| Link-12 | IRREGULAR | 21.10 | 41559.70 | 11.16 | 3705.00 | 513974.86 |
| Link-13 | IRREGULAR | 19.53 | 47187.72 | 10.57 | 4445.00 | 505227.66 |
| Link-14 | IRREGULAR | 16.80 | 57054.48 | 9.76 | 5820.00 | 108091.58 |
| Link-15 | IRREGULAR | 12.56 | 31814.63 | 7.90 | 4010.00 | 477532.57 |
| Link-16 | IRREGULAR | 21.61 | 28299.80 | 9.97 | 2820.00 | 419516.10 |
| Link-17 | IRREGULAR | 26.54 | 23167.30 | 10.43 | 2205.00 | 483435.65 |
| Link-18 | IRREGULAR | 17.69 | 27569.55 | 12.81 | 2140.00 | 519721.27 |
| Link-19 | IRREGULAR | 17.73 | 20769.56 | 10.04 | 2060.00 | 178027.62 |
| Link-20 | IRREGULAR | 16.80 | 13075.69 | 9.98 | 1302.00 | 1673.01 |
| Link-21 | IRREGULAR | 11.51 | 3363.82 | 7.38 | 450.00 | 15185.22 |
| Link-22 | IRREGULAR | 11.51 | 3363.82 | 7.38 | 450.00 | 10931.84 |
| Link-23 | IRREGULAR | 10.91 | 2224.24 | 7.31 | 300.00 | 11021.30 |
| Link-24 | IRREGULAR | 8.69 | 1581.52 | 7.51 | 205.00 | 18552.48 |
| Link-25 | IRREGULAR | 9.60 | 9455.76 | 6.11 | 1540.00 | 144998.55 |
| Link-26 | IRREGULAR | 9.60 | 9455.76 | 6.11 | 1540.00 | 167483.17 |
| Link-27 | IRREGULAR | 14.31 | 5120.80 | 6.79 | 750.00 | 51356.14 |
| Link-28 | IRREGULAR | 11.17 | 5211.85 | 8.47 | 610.00 | 31386.82 |
| Link-29 | IRREGULAR | 10.31 | 8354.81 | 8.22 | 1010.00 | 1878.58 |

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Transect Summary

**********

Transect Link-1a

Area:

| | | | | |
|---|---|---|---|---|
| 0.0052 | 0.0120 | 0.0217 | 0.0390 | 0.0660 |
| 0.0992 | 0.1342 | 0.1717 | 0.2126 | 0.2551 |
| 0.2979 | 0.3409 | 0.3842 | 0.4277 | 0.4715 |
| 0.5155 | 0.5598 | 0.6049 | 0.6515 | 0.7059 |
| 0.7642 | 0.8228 | 0.8816 | 0.9407 | 1.0000 |

Hrad:

| | | | | |
|---|---|---|---|---|
| 0.0528 | 0.0999 | 0.1301 | 0.1277 | 0.1495 |
| 0.1725 | 0.2279 | 0.2647 | 0.3098 | 0.3554 |
| 0.4127 | 0.4696 | 0.5265 | 0.5828 | 0.6389 |
| 0.6947 | 0.7500 | 0.7958 | 0.8366 | 0.7243 |
| 0.7764 | 0.8327 | 0.8887 | 0.9444 | 1.0000 |

Width:

| | | | | |
|---|---|---|---|---|
| 0.0983 | 0.1361 | 0.2216 | 0.3483 | 0.5208 |
| 0.5792 | 0.5969 | 0.6592 | 0.7069 | 0.7185 |
| 0.7226 | 0.7267 | 0.7305 | 0.7346 | 0.7386 |
| 0.7427 | 0.7516 | 0.7721 | 0.7965 | 0.9753 |
| 0.9850 | 0.9888 | 0.9925 | 0.9963 | 1.0000 |

Transect Link-2a

Area:

| | | | | |
|---|---|---|---|---|
| 0.0008 | 0.0029 | 0.0065 | 0.0117 | 0.0267 |
| 0.0465 | 0.0668 | 0.0876 | 0.1098 | 0.1331 |
| 0.1574 | 0.1831 | 0.2105 | 0.2468 | 0.2889 |

0.3416 0.4094 0.4823 0.5555 0.6290

0.7027 0.7766 0.8508 0.9253 1.0000

Hrad:

0.0381 0.0768 0.1194 0.1521 0.1025

0.1738 0.2435 0.3116 0.3755 0.4373

0.4955 0.5407 0.5975 0.6289 0.6546

0.5667 0.4204 0.4936 0.5666 0.6393

0.7118 0.7840 0.8560 0.9278 1.0000

Width:

0.0200 0.0383 0.0541 0.1476 0.2610

0.2677 0.2743 0.2853 0.3055 0.3182

0.3323 0.3537 0.4233 0.5164 0.6058

0.8274 0.9739 0.9772 0.9806 0.9839

0.9873 0.9906 0.9940 0.9973 1.0000

Transect Link-3a

Area:

0.0019 0.0074 0.0155 0.0271 0.0428

0.0668 0.0949 0.1243 0.1556 0.1893

0.2250 0.2624 0.3018 0.3448 0.3929

0.4496 0.5101 0.5708 0.6316 0.6926

0.7538 0.8151 0.8766 0.9382 1.0000

Hrad:

0.0262 0.0694 0.0998 0.1295 0.1459

0.1531 0.2081 0.2614 0.3087 0.3546

0.4002 0.4448 0.4861 0.5228 0.5489

0.4609 0.5208 0.5812 0.6414 0.7015

0.7614 0.8211 0.8807 0.9403 1.0000

Width:

| | | | | |
|---|---|---|---|---|
| 0.0716 | 0.1064 | 0.1623 | 0.2141 | 0.3150 |
| 0.4428 | 0.4649 | 0.4868 | 0.5253 | 0.5635 |
| 0.5918 | 0.6201 | 0.6580 | 0.7330 | 0.8323 |
| 0.9763 | 0.9802 | 0.9828 | 0.9853 | 0.9879 |
| 0.9905 | 0.9931 | 0.9957 | 0.9981 | 1.0000 |

Transect Link-4a

Area:

| | | | | |
|---|---|---|---|---|
| 0.0006 | 0.0024 | 0.0049 | 0.0091 | 0.0326 |
| 0.0631 | 0.0939 | 0.1249 | 0.1560 | 0.1873 |
| 0.2188 | 0.2503 | 0.2830 | 0.3222 | 0.3722 |
| 0.4290 | 0.4883 | 0.5498 | 0.6133 | 0.6770 |
| 0.7410 | 0.8053 | 0.8699 | 0.9348 | 1.0000 |

Hrad:

| | | | | |
|---|---|---|---|---|
| 0.0322 | 0.0722 | 0.1172 | 0.1220 | 0.0736 |
| 0.1341 | 0.1986 | 0.2627 | 0.3265 | 0.3900 |
| 0.4531 | 0.5160 | 0.5761 | 0.6207 | 0.6334 |
| 0.5724 | 0.6142 | 0.5686 | 0.6294 | 0.6918 |
| 0.7538 | 0.8156 | 0.8771 | 0.9383 | 1.0000 |

Width:

| | | | | |
|---|---|---|---|---|
| 0.0196 | 0.0334 | 0.0419 | 0.1536 | 0.4568 |
| 0.4710 | 0.4734 | 0.4757 | 0.4781 | 0.4805 |
| 0.4829 | 0.4852 | 0.5447 | 0.6770 | 0.8343 |
| 0.8925 | 0.9224 | 0.9672 | 0.9745 | 0.9789 |
| 0.9832 | 0.9876 | 0.9920 | 0.9964 | 1.0000 |

Transect Link-5a

Area:

0.0014 0.0038 0.0067 0.0099 0.0136

0.0177 0.0223 0.0292 0.0379 0.0497

0.0681 0.0891 0.1204 0.1567 0.1998

0.2463 0.3007 0.3658 0.4384 0.5297

0.6227 0.7163 0.8105 0.9051 1.0000

Hrad:

0.0596 0.1374 0.2067 0.2707 0.3310

0.3888 0.4013 0.3396 0.3851 0.3331

0.3274 0.3202 0.3430 0.3973 0.4527

0.5225 0.5729 0.6069 0.6281 0.5429

0.6340 0.7245 0.8147 0.9075 1.0000

Width:

0.0233 0.0278 0.0322 0.0366 0.0411

0.0455 0.0555 0.0858 0.0984 0.1489

0.2080 0.2782 0.3508 0.4335 0.4677

0.5270 0.6235 0.7233 0.8709 0.9758

0.9822 0.9887 0.9949 0.9975 1.0000

Transect Link-6a

Area:

0.0004 0.0018 0.0100 0.0265 0.0458

0.0669 0.0913 0.1206 0.1547 0.1951

0.2390 0.2838 0.3297 0.3778 0.4312

0.4867 0.5427 0.5992 0.6558 0.7127

0.7697 0.8270 0.8845 0.9421 1.0000

Hrad:

0.0291 0.0378 0.0535 0.0900 0.1343

0.1773 0.2005 0.2226 0.2556 0.2728

0.3213 0.3696 0.4174 0.4632 0.4532

0.5064 0.5590 0.6144 0.6701 0.7256

0.7808 0.8359 0.8908 0.9455 1.0000

Width:

0.0125 0.0478 0.2288 0.3147 0.3477

0.3808 0.4628 0.5546 0.6228 0.7474

0.7650 0.7829 0.8008 0.8845 0.9519

0.9616 0.9712 0.9755 0.9790 0.9825

0.9860 0.9895 0.9930 0.9965 1.0000

Transect Link-7a

Area:

0.0029 0.0083 0.0147 0.0220 0.0309

0.0462 0.0623 0.0800 0.1028 0.1296

0.1606 0.1975 0.2370 0.2806 0.3284

0.3860 0.4490 0.5160 0.5848 0.6538

0.7230 0.7921 0.8614 0.9307 1.0000

Hrad:

0.0409 0.0977 0.1496 0.1945 0.1809

0.2030 0.2670 0.3127 0.3510 0.3762

0.3973 0.3587 0.4186 0.4736 0.5224

0.5604 0.5812 0.5920 0.5887 0.6573

0.7259 0.7945 0.8631 0.9316 1.0000

Width:

0.0706 0.0855 0.0982 0.1134 0.1915

0.2282 0.2348 0.2794 0.3624 0.4126

0.4855 0.5515 0.6055 0.6490 0.7292

0.8825 0.9511 0.9839 0.9945 0.9957

0.9969 0.9977 0.9985 0.9992 1.0000

Transect Link-8a

Area:

0.0010 0.0080 0.0207 0.0364 0.0542

0.0753 0.1015 0.1314 0.1650 0.2108

0.2580 0.3053 0.3529 0.4008 0.4490

0.4980 0.5492 0.6031 0.6577 0.7128

0.7697 0.8270 0.8845 0.9422 1.0000

Hrad:

0.0266 0.0469 0.0883 0.1325 0.1680

0.1938 0.2201 0.2656 0.3017 0.2592

0.3160 0.3725 0.4281 0.4829 0.5373

0.5731 0.6109 0.6421 0.6941 0.7457

0.7786 0.8342 0.8896 0.9449 1.0000

Width:

0.0428 0.1845 0.2486 0.2916 0.3273

0.3913 0.4955 0.5374 0.7129 0.8133

0.8166 0.8199 0.8244 0.8301 0.8357

0.8690 0.8991 0.9394 0.9477 0.9560

0.9886 0.9915 0.9943 0.9972 1.0000

Transect Link-9a

Area:

0.0012 0.0055 0.0111 0.0186 0.0288

0.0441 0.0699 0.0994 0.1328 0.1733

0.2171 0.2632 0.3110 0.3601 0.4121

0.4657 0.5218 0.5784 0.6352 0.6921

0.7521 0.8136 0.8754 0.9375 1.0000

Hrad:

0.0300 0.0701 0.1117 0.1256 0.1737

0.1809 0.1993 0.2308 0.2631 0.2919

0.3298 0.3763 0.4026 0.4612 0.5086

0.5653 0.5779 0.6387 0.6989 0.7590

0.7679 0.8260 0.8838 0.9414 1.0000

Width:

0.0406 0.0787 0.1010 0.1522 0.1753

0.3575 0.4363 0.5030 0.6058 0.6693

0.7264 0.7480 0.7724 0.8132 0.8447

0.8694 0.9031 0.9057 0.9088 0.9119

0.9795 0.9850 0.9905 0.9959 1.0000

Transect Link-10a

Area:

0.0005 0.0016 0.0045 0.0084 0.0135

0.0206 0.0299 0.0401 0.0513 0.0718

0.1193 0.1706 0.2249 0.2825 0.3429

0.4076 0.4725 0.5377 0.6032 0.6691

0.7352 0.8014 0.8675 0.9338 1.0000

Hrad:

0.0428 0.0818 0.0837 0.1330 0.1419

0.1830 0.2275 0.2728 0.3095 0.2990

0.2483 0.2734 0.2742 0.3343 0.3687

0.4173 0.4815 0.5455 0.6093 0.6716

0.7374 0.8031 0.8688 0.9344 1.0000

Width:

0.0124 0.0224 0.0543 0.0635 0.0950

0.1252 0.1484 0.1620 0.1792 0.5756

0.7612 0.7862 0.8504 0.8896 0.9668

0.9775 0.9821 0.9865 0.9908 0.9971

0.9977 0.9983 0.9988 0.9994 1.0000

Transect Link-11a

Area:

0.0005 0.0022 0.0048 0.0087 0.0138

0.0210 0.0426 0.0880 0.1370 0.1877

0.2400 0.2928 0.3459 0.3992 0.4530

0.5072 0.5616 0.6161 0.6707 0.7254

0.7802 0.8350 0.8899 0.9449 1.0000

Hrad:

0.0272 0.0547 0.0879 0.1073 0.1316

0.1576 0.1195 0.1007 0.1546 0.2070

0.2506 0.3048 0.3585 0.4121 0.4610

0.5146 0.5681 0.6221 0.6763 0.7304

0.7845 0.8385 0.8924 0.9462 1.0000

Width:

0.0193 0.0394 0.0583 0.0840 0.1072

0.1995 0.6785 0.8744 0.9026 0.9341

0.9576 0.9609 0.9649 0.9688 0.9827

0.9856 0.9885 0.9904 0.9918 0.9932

0.9945 0.9959 0.9973 0.9986 1.0000

Transect Link-12a

Area:

0.0005 0.0023 0.0060 0.0114 0.0190

0.0287 0.0414 0.0557 0.0716 0.0883

0.1055 0.1237 0.1469 0.1913 0.2603

0.3328 0.4056 0.4788 0.5525 0.6265

0.7007 0.7752 0.8499 0.9248 1.0000

Hrad:

0.0377 0.0593 0.0925 0.1483 0.1935

0.2195 0.2540 0.2758 0.3294 0.3912

0.4544 0.5018 0.4421 0.3529 0.2707

0.3446 0.4188 0.4908 0.5627 0.6360

0.7091 0.7820 0.8547 0.9271 1.0000

Width:

0.0124 0.0387 0.0652 0.0814 0.1126

0.1495 0.1786 0.2017 0.2172 0.2255

0.2320 0.2785 0.3793 0.7217 0.9619

0.9662 0.9690 0.9759 0.9822 0.9853

0.9884 0.9915 0.9946 0.9977 1.0000

Transect Link-13a

Area:

0.0015 0.0063 0.0119 0.0179 0.0246

0.0318 0.0412 0.0527 0.0657 0.0794

0.0941 0.1099 0.1502 0.2152 0.2808

0.3499 0.4198 0.4911 0.5627 0.6346

0.7072 0.7800 0.8531 0.9265 1.0000

Hrad:

0.0345 0.0876 0.1492 0.2090 0.2625

0.3097 0.2935 0.3440 0.3969 0.4490

0.5027 0.5528 0.4539 0.2431 0.3131

0.3700 0.4419 0.5055 0.5775 0.6449

0.7160 0.7869 0.8576 0.9279 1.0000

Width:

0.0444 0.0716 0.0796 0.0859 0.0936

0.1057 0.1479 0.1657 0.1811 0.1950

0.2031 0.3009 0.8681 0.8852 0.9145

0.9458 0.9599 0.9715 0.9745 0.9841

0.9877 0.9913 0.9948 0.9984 1.0000

Transect Link-14a

Area:

0.0006 0.0027 0.0054 0.0084 0.0118

0.0156 0.0204 0.0285 0.0503 0.0986

0.1533 0.2083 0.2635 0.3187 0.3741

0.4296 0.4853 0.5410 0.5969 0.6595

0.7271 0.7951 0.8632 0.9315 1.0000

Hrad:

0.0284 0.0782 0.1335 0.1845 0.2320

0.2751 0.2913 0.2976 0.2100 0.1252

0.1912 0.2593 0.3272 0.3950 0.4628

0.5301 0.5972 0.6642 0.7310 0.6816

0.7347 0.8011 0.8672 0.9337 1.0000

Width:

0.0225 0.0356 0.0413 0.0469 0.0525

0.0590 0.0993 0.1556 0.5067 0.7883

0.8017 0.8035 0.8053 0.8071 0.8085

0.8105 0.8125 0.8146 0.8166 0.9675

0.9897 0.9925 0.9954 0.9977 1.0000

Transect Link-15a

Area:

0.0010 0.0047 0.0116 0.0227 0.0364

0.0543 0.0761 0.1006 0.1267 0.1544

0.1853 0.2252 0.2757 0.3311 0.3867

0.4432 0.5011 0.5620 0.6237 0.6857

0.7479 0.8105 0.8736 0.9367 1.0000

Hrad:

0.0370 0.0668 0.0950 0.1275 0.1691

0.1848 0.2141 0.2666 0.3163 0.3636

0.3979 0.4249 0.3156 0.3780 0.4402

0.5011 0.5468 0.5779 0.6390 0.6997

0.7584 0.8167 0.8763 0.9382 1.0000

Width:

0.0279 0.0807 0.1452 0.1985 0.2433

0.3210 0.3716 0.4002 0.4248 0.4531

0.5759 0.6863 0.8737 0.8761 0.8784

0.9061 0.9415 0.9726 0.9761 0.9799

0.9862 0.9925 0.9969 0.9984 1.0000

Transect Link-16a

Area:

0.0007 0.0021 0.0039 0.0060 0.0084

0.0112 0.0142 0.0184 0.0278 0.0423

0.0603 0.0823 0.1115 0.1555 0.2100

0.2675 0.3279 0.4052 0.4883 0.5727

0.6575 0.7426 0.8281 0.9140 1.0000

Hrad:

0.0455 0.1115 0.1688 0.2262 0.2814

0.3341 0.3657 0.2992 0.2539 0.2477

0.2883 0.3301 0.3588 0.3283 0.3695

0.4192 0.4717 0.4237 0.5075 0.5836

0.6673 0.7499 0.8326 0.9162 1.0000

Width:

0.0145 0.0187 0.0229 0.0265 0.0298

0.0332 0.0386 0.0787 0.1325 0.1898

0.2286 0.2920 0.4162 0.6025 0.6494

0.6819 0.7334 0.9572 0.9754 0.9823

0.9861 0.9912 0.9953 0.9979 1.0000

Transect Link-17a

Area:

0.0027 0.0090 0.0198 0.0327 0.0472

0.0631 0.0804 0.0984 0.1171 0.1363

0.1560 0.1761 0.1964 0.2184 0.2464

0.2809 0.3223 0.3695 0.4354 0.5051

0.5993 0.6985 0.7984 0.8990 1.0000

Hrad:

0.0531 0.1135 0.1669 0.2410 0.3149

0.3830 0.4606 0.5424 0.6249 0.7072

0.7903 0.8784 0.9659 1.0445 1.0909

1.1164 1.1066 0.9940 0.6605 0.6957

0.6131 0.7095 0.8052 0.9004 1.0000

Width:

| | | | | |
|---|---|---|---|---|
| 0.0502 | 0.0799 | 0.1189 | 0.1361 | 0.1504 |
| 0.1652 | 0.1748 | 0.1816 | 0.1874 | 0.1927 |
| 0.1973 | 0.2002 | 0.2030 | 0.2448 | 0.3081 |
| 0.3741 | 0.4419 | 0.5692 | 0.6593 | 0.7512 |
| 0.9784 | 0.9853 | 0.9922 | 0.9990 | 1.0000 |

Transect Link-18a

Area:

| | | | | |
|---|---|---|---|---|
| 0.0008 | 0.0032 | 0.0098 | 0.0227 | 0.0449 |
| 0.0747 | 0.1087 | 0.1444 | 0.1813 | 0.2206 |
| 0.2613 | 0.3059 | 0.3545 | 0.4055 | 0.4582 |
| 0.5114 | 0.5648 | 0.6185 | 0.6724 | 0.7266 |
| 0.7809 | 0.8355 | 0.8903 | 0.9451 | 1.0000 |

Hrad:

| | | | | |
|---|---|---|---|---|
| 0.0327 | 0.0406 | 0.0596 | 0.0801 | 0.0924 |
| 0.1269 | 0.1722 | 0.2208 | 0.2694 | 0.3046 |
| 0.3441 | 0.3703 | 0.3918 | 0.4298 | 0.4748 |
| 0.5276 | 0.5802 | 0.6326 | 0.6848 | 0.7367 |
| 0.7884 | 0.8400 | 0.8934 | 0.9468 | 1.0000 |

Width:

| | | | | |
|---|---|---|---|---|
| 0.0239 | 0.0776 | 0.1846 | 0.2885 | 0.4871 |
| 0.5964 | 0.6324 | 0.6552 | 0.7013 | 0.7256 |
| 0.7609 | 0.8653 | 0.9065 | 0.9449 | 0.9665 |
| 0.9707 | 0.9749 | 0.9791 | 0.9833 | 0.9874 |
| 0.9917 | 0.9958 | 0.9972 | 0.9986 | 1.0000 |

Transect Link-19a

Area:

0.0027 0.0106 0.0225 0.0383 0.0556

0.0744 0.0950 0.1168 0.1396 0.1631

0.1875 0.2149 0.2467 0.2900 0.3409

0.3929 0.4544 0.5200 0.5868 0.6544

0.7225 0.7911 0.8603 0.9299 1.0000

Hrad:

0.0320 0.0776 0.1109 0.1616 0.2186

0.2637 0.3151 0.3690 0.4219 0.4831

0.5419 0.5848 0.6189 0.4043 0.4695

0.5350 0.4948 0.5503 0.6147 0.6787

0.7432 0.8080 0.8724 0.9364 1.0000

Width:

0.0854 0.1362 0.2029 0.2372 0.2544

0.2824 0.3018 0.3167 0.3310 0.3377

0.3679 0.4099 0.5225 0.7175 0.7272

0.7500 0.9185 0.9451 0.9548 0.9642

0.9722 0.9791 0.9861 0.9930 1.0000

Transect Link-20a

Area:

0.0065 0.0188 0.0351 0.0546 0.0770

0.1022 0.1298 0.1593 0.1907 0.2238

0.2594 0.2969 0.3365 0.3777 0.4205

0.4648 0.5122 0.5611 0.6132 0.6712

0.7346 0.8005 0.8667 0.9332 1.0000

Hrad:

0.0411 0.0865 0.1325 0.1764 0.2256

0.2691 0.3156 0.3623 0.4088 0.4535

0.4975 0.5389 0.5816 0.6238 0.6674

0.7016 0.7295 0.7702 0.7766 0.7963

0.7477 0.8112 0.8744 0.9373 1.0000

Width:

0.1580 0.2184 0.2653 0.3125 0.3560

0.3968 0.4269 0.4549 0.4815 0.5140

0.5447 0.5788 0.6034 0.6277 0.6504

0.6814 0.7196 0.7473 0.8108 0.9163

0.9830 0.9873 0.9915 0.9958 1.0000

Transect Link-21a

Area:

0.0007 0.0028 0.0064 0.0125 0.0281

0.0500 0.0739 0.0997 0.1291 0.1623

0.2028 0.2510 0.3037 0.3584 0.4137

0.4696 0.5261 0.5833 0.6410 0.6993

0.7583 0.8178 0.8779 0.9387 1.0000

Hrad:

0.0309 0.0618 0.0890 0.1069 0.0830

0.1354 0.1847 0.2255 0.2557 0.2861

0.2779 0.3082 0.3459 0.4035 0.4605

0.5169 0.5727 0.6279 0.6825 0.7366

0.7902 0.8433 0.8959 0.9480 1.0000

Width:

0.0229 0.0458 0.0721 0.1673 0.3405

0.3719 0.4026 0.4451 0.5082 0.5712

0.7347 0.8200 0.8834 0.8932 0.9030

0.9128 0.9226 0.9324 0.9422 0.9520

0.9618 0.9716 0.9814 0.9911 1.0000

Transect Link-22a

Area:

0.0007 0.0028 0.0064 0.0125 0.0281

0.0500 0.0739 0.0997 0.1291 0.1623

0.2028 0.2510 0.3037 0.3584 0.4137

0.4696 0.5261 0.5833 0.6410 0.6993

0.7583 0.8178 0.8779 0.9387 1.0000

Hrad:

0.0309 0.0618 0.0890 0.1069 0.0830

0.1354 0.1847 0.2255 0.2557 0.2861

0.2779 0.3082 0.3459 0.4035 0.4605

0.5169 0.5727 0.6279 0.6825 0.7366

0.7902 0.8433 0.8959 0.9480 1.0000

Width:

0.0229 0.0458 0.0721 0.1673 0.3405

0.3719 0.4026 0.4451 0.5082 0.5712

0.7347 0.8200 0.8834 0.8932 0.9030

0.9128 0.9226 0.9324 0.9422 0.9520

0.9618 0.9716 0.9814 0.9911 1.0000

Transect Link-23a

Area:

0.0047 0.0170 0.0313 0.0489 0.0699

0.0940 0.1223 0.1553 0.1933 0.2330

0.2736 0.3151 0.3575 0.4008 0.4455

0.4924 0.5409 0.5965 0.6530 0.7099

0.7672 0.8248 0.8828 0.9413 1.0000

Hrad:

0.0234 0.0787 0.1161 0.1505 0.1835

0.2152 0.2368 0.2606 0.2925 0.3439

0.3947 0.4447 0.4937 0.5419 0.5884

0.6072 0.6226 0.6260 0.6802 0.7340

0.7875 0.8405 0.8932 0.9455 1.0000

Width:

0.2013 0.2173 0.2715 0.3275 0.3832

0.4400 0.5200 0.6000 0.6656 0.6820

0.6974 0.7128 0.7281 0.7435 0.7784

0.8141 0.8722 0.9565 0.9631 0.9696

0.9762 0.9827 0.9893 0.9958 1.0000

Transect Link-24a

Area:

0.0108 0.0332 0.0660 0.1019 0.1394

0.1784 0.2190 0.2608 0.3028 0.3450

0.3874 0.4299 0.4727 0.5156 0.5587

0.6020 0.6455 0.6891 0.7330 0.7770

0.8213 0.8657 0.9103 0.9550 1.0000

Hrad:

0.0286 0.0577 0.0871 0.1278 0.1680

0.2064 0.2433 0.2861 0.3303 0.3742

0.4178 0.4611 0.5042 0.5469 0.5894

0.6316 0.6735 0.7152 0.7566 0.7978

0.8387 0.8794 0.9198 0.9600 1.0000

Width:

| | | | | |
|---|---|---|---|---|
| 0.3870 | 0.5890 | 0.7746 | 0.8155 | 0.8482 |
| 0.8830 | 0.9198 | 0.9301 | 0.9343 | 0.9384 |
| 0.9425 | 0.9466 | 0.9507 | 0.9548 | 0.9589 |
| 0.9630 | 0.9671 | 0.9712 | 0.9753 | 0.9795 |
| 0.9836 | 0.9877 | 0.9918 | 0.9959 | 1.0000 |

Transect Link-25a

Area:

| | | | | |
|---|---|---|---|---|
| 0.0007 | 0.0031 | 0.0083 | 0.0166 | 0.0293 |
| 0.0435 | 0.0596 | 0.0761 | 0.0930 | 0.1110 |
| 0.1457 | 0.2026 | 0.2609 | 0.3197 | 0.3791 |
| 0.4399 | 0.5019 | 0.5639 | 0.6260 | 0.6882 |
| 0.7504 | 0.8127 | 0.8751 | 0.9375 | 1.0000 |

Hrad:

| | | | | |
|---|---|---|---|---|
| 0.0433 | 0.0548 | 0.0891 | 0.0921 | 0.1337 |
| 0.1711 | 0.2285 | 0.2862 | 0.3355 | 0.3722 |
| 0.1658 | 0.2189 | 0.2790 | 0.3386 | 0.3976 |
| 0.4447 | 0.5067 | 0.5687 | 0.6305 | 0.6923 |
| 0.7540 | 0.8156 | 0.8772 | 0.9386 | 1.0000 |

Width:

| | | | | |
|---|---|---|---|---|
| 0.0169 | 0.0564 | 0.0931 | 0.1807 | 0.2196 |
| 0.2544 | 0.2610 | 0.2662 | 0.2774 | 0.2984 |
| 0.8799 | 0.9266 | 0.9362 | 0.9453 | 0.9544 |
| 0.9902 | 0.9912 | 0.9923 | 0.9934 | 0.9945 |
| 0.9956 | 0.9967 | 0.9978 | 0.9989 | 1.0000 |

Transect Link-26a

Area:

0.0007 0.0031 0.0083 0.0166 0.0293

0.0435 0.0596 0.0761 0.0930 0.1110

0.1457 0.2026 0.2609 0.3197 0.3791

0.4399 0.5019 0.5639 0.6260 0.6882

0.7504 0.8127 0.8751 0.9375 1.0000

Hrad:

0.0433 0.0548 0.0891 0.0921 0.1337

0.1711 0.2285 0.2862 0.3355 0.3722

0.1658 0.2189 0.2790 0.3386 0.3976

0.4447 0.5067 0.5687 0.6305 0.6923

0.7540 0.8156 0.8772 0.9386 1.0000

Width:

0.0169 0.0564 0.0931 0.1807 0.2196

0.2544 0.2610 0.2662 0.2774 0.2984

0.8799 0.9266 0.9362 0.9453 0.9544

0.9902 0.9912 0.9923 0.9934 0.9945

0.9956 0.9967 0.9978 0.9989 1.0000

Transect Link-27a

Area:

0.0028 0.0086 0.0168 0.0277 0.0424

0.0608 0.0807 0.1020 0.1244 0.1477

0.1717 0.1965 0.2228 0.2523 0.2862

0.3307 0.3827 0.4488 0.5221 0.5981

0.6755 0.7545 0.8348 0.9167 1.0000

Hrad:

0.0523 0.1017 0.1491 0.1863 0.2079

0.2662 0.3281 0.3909 0.4555 0.5227

0.5900 0.6557 0.6597 0.6765 0.6381

0.5753 0.5415 0.5360 0.5819 0.6538

0.7245 0.7942 0.8628 0.9305 1.0000

Width:

0.0530 0.0843 0.1130 0.1486 0.2043

0.2285 0.2461 0.2610 0.2731 0.2824

0.2908 0.2992 0.3373 0.3725 0.4482

0.5746 0.7067 0.8374 0.8975 0.9150

0.9326 0.9501 0.9677 0.9852 1.0000

Transect Link-28a

Area:

0.0050 0.0155 0.0301 0.0479 0.0676

0.0905 0.1200 0.1546 0.1934 0.2371

0.2856 0.3354 0.3855 0.4357 0.4860

0.5366 0.5874 0.6383 0.6894 0.7407

0.7922 0.8439 0.8957 0.9478 1.0000

Hrad:

0.0308 0.0655 0.0967 0.1347 0.1704

0.1948 0.1944 0.2232 0.2468 0.2659

0.3017 0.3529 0.4039 0.4546 0.5052

0.5556 0.6057 0.6556 0.7054 0.7549

0.8043 0.8534 0.9024 0.9511 1.0000

Width:

0.1616 0.2371 0.3126 0.3571 0.3985

0.4664 0.6202 0.6957 0.7870 0.8955

0.9509 0.9545 0.9580 0.9615 0.9650

0.9686 0.9721 0.9756 0.9791 0.9827

0.9862 0.9897 0.9932 0.9967 1.0000

Transect Link-29a

Area:

0.0031 0.0104 0.0226 0.0423 0.0727

0.1058 0.1409 0.1783 0.2194 0.2654

0.3126 0.3606 0.4091 0.4578 0.5065

0.5554 0.6044 0.6535 0.7027 0.7520

0.8014 0.8509 0.9005 0.9502 1.0000

Hrad:

0.0273 0.0542 0.0756 0.0738 0.1143

0.1541 0.1965 0.2309 0.2448 0.2826

0.3283 0.3734 0.4204 0.4694 0.5182

0.5669 0.6155 0.6639 0.7123 0.7605

0.8086 0.8566 0.9045 0.9523 1.0000

Width:

0.1123 0.1924 0.2997 0.5742 0.6378

0.6885 0.7188 0.7739 0.8987 0.9414

0.9547 0.9679 0.9751 0.9771 0.9792

0.9813 0.9834 0.9855 0.9875 0.9896

0.9917 0.9938 0.9958 0.9979 1.0000

**********

Control Actions Taken

**********

| ********** | Volume | Volume |
|---|---|---|
| Flow Routing Continuity | hectare-m | Mliters |
| ********** | --------- | --------- |
| Dry Weather Inflow ..... | 0.000 | 0.000 |
| Wet Weather Inflow ..... | 0.000 | 0.000 |
| Groundwater Inflow ..... | 0.000 | 0.000 |
| RDII Inflow ..... | 0.000 | 0.000 |
| External Inflow ..... | 598129.641 | 5981358.653 |
| External Outflow ..... | 419303.661 | 4193080.248 |
| Surface Flooding ..... | 1573.832 | 15738.479 |
| Evaporation Loss ..... | 0.000 | 0.000 |
| Initial Stored Volume .... | 1252.653 | 12526.656 |
| Final Stored Volume ..... | 173703.092 | 1737048.999 |
| Continuity Error (%) ..... | 0.801 | |

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Node Depth Summary

**********

| Node | Average Depth Meters | Maximum Depth Meters | Maximum HGL Meters | Time of Max Occurrence days hr:min | Total Flooding ha-mm | Total Minutes Flooded |
|---|---|---|---|---|---|---|
| CS-77 | 9.78 | 11.37 | 16.62 | 0 01:36 | 0 | 0 |
| CS-78 | 12.08 | 13.06 | 15.92 | 0 12:07 | 0 | 0 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| CS-79 | 11.02 | 12.31 | 14.75 | 0 | 11:56 | 0 | 0 | |
| CS-80 | 11.47 | 15.64 | 16.72 | 0 | 12:06 | 0 | 0 | |
| CS-81 | 15.95 | 20.88 | 17.48 | 0 | 12:18 | 0 | 0 | |
| CS-82 | 10.73 | 12.77 | 12.51 | 0 | 11:14 | 0 | 0 | |
| CS-83 | 10.01 | 11.85 | 11.17 | 0 | 11:20 | 0 | 0 | |
| CS-84 | 9.86 | 11.98 | 10.14 | 0 | 11:04 | 0 | 0 | |
| CS-85 | 9.26 | 11.51 | 9.70 | 0 | 10:49 | 0 | 0 | |
| CS-86 | 10.86 | 13.37 | 9.61 | 0 | 10:59 | 0 | 0 | |
| CS-87 | 9.47 | 12.14 | 9.35 | 0 | 10:36 | 0 | 0 | |
| CS-88 | 14.46 | 18.23 | 9.41 | 0 | 10:46 | 0 | 0 | |
| CS-89 | 12.64 | 16.17 | 9.12 | 0 | 10:32 | 0 | 0 | |
| CS-90 | 8.83 | 12.77 | 8.41 | 0 | 09:52 | 0 | 0 | |
| CS-91 | 8.10 | 12.74 | 8.27 | 0 | 10:01 | 0 | 0 | |
| CS-92 | 16.62 | 21.61 | 8.12 | 0 | 09:17 | 523551.43 | | 25 |
| CS-93 | 21.37 | 26.16 | 8.20 | 0 | 09:39 | 0 | 0 | |
| CS-94 | 9.68 | 13.31 | 4.80 | 0 | 11:01 | 0 | 0 | |
| CS-95 | 12.91 | 15.91 | 4.57 | 0 | 10:50 | 0 | 0 | |
| CS-98 | 15.05 | 16.95 | 3.37 | 0 | 06:40 | 0 | 0 | |
| CS-106 | 7.13 | 11.13 | 8.06 | 0 | 10:17 | 0 | 0 | |
| CS-105 | 8.02 | 11.51 | 7.29 | 0 | 08:54 | 1050279.88 | | 147 |
| CS-104 | 3.80 | 4.94 | 2.63 | 0 | 07:03 | 0 | 0 | |
| CS-100 | 4.29 | 7.83 | 4.77 | 0 | 06:34 | 0 | 0 | |
| CS-101 | 8.93 | 12.86 | 5.18 | 0 | 06:41 | 0 | 0 | |
| CS-102 | 5.62 | 8.94 | 4.25 | 0 | 06:47 | 0 | 0 | |
| CS-103 | 4.75 | 5.90 | 2.00 | 0 | 06:49 | 0 | 0 | |
| Outfall | 14.33 | 15.03 | 1.45 | 0 | 05:00 | 0 | 0 | |
| Outfall2 | 4.59 | 5.35 | 1.45 | 0 | 05:00 | 0 | 0 | |

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Conduit Flow Summary

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| Conduit | Maximum Flow CMS | Time of Max Occurrence days hr:min | Maximum Velocity m/sec | Length Factor | Maximum /Design Flow | Total Minutes Surcharged |
|---|---|---|---|---|---|---|
| Link-1 | 95396.68 | 0 01:15 | 6.98 | 1.00 | 0.17 | 0 |
| Link-2 | 71840.01 | 0 02:20 | 8.50 | 1.00 | 0.44 | 0 |
| Link-3 | 92044.73 | 0 12:02 | 7.48 | 1.00 | 0.34 | 0 |
| Link-4 | 203992.17 | 0 12:12 | 7.24 | 1.00 | 0.26 | 0 |
| Link-5 | 89913.66 | 0 05:28 | 9.94 | 1.00 | 0.23 | 0 |
| Link-6 | 82999.55 | 0 05:11 | 25.98 | 1.00 | 0.45 | 0 |
| Link-7 | 69960.48 | 0 05:43 | 6.89 | 1.00 | 0.27 | 0 |
| Link-8 | 71620.55 | 0 04:12 | >50.00 | 1.00 | 1.33 | 1235 |
| Link-9 | 72487.64 | 0 04:01 | >50.00 | 1.00 | 0.11 | 0 |
| Link-10 | 68859.02 | 0 07:40 | 7.05 | 1.00 | 0.13 | 0 |
| Link-11 | 88182.01 | 0 03:56 | >50.00 | 1.00 | 0.06 | 0 |
| Link-12 | 72026.47 | 0 11:40 | >50.00 | 1.00 | 0.14 | 0 |
| Link-13 | 72304.15 | 0 11:26 | >50.00 | 1.00 | 0.14 | 0 |
| Link-14 | 83134.34 | 0 10:58 | 3.81 | 1.00 | 0.77 | 0 |
| Link-15 | 97788.00 | 0 10:44 | 3.32 | 1.00 | 0.20 | 78 |
| Link-16 | 97552.77 | 0 10:29 | 7.99 | 1.00 | 0.23 | 25 |
| Link-17 | 100175.97 | 0 10:32 | 14.27 | 1.00 | 0.21 | 0 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Link-18 | 114892.07 | 0 | 10:43 | 6.40 | 1.00 | 0.22 | 0 |
| Link-19 | 99805.33 | 0 | 11:14 | 5.74 | 1.00 | 0.56 | 0 |
| Link-20 | 96168.29 | 0 | 11:24 | 9.05 | 1.00 | 57.48 | 1439 |
| Link-21 | 10597.28 | 0 | 06:44 | 3.83 | 1.00 | 0.70 | 0 |
| Link-22 | 8943.51 | 0 | 07:04 | 3.38 | 1.00 | 0.82 | 0 |
| Link-23 | 6181.24 | 0 | 11:07 | 4.68 | 1.00 | 0.56 | 0 |
| Link-24 | 6262.33 | 0 | 11:20 | 8.14 | 1.00 | 0.34 | 0 |
| Link-25 | 16320.15 | 0 | 10:18 | 2.69 | 1.00 | 0.11 | 0 |
| Link-26 | 21155.13 | 0 | 10:40 | 3.47 | 1.00 | 0.13 | 0 |
| Link-27 | 6641.21 | 0 | 10:48 | 4.77 | 1.00 | 0.13 | 0 |
| Link-28 | 8623.67 | 0 | 06:54 | 3.54 | 1.00 | 0.27 | 0 |
| Link-29 | 12460.15 | 0 | 06:57 | 4.63 | 1.00 | 6.63 | 1419 |

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Flow Classification Summary

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| | --- Fraction of Time in Flow Class ---- | | | | | | Avg. | Avg. |
|---|---|---|---|---|---|---|---|---|
| | Up | Down | Sub | Sup | Up | Down | Froude | Flow |
| Conduit | Dry | Dry | Dry | Crit | Crit | Crit | Crit | Number | Change |

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| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Link-1 | 0.04 | 0.00 | 0.00 | 0.96 | 0.00 | 0.00 | 0.00 | 0.31 | 0.0002 |
| Link-2 | 0.04 | 0.00 | 0.00 | 0.93 | 0.03 | 0.00 | 0.00 | 0.76 | 0.0003 |
| Link-3 | 0.04 | 0.00 | 0.00 | 0.95 | 0.00 | 0.00 | 0.00 | 0.43 | 0.0012 |
| Link-4 | 0.05 | 0.00 | 0.00 | 0.94 | 0.01 | 0.00 | 0.00 | 0.42 | 0.0023 |
| Link-5 | 0.06 | 0.02 | 0.00 | 0.49 | 0.44 | 0.00 | 0.00 | 0.95 | 0.0008 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Link-6 | 0.08 | 0.00 | 0.00 | 0.92 | 0.00 | 0.00 | 0.00 | 0.48 | 0.0010 |
| Link-7 | 0.08 | 0.00 | 0.00 | 0.91 | 0.01 | 0.00 | 0.00 | 0.69 | 0.0002 |
| Link-8 | 0.09 | 0.01 | 0.00 | 0.89 | 0.01 | 0.00 | 0.00 | 0.52 | 0.0008 |
| Link-9 | 0.10 | 0.00 | 0.00 | 0.90 | 0.00 | 0.00 | 0.00 | 0.25 | 0.0001 |
| Link-10 | 0.11 | 0.01 | 0.00 | 0.83 | 0.05 | 0.00 | 0.00 | 0.35 | 0.0001 |
| Link-11 | 0.12 | 0.00 | 0.00 | 0.86 | 0.02 | 0.00 | 0.00 | 0.13 | 0.0001 |
| Link-12 | 0.10 | 0.00 | 0.00 | 0.90 | 0.00 | 0.00 | 0.00 | 0.27 | 0.0001 |
| Link-13 | 0.08 | 0.00 | 0.00 | 0.92 | 0.00 | 0.00 | 0.00 | 0.45 | 0.0000 |
| Link-14 | 0.08 | 0.00 | 0.00 | 0.92 | 0.00 | 0.00 | 0.00 | 0.44 | 0.0001 |
| Link-15 | 0.04 | 0.04 | 0.00 | 0.93 | 0.00 | 0.00 | 0.00 | 0.25 | 0.0000 |
| Link-16 | 0.02 | 0.02 | 0.00 | 0.94 | 0.02 | 0.00 | 0.00 | 0.29 | 0.0001 |
| Link-17 | 0.01 | 0.00 | 0.00 | 0.39 | 0.60 | 0.00 | 0.00 | 0.97 | 0.0000 |
| Link-18 | 0.00 | 0.01 | 0.00 | 0.99 | 0.00 | 0.00 | 0.00 | 0.40 | 0.0002 |
| Link-19 | 0.00 | 0.00 | 0.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.45 | 0.0002 |
| Link-20 | 0.00 | 0.00 | 0.00 | 0.99 | 0.01 | 0.00 | 0.00 | 0.55 | 0.0141 |
| Link-21 | 0.07 | 0.00 | 0.00 | 0.93 | 0.00 | 0.00 | 0.00 | 0.22 | 0.0001 |
| Link-22 | 0.01 | 0.05 | 0.00 | 0.94 | 0.00 | 0.00 | 0.00 | 0.22 | 0.0001 |
| Link-23 | 0.00 | 0.00 | 0.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.53 | 0.0001 |
| Link-24 | 0.00 | 0.00 | 0.00 | 0.78 | 0.22 | 0.00 | 0.00 | 0.73 | 0.0001 |
| Link-25 | 0.01 | 0.02 | 0.00 | 0.97 | 0.00 | 0.00 | 0.00 | 0.13 | 0.0003 |
| Link-26 | 0.01 | 0.03 | 0.00 | 0.97 | 0.00 | 0.00 | 0.00 | 0.18 | 0.0006 |
| Link-27 | 0.00 | 0.00 | 0.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.40 | 0.0002 |
| Link-28 | 0.00 | 0.00 | 0.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.34 | 0.0001 |
| Link-29 | 0.00 | 0.00 | 0.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.45 | 0.0025 |

**********

Highest Continuity Errors

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Node CS-92 (4.16%)

Node CS-90 (2.74%)

Node CS-89 (2.35%)

Node CS-102 (2.15%)

Node CS-91 (1.98%)

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Time-Step Critical Elements

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None

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Routing Time Step Summary

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Minimum Time Step : 5.00 sec

Average Time Step : 5.00 sec

Maximum Time Step : 5.00 sec

Percent in Steady State : 0.00

Average Iterations per Step : 2.01

**Director: Shri R. D. Singh**

**Coodinator: Dr. J. V. Tyagi, Scientist F**

**Head: Y. R. Satyaji Rao, Scientist 'F'**

**S. V. Vijaya Kumar, Scientist 'F'**

**V. S. Jeyakanthan, Scientist 'D'**

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