DESIGN AND CONSTRUCTION OF STORM AND FOUL DRAINAGE SYSTEM IN BASELINE ROAD IMPROVEMENT PROJECT.

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by

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1.0 Synopsis

Baseline road is the principal road running along the northern perimeter of the Colombo Municipal Council (CMC) limits. For general upkeep and maintenance, it comes under the CMC. Improvements to Baseline Road (which were long overdue) were undertaken as a National Project by the Road Development Authority (RDA) in 1990 with Japanese OEC funding.

Improvements to its storm and foul drainage systems were an integral component of the proposed work. During the planning stages, the joint venture Consultants (Nippon Koei of Japan and WS Atkins of UK) who were appointed by the RDA for Planning and construction supervision work, held extensive discussions with the relevant staff of the CMC, NWS & DB and SLLRDC to obtain the data on the existing drainage system. Consequent to these discussions, the following salient factors were agreed upon.

1. The existing surface drainage system was subjected to extensive abuse by the residents and should be replaced with a piped drainage system. Locations of the outfalls of this system were to be determined in consultation with the SLLRDC.
2. The existing foul drainage system was heavily surcharged and also it did not cover about 25% of the road length. A replacement system was badly required for the already sewered areas. A new system was required for the currently unsewered areas.

Based on the above agreements, a new pipe drainage system for storm drainage and a replacement system for foul drainage were designed, details of same would be discussed in the body of this paper.

Since there were several other services, such as power cables, water mains, and telephone cables buried under the road) the Engineer proposed a "Typical Layout" allocating different offsets of the road cross section to different services. Accordingly, some of the services were to occupy spaces under the footpath and the balance was to occupy spaces under the carriageway.

All parties agreed to this layout and the construction work was commenced in 1996. However, during the construction, it was observed that many existing cables, ducts and pipes previously laid by different Utility Authorities interfered with the laying of newly proposed storm and foul drains. Naturally the Engineer had to recommend to the RDA to request the respective Utility Authorities to divert the offending services from the paths of the new drains. However this was easier said than done due to the following reasons.

1. Some of these utilities were providing vital services to the residents living adjoining the road.
2. Yet others were carriers of such services to the other priority areas within the CMC (eg BMICH, Temple Trees, General Hospital etc.)
3. Utility agencies did not have adequate resources to undertake such diversions.
4. It was extremely difficult to get "service interruptions" to carry out major diversions.

Further, certain large scale abuses of the existing drainage system could not be corrected due to lack of commitments of the abusing parties, mainly state agencies.

On this backdrop, the Engineer and the RDA had to go for compromise solutions and modify or revise the original designs (although they were on one hand not technically the best and on the other hand more costly to the client).

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This paper will discuss the general and specific problems encountered and the solutions thus adopted.

2.0 Design Criteria

The design criteria followed for the design of Storm Water and Foul Sewer Drainage systems are briefly as follows.

2.1 Design Criteria for Storm Water Drainage.

2.1.1 Hydrologic Considerations.

- With reference to 1:5000 topographic maps, 13 separate catchments/sub catchments were identified. No further detailed surveys were considered necessary.
- The paths of inflows during heavy rains were identified.
- Since adequate data on run-offs were not available, inflow - outflow computer modelling was not attempted.
- Design discharges were computed by Rational Method. Run off coefficients between 0.5 and 0.9, Times of concentration between 15 minutes and 45 minutes and return periods between 2 to 10 years were considered.
- Flood threshold conditions assumed were,
    - No surcharging of storm drainage system shall occur during a 2 year return rainfall
    - No flooding shall be caused by down stream backwater effects during a 10 year return rainfall.

2.1.2 Hydraulic Considerations

- The drainage system was to consist of circular concrete pipes with manholes of square-cross section positioned at appropriate intervals.
- As a principle, no waste water (domestic, commercial industrial or institutional) was to be connected to the storm drainage system.
- Discharges were to be computed using Colebrooke White Formula, with a roughness coefficient of 1.5 mm (slimy weathered pipes).
- A flushing velocity of 0.5m/sec was assumed.
- Head losses were taken at 0.20 for manholes and at 0.30 for each catch pit.
- Catch pits were to be located at the sites of major lateral inflows but their levels of entry were to be at the finished carriageway adjoining the kerb at respective points.
- Manhole interval was to be not more than 80m.
- Gullies to be provided with trapped escapes of 150mm dia at intervals as per relevant TRRL. Report No. 2 (and usually at 15 to 20 m intervals)

2.1.3 Structural Considerations

- Pipe strength class to be M as per BS 5911 or NP 3 as per SLS 452.
- Design loading for pipes and manholes to be 30 units of HB loading as per BS 5400 Part II
- Pipe bedding to be in accordance with TRRL pipeline design loading reports.
- Minimum cover from pipe crown to Road Finish level to be 0.85m
- Structural Design standards to be BS8110
- Gullies and manhole covers to be to Grade A; BS 497
- Pipe joints to be flexible with water sealing rings as per BS 5911
- Pipe quality and laying to be as per BS 5911 or SLS 452

2.1.4 Geometrical Considerations

Location chainages of manholes and their Invert levels as well as the diameters of pipes from manhole to manhole and the location chainages of gullies and catchpits were determined as per above criteria.

The location offsets of manholes and in effect, the paths of the drainage pipe runs were left to be determined during construction stage.

Storm Water Drainage layout Plans, the bills of quantities and Technical specifications were prepared to meet with the foregoing design criteria. These documents were included in the Main Contract signed between Road Development Authority and the Japanese Contractor.

2.2 Design Criteria for Sewer Drainage

2.2.1 Demand Projections and design load assessment

Demand Projections were based on the projected use by five user categories.

1. Residential	@	200 litres /capita/day
2. Industrial	@	16,500 litres / ha/day
3. Commercial	@	126,600 litres/ day
4. Industrial	@	30,300 litres / ha/day

5. Public Stand Pipes @ 45 litres per capita /day

Projected population was based on the pronouncements made in the Sanitation Master Plan "A strategy for sanitation to year 2020". This Master Plan assumes that all the currently un-sewered properties close to existing sewer systems will become connected by year 2020. In accordance with the improving quality of life for the Baseline road area, waste water shall ultimately comprise of all water borne waste from water closets, baths, kitchens, washing machines, effluents from trading houses and certain industries.

The pipes used in sewer systems have a design life of 50 years (i.e. from the planning year of 1995 upto year 2045).

The Master Plan projections were only upto year 2020. It was agreed that the population in the target area would reach saturation levels by year 2020. Hence the Master Plan preparation team had discussions with the UDA who were at that time preparing a Proposal for Baseline Road Catchment Area as a future high growth commercial development corridor. Their concepts (yet to be approved at that stage) for change in the population for each Municipal Ward inside the catchment area were accounted for in the sewer design.

Accordingly the current design could be treated as capable of servicing the year 2045 requirements. On the backdrop of foregoing considerations, the load assessments were made as follows

- Each waste water catchment with the projected population for year 2045 were identified in 1: 1000 maps.
- Activities in each area were divided into residential, industrial, commercial, institutional and public stand piped categories.
- Each catchment area was split into;
    1) wards which carried different densities
    2) water supply zones for which projected unit water consumption norms could be applied.
- In the wards and zones, the projected demands were calculated.
- The flows so derived were factored to account for return flows, infiltration, inflows and peaking (for infiltration, inflows and return flows factors upto 1.3 and peaking factors upto 2.75)
- Peak design flows in different parts of Baseline Road were thus assessed.

2.2.2 Hydraulic and Structural Considerations

Hydraulic and structural considerations were in general as per relevant British standards.

Hydraulic Parameters adopted were as follows:

- Vitreous clay pipe was the chosen option
- Minimum pipe diameter was taken as 150mm
- Manholes were to be placed at intervals of not more than 90m. ìSmall diameter pipes to have manholes at more closer intervals.
- self flushing velocity to be kept between 0.6 to 0.75m/sec depending on;
    1) pipe gradient
    2) available peak discharge in each line

(BS 8301 stipulates that 150 mm dia pipe may be laid at a slope not flatter than 1:150 provided that at least four water closets are connected. This criteria was applied in marginal cases).

- Maximum velocity was not to exceed 3m/sec
- Pipe diameters were computed using Colebrooke White formula with roughness coefficient as 1.4mm (i.e. for slimed, worn out pipes)

Head losses at manholes were taken at 0.20

<u>Structural Parameters Adopted were as follows.</u>

- Although VC pipes to BS 65 was the choice design, the possibility of using other pipes (eg. PVC) conforming to BS 5481 were not dismissed.
- Minimum cover to pipe crown was taken as 0.8 m under the foot way and 1.2m under the carriage way.
- Manholes were to be of same strength as for storm water manholes but were to be built using sulphate resistant cement.
- Bedding conditions, several bedding classes were specified as per Hepworth Guidelines - 1994, principally differentiating between loading conditions under the carriageway and the footways.
- Sewer connections were to be always above the horizontal diameter of the parent pipe using 45^0 Y - Junction specials. Interval of connections to be 15 to 20m on average.

2.2.3 Geometric Design Considerations

The criteria adopted was similar to those in the case of storm water drains.

Foul Drainage layout plans, the bills of quantities and technical specifications were prepared to meet with the foregoing design criteria. These documents were included in the Main Contract signed between Road Development Authority and the Japanese Contractor.

3.0 Attempts to address the Geometric Design Problem during Construction Stage

After the award of Construction contract and the appointment of the Supervision Consultant, it became the responsibility of the Supervision Consultant to issue the remaining geometric details for storm and foul sewer layouts to the contractor.

The Contractor's general program was to complete the work on the east carriageway (which was the newly acquired area) first and then to attempt the work in the west carriageway, (which was the existing road). As a preliminary step in resolving the geometry problem in the storm and foul sewer network, the Engineer developed a Typical layout of Utiliti see the attached Diagram No. 1, identifying specific ranges of offsets for different services. According to it the foul sewer main, telecom primary ducts and storm water drain as well as their manholes and the CEB High voltage cables were to occupy adjoining spaces in the carriageway. CEB low voltage cables, telecom secondary ducts, water riders and fuel sewer riders were to occupy the space in the foot path.

There are also several "laterals" in the services mentioned above. For exaple:

1. Gully connections to the storm water drains
2. Property connections to the sewer riders
3. Distribution posts receving cables from Telecom secondary chambers
4. T-joints from CEB low voltage cables (prop erty connections)
5. House connections from water riders
6. Oblique telecom ducts between primary and secondary chambers laid at 30^0 to the road centre line.

In addition to above, the CEB had feeder pillars by the roadside into which both HT and LT cables had to be taken in. Further, both CEB and WB needed road crossings at each and every junction and also at certain intermediate points for load balancing purposes.

The Typical layout prepared by the Engineer addressed the question of longitudinal geometry but could not address the lateral requirements listed above.

However, to enable giving a start, the Contractor was instructed to commence laying the storm water and foul sewer lines on the basis of the given Typical layouts and the paths of "Pipe-runs" were issued to him by way of chainages and off-sets of the manholes. The contractor had also programmed the drainage ahead of road work excavations. His chosen sequence of operation was to place manholes at the given locations and then to dig the trenches in between and lay the pipes. Despite east carriageway being the newly acquired land, many areas attempted by the Contractor were obstructed by existing services. Contractor took an offensive attitude towards these obstructions and wrote to the agencies concerned to remove the obstructing services. These agencies were not prepared to remove their services saying that 'they were live services'. They demanded that they be given alternative locations as well as funds to enable shifting out their services. There were four agencies responsible. CEB for Electricity, Water Supply and Drainage Board (WB) for feeder water mains, CMC and WB for sewer mains and manholes, CMC for water riders, CMC for street lighting, SLT for Telecom ducts and manholes.

More and more obstructions caused by uncharted utilities started surfacing as the trenching work proceeded. Situation gradually developed to a stage that no storm or foul sewers could be laid to the desired lines and grades due to existing services.

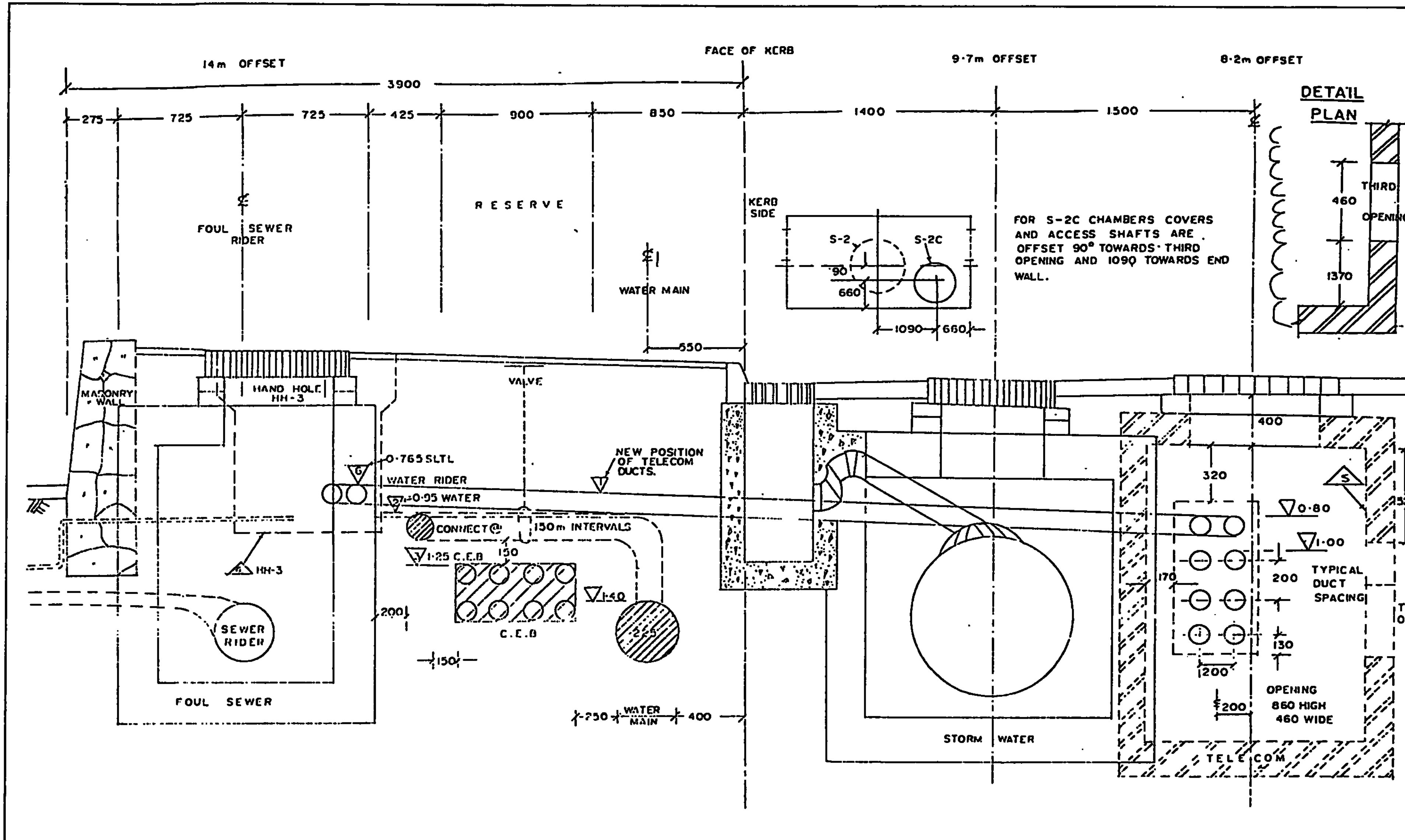
Attempts were made to use Metal detectors to identify the unknown services prior to commencing excavations but it was not a success.

After many discussions held among the Client the Engineer and the Contractor, it was decided to excavate trial pits to search and locate existing services. Accordingly, the Contractor was issued with variation orders to dig a number of trial pits (most of these pits were dug at night to avoid disruptions to traffic) ahead of pipe laying work. These trial pits revealed many existing services that had been laid during the past 75 years. Diagram No.2 gives the details of existing services at a particular location. Other locations too were not different to this. The most number of services (about 15 power cables) were those belonging to CEB. The present officers of the CEB were unaware of the presence of so many cables. To make matters worse CEB were unable to identify whether their cables were live or dead. They needed power interruptions to check the dead/live cables. Such power interruption could only be taken by prior approval at high levels and on week ends only. That too depending upon whether there were important functions in Colombo such as International cricket matches, conferences or Public meetings (attended by govt chiefs).

On the basis of the findings from the trial pits, decisions had to be taken;

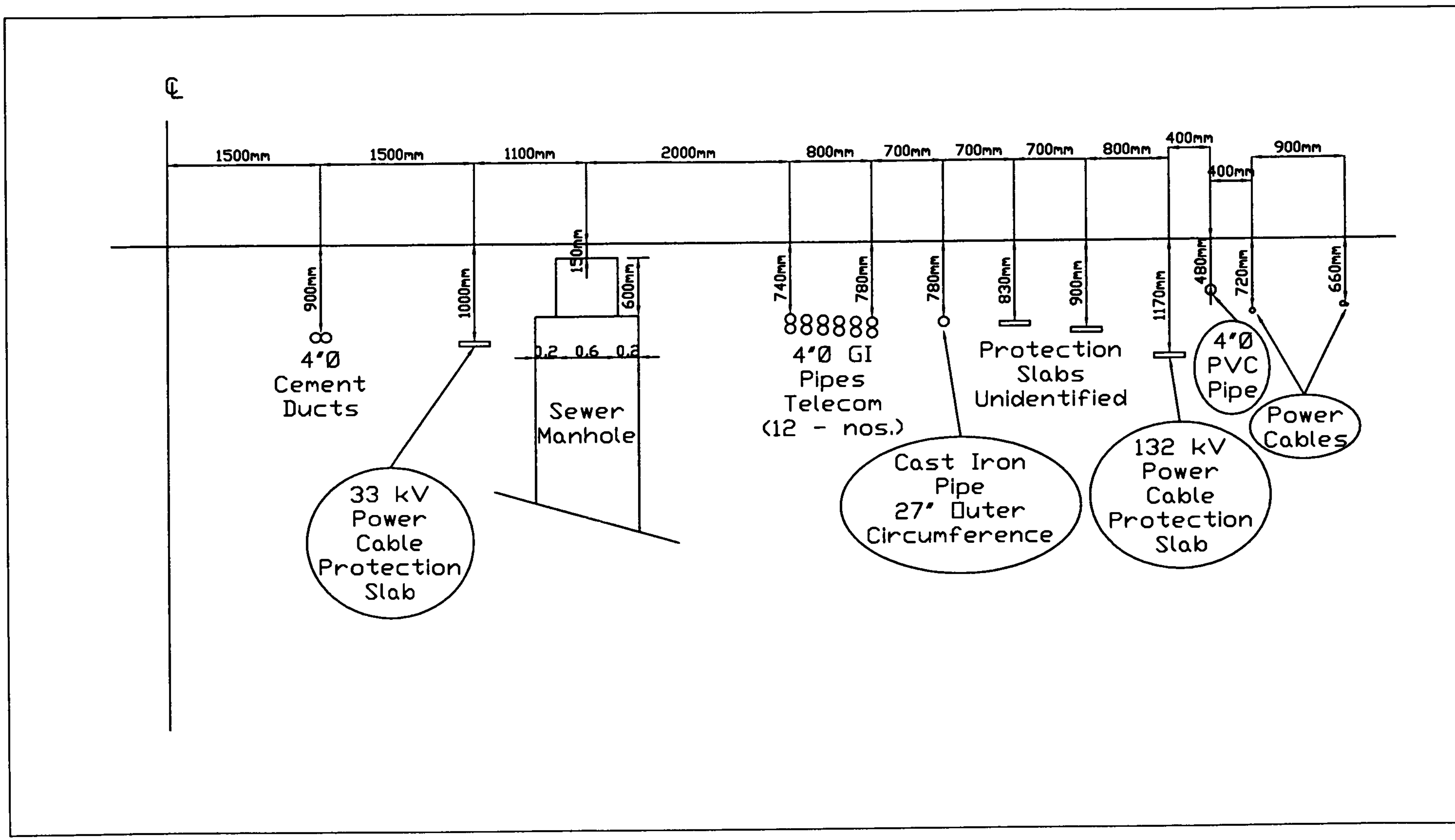
a) to divert the obstructing services; or

b) to modify the given designs to avoid the obstructions



Typical Layout of Utilities

(Diagram 1)



Details of existing Services at a location

(Diagram 2)

When the former method was applied there were invariable delays due to lack of resources, poor planning and poor workmanship by the utility Authorities.

When the latter method was applied it caused to compromise with the given designs because the required grades and / or pipe diameters could not be maintained. It also necessitated a number of additional manholes (each of which costing from Rs. 85,000/= to 150,000/= depending on their size)

4.0 Special Problems Encountered

4.1 132 kv Power cable and 5 Nos 33 kv Power Cables between Kent Road and Campbell Road Junctions

These are high tension power lines originating from Kolonnawa Grid Sub Station and running to vital installations in the Colombo seven area. Unfortunately CEB did not have adequate information on the exact locations of these important cables in relation to the road centerline. Since the cables had not been laid parallel to the road centre line and were laid at varying depths, their presence caused many obstructions to storm and foul drainage work.

There were several damages to 33kv cables during Contractor's trenching operations. CEB took more than a month to repair each damage. In the end they ran short of cable joint boxes for which they had only a single supplier in the whole world. The procurement of cable joint boxes took many months and the RDA had to even advance the funds to CEB in this connection.

CEB also imposed many restrictions when trenching around their 132KV cable. No sheetpiling was allowed within 5 m of the 132KV cable. Whenever piling was to be done at closer distance, CEB wanted their 132KV cable fully exposed throughout such distances and the cable kept supported with hanging devices at 1m intervals to prevent it being subjected to vibrations and also to ensure that it remained in its original position. CEB was not prepared to consider diverting their 132KV and 33KV cables to suitable paths, which would be parallel to the road centerline and also would be away from the storm and foul drains.

Hence, the Engineer was forced to divert the storm and foul sewer drains to alternative paths that were less desirable. Further a number of additional manholes had to be introduced to effect these diversions. All such variations to the main contract caused delays and additional cost, finally to be borne by the Client.

4.2 600 mm diameter pumping sewer between Albion Road Junction and Orugodawatta Junction

This 600 mm diameter pumping sewer (forced main) laid from Maligakanda Sewer Pumping station to the sea outfall on the north of Colombo Port was rather shallow and also had not been laid parallel to the road centreline. Storm water and gravity sewer pipes clashed with this pipe at several locations such as; opposite Albion road at Dematagoda, at Ingram Road Junction and at Orugodawatta Junction. All these points of clashes were to be under the new carriageway. Hence siphoning of gravity lines was ruled out considering maintenance problems. On the other hand if local lowering of the pumped sewer which was a live line was attempted, it would have caused serious delays since on one hand the required specials had to be imported and on the other hand the services had to be interrupted.

Hence the chosen solution was to provide a short length of wide rectangular metal duct, together with two additional manholes at its either end, at each such obstruction. However, the lifetime of these metal ducts would be much less than those of concrete pipes and hence would need periodic replacement in the future.

4.3 600mm diameter pumping sewer between Castle Street Junction and Kitulwatta, Road

Presence of this pumping sewer prevented sheetpiling work by the main contractor, for laying of the new gravity sewer in this area. Although the Contractor was advised to expose pumping the sewer pipe and carryout sheet piles outside its limits, the Contractor was reluctant to do it since he could not guarantee that the joints in the exposed sewer would remain intact during pumping. Further, due to congestion of other services such as 300 mm diameter water pipe and several electricity cables (in addition to the above sewer), no alternative path could be found for the proposed gravity sewer, to enable laying it using open cut excavation methods. After further deliberations on this matter, the new sewer was deleted from the Contract. It was decided that the new sewer would be laid by adopting a suitable technique such as "micro tunneling" at a later date.

4.4 Existing telecom and foul sewer manholes in the routes of new storm water and foul sewer drains

Presence of some of these manholes became known only when the trenching was in progress. Since they were part and parcel of live services, it was impossible to demolish them and as such, the new services had to be diverted to alternative paths. Such diversions resulted in additional manholes of "L shaped" cross section at additional cost and delays to Contract.

There were also cases where (irrespective of however undesirable from Telecom point of view), the need arose to demolish several existing Telecom chambers to make way for the new storm drains.

There was also a classic case of bodily moving an existing live Telecom manhole (of size 2.5 m long x 1.5 m wide x 2.0 m deep), by 0.5 m to enable diversion of existing pumped sewer line. This work took more than 3 months to accomplish and a disputed claim of Rs. 1.3 million by the Contractor.

4.5 600 mm diameter water lines crossing Baseline Road at Orugodawatta Junction, Kent road at Dematagoda Junction

These were cast iron pipes laid many years back from Labugama and Kalatuwawa Water Treatment Plants to Maligakanda Reservoir.

There was no possibility of lowering them and as a result the new storm water drains had to be modified with wide rectangular metal ducts to negotiate these obstructions. Such metal duct had to be linked to manholes at either end. See also para 4.2 above.

4.6 Waste Water Inflows to Site from Government Institutions, Low Cost Housing Plots, Fuel Stations etc.

As was stated section 2.1.2, the intention during planning stages was to separate the waste inflows from rainwater. The reasons for this decision were two fold

(1) Open Storm Drains that were hitherto in existence in Baseline Road, were abused to a very large scale by individuals as well as corporate bodies. There was stagnation of flows in all existing open drains.

(2) Piped drainage system which was proposed to be introduced was to consist of concrete pipes. Concrete is subject to gradual erosion due to continued exposure to waste water. At some stage when the reinforcement wires were exposed due to progressive erosion, there were chances for the drain pipes to collapse under the carriageway.

However, neither RDA nor CMC was able to take to positive acton to arrest the many inflows to the site. Primary responsibility in arresting waste inflows lie with the CMC (being the planning authority for the area). Not only private parties but even several principal government Institutions namely the Sri Lanka Railway, the Welika Prison, Government Press and Lady Ridgeway hospital too were liberally diverting their biologically and/or chemically polluted waste water into the storm drains. Further there were several low cost housing schemes commonly known as 'Gardens' for which the maintenance authority appeared to be the Common Amenities Board. There were also several multi-storey housing schemes which were under the purview of National Housing Development Authority. Waste water from these properties too hade been freely diverted to the road and the CMC had been keeping a blind eye to this problem.

The main Contractor during his road building work faced with the question of dealing with these waste inflows made repeated representations to the Engineer, to RDA and to CMC to take action to seal these inflows, However, even upto the date of writing this paper these waste inflows continue to come to the site. If CMC fails to take positive action to seal these inflows the Engineer may be forced to instruct the Contractor to connect them to the storm water drainage system, (thus negating the original intentions).

4.7 Lack of outflows for Storm Drains for comparatively long distances.

Lands in some parts of Baseline road (eg. between Kelanitissa Junction and Dematagoda and between Castle Street and Park Road) are rather flat. The ground elevations in these areas are between 3.0 to 4.0 m above MSL. The natural streams into which the new drains carry their flows have bed levels about 0.0 m MSL. They in turn have very flat bed slopes and hence quite often carry stagnant water to about 1 m depth. Permissible minimum gradient for storm water drain pipe lines is around 1 : 150 and within a distance of 500 m, such a drain would drop by 3.3 m. When a minimum cover of 0.85 m above the pipe crown is allowed, the outfall of such a drain would be around 0.0 m MSL or even less. Hence invariably the drain outfall would be submerged and there would be backflow into the drain pipes. Hence a free flow situation would rarely exist. This situation would cause siltation of pipe tail reaches and would result in gradual reduction in their carrying capacities.

The only available remedy for this problem is frequent desilting of the affected areas and the beds of natural streams. However, in practice the relevant authorities are very slow in attending to such activities. This is a serious impediment to whatever good drainage system that is provided.

4.8 New Sewers as a replacement or a supplement to existing Sewers.

In the planning stages, the expectation was to build a replacement Sewer system in Baseline Road to takeover from the existing surcharged sewer network. However, during actual implementation, the Engineer could not satisfy himself that all the existing sewer connections were identified and provisions made to transfer their inflows to the new system. Further the question of providing outflows to the new system had not been fully addressed at the design stage. Currently the gravity sewer system in Baseline road ends up at three pumping stations (i.e. Maligakanda, Tickle Road and Narahenpita). These pumping stations are located outside the Baseline Project area (about 500 m away). Hence most of the new sewers could not be "made live" in the near future (i.e. until WB eventually provides the required links to the pumping stations. Hence, the people will still have to depend on existing sewers. Further at Ingram Road and at the North of Orugodawatta Jonction, new sewers have no outfalls at all. The result of all these is the undesirable delay in realising the expected benefits by providing the new sewer system.

5.0 Impact of Uncharted Services to Project Implementation.

Presence of unchartered services and the various remedial measures adopted to overcome the obstructions to drainage work from them, substantially affected the time schedules and the cost of the Project. Table 1 gives an indication of the variation orders issued to the Contractor in this regard.

About 50 claims based on these variations are pending resolution to date. Value of same are yet to be assessed. In the Original Contract, drainage work was to cost Rs. 250 million and the claims run to an equally large amount. However there is still no assurance that the Contractor would eventually succeed in justifying all his claims.

On the other hand, 142 days of delays have been already approved by the Engineer on account of obstructing services for drainage work. A yet unspecified number of days (running upto about March 2000) are likely to be allowed as delays due to various problems.

There is also public outcry about the day to day delays and inconvenience they are undergoing due to ongoing roadwork.

The scheduled date of completion for Phase I was December 1998 and the percentage completion as at October 1999 was about 60%. Although it is not possible to make an exact assessment of the contribution the storm water and foul sewer work to overall delay, it can be safely said that, over 50% of the delays were due to obstructions encountered during drainage work.

6. Lessons for the future

1. Possible ways to resolve the conflict of the Drainage Network with other services

Benefits of improving a principal urban road like Baseline Road undertaken with national funds should be available to all the Sri Lankan citizens.

However, a conflict arises when there is a clash of interests between residents and those who own business premises on either side of the road (or nearby) and the general road users. In urban areas, the residents pay taxes to local authorities. Hence the authorities are bound to give certain services (such as the supply of water, electricity, telephones and the disposal of sewerage and solid waste) to their tax payers.

Table - Variation Orders Issued on Drainage Work

Nature of remedy ordered	No. Of orders issued
Introduction of new Manholes	25
Introduction of non standard manholes	10
General exposure to review the problems	60
Encasement of existing services with protective concrete and / or PVC ducts.	10
Change of location of Manholes or pipelines during Construction	40
Deletion of parts of drainage work	05
Modifications to Gullies	05
Demolition & reconstruction of offending services	05

In providing these services the space below or above a road will have to be used by the authorities who provide such services. For maintenance and upgrading of these services, the authorities concerned will have to dig the road or footpath, lay pipes, ducts, cables, bury chambers or plant posts, draw overhead wires or carryout other similar work. From the point of road maintenance, such activities are generally undesirable. The only service required for maintenance of a road is a storm water drainage system. It is very clear from the foregoing account that the space below the carriageway in Baseline Road is already saturated with other services and as a result it was not possible to find an unobstructed path to provide its drainage network. The service agencies such as CEB, WB, SLT (Being Government concerns) are very much under resourced and they have very little regard whatsoever to the inconveniences undergone by the public. They dig the roads at their will and leave the disturbed surfaces unattended for long periods. Further the safety measures provided by them during their digging and services laying work are far from adequate.

The Municipal Ordinance, which is applicable for the areas surrounding Baseline Road and the Thoroughfare Ordinance which is applicable for principal highways, permit the service agencies to utilize the road carriageway and/or footways for laying their services after signing agreements with the CMC/Highways Authority on specific conditions.

However, at present no such agreement system prevails and neither CMC nor RDA are in a position to control the activities of the services agencies (who come under different Ministries). The service agencies never keep to a given plan but keep on changing their requirements from time to time. The practice by RDA and CMC of charging road "reinstatement costs" from the service agencies has never been an adequate remedy to control the manifold damages caused by them.

Under these circumstances the laying of their services in the roads cannot be justified at all.

1) To persuade the service agencies to have a 'Services Corridor' adjoining each road vested in them so that they could lay or re-lay their services without being a hindrance to general road users. However, it is unlikely that such a step would be taken by the relevant authorities in the foreseeable future due to high cost and time involved in the land acquisition and re-settlement work involved.

2) To provide several large concrete ducts (each with several compartments) under the carriageways and footways so that the Utility Agencies can use them as per their requirements. However, the cost of the ducts should be collectively borne by the utility agencies since it would not be economically viable for Road Authority to add it to road development costs.

3). One possible long-term remedy for this problem would be for the local authorities and RDA to increase the width of gazetted street lines for their roads and thereafter to prevent future structures being built close to the road limits so that a reservation would become available some day to be used by the Services Agencies.

4). It would be essential for the Road Authority to prepare a Code of Practice governing all excavations and reinstatement concerning utility work. Road Authority should specify the paths for all the utilities and also ensure that the Utility Agencies keep to the paths given. Road reinstatement after excavation by the Utilise shall be promptly done by the Road Authority. Quality of work must be confirmed by doing the necessary tests.

5). It would be worthwhile for all the agencies to get together and to prepare a single comprehensive plan (with each of its components funded by the respective agency) and entrust all the work to one Contractor for implementation under joint supervision. Such arrangement will greatly enhance commitment by all parties, would eliminate counter productive and repetitive work and result in minimizing the cost.

6.2 The limitations in meeting the design stage expectations

a) Storm Water Drainage Network

A principal objective at the design stage was to build a storm water drainage system which would be free of foul water inflows. Storm water from the adjacent properties were expected to flow into the road only along the driveways to such properties. Properties with lower ground elevations were expected to have in house disposal arrangements. Further, in order to control the silt intrusion, a trapped gully was proposed.

However in actual situation, the expected co-operation from the CMC to block the undesirable waste inflows to the site was not received. As a result the Consultant was forced to issue 11th hour instructions to the Contractor to connect a number of existing inflows back into the storm drainage system.

With respect to trapped gullies introduced, the Consultant now learns from the CMC that they have no equipment to clean such gullies and as a result they are forced to demolish the gully traps and make direct connections instead.

b) Foul Drainage Network

The objective at the design stage was to provide sewer connections to all the target population by year 2020 and to alleviate the surcharge problems experienced in certain areas almost immediately.

However, due to non availability of out flows in several areas, it is now observed that the new network could not be made functional in most of the areas in the foreseeable future. Further, in some areas, the proposed new sewer mains had to be deleted from the contract work due to excessive obstructions encountered from the existing utilities.

On the basis of the foregoing, it is now clear that the storm water and foul sewer networks now being provided fall short of the design stage expectations. It appears that the commitments from the CMC have not been adequate during the Project Implementation.

7. References

1. Baseline Road Feasibility Study
2. Baseline Road Waste Water & Sewerage Design Report - September 1995
3. Baseline Road Improvement & Extension Project Drainage Design Report - 1995

Important Note

This Article is based on the experience gained by the Author while working as Utilities/Drainage Engineer in the Baseline Road Project Phase I, Supervision Consultancy team. He acknowledges with gratitude the kind permission granted by the Director (Special Projects - RDA) for submission of this Article.

The Opinions expressed herein are purely personal and in no way represent those of the Consultancy team or the Client.