Greater Dublin Strategic Drainage Study

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1 Introduction

The economic success of the Greater Dublin Region since the 1990s has led to a very significant growth in Dublin city and the surrounding counties. The foul and stormwater drainage infrastructure is stretched to keep pace with the increased demand for new serviced land for housing, commercial developments and industry.

Overloading of the existing systems is evident from marked deterioration in water quality, increased risks of flooding and concerns that the drainage system and treatment plants have insufficient capacity to cater for future development.

In 2000 the Department of the Environment, Heritage and Local Government supported the proposal by the Dublin Region Local Authorities to proceed with the Greater Dublin Strategic Drainage Study (GDSDS) to examine these issues and to identify solutions. The Study was funded under the National Development Plan 2000-2006 and Dublin City Council was appointed as the contracting authority for the Study.

The GDSDS was commissioned in June 2001 to carry out a strategic analysis of the existing foul and surface water systems in the local authority areas of Dublin City, Fingal, South Dublin, Dun Laoghaire-Rathdown and the adjacent catchments in Counties Meath, Kildare and Wicklow. The GDSDS catchment area is shown in Figure 1.

Figure 1 GSDP Catchment Area

2 Study Objectives

The Study objectives were:

- To develop an environmentally sustainable drainage strategy for the Region consistent with the EU Water Framework Directive. This strategy should outline the requirements for foul and stormwater drainage capable of meeting the demands of the Region in the context of current Development Plans, the Regional Planning Guidelines and the longer term development potential of the region;
- To provide a consistent policy framework and standards which will apply throughout the Region, and promote the requirements of environmental legislation and the recommendations of the GDSDS itself;
- To develop tools for the effective management of the drainage systems including Geographical Information Systems (GIS), network models and digital mapping; and

- To develop the optimum drainage solution from a range of alternative scenarios having regard to whole-life cost and environmental performance, the solution to be broken down into a set of implementation projects which can be prioritised and put in place.

3 Regional Drainage Policies

The Consultancy undertook a review of local authority drainage practices in five key areas:

- New Development
- Environmental Management
- Climate Change
- Inflow/Infiltration and Exfiltration
- Basements

New policies have been drawn up in all of these areas and incorporated into the Development Plans of the local authorities. A set of detailed technical documents has been prepared to support the implementation of these policies. The policies seek to optimise the performance of drainage assets and to mitigate drainage impacts on the environment. Implementation of the policies is vital to ensuring the ongoing sustainable development of the Greater Dublin Region. Copies of policies are available on the Dublin City Council website.

4 Existing Drainage Systems

The history of Dublin's formal sewerage goes back to 1800, with the construction of sewers in the principal streets to drain rainwater into the River Liffey. Major system construction started in 1881 serving the Rathmines and Pembroke areas. The Centre City Main Drainage Scheme followed around 1900 with the City Quays sewers, being interceptor sewers laid either side of the River Liffey, gravitating flows eastwards to the Main Pumping Station and Primary Treatment Plant at Ringsend in Dublin Bay. The North Dublin system followed in the late 1950's to serve the then rapidly developing area north of the City. Again this system directed sewage in an easterly direction to a sea outfall off the Nose of Howth.

The southern suburbs were serviced by the Dodder Valley sewer in the early 1970's, still directing sewage eastwards to the Ringsend Treatment Plant via a submarine pipeline. The Dun Laoghaire catchment was connected to Ringsend in the early 1990's by a submarine pipeline.

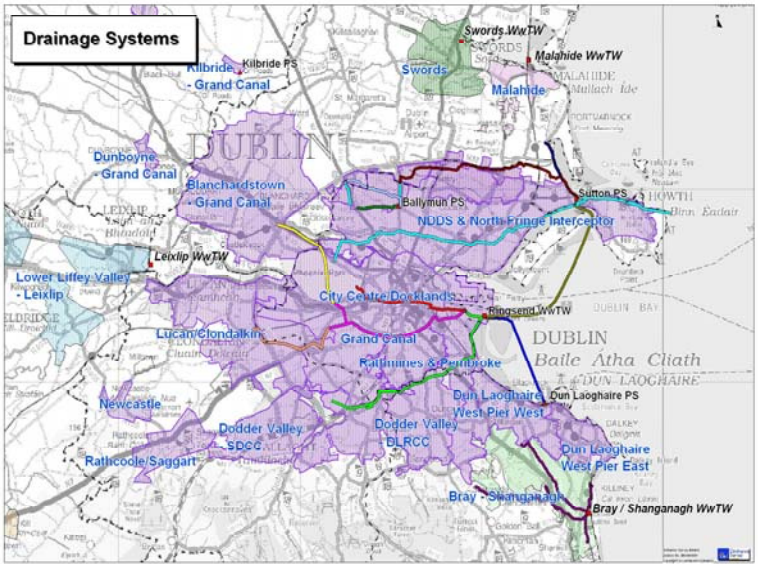

Figure 2 Dublin Existing Drainage Systems

The Grand Canal system was built in the 1980's to serve the new industrial development areas to the west of the City, and relieve the overloaded south city sewers. Through the City, the Grand Canal system

comprises a two-compartment tunnel, passing both foul and storm flows. The foul flows gravitate to the Main Lift Pumping Station, which lifts flows into Ringsend Treatment Plant, while the storm flows gravitate to Dublin Bay.

The most recent major sewerage system the North Fringe Interceptor, completed in 2003, directing foul flows initially to the Howth outfall, and lately to the Ringsend Wastewater Treatment Works.

The Ringsend Wastewater Treatment Works and Main Lift Pumping Station were upgraded in late 2003, from a treatment capacity of 950,000 population to 1.64 million, with sewage flows from North Dublin also transferred to Works via the Dublin Bay submarine pipeline, from Sutton to Ringsend.

Stormwater systems are sparse in the older central areas, such as City Centre, Docklands and Dun Laoghaire, which are served by foul/combined or partially separate sewerage. Most stormwater systems have been constructed as part of the separate systems serving post 1960's developments. The Study included all the major rivers, except for the Liffey and Dodder, with their associated surface water systems.

5 Conduct of the Study

In June 2001 the Study started by the Dublin Drainage Consultancy, which is the joint venture between Hyder Consulting, and Dublin based firms, PH McCarthy & Partners and RPS-MCOS (in association with HR Wallingford). The Consultancy included specialists from Wallingford Software for GIS advice, University of East Anglia for Climate Change aspects, University College Dublin for coastal water quality modelling and Dublin-based town planners, Brady Shipman Martin.

The Consultancy Team was over 90 staff, comprising managers, specialists, modellers, and technicians and survey supervisors. Around 50% of the team are modellers. Monthly staffing numbers vary between 44 and 62, averaging around 50. The budgeted staff input was 358 man months, being 30 man years – hence the large team.

The Client's Team was 6 permanent staff, comprising Study Manager, drainage engineers, GIS and survey staff from Dublin City Council, and 6 part-time representatives from the other Councils. As well as monitoring the Study, their input has been pivotal in data collection, comments, reviews and approvals, workshops, etc.

The Study area comprised over 50 foul and storm catchments, varying from dense city centre development to rural streams and rivers. As in most cities, foul drainage is a mixture of separate and combined systems with overflows to watercourses. The storm systems included separate drains, watercourses and major rivers. Foul, combined and storm systems were all represented by InfoWorks models, the detail of the models depending on the availability of asset information and their importance to future development.

The hydraulic models were built from existing SUS25 databases, with further assets being digitised from record drawings, mostly carried out in-house. Asset surveys by specialist contractors provided information on ancillary structures and pumping stations. Information on the main rivers was provided by topographical surveys of the channels, combined with LIDAR aerial survey of the flood plains.

The Consultancy arranged and supervised site surveys to the value of €3.5 million, involving 12 contracts. The specialist surveys included installation of over 480 flow monitors and 270 rain gauges, survey of over 4100 assets and topographical survey of some 74 km of rivers and streams.

All modelling and survey information was held in the Study Geographical Information System (GIS), incorporating digital mapping, ortho-rectified aerial photography, digital terrain mapping, and system information. Reporting and drawing production was also based on the GIS using MapInfo software.

6 Methodology for the Study

The Study used a phased approach of initial planning, followed by hydraulic modelling, and optioneering, all leading to the overall strategy output, as shown in the flow chart in Figure 3.

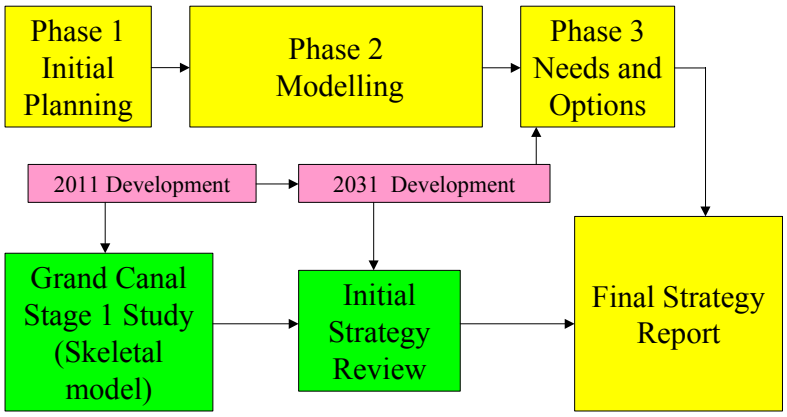

Figure 3 Flow Diagram for Overall Methodology

Reflecting the importance of development as a driver for the Study, a short-term initial study of the Grand Canal system was carried out, to obtain an initial review of capacity availability for this main system serving the ongoing development areas to the west and northwest of the City. This study was completed in September 2002, and confirmed that the existing system was performing adequately, but that both trunk sewers were suffering from significant inflow and infiltration. The overall system would be at capacity around the future timeframe of 2011.

The Consultancy initiated the concept of an Initial Strategy Review, bringing together the members' widespread knowledge of the sewerage and treatment systems with the results of the Grand Canal study. This initial review of possible strategy options was issued in April 2003, and provoked many useful comments and concepts, which were followed up by the later optioneering for the overall master plan.

7 Population and Land Use

In defining the existing and future drainage requirements of the Region, the Study used three planning scenarios: years 2002, 2011 and 2031. The 2002 scenario represented the existing situation, incorporating the 2002 Census results. The 2011 scenario corresponds to the planning horizon of the Regional Planning Guidelines, which have been reflected by local authorities in their current Development Plans. The 2031 scenario is a long-term horizon reflecting regional planning policy and drivers. This latter scenario is appropriate for the planning of major long lead-time strategic infrastructure and has regard to likely demands for the foreseeable future. The development intentions for the Regions are challenging, as demonstrated by Figure 4 for residential population.

	2002	2011	2031
Population	1,225,545	1,489,962	2,054,401
Compared with 2002		+ 22%	+ 68%
Household Size	2.92	2.46	2.18
Compared with 2002		- 16%	- 25%
Housing Units	420,130	605,667	943,627
Compared with 2002		+ 44%	+ 125%

Figure 4 Residential Population Statistics

The combination of increasing population and decreasing household size gives rise to a significant increase in numbers of household units. Within the existing urbanised areas (such as City Centre, Docklands, Rathmines and Pembroke, North Dublin and Grand Canal) this is being achieved by infill development of open spaces, or by intensification of redevelopment sites. Increased population in these areas places greater pressure on the city's drainage and treatment systems.

For the outer areas and commuter towns surrounding Dublin, development is occupying new development lands. The large areas being occupied and attendant large flows being discharged to the city networks are producing flows greater than available system capacity. Therefore, the current practice of bringing such external flows into the City's systems for treatment is no longer sustainable.

8 Data Collection, Processing and Hydraulic Modelling

The first step in the Study was to collect and review the validity of existing data. This included all paper and digital records as well as available hydraulic models. To supplement this data four short-term flow and rainfall survey contracts, three asset survey contracts, three topographical survey contracts and one CCTV survey contract were awarded.

A study Geographical Information System (GIS) was established. This involved the digitising of existing paper records and the merging of existing digital databases. A major data management exercise was required to develop an integrated asset inventory.

To enable the hydraulic performance of the existing drainage systems to be replicated and to assess existing and future deficiencies, hydraulic models were prepared for 37 separate catchments. The specified modelling software was InfoWorks CS from Wallingford Software.

9 Sewerage Systems

The sewerage system for the Dublin Region comprises 18 catchments for which scoping reports were produced. Hydraulic models were produced for each catchment, except where separate studies were ongoing, being the Rush/Lusk and Donabate/Portrane areas. Capability of the existing foul/combined systems to serve existing and future development can be summarised as:

- Grand Canal System – This system, which includes the 9B Branch from Lucan/Clondalkin and the 9C Branch from Blanchardstown, is the backbone of the City's drainage network. The foul cell of the Grand Canal Sewer has capacity for the original catchment only. The capacity of both the 9B and 9C Branches are exceeded with current development.
- Dodder Valley Sewer – This sewer serving South Dublin is currently at capacity with the risk of local flooding.
- North Dublin Sewers – The new trunk sewers in place in the North Fringe area have the capacity for future foreseeable development. Local overflows and flooding risk issues have been identified in the older catchment sewers.
- City Centre and Docklands – The capacity of the system is exceeded with excessive spills at combined sewer overflows causing pollution of the Liffey. There is a risk of flooding in some areas.
- Rathmines and Pembroke – The capacity of the combined system is exceeded with high flood risk areas needing relief.
- Dun Laoghaire – The pass forward flows are limited to the capacity of the pipeline to Ringsend. Storage systems will be required to cater for future development.
- Shanganagh Bray – The systems require upgrading to cater for future development.
- Osberstown and Leixlip – These Kildare systems require upgrading to cater for future developments.

In summary, there is very limited capacity in the existing systems for development beyond the existing zoned areas especially to the west and southwest of the city.

10 Wastewater Treatment Works

The existing wastewater treatment works in the study area were assessed in relation to their currently planned expansion, the ultimate design load and receiving water and existing site constraints. The wastewater treatment works can be summarised as:

- Ringsend – The existing plant is at capacity and needs immediate expansion for short term needs to meet the requirements of the Nitrogen Discharge Standards for Dublin Bay as set out in the Urban Wastewater Regulations.
- Local Works – The Shanganagh, Osberstown, Leixlip and Fingal Coastal Works can meet future needs with the current planned upgrading. Treatment capacity as Osberstown, Leixlip, Swords and Malahide may be marginal at the 2031 design horizon.

11 River and Stormwater Systems

The Study area was split into 33 river and stormwater catchments. Detailed scoping reports were prepared for each of each catchment, detailing the existing situation and future expectations for its system. Modelling of the river and stormwater catchments was prioritised depending on their significance.

In general, local flood risk areas have been identified and there are increased risks of flooding from the impacts of new development and climate change.

Pollution levels are elevated in urban watercourses. This is linked to pollution load from the stormwater drainage system and in particular the impacts of spills at combined sewer overflows (CSOs).

12 Criteria, Standards and Influences on Strategy

The strategy is based on appropriate (best practice) criteria, standards and influences, which can be summarised as:

- Standards relating to continuous discharges to receiving waters would be based on detailed studies of the receiving waters in the context of all relevant statutory requirements including the Water Framework Directive.
- Load management to reduce non-domestic loads at source would be undertaken in conjunction with the extension of the treatment works at Ringsend to meet the short-term needs.
- Operational standards of intermittent discharges from CSOs would be based on best practise environmental standards, retention of “first flush” and controlled spill frequency.
- The wastewater treatment strategy would be based on the optimisation and maximisation of the existing facilities to meet identified needs. Developments beyond those currently zoned will require additional capacity.
- The foul sewer strategy would allow the capacity of the existing systems, principally the Grand Canal system to be consolidated for existing development.
- Stormwater drainage strategy would be developed on a catchment-by-catchment basis taking account of flood risk, the impact of climate change and the systematic use of Sustainable Drainage Systems (SuDS) for new developments.

13 Strategy Scenarios and Resulting Options

Eight different strategy scenarios were identified. Six of these scenarios, on evaluation, were considered unfeasible due to technical, social, economic or environmental constraints. Medium to long-term needs, therefore, would require either of the following two options:

Option 2B – Wastewater Treatment in South Dublin for new development south and west of Clondalkin and discharge via the Grand Canal Tunnel Sewer to the Liffey Estuary combined with the development of a new Regional Treatment Works at Portrane and diversion of North Dublin flows to it. The ultimate development of an orbital sewer to Portrane serving the West of Dublin would provide for the long-term needs of the region beyond the current design horizon. This twin plant option has a number of disadvantages. The principal disadvantage is uncertainty as regards the treated effluent criteria that would apply to the Liffey estuary in the future.

Option 2C – Regional Wastewater Treatment at Portrane, with development of an orbital sewer to serve the Northern and Western environs of the city and with a pumped connection from South Dublin beyond 2011, and from Leixlip prior to 2031. While this option has the potential to provide an integrated and comprehensive scheme to meet the requirements of the region for the 2031 design horizon and well beyond, it does require that the orbital sewer between Blanchardstown and Portrane be provided in the medium term to meet the development needs of South Dublin and West Fingal beyond those areas currently zoned.

14 Proposed Works and Cost Estimate

Capital and Whole Life Costs of Option 2B and 2C proposals were prepared and a comparison of the costs is summarised in Figure 5.

The costs include strategic option costs, all foul and storm catchment network upgrading costs, wastewater treatment works costs, and includes contingencies, overheads, planning and VAT.

Description	Option 2B	Option 2C
Capital Costs	2,193	2,361
Operational Whole Life Costs	240	224
Comparative Total	2,433m	2,585m

Figure 5 Strategic Options 2B and 2C Comparison of Costs

The estimated capital cost difference between Options 2B and 2C is calculated at €168m in favour of Option 2B (inclusive of overheads and VAT). This figure is reduced to the order of €152m when relative operating costs are accounted for in the NPV calculation. This represents a 6% difference in favour of Option 2B.

Given the sensitivity to changes in quantities and the unit rates used in estimation of costs at strategy stage, this difference cannot be regarded as significant. Furthermore, the level of risk associated with the Option 2C estimates is considered to be lower than for Option 2B, given that a larger proportion of the works can be accommodated in green-field sites.

15 Recommended Strategy

The recommended strategy for the long term drainage requirements for the Greater Dublin Region is that set out in Option 2C, being:

- New Regional Wastewater Treatment Plant at Portrane
- Orbital sewer to Blanchardstown
- Pumped connection from South Dublin to orbital sewer
- Pumped connection from Leixlip to orbital sewer
- Pumped connection from Meath to orbital sewer
- Redirecting excess flows from Swords and Malahide
- Maintain Ringsend Wastewater Treatment Plant for existing catchments
- Upgrade existing treatment works to their ultimate design capacity
- Upgrade local sewerage networks

The recommended strategy offers:

- The least environmental risk in the context of receiving water standards and community impacts, and
- The most robust and secure operational regime, relying largely on proven technologies and with lower community impact where the bulk of the works can be constructed outside of existing developed areas.
- A future proofing of the strategy for growth beyond the 2031 horizon.

In whole life costs the difference between the two feasible options is marginal when the risk factor is considered.

The orbital sewer to Blanchardstown is required for the long-term drainage needs of the region. This will be provided as part of Option 2C but not as part of Option 2B. If Option 2B were chosen now, the orbital sewer would have to be provided as an additional item, post 2031. This means that over a 40-year time frame the recommended strategy would show a positive NPV over option 2B.

16 Implementation of the Strategic Plan

Implementation of this recommendation will require an agreed regional approach between the Local Authorities and the Department of the Environment, Heritage and Local Government in support of the successful planning, funding arrangements and procurement strategies for implementation according to the required timescales.

The timetable for implementation of the major infrastructure would be spread over the period 2005 to 2031. However a significant proportion of the plan needs to be implemented over the period 2006-2013 to ensure that capacity is available for planned development. This will require up front expenditure of some €1,560m. A critical element of the plan is the immediate extension of the Ringsend Wastewater Treatment Works.

The implementation of the policy elements of the strategy is crucial to its delivery of a sustainable drainage system. Formal adoption of the policies should be followed by active implementation across the region.

Implementation of the GDSDS is currently being promoted on the following fronts:

- Extension of Ringsend Wastewater Treatment Plant
- Strategic Environmental Assessment
- Orbital sewer and Portrane Wastewater Treatment Works
- Sewerage upgrading in Blanchardstown
- Sewerage upgrading in Rathmines and Pembroke High Level system

Regional drainage policies have been rolled out to stakeholders, such as developers, consultants, etc and are being applied by the seven Local Authorities.

17 Summary and Conclusions

The GDSDS was one of the largest drainage studies undertaken in Europe, investigating sewerage, drainage and river systems within a developed area of over 30,000ha and over 1.2 million population. The associated hydraulic models were among the largest created worldwide. New processes and techniques were created to take advantage of the latest developments in hydraulic modelling, Geographical Information Systems and database management. Regional policies have incorporated up-to-date best and sustainable practices in drainage design, operation and management.

The study has defined the issues facing the Region's drainage and taken a strategic approach to address them, being:

- To relieve overloading at Ringsend Wastewater Treatment Works, while catering for committed development to 2011 of zoned lands and resolving pollution and flooding risks within the existing networks.
- To provide for necessary ongoing development in the Greater Dublin Region, while ensuring that existing networks, Ringsend and other local WwTWs can accommodate the needs of the existing catchments to 2031.

Implementation will involve a major programme of works and funding needs of €2,585 million, in parallel with systematic implementation of policies and operational recommendations. A strong co-ordinated regional approach will be required to deliver successfully on these recommendations, together with further local detailed work to follow up on the strategic investigations undertaken by the Study.