The Value of Water Level Management

Transportation Network

ada

Introduction

Foreword from the Chairman

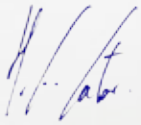
This report emphasises the importance of water level management in ensuring the security of the transportation network in England and Wales. Furthermore, it highlights the interconnectivity of the transportation network, and the important role Internal Drainage Boards (IDBs) play in continuing to keep the country, and the economy, moving.

> *"…the interconnected nature of its networks...lends resilience to the sector. However, the scale and exposed nature of the network leaves it vulnerable to some significant risk."*
>
> 2012 Sector Resilience Plan for Critical Infrastructure, Cabinet Office

Britain currently faces a number of stresses: a growing population, climate change and a large budgetary deficit. To meet these challenges we need an economically competitive Britain. For any society this must start with ensuring that fundamental building blocks for growth and prosperity are in place. Transport is one of those crucial building blocks.

As a nation we are renewing and improving our transportation networks; Crossrail is currently being built underneath Central London; plans are in place for a new Forth crossing (Queensferry Crossing) and for HS2. But new projects are just part of the picture, at the same time we must do what we can to preserve and enhance our existing infrastructure. The flooding experienced across England in November 2012 is a timely reminder about the impact our weather and climate can have on our ability to move people and freight about our country.

ADA and its members play their part in helping keep the country moving, regardless of the mode of transportation.



Henry Cator OBE DL FRICS

Chairman

Association of Drainage Authorities

Introduction

About this report

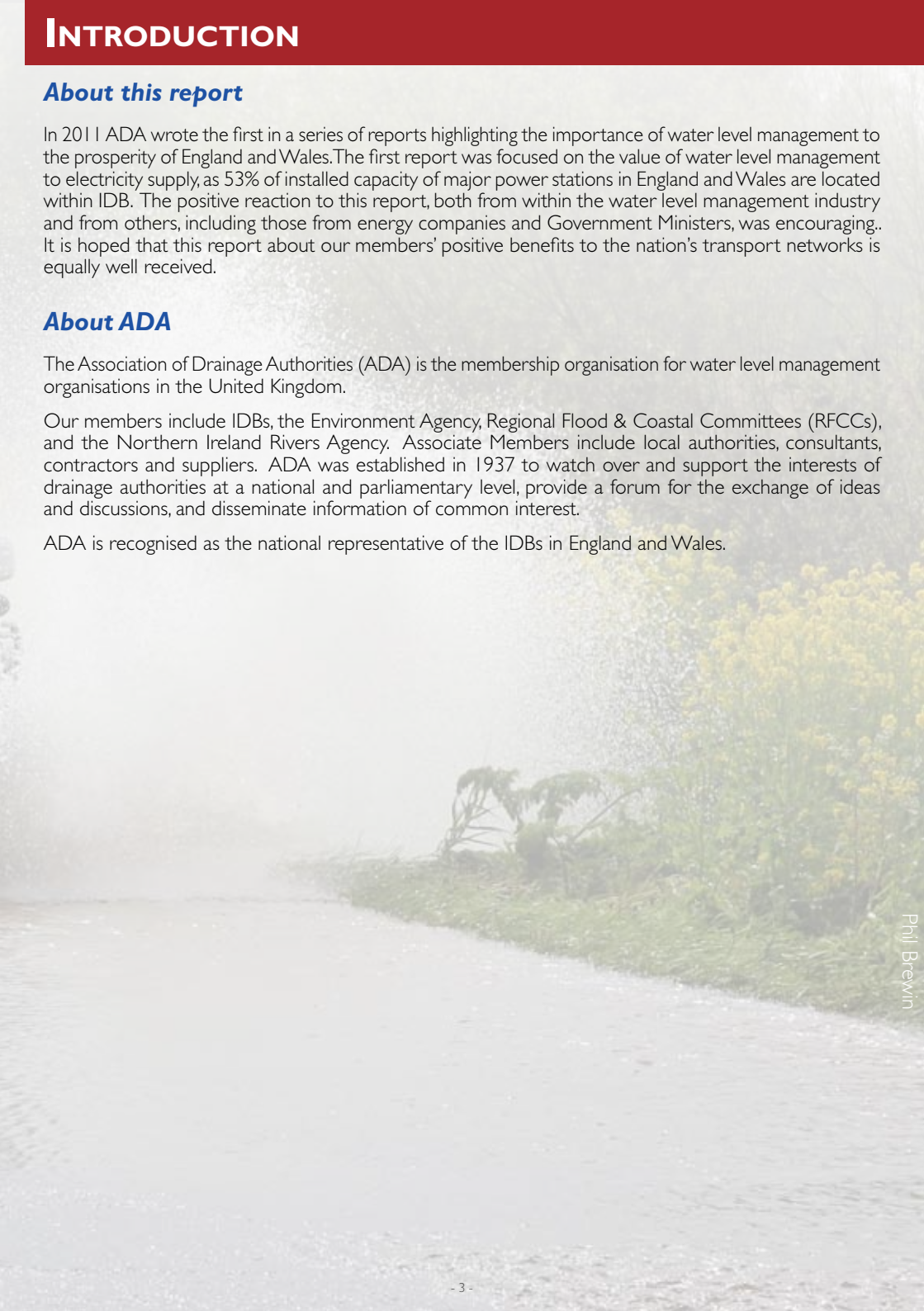
In 2011 ADA wrote the first in a series of reports highlighting the importance of water level management to the prosperity of England and Wales. The first report was focused on the value of water level management to electricity supply, as 53% of installed capacity of major power stations in England and Wales are located within IDB. The positive reaction to this report, both from within the water level management industry and from others, including those from energy companies and Government Ministers, was encouraging.. It is hoped that this report about our members' positive benefits to the nation's transport networks is equally well received.

About ADA

The Association of Drainage Authorities (ADA) is the membership organisation for water level management organisations in the United Kingdom.

Our members include IDBs, the Environment Agency, Regional Flood & Coastal Committees (RFCCs), and the Northern Ireland Rivers Agency. Associate Members include local authorities, consultants, contractors and suppliers. ADA was established in 1937 to watch over and support the interests of drainage authorities at a national and parliamentary level, provide a forum for the exchange of ideas and discussions, and disseminate information of common interest.

ADA is recognised as the national representative of the IDBs in England and Wales.



Phil Brewin

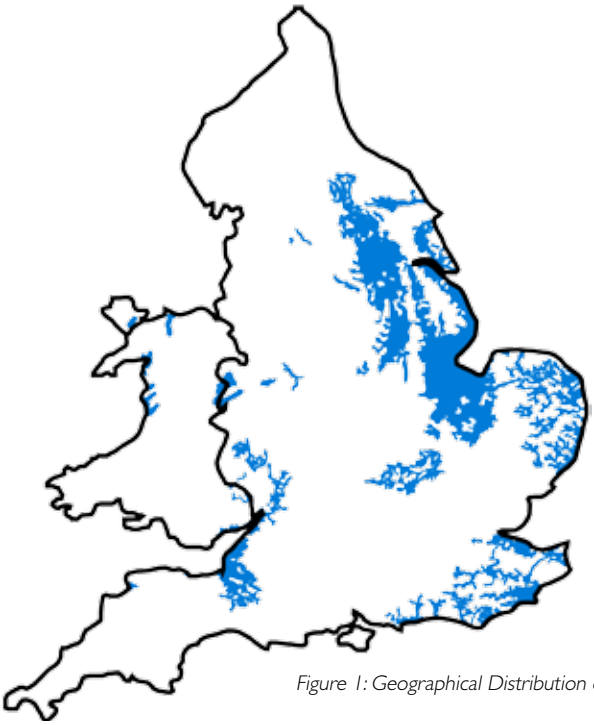


Figure 1: Geographical Distribution of Internal Drainage Districts in England and Wales

Figure 2: Indicative Flood Risk Map for England and Wales (Based on Environment Agency Flood Zone 2 data)

About Water level management

Water level management is the close management of water levels in watercourses and underground for the purpose of reducing waterlogging and the risk from flooding, and for the sustaining of land uses and the environment.

Low lying areas of England and Wales particularly require the daily close attention of specialist local water level management bodies to actively manage and reduce waterlogging and the risk of flooding. Internal Drainage Districts (IDDs) across England and Wales can be used as an effective proxy for areas where careful water level management is required, as figures 1 and 2 illustrate. However, it should be noted that there are no longer IDDs in Cumbria, Essex, Lancashire, Northumbria and the Thames catchment.

About Internal Drainage Boards

Internal Drainage Boards (IDBs) are statutory local public bodies in areas of special drainage need in England and Wales which undertake works to reduce flood risk and manage water levels on behalf of their community. They carefully manage water levels within their IDDs for land drainage, flood risk management, irrigation and environmental benefit.

IDBs cover 9.7% of the land area of England and 1.4% of Wales' land area. They are geographically concentrated in the Broads and Fens of East Anglia, the Somerset Levels, Kent, Nottinghamshire and Yorkshire. The actions of IDBs contribute to the security of civil infrastructure within their districts, including the transportation network for England and Wales.

Challenges facing the UK Transportation Network

- Climate Change

  2012 saw the United Kingdom experience what is now being called "Weird Weather". A drought swiftly gave way to the second wettest year since records began, with flooding causing not only delays, but also significant damage to sections of road and rail in some areas. Current predictions state climate change is likely to increase the frequency of these events in England and Wales.

- Funding

  In the light of the 2008-9 recession, all business has been forced to make financial savings. The Highways Agency and Local Authorities have both seen cuts to their budgets from Central Government in the recent spending review, while Network Rail are aiming to make £1 billion per year in efficiency savings between 2009 and 2014.

- Economy

  The last fifty years have seen a dramatic change in the way many businesses operate. In the past, large amounts of stock would be held on the business premises or at a central warehouse. However, the introduction of the "Just in Time" (JIT) business model means that businesses hold smaller quantities of stock, ordering only when a minimum stocking level has been reached. While this has many benefits for business, it relies upon an efficient supply chain to supply the stock when required. Should an event such as flooding affect the transportation network by even a small amount the consequences can be significant.

- Demand

  As a greater number of people work further from their homes there will continue to be increasing demand across the transportation network. Rail passengers have increased year on year for the last nine years, while the Department of Transport predicts that road usage will increase by 44% between 2010 and 2035.

Current Transportation Network

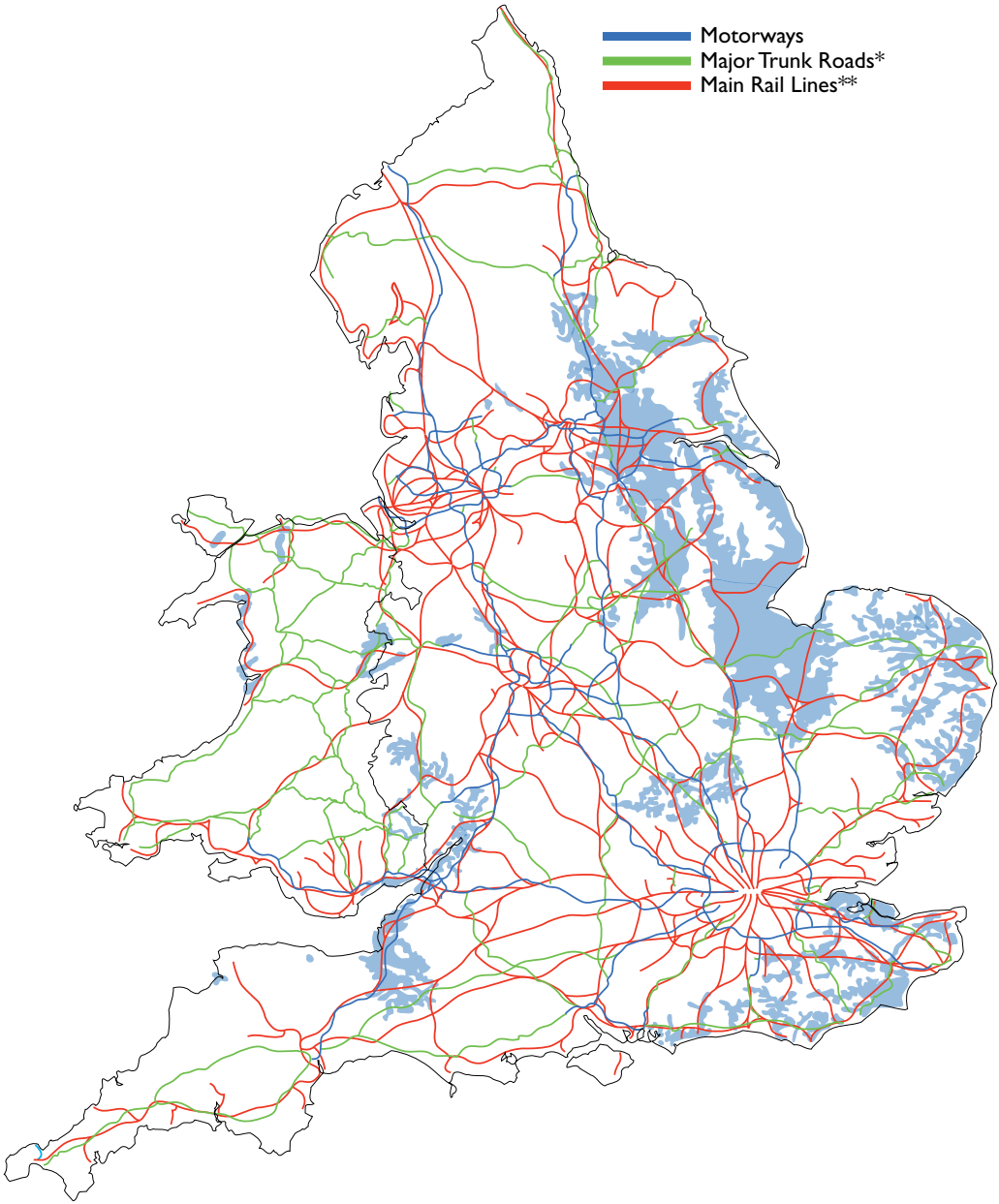


Figure 3: Strategic Road and Rail network in England and Wales
(Based on data from the Highways Agency, Traffic Wales and Network Rail)

Current Transportation Network

The transportation network in England and Wales is key to ensuring that the country can continue functioning. Almost all sectors of the economy are reliant upon good transport links, whether for employees commuting, supermarkets awaiting their daily delivery of fruit and vegetables, or fuel companies delivering petrol and diesel to service stations. Due to the interconnected nature of the transport network, a failure of a single item can lead to the failure of other infrastructure.

As an example, the snow of December 2010 cost the UK economy an estimated £1 billion per day, as airports reduced their flying schedule, deliveries were not made and staff could not get to work.

The problems are not restricted to road and rail. In an effort to reduce the nation's dependence upon cars, the public are being encouraged to walk or cycle, rather than drive. However, the poor weather in 2012 has also had a detrimental effect on the National Cycle Network, with riverside paths in York suffering scour damage, and bridge damage caused by winter storms in Plymouth. The lack of proper cycling routes and facilities could put more people back into cars or on trains, putting greater pressure on these systems.

The work that IDBs carry out helps to reduce the level of disruption which occurs during periods of heavy rainfall and, without the daily water level management, some areas would quickly become waterlogged. Although this is not as visible as flooding, waterlogging can be destructive, particularly if it happens over a period of time. This is because, if ground water were to lie just beneath the surface of a road, its condition would quickly deteriorate, especially if the road was part of a busy commuter route. Repair work would cause disruptions to motorists and would be an expensive overhead for the relevant body (local authority or Highways Agency). If the waterlogging was not managed effectively the damage would reoccur, causing more delays and escalating repair costs. Water level management, which IDBs do on a daily basis, helps to keep groundwater levels low, reducing the problems caused by both waterlogging and flooding. This reduces both repair cost to authorities and disruption to travellers.

Case Study: Workington, Cumbria

The River Derwent splits the town of Workington in Cumbria. On 19 November 2009, more than 300mm of rain fell in a 24 hour period on the town, causing the river to burst its banks and flood the town. The ferocity of the flow was such that three bridges, which connect the two sides of Workington, were affected – the Calva bridge, which was declared structurally unsound, the Navvies footbridge (see image below) and the Northside bridge, which collapsed as police were trying to prevent traffic from crossing, leading to the loss of one life. The loss of the two bridges crossing the river effectively meant that Workington was cut in half. The trip from one side to the other, in the past just a small matter of crossing a bridge, now necessitated a 25 mile round trip. The scale of repair work required to make the Calva bridge safe would mean that it would take two years before it would completely reopen. In order to reconnect the town, two temporary structures were built in place of the Northside Bridge, enabling pedestrian access 2.5 weeks later on 7 December 2009 and vehicular access 5 months later, on 21 April 2010.

Map of Major Road Network:

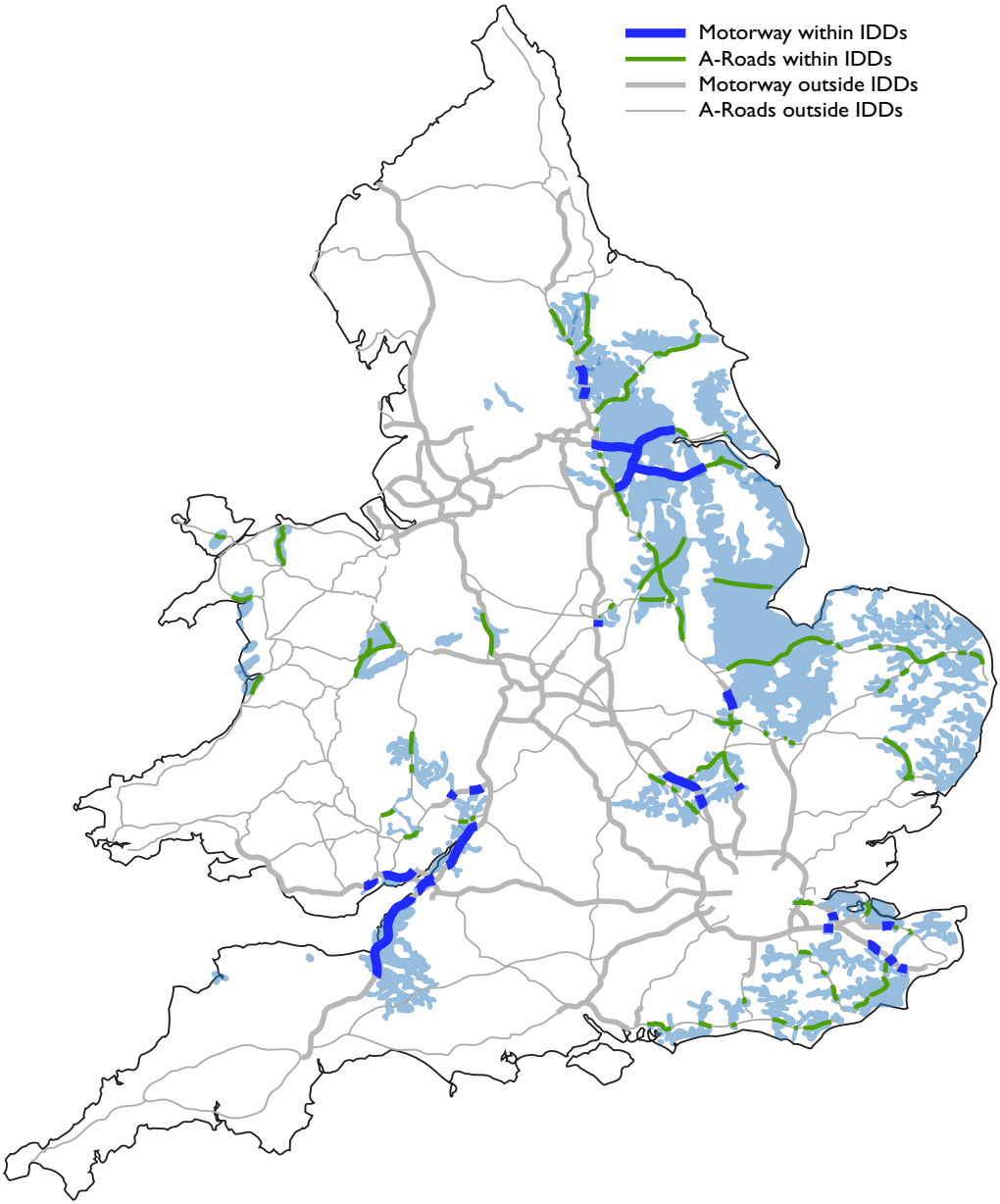


Figure 4: Strategic Road network in England and Wales
(Based on data from the Highways Agency and Traffic Wales)

Motorways and Major Trunk Roads

Travel by road is by far the most popular method of transportation, both for social and business purposes. This is demonstrated by figures showing that two-thirds of freight moves by road, and on average each person makes 600 trips by car per year. The Cabinet Office Sector Resilience Plan for Critical Infrastructure 2010 states that *"England's road network... is managed by multiple layers of government.... Local Authorities have the legal duty to maintain local roads (98% of the road network), whilst the Highways Agency... retains overall oversight of the sector... Wales... largely plans their own road network."*

Within England and Wales there are more than 335,000km of road, of which over 39,000km are motorways and A-roads. This report focuses on the trunk road network (defined as centrally managed motorways and A-roads by the Department of Transport, managed by the Highways Agency) and principal A-roads (managed by Local Authorities). More than 3% of the trunk road network is located within IDDs.

Examining the two types of roads shows that almost 6% of all motorways lie within IDDs. The length of motorway affected varies from region to region, but almost a quarter of the affected motorways are located within the Yorkshire and Humber Area (based on the Highways Agency regions). Large stretches of the M65, M18 and M180 lie within various IDBs and could be affected without adequate water level management. Fewer A-roads are located within IDDs, with the figure standing at 3%. However, as with the motorways, there is a great deal of disparity between the various regions. Again it is Yorkshire and Humber which has the highest proportion of A-roads within IDDs (16%), while the East of England has almost 15% of all A-roads affected. Several sections of the A1 lie in IDDs in both the East of England and Yorkshire and Humber.

In order to minimise the problems which can occur when flooding takes place, the Highways Agency has identified the sections of the strategic road network that are most at risk of flooding and developed guidance for the implementation of flood risk management strategies. This is in addition to monthly risk assessment of all key hazards on the roads it maintains. However, without the water level management that is carried out by IDBs on a daily basis, motorists could face greater delays whenever an extreme weather event takes place.

Case Study: The Somerset Levels

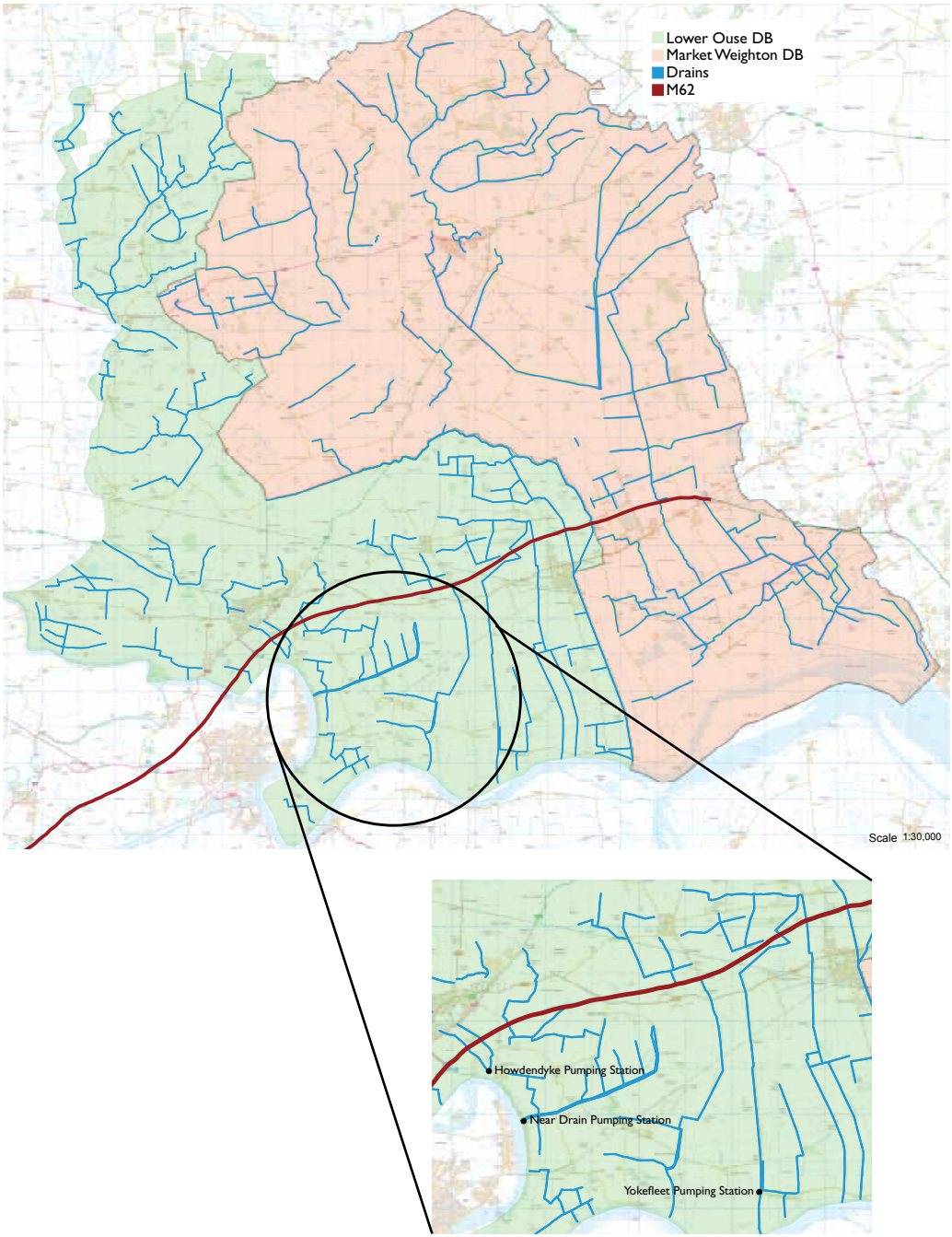

Phil Brewin

Somerset Drainage Board Consortium manages two drainage boards in Somerset; Axe Brue IDB and Parrett IDB, which predominantly carry out water level management in the Somerset Levels. Due to the low lying nature of the land (much of the area is between 2 and 6 metres above mean sea level) the water level management carried out is crucial to enable both the existence and development of the urban and large farming community in the area. The management, both for flood risk and for irrigation, enables excess water to be carried along drainage channels to discharge into main rivers. This work does not just benefit those in low lying land, as there are some areas which are naturally raised above the Levels ("islands"), and appropriate water management also benefits these communities as without it access would be restricted.

Within these two drainage districts there are 585km of roads and two of these roads are principal A-Roads, maintained by Somerset County Council: the A361 between Glastonbury and Taunton; and the A372 between Langport and Bridgwater. Sections of these roads are at higher risk of flooding and in 2012 and 2013, they were closed to traffic for long periods. The consequences of these closures mean that those travelling along these roads have to use diversionary routes. This can lead to delays and disruption, not only to those travelling through the area who have been diverted, but also to local users of the route. Analysis by Somerset County Council has estimated that the economic costs of disruption will be of the order of £200,000 per week.

Without the work the Somerset Drainage Board Consortium carries out on these roads, along with others, roads would suffer closure due to flooding and flood related damage on an annual basis. This would cause disruption to motorists and increase maintenance costs to the Local Authority. Furthermore, without this work, the "islands" would suffer poor access at best, or complete isolation at worst.

Major Road Network:



Top - *Figure 5: Market Weighton IDB and Lower Ouse Drainage Board sub-catchment area*
Bottom - *Figure 6: Location of pumping stations funded by the Department of Transport during construction of junctions 36 - 38*
(Map courtesy of Ouse and Humber IDB. Contains Ordnance Survey data ©. Crown copyright and database right 2010.)

Case Study: M62, Junctions 29 – 33, Yorkshire

The early 1970s saw the continued construction of the M62 motorway in Yorkshire, with a 13 mile section of motorway between Lofthouse and Ferrybridge completed in 1974. At this time the Yorkshire Water Authority raised concerns regarding the increasing water levels in the Market Weighton Canal, proposing heightening and strengthening of banks surrounding it. Market Weighton Drainage Board (now Ouse & Humber Drainage Board) were also concerned about the increasing main river levels leading to reduced effectiveness of the gravity drains in the area, suggesting that pumping stations were the only viable option.


Ryan J Nicholson

Discussions between Yorkshire Water Authority, Market Weighton Drainage Board and the Department of Transport resulted in the Canal Area Improvement Scheme. This saw the Water Authority raising and strengthening the Market Weighton Canal banks, while Market Weighton Drainage Board installed six pumping stations along the Canal and the Lower Foulness River. The Department of Transport contributed costs towards two of the pumping stations, as they would receive water from the new section of the M62 via the Board's drains. The Highways Agency now pays an annual contribution to the IDB for work carried out to maintain the M62 drains on its behalf, and for IDB channel maintenance and pumping costs. The M62 drainage is such that the motorway drains flow into the IDB drains.

This work is essential as the motorway is built on a raised embankment; therefore any flooding could result in foundation failure and subsidence.

Case Study: M62, Junctions 36 – 38, Yorkshire

The construction of junctions 36 - 38 of the M62, where it passes through Howden, commenced in 1973. At this time the Lower Ouse IDB (now Ouse & Humber Drainage Board) was the land drainage operating authority in this area. The proposed alignment of the Motorway meant that it severed several of the Board's main arterial watercourses, one serving the town of Howden. The Department of Transport approached the Board regarding drainage of the section of the M62 between Howden and Newport, proposing that it discharge into the Board's System. The Board appointed engineers to carry out an investigation into the impact this would have, concluding that three pumping stations would need to be constructed. The three stations, Howdendyke, Near Drain M62 and Yokefleet (see figure 6), were all financed by the Department of Transport.


Eddy Allen

The Department of Transport also asked the Board if they would carry out the future maintenance of the M62 drains, and the Board successfully negotiated commuted sums for this work and for maintenance costs of the three pumping stations. Between 2010 and 2012 the Board have completed refurbishments of two of these pumping stations, Near Drain Station (pictured right) and Yokefleet Station.

Map of UK Rail Network

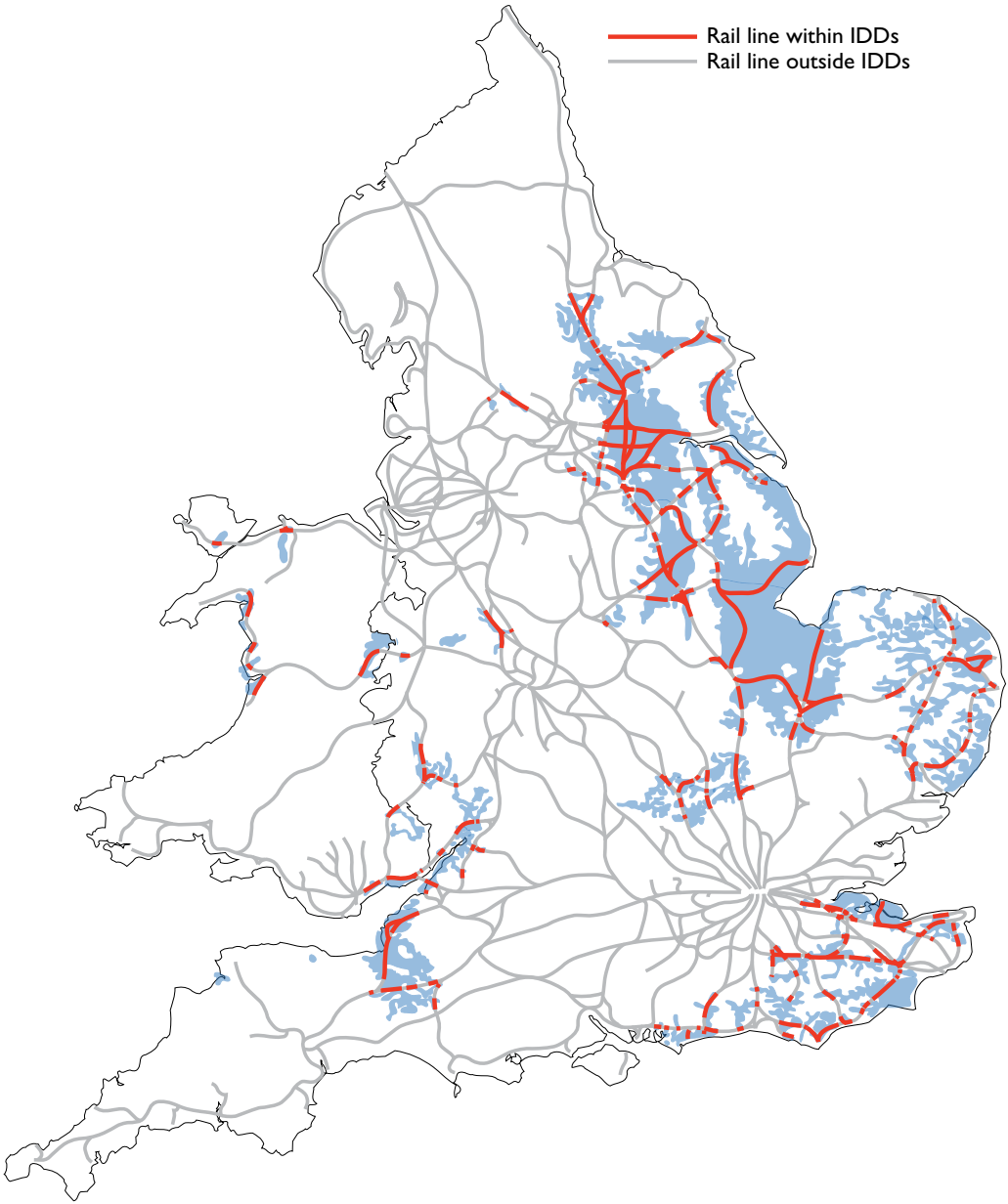


Figure 7: Strategic Rail routes in England and Wales

Main Rail Lines

Within England and Wales there are more than 26,000km of rail track, stretching from Berwick on Tweed in Northumberland to Holyhead in Wales to Penzance in Cornwall. The tracks, and associated signalling equipment, are maintained by Network Rail (the national body which owns the infrastructure of the rail network within the United Kingdom). The majority of this network has been built to withstand a 1% annual probability flood risk.

The past nine years have seen an increase in passengers, leading to trains in the UK being busier on weekdays than Switzerland, Netherlands, Portugal and Norway combined. This puts great pressure on the network to run as efficiently as possible. All delays will have knock-on effects throughout the day and, potentially, across the network to a far greater extent than those experienced by road users.

More than 5% of the 26,000km of track lies with IDDs. The implications of rail flooding, as demonstrated at Cowley Bridge Junction (see below), can be severe. This is compounded because, while diversions can be set up for road flooding, it is unlikely that the same can be done for trains. Should a section of track flood, it is likely that this section of the line will be closed and passengers will have to use rail replacement services or long diversions along different lines, increasing their journey times.

Disruption is not limited to flood water blocking a route. Persistent rain can also cause banking surrounding roads or rail lines to slip, causing a danger to all users. During June 2012, heavy rain caused land slips on the West Coast rail line in Cumbria and on the East Coast rail line in Northumberland (see image right). Both these lines connect Southern England with Scotland, and the landslips caused major disruption, with sections of both lines closing, cutting off direct train access between England and Scotland for a period of more than 24 hours. Further problems were caused when a train derailed on the West Highland line in Scotland after striking a boulder, which is likely to have been dislodged during a landslide.

Network Rail has established technical recommendations, stating the flooding levels which are safe for continuing to run a service. It has also set up codes of practice and reviewing standards for dealing with extreme weather. However, the actions of IDBs to reduce the risk of flooding and damage to lines help to reduce the amount of flooding related incidents affecting the rail network, meaning that passengers affected by flooding is minimised.

Case Study: Cowley Bridge Junction, Devon

Cowley Bridge Junction lies between Taunton and Exeter, maintained by Network Rail and falls within the First Great Western Rail network franchise. The line is a critical part of the network, connecting London with the West Country, as far as Penzance. The junction is located in an area susceptible to flooding, with the River Exe running alongside the track before passing under the line. Heavy rain normally floods the surrounding fields, but the volume of rain falling in November and December 2012 on already saturated ground led to the water reaching the tracks, destabilising the formation and washing the track ballast away. The water continued down the tracks towards Exeter Station, flooding a relay room and several trackside location cabinets. The track was closed due to the flooding on three separate occasions, and once opened operated for a three week period without any signalling.

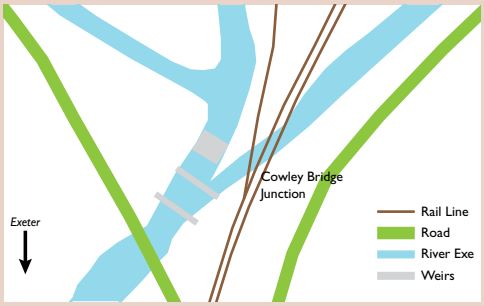
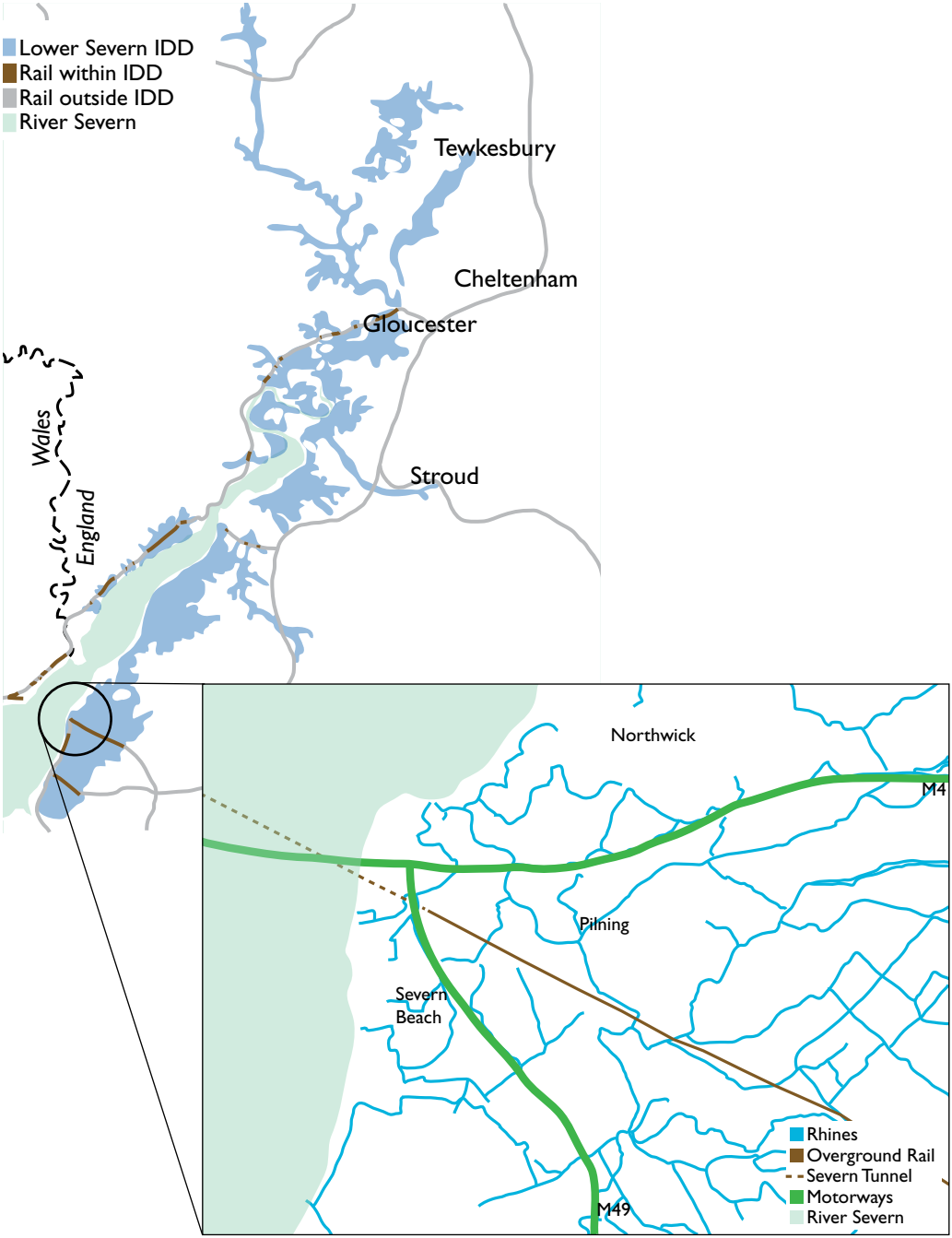


Figure 8: Location of Cowley Bridge Junction

UK Rail Network



Top - *Figure 9: map showing the Lower Severn Internal Drainage District area*
Bottom - *Figure 10: Lower Severn IDB Rhine Layout surrounding the Severn Tunnel*

Case Study: The Severn Tunnel

The Severn Tunnel, connecting England with Wales, was constructed by the Great Western Railway (GWR) between 1873 and 1886. It is 7km (4.35 miles) long, although only 3.6km (2.25 miles) of the tunnel are under the river. For well over 100 years it was the longest mainline railway tunnel within the UK, until the two major High Speed 1 tunnels (London East and West) were opened in 2007 as part of the Channel Tunnel Rail Link. The Tunnel and surrounding track on the English side of the tunnel fall within the Lower Severn Internal Drainage District.

There is a continuous drainage culvert between the tracks to lead ground water away to the lowest point of the tunnel, under Sudbrook Pumping Station, where it is pumped to the surface. The hazard of ignited petroleum running into the culvert in the event of derailment of a tank wagon means that special arrangements have to be made to prevent occupation of the tunnel by passenger trains while hazardous liquid loads are being worked through.

Prior to the building of the tunnel, the railway journey between the Bristol area and South Wales involved a ferry journey between New Passage and Portskewett or a long detour via Gloucester. The rail journey time could be hugely shortened by construction of a tunnel and work began in March 1873.

As Thomas Walker (the contractor for the work) notes in his book, the GWR had expected the critical part of the work to be the tunnelling under the deep-water channel. However, the real difficulties began in October 1879, when, with only 119m (130 yards) separating the main tunnel heading being driven from the Monmouthshire side and the shorter Gloucestershire heading, the workings were inundated.

The Tunnel was completed during 1885 and a goods train passed through it on 9 January 1886, but regular services had to wait until the pumping systems were complete. The Tunnel opened to goods trains in September and to passenger traffic in December 1886, nearly 14 years after work had started.

The Second Severn Crossing crosses over the tunnel on a "ground level bridge" on the English side, supported in such a way that no load is imposed on the tunnel.

Lower Severn Internal Drainage Board operations in the area are fundamental to the continued use of the tunnel. The channels maintained protect the English side of the tunnel from inundation and ensure the 200 trains that use the tunnel daily can operate. The IDB's system is drained via gravity to the Estuary of the River Severn and discharges through the Environment Agency maintained Chestle Pill.

The pumping system in the Severn Tunnel

Conclusions

- Much of the economy is reliant upon having an efficient and well maintained transportation network. Individuals need to use the road and rail network to travel from one area to another, be it for social activities or work. Businesses are dependent upon employees getting to work and stock arriving.
- The water level management work (that IDBs carry out on a daily basis) assists in preventing waterlogging, particularly in areas where there is a higher potential for this occurring. This work can not only help lessen the frequency and intensity of flooding events, it helps keep people and products moving.
- Water level management enables the Highways Agency, Local Authorities and Network Rail to concentrate on specific areas. Without the important work that IDBs carry out it is likely that all three bodies would have to carry out planning and maintenance over a far greater part of the network, with an increased amount to be spent on flood risk management and maintenance.
- Increasing demand on both the road and rail systems could lead to expansion of the network. If these were to travel through, or near to, an IDB, it would be important for the IDB to be consulted to enable good water level management to minimise any waterlogging or flooding problems in the future.

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