Exploring Greater Manchester

a fieldwork guide

Web edition edited by Paul Hindle

Original printed edition (1998) edited by Ann Gardiner, Paul Hindle, John McKendrick and Chris Perkins

5.1 Urban floodplains and slopes: the human impact on the environment in the built-up area

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A. The River Mersey

The urban development of Manchester has modified runoff to rivers (see Figure 1), producing changes in flood behaviour, which have required expensive remedial measures, particularly, the embankment of the Mersey from Stockport to Ashton weir near Urmston. In this embanked reach, runoff from the urban areas includes natural channels, storm drains and overflows from combined sewers. Alternative temporary storages for floodwaters involve release of waters to floodplain areas as in the Didsbury flood basin and flood storage of water in Sale and Chorlton water parks. This excursion examines the reach of the Mersey from Didsbury to Urmston.

Recommended route finding and navigation maps:
OS Explorer Map 277 (Manchester & Salford) and an A-Z street atlas of Greater Manchester.

STOP 1: Millgate Lane, Didsbury

From East Didsbury station and the junction of the A34 and A5145, proceed south along Parrs Wood Road and into Millgate Lane, Stop at the bridge over the floodbasin inlet channel at Grid Reference (GR) 844896 (a car can be turned round at the playing fields car park further on). Looking south from here the inlet channel from the banks of the Mersey can be seen. At flood times the gates of the weir on the Mersey embankment can be opened to release water into the Didsbury flood basin that lies to the north. Here, and at other sites along the Mersey, evidence of multi-purpose use of the floodplain, for recreation and wildlife conservation as well as flood management can be seen (Figure 2).

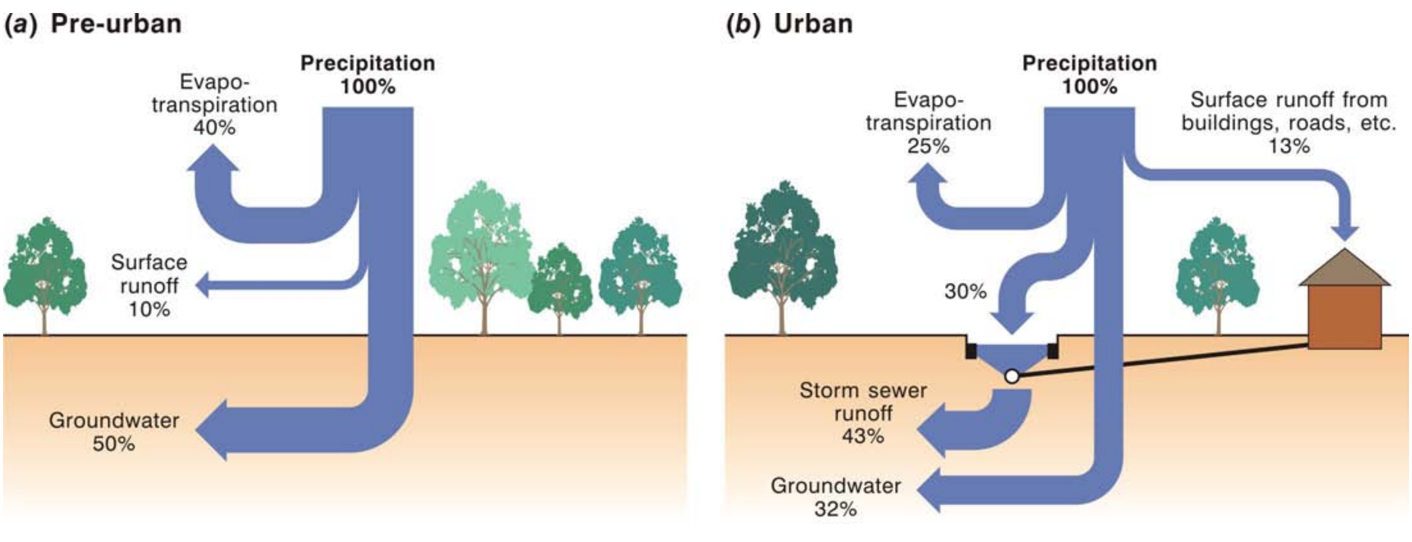

Figure 1: Contrast between natural and urban runoff pathways.

STOP 2: Palatine Road (GR 835908)

Opposite the Britannia Ringway Hotel, stop 2 provides an opportunity to examine encroachment on to the floodplain of the River Mersey. Note how the golf club house and car park are on raised land well above the level of the golf course itself. The low-lying land is part of the Didsbury floodbasin into which water is released during times of high river levels, to prevent overbank flooding. In 1991, the car park of the Britannia Ringway Hotel was flooded and cars had water up to their windows (Figures 3-4).

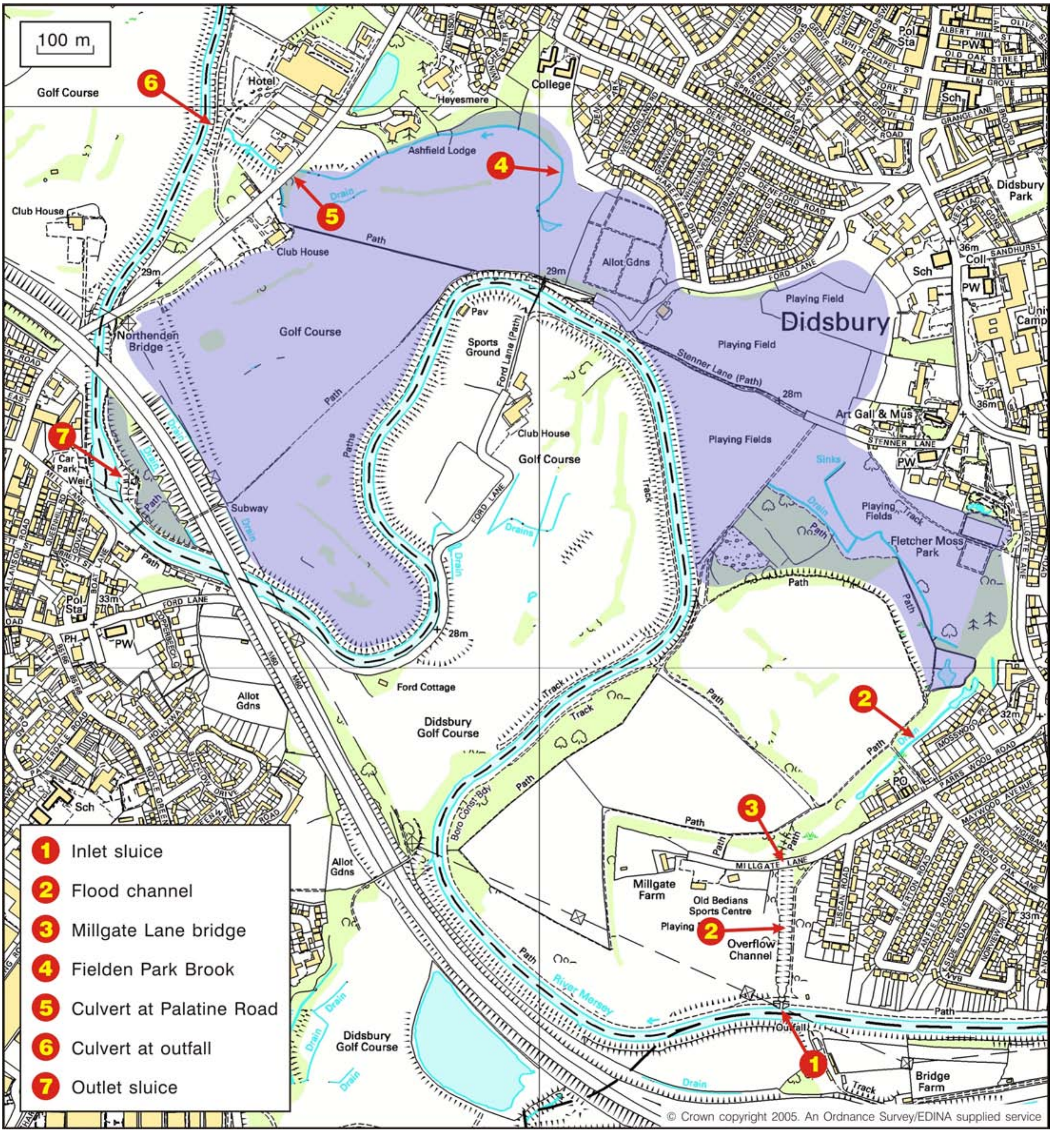

Figure 2: Flood plain map of the River Mersey between Northenden and Didsbury showing the inlet weir at point 1 and the outlet at point 7.

STOP 3: Northenden

By the footbridge, near the Tatton Arms at the end of Mill Lane (GR 833902) examine the embanked channels and the provision for floodwater management with passages beneath the M60 embankment, which occupies the floodplain and control gates for the release of overbank water back into the Mersey channel. Recently a new flood wall has been built on the Mill Lane side of the river. From the footbridge looking upstream a "trailer home" caravan park is visible on the south bank. Characteristically, such removable homes have been permitted on floodplains, on the assumption that they could be removed in the event of floods. Now the flood wall protects them, as well as the houses on Mill Lane.

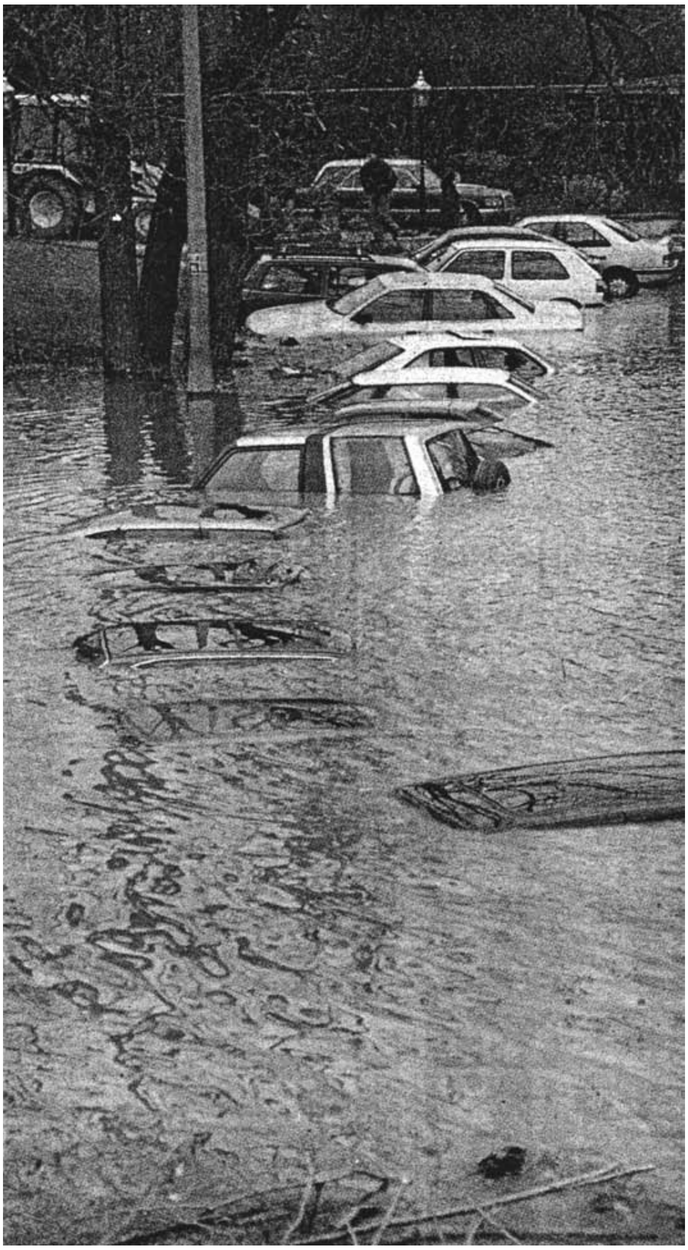

Figure 3: Photograph of the Britannia Hotel car park after the flood of 27 December 1991.

Downstream from the footbridge on the north (right) bank is the outlet gate to release water from the Didsbury floodbasin. Note the tunnels to carry floodwater underneath the motorway. The tree planting here by the Mersey Valley Warden Service is part of the creation of urban woodlands in Greater Manchester's river valleys.

STOP 3 TASKS

1. What do you consider to be the likelihood of flooding of the area on the south side of the river (the bank on which the Tatton Arms is situated)?
2. What alternatives would have been available for regulating floodwaters in the areas of the floodplain occupied by the motorway?
3. What examples of floodplain encroachment, other than the motorway, can be seen in the Northenden area?
4. Just below the weir, the banks of the river are eroding, loose blocks being seen at the foot of the bank. In the middle of the stream a gravel bar has formed. How do you explain this?
5. What are the benefits of woodland creation on the floodplain?

JOURNEY ALONG THE M60 TO URMSTON

As you join the M60, the motorway is at the southern edge of the floodplain, with playing fields to the north (right hand side). After the next junction (Junction 6), Sale Water Park will be seen to the right. This was a gravel pit from which material for the motorway embankment was excavated. Now the water park provides for:

- Water-based recreation
- Wildlife conservation (an area is set aside as a reserve for wading birds)
- Flood mitigation (a weir allows water to flow from the Mersey into the water park and to be stored there until the floodwaters have passed (Figure 5)).

At the end of the Water Park, the motorway crosses the former Manchester South Junction and Altrincham Railway, now the Metrolink line from Altrincham to Bury, and the Bridgewater Canal from Manchester to Runcorn. The canal was built in 1760; it is carried over the river by an arched aqueduct. The arch form means that as the river level rises, there is less space for the water to pass under the arch. Backing up of the water against the canal threatened to undermine its embankment and thus in 1840, a diversion weir was built in the Mersey bank, to the north of the present motorway, and an overflow channel takes the floodwater under the canal at another point. The next junction is the

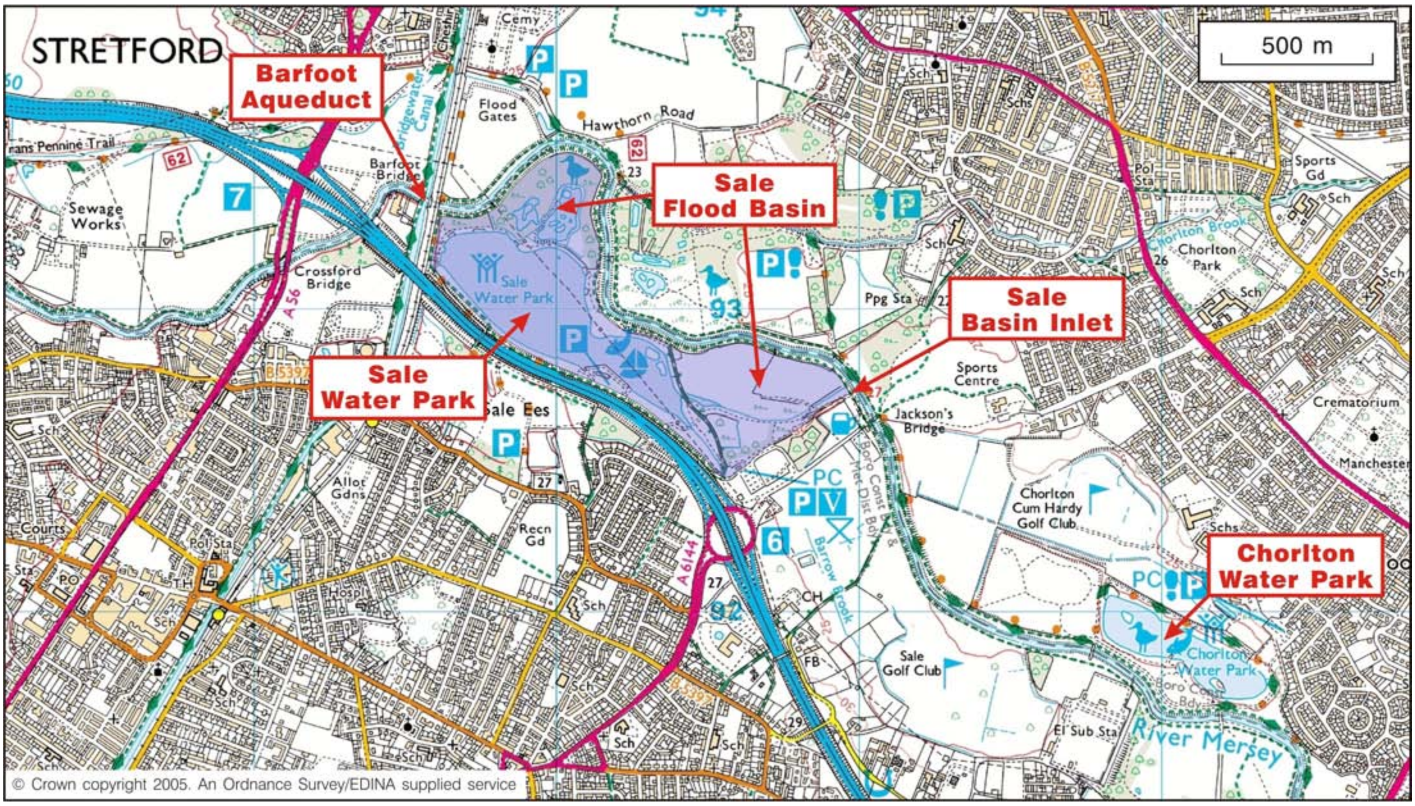

Figure 4: Flood plain map covering Chorlton Water Park and the Sale Flood Basin, again showing the basin inlet.

A56, and the area to the south of the junction, known as Crossford Bridge, where the A56, the old Roman road from Chester to Manchester, crosses the Mersey used to suffer frequent flooding until the Mersey was embanked in the nineteenth century. Immediately after the junction you will see intensively used farmland to the south (left-hand side).

Just after the junction with the A56, the M60 passes, on the northern (right) side, the Stretford landfill site where low hills are made of domestic waste dumped over the past 15 years. Formerly, NORWEB (now part of United Utilities) had a small installation where methane gas from the landfill was used to generate electricity. This is a good example of wise management of waste disposal. Much of the floodplain in the area around Urmston has been used for landfill in the past.

The route leaves the motorway at Junction **9** and turns into Urmston. This is a typical south Manchester suburban area. The nineteenth century node is the shopping area on both sides of the railway line, the original node, after crossing the railway line is near the church, on the top of the first terrace, just above the floodplain.

Figure 5: Floodwaters being released from the Mersey into Sale Water Park through the basin inlet near the Jackson's Boat Public House.

THE MERSEY MEANDER AT URMSTON

STOP 4: Urmston (GR 767937)

Examine the meanders downstream of Ashton Weir where the river is no longer embanked and has changed its course considerably in the last 25 years. Proceed down Queens Road from the traffic lights at the junction of the B5213 and B5214 in Urmston, turn left (east) down Eeasbrook and right (south) along the narrow unsealed lane behind the houses. Where the lane widens go left down the slope, cross the floodplain (yazoo) stream and go forward the bank of the Mersey. Examine the deep channel and eroding banks. [A ***yazoo*** stream collects drainage from the floodplain and immediately adjacent areas, but is at a lower level than the levees along the main river and so flows parallel to the river along the lowest axis of the back swamp (named after the Yazoo River on the lower Mississippi River floodplain in the USA). It is perhaps worth noting that such a feature occurs at a much smaller scale on the Mersey floodplain!]. Flooding is more frequent here than further upstream because the river is no longer firmly embanked. Buildings on the floodplain are occasionally surrounded by floodwaters (Figure 6).

When the Manchester Ship Canal was built it replaced the lower reaches of the Mersey's major tributary, the Irwell. The Mersey bed was lowered so that it could flow into the canal. This meant that the Mersey cut down into the floodplain more deeply than before. This explains why the Mersey bed is so far below the floodplain level at the point where you see it at Urmston. Some of the erosion of the bank here results from this deepening, but the main cause is that after being embanked and unable to erode for many kilometres above Ashton Weir, the Mersey is now free to erode and change its course.

In about 1980, iron piling was inserted to protect the opposite (left) bank of the river (Figure 7). This massive shift of the channel is a continuing process, and slumped pieces of turf are visible on the undercut banks. The National Grid (now National Grid Transco) had to spend £ 500,000 moving a pylon from the top of the undercut bank to the point bar. To avoid further risk, a caisson was sunk down to bedrock beneath the river alluvium, so that whatever the river did, the pylon would be firmly anchored in position (Figure 8).

Figure 6: Floodwaters around Willow Farm in the Mersey floodplain, 27 December 1991.

Figure 7: The Mersey at Urmston in March 1983 (top) and in early 1986 (bottom) showing how shift to the channel caused the iron piling put into to protect the pylon on one bank ended up on the other side of the channel. (The piling was removed around 1990).

Figure 8: The River Mersey at Urmston showing (left) the new pylon nearly completed in about 1988 and (right) surrounded by floodwater on 27 December 1991 (the bridge over the yazoo stream is in the foreground).

By 2005, the river had shifted right across the site of the replaced pylon and at low flows the concrete foundations of the pylon could be seen exposed on the channel bed. The successive meander cut-offs at this point can be examined by walking to the left (northwards). Keep at the floodplain level; do not follow paths going down towards the river. At first you will be able to see a cut off that began to be formed after 1983. The former river bank can be followed at the flood plain level. Evidence of the past rotational slumping of this bank can be seen at the bank edge and careful examination will reveal gaps between the original land surface and sections of the bank that slid downwards near bankfull flows undercut the bank (Figure 9).

Further north, at GR 939768, the old river meander of 1971 can be seen. This is an important bird habitat. Frequently herons, which use suburban fishponds as a food source, can be seen here. The ox-bow lake is well-developed. Both the cut-off lakes are indicated on the OS Explorer Map 277 2004 Edition.

STOP 4 TASKS

5. Draw a sketch map to show the changes in the positions of the river meander since 1971 (the earlier meanders are indicated by the ox-bow lakes which are also shown on the OS Explorer Sheet 277).
6. The pylon opposite the car park by the river appears to be reasonably stable at present. What changes by the river could affect it in the future?
7. There is a proposal to infill the abandoned 1971 meander on the Urmston side of the river by using it for dumping and landfill. Set out the arguments for and against the proposal.
8. List or sketch the signs of active bank erosion and sediment deposition that you can see in this area.
9. What type of material is the river cut into at this point? Describe its stratigraphy, texture and grain size composition.

Figure 9: The River Mersey at Urmston showing (top left) the willow tree on the bank in early 1983; (top right) severely undercut in late 1986; (bottom left) in the river in May 1989 as a result of 2.5 metres of bank erosion during the 30 December 1986 flood; and (bottom right) as the site appeared in July 2005 (note the growth of vegetation on the gravel bare that formed between the piling and the opposite bank after 1986).

B. Trafford Park and the Manchester Ship Canal

From Ashton Weir the route passes back through Urmston to the Manchester Ship Canal at Barton Bridge. After passing through suburban Urmston and under the M60, the route passes the Trafford Centre opened in 1998. Peel Holdings, the company that owns the Manchester Ship Canal, built it on the greenfield site at Dumplington. This is the first, and possibly the last, really large out-of-town shopping centre to be approved in Greater Manchester. The old Greater Manchester Council had a policy of reinforcing existing shopping centres and of maintaining a regional hierarchy with Central Manchester at the top and sub-centres such as Altrincham, Bolton, Stockport and Oldham at the next level and places like Urmston and Stretford at a level below them. The Dumplington scheme upset this strategy. But so far appears to have had less effect on the urban shopping centres than predicted. The Trafford Centre is obviously dependent on cars, but it has a good, well-used bus station and Peel Holdings has offered to contribute to an extension of the Metrolink to the Centre, if it is given planning permission to build and extension to the Centre. Currently a shuttle bus service to Stretford links the Trafford Centre to the Metro link service.

At the roundabout past the entrance to the Trafford Centre (GR 769972) the first buildings of Trafford Park, the earliest, and still one of the largest, trading estates in the world, can be seen. Trafford Park Development Corporation is undertaking many schemes to revitalise the area, which still contains many major industries, including the Kellogg's cereal factory and a major Colgate-Palmolive works. However, the heavy engineering has all gone. The last vestige of the former Metropolitan-Vickers electrical engineering plant, Alstom Turbine Generators, closed in 1999 and the power station design team was moved to offices in Knutsford. Problems of contaminated land abound in Trafford Park, particularly in old oil refineries and gasworks. Just after the roundabout the route passes the site of the former Barton Power Station (now occupied by B&Q Warehouse) which, like many other urban area power stations was built early this century to supply industrial power to local factories but became to old and too small for modern needs.

STOP 5: The Barton Swing Aqueduct (GR 767976)

Turn on to Redclyffe Road and immediately before the swing bridge turn into Old Barton Road to park. Turn back and cross Redclyffe Road (with care!) and follow the path up to the bank of the Bridgewater Canal. Turns left (north-westwards) and climb the ramp up to the bridge over the canal for a good view of the Barton Swing Aqueduct and the Manchester Ship Canal. The Barton Road Swing Bridge and the high level M60 bridge can be seen to the right hand side. Here, in the early 1890's the ship canal engineers had to provide a means whereby traffic along the Bridgewater Canal could be maintained, while allowing for the passage of ocean-going vessels along the ship canal. The old stone aqueduct over the Irwell built by Brindley was replaced by the Barton Swing Aqueduct, a great feat of late nineteenth century engineering. The vehicle depot just across the Bridgewater Canal from the access ramp is on the site of a former fuel oil depot. This is just one example of the many changes in industrial land use that have occurred in Trafford Park.

The Ship Canal is used only by a few ships, serving the Cerestar starch factory, with regular shipments of coming from Bordeaux and Mediterranean ports, a major scrap metal dealer at Eccles and a ship repair yard in Trafford Park. Mersey Ferries run an excellent tourist trip from Salford Docks to Liverpool and vice-versa on several occasions each summer. In the summer, the Bridgewater Canal has a large amount of tourist traffic gaining access to Worsley and to the Leeds-Liverpool Canal beyond Leigh. The aqueduct is thus part of a through route from Liverpool to London by canal.

C. The fluvioglacial gravel ridges of Salford and flooding on the River Irwell

From Barton, follow the B2511, Barton Road across the Ship Canal alongside the Bridgewater canal to A57 at Patricroft, going straight ahead at the traffic lights on to Worsley Road. In Worsley stop on the roadside near Farm Lane (GR 749002) and cross the road and proceed on to the footbridge over the canal.

STOP 6: The Bridgewater Canal at Worsley

Here is some fine industrial heritage and also an opportunity to discuss the nature of the coal measures that the canal helped to exploit. Note the colour of the canal. It is due to the iron staining of the mine water that drains out the horizontal adits formerly used as undergoing canals to enable the mined coal to be loaded direct on to barges for transport to Manchester and elsewhere. Cross the footbridge and walk on to Worsley Green. Worsley Green is an area of public open space, bordered by a heavily trafficked road and by terraces of 18th century cottages and 19th century houses with elevations in black-and-white vernacular style. The Victorian ornamental fountain, an important feature of the Green, originally formed part of a chimneystack on factory buildings that stood on the site of Worsley Green. Worsley village was designated as a conservation area by the former Lancashire County Council. The boundary was drawn to include, at that time, approximately 40 listed buildings, together with some less attractive but historically interesting industrial buildings. The settlement originated in the last quarter of the 18th century as a group of industrial buildings, cottages, shops, inns and other community buildings at the Delph where the entrance to the Duke of Bridgewater's underground coal mining and canal system was situated.

Walk up the west side of Worsley Green on to Worsley Road (A572) cross the road, turn left (west) and stop just past Mill Brow and look at the rock face and water body visible to the north. This is the Delph where the underground canals begin. The Duke of Bridgewater commissioned James Brindley to design the Bridgewater Canal and then in 1760 he engaged the engineer John Gilbert to create 72 km of underground canals, together with a series of inclined planes that lifted loaded barges from one canal to another. Two main canals, one 30 metres above the other, run northwards from Worsley Delph to Farnworth. A herringbone of minor canals link up to dozens of pits on either side. The most interesting buildings of interest in this area are the Bridgewater Estate Offices, the Nailmaker's House, Rock House, Packet House, Court House and former Police Station (The Old Nick).

From Worsley take the A572 to the intersection with the East Lancashire Road (A580) Go straight across at the traffic lights and then take the left (northwards) turn for Swinton on Partington Lane (B5231) The rising ground is one of a series of ridges of fluvio-glacial material north of the Irwell. At Swinton, the large Town Hall building houses the offices of Salford City Council. Cross the A6 and continue up Station Road to the A666 Bolton Road. Around here a few old mill buildings can be seen, en route to Pendlebury, which is on a high ridge overlooking the lower Irwell Valley. At the A666 turn right (south-eastwards) and after 1 km the road crosses a railway tunnel with a parapet on the left (northeast) side. Take the second turning into Ethel Avenue and park near the railway bridge opposite the houses.

STOP 7: Pendlebury

After crossing the railway line, a good view of the Lower Irwell Valley and the City of Manchester is obtained by going through a gap in the fence and walking onto the grassy area to the east (GR 790016). To the left of the viewpoint is the abandoned Lumns Lane landfill site occupying approximately 23 ha. The site operated from 1982 to 1991. It has been capped with soil, is half wooded, 40% unmaintained grassland and 10% degraded soil surfaces. New planting has been carried out on the site recently as part of the Mersey & Red Rose Forest Landfill Woodland Project. A landfill of this type acts as a bioreactor and the decomposing organic matter releases methane (a greenhouse gas) that in recent years has been vented from the fill by a series of vertical pipes. The liquid leachate from the site is collected in drains, but the control is probably not effective. A project is underway to study the possibility of reedbed anti-pollution control for the site. There is an extensive network of surface water drains, leachate drains/chambers and manhole over the site. These measures all indicate how the cessation of tipping is not the end of maintenance on a landfill site. The chemical and hydrological processes of decomposition and leaching continue and have to be managed for many years.

The area immediately in front of the viewpoint is the site of the former Agecroft Colliery, the last working coal mine in the Greater Manchester area. This site has a long industrial history; a colliery was already established by 1848. By 1893 there was a railway running north to south along the western boundary of the site. Later the site was used for the dumping of mining waste, a process that continued until Agecroft Colliery was closed in the mid-1980s. Now the Clifton Hall landfill site (Figure 10), which operated from

Figure 10: Two views of the Clifton Hall Landfill Site: (left) in March 2000 and (right) in August 2005. The active cell was being filled in 2000. By August 2005 it had a full grass cover and the second cell is visible to the left.

1997, has provided for the disposal of approximately 150,000 tonnes of waste per annum for 7 years, (thus taking about 10 per cent of the waste generated in Manchester each year). The total capacity of the landfill is thus about 1 M m^3. The site was operated on the basis of 'containment' whereby any polluting matter generated at the site will be contained within the site. Systems for the collection of leachate and landfill gas were installed at the site, as the development proceeds. The site was developed in four phases, each phase being divided into a number of cells. The cell is that area of the site, which can be operated so that theoretically no free water or leachate is generated as a result of rain percolating through the waste. There was careful management using a lining of plastic sheets and layers of clay to prevent leakage of contaminated effluent into the groundwater below. At the active disposal area, the wastes were compacted into layers across the working phase. At the end of each working day all exposed wastes was covered to minimise potential for the escape of loose debris or other environmental problems. The daily cover may be colliery spoil material or inert debris such as crushed concrete and bricks from demolition contractors. By July 2005 one of the cells had been capped and landscaped but the chimney for the burning of methane and some of the pipes used to collect leachates and gases were still visible. At that time the second cell was in the process of being formed out of colliery spoil still stored on the site and the plastic liner and drainage system was still clearly visible. This second cell is expected to be ready to accept waste by end 2005. The new "landraise" hills, as at Stretford, are a reminder that despite the tree planting and wetland management, urban activities are still transforming the physical and ecological environments of our Greater Manchester river valleys.

To obtain a better view of the once industrial Lower Irwell Valley, which has been undergoing a revitalisation with provision for new housing, recreation and employment opportunities through a major regeneration programme, go back to the railway bridge and take a short steep path up on to the old Lumms Lane landfill for the valley for 20 m then turn immediately right at the top of the slope and walk for 130 m to obtain an excellent view of Manchester and the lower Irwell Valley. Look at the shaley character of the material in the soil hereabouts, indicating the origins of the ground material in coal mining spoil.

Return to Ethel Avenue and the A666. Turn towards Manchester but take Agecroft Road (A6044) to the east. The route descends the hill past the former colliery site (note the new housing developments and Forest Bank Prison to the north and the industrial estate to the south) and the location of the former Agecroft Power Station to cross the Irwell and enter a corner of the Borough of Bury where the entrance to an area of tree planting on the valley side can be seen. This plantation is part of the Red Rose Forest, the community forest scheme in Greater Manchester. [It is possible to stop at this site at the car park off the small roundabout at GR 807021 immediately after the bridge over the Irwell and walk along the riverbank to see both the remains of the power station and the development of the urban woodland.

Immediately after crossing the Irwell turn south (downstream) along Kersal Vale following the river into the centre of the wide floodplain in the large meander at Lower Kersal (Figure 11). These wide meanders of the Irwell mainly have been kept free of development. The area close to the river has major flood problems, with severe floods in 1866, 1946, 1954 and 1980. People are now not very aware of the floods, which occurred so long ago, and they make little attempt to protect themselves against future floods. The large council estate built here in the 1930s had many houses, which were seriously flooded in 1946 and 1980. Several houses in Lower Kersal had over a metre of water over their ground floors. The entrance doors of many houses on the estate are below the level of the road.

The residents facing the flood risk here are relatively poor, yet a 1 in 100 year flood would cause some £55 million damage to property. Two flood storage basins to alleviate the flood problem by protecting some 3000 properties against the 1 in 75 year flood are nearing completion to the west of Littleton Road (Figure 12). The cost of the work is around £ 11 million (Penning-Rowsell, 1999). People might expect a higher level of protection against large, rarer floods, but the Environment Agency states that further raising would have detrimental impact on landscape and accessibility and may make existing sewer flooding problems worse. There are also concerns over the impact of pass forward flow through Manchester City Centre and the Ship Canal and increased public safety risk should defences breach.

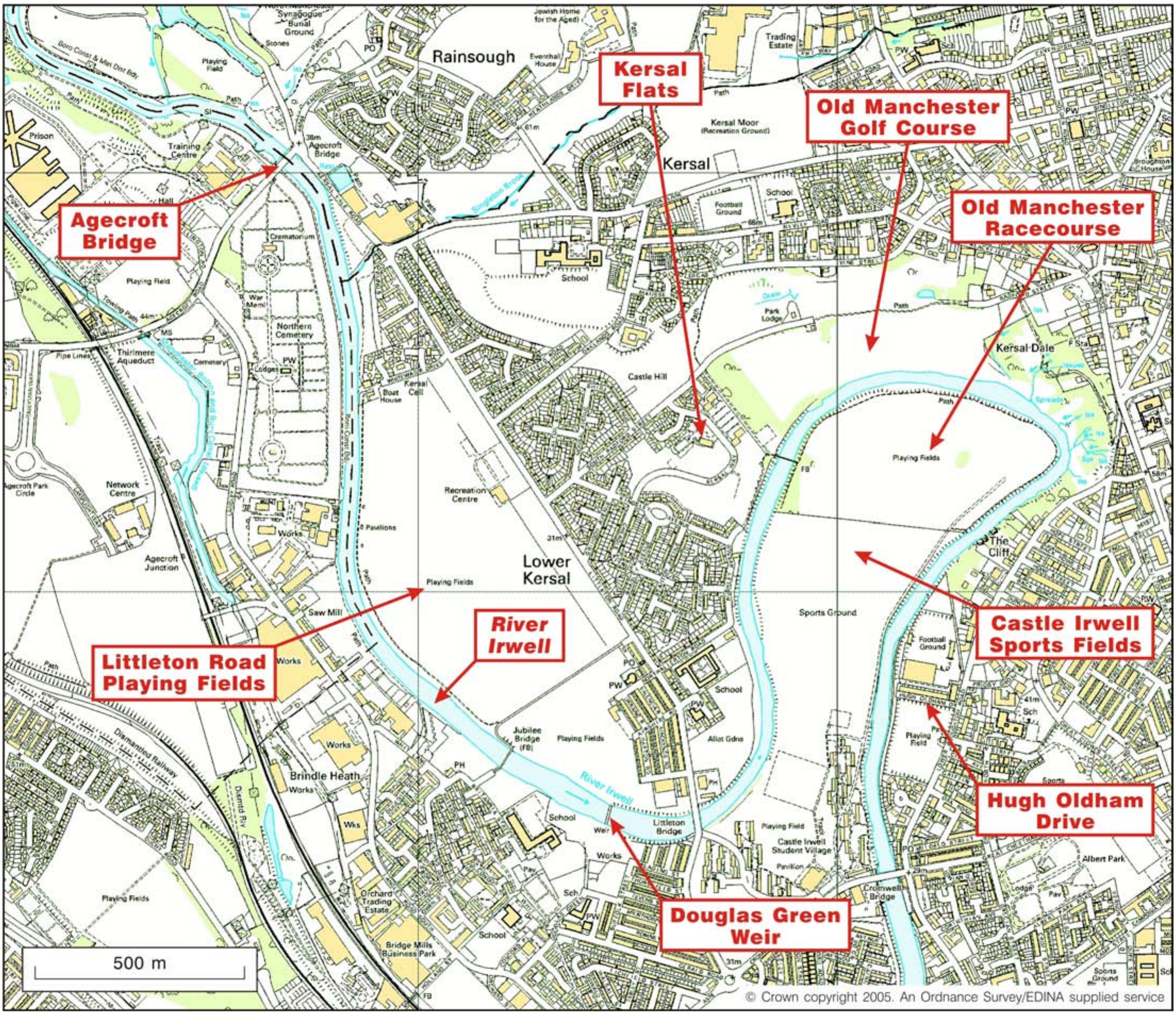

Figure 11: Map of key locations in the Lower Kersal and Cliff Areas of the Irwell Valley.

STOP 8: Lower Kersal

Turn off Littleton Road into South Radford Street and then into Kersal Way. Proceed to a barrier across the road. Park here (GR 818013) and go up to the river bank to the right. From the levee bank a good view of Lower Kersal is obtained The two multi-storey apartment blocks were part of a series of council flat tower blocks that stood on the vacant ground west of Kersal Way. The others were demolished, but the remaining two were privatised under Salford City Council's policy of working with private companies to privatise former council flats and develop them into more attractive properties. Improvements to the flood bank have been made several times since the 1946 flood event The low-lying pre-1940 council houses were all flooded in both 1946 and 1981. The new housing in Kersal Way is all above the flood plain level. This is still a major flood risk area, see the Environment Agency map at: http://www.environment-agency.gov.uk/maps/info/floodmaps/ (enter Broughton in the place box, then Select Broughton Greater Manchester, then shift the map north-westwards by clicking in the top left corner).

From Lower Kersal, return to Littleton Road and south-eastwards towards Manchester and cross the River Irwell. The route passes Castle Irwell, once Manchester Racecourse, but now a large Student Village for Salford University. Turn left on to Cromwell Road at the roundabout. The old grandstand on the left now provides social facilities for the students. The River Irwell is crossed again after Castle Irwell. Immediately after the bridge turn left into Lower Broughton Road. The route rises, parallel with the river to

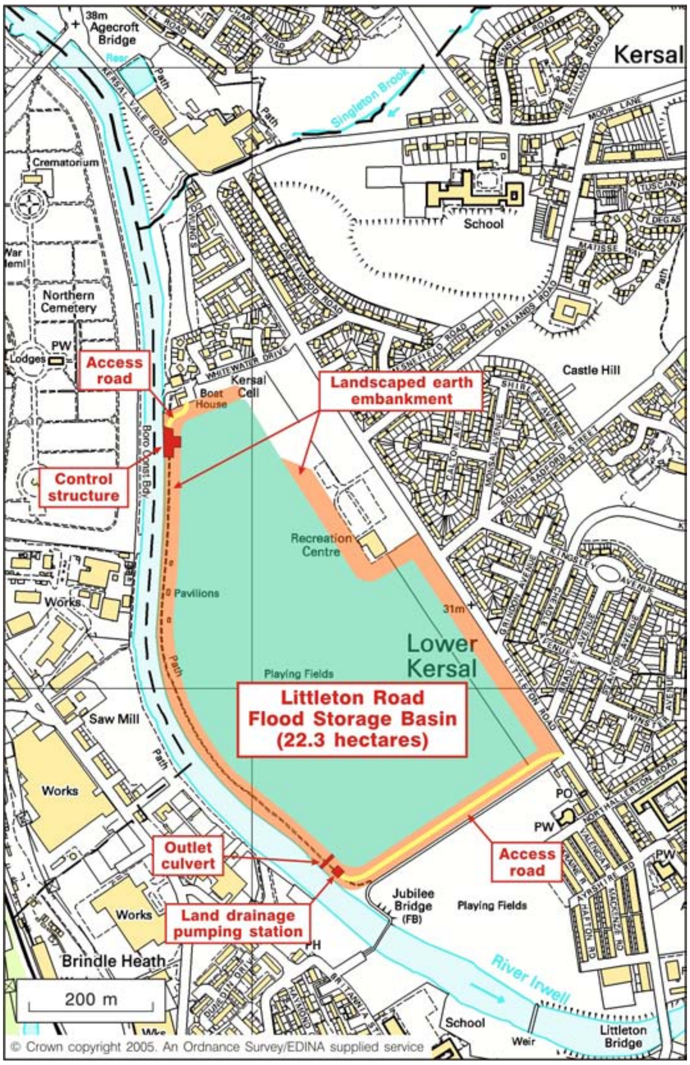

Figure 12: Diagram of the Littleton Road Flood Storage Basin at Lower Kersal.

The Cliff. As the road goes up the hill early to mid-nineteenth century house built by industrialists on the edge of the then industrial town can be seen. The oldest house that now exists is Cliff House dating from 1817, which was the first of a number of large houses to be erected overlooking the River Irwell. In the mid-19th century the majority of residents at The Cliff were members of the professional classes but a number of merchants also resided there. The Cliff was one of the earliest residential suburbs for commuters into Manchester and Salford. Whilst the layout of The Cliff was not as formal as areas such as Victoria Park, Manchester, it was a prototype for such later developments.

The Cliff is a Conservation Area. The Grade II listed buildings on Lower Broughton Road are: 388 (Ivy Cottage), 390, 464, 466, 435 (Scarr Wheel House), 461 (Cliff House), 437, 451/459.

STOP 9: The Cliff (GR 827013)

The junction of Lower Broughton Road and Great Clowes Street provides an excellent opportunity to study the effects of mass movement on the steep slope overlooking the river and to look for signs of subsidence affecting housing in the local area. The section of Great Clowes Street north of the junction had to be closed because of the mass movement on The Cliff. Signs of the former tram tracks are clearly visible in the area behind the partially destroyed fence immediately north of the junction. Walk along the footpath in front of the houses and pass through metal gateway into the area at the top of the wooded slope. Turn back and look over the fence on The Cliff side at the exposed reddish brown sands beneath the former street. These sands are part of the fluvioglacial sequences underlying this highland. Water moves preferentially through lenses of coarser material with these deposits. By descending through the woods, evidence of mass movement, in the form of tilted fences and walls, and trees whose trunks have grown at different angles as they have slipped from the vertical, can be seen. Follow the path down to the river bank, examine whether the river appears to be undercutting The Cliff. Then explore the undergrowth below The Cliff to find small streams carrying sandy material that descend from springs part-way up the slope. These suggest that one hypothesis about the dynamics of The Cliff is that spring sapping, headward erosion of these stream sources, is responsible for the mass movement. It seems that the subsidence at The Cliff is a natural process associated with the short geological time since the meltwaters during the last glaciation dumped the fluvioglacial material. [Teachers may wish to use this example to illustrate the method of multiple working hypotheses in the field]

STOP 9 TASKS

10. What evidence can you find of subsidence in buildings and walls at this point? Draw a sketch map of the streets to show the places where you think movement has occurred.
11. What indicators of mass movement can be found on the slope below The Cliff? Draw diagrams to show the tell-tale features characteristic of areas suffering mass movement.
12. Look for seepages on the slope below The Cliff. Are there any signs of material being carried out of the ground by spring water? How do the springs relate to the level of the river? Does river undercutting affect The Cliff?
13. How has the opening up of The Cliff to recreational use affected the stability of the slope?
14. Describe the stratigraphy and materials of the slope.

From The Cliff, the route returns via Great Clowes Street, Camp Street, Frederick Road, Albion Way, Trafford Road and Broadway into Salford Quays to the Lowry Centre to examine the problems of dealing with pollution in the enclosed basins and in the ship canal itself.

STOP 10: The Lowry Centre and Manchester Ship Canal Turning Basin

The Manchester Ship Canal begins at the confluence of the Rivers Irwell and Medlock, which used to carry combined sewer overflows that delivered domestic and industrial sewage and road runoff to the canal. Being 8m deep, steep sided and up to 50 m wide, the canal experiences slow flows, especially immediately upstream of the Mode Wheel Locks that regulate the water levels in the Salford Quays area. As a result the highly polluted organic-rich sediments from the sewers and road runoff were deposited in the dock basins and turning area causing range of environmental problems, such as including water-column anoxia, sediment rafting, noxious-gas generation and metal mobilization. On hot summer days the release of gas from the sediments became a sensitive problem threatening the attractiveness of the new waterside developments. New problems threatened in 1987 when the dock basins at Salford Quays were hydrologically isolated from the canal, to prevent future contaminated sediment input. However, the highly contaminated sediment was not removed. The high oxygen demand of this sewage-rich sediment, coupled with the steep-sided nature of the Quays, led to the depletion of oxygen within the water column and thus to prolonged periods of water column anoxia. This anoxia development was remedied through the use of Helixor pumps to circulate compressed air through the water column were installed to counteract the anoxia by keeping the water well mixed The resulting improvement in water quality has led to marked changes in the biology and sedimentology of the Salford Quays (Taylor *et al.*, 2003).

Before remediation the organic-rich urban sewer and run-off sediments were being deposited. During remediation detritus from the clearance of wharves provided a pulse of debris from demolition waste into the basins. After remediation the improved water quality and development of aquatic flora and fauna led to the deposition of clays and algal material, while the decomposition of some of the demolition debris released metals to the porewaters of the sediments that remained in the basins.

Outside the enclosed basins the large turning area near the Lowry Centre still received sediments from upstream. The problem of decomposition of the organic matter in the sediments and the release of gases during hot weather had to be tackled by investing in a system of oxygen injection that came into operation in 2001. At that time 15 tonnes of oxygen were pumped each day into water near the Lowry arts centre and the Imperial War Museum North. When the equipment is turned on during hot periods, the dissolved oxygen in the water can increase by almost 300%. By 2003 the number of vertebrate species had risen to more than 30, including the freshwater shrimp and species which cannot tolerate polluted environments. Fish, including roach and perch, have been found to be spawning and fish growth rates, particularly of roach, were among the highest anywhere in the country.

While sewer overflows continue and while the organic matter-rich sediments remain on the bed of the canal, the oxygen injection is a cost that has to be paid to overcome some of the hangover effects of the past 200 years of urban and industrial development upstream. It shows that even in the heart of this industrial area, environmental processes cannot be segregated from economic development and urban retailing, residential and leisure activities.

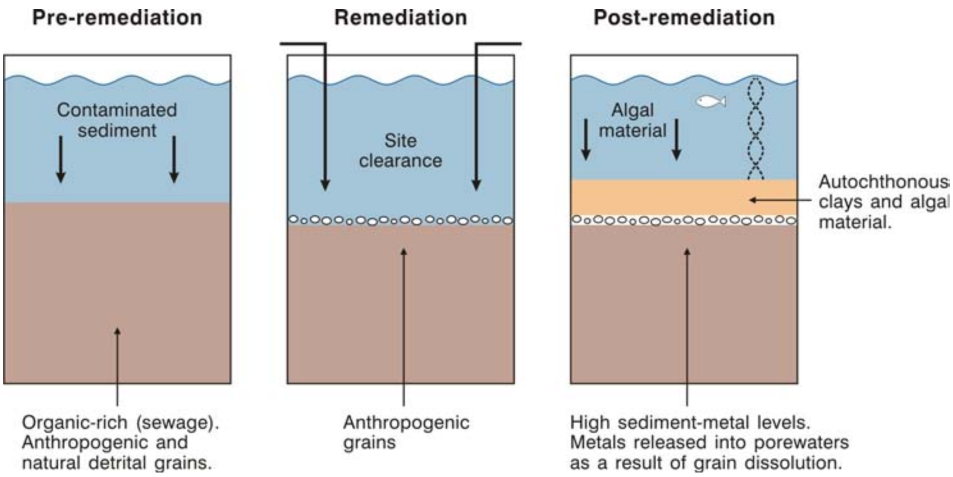

Figure 13: A schematic diagram of the changes in sedimentation within the enclosed Salford Quays basins (after Taylor et al., 2003).

The pipe work for the oxygen release can be seen just below the level of the walkways on either side of the footbridge from the Lowry Centre to the Imperial War Museum of the North. From the canal side of the Lowry Centre the dry dock used for tug boat repairs can be seen to the right of the War Museum. The transformation from docks to waterside development is still in progress.

From Salford Quays access to Manchester city centre or the motorway network is easy via Regent Road or the M602.

FURTHER READING

Douglas, I. 1985 Geomorphology and urban development in the Manchester area. In Johnson, R.H. (ed.) *The Geomorphology of North-West England.* Manchester University Press, Manchester, 337-352.

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Douglas, I. 1999 Physical Problems of the Urban Environment, In Pacione, M. (ed.) *Applied Geography: Principles and Practice.* Routledge, London, 124-134.

Penning-Rowsell, E. 1999 Floods. in Pacione, M. (ed.) *Applied Geography: Principles and Practice*, Routledge. London, 95-108. (Has particularly important section on flooding on the River Irwell in Greater Manchester on pages 101-103 which should be read by all).

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