8.0 WATER, HYDROLOGY AND DRAINAGE

8.1 Introduction and Methodology

8.1.1 The protection of the water resources within and near the site (both in terms of quality and quantity) is highly important in the planning of the Bilston Urban Village (BUV). Any impact from development could lead to depleted supplies, increased risk of contamination, increased risk of flooding and adverse affects on fisheries and industrial usage.

8.2 Regulatory Authorities

8.2.1 The Environment Agency (EA), as Regulatory Authority for England and Wales, have the responsibility for the protection and monitoring of the quality of controlled waters. Controlled waters are defined in law as those waters either above or below ground, which are neither in the drinking water supply nor in the sewerage network. As such the EA have to be consulted on any development that could have an impact upon the quality, or level of flow, of both surface water and ground water.

8.2.2 The EA Local Environment Agency Plan (LEAP) document indicates that the Bilston Brook has a sizeable catchment area which has contributed to the pollution of the Brook (past and present) due to mining and industrial influences. Under the General Quality Assessment (GQA) system the Brook achieves a grade D (fair) rating.

8.2.3 Additionally, the Brook receives a number of storm sewer overflows which effect its water quality. These water tributaries join the Brook from the Bradley Arm area (and beyond) and Ladymoor Pool to the south west of the site which is known to overflow into the Brook.

8.2.4 The other Regulating Authority for the site is the British Waterways Board (BWB) who are responsible for the monitoring of the Bradley Arm section of the Birmingham Canal which borders the site to the south.

8.3 Hydrogeological Setting

8.3.1 Made ground encompasses the site and varies in thickness between 1m to 13m. It make up includes quarry/mining waste(slag) , furnace waste (ash), industrial waste and construction waste. The made ground overlays coal measures which comprises of interbedded sequences of mudstone, siltstone and sandstone with occasional seams of coal. Groundwater in the made ground areas flows towards the centre of

the site to the line of the culverted Bilston Brook. Minimum groundwater levels are approximately 130m AOD. This groundwater shows poor to moderate levels of contamination with evidence of concentrates of sulphate, cadmium, zinc and ammoniacal nitrogen.

8.3.2 Local watercourses on the site have been significantly altered: the closest watercourse to the site is the Bilston Brook, which flows through the centre of the site. This was originally natural but is now entirely culverted. Other water features are canals and flooded mineshafts. The rest water level of the mineshaft is understood to be about 116m AOD, approximately 20m below ground level, and about 16m below the level of the Bilston Brook. The brook is therefore not in direct contact with the groundwater system of these shafts. Ground water flows towards the centre of the site coincident with the culverted Bilston Brook.

8.4 Coal Measures Hydrogeology

8.4.1 The 1:50 000 geological map (Sheet 167:Dudley) shows that the site is founded on Coal Measures strata, with no intervening superficial deposits. The Coal Measures in this area comprise 'grey' shales, clays and fireclays, with sandstones, coal seams, ironstones and marine bands'. The only widespread superficial deposits on the site comprise Made Ground; with a stringer of alluvium along the course of the Bilston Brook.

8.4.2 The hydrogeology of the Coal Measures aquifer system is complex. In an un-altered state, groundwater flow is primarily via fracture networks in the sandstone units and is normally confined to these units by intervening low permeability shales. Faulting may add further complications. Coal mining breached these aquifers and there are now multiple interconnections between sandstone units via shafts and unfilled boreholes. This is not, however, to conclude that mining has homogenised the sandstones into one effective aquifer unit.

8.4.3 The BUV development will feature a permanent wet pond which will be sustained by run off from the site and the abstraction of groundwater. Licenced groundwater abstraction has occurred on the site but since the former Metrabrasives abstraction licence expired, the only groundwater abstraction in the vicinity is that of the British Waterways Board (licence number 03/28/08/0140). The abstraction is via eight separate shafts at a range of distances from the Metabrasive shaft, but none closer than 650m (Table 1). We understand that only the Bradley and Deepfields shafts are currently pumped. The total licensed amount is 32 700m^3/day for supplying the

Midlands canal navigation. There are no further licensed groundwater abstractions within 1000m of the site.

Table 1: Nearby Groundwater Abstraction Points

REFERENCE	MINE SHAFT	GRID REF.	SHAFT SIZE
1	Deepfields (x2)	SO 946950	180m and 130m deep, 2.4m dia.
2	Bradley	SO 956952	270m deep, 3.3m dia.
3	Boat Dock	SO 956955	45m deep, 4m dia.
4	Hawkins	SO 957955	110m deep, 2.7m dia.
5	Herberts Park (x2)	SO 967971	36m deep each, 2.3 dia.
6	Perry Well	SP 076922	45m deep, 3.9 dia.

8.4.5 Information held by WS Atkins on the water quality of the made aquifer shows variable levels of contamination across the site ranging from slightly to significantly polluted. The pollutants include modest levels of heavy metals and fairly significant levels of BOD/COD and ammoniacal nitrogen. Other influences include modest levels of mineralization (high sulphate levels) and some very alkaline waters. Further analysis will be required to determine if treatment of the ground water is necessary if it is to be used to supplement any wet pond features.

8.4.6 If treatment is necessary it could be provided in the form of reed beds which will biologically treat the ground water pollutants. Vertical flow reed-bed systems would be the preferred option as they are much more effective than horizontal flow reed-beds not only in reducing BOD and suspended solid levels but also in reducing ammonia levels and eliminating smells.

8.4.7 The site does not lie within a Groundwater Source Protection Zone, as defined by the Environment Agency.

8.5 Assessment of Impacts (Hydrogeology)

8.5.1 The propose construction of a permanent wet pond may require the necessity to abstract from existing water bodies during the summer months. The calculated abstraction rate to supplement losses due to evaporation and infiltration into the underlining strata is $50m^3$/day for up to 3 months a year. This rate of abstraction will have a negligible impact on the sustainability of the groundwater system.

8.5.2 Estimation of recharge to the area is complicated by its urban setting. The EA estimates that the long-term average recharge to the Wombourne Groundwater Management Unit (about 10km south west of the site) is 250mm per annum. This is expected to be a reasonable estimate for open grass in the Bilston area. Although urbanisation restricts the amount of infiltration with drained impermeable cover, it is generally thought that water main and sewer leakage makes up that shortfall and the recharge under urban areas is similar to that under grassland (Foster et al,. 1998).

8.5.3 At an average recharge of 250mm/a (and with no augmentation from surface water courses), an abstraction of 4500m^3/year requires a catchment area of 18 000 m^2, which corresponds to a circular catchment of radius 76m. By comparison the area of Bilston Urban Village is to be approximately 440 000m^2, approximately half of which is grassed, so the abstraction will draw water from an area much less than that of the site.

8.5.4 To predict the effects of the maximum three-month abstraction on the local hydrogeology, the Theis equation may be used to estimate drawdown at the nearest licensed abstraction – The Deepfields shafts at 650m distance. It is assumed that since the shaft is actively pumped and yields thousands of cubic metres of groundwater per day, an additional drawdown of 1m or greater in the shaft may be noticeable. With a storage coefficient of 10^{-5} and no recharge input, this drawdown could be achieved in 90 days pumping at the full rate of 50m^3/day if the Coal Measures have a transmissivity of 28m^2/day or less.

8.5.5 However, the Coal Measures here clearly do not have such a low transmissivity because they are able to sustain the very large British Waterways abstraction. Clearly these shafts are being supplied from elsewhere hence this abstraction would have been unsustainable long ago. The previous abstraction from the Metrabrasives shaft, which was a greater abstraction rate than that proposed for the BUV, did not draw down the water level in the Deepfields shaft sufficiently for it to be reliably detected.

8.5.6 Calculations completed in the ESI report, 'Bilston Urban Village: Groundwater Abstraction', dated September 2005 show that any abstraction of groundwater to supplement the permanent wet pond can be sustained and will not cause losses on other water features in the vicinity. The report concludes :-

- Local watercourses are disconnected from the deeper groundwater system and therefore will not be impacted by the proposed abstraction rates.

- The previous licensed abstraction rates for the site did not have an impact on hydrogeology. These abstraction rates were much greater than those that are suggested for the BUV.

- Sufficient recharge reaches the Coal Measures from within the site area to supply the proposed abstraction, even if half the site becomes impermeable.

8.6 Surface Hydrology

8.6.1 The site is currently bisected by the Bilston Brook which is culverted through the middle of the site from Highfields Road in the south west to Brook Street in the north east. This 2.1 m wide x 2.4 m high box culvert structure has invert levels in the range of 131m to 129m AOD, with depth variations below existing ground level of between 3 and 6 metres.

8.6.2 Existing storm water sewers tributaries are present across the whole site. These sewer drainage systems discharge flows directly into the Bilston Brook and serve the Bradley area and Carder Crescent estate in the south, as well as flows from Bilston in the North.

8.6.3 Other surface water features include the Bradley arm length of the Birmingham Canal which borders the site to the south and Ladymoor pool just to the southwest of the site. Additionally, in the southwest of the proposed BUV is a wet land area on the northern side of the raised canal embankment.

8.6.4 Hydraulic models completed by Severn Trent Water in November 2004 indicate the performance of the Bilston Brook is generally satisfactory with no surcharging or flooding predicted in a 30 year event.

8.7 Assessment Impacts (Surface Hydrology)

8.7.1 The size of the development will lead to a significant runoff and the Bilston Brook is considered the logical outlet for flow from the site.

8.7.2 Previous comments made in the July 2001 ENTEC report suggested that the brook could adequately accommodate flows to 1310l/s. However recent discussions with Severn Trent Water indicate that the brook is running close to capacity with some lengths on the eastern side of the development surcharging on a 2 year storm period and flood on a 10 year return period. Discharging flows of the order of 1310l/s in the system would lead to capacity problems. Severn

Trent Water have completed modelling exercises on the Bilston sewer network and have concluded that inflows up to 592l/s will have no adverse effect on the system.

8.7.3 Severn Trent Water have stated that their preferred method of dealing with surface water flows from the development is by discharging to an adequate soakway or infiltration system applying the principles of Sustainable Urban Drainage Systems (SUDs).

8.7.4 The Environment Agencies Indicative floodplain maps (Ref Fig 8.1) indicate that the Bilston Brook is at a moderate risk of flood. The chance of flooding in any 1 year is 1.3% (1 in 75) or less but greater than 0.5% (1 in 200). However a hydraulic assessment of the Bilston Brook completed by Severn Trent Water in November 2004, indicates that the performance of the Brook through the site is generally satisfactory, with no surcharging or flooding predicted in a 30 year event. The model was also tested for flooding in a 100 year event and the results indicated that no flooding would occur. This concurs with the July 2001 Entec Environmental Statement which stated that there were no flood plains constraints associated with the site.

8.7.5 The implementation of SUDs will help reduce the likely impact of flooding and if the brook should flood it will only flood areas in the green corridor that is proposed adjacent to the BUV central spine road. However a more detailed investigation is required and a flood risk assessment will need to be completed to confirm the likelihood and impact of any potential flooding. All properties will need to be constructed outside of any floodplain.

8.8 Preliminary Analysis

8.8.1 Preliminary analysis for the drainage strategy for the site has shown that by adopting some of the SUDs principles inflow into the Bilston Brook can be controlled. To limit the discharge from the development, retention basins and detention ponds are proposed through the centre of the site. Initial calculations estimate that five control basins of a combined volume of approximately 7,000m^3 will comfortable accommodate storm events of a 200 year return severity. Inflow into these ponds will be via a combined swale/piped system. To control discharge into the Bilston Brook, hydro brake structures at the outlet to these ponds would be installed. These devices help control discharge to a lower, more constant rate.

8.8.2 Sustainable Urban Drainage System (SUDs)

8.8.3 The drainage strategy for the Bilston Urban Village will be developed in accordance with the Government national strategy to manage the balance between social, economic and environmental requirements.

8.8.4 Sustainable Urban Drainage Systems (SUDs) are methods that take account of quantity, quality and amenity issues. It is an alternative to more traditional drainage systems in terms of planning, design and management. The application of SUDs aims to reduce pollution and flood risk, whilst also improving the urban environment for those who live and work in it.

8.8.5 SUDs are more sustainable than conventional drainage systems because they:-

- Manage the runoff from new urbanised areas and their impact on the existing network, thereby reducing the risk, frequency and size of floods
- Protect or improve river and ground water quality
- Contribute to the environmental setting and the needs of the local community
- Provide a habitat for wild life in urban watercourses
- Encourage natural groundwater recharge (where appropriate)

They do this by:-

- Dealing with storm runoff close to the area of the rainfall
- Managing potential flooding at its source now and in the future
- Protecting water resources from direct pollution (such as accidental spillage) and diffuse any pollution.

8.8.6 SUDs is an alternative approach to conventional drainage design and implementation, because it attempts to deal with drainage in a more natural way.

8.8.7 Methods of SUDs that will be introduced into the drainage strategy surface water.

- *Swales*-These would be constructed mainly adjacent to the proposed central spine road and would contribute to the green corridor effect through the site. They would also help control the speed of water run-off from the site by reducing its velocity, reduce the volume of run-off due to infiltration into the topsoil as the grassed surface of a swale can act as a filter by trapping silt and solid contaminants.
- *Passive treatment systems such as detention basins, retention ponds and wetlands.* These features are generally dry outside rainfall periods but retain water both during and after a storm water event. There will be a retention pond located to the south of the Pedestrian High Street link. This permanent water feature will be fed by the swale system and will form an attractive feature to the environment.
- *Porous pavements to roads and car parks*- These are an alternative to conventional paving and their use would be encouraged in the developable plots. They work by allowing water to pass through the paved structure rather than drain off it, and collect in a reservoir under the paving which allows storage, treatment, transportation and some infiltration of the water.

8.8 To prevent the likelihood of silt loadings or insoluble contamination from entering the surface water system, silt traps and interceptors would need to form an integral part of the design.

8.9 Construction Effects

8.9.1 Any construction activities within a major development has the potential to affect the existing hydrology and surface water environment. Surface water may be polluted, either from spillages from plant/construction traffic movements, the remediation of existing contaminated soil 'hot spots' or from surface water run off from excavations or exposed contaminated areas.

8.9.2 There will be major earthworks works associated with the site, as well as possible deep excavations in certain areas of the site (i.e. service corridors) which may require dewatering. If such action is required, either agreement with necessary authorities to discharge to a controlled water course or foul sewer will be necessary.

8.9.3 This site is not considered a major contaminated site but there are areas, particularly at the former scrap yard, where contaminants will be present. During the earthmoving operations the site will be exposed to the elements, and care

must be taken to prevent excessive infiltration of any soil bound contaminants into the underlying aquifer.

8.9.4 Sediment and fine particle run-off from the construction site could lead to oxidation of the organic content within the Brook or the Canal. This could lead to a reduction in the level of the waters oxygen content which could threaten fish through deoxygenation. In addition, considerable quantities of nutrients can be released through the disturbance of soils in groundwater and surface water, leading to enrichment of water courses, which have an impact on their ecosystems.

8.10 Operational Effects

8.10.1 The development of new infrastructure and the consequent increase in traffic flows is considered the most likely source of possible contamination to receiving water courses. Possible contaminants from this source includes silt, hydrocarbons, metals and spillages due to accidents.

8.10.2 The water feature(s) will be hydraulically separate from the baseline hydrology, with a current proposed minimum bed level for the permanent wet pond of 132.5m AOD. This water feature will need to be lined to reduce infiltration into the made ground and hydraulic interaction with the aquifer. It is not envisage that this water feature will become a designated fishery.

8.10.3 The water feature will need to be sustained to compensate for the effect of evaporation and some infiltration. A supplementary water supply will be necessary during periods of low rainfall. The favoured option is the licensed abstraction from flooded mine shafts. This proposal could result in a negative impact on the hydrogeology of the site due to the need to extract 50m^3/day for up to 3 months a year to supplement the permanent wet pond, as well as the reduced water infiltration due to the larger amount of impermeable area that will result from the highways, car parks and buildings. However, as discussed earlier in this chapter the hydrology of the site can be sustained and any abstraction will have negligible impact on the local hydrology. The adoption of SUDs principles within the BUV development will further help maintain storm infiltration into the existing aquifer.

8.11 Mitigation Proposals

8.11.1 Construction Phase

8.11.2 During construction, materials should be stockpiled as far as possible from the Birmingham Canal. Contaminated areas of the site have been identified and will be remediated as part of the works. Any excavated contaminated soil should be either immediately removed from the site or stockpiled in specially designed stockpile/treatment areas which have appropriate bunding and covering to prevent leaching of contaminants. A risk assessment should be completed on any previously contaminated soil that may be exposed during construction works which has not been previously identified.

8.11.3 Any remediation or construction works within 10metres of the canal should be agreed with the British Waterways Board and possibly the EA.

8.11.4 The following pollution prevention guidelines for construction sites issued by the Environment Agency should be followed:-

- PPG01 General Guide to the prevention of water pollution
- PPG05 Works near or liable to affect watercourse
- PPG06 Working at construction demolition sites

8.11.5 Operational Phase

8.11.6 The proposed development of SUDs for the site will help reduce the non contaminated pollutant loads on the surface water features by the natural processes of sedimentation, filtration and biodegradtion. The grassed surface of the swale would act as a filter by trapping silt and solid contaminants. These contaminants are then further broken down by micro-organisms in the soil.

8.11.7 The swales will control the speed of water runoff from a site by reducing velocity as it runs down the side slopes of the swale. The speed of the water is slowed further as it flows along the channel, particularly if the swales are constructed at a shallow gradient. The volume of storm discharge is reduced as it runs down the swales due to filtration into the topsoil.

8.11.8 Also the application of SUDs will ensure that a significant volume of water runoff from hard standing areas is controlled. The use of permeable pavements and swales allow water run off, which with traditional design methods would have run into a piped system, to filtrate into the topsoil and underlying ground water. This process will ensure the recharge of the underlying aquifers.

8.11.9 The provision of silt traps and oil interceptors will need to be considered for any run-off from the site which will discharge directly into the surface water systems.

8.12 Statement of Effects

8.12.1 The impact of the BUV should not have any detrimental effect on the hydrogeology or the surface water of the site. The adoption of SUDs principals as a method of draining the site will contribute to the sustainability of the aquifer and also reduce the contaminants entering this system. SUDs will also help reduce and control the volume of discharge entering the existing sewer system and help contribute to the environmental setting of the BUV.

8.12.2 The ESI report, 'Bilston Urban Village: Ground Water Abstraction' dated September 2005 has concluded that the abstraction rate proposed can be sustained without having detrimental effects on other water features in the vicinity.

8.12.3 The Bilston Brook is a culverted watercourse therefore flooding should not be an issue. Recent hydraulic models completed by Severn Trent Water also predict that the proposed runoff from the site will not cause flooding up to a 1 in 100 event. EA flood maps appear to show the line of the brook lying in a flood plain but this does not seem conform to the modelling exercises that have been completed. Further liaison is required with the EA and a flood risk assessment may be necessary.