

CONTROLLING AND DE-CONTAMINATING SITE WASTEWATER

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The Castleford site of Hickson & Welch is situated astride the river Aire, just below its confluence with the River Calder. The site handles a wide range of toxic and corrosive organic chemicals, which have the potential to produce severe effects in the river, were they allowed to reach it. The protection of the river has assumed ever-greater importance during the last decade and the company has adopted a comprehensive strategy to protect the river from both accidental contamination and routine discharge.

The paper will describe the elements of the strategy, which includes action now completed, and the current programme of work. The completed strategies include: a site kerb, a low wall round the site which prevents accidental spillage and fire water from reaching the river; rigorous segregation of clean cooling water, which can be returned to the river, from process and rain water, which goes to the site effluent treatment plant; and site-wide renewal of the effluent collection system, bring it above ground into custom made piping systems.

Work in progress includes: the generation of a site storage register which is coupled to a storage risk assessment system – being developed with HSE – to assess potential risks from the storages onsite; a ground water survey to ensure that legacy pollution is understood; and work on the safe storage of drummed materials around the site.

At the centre of the strategy is a new best practice standard setting, wastewater Treatment Plant. This combines a Loprox®, wet oxidation plant using liquid oxygen at moderate temperature and pressure to detoxify otherwise hard to treat waste streams; and a Vitox® biological treatment plant, using an oxygen fed activated sludge. This holistic approach has enabled the site to treat most aqueous waste streams on site and to cease sending site effluent to the local municipal sewage treatment plant. The final treated stream is now discharged direct to river with consequent improvements in the quality of the site effluent stream. This has also enabled the local sewage treatment plant to improve its discharge. These two changes have contributed to a significant improvement in river quality.

The paper will describe these various initiatives in technical detail and indicate the site's vision for the future.

SITE DESCRIPTION

Hickson has been operating on its present site since 1915. Founded during the First World War it soon found its niche in the manipulation of aromatic organic chemicals, principally dye and pigment intermediate production. Through to the 1970s the company expanded on its present site, installing larger scale, more modern plant; introducing the production of optical brighteners ("Photines"); and building long-term alliances with other manufacturers for the custom manufacture of speciality chemicals. By the late 1980s Hickson & Welch employed over 1000 people at Castleford with large-scale nitration, hydrogenation and chlorination capacity; complemented by the custom manufacture of agrochemical intermediates and other speciality chemicals. The site also produced timber treatment chemicals for its sister company Hickson Timber Products.

Today the company is focused on contract manufacture but the site still handles large quantities of hazardous chemicals, is subject to the COMAH regulations and has 15 IPC authorisations. The expansion in the contract business means that over 30 new reaction stages were introduced during 2000, a rate which has continued into 2001. These changes have formed the backdrop to the improvement in the company's Responsible Care Performance.

The Hickson & Welch site lies on the north east outskirts of Castleford (a town of some 40,000 inhabitants) and within 1 Km of the town centre. Areas to the north and east are largely farmland and of relatively low population density. The surroundings of the site have changed substantially over recent years, from heavy industry to light industrial sites and a number of new housing developments. Coal mining and the associated engineering industries have all but disappeared from the locality. About 2 km to the north west of the company's site, the area of a former mine is to be redeveloped as an environmentally friendly 'Millennium Village' integrating housing and employment on a brownfield site.

A large and very important site of special scientific interest (SSSI) Fairburn Ings, a major wetland used by migrating birds and owned by the RSPB, lies approximately 1 Km to the northeast. Within 5 km of the site are a number of other SSSIs which harbour an array of sensitive flora. To the south and west lie the domestic and industrial conurbations of West Yorkshire.

The site has grown from an original 6 acres (just over 2 hectares) in 1915, to some 75 hectares today. It is essentially flat and has been assembled by acquisition of surrounding, mainly industrial land - some sections are the sites of other chemical companies acquired by Hickson & Welch. The rivers Aire and Calder join just west of the site and the resultant river runs through the centre of the site, with a canal running next to the site's northern perimeter. Manufacturing plant is situated on both sides of the river. Most of the site is developed, with significant areas used for on-site warehousing and outdoor storage. The site was no doubt chosen for its access to coal - both as fuel and as a source of raw materials - and to the river, used as a source of water, a convenient disposal point for wastes and as a transport route. Now, of course, protection of the river is a major management consideration.

The site and its surroundings can be seen in fig 1.

SITE HISTORY (PRE 1972, 1972 – 1992, POST 1992)

Over the period of its existence, the company's approach to water management has changed from being non-existent to a pro-active approach based upon the 'source – pathway – receptor' principle.

Prior to 1972, the river (just like most rivers in the industrial conurbations of the country) was used as a convenient disposal point for wastewaters, with only scant regard for resultant river quality. By the time the river reached Castleford having passed through industrial West Yorkshire, it was a polluted waterway with little perceived intrinsic value other than as a sewer and for the transport of goods. This attitude changed significantly in the early 1970's. The local authority proceeded with a major renovation of the local sewage treatment works and simultaneously, the company began its first major improvement of wastewater management.

1972 – 1992: FIRST STAGE EFFLUENT TREATMENT FACILITY

Instead of discharging (essentially) all wastewaters to the local river, the company began to collect them together for treatment at the local sewage treatment works. However, an assessment of the capabilities of that plant immediately identified that certain wastewaters were unsuitable for treatment by the local sewage treatment facilities and perversely these continued to be discharged directly to the river.

Given the variety of wastewaters and the range of processes they came from, primary consideration was given to controlling their pH and a neutralisation plant was installed (which is still operating). The plant built consisted of two neutralisation reactors in series, one utilising calcium lime and the second sulphuric acid. The product of this reaction was relatively insoluble calcium sulphate, which was separated in a gravity-settling tank. Calcium sulphate was drawn off the bottom of the settlement tank and filtered in a plate and frame press. Clarified liquid from the surface of the tank then passed to a flow-balancing tank prior to discharge via local sewers to the town's sewage works and ultimately to the river.

Also during the early 1970s, charging schemes were introduced which related disposal costs to the strength and volume of the wastewater. It became economically viable to install a system of pre-treatment to reduce chemical strength on site. The system installed was a high rate biological treatment plant based upon the ICI 'Flocor' system. In this system, wastewaters were deluged over a stacked plastic media on which biomass was allowed to accumulate. Air draught was induced below the packed media and a significant reduction in chemical strength was identified. The efficiency of the system was sufficient to reduce Biological Oxygen Demand (BOD) of the wastewater by approximately 50%. Unfortunately, the reduction in strength was as much as a result of volatile solvents being air-stripped as biological activity.

The site operated this effluent treatment plant from 1972. There were some modifications during the 1970s and 1980s but the basic processes were not reconsidered until the late 1980s. The original air-aspirated, biological treatment tower was extended by 50% to cope with the increase in the site's effluent. Wastewater from the on-site plant continued to be sent to the local Yorkshire Water sewage treatment plant, where it was further treated along with the local domestic and commercial effluent, before discharge to the River Aire. However, the quality of the ultimate outfall to river had room for significant improvement and, as noted above, some aqueous effluents could not be treated and were still being sent straight to river. Although these were licensed outfalls, by the late 1980s it was clear that the situation could not be allowed to continue and significant improvement was needed.

POST 1992: INTEGRATED POLLUTION CONTROL

The drivers for change increased radically with the introduction of Integrated Pollution Control (IPC) following the Environment Protection Act of 1990. The chemical industry was faced with having to identify its effects on the environment and more significantly introducing control measures to limit the effect of its operations. An assessment of the environmental effects and risks from each activity on the Castleford site was therefore undertaken. This led to an intensive programme of improvement, firstly to the process themselves and then to the waste streams, to ensure that the company's activities could be properly authorised under IPC.

Given this activity and the other activities that IPC was clearly going to require, the company realised that a significantly increased resource would be needed to manage and run its environmental programme. Initially the resource was targeted at the 18 (now 15) IPC applications/ authorisations (though significant external resource was also used to get these in place by the required date). Subsequently it was tasked with managing the environmental monitoring programme, running the existing effluent plant and managing the environmental improvement programme which was agreed with EA. Initially, the Environment Department operated separately, alongside the Health & Safety Department. By 1999 it was recognised the departments had sensibly identical goals and therefore the two departments

were combined into one Safety, Health, & Environmental (SHE) Department. As would be expected, this department maintains a close relationship with other departments, particularly operations, and is also charged with maintaining good relations with the two regulators, EA and HSE.
The company's current Responsible Care programme is discussed further at the end of the article.

THE SITE ENVIRONMENTAL IMPROVEMENT PROGRAMME POST 1990
The programme of improvement initiated by the company from 1990 can be broken down into various aspects. Each of these is discussed below.

PROTECTION OF THE RIVER.
Water flows within the site can be broadly classified into two separate categories. The first is water used in chemical processing and which therefore is potentially heavily contaminated. The second water system uses water taken from the river, filtered and then pumped round the site to provide cooling. This can be returned to the river provided it is uncontaminated and only slightly warmer than the river itself.

DRAINS
In the period before 1972, all site drains passed directly to river, mixing cooling water, rainfall (potentially slightly contaminated), and contaminated process water. Little or no segregation of different classes of water was undertaken. Once the first on-site treatment facility was available consideration was given to process water collection. The first scheme saw the conversion of the discharge chambers, which were immediately adjacent to the river, to collection chambers. Contaminated wastewater was pumped overground from these collection chambers to the new treatment facility. This was only applied to those streams which were deemed suitable for treatment, though during the period from 1972 to 1992, progressively more streams were captured. Also, the feeds to the collection pits were generally still in the original underground drainage systems installed when the plants were first developed, which meant that some dated from the 1920s.
By 1990 then, the contaminated wastewater collection system was still mainly underground, with collection pits close to the site boundary - usually next to both the river and to the pits for the cooling water system. Plant drains were not part of the process plant and were considered solely as a civil engineering problem. Not surprisingly, after up to 70 years of constant use by process discharges containing everything from oleum to strong alkali, the drains were often in a poor condition.
From the early 1990s drains from individual plants have been renewed with the design and construction of the drains being based upon chemical engineering principles. Drains are now being constructed of material suitable for purpose (special steels, PTFE etc.), often with a double skin to prevent leakage to ground. Wherever possible, drains are mounted at or above surface level and are easily inspected and cleaned if necessary (see figure 2). This has the added advantage of reducing the potential for ground contamination. This is not a novel idea; it was used in the Ebbw Vale steel works from the early 1970s. The relative age of the idea perhaps shows that its more widespread adoption is overdue. The process water drains now go to new, well-lined but less deep collection pits, which have been constructed near to the centre of the site. These are continuously pumped overground to the effluent treatment plant. Each pit has been fitted with both a duty and a standby pump to ensure continuity of pumping. This arrangement draws water inwards to the site, away from the river and ensures that any leaks in the system are readily visible.

COOLING WATER

Water for cooling (and fire fighting) is drawn continuously from the river and distributed around the site in a dedicated system. The system is important to the safe operation of the site and relies on 3 river water pumps to provide a continuous flow. The site has a license to abstract up to 630 litres of water per second from the river which represents up to 10% of the river's flow at low (summer) flow. The system is kept rigorously separate from the process water system and considerable effort has been expended on-plant to ensure that it does not become contaminated, by covering tun dishes and removing open drains for example. Within buildings, cooling water collection systems are run approximately 1 metre above floor level to ensure that spillages etc. cannot enter the 'clean' water system. The collection systems are either enclosed or at very least covered.

Cooling water is returned to the river at a number of outfalls which are tightly controlled with continuous monitoring by the company and periodic monitoring by EA. The outfalls are monitored for various parameters including temperature, pH, and Total Organic Carbon (TOC). The outfalls are protected and can be closed if the continuous monitoring detects any significant deviation. The site's current consent allows the discharge to be no more than 10 ppm BOD different to the river, with no significant increase in prescribed micro-pollutants, and at no more than 28°C – essentially the discharge must be equivalent to the water upstream of the site. As we explain to the public, in terms of micro-pollutants this is equivalent to one eggcup full of petrol in an Olympic swimming pool. (Interestingly, as the cooling water is filtered to remove debris before distribution around the site, the outfall is usually cleaner than the upstream river.) Connected to the continuous monitors are sampling stations which will take grab samples in the event of any deviation. The monitoring stations were installed during 1994 at a cost of around £50,000 each (the site has 5 outfalls) and have been invaluable in ensuring a constant high quality discharge to the river.

The result of this effort can be seen in that over the last 4 years the site has not had to make a schedule 1 report to EA because of an excursion outside the consent limits, for the cooling water outfalls.

RAINFALL

Rainfall was traditionally mixed into the cooling water system to be returned to the river. However, with over 85 years of operation on the site, it is not possible to be sure that rainwater has not become contaminated. There is also the obvious possibility of material spilled on site roadways (for example) finding its way via the rainwater drains, into the river. Over the last decade the site's surface water drainage system has been progressively re-routed to the site effluent treatment system. As can be seen in figure 2 above, surface drainage is collected in the outer channel with process waters being carried in the inner pipe. This has clear cost and production implications - prior to the commissioning of the new ETP the site, had to curtail production in times of prolonged heavy rainfall.

SITE KERB

Given that the site lies astride a major river and in its flood plain, the major area of concern is the fate of material which escapes from storage, either bulk or packaged. The dangers are both from the material itself and from attempts to clean up after a spill, and the problem is compounded by the fate of firewater used on-site in time of emergency. Probably the most significant environmental incidents which have started on a chemical site but had consequences off the site are those due to contaminated firewater. The incidents at Sandoz in Basle, and two incidents in West Yorkshire – at Woodkirk in 1982 at Allied Colloids in 1992 – are three obvious examples. Material lost from storage has reached a number of rivers with significant - if less headline catching - effects. Indeed material does not have to be chemically toxic to cause damage, milk releases have caused significant disruption to river systems. At Castleford although bulk HFL storages have been bunded for many years, toxic, corrosive and other materials have normally not been fully bunded Protection of the river had to be balanced against the high cost of bunding all 400 storages on site. Also, it was recognised that material can be lost during transfer to and from storage and that losses during movement around the site could not be discounted.

An alternative solution was sought, to complement the isolation of the site's drains from the river. The site has significant emergency tanks which can collect the main effluent flow for some time and the site is essentially level. The decision was taken to build a site kerb, about 350mm high, along the riverbank at all the vulnerable points. This kerb is constructed either from poured concrete or from "Trief" kerbs (the high rebated kerbs used where HGV turning damage is likely). The kerb means that it is virtually impossible for losses on site to reach the river, even in the worst cases. The kerb has proved its value. Not long after construction, a spillage of a non-toxic material would probably have reached the river had the kerb not been in place. This type of material would have had a very low priority for bunding but, like milk, it could have had a significant impact on the river.

The site kerb is of major advantage in the control of firewater run-off. Should large amounts of water need to be used on site for any purpose we can be certain that the run off will go to the effluent collection system. The network of surface drains allows water to go either direct to the on site effluent treatment facility or be diverted to the emergency tanks. If even this proved not to have enough capacity it would be possible, in extremis, to allow areas of the site to flood, giving an enormous volume of retention. Obviously, open channels have the potential to allow spread of fire via flammable materials floating on the surface run off and therefore the design of the drainage network includes fire break chambers at intervals to overcome this problem.

FLOODING

As the site lies in the flood plain of the River Aire, there is some potential for flooding during periods of heavy rainfall, indeed during 1979 part of the site was flooded at a time of very high river levels. The problems then were due to water backing up onto site through surface water drains and a "level imbalance" between the canal and the river due to the settings of the lock gates. The isolation of the site surface water drains from the river and building the site kerb have significantly changed the potential for flooding. Even in November 2000 when the river Aire reached record high levels in Castleford, the site was not significantly affected. The latest projections from the Environment Agency have however indicated that the present level of the kerb does not offer full protection against their calculations of the most extreme event (the 200-year flood) and work is currently progressing to raise the site kerb to the requisite level.

STORAGE OF CHEMICALS

Although the site kerb does provide ultimate protection of the river, it does not provide adequate protection for the environment on or off site. The site kerb has been complemented with a number of projects designed to provide better storage of all types of chemicals on site. As noted above, HFL storages have long been protected with bunds but drummed HFLs were for a long time not protected. A major HFL drum storage area has been constructed next to the main warehouse offering full containment for storage, loading and unloading together with shaded storage for heat sensitive materials. [As an indication of the significant costs involved in these projects, this area cost £330,000.] This area is not covered and rainwater is collected in a sump for tankering to the site ETP. For drummed toxic material and material which reacts strongly with water, a former tanker cleaning shed has been converted to a toxic drum store, again fully bunded but dry. To complement the main HFL drum store, a number of bunded drum storage areas have been constructed at strategic locations around the site.

The bulk storages on site are of varying ages, some being over 40 years old. Many are bunded (fully or partially) and they have varying types of overfill protection, ranging from operator control to full level monitoring by the plant control system backed up by high and high-high protection interlocked to the feedlines to the storage. To assess the hazards the storages posed, a major exercise was undertaken to build a site storage register. This has proved to have a number of uses outside those originally envisaged, not least giving the site emergency controllers information on the contents of the 400 storages around site. (With increasing short-run contract manufacture, this can be very important as the use of storages now changes frequently.) The register is now being extended - in discussion with HSE - into a storage risk assessment system.

This has entailed building into the register weighting factors for the various hazards (content type, degree of bunding, overfill protection system, etc) the aim being to provide a guide to relative hazards posed to people and the environment by the various storages on site. In future the register will be used to assess the priorities for improvement and to provide a driver for future spending on storage protection.

PROTECTION OF THE EFFLUENT TREATMENT FACILITIES

All of the previous improvements have been designed to ensure that any potential contamination remains on site, and therefore is kept away from receiving waters, and to direct it to the site effluent treatment plant. However, this does transfer the risk to this facility. Given the importance of the ETP and the potential consequences of its failure, great thought was given to ensuring that it was adequately protected from damage. Primary protection was given by the installation of large, purpose-built emergency diversion tanks. Four such tanks were built each of 225 m^3 capacity. They are constructed of reinforced concrete and are lined with a resin liner to enable them to withstand the varying conditions to which they may be exposed. The tanks themselves are fully bunded to 110% of the capacity of any individual tank. Material may be diverted at any of four points within the primary treatment system:

1 Prior to reception
2 Immediately post neutralisation and prior to settlement of entrained solids
3 Post settlement of entrained solids
4 Post capacity buffering (in times of excessive flow).

Material diverted to these tanks is analysed prior to a decision on treatment, normally controlled flow back into the effluent treatment system.

A system of management control is also applied to all wastewater discharges to ensure, as far as is practicable, that all materials sent to the site ETP receives appropriate treatment. This results in an on-site ‘licensing’ system for discharge.

THE URBAN WASTE WATER TREATMENT DIRECTIVE AND THE LATEST EFFLUENT TREATMENT FACILITY

In the early 1990’s a new driver for improvement appeared in the shape of the European Union’s Urban Waste Water Treatment Directive (UWWTD). This directive meant that all discharges into controlled waters would have to reviewed. Any discharge not meeting the required standards would need either to be diverted away from the controlled water or the discharge would need to be brought up to standard. With the whole of the contaminated wastewater from the site passing through the local sewage treatment plant, any alteration to their operation could have had significant effect on site activity. At the same time the charging regime for treatment for contaminated wastewater by the local operator (Yorkshire Water) was changing and it was clear that, having previously offered a relatively cheap disposal route, use of the local sewage treatment plant would become significantly more expensive. Discussion with the plant operator identified that three things would be required to give compliance with the UWWTD whilst continuing to use their facility:

1 A significant upgrading of the local sewage treatment plant,
2 A significant contribution to the funding requirement for the upgrade,
3 Potential restrictions on the nature and volume of discharges to the new plant.

Given the nature of the UWWTD - which is directed towards improving water quality - the improvements required for this wastewater treatment plant could be extended in future and this would almost certainly apply to the treatment facility even after the upgrading. Hickson & Welch therefore began an assessment of its future water treatment needs for the period from 2000 onwards (the activation date of the UWWTD).

Of particular concern in this area was the discharge from one small-scale treatment plant on site directly to river. This plant had been built as recently as 1993 and was a fully licensed discharge from a process which is fundamental to the site's processes. Discharge to the river had only been licensed following a significant research programme carried out at the Water Research Council into the potential environmental effects of the discharge. This research had identified that the discharge – even at the levels given above - had no significant effect on the river water quality. The discharge however suffered from two problems. Firstly the discharge was highly coloured and secondly it had a very high residual Chemical Oxygen Demand (COD) - of the order of 20,000 mg/l. The UWWTD requires discharges no higher than 125 mg/l (although action is taken at levels in excess of 250 mg/l). The discharge contains many conjugated benzenoid structures which are not amenable to biological degradation.

Studies were therefore instigated into potential technologies which would be able to overcome this particular problem. The range of technologies selected included:

1 Ozonation
2 Electrolysis
3 Oxidation with hypochlorite
4 Wet air oxidation
5 Oxidation with hydrogen peroxide
6 A variant of wet air oxidation utilising pure oxygen

Each of the techniques was evaluated over a period of some three years to establish effectiveness and economics. The evaluation was carried out both in our own on-site laboratories and at the laboratories of the developers of the techniques. Before acceptance of the results trials were always done with quite large samples of real effluent taken from the H&W effluent stream. Table 1 compares the results of the assessments.

Table 1 – Comparison of assessment results of treatment techniques

Technique	Colour destruction	COD destruction	Cost Index *
Ozonation	95 %	50 %	1.42
Electrolysis	95 %	50 %	1.29
Hypochlorite oxidation	90 %	35 %	1.18
Wet air oxidation	90 %	70 %	1.43
Peroxide oxidation	95 %	80 %	2.41
Variant wet air oxidation	95 %	80 %	1.00

* Cost index is the relative cost per tonne, with the cheapest technique given a value of 1.00

Following this assessment the two techniques with the highest quality output were subjected to large-scale trials to prove effectiveness. These trials confirmed the suitability of both techniques, however, as can be seen from the table, variant wet air oxidation was strongly favoured both technically and economically. The results of these trials convinced the company to go ahead with the building of a variant wet air oxidation plant to deal with this difficult to treat waste.

During subsequent discussions with suppliers of the chosen system and discussions with the local waste water treatment plant operator, it became clear that an option of a new plant to treat all of the sites wastewater should be considered. The plans were developed and refined over a period of two years and finally produced a combined plant, on the Hickson & Welch site, which would provide for treatment not only of the 'difficult' waste, but also the whole of the site's wastewater and allow discharge direct to river.

An aerial view of the plant is shown in Figure 3

This plant was subsequently built under an agreement with BOC under which BOC would build, own and maintain the facility and Hickson & Welch would operate the facility. This allowed Hickson to concentrate on the control of wastewater generation, treatment and quality of discharge to the river. The plant was constructed during 1998 and began commissioning in summer 1999 with treated wastewater discharge direct to river commencing in January 2000. The operation of the plant was described in "Process Engineering" at the time (Ref 1).

The plant retains the old neutralisation/ settling plant but dispensed with the Flocor unit. Wastewater is now treated in a BOC Vitox® oxygen based activated sludge treatment plant. The capacity of this unit is some 3,850 m^3/day compared with the original plant capacity of 2,250 m^3/day. The unit has two parallel streams each rated at up to 70% of full plant capacity to allow for essential maintenance. An integral part of the system was the provision of 2 further emergency storage tanks, each of 3,000 m^3 capacity in addition to the existing emergency capacity (900 m^3). Together these tanks give a total capacity of roundly 3 days normal wastewater flow and thus give greatly enhanced protection of the river.

The new facility also saw the introduction of a BOC Loprox® variant wet air oxidation plant, the first such facility in the UK and the first time in the world that these two technologies had been combined on the same site. The Loprox® unit has a capacity of 300 m^3/day and is utilised to treat the more intractable wastewaters, discussed above, which were previously discharged to river at high COD strength. The plant has achieved greater than 85% destruction of COD in its first months of operation. Wastewater from the Loprox® unit is further treated in the Vitox® unit prior to discharge to river and the combined plant has proved to be very satisfactory.

One peculiarity of the Loprox® process is that in the reaction, organic nitrogen in the feed results in the formation of ammonia in the wastewater. This could have presented problems as assessment of the biological treatability of site wastewater suggested that nitrification would be so heavily inhibited as to be unattainable with the predicted product mix. The river Aire is at a transitional point in terms of its quality and there is ample evidence of a resurgent juvenile fish population. Ammonia discharges are highly toxic to young fish and would put this resurgence at peril. The design of the Loprox® plant was thus modified to include an ammonia stripping system, which would allow the extraction of the ammonia and produce a saleable by-product.

Experience of the operation of the new plant continues to be gained. To date the facility is producing a relatively high-grade discharge. One demonstration of this quality can be demonstrated by considering particular molecular species present in the discharge. The consent granted under IPC for the new facility requires the concentration of specific molecular species (chosen to be relevant to the Castleford site operation) to be within the levels achieved by the best 80% of the samples taken during the previous two years at the town's sewage treatment plant (adjusted for the dilution provided at that plant). All samples taken at the new discharge of the new plant have been significantly better than this consent. Figure 4 shows the mean values obtained for certain species compared with this consent value (note the logarithmic scale of this graph).

Overall, the strategies adopted by Hickson & Welch has enabled the site to transform its wastewater treatment. Whilst some work remains to be done, the site currently has a system in place which we believe makes it a UK, and probably European leader.

RESPONSIBLE CARE

This paper has concentrated on the technical side of the improvements the company has made. However the site's current performance could not have been achieved without the understanding, commitment and support of staff at all levels. The improvements are part of the company's commitment to Responsible Care, the chemical industry's commitment to excellence in its SHE performance.

The company's Responsible Care programme is led by the SHE department whose aims are to:

1. Increase focus and ownership of SHE issues within all operational departments and therefore increase commitment of all staff to SHE excellence.
2. Utilise core strengths that exist within departments to identify and carry through improvements which will improve SHE performance.
3. Utilise the SHE department's own strengths to provide advice, support, and assistance where it is needed

In order to progress this approach, one problem that had to be overcome was the attitude of staff towards environmental protection (and SHE performance in general). Geography (the nature of the surrounding work and social environment) and history (the company's traditional poor performance in SHE matters) conspired to push environment to the back of most people's minds.

Education and training have therefore been a major part of the site's SHE improvement programme. Increasing the awareness of all staff (and particularly those who actually operate process on an hour to hour basis) about their environmental responsibilities is absolutely vital in achieving compliance. Almost all deviations can in some measure be traced back to human error and operators must understand both their responsibilities and the potential consequences of their actions or inaction. The Environment Agency has recognised this fact and is insistent that operators are appraised of and understand the IPC authorisations for the processes which they are running. EA's OPRA assessments are increasingly concentrating on management systems and training.

Training and management both require good communication. Training is of little use if the resulting effort is not properly directed and that requires a management process which sets and monitors SHE objectives. Both objectives and monitoring must then be accurately conveyed to those expected to fulfil the plan. Over a period of time we have evolved, and indeed continue to evolve, a series of formal meetings, committees, and training programmes to carry out this function.

Amongst the principal elements of the routine Responsible Care programme are:

Management Committee	Monthly	Review performance/approve expenditure (SHE is the first agenda item)
SHEQ Committee	Monthly	Review performance/agree action jointly between management and union safety reps.
Senior Managers Meeting	Monthly	Reviews company performance, with SHE performance always as the first agenda item.
Operations Management Team	Weekly	Review and discuss issues, starting with SHE performance area by area.
Safety Briefing	Monthly	Communicates key issues formally to all staff - managers and technicians

The annual programme of SHE performance and improvement is agreed by both the site Management Committee and by the SHEQ Committee. Both groups are also encouraged to identify key issues for inclusion in the programme. This consensual approach ensures commitment by all sides and has been very important to the improvement seen on the site over the last 10 years.

Whilst this may seem a plethora of committees, it illustrates that environmental (and SHE) considerations figure at all operational and decision making levels. Equally, external debate and communication is strongly encouraged. The company seeks active liaison with the regulators and local authorities, is very active in the local Responsible Care cell, and has for many years hosted a local Liaison Committee. This committee has been very important in maintaining good relations with those who live around the plant through some difficult times for the company. The company also puts its performance in the public domain by publishing an annual Responsible Care Report identifying the company's key SHE performance indicators. Finally, we actively communicate with local (and distant) groups such as educational establishments to ensure that we are aware of public opinion and concerns.

We strongly believe that this commitment to the Responsible Care programme has been essential to the current good site SHE performance.

FUTURE DRIVERS

The programme, both technical and people based, described above has allowed the environmental performance of Hickson & Welch to very markedly improve over the past decade. Indeed the Effluent treatment plant built in 1998/1999 won critical acclaim and was awarded the Water Section Award at the IChemE environmental awards ceremony in 2000. This award supplements that of the previous year when the company won the same award for the improvement in the site's performance for loss of VOCs to atmosphere (now less than 1% of the 1993 figure and to which the new ETP has contributed with now no loss of VOC from this plant).

The future will continue to present challenges as legislation is enacted. Already the Contaminated Land (England) Regulations 2000, The Groundwater Regulations (SI 1998 No. 2746), Pollution Prevention (England and Wales) Regulations 2000 and the Water Framework Directive proposed by the European Commission are affecting our medium term planning for environmental improvement. We believe and intend that the approach developed at Castleford will continue to form the basis of our future programme, ensuring not just compliance but continuing improvement in the performance of the site.

Ref 1 – Process Engineering - June 2000, P22/23

Figure 1: View of the site from the southwest showing the predominance of the river

Figure 2: Typical drain installation, showing the "pipe within a pipe" collection system.

Figure 3: The Vitox® & Loprox® facility at Castleford

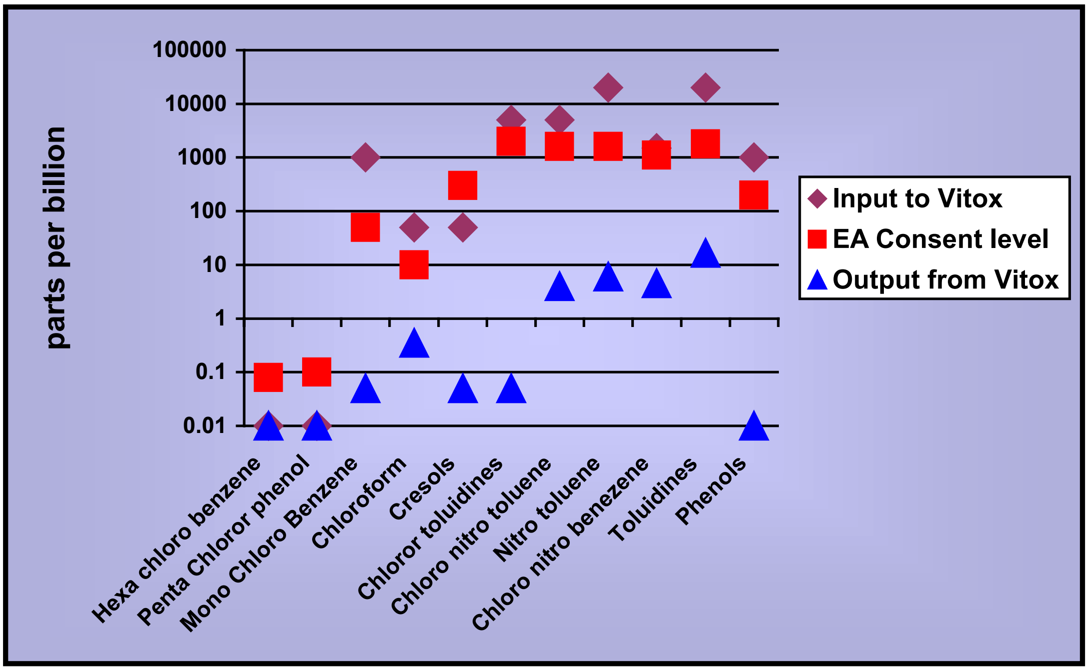

Figure 4: concentration of specific species in Vitox® effluent