Guidance for the Wise Use of Water in the Aggregates and Quarry Products Industry

Northern Ireland

An Agency within
DOE
Department of the Environment
www.doeni.gov.uk

NIEA
www.ni-environment.gov.uk
Northern Ireland Environment Agency

QPA
Northern Ireland
Providing Essential Materials

Foreword – Northern Ireland Environment Agency

I very much support this guidance document "Wise use of Water in the Quarry Products Industry" that has been jointly produced by the Northern Ireland Environment Agency (NIEA) and the Quarry Products Association of Northern Ireland (QPANI). It was first published in 2008 and continues to provide advice to our Quarry Industry here in Northern Ireland.

The environment is the engine of the economy and is at the heart of our well-being. We must recognise that our environment, our society and our economy, are not separate; they are integral to our prosperity and well-being.

The supply and use of aggregates and quarry products are essential to provide the buildings and infrastructure we need to allow our economy to grow. The quarry products industry undoubtedly brings a wide range of benefits to society, but with this comes some risk of environmental damage to landscape, natural habitats, air and water. We must all work together to minimise the adverse impacts of the supply and use of aggregates and quarry products.

This guidance document continues to assist in protecting the environment by informing the industry of the environmental and commercial benefits that will be delivered through pollution prevention, environmental monitoring and the wise use of water.

The use of case studies brings the guidance to life by highlighting what others have achieved in complying with their consents, preventing pollution and conserving water. I hope that there will be many more examples of industry and environmental bodies working together in the coming years. I anticipate that these joint ventures will be a model for successful business operations which otherwise have the potential to impact negatively on our environment.

I am delighted that this Report will be available on the NIEA, QPANI and NetRegs web sites, making it accessible to everyone working in the industry.

I believe that this is an excellent example of stakeholder participation which points the way for other sectors and that the adoption of the principles contained within the guidance will contribute to the further development of "Better Regulation".

Wesley Shannon
Acting Chief Executive

Foreword – Quarry Products Association NI

If aggregates are important in maintaining the quality of life we all enjoy, then clean water is even more so. Water management is a daily and necessary consideration in our construction materials industry, with quarrying developments and manufacturing operations impacting on groundwater, surface water and discharges to the local freshwater environment. With increased requirements on businesses to consider the environment from National and European regulation, from customers and stakeholders, it is vital that we protect this important resource by carrying our operations in a manner that not only minimises the risks of pollution but removes them completely.

Quarry Products Association NI (QPANI) members' recognise the potential their operations have to affect the environment and are committed to minimising and mitigating such effects by carrying out their work sensitively and responsibly. QPANI welcomes the assistance and knowledge from the NIEA Water Management Unit in producing the Wise Use of Water Guidance document, and the opportunity to be able to work with our regulators in a cooperative and constructive fashion.

We recognise that by minimising waste and removing pollution risk our construction materials industry will be more profitable and viewed more responsibly by our stakeholders. Implementing and adopting the best practice highlighted in this "Wise use of water" guidance will bring peace of mind for an operator. Industry also recognises that any negative publicity accompanying poor management practice will damage a company's and our industry's image due to society's increasing environmental awareness.

We want this "Wise Use of Water" guidance document to be a working toolkit and it is our aim to share good practice within the industry by gathering further case studies to the portfolio. It aims to provide an overview of the key issues and should be used as an aid by managers to review and improve upon an individual operational site performance. Thank you to all who have contributed to the development of this guidance document and the case studies within.

Gordon Best, Regional Director QPANI

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Introduction

Wise use of Water within the Quarry Products Industry

This guidance document has been jointly produced by the Northern Ireland Environment Agency (NIEA) and the Quarry Products Association Northern Ireland (QPANI). NIEA contributions have been made by staff from various disciplines. Contributions have been made by QPANI, Gordon Best (Regional Director) and his team.

This document aims to help quarry managers to improve environmental performance on their sites. It is also intended to raise awareness and emphasise the importance of water management, more specifically it aims to highlight:

the benefits of carrying out a water audit on a site specific basis;
the benefits of capturing and utilising stormwater as a resource within the quarry;
the benefits of reducing pollution risk by active pollution prevention;
implementing the use of sustainable drainage techniques (SuDs); and
the benefits of operating a pro-active maintenance and monitoring regime.

Examples of best practice for water conservation and reuse, effluent reduction, and effective treatment are also explored, and supported by local case studies.

It is recommended that quarries develop and operate a system to manage water throughout the entire site. This will include the quarry boundary (interception and diversion), all of the points where water enters, where water moves across the site, and at locations where water is either utilised for processing or treated prior to discharge i.e. a cradle to grave approach. Having a better knowledge of water sources, of how water moves and transports sediment, and the principles of effective treatment, will provide managers with opportunities to minimise, reuse, and improve quality within their site. If adopted, the overall impact the quarry operation has upon the environment will also be reduced. Tarmac Ltd has provided useful feedback stating that a dryer quarry is a safer work space, risk of accidents reduces and plant require less maintenance. This translates into financial savings.

This document has been written in 5 sections, each section focusing on a particular water related topic. The first section focuses on water and why it should be managed, the second section on pollution prevention and sustainable drainage, the third on discharge consent compliance monitoring and maintenance and the fourth on the importance of water for nature conservation. The fifth section provides examples of case studies and draws out key recommendations.

In summary, the key message emanating from this document is that “**effective water management within the quarry will deliver both environmental and commercial benefits to the businesses**”

Section 1 Water and why it should be managed

1.1 Water and the Quarry Environment

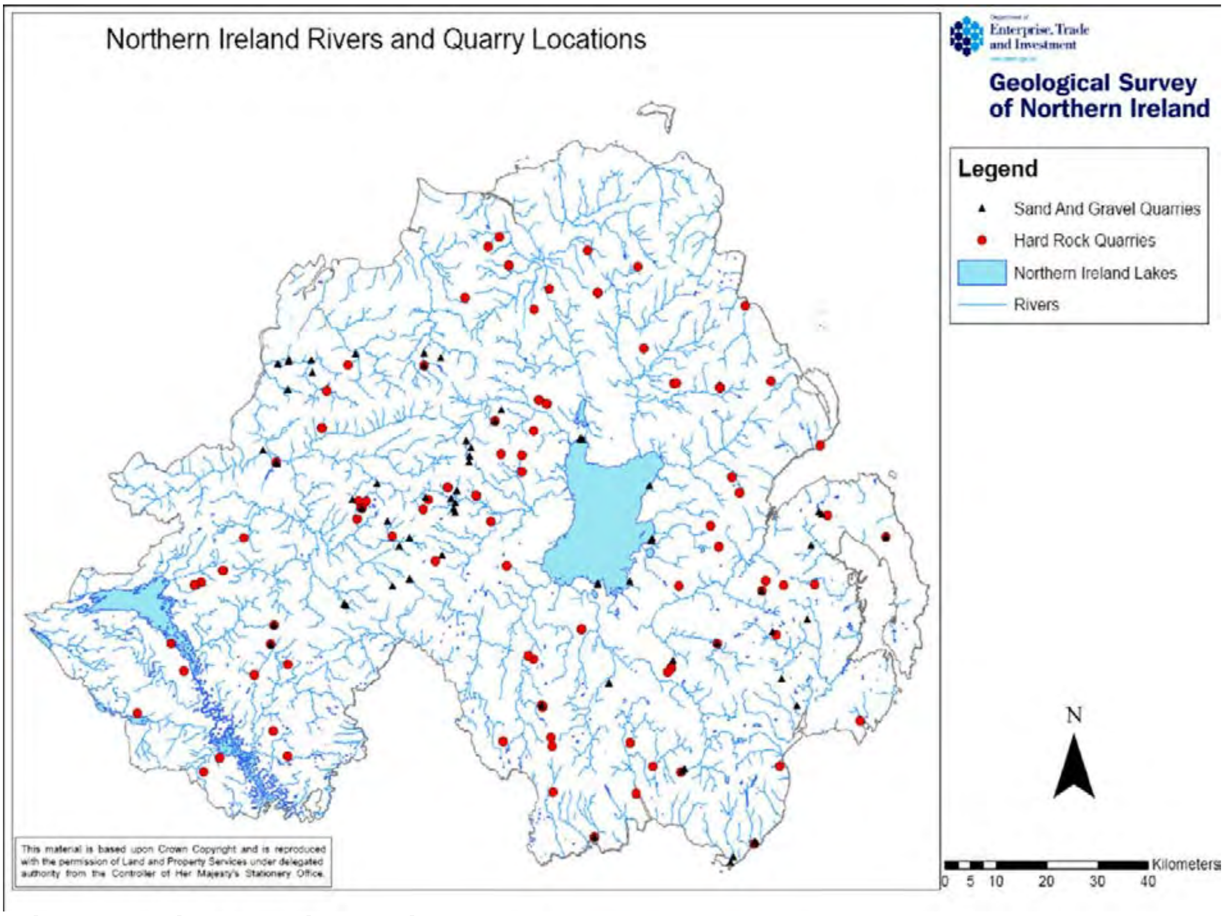

Figure 1. Rivers and Quarries

As you can see from the above map, quarries in Northern Ireland are almost always located close to a watercourse. Water movement within quarries is a complex process. In most instances extraction occurs below or close to the water table, which influences groundwater movement. For all sites rainwater volumes need to be considered and managed.

It is considered best practice that quarry operators capture and utilise rain water for production and / or dust suppression purposes, ahead of abstracting groundwater or pumping / diverting river water into the site.

Rain, groundwater seepage, borehole water or diverted stream water if contaminated within the quarry is legally considered a trade effluent and must be treated and discharged back into the natural environment in accordance with a Water Order discharge consent.
The main contaminants in trade effluent from the quarrying sector are silt (suspended solids) and oil. If these are not controlled prior to discharge they can cause considerable damage to aquatic ecosystems.
Specific harmful effects of these pollutants include the following:

Oil

1. Directly toxic to fish and invertebrates;
2. Depletion of dissolved oxygen in the water;
3. Preventing transfer of oxygen and carbon dioxide at the water surface;
4. Tainting fish flesh;
5. Creating a barrier to fish movement;
6. Endangering bird life;
7. Contaminating drinking water supplies; and
8. Very visible over large distances.

Silt

1. Clogging fish gills leading to stress, smothering and death;
2. Destroying fish spawning sites leading to a reduction in fish populations;
3. Destroying habitats for invertebrates (e.g. snails, caddis flies, stone and mayflies) which are an important food source for fish; and
4. Blanketing aquatic plants leading to reduced growth rates and reduction in dissolved oxygen levels in the water.

It is therefore essential that potential pollutants are reduced to levels that can safely be discharged to the environment. It is for this reason that limits are imposed on a discharge consent and it is imperative that these limits are complied with. Water Order Consents are issued under the Water (Northern Ireland) Order 1999.

1.2 Sources of Water

You can see in figure 2, that water is always in constant movement within the natural environment. Water in the air, ground, watercourses and the sea are continually interacting. Having a better knowledge of this process helps understand the movement of water at the micro level i.e. how water in quarries move and interact within the environment

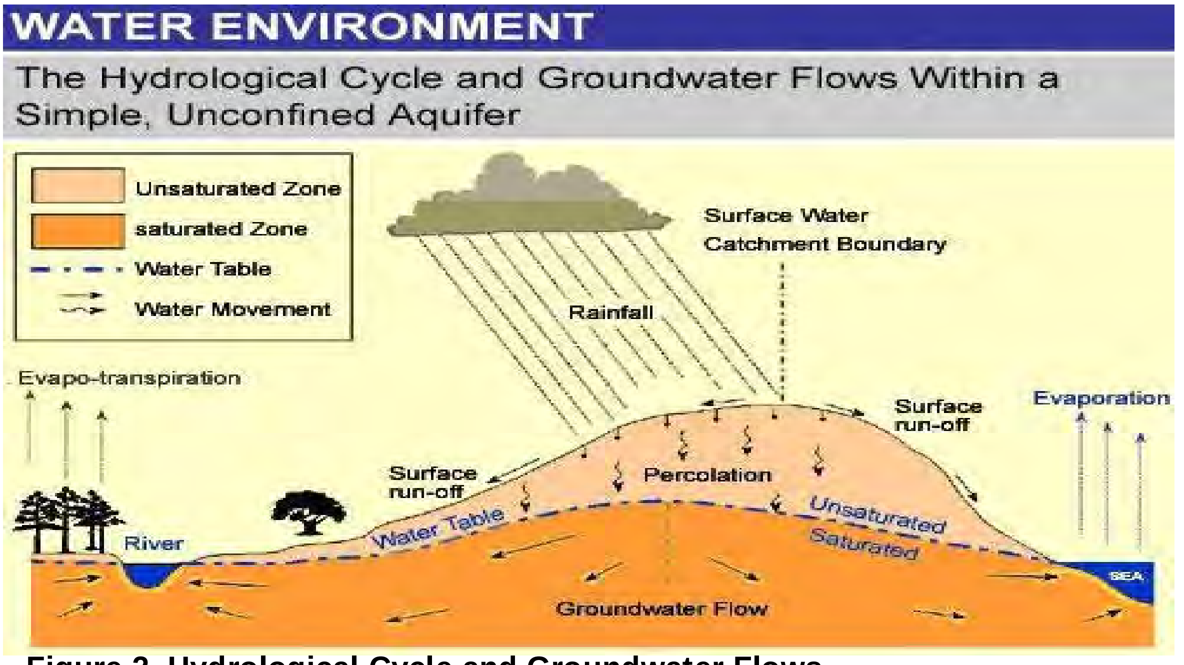

Figure 2. Hydrological Cycle and Groundwater Flows

Source
http://www.sustainableaggregates.com/sourcesofaggregates/landbased/water/water_opsstage_page1.htm

Quarries source or receive water from the natural environment in a number of ways:

1. water which falls directly into quarry voids as rainwater;
2. groundwater seepage;
3. “run-off” where the quarry is bordered by higher adjacent land (this can have significant volumetric contributions, particularly during the wetter months); and
4. road run-off entering a site at the quarry entrance, which in some instances can contribute unwelcome volumes.

In addition to rainfall / seepage, many quarries also need / choose to pump in water. This additional source of water ensures a constant supply of clean water, which may be necessary for quarry product processes and/or for wash water purposes.

Pumped water is mainly abstracted from boreholes but in some cases streams are impounded and water is taken directly from the waterway. One final alternative source of water is potable water, although it is not commonly used for either production or wash water.

1.3 A Better Understanding of Water in and around the Quarry

In order to identify improvements or to better understand opportunities managers first need to know what water processes are currently in place at the quarry. A useful first step is to carry out a water audit, as set out in the following 9 steps:

1. Investigate and understand how and where water is entering the quarry;
2. Estimate the quantity of rainfall and seepage entering the quarry, allow for seasonal variation and seepage back to groundwater;
3. Using pump records, calculate the amount of borehole and/or river water which is lifted into the quarry;
4. Collate the amount of potable water used by the quarry (only volumes used for operational purposes);
5. Calculate the volume of water utilised for on-site production, washing and for dust suppression, assess the quality parameters for each use;
6. Carryout an assessment of options to divert unwanted water; plan to keep it clean;
7. Investigate the feasibility for intercepting and storing clean water at a high ground position to best utilise a clean source of water under gravity;
8. Design to infiltrate and create effective storage for settlement and reuse; and
9. Estimate the pumping and treatment costs associated with your site, make these changes and calculate your savings.

The following sections aim to help quarry managers work through the above steps.

1.4 Water Calculation Tools

The following tools were jointly developed by NIEA and the QPANI. They are designed to assist quarry managers with ‘water audits’ and with the completion of water abstraction licence application forms. For abstraction licensing purposes it is now accepted by NIEA, that groundwater seepage into a quarry void is ‘broadly’ balanced out by the quantity of water that then re-enters the groundwater via the quarry floor. Therefore quarry managers now need only to apply for the direct abstraction of groundwater or river water by pumping and/or diversion.

An additional benefit of using the tools on the NIEA website is that, not only, will quarry managers be able to determine the groundwater volume, but the process simultaneously estimates at each site, the volume attributable to rainfall including the drainage component entering the quarry at its boundary. By then using the ‘quarry ready reckoner’ a manager can calculate the water requirement for the production of quarry products. Knowing what the quantities of water required by product and pump specifications and operating hours helps to deliver the ‘pumped abstraction’ figure. Having all of the above information goes a long way to completing a ‘best estimate’ water audit for a quarry business. This knowledge or water balance for a site, provides a baseline for future management decisions.

A brief explanation of these tools including ‘links’ are set out below.

Quarry Sump Calculation

Quarry Sump in Magheramorne

This tool was developed to help quarries best estimate the volume of groundwater that enters quarry sumps. Quarries are asked to record pumping activity over a month and submit this information to the NIEA in support of their abstraction licence application.

http://www.doeni.gov.uk/niea/quarry_sump_calculation_pack.pdf - See Annex B

Rainwater and Run-Off Estimation Tool

Quarries are asked to provide NIEA with a quarry site map indicating the extent of the quarry void and adjacent land. Using this map the Hydrology team within NIEA can calculate the average rainfall and run-off figure for the quarry.

By subtracting the average rainfall figure from the average pumped volume leaves the volume of water that enters the quarry as groundwater.

http://www.doeni.gov.uk/niea/quarry_sump_methodology.pdf - See Annex C

Water Usage for Quarries 'Ready Reckoner'

Crusher

This tool was developed to help quarry managers estimate the volume of water used up during the production of quarry products at individual sites e.g. concrete / manufactured blocks.

http://www.doeni.gov.uk/niea/quarry_ready_reckoner.pdf - See Annex B, Water Usage Calculations

Remember – quarry managers now only need to apply under the Water Abstraction Regulations for the quantity of water pumped or diverted into the quarry from adjacent waterways and/or from groundwater sources.

Section 2 Pollution prevention and sustainable drainage

This pollution prevention section of the report recommends that quarries employ pollution prevention activities.

Tank pallet to help capture any leakage

2.1 Mitigation measures designed to reduce pollution

Never forget that prevention is always more effective than cure and that small volumes are always easier to treat. Therefore, don't allow pollutants to get into water and/or effluent streams on site.

Good water quality is important to us all. Quarry managers know that it is impossible to prevent water from entering the quarry, but he or she should also appreciate that reducing the volume that does come in, makes managing, treating and discharging, an easier task.

Quarry managers are equally aware that a clean source of water is essential for many quarry operations (e.g. the washing of crushed stone or wheel washes) and for the production of quarry products (e.g. block and concrete production). Actively reducing volumes and reusing water within existing treatment systems reduces treatment volumes, saves money and reduces the risk of a pollution incident caused by dirty water.

Quarry managers understand that effective treatment and then the returning of clean process water back to the aquatic environment is their biggest challenge. Always look to reduce your effluent volume; the treatment of quarry water is expensive.

Settlement pond to trap silt

Understanding better how water moves within the quarry, how to reduce the energy associated with moving water, coupled with, actively managing that system will significantly help deliver easier effluent treatment and improved final discharge quality.

Quarries need to invest in appropriate training with built in refresher training carried out on a regular basis. A positive culture of pollution prevention will in itself significantly reduce pollution incidents. Prevention of pollution incidents will save money and also reduce the risk of accidents occurring on site.

The following section highlights the causes, prevention opportunities and treatment options for the pollutants associated with quarries.

2.2 Oil and Chemicals

Quarry managers should focus on managing the risks associated with oil and chemical storage and use on site. The consequences of polluting the groundwater are far reaching and the costs associated with a clean-up / remediation will always be high. Therefore quarry managers should invest in dedicated and appropriately bunded storage and have a management system for filling, using and disposing of spent products or containers.

Emulsified oil and absorbent boom *Integrally bunded steel tank*

Some of the causes of oil and chemical pollution:

1. Overfilling storage tank/s;
2. Spillage while refuelling vehicle;
3. Spillages during transport within the site;
4. Failure of a tank/drum or tank support;
5. Pipe work failure through mechanical damage or corrosion;
6. Waste Lube oil from servicing;
7. Failed Hydraulic systems;
8. Inappropriate use of chemicals;
9. Inappropriate use of chemicals which are restricted or authorised; and
10. Theft/ vandalism.

Opportunities to prevent oil and chemical pollution:

1. Provide contents measurement;
2. Fit overfill protection device;
3. Fit cut-off trigger to hose;
4. Only use tanks and pipe supports which are compliant with the requirements of the Control of Pollution (Oil Storage) Regulations (Northern Ireland) 2010 (the Oil Storage Regulations);
5. Fit lockable valve at tank and end of hose;
6. Provide waste oil and filter facilities;
7. Inspect regularly and consider the H&S aspect;
8. Know your chemicals. How to store, use and dispose of;
9. Use chemicals in accordance with the REACH Regulations; and
10. Consider steel integrally bunded tanks which are compliant with the Oil Storage Regulations.

Options to prevent pollution from oil and chemicals:

1. Provide absorbent;
2. Fit appropriately sited interceptor suitable for the level of risk posed by the site on storm drain;
3. Fit a scum board / elbow on settlement pond outlet;
4. Prepare booming site downstream with anchorages; and
5. Bring in expert clean up services.

2.3 Silt and Cement

Where a good oil and chemical management system is in place then the quarry manager needs to concentrate on reducing the amount of 'dirty water' generated within the quarry. Pollution prevention should always be at the heart of the water management system for the site. It should always be remembered that sediment carried out of a site in either a pumped or gravity fed discharge will have devastating polluting impacts on the receiving waterway.

Silt Fence

Some of the causes of silt and cement pollution:

1. Spoil heaps – rain mobilizes the finest material, with high heaps there will be significant erosion gullies and it will provide lots of muddy run off;
2. Roads and roofs – collect rain water and the volume involved may give rise to erosion in ditches or nearby surfaces;
3. Wheel and vehicle washing – produces lots of muddy water. Without precautions this will contaminate roads and ditches;
4. Unmade surfaces – vehicles crossing soft wet ground churn up mud which will seal the surface and prevent percolation, the resulting mud will run off in wet weather; and
5. Sand washing – produces lots of silt. This material cannot be stacked up and will give rise to muddy run-off which, ending up in ponds, can pose all sorts of H&S

problems and in some cases catastrophic wall collapse would cause really severe pollution risks.

Opportunities to prevent pollution from:

1. Spoil Heaps

1. Textile swales installed around the base of the heap and for tall ones at intervals up the face will help silt to settle;
2. Geotextile cover will dissipate rainfall energy and prevent mobilisation of the finer material. For permanent heaps seeds within the textile may tie down securely;
3. Gravel cover is often available and will dissipate energy and provide drainage;
4. Vegetation will tie down silt and help dry the surface; and
5. Cut off ditches especially with check dams will help settle out silt and prevent its spread. Summer ‘dry weather’ servicing makes silt management / disposal easy.

2. Roads or roofs

1. Should have regular sweeping to remove silt;
2. Hard surfacing produces much less mud;
3. Drains remove water and check dams collect silt which will need to be removed regularly;
4. Unmade surfaces are easily churned up and should be protected by excluding vehicles from them; and
5. Infiltration ditches alongside roadways will remove water but will need replaced from time to time as they silt up.

3. Wheel and vehicle washing

1. If the entrance and exit are sloped back into the bath that will collect many of the drips;
2. The tank must be desludged regularly; and
3. The system should recycle water and provide containment.

2.4 Design of Settlement Ponds

The simplest method for removal of suspended solids in quarry drainage is to construct a system of settlement ponds. These are employed to treat any drainage potentially contaminated with silt. Settlement ponds work by slowing down the velocity of drainage they then provide retention time to allow silt particles to fall out of suspension, with the aim of producing an effluent suitable for discharge back to the aquatic environment.

Obviously it makes sense to reduce the amount of drainage coming into contact with any form of contamination, as the smaller the volume of drainage to be treated, the smaller the treatment system required.

The nature of the solids to be removed must also be taken into account, sand will settle much quicker than clay, and will require much less surface area of settlement system to deal with a similar volume of drainage. When designing any settlement system, consideration must be given to maintenance issues, particularly access for, and frequency of de-sludging.

Regular checks should be carried out on the system, which should include checks on final discharge quality, to ensure the system is maintained in order that consent levels are not breached.

Settlement Pond

In general

The pond must cover a large enough area to allow the solids to settle, this will allow the surface water to move very slowly from inlet to outlet. Several small ponds are more effective and much less subject to wind/wave disturbance of the bottom.

Size

The theoretical size of the pond can be calculated if the rate of settlement and volume of discharge is known. The area (square metres) of the pond will be calculated as the rate of flow (in cubic metres per hour) divided by the velocity of settlement (in metres per hour). This only applies in ideal conditions so it would be prudent to build in a large safety factor.

Depth

It must be deep enough for settled solids to drop below the level of moving water (and also to provide enough storage below this level) for a reasonable time between cleanings. In practice this will need a depth of more than one metre. For safety either the pond should be fenced off or have a shallow shelf 2-3 metres wide around the margin if there is sufficient space. Ropes across the surface improve escape chances.

Inlet

The inlet to reduce energy/flow and provide even distribution e.g. a wide low weir.

Shape

The pond should be longer than wide, ratios of 4/5 to 1 are quoted but it is less important than maintaining an even flow. There should be no baffles or other obstructions as these increase flow velocity and make cleaning problematic. Similarly bends and corners will locally increase flow velocity and form eddies and shoals. Long narrow ponds can be split up by inserting weirs or check dams. Islands may be an attractive wildlife feature in very large ponds but will reduce the effectiveness of settlement and make cleaning difficult.

Outlet

The outlet should be similar to the inlet but it may be necessary to control outlet velocity where a secondary purpose is to provide attenuation for flood prevention.

Cleaning

There should be provision for cleaning. It will probably be very effective to have a small 'forebay' or pond to gather large particles which can be frequently cleaned out without disturbing the bulk of solids.

2.5 Vehicle/Plant Washing Operations

Wash water from vehicle/plant washing, especially that from activities using detergents or vehicle wash formulations, has the potential to pollute waterways and groundwater as it is likely to contain a mixture of detergents, dirt particles, organic matter and oil residues.

The Department has a preference for how such effluent is disposed of based on the potential to pollute. The options in order of preference are:

1. Re-cycling without discharge;

2. Northern Ireland Water for foul sewer. Relevant permission must be obtained from NIW before making this connection. NIW headquarters on Belfast 03457 44 00 88;

3. Holding tank and disposal via a registered/licensed carrier to a consented treatment facility with the capacity to adequately treat the effluent prior to discharge; and

4. Consent – this will only be considered **either** where detergents will not be used **or** where the effluent is going to a treatment system that has a separate nutrient supply (e.g. sewage) and has the ability to reduce the combined BOD to within consent limits.

Use of Detergents and Appropriate Treatment

The use of detergents will only be considered where the detergents used comply with Regulation (EC) No 648/2004 of the European Parliament and of the Council of 31st March 2004. This regulation is designed to ensure that any detergents used are bio-degradable and suitable for discharge after appropriate treatment.

Detergents however do not contain sufficient nutrient to sustain a conventional biological waste water treatment system and NIEA will therefore only consider consenting the use of detergents where it is to a treatment system that has a separate nutrient supply (e.g. sewage) and has the ability to reduce the combined BOD to within consent limits.

Discharge to a Waterway

Consent conditions are site specific and vary depending on the following criteria:
1. the proposed maximum daily discharge volume;
2. the water quality target for the receiving waterway; and
3. the available dilution under low flow conditions in the receiving waterway.

Discharge via a Drainage Field (soak-away/sub-surface irrigation system) to Underground Stratum

Consent to discharge via a drainage field into groundwater is dependent upon the capacity of the land to percolate water and the predicted maximum daily volume generated by the vehicle wash.

The applicant must demonstrate, by doing a percolation test, that the land proposed for use as a drainage field is suitable for the proposed volume. The percolation test and the proposed drainage field, provided that the percolation test demonstrates the ground is suitable, must both be in accordance with British Standard BS6297:2007.

Any discharge to an underground stratum must be via a drainage field/soak-away capable of providing adequate treatment and dispersal of the maximum consented volume of effluent.

Discharges to un-made ground will not be consented – all wash water must be captured on an impermeable surface and directed through a suitable sample point to the drainage field/soak-away.

Good Practice

Any treatment system used must produce an effluent which complies with the conditions of the consent issued.

All parts of any treatment system should be regularly maintained to ensure their continued performance.

Oil interceptors are recommended as a method of catching oil and preventing it either compromising a treatment system or causing pollution.

Detergents, if present in wash effluent, may cause oil to emulsify. Interceptors are designed to retain oil but may not retain emulsified oils. As a consequence it is important to ensure that vehicle wash effluent does not enter interceptors designed to retain oil.

Where feasible the use of grit/silt traps, accompanied by regular checking and maintenance, is advisable. These will help to prevent silt accumulating in pipes and/or treatment systems and/or soak-aways. Where excessive silting occurs the system will fail and there is an associated danger of pollution. The positioning of grit/silt traps should be designed to protect the treatment system and avoid suspended solids reaching the discharge point.

Where an applicant wishes to discharge to/via a storm drain they must provide the Department with written permission from the owner of the storm drain (e.g. Northern Ireland Water (NIW) or Road Service). The consent conditions will be set as though the discharge is directly to the waterway into which the storm drain finally discharges.

Section 3 Discharge consents, monitoring and compliance

3.1 Water Order Consents and Compliance

It is advisable to contact the Industrial Consents section of NIEA Water Management Unit as soon as possible and, in the interests of the applicant, before purchasing equipment or making an illegal discharge. Granting of Water Order consent is not guaranteed and will depend on a range of variables.

No two locations or proposals are the same and the Department cannot make a final decision on the appropriateness of a consent until it has received a completed application with fee and made a full assessment.

Where the site and/or the receiving medium (waterway or soil) prove unsuitable then the application will be refused.

This legislation will affect your business if you make a discharge to the environment of any trade effluent, which can include the following:

1. Potentially contaminated site run-off;
2. Wheel wash effluent;
3. Vehicle washing effluent;
4. Sand or stone washing effluent; and
5. Concrete washout effluent.

In addition to discharges of trade effluent, Water Order consent will also be required for any discharge of sewage effluent from the site, should this not be diverted to Northern Ireland Water foul sewer.

3.2 Monitoring

Spot sampling is carried out by our field staff that routinely visit consented sites and collect samples of effluent being discharged. Since the purpose of the sampling is to assess compliance you will not normally be given advance notice of when samples are to be collected.

The samples are taken to the NIEA laboratories located in Lisburn where they are analysed to determine that the quality of the effluent meets the limits set by the consent. The laboratories participate in a number of national quality control schemes and are accredited under the United Kingdom Accreditation Scheme (UKAS).

The analytical results are then sent to staff for processing and storage on a computer database which enables us to readily check on the compliance of individual dischargers or different industrial sectors. If the effluent is found to be compliant the results are recorded and an annual summary is sent out to consent holders early in the next calendar year. If the effluent is found to be non-compliant, as soon as the results become available, the discharger will be notified.

3.3 Compliance

In order to comply with the conditions of a discharge consent, your business will need to provide adequate treatment designed to remove the potential contaminants which may be present in the effluent.

There are various options to control the level of contaminants in a discharge. The simplest method is to reduce the amount of water coming into contact with contaminants, hence reducing the volume of effluent which must be treated. Re-use of water should also be considered, e.g. for dust suppression, this again reduces the treatment volume and the size of treatment facility required in order to clean up the effluent.

The following practices will help reduce the polluting nature of drainage and increase the likelihood of compliance with consent conditions:

1. Encourage infiltration of storm water by designing filter drains rather than using conventional pipes, or incorporate infiltration sumps as part of the overall design;
2. Shallow slope design is crucial for effective infiltration and settlement;
3. Settlement systems must be adequately designed and sized in terms of depth and surface area in order to be able to treat the drainage from the entire catchment area;
4. Avoid high flow velocities particularly at the entry point to the final settlement pond. Energy dissipation devices or multiple outflow structures will help avoid re-suspension of sediment. Low flow velocity through a settlement pond will facilitate the deployment of booms in the event of an oil spillage;
5. The installation of pre-settlement traps or gully pots on internal drains will provide additional treatment capacity and also provide accessible service points for desludging accumulated sediment before it reaches the settlement pond system;
6. Consider vehicular access for desludging of settlement systems and take all necessary measures to ensure proper and safe disposal of accumulated silt. Access for desludging must be taken into account at the design stage;
7. T-pipes or baffles will help trap oil and floating debris; and
8. The installation of oil interceptors in areas where there is a higher risk of oil.spillage (e.g. storage and refuelling areas) should be considered.

Non-compliance with Water Order consents, may trigger enforcement proceedings ranging from warning letters, through issue of formal enforcement notices and (possibly) eventually to prosecution.

It is essential that all conditions of a consent be complied with. For example, as well as discharging effluent in excess of numerical limits, it is also an offence not to provide safe access to a point where a sample of the discharge can be obtained. A sample point must be of a design to allow a representative sample of what is actually being discharged to be obtained, ideally with a “drop” under which a sample receptacle can be positioned.

Section 4 Water for Nature Conservation

4.1 The importance of our Natural Rivers

Water related ecosystems such as wetlands provide us with essential services – from drinking water, water for agriculture, energy, industry, flood management, recreation opportunities, filtering and waste services, fisheries and tourism.

Quarries and pits can provide terrific wildlife wetland habitats both during extraction and in restoration plans. This can include wetland habitats to benefit local biodiversity for example, wet woodland, wet grasslands, ponds and reedbeds.

As noted earlier in this guidance document, many of our quarries and pits are located alongside watercourses.

QPANI supports closer working partnerships between local authorities and conservation bodies. The Loughs Agency contribution to the Wise Use of Water Guidance communicates the importance of our watercourses to development of fisheries and aquaculture, conservation and protection of inland fisheries and sustainable development of marine tourism.

Like many local Angling Clubs, the Loughs Agency undertake fishery habitat improvement schemes which are designed to improve the quality and availability of suitable habitats for native fish species including salmon and trout.

4.2 Biodiversity Gains

Biodiversity essentially refers to the range of living species, including fish, insects, invertebrates, reptiles, birds, mammals, plants, fungi and even micro-organisms. Waterbodies and wetlands can provide potentially valuable biodiverse habitats in the quarry context.

Ditches, small watercourses, ponds and drainage channels are all potentially valuable wildlife habitats. Amphibians such as frogs and newts use pools for part of the year to breed, but then disperse to other locations to feed and hibernate. Moorhens and coots are familiar sights throughout spring breeding in quarries. Damsel and dragonflies can also be seen at shallower pools during the summer months.

With appropriate management, the wildlife value of quarries can be improved while still maintaining their operational function. Settlement lagoons, SUDS and other pollution control features can provide opportunities for enhancing wildlife value. Allowing ponds to recolonise naturally, or planting shallow areas with native wetland plants can support a variety of invertebrates and other species. Purchase from a reputable source of local provenance and, avoid buying plants from garden centres.

Restoration presents the opportunity to reinstate areas of habitat which may have been historically important to the local area. Water-based restoration schemes in particular can help to create, conserve and enhance a network of semi-natural wetland habitats, ecological corridors and community assets on former quarry workings. Ponds are now a UK Priority Habitat and a toolkit has been provided to the Aggregates and Quarrying Industry by the Freshwater Habitats Trust for the creation of ponds.

www.freshwaterhabitats.org.uk/projects/million-ponds/pond-creation-toolkit

Disclaimer: We would advise that not all of the content in the Aggregates Toolkit is necessarily relevant to Northern Ireland's native flora and fauna.

Cormorant feeding at a quarry pond in the Belfast Hills.

Wet woodland habitat on a former sand extraction site at Lough Neagh.

Restoration of former Sand and Gravel Pit to large ponds, island and associated wetland habitats at Ballinagilly, Cookstown. Good example of what an aggregate site can become.

The density of reed growth and native species such as willow shrub benefits biodiversity as well as treatment of water prior to discharge in the series of settlement ponds at Doon Quarry, Co Fermanagh.

Section 5 Case studies and key recommendations

5.1 Local Case Studies of “best practice”

Rainwater Harvesting

Northstone (NI) Limited Concrete Division incorporated a rainwater harvesting system into their new Tile Plant in Toomebridge (2008). Rainwater is now captured from the factory's large roof; the newly installed syphon system directs rainwater to storage tanks with a holding capacity of 120,000 litres. The syphon system provides a better control system and reduces the volume of storm water directed into the local drainage system. The company has benefited with financial savings from recycling and at the same time has reduced the environmental impact of its abstraction activity.

“*We decided to venture into rain water harvesting for re-use of rainwater in the tile manufacture process, not only because of the cost benefits to be gained from recycling rainwater, but also because it reduces our environmental impacts. We are also aware that reduction of surface run off water on the site automatically reduces any potential pollution (spill) spread.*”

BrianWatt,
Production Director
New Tile Plant, Toomebridge
Northstone (NI) Limited, Concrete Division

Redirecting Water

Like many other quarries in Northern Ireland J Robinson & Son Ltd Craig’s Quarry at Glenwherry, Ballymena faces a problem of excess water entering its void from run-off from adjacent land. This meant expensive pumping is required in order to allow continued extraction and to prevent flooding of the quarry floor. As the quarry grew in depth and size the problem was exacerbated and an innovative solution was required. Rather than upgrading the pumping system, an interception pipe has been installed around the perimeter of the upper quarry face. The cost of this interception solution was much less than the pumping upgrade cost. This new network of open drains and piping successfully intercepts and diverts land drainage by gravity around the quarry void. The resultant saving on energy costs from reduced pumping, and the lower volume of trade effluent has meant compliance with the sites consent has improved i.e. cleaner water is being returned back to the natural environment.

"On the back of advice taken from a NIEA Pollution Prevention Team presentation at a QPANI Environment Conference, we have reduced the volume of water entering the sub grades by approximately 70% and contained all the clean water from being contaminated by the working faces. The cost of the piping works was half the cost of upgrading our pump system which we would have had to do in order to cope with peak periods of rainfall."

Alex Robinson, Director Craigs Quarry
J Robinson & Son Ltd

Recycling Water

Norman Emerson Group's Tandragee Quarry incorporated a sustainable drainage system to capture run off and drip from the wheel washing plant. Water would be pumped from a borehole to a reservoir before it was used. Any excess water would collect in a settlement tank before being fed back to a reservoir. This enclosed system negated the need for discharge consent, providing financial savings and recycled 80% of the water; reducing the impact on the groundwater aquifer due to reduced pumping from the borehole.

This enclosed system also meant that water being used in the concrete batching plant was recycled and reduced the amount of water required from the borehole. The quarry benefited from reduced costs through not needing a discharge consent and removed any risk of non compliance.

"Keeping our vehicles, our haul roads and public highways clean are stipulations all quarry operations have to abide by. By achieving this in a sustainable manner we are putting lest pressure on the water table and preventing risk of contamination – all of which are vital importance in maintaining good relations with our local neighbours and regulators."

Colin Emerson, Operations Director Norman Emerson Group

On Site Water Management

The water management system at our Draperstown Pit is such that there is no off site discharge leading to reduced potential of water pollution in nearby streams or the nearby Lough Fea (a public water supply and renowned for trout fishing) and Teal Lough (ASSI, SAC), Lough Patrick, Cow and Mill, which range from around 1.5km to 6km from the site. There are no significant water courses within the site and the nearest water course is the Black Water which flows from the SE to NW is a closest about 300m from the sand and gravel operation. The principle route for surface water drainage from the area around the quarry is a small tributary which flows on the SE boundary within a shallow valley.

All water used at the plant comes from natural sources including rain water, ground water and water recycled from the washing process. All water from the processing plant is pumped from the washers to the settlement ponds were the silt settles out and the water is returned to secondary settlement ponds before being reused in the washing processes on site.

"*A number of lagoons have been created within the site voids created by the extraction process. There are no discharges of water from the site directly other than those which would percolate through the sand and gravel or evaporate. Water is collected, pumped, settled and reused in the washing process. Re-use is increasingly important to our operations demonstrating efficient and sustainable water usage."*

Colm Scullion, Sand Pit Manager Creagh Concrete Products Ltd

5.2 Conclusion

It is recommended that quarry businesses take the key principles contained in this 'Wise Use of Water' guidance and incorporate them into the heart of their environmental management strategy.

It is intended that quarry managers adopt this document and apply its many recommendations and develop their own site specific water management plan. Through the adoption of recommended pollution prevention meas ures, by incorporating 'best practice' advice for treating effluent, and by actively managing water within their site, quarry managers will see environmental quality and financial benefits.
Quarry managers are urged to complete a water audit. The findings of that audit will help identify the best ways in which to improve upon environmental performance, reduce health and safety risks, and at the same time deliver financial savings.

The active management of water at key locations within the quarry invariably delivers multiple benefits. A few are highlighted below:

The diversion of un-wanted water from around the edge of the quarry will reduce the volume of trade effluent generated within the quarry. Less trade effluent will mean lower treatment costs, i.e. less pumping, less frequent servicing / maintenance at the treatment plant. Also the resultant 'dryer' quarry environment improves overall working conditions for staff, particularly for that of lorry drivers. Improved working conditions will lower the risk of accidents.

The construction of an interception pond on a water diversion channel at the quarry edge can create an 'energy free' and constant source of clean water for stone washing and production purposes. Using water supplied under gravity will reduce the both the quarries energy bill and carbon foot print and also helps to preserve groundwater reserves. By adopting a policy of using quarry effluent ahead of groundwater further reduces the quarries impact on the environment.

Soft engineering and the use of infiltration trenches for transporting water within the quarry will both encourage groundwater recharge and will benefit effective treatment by reducing water velocities at the entrance to settlement ponds.

Both NIEA and the QPANI would like to recognise and thank the companies and individual quarries who contributed 'best practice cases' to the document.

It is intended that this guidance document will remain a 'living document'. As knowledge in this area of environmental management improves, this document will be reviewed, updated and re-issued.

Annex A – Legislative Drivers

Habitats Directive

The Habitats Directive 2008/99/EC on the protection of the environment through criminal law requires member states to have a formal/legal method of assessing the potential impact of abstraction/impoundments on protected and sensitive sites (e.g. wetland). A protected site is defined as one which has a European designation, for example, a Special Area of Conservation or a Special Protection Site, it will be subject to further assessment and consent controls.

http://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32008L0099&qid=1436362959423&from=EN

Water Framework Directive

Article 11 of the Water Framework Directive 2000/60/EC establishing a framework for Community action in the field of water policy requires that the programme of measures established by river basin plans should include controls over abstractions and impoundments. While the programme of measures does not have to be established until 2009, or become operational until 2012, the introduction of the scheme now will provide valuable information for the river basin planning process and enable Businesses and the Department to plan ahead to meet the required Water Framework Directive standards.

http://www.doeni.gov.uk/niea/ec_water_framework_directive_2000_60ec.pdf

The Water (Northern Ireland) Order 1999 - Water Order consents

It is an offence to make a polluting discharge or trade effluent into a waterway or water contained in any underground strata, unless it complies with a consent issued by the Department. “Trade Effluent” means any liquid, either with or without particles or matter in suspension, which is discharged from any premises or site used for carrying on any trade or industry.

Further information on making an application for consent to discharge, including copies of the relevant application forms, can be obtained by following the link below.

http://www.doeni.gov.uk/niea/water/regulation_of_discharges_industrial/industrial_and_private_sewage_2.htm

The REACH Regulation

REACH stands for Registration, Evaluation, Authorisation and restriction of chemicals.

REACH Regulation (EC) No 1907/2006 is a European Union regulation that affects the supply and use of substances. It came into force on the 1st June 2007, and replaced a number of European Directives and Regulations with a single system. The key aim of the REACH Regulation is to protect human health and the environment from the risks arising from the use of chemicals.

- The Regulation:
- requires manufacturers and importers of chemical substances to gather hazard information and assess risks;
- can require the use of some particularly high-risk substances to be authorised; and
- restricts the marketing and use of certain hazardous chemicals and mixtures.

http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:02006R1907-20140822

Classification, Labelling and Packaging (CLP)

European Regulation (EC) No 1272/2008 on classification, labelling and packaging of substances and mixtures came into force on 20 January 2009 in all EU Member States, including the UK.

The CLP Regulation ensures that the hazards presented by chemicals are clearly communicated to workers and consumers in the European Union through classification and labelling of chemicals so that workers and consumers know about their effects before they handle them.

http://eur-lex.europa.eu/legal-content/en/TXT/?uri=CELEX%3A02008R1272-20150601

The Abstraction and Impoundment Licensing Regulations (Northern Ireland) 2006

These Regulations cover the abstraction (removal or diversion) of water from a:

- river
- lake
- lough
- groundwater aquifer
- coast

These sources need monitored to help prevent any adverse impacts to the environment.

If you over abstract it may:

- increase pollution through reduced available dilution
- reduce flows which can impede fish migration
- cause morphological changes in a river bed / banks
- cause loss of aquatic habitats,
- possibly draw salt water into groundwater sources
- lower local water tables thus impacting neighbouring wells and impact the integrity of archaeological sites and protected wetland habitats.

The operation, construction or maintenance of any impounding structure may also require you to apply for a licence from the Department. Impounding structures can adjust the level of a river upstream. You may already be achieving this through the use of weirs and dams to hold back water or divert it down a mill race or other type of channel. Poorly designed weirs can prevent fish migrating upstream of the abstraction point.

The maximum **volume** of abstracted water is the important factor when determining if your processes utilise enough water to warrant a licence. More information and an application form can be obtained from the address at the end of this document or via the weblink:

http://www.doeni.gov.uk/niea/water/water_resources/abstraction.htm

The Control of Pollution (Oil Storage) Northern Ireland Regulations 2010

Oil is considered a hazardous substance within the meaning of EC Directive 2006/118/EC on the protection of groundwater against pollution and deterioration. The environmental damage caused as a result of a pollution incident due to the release of oil can be significant and expensive to remedy. The most frequent polluting oil types are diesel, central heating oil, petrol and waste engine oil. The Water Framework Directive (2000/60/EC)(WFD) requires that for diffuse sources liable to cause pollution, measures are put in place to prevent or control the input of pollutants. The WFD is implemented in Northern Ireland through River Basin Management Plans which were first published on 21 December 2009. Programmes of Measures have been developed to ensure that the objectives of the WFD are met and included in these was a commitment to make the Control of Pollution (Oil Storage) Regulations (Northern Ireland) 2010.

Who do the Oil Storage Regulations affect? If you store more than 200 litres of oil above ground at an industrial, commercial or institutional site, then these Regulations affect you.

Why do we need Oil Storage Regulations? Over a sixth of all pollution incidents affecting the environment involve oil. Most incidents are caused by oil leaking from tanks or pipework, tanks being over-filled or vandalism. The Regulations help us prevent these incidents by requiring tank owners to provide a secondary containment facility, such as a bund and/or drip tray, to prevent oil escaping into the environment. Oil is toxic to plants and animals; even a small amount of oil can destroy river life. It forms a thin film on the water surface and stops oxygen getting to plants and animals. Oil spilt on the ground can pollute groundwater making it unfit for use and it is very expensive to clean up.

The Control of Pollution (Oil Storage) Northern Ireland Regulations 2010 aim to reduce the number of oil pollution incidents. By meeting the requirements of the Regulations you will be storing your oil safely, legally and reducing the risk of a potentially costly pollution incident.

The Regulations and Guidance on how to comply with them are available at the following link:

http://www.doeni.gov.uk/index/protect_the_environment/water/oil_storage.htm

The Control of Pollution (Oil Storage) Northern Ireland Regulations 2010 and amendments are available at the following links:

http://www.doeni.gov.uk/control_of_pollution__oil_storage__regualtions__northern_ireland__2010_sr_412.pdf

http://www.legislation.gov.uk/nisr/2011/385/contents/made

The Pollution Prevention Guideline relating to Above Ground Oil Storage Tanks is available at the following link:

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/290118/pmho0811bucr-e-e.pdf

Annex B - Quarry Sump Calculation

Dear Sir/Madam,

The Water Abstraction & Impoundment (Licensing) Regulations (Northern Ireland) 2006

The above Regulations came into operation on 1st February 2007 and give the Department the powers to authorise or licence all abstractions and impoundments of water within Northern Ireland. The key aim is to provide a single and consistent environmental risk based approach to help protect our water environment and to deliver efficient and sustainable water usage in
Northern Ireland. Northern Ireland Environment Agency (NIEA) is charged with ensuring that these regulations are properly administered and enforced.

On completion of your application form it was stated that at least one of the sources of abstracted water was from a quarry sump/lagoon. As part of the licensing process the volume abstracted from a quarry sump will be determined by NIEA in cooperation and consultation with the applicant by applying the **Quarry Ready Reckoner** and **Hydrological Methodology.**

This will help ensure that the volume applied for reflects the best estimate of the **groundwater** component entering the quarry and will therefore prevent over and under estimates of water abstraction/usage.

Please note that the abstracted volume of **rainwater** and **runoff** that collects in a quarry sump is not a licensable activity. It is our intention to remove this volume from the total volume submitted to estimate (if any) the groundwater ingress into a quarry sump.

Once NIEA Water Management Unit is in receipt of submitted volumes, the Hydrology Section, using a methodology endorsed by the QPANI for calculating rainfall figures, will remove the estimated volume of rainwater and runoff that collects in a quarry sump from the submitted volume. Any remaining volume, i.e. the groundwater component will be authorised or licensed dependent on the size of the abstraction activity.

We have enclosed a table to capture the abstracted volumes from a quarry sump, over a 30 day period. The **Quarry Ready Reckoner** should help with calculating these volumes and a **Glossary** has been provided to help explain each heading within the table.

PLEASE READ THE GLOSSARY BEFORE FILLING IN THE TABLE

We look forward to your co-operation but if you have any queries please do not hesitate to contact us.

Yours sincerely

Abstraction and Impoundment Licensing
AIL@doeni.gov.uk

Sheet for Daily recording of abstracted volumes over a 30 day period.

Methodology Used

Source: Quarry Sumps/Lagoons **Application Ref: AIL/ ____________/**

Date(dd/mm/yy)	Volume	Weather	Comments

Glossary

Methodology used

This is how the volumes were calculated. Examples of methodology used are demonstrated in the Quarry Ready Reckoner sheet which has been supplied with this pack. An example of a methodology could be:

Pump rate x number of hours of use

Date

The date should be written in the format of day, month and year, i.e. 01/02/08

Volume

This is the total amount of water abstracted from the quarry sump for discharging off site and/or in production of materials.

The volume is in m^3 per day; day being 24hours.

$1m^3$	=	220 gallons
$10m^3$	=	2200 gallons
$100m^3$	=	22000 gallons

If no volume is abstracted within a 24hour period then please write **N/A**

Weather

This is the average weather conditions for that day, this could be:

Cloudy Light Rain Sunny Heavy Rain Showers Snow Sleet

Comments

Please fill this section in if you have any additional information to add, i.e.
No pumping took place as quarry is shut over weekend
After heavy rain the pump needed to be on 24hours to prevent flooding of Quarry

Please return all completed sheets to:
Abstraction and Impoundment
Licensing Team NIEA
17 Antrim Road
Lisburn
BT28 3AL

Annex B - Water Usage Calculations

Water Ready Reckoner Table.

The following table can be used to calculate the average volume of water required to produce a known amount of product.

Type	Units	SWC (Specific Water Consumption)	Vol Water m^3 in
Concrete Products Concrete	m^3/t product m^3/	1.00	0.10
Blocks Reinforced Concrete	200 blocks m^3/m^3	1.00	0.25
Concrete slab	dry concrete m^3/t	0.40	0.135
production Industrial Sand	m^3/t	0.04 - 0.4	0.10
Washed Sand and Gravel	m^3/t	0.61	0.08
		0.02	0.02

SWC- Volume of water (m^3) brought onto site per unit of product dispatched

*Table is based on figures from Environment Agency R&D Technical Report W6-056/TR2 and input from the Quarry
Product Association Members.

I.e. a quarry produces 4000 blocks per day, it would therefore abstract:

4000/200 x 1 = 20m^3 per day

Other Methods for Determining Volume of Abstracted Water:

1. Pump rate x number of hours of use
2. Machine specification x number of hours of use
3. Number of secs/mins/hours a bucket/tank takes to fill

Please note all of the above methods can be used individually or together to calculate the total volume of water abstracted in a quarry.

If you require any assistance with filling in an application form or have any further queries, then please contact the
Abstraction and Impoundment Licensing Team on:

AIL.Team@doeni.gov.uk

or

028 9263 346

Annex C - Quarry Sump Methodology

Estimating the rainfall/run-off component of water abstracted from quarry sumps.

1.0 Background

The Water Abstraction and Impoundment (Licensing) Regulations (Northern Ireland) 2006, came into force in February 2007 and require the licensing of water abstraction where this exceeds 20m^3/day.

In many quarries water is pumped or discharges by gravity from one or more sump areas, usually located with a lower elevation portion of the quarry. Abstraction of groundwater from boreholes drilled in the quarry floor or adjacent to the quarry working area can also take place. Water may also be abstracted from local watercourses by diversion or pumping.

The water pumped out of a quarry sump normally consists of two* main components:

a) ‘Surface water’ from local catchment surface rainfall run-off.

b) ‘Groundwater’ where the sump extends below the (pre-quarrying) natural water table and where there is some degree of hydraulic contact between the sump and the surrounding strata (this will almost always be the case, unless some form of engineered liner has been installed.)

For the purposes of abstraction licensing charging, an estimate of the volume of water abstracted from a sump is required, recognising that the entire volume pumped will also comprise quarry drainage, local surface catchment run-off and incident rainfall. Surface water run-off is not a licensable component of the total volume abstracted under the Regulations. Whilst understanding the different components of the water balance in detail for quarries may be justified in certain cases with respect to prediction of impact on the local water environment. Undertaking this level of assessment for the purposes of abstraction licensing charging could be considered as excessive.

The purpose of this report is to consider an option for producing a simple method that allows an acceptable estimate of the surface water run-off component that is abstracted from a quarry sump. This method proposes to estimate the surface water run-off and subtract this from the total gauged or recorded volume of water discharged from the quarry sump or exported in product.

* There may in some cases be some public supply mains water draining to sump

2.0 Estimation of long-term average surface water run-off.

The Meteorological Office (UK) publishes datasets of both long-term standardised annual average rainfall (SAAR) and annual average potential evapo-transpiration (AAPE). The most recent datasets, considered to be representative of current Northern Ireland climate conditions are for the period 1971 – 2000. The data is published at a 1km grid resolution, so each 1km square in Northern Ireland has representative SAAR and AAPE values.

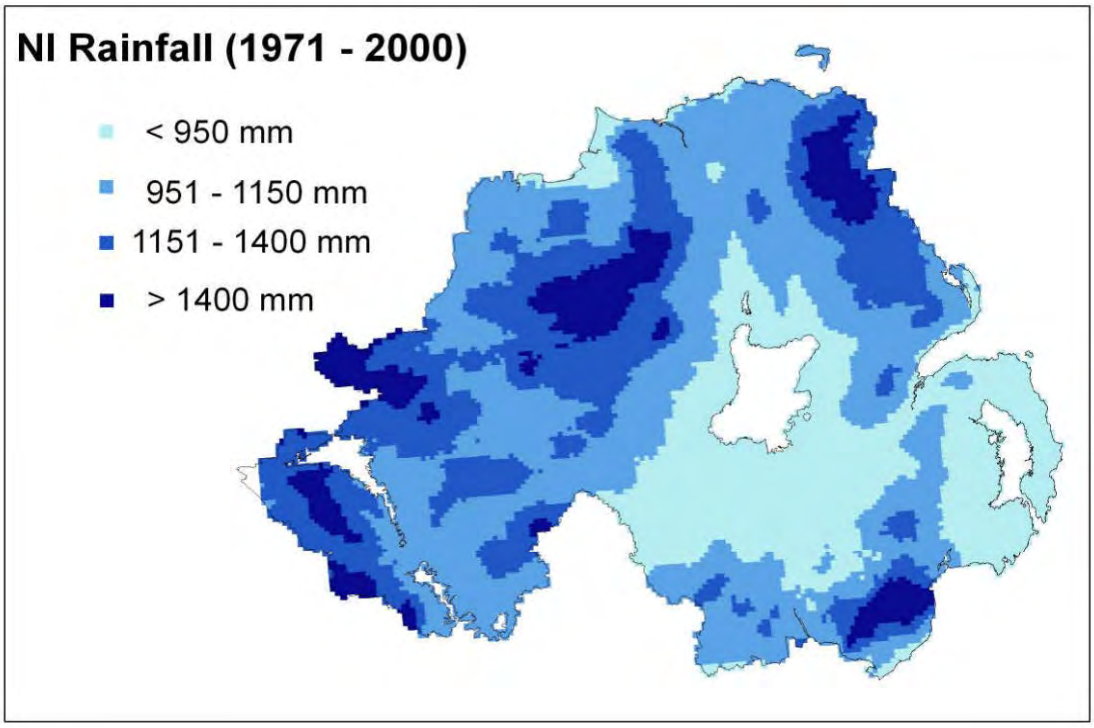

Figure 1. *Standardised Annual Average Rainfall in mm (1971-2000)*

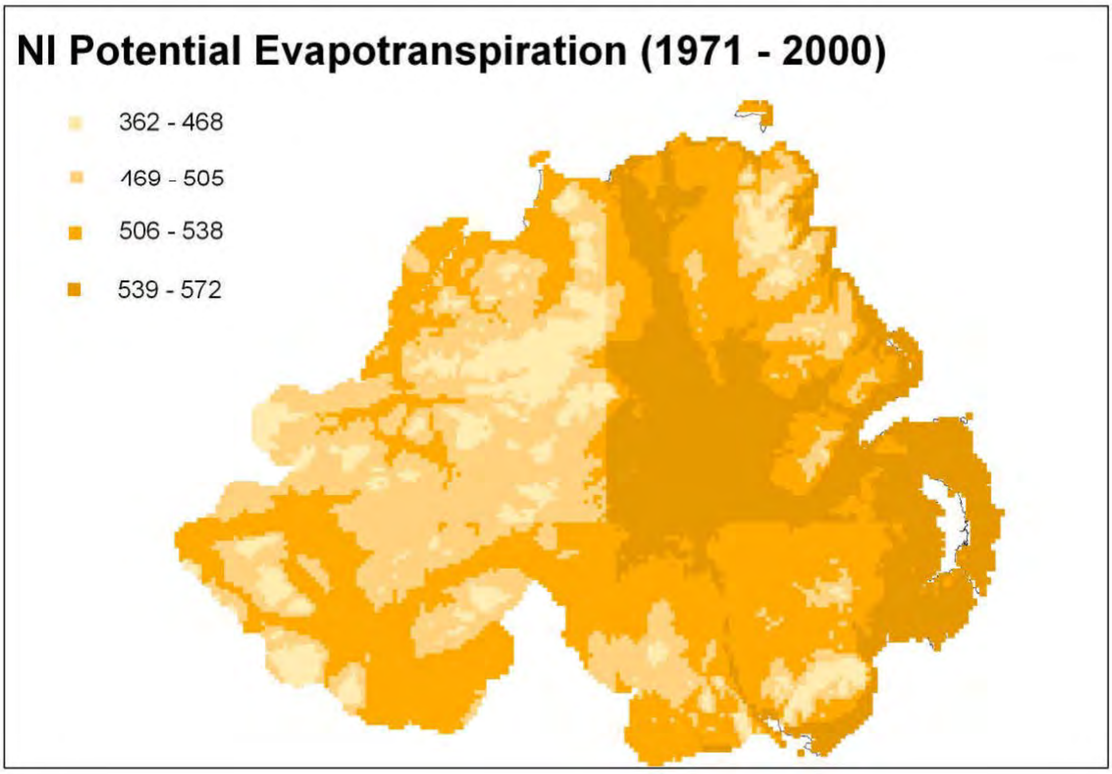

***Figure 2.** Annual Average Potential Evapo-transpiration in mm (1971-2000)*

Figures 1. and **2**. show the distribution and variation of these climatic parameters across Northern Ireland. It is clear to see that both distributions are closely reflective of differences in altitude. Analysis and computation of these datasets allows for the generation of a run-off depth distribution map. Simplistically, run- off depth can be calculated as the rainfall less the potential evapo-transpiration:

Annual Average Run-Off Depth	**=**	**Standardised Annual Average Rainfall**	**=**	**Annual Average Potential Evapo-transpiration**
(mm/year)		**(mm/year)**		**(mm/year)**

Run-off is potentially generated within any given surface water catchment area that drains in to the quarry void and ultimately the sump or lagoons. Where stream diversions are in place to divert streams or surface flow around the quarry void, little or no surface water may drain into void and only incident rainfall accounts for the sump volume not abstracted from groundwater or other active abstraction processes. The distribution and variation of the calculated run-off depths are shown in **Figure 3.**

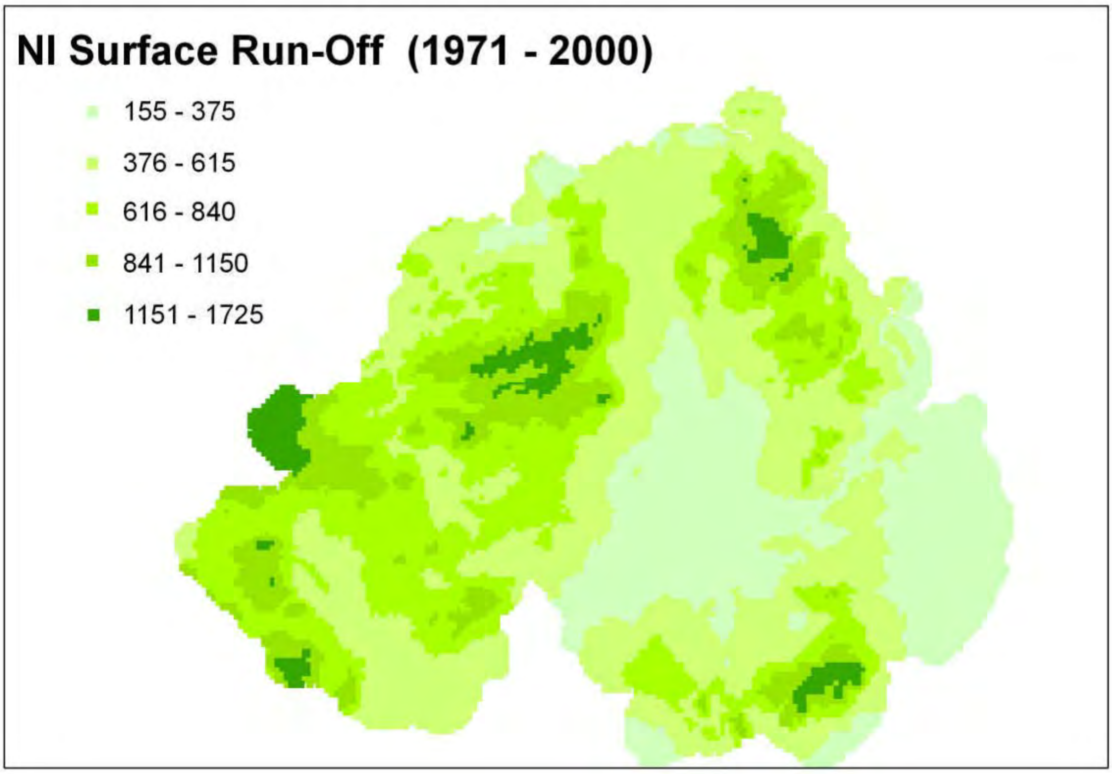

Figure 3. *Annual Average Run-off Depth in mm (1971 – 2000)*

The potential run-off for any given surface water catchment area can easily be calculated by multiplying the area in km^2 by the run-off depth in mm, to yield the volume in m^3/year. The annual daily average volume can then simply by calculated by dividing this figure by number of days in year.

3.0 Groundwater Recharge

Not all the run-off generated within the catchment will be available to form surface water flow. A proportion will infiltrate through the soil surface and percolate through sub-soil layers to recharge groundwater held in superficial deposits or bedrock. This proportion is dependent on many factors such as the soil and sub- soil hydrological characteristics and the nature and depth of the groundwater aquifer. Even for the most impervious bedrock types a groundwater recharge of 100 mm/year is typical. For superficial aquifers such as glacial sand and gravel deposits, the annual recharge value is likely to be a minimum of 350mm/year†. To account for this range in potential groundwater infiltration rates for different catchments, the 2 stated groundwater recharge values will be applied to reduce the calculated run-off for bedrock and sand and gravel quarries respectively.

† Robins, N.S., 1996, The Hydrogeology of Northern Ireland, HMSO for the British Geological Survey

Therefore, the run-off can now be corrected to account for the losses from groundwater recharge within the catchment area of the quarry, as below:

Annual Average Run-Off Depth **-** **Groundwater Recharge Annual Average** **=** **Annual Average Run-Off Depth**

(Modified)

(mm/year) **(mm/year)**
(mm/year)

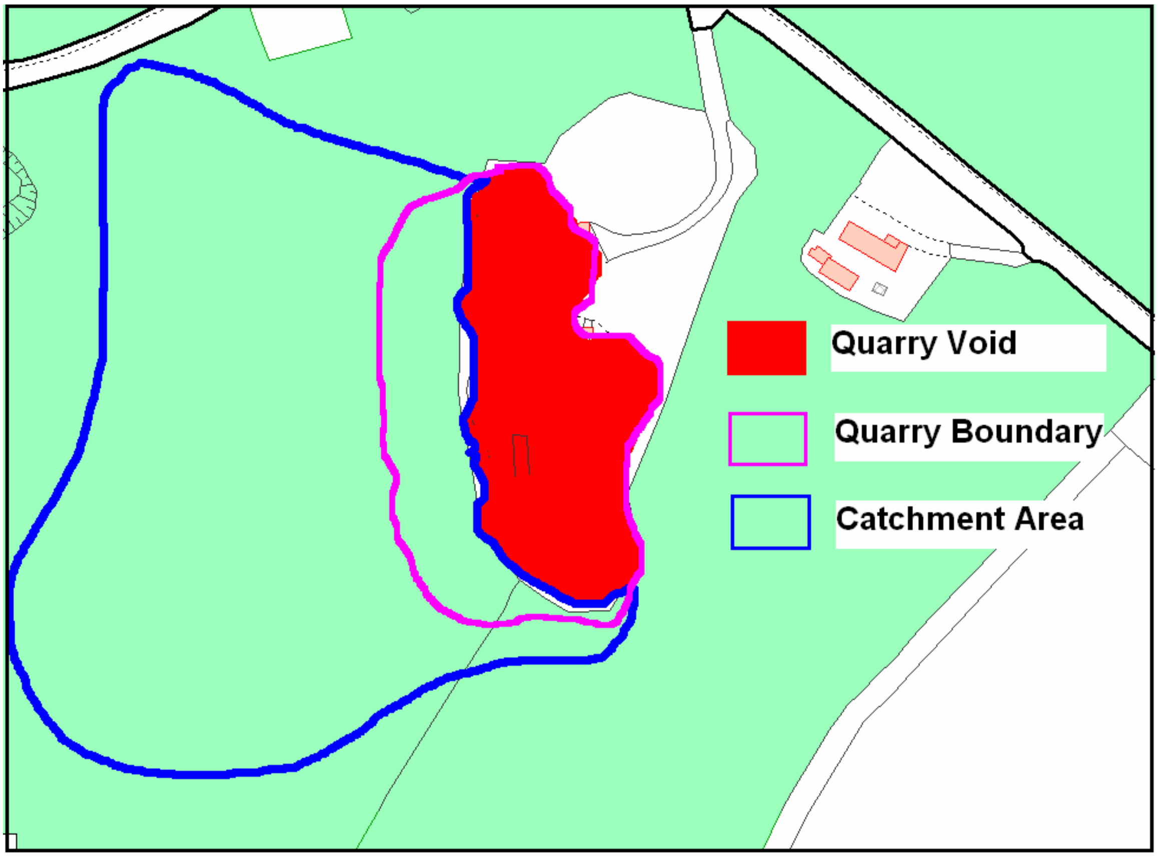

***Figure 4**. Example of a typical quarry hydrological catchment*

Figure 4 represents a typical quarry layout with quarry void, quarry boundary and surface water catchment identified. In this case it is assumed that surface water flow is free to run across ground or through watercourses into the quarry void.

Example 1:

Catchment area (km^2)	**=**	**0.025**
SAAR (mm)	**=**	**1000**
AAPE (mm)	**=**	**250**
Quarry type	**=**	**Bedrock (Granite)**
Groundwater Recharge (mm)	**=**	**100 (Bedrock)**

1) Run-Off Depth = SAAR (mm) – AAPE (mm) – GWR (mm) = AARD (mm)

= 1000 - 250 - 100 = 650 mm

2) Surface Flow = AARD (mm) x Area (km^2) x Factor* = Flow (m^3/day)

= 650 x 0.025 x 2.73888 = 44.5

**Factor converts (mm/year x km^2) to m^3/day*

In this example, the total catchment area of 0.025 km^2 or 25,000m^2 generates a surface water flow of 44.5 m^3 per day, as an annual average. However, due to seasonal variations in rainfall and temperature during the year, run-off potential will be reduced significantly during the drier summer months. This is primarily due to reduced rainfall in summer but developed soil moisture deficits and other factors may also have an effect. To allow for this variation, a template may be applied to the proportion of the annual run-off values to individual months. This template is derived from the long term monthly average rainfall for the period 1971 – 2000 for the whole of Northern Ireland, as shown in **Table 1.**

Month	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Mean Annual Rainfall (mm)	119.1	86.5	93.4	70.6	68.1	72.1	73.2	90.8	94.4	114.5	110.5	118.5
% of Annual Total	10.7	7.8	8.4	6.4	6.1	6.5	6.6	8.2	8.5	10.3	9.9	10.7
Monthly /Annual Factor	1.28	0.94	1.01	0.77	0.73	0.78	0.79	0.98	1.02	1.24	1.19	1.28

Table 1. *Monthly Average Rainfall % of Annual Total and Mean Monthly/Mean Annual Factors for Northern Ireland (1971 – 2000)* **Table 1** shows that long term average daily rainfall varies from 0.73 times the annual mean in May to 1.28 times the annual mean, during December and January. It is proposed to apply this monthly rainfall variation template to the long term annual average run-off

value to allow for adjustment to monthly abstraction values that may be stated on the application. Although potential evapo-transpiration will also vary seasonally, it is perhaps overly complex to re- adjust for this, as rainfall is the primary driver for direct run-off variation.

Example 2:

Mean annual daily run-off: **44.5 m^3/day**

During month of May run-off adjusted to: **44.5 X 0.73 = 32.5 m^3/day**

During month of December run-off adjusted to: **44.5 X 1.28 = 57.0 m^3/day**

4.0 Incident rainfall

This is the component of the rainfall that does not 'run-off' to the quarry void but falls directly into the quarry void, including the sump. It may be argued that such rainfall is not subject to as much potential evapo-transpiration as it does not fall on ground covered with vegetation allowing for plant uptake and subsequent transpiration or on soil, allowing for infiltration and percolation to groundwater. However, incident rainfall draining through the quarry void is subject to losses through infiltration to groundwater.

Water held in quarry sump can also be considered to be open water and subject to high potential evaporation. Given the scale of quarry voids, boundary areas and catchment areas, it is thought appropriate to apply a single SAAR value and PE value to each quarry site as the data is available at 1km grid scale only. Resolution of available data to the scale of the typical quarry in Northern Ireland would require some considerable effort and given the hydrological risk posed by the scale of quarrying activities, this is deemed inappropriate.

5.0 Conclusion

The monthly or annual surface run-off component established for a quarry operation can then by adopted to calculate the net licensable abstraction from any site. Records of the water use from the quarrying operation are required to ascertain the total used consumptively, using the ready-reckoner, and the total volume discharged from the sump to a local waterway or elsewhere.

6. Glossary

Aquifer
An underground permeable water-bearing rock or deposit formation capable of yielding exploitable quantities of water.

Catchment
An area having a common outlet or discharge point for surface water flow (also known as a watershed).

Evapo-transpiration
The process by which water is transferred from the soil to the atmosphere by evaporation and plant transpiration.

Groundwater
Sub-surface (underground) water occupying the saturated zone of an aquifer.

Groundwater Recharge
The process by which water is added to the saturated zone of an aquifer from outside it, either directly or indirectly.

Run-off
The part of precipitation (rainfall) that appears as stream flow.

3. Quarry Ready Reckoner

Water Usage Calculations

Water usage 'Ready Reckoner' table.

The following table can be used to calculate the average volume of water required to produce a known amount of product and/or the water quantity remaining in the product.

Type	Units	SWC (Specific Water Consumption)	Vol Water m^3 in Product
Concrete Products Concrete Blocks Reinforced Concrete Concrete slab production Industrial Sand Washed Sand and Gravel	m^3/t product m^3/ 200 blocks m^3/m^3 dry concrete m^3/t m^3/t m^3/t	1.00 1.00 0.40 0.04 - 0.4 0.61 0.02	0. 1 0 0. 2 5 0.1

SWC – Volume of water (m3) brought onto site per unit of product dispatched

*Table is based on figures from Environment Agency R&D Technical Report W6-056/TR2 and input from the Quarry Product Association Members.

i.e. a quarry produces 4000 blocks per day, it would therefore abstract:

- 4000/200 x 1 = 20m^3 per day to manufacture the blocks; of which
- 4000/200 x 0.25 = 5m^3 per day will leave the quarry in the blocks

Other Methods for Determining Volume of Abstracted Water:

1. Pump rate x number of hours of use
2. Machine specification x number of hours of use
3. Number of secs/mins/hours a bucket/tank takes to fill (no. of tank fills used per day)

Please note all of the above methods can be used individually or together to calculate the total volume of water abstracted in a quarry.

If you require any assistance with filling in an application form or have any further queries, then please contact the Abstraction and Impoundment Licensing Team on:

AIL.Team@doeni.gov.uk or 028 9263 3462

Annex D – Pollution Prevention Guidelines

The Mining and quarrying Pollution Prevention Guidelines (PPGs) produced by the Scottish Environment Protection Agency (SEPA) and Northern Ireland Environment Agency (NIEA) provide advice on legal responsibilities and good environmental practice.

The PPGs listed below may be of interest to your mining or quarrying business.

PPG 1 General guide to the prevention of pollution

PPG 2 Above ground oil storage tanks

PPG 3 Use and design of oil separators in surface water drainage systems

PPG 4 Treatment and disposal of sewage where no foul sewer is available

PPG 5 Works and maintenance in or near water

PPG 7 Refuelling facilities

PPG 8 Safe storage and disposal of used oils

PPG 13 Vehicle washing and cleaning

PPG 18 Managing fire water and major spillages

PPG 20 Dewatering underground ducts and chambers

PPG 21 Pollution incident response planning

PPG 22 Incident response – dealing with spills

PPG 23 Maintenance of structures replaced by PPG 5

PPG 26 Drums and intermediate bulk containers

PPG 27 Installation, decommissioning and removal of underground storage tanks

These can be viewed on Netregs here:

http://www.netregs.org.uk/library_of_topics/pollution_prevention_guides/mining__quarrying_ppgs.aspx

The contact details within some of the PPGs are currently being revised so please refer to Annex D - Contact Details, within this document for the most appropriate contact.

Annex E – Contact Details

Mail: **Abstraction and Impoundment Licensing Team** Northern Ireland
Environment Agency
17 Antrim Road
Lisburn
BT28 3AL
Phone: 028 9263 3482
Email: AIL.Team@doeni.gov.uk

Mail: **Quarry Products Association Northern Ireland** Unit 10 Nutts Corner
Business Park
Dundrod Road
Crumlin
BT29 4SR
Phone: 028 9082 4078
Email: info@qpani.org

Mail: **Quarry Products Association, Point of Contact**
Northern Ireland
Environment Agency
Klondyke Building
Gasworks Business Park
Belfast
BT7 2JA
Phone: 028 9056 9798
Email: carol.majury@doeni.gov.uk

Mail: **Pollution Prevention**
Northern Ireland
Environment Agency
17 Antrim Road
Lisburn
Bt28 3AL
Phone: 028 9262 3173
Email: nieapollutionprevention@doeni.gov.uk

Mail: **Industrial Consents**
Northern Ireland
Environment Agency Water
Management Unit
17 Antrim Road,
Lisburn
BT28 3AL
Phone: 028 9262 3034
Email: industrialconsents@doeni.gov.uk

Mail: **Geological Survey**
Northern Ireland
Dundonald House
Upper Newtownards Road
Belfast
BT4 3SB
Phone: 028 9038 8462
Email: gsni@detini.gov.uk

NIEA central contact number: **0300 200 7856**

Annex F- Useful Links

A Guide for the Mineral Extraction Industry

http://www.doeni.gov.uk/niea/mineral_extraction_industry_screen.pdf

Note that although this document was produced a few years ago and the branding and contact details have been revised the content remains accurate.

Geological Survey of Northern Ireland

https://www.bgs.ac.uk/gsni/contact/index.html

Sustainable Aggregates

http://www.goodquarry.com/

Quarry Products Association Northern Ireland

This website contains valuable information on the QPANI's role as the trades association for the aggregates and quarry products industry.

http://www.qpani.org/

NetRegs:

This website provides free environmental guidance for small and medium-sized businesses specifically for NI and Scotland. It helps to explain what must be done to comply with environmental law and protect the environment.

http://www.netregs.gov.uk/

Northern Ireland Environment Agency

This website provides valuable information regarding the work that NIEA does to help protect and conserve Northern Ireland's natural and built environment. It also includes important contact details with regards to environmental concerns.

http://www.doeni.gov.uk/niea

Glossary

Absorbant
Generally a powder that will absorb oil but not water. There are textiles that can be used on water as booms or sweeps.

Abstraction
The removal of water from the natural environment by mechanical means, pipe or any engineering structure or works. This applies to water that is removed or diverted permanently or temporarily or for the purpose of transferring to another part of the natural environment.

Booming site
Oil absorbent booms only work well in smooth water – repositioning anchorage points allows quick emplacement in a good point.

Borehole
An engineered structure which is drilled into the earth to obtain water from an underground source.

Bund
Originally used to describe an earth wall to prevent a river flooding but now includes any structure that is designed to contain an escaping liquid; e.g. a concrete or steel wall around an oil tank

Check dam
A low dam constructed across a broad and shallow ditch to form shallow pools for silt settlement. Can be formed from gravel or a plank or other abrasion resistant material.

Cut - off ditch
A ditch cut across the slope designed to intercept rainwater flowing across a surface.

Erosion gullies
Water running down an earth slope mobilises the lighter material carries it away and progressively gouges a deeper and deeper gully.

Evaporation
Changing from liquid to gas – causes the drying of wet surfaces.

Geotextile
A fabric used to consolidate soft ground – comes in a wide range of weights and strength.

Groundwater
Water held below the surface of the ground in the saturation zone and can be in direct contact with the ground or subsoil.

Impoundment
Any dam, weir or other works by which surface water may be impounded; or any works diverting surface waters in connection with the construction or alteration of any dam, weir or other works.

Infiltration
The process of allowing liquid (especially water) to penetrate into the ground – often through a soakaway or 'french drain'.

Integrally bunded tank
A tank constructed within a tank. The contents of the inner tank exit from its top. Most provide security for hose and filler.

Mobilisation
To support another phase (liquid or solid) in water – making mud from water and soil.

Overfill protection device
A threaded valve on a storage tank that shuts off flow when the tank is full.

Percolation As Infiltration.

Polishing wetland
A wet vegetated area which provides very long-term undisturbed storage for a clean effluent and so improves it. Could be quickly overwhelmed by high suspended solids.

Scumboard
A timber or metal structure across a pond that penetrates below the surface with the intention of retaining any floating material especially oil.

Silt
A fine material with particles larger than clay but smaller than sand. It is a major component of soil or till.

Textile Swale
A fabric sheet supported on poles; laid across a slope with the foot dug into the surface it moderates water flow and settles out suspended solids - looks like a beach windbreak.

Transpiration
The loss of water as vapour from the leaves of plants need watered.

Photography

Photography by the staff of:

Northern Ireland Environment Agency (NIEA)
Quarry Products Association Northern Ireland (QPANI)
Quinn Group
Geological Survey Northern Ireland (GSNI)
Land and Property Services (LPS)

NIEA www.doeni.gov.uk/niea Northern Ireland **Environment** Agency

Northern Ireland Environment Agency
Water Management Unit
17 Antrim Road
Lisburn
BT28 3AL

Tel: 028 9262 3034
Email: industrialconsents@doeni.gov.uk

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