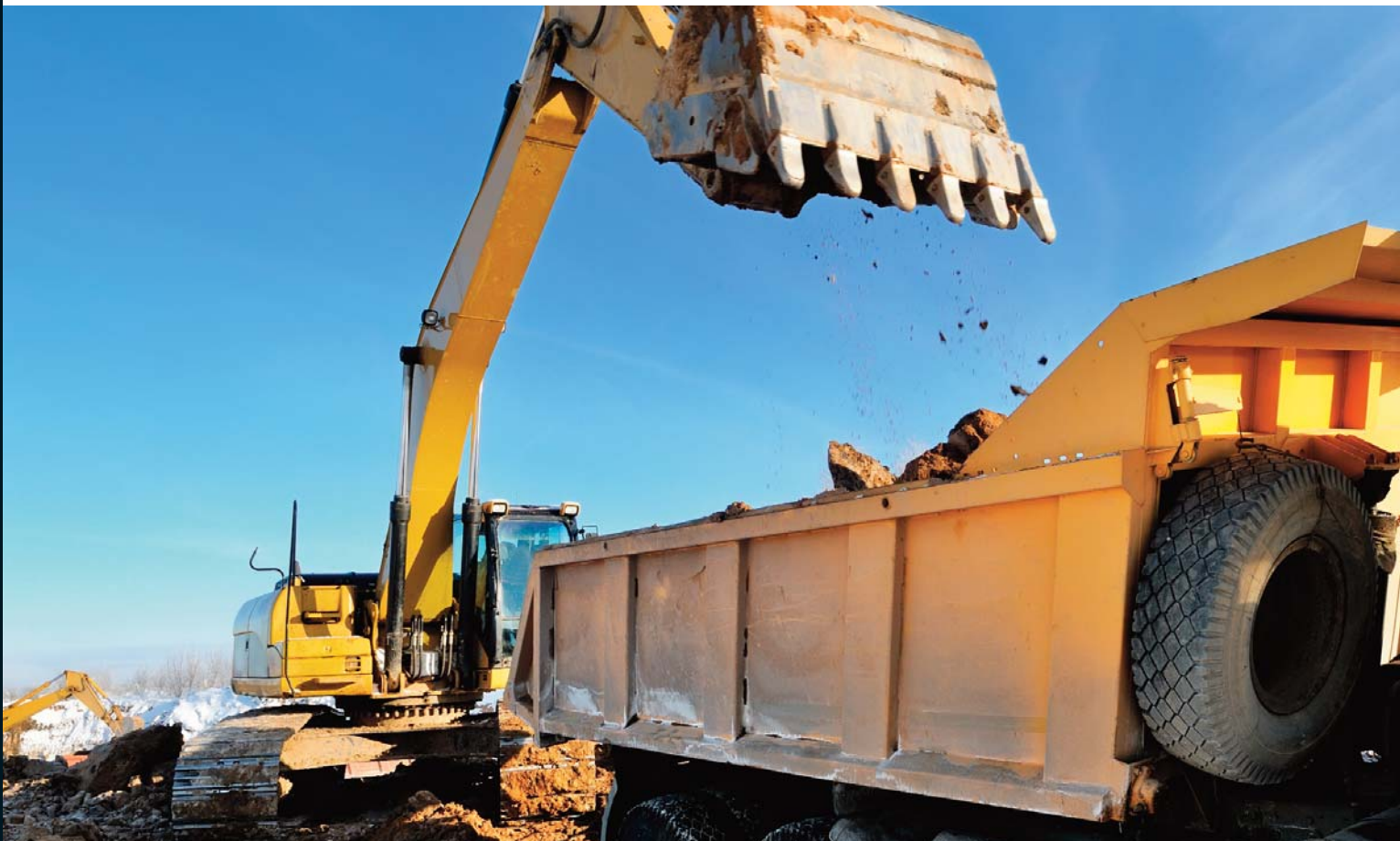




Everything you wanted to know about **Soil Remediation** but were afraid to ask

Do you want an insight in to contaminated soil remediation? If so read on...

If you're new to contaminated land, it's only natural that you will have lots of questions about the whats, the whys and the hows of soil remediation. Happily, this simple guide has been written just for you! We hope it will help you an insight into the mechanisms of soil remediation because no-one can see in the ground!



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► What is soil remediation

Soil remediation is a broad term used to define any process employed to solve the problems caused by contaminants, whether they are affecting soils or waters in or on the ground surface.

The definition of contamination is, roughly speaking, the abnormal presence of something which is adversely impacting upon an object, e.g. kerosene in soil which produces vapours dangerous to human health, kerosene is contaminating the soil. Contamination comes in many forms from asbestos to diesel to mercury, etc.

The aim of remediation is to remove or reduce concentrations of these contaminants to 'safe' levels where they no longer adversely impact upon the object in question. This really sounds very simple and with the correct advice and guidance there is no reason why it shouldn't be. Where it gets interesting is the selection of the 'best' method(s) to remediate the contaminants.

► Why is soil remediation necessary?

To keep it simple the answer is 'because you have a problem'. How do you know if you have a problem?

We've covered that stage in the next section regarding phase I & phase II reports. These investigative steps identify any contaminants and detail potential issues as part of the following concept:

'Source' → 'Pathway' → 'Receptor'

The **'source'** is the point or area from which contamination can spread, i.e. the material which is the root of all the problems.

The **'pathway'** is the method by which the contamination gets to the receptor. Ingesting, inhaling or touching certain contaminants can cause serious harm. Contaminants can be static in the soil but can be 'taken up' in to crops and subsequently eaten, or contaminants can simply become airborne on dry dusty days and inhaled by us, contaminants can also migrate through the ground affecting groundwater.

The **'receptor'** is the term used to describe anything that can be adversely affected by the contaminants; namely you, me, animals, plants, ecosystems, ground and above-surface waters, etc, though this is not an exhaustive list of possible receptors.

If you have identified contamination on your site you need to break the source-pathway-receptor chain by removing at least one of these three components to make things safe. This can be done by removing the receptor e.g. fencing off the area from people (not always a practical move), removing the pathway by installing a barrier, e.g. a capping layer across the site preventing the uptake by crops, or by dealing with the contamination source, e.g. reducing or removing the contaminant to levels which will not affect the receptor.

► The Phases of Remediation

'No-one can look in to the ground', but the industry does do its best!

If you're only interested in remediating a site then go straight to Phase III – Remediation. Phases I and II are essential in discovering if you need to remediate your site, especially if you're going through planning then you'll need to have these boxes ticked.

Phase I – Historical Search and Site Walkover

It does what it says on the tin, thankfully. A report is put together detailing the former uses of the site in order to help predict potential environmental issues.

Historical maps are reviewed to look for former uses, geological and hydrogeological maps interpreted, and regulatory authorities contacted. The site should then be visually inspected for signs of issues (e.g. a leaking oil tank may raise concern, as may a sudden change in the colour of grass or patches of no plant growth), and if required the coal board may be approached for information on mining in the area. All this takes an experienced professional's touch, the site walkover should be carried out by a 'trained eye' to spot changes in vegetation growth and to interview neighbours to the site to ascertain local knowledge.

Phase II - Intrusive Site Survey

The good news is that an intrusive survey may already be in you plans for structural purposes. Environmental surveys can and often are carried out concurrently with geotechnical surveys, taking samples for both surveys from the same bore holes and trial pits.

The extent of a phase II survey is based on the information in the phase 1 report. For example former gasworks sites will generally require a more thorough investigation than a previously undeveloped site. The intrusive survey involves digging in to the soils on the site using at least one of the following methods:

- ✘ Trial pit - digging a pit with an excavator
- ✘ Hand pit - a trial pit dug by hand
- ✘ Borehole - drilling a hole into the ground,

All of the above come in different forms, drilling rigs themselves can range in size from rigs weighing less than 1 tonne in weight, to 10's of tonnes, depending upon predicted ground conditions, and the depth and type of sampling required.

From each intrusive location, soil and/or groundwater samples may be taken. The samples could then be analysed to determine the presence of contaminants. The results, which are known as the 'data set', are then entered into one, or several, computer modelling tools along with the location and type of local receptors, ground conditions, along with any other 'relevant' factors determined from phases 1 & 2. These modelling tools determine whether a site is contaminated, which areas of the site are contaminated, and can be used to produce 'target' levels to assist in the identification of the best available remediation technique.

A conceptual site model must then be produced in order to demonstrate the source(s), pathway(s) and receptor(s) which need to be considered.

► The Phases of Remediation continued

Phase III – Site Remediation

Assuming you have a contaminated site, then some form of action will be required in order for you to proceed with your development plans. You may be interested to know that remediation can be carried out before and/or during your development works. Several of the techniques below can be carried out without excavating the soils.

Armed with the phase 2 study you should then assess your options. Remedial options, which are discussed in more depth on the next page, are wide ranging and generally vary significantly in timeframe and cost implications. Commissioning a 'Remedial Options Appraisal' will give the full insight into the remediation methods which are suitable to your site, and costs and timeframes involved for each.

Once you have found the best solutions for you and your site, preparation works including gaining approval and licenses from the regulators needs to be carried out before setting a foot on site.

Phase IV – Verification

This phase simply closes the loop in that it allows for independent verification testing demonstrating that the remediation has achieved what it set out to do. It provides assurance to lenders, compliance to the regulators and confirms that what you have paid for has been achieved...!

► Treatment options

What are your options?

So what's the best method of soil remediation for your site and circumstances?

Well, that entirely depends on the specifics of the site, which is about the least helpful answer possible but let us explain this. The remediation methods which are most suitable for organic contaminants such as petrol, diesel or oil would not be effective for treating heavy metal contamination and vice versa. So what follows is a short list of the most commonly applied soil remediation techniques with a brief description including a few pros and cons of each:

'Cleaning' the soils has major advantages in terms of cost and disturbance.

Remediating soils on site will either enable soils to be reused on site, or disposed of at cheaper rates. It is also possible to remediate soils off-site for the same purposes. Some soil treatment centres can assist you in avoiding the expensive landfill tax rate thus making off-site disposal a contender for remediation. Some treatment centres may also offer to clean your soil and return it to you. It is worth noting that all soil treatments must be carried out under appropriate licenses.

Bioremediation

Pros:

- Cost effective, low price range
- In-situ and Ex-situ options

Cons:

- Can require use of space for long duration
- Can take from 2-24 months (and longer)

Bioremediation, or bio as we call it in the trade, is the process of using contaminant degrading microorganisms within the soil to break down the contaminant. It's just like composting your garden waste, just on a bigger scale. As with chemox, this remediation method is primarily for the treatment of organic contaminants such as oils and petroleum based fuels. The time required to achieve target concentrations can vary from weeks to years. Both in-situ and ex-situ treatments are possible, though ex-situ will deliver faster results. With sufficient space and time, bioremediation is often the most economical remedial solution.



Bioremediation in action, our purpose made covers keep the warmth in and allow us to control moisture in the soils.

Chemical Oxidation

Pros:

- Can take from weeks to months
- In-situ and Ex-situ options
- In-situ options can cause minimal/lower levels of site disturbance

Cons:

- Mid / High Price Range

Chemical oxidation, or chemox for short, is the application of chemicals in to soils which oxidise and breakdown contaminants within the soil. This is commonly used to treat organic contaminants and can be used either ex-situ where soils are excavated prior to treatment, or in-situ where chemicals are injected into the ground. We've had great success using chemox to treat soils beneath residential houses while keeping the homeowner in their property.

► Treatment options continued

Stabilisation

Pros:

- Short timeframes
- Cost certainty

Cons:

- Mid / high price range
- Can be highly disruptive

Stabilisation (no shortened name for this fellow) is a process where contaminants are bound up in the soil by mixing through binding agent(s) such as lime, PFA and/or cement. This process is most commonly used for inorganic contaminants such as heavy metals but can also be used to treat organic contamination. The product of stabilisation is a material in which the contaminants are chemically bound, are much less permeable and have an improved structural capacity. Improved structural capacity may be part of your geotechnical site development, something which should be factored in at the appraisal stage. Both in-situ and ex-situ methods of stabilisation are possible.

Every stabilization project firstly requires laboratory tests to determine the correct binding agent and ratio required. Beware of people who don't do analysis, but try selling magic pixie dust proposing to be the one for your needs.



Soil washing

Pros:

- Can be highly efficient

Cons:

- Requires large soil volumes to be cost effective

Soil Washing is probably the simplest to explain of all of the concepts for the treatment of soils outlined in this guide. It is exactly what it sounds like. Soils are passed through a specialist washing plant which washes out the 'fine' contaminated particles, leaving a 'clean' granular soil that can be re-used on site. As with all of the treatment options, the soil and contaminant must be suitable for the application, in this case the soils must be predominantly of a granular nature in the first instance. It is only economically viable to use this option on large volumes of suitable material. You also need space to stockpile and dry treated soils and allow for the disposal or secondary treatment of the fines.

Thermal Desorption

Pros:

- Highly efficient
- Recovered contaminant can have value.

Cons:

- Requires large soil volumes to be cost effective
- Only suitable for organic contaminants.

Thermal desorption is an ex-situ process where organic contaminants are removed by heating the soils. Contaminants are effectively boiled off into a vapour capture system where it can be possible to re-use them as a resource. This method of treatment is only suitable for organic contaminants and due to the high set up costs only considerable volumes of soil make this technique viable.

► Non-treatment options

Excavation and removal

- Pros:**
- Quick
 - Highly Effective

- Cons:**
- High Price Range
 - Highly disruptive

Excavation and removal of contaminated soils is a tried and tested technique, it is in general a very effective method, and is almost certainly the quickest way of achieving your environmental targets. It's not all good news though, as due to government efforts to divert waste from landfill with annual Landfill Tax increases, combined with increasing transport costs, this method has become very expensive. It may be possible to use a soil treatment centre to avoid landfill tax.

There will also be the added cost of backfilling to consider.

A recent excavation & removal job of ours, treatment was not a practical option.



A recent excavation & removal job of ours, treatment was not a practical option.

Engineered Solutions

- Pros:**
- Can be relatively cheap

- Cons:**
- Does not treat the contamination so your problem won't go away

Engineered solutions are employed to remove the pathway from the source to the receptor. These can come in many different forms from a 'capping layer' which is essentially a barrier of clean soil lain across contaminated soils, or insertion of a gas proof membrane beneath houses which are at risk from ground gas.



Engineered capping layer prior to development of a residential housing estate.

► The next step

In order to take the most effective and efficient through this process we recommend finding a good environmental consultant for the phase I and phase II stages of the work, and a good remediation contractor for the remediation phase. A small 'grey area' exists for the remedial options appraisal part of the work, experienced remediation contractors are best placed to do them, however some experienced environmental consultants also provide the service.

How to pick a good contractor/consultant

'Buy cheap buy twice' isn't exactly right, but we think you should bare it in mind, often companies who charge less offer you less, and in these circumstances this can end up costing you more in the long run. There are plenty of remediation tenders out there which don't provide enough information to put together a robust price, or a well scoped options appraisal. We've visited sites under direction of site owners for further investigative works to find the final pieces of the jigsaw, resulting in extra costs, simply because the phase II was insufficient for purpose and ultimately costing more than a comprehensive phase II would have.

When comparing prices ideally consider the following-

- ✘ **Phase I** (Desk study)- Resources being checked, as discussed above, maps, aerial photos etc... Will they visit the site? (Industry gossip purports some companies are using Google earth and street view rather than visiting the site...!) The more extensive the works carried out at this stage, the more accurately a phase II can be priced.
- ✘ **Phase II** (Intrusive Investigation) - Compare the number sample locations, the number of samples being analysed, justification for the numbers. British Standards denote a minimum frequency of locations and samples, but bare in mind that in doing the minimum you may not get enough information for remedial works to be priced, that will mean you either need more investigation at a later stage, or the risk will be priced on to the remediation contract (depending upon contract terms of course).
- ✘ **Phase III** (Remediation)- References & case studies can be really helpful to inform your decision and are often available on companies web-sites. If you like to talk, phoning, or ideally meeting the contractors on-site will help both parties understand the site and objectives of the work.

We hope the above has been of some use to you. We're going to be putting together further white papers so if you're not already on our mailing list and want to receive them our contact details are:

Contacts us

If you can't find what you're looking for, or if you want further information on what we have covered, get in contact with us.

- ✘ Phone us on **0131 538 8456**,
- ✘ e-mail us **info@soilutions.co.uk**
- ✘ browse our web-site at **www.soilutions.co.uk**; and / or
- ✘ read our blog at **blog.soilutions.co.uk**
- ✘ Should you like this and want to learn more then please sign up **here** and we'll send out more info on a regular basis for you to read at your leisure...!