Inspiration!

REUSING WATER SECTOR RESIDUALS

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You can still do so many great things with the residuals and resources recovered from the water sector. In this booklet we present all of the applications that are already now possible. We think it is important that the residuals be used as sustainably as possible or even in a completely circular manner. The ideal for us is to see the drinking water companies and Water Authorities reuse their own or each other's residuals. Whenever this is not (yet) feasible, we look for applications outside of the water chain that are as sustainable as possible.

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Softening with own calcite

Calcite pellets are formed in the drinking water softening process. These calcite pellets have Cradle to Cradle® Gold certification. The Calcite Factory in Amsterdam uses the sand-free calcite pellets to produce seeding material that can be reused in the softening process, thereby closing the loop. A wonderful circular application! Furthermore, the climate footprint of the calcite as seeding material is significantly better than that of dolomite from Italy, garnet sand from Australia and even river sand from the Netherlands.

Remineralisation with broken sand-free calcite pellets

Vitens uses its own calcite pellets at several sites in order to harden water. These pellets are used instead of a marble bed. Moreover, broken calcite pellets can also be used for the remineralisation of drinking water following membrane treatment, such as reverse osmosis (RO). RO removes all minerals, such as calcium, from the water, and these then need to be added again to it. Calcium is added by having the water flow over a lime filter. In 2016, the Evides water company carried out pilot tests aimed at remineralising the water at low temperatures using broken and unbroken sand-free calcite pellets. The results were positive.

Drinking water

Research phase

Slaked lime from calcite pellets

Drinking water companies use slaked lime to soften drinking water at some of their production sites. The lime they use comes from limestone quarries; a source that will become depleted in the long term. Calcite pellets generated in the softening of drinking water could potentially also be used for this purpose. The reuse of these pellets as slaked lime in the softening process would effectively close the loop. AquaMinerals is investigating the possibilities together with these slaked lime producers.

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Drinking water

Research phase

Arsenic removal with iron pellets from aquafer

The Dutch drinking water sector has undertaken to cut arsenic concentrations in drinking water from the initial objective of 10 µg per litre to 1 µg per litre. Among the ways this can be achieved is to use sustainable iron pellets made from aquafer. Following lab research, the pellets were applied in practice at Dunea and Brabant Water production sites. The pellets performed superbly: arsenic concentrations remained below the targeted standard. Follow-up research into the leaching of manganese and organic matter is currently underway (TKI project).

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Drinking water

Water Authorities

Research phase

Circular coagulant for the water sector

Drinking water companies and wastewater treatment processes use lots of iron salts as coagulants and flocculants. Working with Feralco and KWR, the drinking water companies are developing a coagulant made from aquafer that can be reused in the water sector (TKI project). In the first instance, this concerns coagulant from pure iron sludge from the groundwater abstraction, but there are prospects for creating a complete chain. The coagulant from groundwater sludge can be used for the coagulation of surface water. From the resulting coagulation sludge, one could again make a coagulant for application in a WWTP.

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Photo: KWR

Adsorption pellets from aquafer

Aquafer, or ferric (hydr)oxide, is an excellent binding agent for phosphorus, sulphur and various heavy metals, such as arsenic. It is no surprise that aquafer has been used for decades in bio-digesters and WWTPs as a phosphorus- and sulphur-binding agent. There are also several commercial iron adsorption pellets available on the market. Together with KWR and Agravis, we are working on a similar iron pellet from aquafer for use in the removal of sulphur from (bio)gas, phosphorus from surface water and arsenic from groundwater (TKI project).

Water Authorities

WWTP odour control with aquafer

Wastewater treatment processes use large amounts of iron salts to prevent the formation of foul-smelling hydrogen sulphide gas (H_2S). Rather than using iron salts, a number of WWTPs are using aquafer. The advantage of aquafer is that less corrosive chlorine gets into the installations and the environment, and the plant's CO_2 footprint is also significantly reduced.

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Photo: swimming pool association Zwemlust

Algal control with ferrous sand

Blue-green algal blooms can be seen in many ponds, lakes and ditches in the summer. The algae can grow exponentially if the water contains enough phosphorus and the weather is warm. Blue-green algae can cause health problems and are therefore not desirable in bathing water. 'Zwemlust Nieuwersluis' – 'the most attractive natural bathing pool in the Netherlands' – removes the phosphorus in its pool using ferrous sand. Similarly, ferrous sand is applied in the ditches around De Blaricummermeent, a new residential area in Blaricum. The ferrous sand binds the phosphorus in a kind of filter, making it unavailable to the algae. To make this application fully circular, a technique still needs to be developed to recover the phosphorus and to regenerate the sand.

Water Authorities

Research phase

Powdered carbon reuse

Together with the Dunea drinking water company and the Aa and Maas Water Authority, AquaMinerals is participating in a KWR project on the reuse of powdered carbon. The production of drinking water involves the use of activated carbon to remove undesirable particles, in a process which generates carbon sludge. The project's aim is to use the carbon sludge to remove pharmaceutical residues in the wastewater treatment process: thus, a reuse within the water chain.

The research focuses on the remaining adsorption capacity, the leaching of undesirable substances into the effluent, as well as the business case. If the outcome is successful, the carbon sludge could replace a portion of the powdered activated carbon commonly used in wastewater treatment. This would save many CO_2 emissions. This would constitute a win-win application for drinking water companies and Water Authorities.

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Ceramic with aquafer glazing

Terrazzo is Italian for terrace. The floors are made of mineral materials; small stones, marble pellets or pellets made from other materials, are bound by cement, dried and then polished. This flooring technique is hundreds of years old but remains very popular today. It is used in both indoor and outdoor floors, but also for wall cladding.
In the Groningen Water Company's 'industrial building of the future', Castellanos installed a terrazzo floor containing the water company's own calcite pellets. Thanks to its impact- and scratch-resistance, this kind of floor is an excellent choice for the distribution centre.

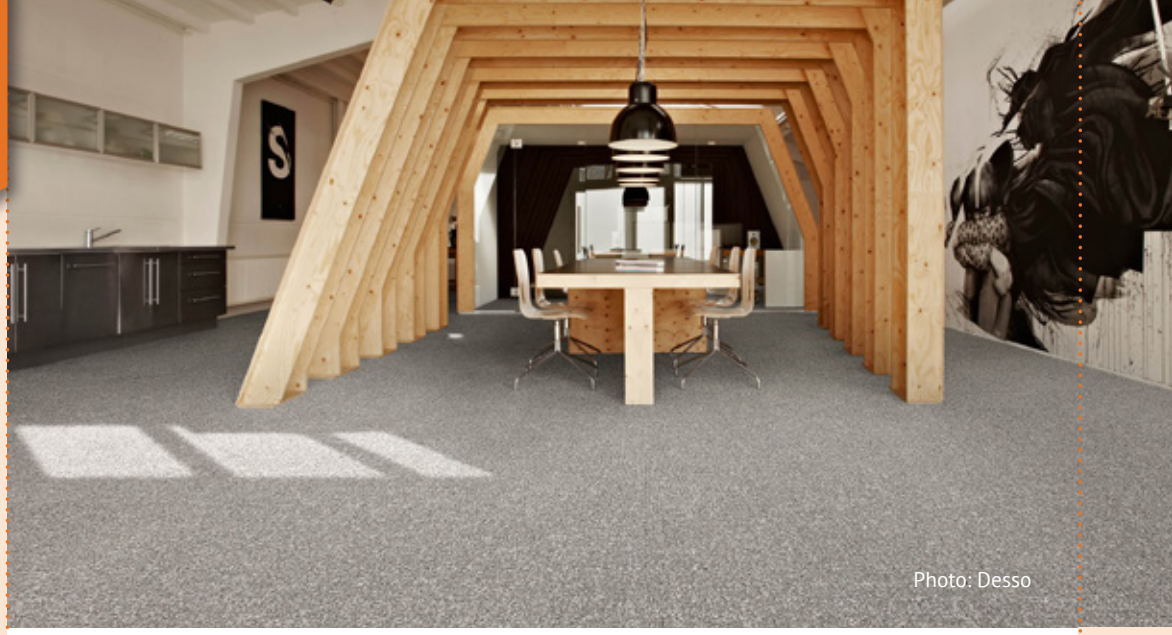

Photo: Desso

Cradle-to-cradle carpet with sand-free calcite pellets

Carpet manufacturer Desso uses ground sand-free calcite pellets in its EcoBase carpet tiles. The calcite pellets from the drinking water companies have Cradle to Cradle® Gold certification, and Desso's carpet backing has Cradle to Cradle® Silver certification. Desso can recycle 100% of the carpets in its own production process. Only sand-free calcite pellets are suitable for use in Desso's carpet tiles, since the presence of sand would quickly cause the carpet cutters to become blunt.

DESSO
The Floor is Yours

Building and equipment

Diamond glass with sand-free calcite pellets

Saint-Gobain produces unique colourless glass that generates a high transmission of light. This extra clear 'SSG DIAMANT' glass is considerably less green than normal window glass. The production of this glass requires very pure lime; the white, 100% calcite pellets from the Limburg Water Distribution Company (WML) are perfectly suited for this purpose. This luxury glass with calcite pellets is used in high-profile projects all over the world.

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Applications with ground sand-free calcite pellets

The number of applications for ground limestone is virtually endless. Ground calcite pellets can be supplied to all kinds of – and sometimes new – markets. Take, for instance, cattle fodder, fertilisers, plastics (PVC), coatings, paints, gluing and abrasive agents, gas treatment, glass production, carpet backings, cement-binding agents, drilling fluids and ceramic products. All of these products are also used in the water sector, and therefore present ample new circular application opportunities.

Container glass with calcite pellets

The basic components of glass are sand, soda and lime. Ardagh's glass factory in Dongen uses large volumes of calcite pellets in producing its container glass, such as Coca-Cola bottles and HAK jars. One important precondition is that the calcite pellets have to be delivered dry. This is why Van Lijssel Transport built an innovative truck, in which the calcite pellets are dried en route using the exhaust heat from the vehicle's engine.

Water Authorities

Environmental technology

Sulphur-binding in digesters with aquafer

Gas can be produced from biomass by means of digestion. This process sometimes releases the foul-smelling and toxic hydrogen sulphide gas (H_2S). The problem can be prevented by binding the sulphur with aquafer (iron sludge). This is done in two-thirds of the co-digesters in the Netherlands.

One great advantage of aquafer compared to ferric chloride, which is also used, is that it is not corrosive to the installation. Moreover, household-waste digesters, KGW digesters, sludge digesters and biodigesters in Germany, Belgium and France also use aquafer from the Dutch drinking water companies. The digestate, which is the product that remains after the digestion, is often used in land applications. In this way, the iron is reincorporated into the natural resource loop.

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Miscellaneous

Research phase

Cellulose from screenings

Wastewater of course contains lots of toilet paper. With new techniques it is possible to screen the paper out of the water. These extracted materials are known as 'screenings'. About half of the screenings consist of cellulose fibres, a material with a number of interesting properties and a variety of applications. For example, as a raw material in panelling, paper and cardboard, bioplastics, insulation material, activated carbon or as an asphalt spill container. The Water Authorities are working on the development of these applications within the framework of the Energy and Resources Factory (EFGF).

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ENERGIE EN Grondstoffen FABRIEK

Manure processing with coagulant from aquafer

Coagulant is used in manure processing to separate the thick and thin manure fractions. Ferrous chloride is usually used as the coagulant, but it can also be done with aquafer which is acidified onsite. This method was applied for the first time at the manure processing company, Mestverwerking de Kempen, in a collaboration with Feralco. The use of aquafer delivers a big environmental benefit, especially if a recycled acid is also used.

Agriculture

Environmental technology

Phosphorus control in flower bulb fields with ferrous sand

Phosphorus is used as a fertiliser in flower bulb cultivation. Some of this phosphorus discharges into surface water via the drainage systems, leading to eutrophication and the formation of blue-green algae. By using ferrous sand rather than ordinary sand around the drainage pipes, at least 90% of the phosphorus can be trapped. This diminishes the negative impact on surface water. The concept was researched as early as 2010 at Wageningen University & Research (WUR), and in 2018 it was applied for the first time in the field.

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Photo: KWR

Nature development with iron-lime sludge

As a result of years of crop fertilisation, former agricultural lands contain lots of phosphorus. This is an obstacle to biodiversity. In response, nature development measures often involve excavating such phosphorus-rich soil. But this approach is not only costly, it is also not always possible because of cultural-historical or archaeological considerations, or due to its negative impact on water management. The addition of iron sludge or iron-lime sludge can offer an alternative for some soils. The iron binds the phosphorus, which makes it unavailable to plants. Field trials have been successfully conducted with KWR, WUR, nature managers and drinking water companies.

Phosphorus fertiliser from struvite

Phosphorus is recovered from treatment sludge or wastewater in the form of struvite (magnesium ammonium phosphate). Struvite can be directly used as a fertiliser, or as a raw material in artificial phosphorus fertilisers, and in various compound fertilisers.

ICL Fertilisers, among others, uses struvite in its plant in Amsterdam to replace part of the phosphorus it takes from phosphate ores. ICL's phosphorus fertilisers are sold all over the world.

Calcite pellets as slow-release fertiliser

Most lime fertilisers dissolve quickly in the soil. But some applications actually require a lime fertiliser that dissolves slowly. Calcite pellets are perfectly suited for this. ECOstyle has for years sold calcite pellets to consumers and landscaping companies. In 2018 the agricultural cooperative, Agrifirm, introduced calcite pellets to the market as a slow-release lime fertiliser for the agricultural sector.

Humic and fulvic acids as biostimulants

Humic and fulvic acids can be recovered from the brine produced by the regeneration of ion exchangers. These acids are excellent biostimulants, ensuring an efficient nutrient uptake by plants. This application is attracting growing interest as a means of producing more and safer food per surface area. Vitens has made a humic acid product, HumVi, at several of its sites since 2015.

Large-scale application of ferrous sand in aquaculture, ponds and aquaria

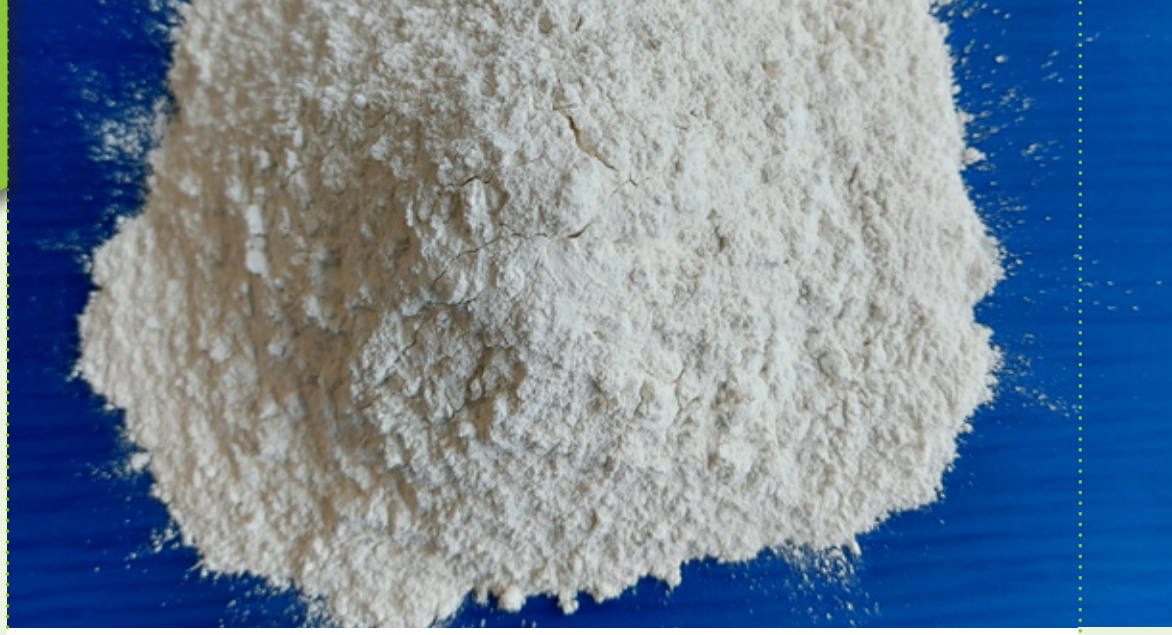
Green XL Pond Products and AquaMinerals signed an agreement for the delivery of ferrous sand (actually 'iron-coated sand') for application in aquaculture. The iron that coats the sand binds the phosphorus in the water, thus preventing the growth of algae and keeping the water nice and clear. But that is not all: the phosphorus becomes more available for the aquatic plants, which therefore grow faster and bigger. In a partnership with the aquatic plant nursery, Moerings Waterplanten, this product has been brought to the market and is sold, under the BIO KORREL label, at pond specialists and garden centres.

Lime sludge as fertiliser

Farmers in the vicinity of drinking water production sites have long used lime sludge from drinking water as a lime fertiliser. The sludge can be applied dust-free, and works as quickly as commonly available lime fertilisers.

Poultry feed with calcite pellets

Poultry farmers like to see strong egg shells and a good egg mass. This is why lime is an important ingredient in laying-bird feed. Following extensive tests with calcite pellets from Vitens, animal feed producer Agrifirm concluded that the pellets could suitably replace the small lime stones in its poultry feed. To guarantee the quality and safety of animal feed, the suppliers must obtain a GMP+ certificate for the product. Vitens is the first drinking water company to receive this GMP+ certification.



Very pure lime in cattle fodder

Since 2019 very pure and finely-ground calcite has been supplied for the production of cattle fodder. A number of drinking water companies have obtained GMP+ certification to this end. Together with companies dedicated to the grinding of products for the feed and the food industry ('feed' is for animals, 'food' for humans), the possibility of using calcite in food products is also being investigated.

Building and equipment

Ceramics with aquafer glazing

The Lithuanian designer Agne Kucerenkaite uses aquafer in her glass and ceramic work. Her beautiful collection of glazed porcelain won the 'Good Design Award' in her native country, and was exhibited at the Dutch Design Week 2016. The designer recently expanded her collection with ceramic tiles. Each tile is handmade and unique, and the composition works with light and colours to produce a most attractive effect.

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Bricks with coagulation sludge

Clay is the principal ingredient in bricks. Depending on the formula, bricks can be made in all sorts of colours. One substance that affects a brick's colour is iron: it makes it red. Brick manufacturer Wienerberger uses iron-rich coagulation sludge from surface water abstraction processes to produce street bricks. The iron sludge serves not only as a colouring for the bricks, but also as a filler instead of clay.

Concrete with calcite pellets

The concrete industry is using more and more waste and recycled material in its products. Two producers use calcite pellets in their concrete to replace some of the sand. Struyk Verwo Infra uses the calcite pellets as an additive in concrete paving products, such as concrete street bricks and tiles. Heembeton (De Ruw Bouw Groep) uses calcite pellets in structural concrete, such as façades, walls and top elements.

Photo: Schot groep

Soil sealer from calcite pellets

Many crawl-spaces are affected by subsidence and humidity. De Schotgroep has for many years used calcite pellets to tackle these problems. The pellets are well suited for this, because they don't absorb moisture, have no capillary effect (i.e., do not draw water from below), and also provide insulation. Moreover, because of the pellets' high pH level, both mould and odour nuisance are significantly reduced.

Composite with calcite pellets

Ceramic products, such toilet bowls, washbasins and bathtubs contain all kinds of fillers. Calcite pellets are perfectly suited for this, because their round shape improves the flow behaviour. This is why many clients incorporate calcite pellets into their filler mixes for ceramic products.

Coloured lime pellets for aquaria and terraria

Creative owners like to add a little colour to the bottom of their aquaria. Traditionally, dyed sand or gravel has been used, but calcite pellets can also be beautifully coloured. VDL Siergrind has long had decorative gravel made from calcite pellets in its product assortment – in all colours of the rainbow.

ECOstyle lime

ECOstyle markets calcite pellets – enriched with microorganisms – as a soil improvement product under the well-known 'AZ-Kalk' brand. Gardening enthusiasts use the calcite pellets to neutralise soil acidity. The advantage for the user is the product's easy, dust-free and year-round use. Landscaping companies also use this AZ lime.

Photo: Naïf

Naïf circular face scrub with calcite

The cosmetics industry still uses lots of microplastics, which are hazardous for the environment and notably for drinking water. This can be changed! In 2018, a collaboration with the Naïf cosmetics company resulted in the development of a face scrub with ground calcite. This application confirms the calcite's high quality, since the requirements of the cosmetics industry are after all particularly strict. The face scrub is a product of a collaboration between AquaMinerals, Naïf, Waternet and The Calcite Factory.


Photo: Mosa

Mosa tiles

Mosa uses calcite from drinking water companies in its wall tiles. Calcite is the chemical reference ($CaCO_3$) for the lime that is generated in the drinking water softening process. This calcite is used instead of non-renewable quarry lime. 99% of Mosa's tile collection has Cradle to Cradle® Silver certification. The lime pellets supplied have Cradle to Cradle® Gold certification.

Struvite for improved industrial treatment processes

Opure and AquaMinerals have jointly developed a new application for struvite. Heavily-loaded industrial wastewater can contain too few nutrients. This results in a diminished treatment process performance. Struvite (recovered phosphorus and magnesium) can provide these nutrients and thus be used as a replacement of primary raw materials, which are typically used to correct the problem. The Vallei and Veluwe Water Authority will make the first struvite from the Apeldoorn WWTP available. The Water Authority played a key role in initiating the partnership with Opure.

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CO_2 for greenhouse horticulture

Carbon dioxide is captured at the Delfland Water Authority. The CO_2 is released during the process of upgrading biogas to green gas. Currently the CO_2 is sent to greenhouse horticulturalists where it replaces fossil CO_2. In the coming years a larger volume of CO_2 is expected from the Water Authorities. Additional higher-value disposal possibilities will be explored with the market players involved.

Water Authorities

Research phase

Powdered carbon woody biomass

AquaMinerals is working in a partnership on a new raw material for the production of activated carbon. The material is the woody biomass from the timber and cuttings from water companies. It is expected that this material can be used to make quality powdered carbon, suitable for the removal of pharmaceutical residues in wastewater treatment processes. This would be a good substitute for the commonly used types of powdered carbon of fossil origin.

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The examples in this booklet were developed by AquaMinerals with many of its partners, including the drinking water companies, Water Authorities, research institutes and market players, who could not always be mentioned.

For further attractive examples from the wastewater chain, we gladly refer you to the Energy and Resources Factory website: **www.efgf.nl**.

More information

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