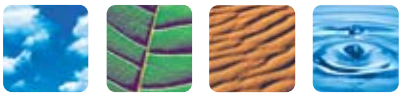
VIROTEC Global Solutions



VIROTEC GLOBAL SOLUTIONS

SUSTAINABILITY FRAMEWORK

VIROTEC'S SUSTAINABILITY FRAMEWORK

As a result of developing and commercially applying environmental remediation and waste treatment technologies, the question of Virotec's larger role in the context of business and community sustainability is relevant.

For the alumina industry in general and for the neutralisation and reuse of alumina refinery residue (ARR) in particular, the question of sustainability is particularly significant given the amount of ARR generated around the world and the potential for downstream, long-term environmental and social impacts. With annual production of 150 million tonnes of ARR each year, it has become imperative to find cooperative and sustainable ways to convert, reclassify and reuse this material, ways which not only lessen the liability to refineries but also create downstream benefit.

This sentiment has been echoed by Alcoa when they say "through recent long-term planning for residue storage, it has become increasingly apparent that community and government expectations are changing, and that further improvements to the way residue is managed into the future will need to change".

In this context, sustainability should mean more than merely acknowledging the oft-quoted "the needs of the present should be met without compromising the ability of future generations to meet their own needs", but should be expanded to mean the management of resources in ways that maintain a sustainable yield of resource services, that reclassification and reuse of waste is better than disposal and long-term storage, and that the minimum conditions for ecosystem resilience should be maintained through time.

Virotec believes the conversion of ARR into Virotec's Bauxsol Raw Material (BRM), and the amalgamation of BRM and other additives coupled with industry know-how and expertise to solve intractable industrial and environmental problems, as presented herein, are consistent with these sustainability conditions. Figure 1, shows the four main stakeholders involved in using ARR in combination with Virotec's technologies to create sustainable regional outcomes, namely: alumina refineries; government agencies; local or regional remediation sites or sources of waste; and Virotec as the technology and service provider.

These four fundamental stakeholders are connected by a variety of inputs and outputs to create the sustainability framework. For example, the alumina refinery provides ARR (a liability, upper left-hand box), but may also provide benefits in terms of technical and management expertise. Government agencies contribute a number of important aspects to regional sustainability, including granting regulatory approvals and licenses.

They may be the source of remediation funds, particularly when the government is also a "customer stakeholder" due to it being the responsible agency for cleaning up disused mine sites, for example, such as is the case for the U.S. EPA in the management of its 1,305 superfund sites.

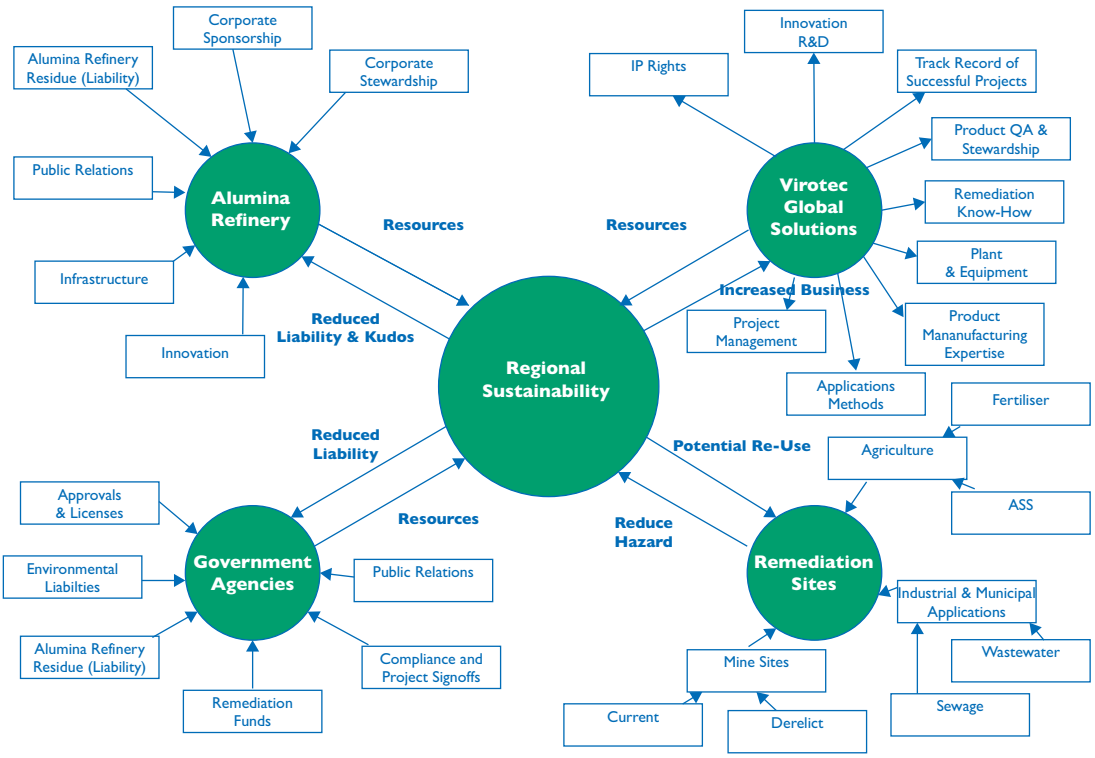


Figure 1: Regional sustainability framework for ARR conversion, reclassification and reuse, showing the four main stakeholders to sustainability, inputs to stakeholder's contributions, and the various flow-path benefits to stakeholders.

Other stakeholders include commercial and municipal generators of waste or environmental remediation project managers, whose inputs include not only the site to be remediated or wastes to be treated, but also the necessary funds for treatment applications.

Finally, Virotec provides the technology know-how, products, project management, and chemical reagents for remediating sites and treating waste. Together, these four fundamental stakeholder groups contribute to and participate in solving environmental and waste problems and also share in the benefits of contributing to regional sustainability.

Figure 2 goes on to highlight three other stakeholders who come into play once the above four stakeholders have been engaged. In fact, the regional sustainability framework is often driven by one or more of these so-called "secondary" stakeholders.

For example, it is fequently the general public who drives debate and change, and third-party consultants are often the intermediaries between the customer with an environmental or waste problem and the solution provider and government agency regulating the problem. Some of the main input and output (i.e., benefit) contributions to regional sustainability by each stakeholder are also summarised in Figure 2.

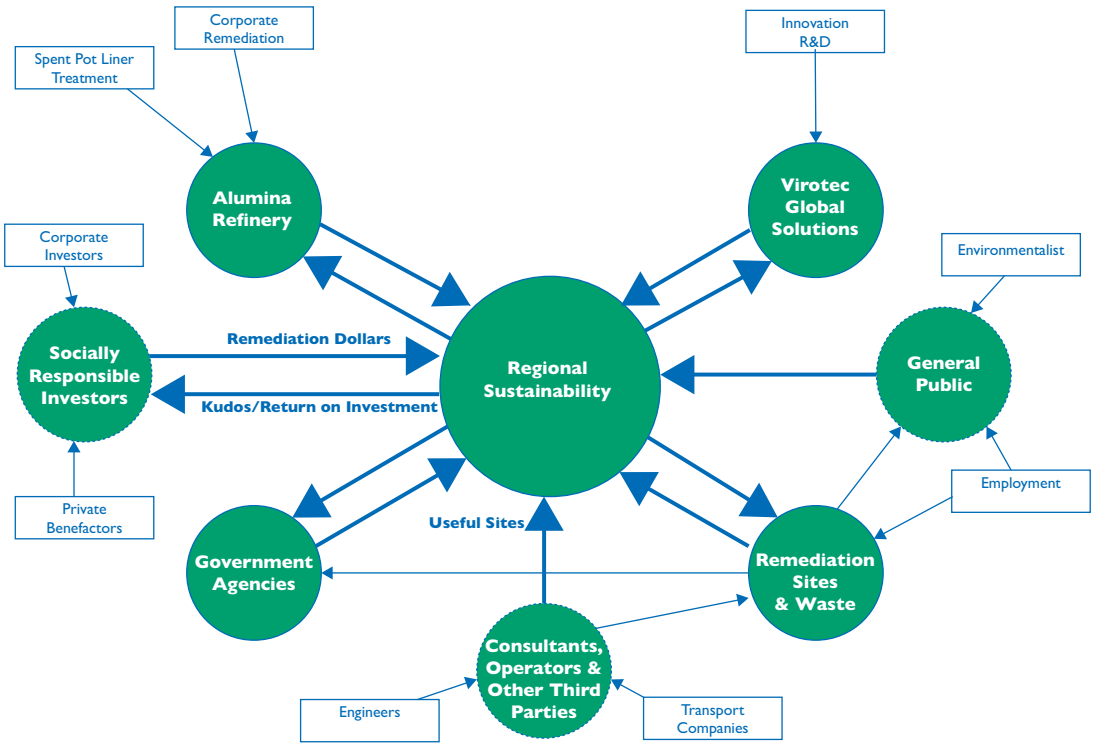


Figure 2: Regional sustainability framework for ARR reuse, showing the four main stakeholders to sustainability, introducing the inputs and benefits of socially responsible investors, third party stakeholders and the general public. Finally, Figure 3, presents examples of some of the sources of input waste into the regional sustainability framework; these are: sewage treatments plants (STP), which generate biosolids and municipal wastewater; agricultural and horticultural activities in the region; composting facilities, which compost household "curb-side" waste and green waste; mine sites, which generate a variety of liquid and solid waste streams; and general regional industries, which generate a variety of liquid and solid waste streams.

The diagram shows how the outputs from each of these sources can act as inputs to other waste generators, and shows how the flow of waste outputs can serve as raw material inputs to other processes. It should be noted that for this model to produce a sustainable future for a specific region, technology interventions are required to transform the waste of one activity into a viable raw material input for another activity, thereby continuing the value chain of waste to resource feasibility.

Of interest also is the observation that there are no "outputs" or waste streams entering the environment according to this sustainability model; the only outputs are those which must go to landfill, and these have been treated in a way that makes their long-term impact on the region negligible.

By utilising Virotec's technologies to first convert hazardous ARR into a viable, "inert" raw material and then treat the waste generated from municipal sewage treatment plants, mine sites and industrial facilities, for example, low level waste can be transformed into a resource of value to another industry, thereby minimising the volume of waste re-entering the environment, the supply chain or the food chain. Such a model provides a vision of sustainable reuse of ARR when used in combination with know-how, chemical and biological additives and other forms of waste.

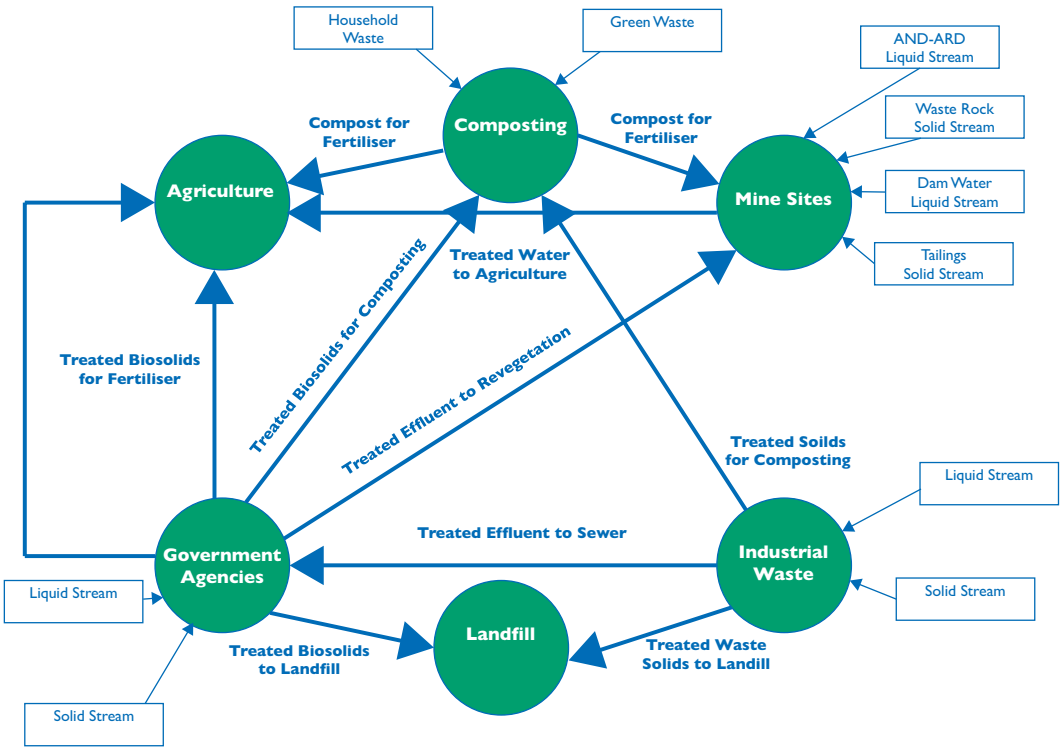


Figure 3: Regional sustainability framework showing six example waste streams and their interrelationships, including waste "inputs".

These frameworks demonstrate how a sustainable future can be created for not only the alumina industry but, through the conversion, reclassification and reuse of alumina refinery residue and the application Virotec's technologies to a range of industrial and municipal waste challenges, for the whole society. By treating one industry's waste, converting it into a reusable material, coupled with the application know-how and experience of Virotec, a wide variety of waste streams, many of them hithertofore intractable and unproductive, can be treated, and environmental and waste problems resolved.

Such a model pays a "sustainability dividend" to not only an organisation's shareholders and stakeholders, but also to the local community and wider society. The regional sustainability frameworks presented by Figures 1-3 are not simply a theoretical model of what might be possible when considering the conversion, reclassification and reuse of ARR, nor are they fanciful. They are a practical reality being driven by current regional stakeholders. Initiatives such as those documented by Gräffe, et al. demonstrate a commitment to finding sustainable solutions to intractable problems associated with the management and potential reuse of ARR.

This Sustainability Framework has drawn from data found in "Virotec: A Ten-Year Story of Success in Environmental Remediation" by Dr Lee Fergusson, published by Prana World Publishing, 2010. To better demonstrate this conclusion, the frameworks therefore also include a series of notes which cross-reference many elements of the Sustainability Framework to other sections of this, thereby demonstrating the holistic and practical nature of the Framework. These notes can be found in Appendix D of that publication.

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