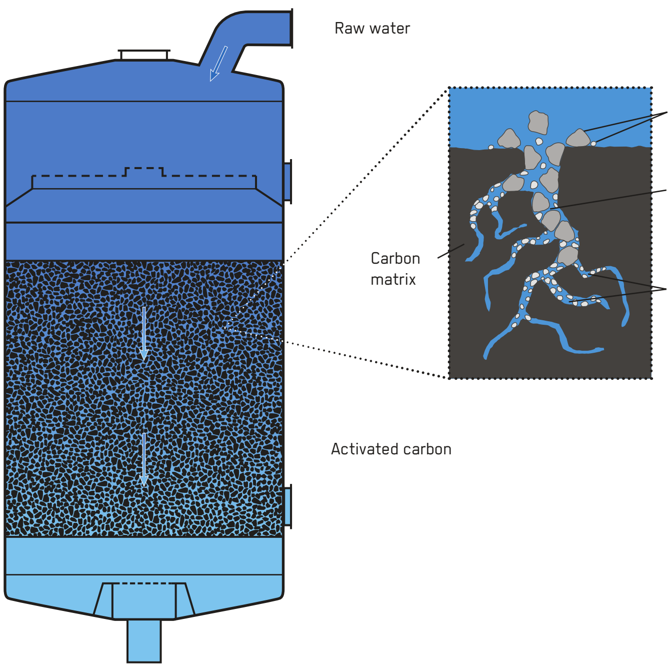
Granular Activated Carbon (GAC)

Response Phase	Application Level	Management Level	Objectives / Key Features
* Acute Response ** Stabilisation ** Recovery	** Household ** Neighbourhood ** City	* Household * Shared ** Public	Water quality improvement, taste and odour improvement, adsorption of chemicals
Local Availability	**Technical Complexity**	**Maturity Level**	
** Medium	** Medium	*** High	



Granular Activated Carbon (GAC) is the most used adsorption method in drinking water to remove taste, odour and colour-causing compounds, natural organic matter, disinfection by-products and synthetic organic chemicals present in the source water. GAC is also used for vapour treatment to remove noxious odours and contaminants. In small-scale treatment plants, it is often used for chlorine and chloramine removal. GAC can be used in all phases of an emergency.

GAC is a form of granular porous carbon that is packed into a manufactured vessel, and raw media is pushed through the vessel using a powered pump to maintain flow within the design parameters. The GAC matrix acts like a sponge to adsorb small and large organic molecules from the media (water or air) that is then discharged from the vessel ready for use. GAC is a widely applied and accepted technology that is applied based on the concentration of contaminants, the number of people to be served and the available space.

Design Considerations: The GAC technology is mature and easy to use but does require an analysis of the medium/media (water and/or air) to be filtered to ensure that it meets the applicable initial quality standards. The higher the concentration of contaminants in the raw media, the faster the GAC will be exhausted and require replacement. GAC typically cannot be regenerated at the treatment facility and therefore will require off-site disposal or regeneration on a regular basis. The size of the GAC vessel can become a limiting factor depending on available resources (time, money, storage). Design and operations can vary depending on the available materials, specifically the availability and purity of GAC.
To design any GAC system, a qualified expert, the manufacturer and/or media supplier should be consulted. The quality and flow of the raw medium input are critical to proper design of the filter and media. Raw media flow rate and pressure must also be coordinated with the design inlet and outlet pressure and flow of the manufactured GAC vessel. GAC can also be used to treat foul

air or fumes typically found in industrial processes or municipal wastewater treatment. It is important to note that aqueous-phase GAC treatment removes chemical contaminants but not biological contamination, so a pre-treatment process for biological contamination, such as Chlorination **(T.6)**, should be considered.

Materials: GAC media is consumable and must be periodically replaced to maintain effectiveness. The media manufacturer should be consulted to determine the contaminant breakthrough point. Designed vessels, connection fittings, and piping/hoses to reach the intake and distribution connections are required for vessel installation. Properly designed powered media pump(s) capable of maintaining the raw media pressure and flow through carbon vessel are required and need a steady source of power and fuel. Pressure gauges are required to measure pressure drop across the filter and monitor hydraulic performance. Sample taps should be installed both upstream and downstream of the GAC filter to ensure the media is meeting quality metrics.

Applicability: For either air or water treatment, GAC can be used in a variety of settings and can be scaled up or down depending on need, but in an emergency, it is best used to treat a large volume of water for many people at a time rather than for individual households. Nonetheless, if sufficient small-scale systems are available, they can be used in conjunction with larger systems. GAC can be used in all phases of an emergency when readily deployable. Physically, the technology does not require much more than a flat surface that can support the vessel and the weight of GAC. If all materials are readily available, installation can take 30 minutes or less.

Operation and Maintenance: O & M tasks include ensuring all connections are watertight. A crew of up to three people will be needed to install the system and prepare for operation. For aqueous-phase GAC treatment, the vessels need to be hydrated after installation to activate the carbon. Unused fresh/virgin GAC should be stored away from the media. Monitoring of the effluent is required to detect an exhausted adsorption capacity and replace the GAC. Vessels can be emptied to exchange the carbon, or the entire vessel can be replaced with a virgin pre-packed GAC. The vessel manufacturer should be consulted to determine a media replacement period based on the raw water input. The vessel should not be over-pressurised, and vessels should not be used outside of the design parameters. More specific O & M tasks should be determined with the manufacturer.

Health and Safety: Wet GAC confined in large vessels creates an oxygen demand that is hazardous to human health and potentially deadly, so safety precautions for an oxygen deficient environment should be taken. Chemical-resistant gloves and safety glasses must be worn when operating and using GAC vessels. GAC filters may develop a biofilm that can subsequently remove some of the organic contaminants to increase the biological stability of the water. However, this process does not provide residual protection from contamination, so post-treatment Chlorination would be required.

Costs: Costs are dependent on the volume of water to be treated. Recurring costs include the replacement costs of GAC material (not always locally available), vessels, piping and transportation.

Social and Environmental Considerations: No cultural issues and considerations, user preferences and acceptability or local capacity issues are noted. GAC can improve the aesthetic properties of water (taste, smell, appearance) and is therefore well accepted by users. Saturated GAC should be disposed of safely.

Strengths and Weaknesses:

(+) Provides good removal of taste, odour, chlorine and organic contaminants
(+) Requires little maintenance
(+) Adapts to many designs and target compounds
(+) Simple replacements of filter elements and carbon blocks

(−) Loses performance rapidly if treating source waters with high turbidity or background organics
(−) Poor removal of microbial contaminants in aqueous-phase treatment
(−) Can result in higher costs due to regular replacement of GAC

→ **References and further reading material for this technology can be found on page 219**