CERAMIC TILE TEAM

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IDENTIFY ALL AT RISK POPULATIONS: Manufacturers and Installers

PRODUCT CATAGORY	FIRECLAY - Recycled Clay	KOHLER - Ann Sacks	MOSA - Core Collection
Description	Over 80% of the recycled Clay Body is made from recycled content including post-consumer recycled porcelain/glass and pre-consumer recycled granite dust. In addition, we recycle our own tile and glaze. The clay body is made of raw materials sourced in the USA, and every tile is handcrafted at our Aromas, CA factory. Screen reader support enabled.	Uses landfill bound clay material from Kohler's toilet production. Glazes are made from reclaimed enamel powder and glaze overspray powders collected during the processing of toilets, etc.	Quartz combines robustness with an intricate, yet subtle ceramic surface made of grains and crystal-like particles. Suitable for application on walls, floors, façades and terraces. Their functionality and slip resistance make them perfect for high-traffic spaces, both inside and outside
Certification	HPD Filed, Leed elligible	I-13 LBC Red List Free; I-14 Responsible Sourcing: Not Applicable; I-10 Healthy Interior Performance: Not Applicable; Not LPC Certified	All products are Cradle-to-Cradle® Silver certified. Ghey do not release any hazardous substances during or after their long service life.
HUMAN HEALTH	***	***	***
	Silica (45-55%) - cancer hazards - category1A Aluminum Oxide (15-25%) - respiratory hazards, asthmagens (ARs) i Frits, Chemicals (5-15%) - multiple hazards Ferric Oxide (2-3%) - cancer hazards - carcinogen Group 3B - evidence of carcinogenic effects but not sufficient for classification	The primary pollutants are particulate matter (PM). Because this is a recycled material sourced from their standard ceramic lines; binders, plascticizers and lubricants may be present and can release VOCs during the manufacturing and firing process	During the firing process a very stable chemical crystal grid structure is formed. Tiles therefore are not considered as hazardous to health. However, during manufacturing activities like drilling, sawing and grinding of tiles dust is generated containing crystalline silica. Inhalation of this type of dust is hazardous to health and should be avoided.
INDOOR CLIMATE	VOC content data is not applicable for this product category - ceramic tiles do not give off VOC's	Low to no VOCs	VOC-free
ENVIRONMENT - ENERGY	Hand Cut Tiles; Involves Standard Ceramic Processes Of Batching, Wet Milling, Spray Drying, Heat Tunnel Drying, and Firing in a Kiln	Hand Cut Tiles; Involves Standard Ceramic Processes Of Batching, Wet Milling, Spray Drying, Heat Tunnel Drying, and Firing in a Kiln	We utilise renewable energy sources and local materials whenever possible, resulting in a favourable CO2 balance. Moreover, in 2007, Mosa switched over entirely to 'green power' generated by hydroelectric power stations.
ENVIRONMENT -	***	***	***
CARBON	Made from 80% recycled content (post-consumer recycled porcelain/glass and pre-consumer recycled granite dust. Self recycling as well. Materials sourced in USA, and every tile is handcrafted in California	Reclaimed Clay Tile Body: Semi-vitreous (absorbes 3-7% of water) ceramic body Glaze with up to 99.7% reclaimed content: ceramic glaze	Mosa uses unglazed porcelain tiles contain up to 45% recycled material, depending on product type
AFFORDABILITY	\$45.00/SF	\$39.95/SF - \$44.95/SF	TBD - Sent request
MAINTENANCE	Life Expectancy: Life of structure Recommended Tools: Non scratching sponge, mild dishwashing soap with water and a clean rag or mop OR any neutral pH tile cleaner Durability: Class A fire rating	Life Expectancy: Life of structure; re-grouting may be necessary in high traffic areas Easy to maintain and durable.	Life Expectancy: Inert and non-degradable Recommended Tools: Floor tiles that in time get a dirty and patchy appearance can be restored to their original state by means of a deep cleaning
DISASSEMBLY/		$\star\star\star\star\star$	
RECYCLING	Salvageable/Reusable in its entirety by manufacturer for self recycling 100% Landfill	Salvageable/Reusable in its entirety 100% Landfill	Salvageable/Reusable: Contain natural raw materials and can be recycled. Wall tiles 22%- 25% of recycled materials, and floor tiles 21%- 45%. 100% Landfill

We began by looking at the different categories of Ceramic Tiles which consist of Glazed Porcelain Tiles (usually made from refined clays and glazed), Mosaic Tiles (usually of porcelain with color), Quarry Tiles (typically unglazed and made from common clays and shale), and Pavers (similar to quarry tiles but thicker and used in heavy wear areas, needs resealing once or twice a year). Tiles can then be Glazed or left unglazed. Glazed tiles are nearly impervious to water and thus more resistant to mold, but the grout needs to be resealed as cracks form. Unglazed tiles require a sealant to keep clean and stain free. There are sealants of different particle sizes which include penetrating sealants that soak into the tile itself and surface sealants that lay a thin coating on top of the ceramic and alter its appearance. One example of this tile sealer has a hazard statement saying it may cause eye damage, skin irritation, and damage fertility or an unborn child.

Next we looked to common manufacturing processes associated with both industrial and handmade tile making. It is important to note, before we arrive into the matrix with specific products, many of the health hazards, particulate and chemical exposure concerns, and most importantly the individuals exposed to them, arise from the making process, and not necessarily post-installation.

The first step in the manufacturing process is Batching which is combining all the raw materials for the desired product together. Common hazards are higher levels of particulate matter exposure, nitrogen oxides, carbon monoxide, CO2, and VOCs. Next Mixing and grinding which is generally a wet process with fewer hazards, however the use of binders, plasticizers, and lubricants may have VOC emissions. Spray Drying then takes place which vaporizes and heats the slurry creating a powder, with the risk of particulate matter and combustibles exposure. The next step forms the tiles, by dry Pressing. Extrusion and punching is often used in wet forming processes as well, with few emissions from this step. Once the tile is formed the Drying process can last several days. Water is removed at a slow rate to reduce shrinkage and cracking. Tunnels or Continuous Dryers heat the tiles using oil, gas, infrared lamps, or microwave energy. Few hazards exist during this step as well. Once dried the tiles can be Glazed if desired. Glazes are made out of silica, feldspar, and other glass-like materials. There is a high chance of PM exposure associated with both the glaze preparation and application. Lastly, once glazed the tiles have to be heated intensely to strengthen it and give it the desired porosity. Different Kilns are used for this process.

The installation process depends on what kind of subfloor you will be installing the tile on. A Wood Subfloor needs a thin set mortar underneath a Membrane/Underlayment. Then another layer of thin set mortar underneath the tiles. Grout is then used between the tile joints to hold the tiles in place. For cement floors a similar process is used without the need for a backerboard to provide a rigid

We found several hazards with this process and these accessory materials, again mostly affecting the installers. Looking at the Mortar and Adhesives used, we found three products that are taking steps towards being a healthier material. The first two are more akin to your standard mortar product but opting to not use additives and mildewcide. Though varying in chemical make up they have similar hazards with the more impactful being carcinogens and organ toxicity mostly due to the dust. Both of these products are prone to cracking because of their lack of additives. From our research, we recommend a water based, non-toxic, and low-odor adhesive over the other two. This product is not without its issues, It does release small amounts of VOCs as well as being toxic to aquatic life, but it doesn't contain any carcinogens

We looked at three different products for the Membrane/Underlayment section as well. The Wonder Board is more typical of standard use cement backer boards and has similar issues as the Mortar with possibly causing cancer and issues arising from the exposure of dust. The High Density Polyethylene DITRA product might have a less detrimental impact on the installer but doesn't break down and is thus an issue to the Environment. And the PEVA Kerdi- Board has issues with dust creation during the sawing of the board as well as an issue with if it were to catch fire it creates black smoke and acid gas.

The final accessory product is Grout all of which have similar hazards around dust and possibly cancer causing issues. We chose Polyblend Grout for its indoor climate rating with its exclusion of Mildewcides and Antimicrobials

We looked at products from Crossville, Fireclay, Mosa, and Kohler which are using recycled materials, carbon emission offsetting, lead-free ingredients, and have HPD, Declare, and Cradle to Cradle registered products. Fire Clay tile has 80% of the recycled Clay Body made from recycled content and is HPD Filed and LEED eligible. KOHLER - Ann Sacks uses landfill bound clay material, and glazes are made from reclaimed enamel powder. The product is LBC Red List Free. The MOSA - Core Collection also contains recycled materials and isCradle-to-Cradle® Silver certified and HPD filed for floor tile.

In terms of a human health factor the Fire Clay tile has hazards listed as cancer and respiratory hazards from materials such as Silica (45-55%) and Aluminum Oxide (15-25%). The KOHLER tile's primary pollutants are particulate matter (PM) binders, plasticizers and lubricants may be present and can release VOCs during the manufacturing and firing process. MOSA didn't specify but we believe there is still the potential of releasing particulate matters during manufacturing. All claim their product is VOC free.

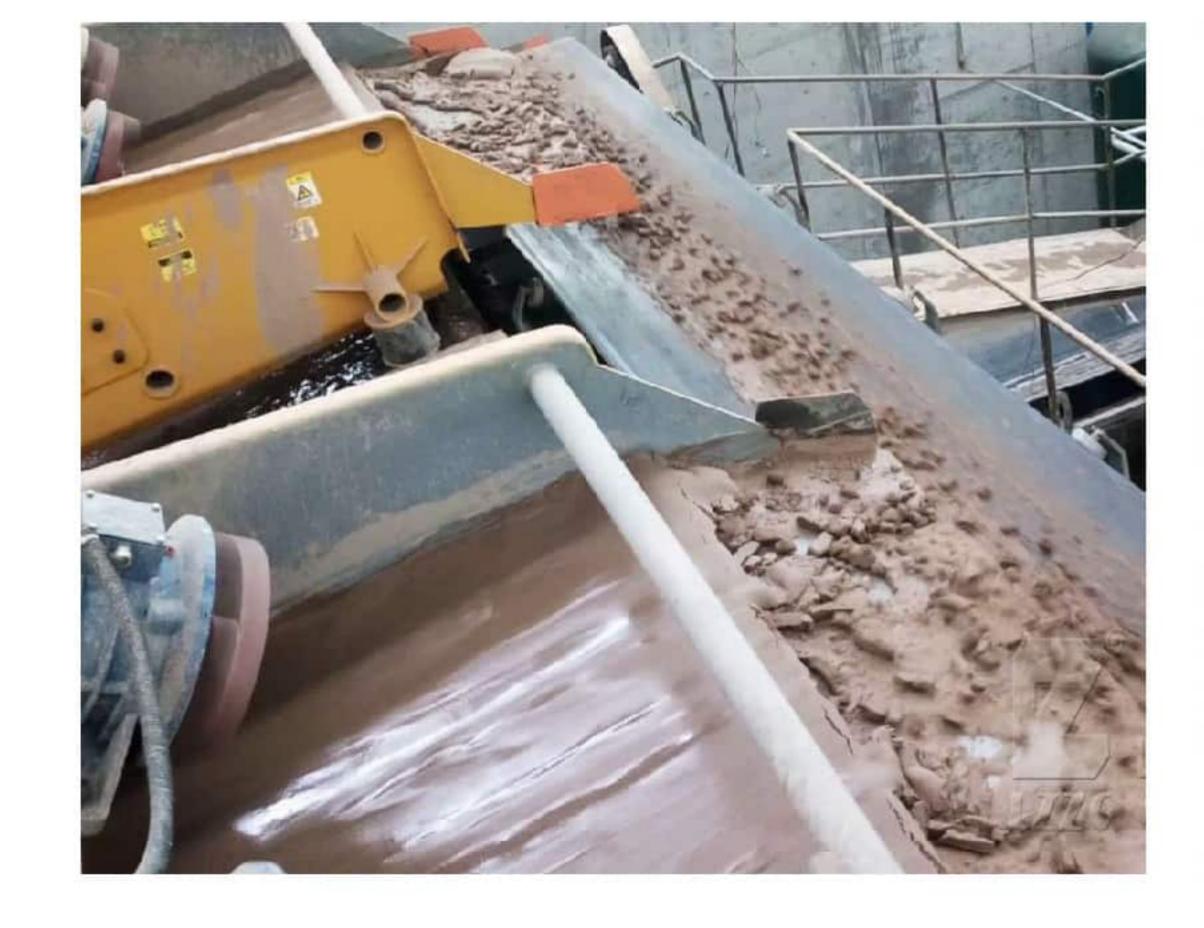
Despite a range of hand-cut tiles and more industrial factory made tiles, the processes of making are similar. Across the boards all three tiles utilize local and recycled materials. However, MOSA also utilizes renewable energy sources. In 2007 they switched to entirely green hydroelectric power.

All three manufacturers and tiles were made from recycled and reclaimed content. MOSA is on the lower end with tiles up to 45% recycled material. Fire Clay is a local manufacturer (california) which uses up to 80% recycled content, including pre-consumer and post-consumer recycled parts, and also does self recycling within their factory. Kohler takes it a step further using glaze with up to a 99.7% reclaimed content.

The average ceramic tile price ranges within 3-35/SF. In this case, our options are certainly not cheap. Fireclay coming in at \$45/SF, and Kohler ranging from \$40-45/SF. The MOSA catalogue did not reveal prices, nor did they respond to our email request regarding price. Ceramics tiles are inherently durable and each of these products have a life expectancy of the building they're installed in. Regrouting and replacing of broken tiles may be necessary. Soap or neutral tile cleaner can be used to clean

Finding a place to recycle ceramic tiles can be difficult but if found, ceramics, most commonly recycled toilets, are broken up and used in road aggregates, drainage materials and similar uses. All the tiles we chose are salvageable or reusable in their entirety and Fireclay has a program where they self recycle their products as well as others. This process requires crushing the tiles into powder and adding it to the raw materials in the beginning of the manufacturing process In Summary, all the materials we compared came close to being our pick and that's probably a result of us selecting products with recycled materials and similar processes. In the end the Kohler tile won out for its use of landfill bound clays and reclaimed enamels. In reality these all three of these products are likely too expensive for most projects and certainly for affordable housing projects, but the main hazards in the manufacturing and installation process remain. Moving forward we would recommend a specification requiring certain PPE requirements and ensuring proper cleaning, airing out of the space, and recycling of old or broken tiles.

Manufacturing Process - Steps and Hazards



1. **Batching** - For many ceramic tiles, body composition is determined by the amount and type of raw materials, taking into consideration both physical and chemical compositions of the raw material

Hazards - particulate matter, combustible NOs, CO, CO2, and other VOC's



2. Mixing and Grinding - Mixed raw materials will then be weighed and transferred into a mixer. Commonly wet milling is needed to improve the mixing of the batch

Hazards - generally a wet process, however VOC emissions may arise from the volatilization of binders, plasticizers, and lubricants



3. Spray Drying - Process of removing excess water. This is done by pumping the slurry into an atomizer, turning the mix into a powder which is ideal for forming.

Hazards - particulate matter and other combustibles

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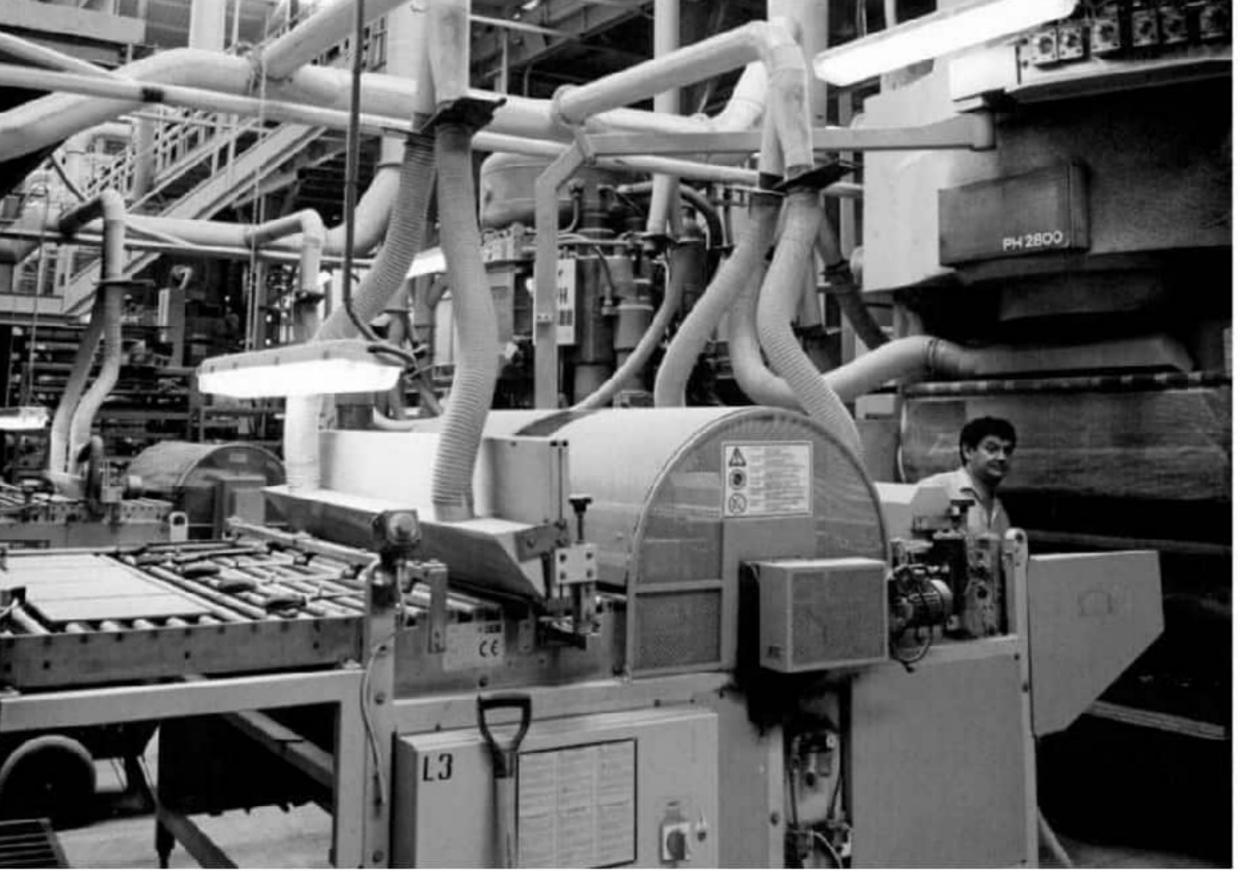
4. Forming - Most common method is dry pressing. Material is compressed, where steel plungers apply pressures of up to 2,500 tons of the powder

Hazards - generally performed in sealed containers and is a wet process, so emissions from this step are likely to be negligible. However, for dry forming PM is likely to be emitted from grinding, punching, and other machining activities.



5. **Drying** - After forming, ceramic tiles need to be dried in an environment with high humidity. If the ceramic tiles were made with the wet method, humidity levels would need to be higher. This process of creating ceramic tiles can take several

Hazards - negligible



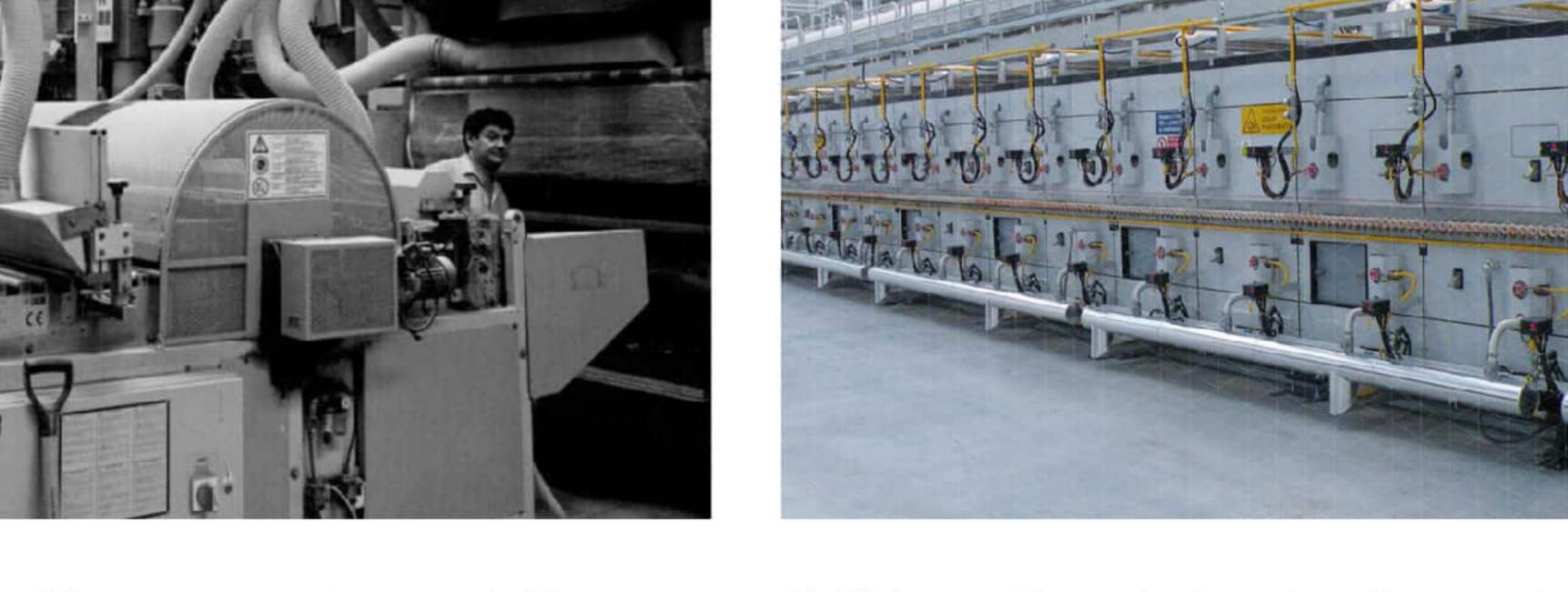
6. Glazing (optional) - Glazes are made out of silica, feldspar, and other glass-like or glass-related substances which act as a vitric coating for the ceramic tiles

Hazards -

from metal and mineral oxides

Glaze application: if sprayed, PM emissions

Glaze Preparation: particulate matter emissions



7. **Firing** - After glazing, the tile must be heated intensely to strengthen it and give it the desired porosity. Firing is the final step of the process before the tiles are sent to be sorted and packed for the market. This is among the most vital parts of the ceramic tile creation process. After the glaze is applied, continuous firing is needed to strengthen the tile

Hazards - combustion products and filterable and condensable PM, consisting in part of metals and inorganic minerals associated with raw materials

Accessory Products - Mortar/Adhesives

★ ★ ★ ★ ★

More prone to cracking than mortar with

MAINTENANCE

AT RISK POPULATIONS: Manufacturers and Installers SCHLUTER - SET Thin Set Mortar CUSTOM BUILDING PRODUCTS AFM - Safecoat 3 in 1 PRODUCT CATEGORY: CustomBlend Thin Set Mortar Mortar/Adhesives With selfs Time that Authors the Highest Second Strengthin. STREET, STREET, STREET, ow-Odor, Non-Toxic, Water-Based Adhesiv ** **HUMAN HEALTH** Contains: Crytalline Silica, Quartz, Portland Contains: Quartz, Calcium Aluminosilicates Contains: Vinyl Acetate Ethylene Copolymer Cement, Calcium Carbonate Calcium Oxide, Potassium Oxide, Manganese Attapulgite, Polyethylene Glycol, Aqueous Causes severe skin burns and eve damage Dioxide, Phosphorous Pentoxide Serious eye damage/eye irritation Category 2/ Causes serious eye damage May cause an Ilergic skin reaction Carcinogenicity Category 1A - May cause an allergic skin reaction May cause respiratory irritation Causes serious eye irritation Specific target irgan toxicity (single exposure) Causes damage to lungs through prolonged or toxic to aquatic life with long lasting effects repeated inhalation of dust Specifictarget organ toxicity (repeated May cause cancer through inhalation of dust $\star \star \star \star \star$ *** *** INDOOR CLIMATE No VOCs VOC - Coatings: 7g/l, Material 3g/l No VOCs

More prone to cracking than mortar with

Accessory Products - Membrane/Underlayments

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INDOOR CLIMATE	No VOCs	Low to No VOCs	
HUMAN HEALTH	Contains: Portland Cement, Expanded Shale & Clay, Crystalline Silica, Quartz; Expanded Polystyrene. - Causes skin irritation; - Causes serious eye damage - May cause an allergic skin reaction - May cause respiratory irritation - Causes damage to lungs through prolonged or repeated inhalation of dust - May cause cancer through inhaltation of dust	Polyethylene is an essentially biologically inert solid and considered non-toxic. It is stable (does not decompose) in landfills or in aquatic systems. - Contact of powder or fines with eye may cause irritation - Contact of powder or fines with skin may cause mild to more serious irritation - Inhalation of fine particles may cause respiratory irritation. - Fumes produced while thermal processing may cause irritation, pulmonary edema and a possible asthma-like response.	 Expanded Polystyrene products are combustible solids. May off-gas pentane which can accumulate at hazardous concentrations Grinding, sawing, rasping of products, and similar activities can produce dust particles which under certain conditions may form explosive dust atmospheres and ignite. If heated above decomposition temperature or burned, products can emit an irritating black smoke and acid gases.
Description	Cement Backerboard	High-Density Polyethylene (HDPE)	Modified Polyethylene (PEVA) Core with Non-Woven Polypropylene
Mortar/Adhesives			SCHUROL AREA DA PARAMENTA
PRODUCT CATEGORY:	CUSTOM BUILDING PRODUCTS - Wonderboard Lite Backerboard	SCHLUTER - Ditra	SCHLUTER - Kerdi-Board
AT RISK POPULATIONS:	Manufacturers and Installers		

Accessory Products - Grout

