

# M&T Integration Lab

Business Plan Update

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## TerraStone

*Modified porous concrete for vegetation growth in structural applications to scale urban greenery.*

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## **Executive Summary**

TerraStone presents a groundbreaking solution to sustainable construction by introducing a novel material that combines structural integrity with vegetation support, revolutionizing the way urban spaces are built and maintained. This report outlines TerraStone's value proposition, target customer segments, market research insights, stakeholders, competition analysis, cost of production, and revenue model. TerraStone offers a unique material that serves as both structural concrete and a medium for vegetation growth without soil. By seamlessly integrating three carbon reduction methods, TerraStone enhances sustainability in construction while fostering urban greenery, thereby addressing environmental and mental health concerns. Target customers include construction firms, urban planners, and environmental policy advocates. By aligning with these stakeholders, TerraStone aims to penetrate the market and establish itself as a premium green construction material. The construction industry's growing demand for sustainable materials, coupled with increasing environmental awareness, creates a ripe market for TerraStone. With its ability to reduce embodied carbon and support urban greenery, TerraStone stands at the forefront of innovation in construction materials. Primary stakeholders encompass investors, construction firms, and urban planners, while secondary stakeholders include environmental agencies and local governments. TerraStone distinguishes itself from competitors by offering a unique combination of structural integrity, vegetation support, and carbon reduction. Its integration of recycled aggregates and multiple carbon reduction methods positions it as a versatile and sustainable alternative to traditional concrete. TerraStone's cost of production is competitive with traditional concrete, making it economically viable for mass adoption. By leveraging lower raw material costs and optimizing production processes, TerraStone aims to deliver value to both customers and investors. While pricing details are contingent on further market testing, TerraStone anticipates commanding a premium price in the market. With potential revenue streams for material users from carbon credits, TerraStone also offers economic value to customers. In conclusion, TerraStone represents a game-changing innovation in sustainable construction, with the potential to reshape urban landscapes and mitigate carbon emissions. Through strategic targeting of key customer segments and alignment with stakeholders, TerraStone aims to drive widespread adoption and establish itself as a leader in the green construction materials market.

## Value Proposition

TerraStone is a new material that functions as structural concrete and supports vegetation growth omnidirectionally without soil.

Our solution offers a revolutionary approach to sustainable construction by seamlessly integrating three carbon reduction methods into a structurally compliant and bio-receptive porous concrete. Our value proposition relies on optimizing pH and porosity in a new concrete to facilitate vegetation growth while retaining structural integrity. TerraStone simultaneously reduces carbon emissions in the construction industry and scales urban greenery to improve the mental health of city-dwellers, as urban green spaces have been reported to reduce stress, anxiety, and depression. Two of the three carbon reduction methods stem from use of a recycled aggregate. First, it inherently reduces carbon emissions upstream in the supply chain, and second, it is also larger than traditional concrete to increase the porosity, simultaneously decreasing the material's density and permitting vegetation growth by allowing space for roots to propagate. The final carbon reduction method is from the vegetation functioning as a significant carbon capture mechanism. This material also facilitates the scaling of urban greenery by allowing for plants to grow in any direction and without soil, reducing the general maintenance required for upkeep.

## Customer Segment

Target customers can be broken down into three categories by industry: construction, urban planning, and environmental policy. Firstly, in the construction industry, the focus will be on general contractors seeking sustainable materials. In the construction industry, developers purchase plots and then hire an architecture firm to design buildings and a general contractor to oversee and execute the building process. When our team spoke to Alexandra Donovan, the Architectural Design & Innovation Lead at Assembly OSM, a disruptive modular construction firm, we learned that the construction industry values decarbonization and greening of concrete. However, this reflects the preference of architects because they're not footing the bill. Therefore, we must target general contractors to get a premium green material into a building, as architects inherently value our material for its design opportunities. We learned that concrete is valued by general contractors for its cheapness relative to other construction materials, so when we say we want our material to be functionally comparable to Ordinary Portland Cement (OPC), we must include economic viability in that definition to appeal to general contractors. To create this economic viability in the construction industry, we must target customers in environmental policy. If environmental agencies promoting sustainable construction practices and carbon reduction support our material, then we align with cutting-edge environmental policy and help our product achieve economic viability via carbon credits. Finally, when we asked Alex, "as an architect and employee of a construction firm, where do you see greenery intersecting most with urban design?", she helped us brainstorm value-creating applications for TerraStone, such as highway dividers and sound barriers that would help the product achieve economic viability via scale. We also discussed POPs, or privately-owned public spaces, which are monetarily incentivized by the government to "be pretty", so they would pay a premium for a greener concrete that facilitates the construction of unique urban greenspaces. Thus, our final target customers are city Departments of Public Works, as they control urban planning and can serve as a vehicle to market for these materials to prove their environmental and mental health benefits at a premium price or a large scale to serve as a point of reference for general contractors that tend to stray from new materials in residential construction projects. In conclusion, we first target urban designers at Departments of Public Works to use TerraStone in highway dividers or sound barriers to leverage economies of scale or in POPs that have larger budgets for designing unique greenspaces. Simultaneously, we will align our material with environmental agencies looking to promote sustainable construction

practices via carbon credits to cross the chasm to the early majority: future-oriented general contractors looking to be more sustainable.

## **Market research**

TerraStone is serving two markets: sustainable materials for construction and structurally sound urban greenery design. The global green building materials market size, valued at \$422.3 billion in 2023, is actively seeking solutions to reduce embodied carbon and projected to grow with a CAGR of 12.3%.<sup>4</sup> The demand for sustainable construction materials is growing due to increased environmental awareness and regulatory changes. The sustainability of products in the construction industry is quantified with Life Cycle Assessments (LCA). There are many ways to reduce carbon in construction: (1) use a less dense alternate material, (2) design a less material-intensive/energy-intensive fabrication process, (3) purchase carbon offsets, or (4) develop a way to capture carbon on-site. While various research has gone into developing solutions based on one of these many methods, there has not yet been a viable solution that can combine multiple carbon-reduction methods into one for effect multiplication. We are focused on concrete, as it is currently responsible for 8% of CO<sub>2</sub> emissions and there are many paths to increase its sustainability as compared to other materials with similar functions. Additionally, concrete has negative social impacts, as evidenced by the growing efforts to improve urban greenery in cities, like the Highline in New York City or the 606 in Chicago, turning abandoned train tracks into elevated green spaces without disturbing the functionality of urban transportation and city life. Green spaces have been reported to reduce stress (cortisol levels), anxiety, depression and improve general well-being.

## **Stakeholders**

Our primary stakeholders are investors, construction firms, and urban planners. Our secondary stakeholders are environmental agencies, advocating for sustainable construction practices, and local governments, promoting greener construction via monetary incentives. If we align with our secondary stakeholders, then we can become a cost-effective material for construction firms seeking environmentally friendly alternatives, especially when they are working with urban planners interested in enhancing green spaces within urban environments. If we can leverage carbon credits from governments, then we become a profitable construction material supplier, simultaneously creating value for our investors and customers in the construction industry.

## **Competition & Competitive Advantage & Potential IP**

Our key competition includes permeable concrete and biochar-based concrete. Applications for permeable concrete are limited by the need for adjacency to soil, making it unsuitable as a structural component. Biochar-based concrete addresses carbon absorption but lacks the ability to support vegetation growth. TerraStone offers a one-of-a-kind combination of structural integrity, vegetation growth, and carbon reduction, differentiating it from other green concrete on the market. Integration of a relatively large, recycled aggregate increases the porosity of the material, permitting vegetation growth, and leverages multiple methods of carbon reduction, setting TerraStone apart from its competitors. TerraStone is positioned as a versatile and sustainable concrete poised to redefine the landscape of green construction materials, simultaneously addressing the evolving needs of the construction industry and city dwellers. The one concern that TerraStone faces is the viability of our sustainable formula without vegetation that simply reduces the amount of OPC compared to traditional concrete. We were able to create a formula that retained the characteristic strength of traditional concrete while reducing its embodied carbon by over 70% by substituting recycled raw materials for OPC. We questioned why people

don't do this and found that there are heavy barriers to market entry for new construction materials due to strict regulations. It is possible to get new materials approved, but we anticipate the need for robust IP and documentation to account for this taxing approval process for TerraStone products.

## **Cost of Production**

TerraStone has developed should-cost models for both OPC and our material to compare the raw material costs of each product, including different vegetation options (see **Appendix A**).

The average market price for OPC is about \$9.00/square foot and the cost of sales for cement manufacturers is ~50% of revenue using a comparable firm. We assume this applies to unit economics, such that the cost of manufacturing and materials is \$4.50. Our should-cost model estimates that the raw material cost for OPC is about \$3.78, yielding a cost of \$0.72/square foot for other costs of sales. Assuming a similar, but not yet standardized and optimized, process can be used to manufacture and test TerraStone products, we mark up this cost 2x to be \$1.44. We add this to our raw material estimate of \$0.20 per square foot to yield a total COGS of \$1.64 per square foot without any vegetation, while moss costs an additional \$0.17/square foot, algae is \$0.01, and sedum is \$1.35. Thus, the total cost of sales for each product are \$1.81 per square foot for moss TerraStone, \$1.65 for algae TerraStone, and \$2.99 for sedum TerraStone.

## **Revenue Model**

Due to TerraStone's early stage of research and development, it is difficult to price the end-product because the applications of the technology are entirely dependent on future testing. However, TerraStone anticipates that the material will be a premium product that exceeds the current price of concrete (\$5.50-\$9.00 per square foot). Customers will have an increased willingness to pay, as they will be able to derive monetary value from carbon credits by using TerraStone to reduce their emissions and sell their excess allowances in accordance with future policies based in the Inflation Reduction Act of 2022.

Using a comparable firm that makes building materials, we estimate that cost of sales is ~64% of net sales, such that we can mark up our cost of sales for each product to determine the appropriate prices at \$2.82/square foot for moss TerraStone, \$2.58/square foot for algae TerraStone, and \$4.67/square foot for sedum TerraStone. These are all extremely competitive with the current price of concrete and traditional building materials that are valued for their inexpensiveness.

## Works Referenced

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