



Ara Built to
Decarbonize.®

Wastewater Treatment

The sewage problem Wall Street is
betting on

Introduction

"Substantial untapped investment potential of wastewater treatment across the industrial decarbonization landscape."

The next major infrastructure build-out in the United States may not be a highway, data center, or transmission line. It may be the systems we use to manage the millions of tons of sewage sludge our cities produce every year. For decades, utilities managed this material in a relatively straightforward way: sludge (biosolids) from the wastewater treatment plant is run through various processes to reduce mass and volume as well as stabilize the material before final disposition. The core wastewater unit operations for solids handling prior to disposal often include thickening, digestion, dewatering, and drying.

These traditional approaches to biosolids handling and disposal all require the final product to be hauled away and discarded, most often through land application. However, growing concerns around PFAS are making these options increasingly constrained in both availability and capacity for many water and wastewater utilities. What was once a relatively inexpensive and conventional solution for biosolids management is now rapidly evolving.

Regulatory and public pressures, legal liability, and rising costs are forcing utilities to rethink how they handle and dispose of biosolids. While there has been significant investment in water and wastewater infrastructure focused on improving effluent water quality and advancements in water reuse, wastewater system, sewage sludge, is now becoming a strategic priority.

In this paper, we describe the forces reshaping biosolids management in North America and highlight how this important segment of the wastewater system, biosolids management, is evolving into a distinct, investable infrastructure theme.



From routine practice to regulatory target

"Land application of biosolids has become untenable in many geographic areas given mounting PFAS concerns."

The United States produces roughly six million dry tons of biosolids a year.¹ Historically, more than half has been land-applied as fertilizer, with the remainder split between landfills, incinerators, conventional thermal dryers, and composting. The practice is encouraged as a way to recycle nutrients and organic matter back to soil.

That picture, however, has become more complicated as concerns about perfluoroalkyl and polyfluoroalkyl substances (commonly known as "PFAS") have mounted. These "forever chemicals" do not readily break down—they are now being detected at elevated levels in wastewater, biosolids, and farm soils and have been linked to cancer and other health impacts.

In response to finding PFAS contamination on dairy farms, in 2022, Maine implemented a statewide ban on land application of biosolids. Utilities shifted rapidly to landfill disposal, where capacity is limited and costs are higher, causing tipping fees to rise sharply. Connecticut followed with its own prohibition in 2024, and legislators in Massachusetts, Vermont, and New York have introduced similar measures. Several Midwestern, Mid-Atlantic, and

Western states now require PFAS testing and set screening levels that constrain land use above certain thresholds.

At the federal level, the Environmental Protection Agency has set very low limits for certain PFAS in drinking water and classified some PFAS as hazardous substances under Superfund law. The agency has also finalized a method for measuring dozens of PFAS compounds in wastewater and biosolids and is preparing a risk assessment that could lead to national PFAS standards for biosolids management. The threshold PFAS levels that the EPA considers safe are less than a few drops in an Olympic-sized swimming pool, and current EPA limits are below EU levels, representing a rare instance in which U.S. public health standards are stricter than those in Europe. In all instances, experts broadly agree on the direction of travel toward tighter PFAS controls, even though the science around pathways and causes of harm is still evolving.

Taken together, those actions have made traditional land application more complex and, in some cases, untenable.



¹ BlueTech

Landfills and incinerators under strain

"The traditional fallback disposal options, such as landfills and incinerators, are also constrained."

Since 1990, the United States has experienced a dramatic decline in the number of municipal solid waste landfills. Operators of the remaining facilities are increasingly reluctant to accept wet, odorous organic materials, and those willing to do so typically impose higher tipping fees. Growing concerns about PFAS contamination in the liquid leachate that drains from landfills, which is often sent to the local wastewater treatment plant, have further influenced this trend, prompting many operators to restrict—rather than increase—their acceptance of biosolids.

Incinerators face different challenges. Most sewage sludge incineration capacity dates back to the 1980s. Replacing or upgrading those facilities involves large capital budgets and long permitting processes, often facing significant local opposition. Air regulations have tightened, and building new combustion infrastructure for waste is politically sensitive.

The result is visible in price trends. For example, utilities in some Florida markets, after state rules reduced land application to protect watersheds, have resorted to hauling biosolids hundreds of miles out-of-state. Transportation alone can range from \$50 to \$150 per wet ton before layering on processing and disposal fees.²

As populations grow and wastewater volumes rise, the gap between routine waste generation and decreasing disposal capacity is widening.



² Ara and Sedron management estimates

Market size and growth drivers

"Volume growth, sustainability considerations, and evolving customer preferences drive growth and innovation in the wastewater treatment market."

The septage and biosolids treatment market in the United States is estimated at \$9-11 billion per year.³ Within this, the addressable market for advanced treatment platforms focused on larger municipal and industrial sites is in the range of \$5-6 billion.³ This portion is characterized by meaningful volumes per site, technical sophistication, and willingness to enter into multi-year service agreements.

The combination of volume growth, infrastructure renewal, and evolving customer preferences points toward a market opportunity that is capable of supporting hundreds of advanced biosolids facilities in North America alone, with similar dynamics likely to unfold in Europe, Asia, South America, and other developed regions.

\$9-11 b/yr

US spending goes to septage & biosolids treatment³

Several demand drivers support continued growth:

- > **Population and urbanization:** expanding metropolitan areas and extensions of sewer networks increase wastewater flows and biosolids production. This growth is steady and completely independent of short-term macro cycles.
- > **Replacement and upgrade cycles:** a significant portion of existing infrastructure dates back several decades. As systems reach the end of their useful lives, utilities evaluate alternatives. This often opens the door to public-private partnerships for treatment infrastructure and new technology.
- > **Cost volatility in traditional outlets:** as land application, landfill, and incineration options become less available or more expensive in a given region, utilities look for more predictable cost structures, even if the base price is initially higher.

³ LEK

A significant advancement in circular wastewater treatment systems

"A new level of resource recovery from wastewater treatment streams."

The improved model treats biosolids less as a waste to be discarded and more as a feedstock to be processed. A class of projects is exploring advanced treatment and separation approaches that can reduce volumes, recover useful materials, and minimize environmental impacts. In broad terms, with the right technology, sludge has potential to be converted into distinct and valuable outputs—such as water that can be reused locally and solid materials that can be put to productive use in industrial processes or to generate carbon negative electricity.

In addition to the monetary benefits, these systems are becoming a tool to help manage contaminants of concern, particularly PFAS. Rather than simply moving those compounds from wastewater into incinerators or landfills, intensive processing and treatment aim to concentrate, transform or otherwise handle them in ways that are easier to control. Executing on this capability is increasingly important for utilities anticipating tighter standards surrounding PFAS in the future.



A new infrastructure-style revenue model

"Wastewater treatment and biosolids management have become a generational, infrastructure-like investment opportunity."

What makes this shift particularly interesting is not only the technology, but the infrastructure-like business model around it.

Rather than selling equipment outright, a few project developers now finance, build, own, and operate resource recovery facilities. Wastewater utilities sign long-term service contracts, paying a fee per ton or per gallon treated. That structure allows municipalities to avoid major upfront capital expenditures and the complexity of operating new processes, while securing reliable disposal that meets cost, emissions, and contaminant requirements.

Revenues for these projects rest on two pillars. On one side are tipping or service fees paid by utilities, structured under multi-year agreements. Those payments are underpinned by the essential nature of wastewater treatment and the limited alternatives available. On the other side, projects can generate income from selling recovered products—reclaimed water and energy-rich solids—to industrial offtakers.

Sedron Technologies is a perfect example of this new model.

ENERGY AND EMISSION IMPROVEMENTS⁴



~8x

Lower energy intensity vs.
market incumbents



~83%

Lower GHG emissions vs.
market incumbents



⁴ Ara and Sedron management estimates

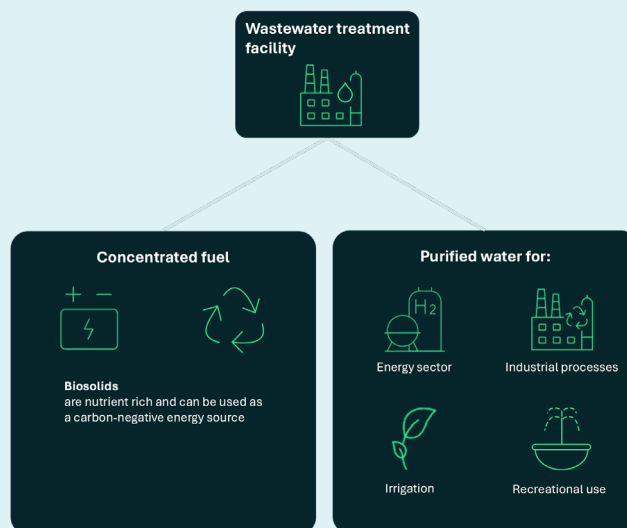
Sedron Technologies

"Sedron's Varcor system efficiently processes biosolids into valuable fractions: clean water and renewable fuel."

Sedron's Varcor system uses mechanical vapor recompression, a familiar technology to the water industry used in thermal desalination, in an efficient evaporative process to convert incoming wastewater into two main outputs:

- > Dried solids suitable as a carbon-negative fuel (biomass) and a mineral-rich input (ash) for industrial applications such as cement
- > Clean water that can be reused for irrigation or industrial processes

SEDRON'S VARCOR SYSTEM



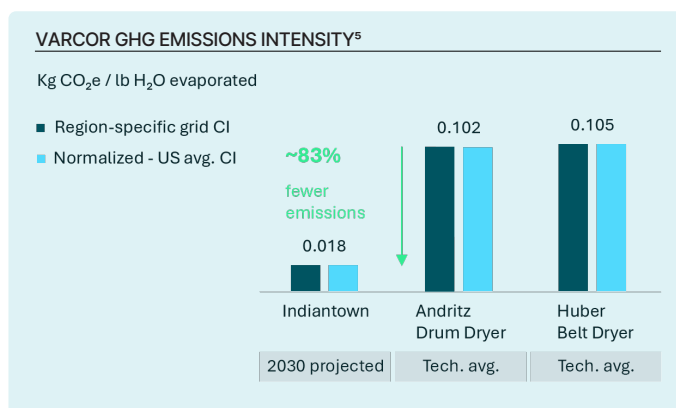
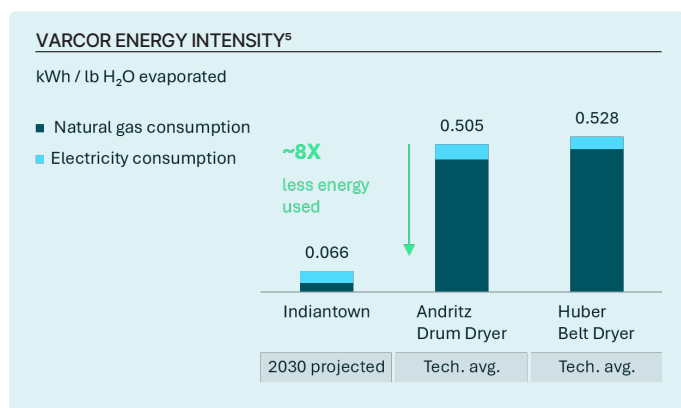
SEDRON DEMONSTRATION FACILITY



Sedron Technologies

"Sedron's process saves energy and lowers greenhouse gas emissions."

The Varcor system can achieve significant energy savings—up to 8x lower energy intensity—relative to conventional drying on a per unit of water removed basis. Integrated facilities using Sedron's technology can lower operational emissions by up to 83% compared to many conventional pathways, particularly when the solid fraction replaces fossil-based fuels or inputs.⁵



The important point from a market perspective is that this model creates multiple revenue lines against a single feedstock:

- > Treatment fees from utilities, often under long-term contracts
- > Revenue from solids used as renewable fuel or industrial inputs where customers value both calorific and sustainability attributes

This multi-product structure helps decouple project economics from any single-end market or commodity price. It also allows the platform to respond to regional differences in demand. In industrial hubs, demand for carbon-negative fuels or lower carbon material substitutes may be the key differentiator.

MUNICIPAL WASTEWATER TREATMENT (BIOSOLIDS) ⁶	
Value proposition	Replaces large and expensive infrastructure to more efficiently and economically process biosolids; advanced thermal systems destroy PFAS and generates excess electricity for the grid
TAM (2023)/market growth	~\$9 – 11B / ~3 – 4% p.a.
SAM (varcor potential)	3,400 – 4,400 Varcors
Primary revenue driver	Tipping fees from wastewater treatment plants & offtake of downstream products
ITC qualification	Yes (30 – 50% of CapEx)
Supply & offtake contracting	✓
Ability to secure financing	✓
Ease of permitting	✓
Overall attractiveness	✓

⁵ Ara and Sedron management estimates

⁶ LEK

Customer needs and buying criteria

"Value streams from wastewater treatment are appealing to a variety of customers."

Understanding the wastewater treatment and biosolids management opportunity requires a clear view of how different customers make decisions.

1) Municipal and industrial utilities

Utilities are the primary biosolids feedstock generators and customers of needed solutions for handling and disposal. Their main objectives are cost control, regulatory compliance, operational reliability, and community acceptance. They tend to value:

- > Predictable per ton or per gallon pricing over long contract terms
- > Turnkey solutions that limit the need for internal capital deployment and specialized operating staff
- > Proven performance at commercial scale, with clear risk allocation between the utility and the service provider

For many utilities and municipalities, an infrastructure-as-a-service model is attractive. Under this approach, a platform such as Sedron finances, designs, builds, owns, and operates the facility and charges a contracted treatment fee. The utility or municipality avoids large upfront capital commitments and transfers a portion of technical and operating risk to the developer.

2) Industrial buyers of renewable fuel and raw materials

Cement producers, power generators, and other energy-intensive industries are under pressure to reduce direct emissions and improve the life cycle profile of their products. Dried biosolids-based fuels and mineral-rich fractions can play a role where they meet technical specifications, offer a competitive cost per unit of useful output, and achieve carbon-negative energy goals. Upcycled nutrient recycling for wastewater utilities provides another approach to improve life cycle profiles. Here, the ability to guarantee reliable supply and quality is often as important as the headline emissions benefits.

A successful biosolids platform is one that can translate the requirements of these three groups into bankable facility designs, attractive contracts, and stable cash flows.



Ara Partners' investment thesis in wastewater treatment

"Wastewater fits Ara's investment criteria and has potential to scale and grow."

Ara Partners' strategy focuses on backing platforms that combine technology, operating capability, and market access in sectors with clear decarbonization potential. Wastewater treatment aligns with this approach on several fronts.

- > **Non-discretionary demand:** utilities and municipalities must manage wastewater in all market conditions. This underpins the stability of treatment fee revenues.
- > **Multi-product revenue streams:** properly structured facilities can earn from three or more sources: treatment fees, renewable fuel, upcycled nutrient recovery, or material offtake. This diversity reduces dependence on a single commodity or policy instrument.
- > **Tangible emissions impact:** by recovering resources and displacing more carbon-intensive alternatives, advanced wastewater treatment systems can demonstrate clear, measurable reductions in greenhouse gas emissions and other environmental metrics.
- > **Barriers to entry:** developing, permitting, financing, and operating advanced treatment facilities with complex feedstocks and multiple product streams is not easily replicated quickly. Experience, proven scaled technology, reference plants, and long-term contracts create defensible positions.

Ara's role is to help companies move from technology developer to scaled infrastructure platform—what we typically call process technology rollouts (PTR). Through hands-on support with project financing, contract structuring, offtake development, and enterprise building, Ara is able to scale decarbonization solutions with the ability to make a meaningful emissions reduction.



The Ara advantage

"Ara's unique experience gives us pattern recognition of which PTRs work best, where customer demand is strongest, and how best to structure them for scale."

Ara has built a portfolio that is focused squarely on industrial decarbonization, including energy efficiency, low carbon fuels, circular materials, and process improvements. Our senior investment professionals have on average 25+ years of investing experience and have evaluated thousands of deals across the decarbonization landscape, backing multiple PTR platforms such as onshoring North American permanent magnet production and cement decarbonization businesses.

Where most firms advise, Ara builds—bringing unmatched industry depth and hands-on portfolio leadership to every investment. Ara Portfolio Services (APS) functions work in lockstep to provide project execution and operational optimization, commercial and policy expertise, and rigorous carbon accounting to unlock growth for the portfolio at an industrial scale.

ARA PARTNERS AT A GLANCE

Private equity

Infrastructure

Energy



Project
execution &
operations



Decarb



Government
affairs



Ara insights



Commercial
services

The Ara advantage

"Ara brings a distinctive track record in delivering PTRs at a pace and scale that is rare in industrial decarbonization."

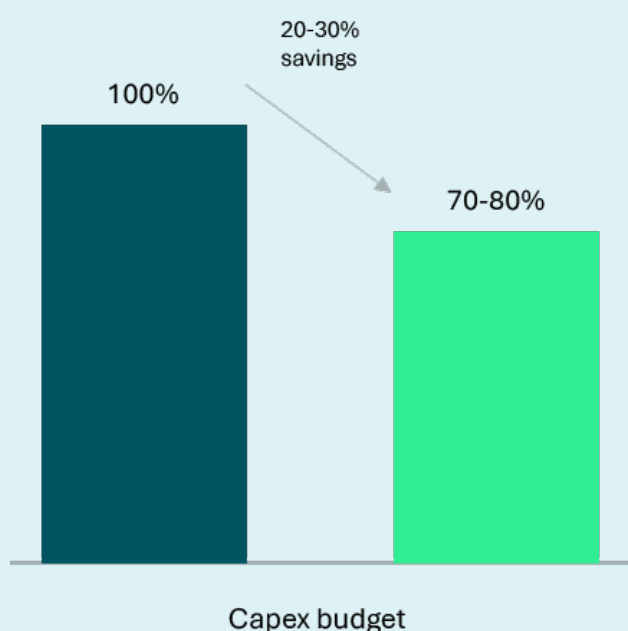
Project execution and operations

The Ara project execution and operations (APEX) group oversees capital project delivery and is a catalyst for project and operational maturity. APEX helps portfolio companies design and run capital projects using a standardized toolkit, from pre-deal cost and schedule analysis through commissioning. APEX's objective is straightforward: achieve commercially modeled capacity in the fastest and most cost-efficient way possible. For Nth-of-a-Kind (NOAK) plants, Ara targets 20-30% CapEx savings.

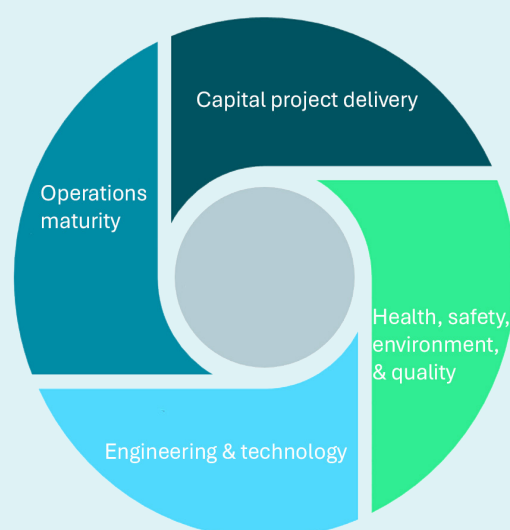
The team brings deep experience in project development, EPC, operational readiness, safety, and systems. It has overseen about \$4.3 billion of development CapEx across 29 portfolio companies, with more than 400 industrial projects delivered.

This on-the-ground activity, spread across sectors and geographies, gives Ara a practical base from which to run and refine PTR programs at pace and scale.

BUILD FASTER, BUILD FOR LESS: TARGET ARA CAPEX SAVINGS



CORE APEX FOCAL AREAS



The Ara advantage

"Ara brings the complete resources of the firm to ensure each PTR is successful—a support system that is differentiated and rare in private equity."

Decarbonization

Our decarbonization team ensures that assets deliver measurable emissions reductions and helps portfolio companies turn that impact into revenue. In addition to robust baselining and monitoring, reporting, and verification, we help identify and monetize environmental attributes in both voluntary and compliance carbon markets. That can unlock an incremental, recurring, high-margin revenue stream through carbon credits or other instruments that reflect the emissions performance of the plants. When structured correctly, this revenue improves project economics and can make lower-carbon products more competitive against fossil incumbents.

Commercialization services

Ara's commercialization support is built around partnerships, not just transactions. We help portfolio companies:

- > identify and engage strategic commercial partners
- > set up customer and industry advisory councils to accelerate traction and strengthen the brand
- > sharpen product market fit, route to market, and pricing strategies
- > structure and negotiate offtake agreements that support financing and leave room for multi-plant growth

The aim is to move from one-off sales to durable commercial relationships that support the entire PTR roadmap.

Ara insights

Ara Insights is our market intelligence and thought leadership engine. It tracks industry trends, regulatory and policy shifts, competitive dynamics, M&A activity, and technology developments across our focus sectors.

These insights help portfolio companies and deal teams anticipate where demand is likely to grow, where incumbents or new entrants may pose threats, and where new policy or market structures create opportunities. They inform which PTRs to prioritize, which markets to enter first, and how to position platforms relative to evolving industry narratives.

Government affairs

Ara's government affairs capability identifies and capitalizes on relevant policies, tax incentives, subsidies, grants, and regulatory opportunities, and integrates them into project design, siting, workforce development, and financing structures. This speeds up incentive capture, reduces permitting risk, and makes it easier to replicate structures across multiple projects and jurisdictions. Access to non-dilutive capital enhances Ara's returns.



⁷ Plant picture: Genera plant built with Ara Partners' PTR model

Conclusion

"From liability to generational investment opportunity."

The story of wastewater treatment, or water resource recovery, is the story of how environmental externalities become infrastructure opportunities. For years, society benefited from cheap disposal routes that did not fully account for long-lived contaminants or greenhouse gas emissions. As regulations, science and public expectations catch up, those externalities are being priced in. Utilities, municipalities, and local communities are demanding solutions that do more than shift the problem from one place to another.

That demand is creating space for new infrastructure: plants, pipelines, offtake agreements, and long-term service contracts that treat wastewater as a valuable resource to be managed and monetized.

Sewage waste will never be glamorous. But for investors willing to look beyond the more visible corners of the energy transition, wastewater treatment is beginning to look less like a headache and more like a durable, scalable way to align capital with improved climate and public-health outcomes. The question is not whether this market will develop—it already is—but how quickly utilities, municipalities, regulators, and capital providers can move to replace a strained, fragmented status quo with the next generation of critical infrastructure.



Meet the authors



Cory Steffek
Partner

Cory Steffek brings 25 years of experience launching new products and investing in the advanced materials and energy space. Cory has dedicated his career to working with talented entrepreneurs and executives who are focused on developing game-changing technologies that advance sustainability and lower carbon footprints. He currently serves on the board of directors for several Ara portfolio companies.



Tuan Tran
Senior Managing Director,
Head of Ara Insights

Tuan Tran is a Senior Managing Director at Ara Partners, where he serves as the firm's Head of Strategic Relations and Head of Research across its Private Equity, Infrastructure, and Energy strategies. He has over 25 years of experience in private equity, investment banking, and equity research.



About Ara Partners

Founded in 2017, Ara Partners is a global private markets firm focused on decarbonizing the industrial economy. We invest in the middle market across three strategies: Private Equity, Infrastructure, and Energy. We scale commercially demonstrated decarbonization solutions, support the businesses and infrastructure that enable their adoption, and reduce emissions at the source across the conventional energy value chain. Our model combines investing, market and policy expertise, project execution and operational optimization, and rigorous carbon accounting to reduce emissions economically and unlock growth at an industrial scale. Ara operates from Houston, Boston, Dublin and Washington D.C.