Executive Summary

Using biogas as a possible revenue stream
Producing Value-Added Biopolymer from Methane Gas Generated by Water Resource Recovery Facilities (NTRY5R14)

The Central Issue
If not used for renewable energy, biogas which is predominantly composed of methane, has traditionally been considered a waste. However, in recent years, water resource recovery facilities (WRRFs) have investigated ways to cost effectively purify it for further uses. Most biogas conversion technologies require a pure methane stream without carbon dioxide, hydrogen sulfide (H₂S), and siloxanes. The equipment needed to treat the biogas and remove these contaminants can be expensive and requires ongoing maintenance. The ability to utilize untreated biogas would make biopolymer production from methane more economical.

Context and Background
In the late 2000s, researchers at Stanford University developed a bacterial fermentation process to produce a biopolymer from methane. This bio-based, biodegradable material (polyhydroxyalkanoate, or PHA) is an economically and functionally competitive substitute for petrochemical-based plastic. The original graduate student researchers went on to start Mango Materials in order to commercialize this technology at methane production sites, including WRRFs.

The objective of this research was to advance the practical implementation of biopolymer production from methane gas at WRRFs. The research investigated several components of integration: the effects of biogas contaminants on the fermentation process, the use of effluent and recycled water in process media, and whether biopolymer production from WRRF biogas is feasible and economically favorable. The study also investigated the regulatory permits that would be required before establishing a commercial facility. The project team used the Silicon Valley Clean Water (SVCW) plant in Redwood City, CA, as a model site for Mango Materials’ first commercial plant.

Findings and Conclusions
The researchers found that converting biogas into biopolymers was more than three times more economical than converting it to electricity and more than two times more economical than converting it to vehicle fuels, creating an economic incentive for Mango Materials’ technology. They also found that PHA biopolymers from renewable WRRF biogas can replace petrochemical-based plastics in a large range of high-value applications. The project team identified several markets in which there is both a good fit and a demand for PHAs, including disposable goods, marine applications, microbeads, agricultural items, electronic casings, non-wovens, and niche products.

Management and Policy Implications
Ultimately, producing biopolymer is advantageous for WRRFs as it will give them an additional source of revenue from the sale of biogas that would be integrated into environmentally friendly products. Co-locating biopolymer production facilities at existing WRRFs yields a number of benefits, as considerable infrastructure is already in place that can be leveraged and integrated.

Aside from permits, the production process also requires physical space, which may be limited at some methane sites. Mango Materials anticipates it would comfortably require about four acres; however, much of this space (such as the area needed for a tractor trailer to maneuver) could be integrated at specific sites and stacking of certain operations could occur, if space is at a premium.
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Mango Materials’ estimated TAM for disposable items.

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