City of Philadelphia

Proposal for RFI

Presented by

LITTERATI

RTI INTERNATIONAL

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1. General Information

1.1	Organization/Respondent Name	Litterati
1.2	Street Address	411 W. Chapel Hill St, Suite C2
1.3	City, State, Zip	Durham, NC 27517
1.4	Primary Business	Litter and Mismanaged Waste Data
1.5	Point of Contact Name	Jeff Kirschner
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1.9	Organization Web Address	litterati.org

2. Proposal Introduction

Litterati's journey began with a vision of empowering everyday do-gooders to document litter in their neighborhoods. Our platform turned these grassroots efforts into meaningful data, building a global community of environmental stewards - from students and teachers to corporate volunteers and passionate individuals. As our impact grew, we recognized the opportunity to elevate this community engagement to new levels of scientific rigor. By developing specialized training programs, we transformed passionate citizens into skilled researchers capable of following specific protocols, creating standardized, comparable datasets that support large-scale research initiatives.

Since our inception in 2014, we've empowered people across 180 countries to document over 25 million pieces of litter. Our sophisticated technology platform supports these citizen scientists, transforming their efforts into actionable insights. Recognized by the National Science Foundation and featured on TED, Litterati is driving a global movement to combat litter and create meaningful change.

Our clients include municipalities like Memphis, San Francisco, and Norfolk; global NGOs such as the World Bank, WWF, and Keep Britain Tidy; leading corporations like Philip Morris and Atlassian, and organizations including CITEO and the Alliance to End Plastic Waste.

Over the past five years, with a team of two full time employees, and dozens of independent contractors, Litterati has dedicated its focus to scientific research, conducting more than 80 litter research projects, ranging from single-city analysis to national studies. We distinguish ourselves through:

1. **Verifiable Data and Rigorous Methods**: Ensuring transparency and reliability at every step.
2. **Geospatial Insights**: Moving beyond composition analysis to reveal where litter is and the patterns driving its presence.
3. **Compelling Storytelling**: Translating data into powerful stories that inform, influence, and impact.

All of this is enabled through a simple photograph.

Our partner organization, RTI International, is an independent, nonprofit research institute dedicated to improving the human condition. With almost 7,000 staff located in offices across the U.S. and the globe, RTI uses rigorous, yet innovative techniques to answer questions and address social issues that demand an objective and multidisciplinary approach—one that integrates expertise across the social and laboratory sciences engineering, and international development.

Of relevance to Philadelphia, RTI has a deep bench of social, environmental, and behavioral scientists who leverage state-of-the-science methods to explore the factors driving today's environmental challenges, including pollution and littering. Our cross-disciplinary teams provide insight into why these challenges occur and then use that knowledge to conceptualize, design, and deliver meaningful initiatives to shift individuals' and communities' behaviors.

Combining scientific rigor and technical proficiency, we deliver reliable data, thorough analysis, innovative methods, novel technologies, and sustainable programs that help clients inform public policy and ground practice in evidence. We scale our approach to fit the demands of each project, delivering the power of a global leader and the passion of a local partner.

We believe in the promise of science, and we push ourselves every day to deliver on that promise for the good of people, communities, and businesses around the world.

In the 1960s, Research Triangle Institute (RTI) pioneered the first Keep America Beautiful Litter survey, establishing a foundation for understanding our nation's litter problem through methodical research. Half a century later, Litterati emerged with AI-based tools that advanced litter identification and analysis, bringing technological innovation to environmental stewardship.

Today, our two organizations—one with decades of scientific research experience and the other with technological expertise in litter data collection—are proposing an approach to address the needs of City of Philadelphia, combining historical knowledge, domain expertise and the latest technologies to deliver insights into the city's litter and illegal dumping challenges.

The partnering of our two organizations will help set the foundation for creating more than a report that lives on a shelf. Our approach moves beyond simply quantifying Philadelphia's litter problem. Ultimately, we propose building a Knowledge Tool—an intelligence engine that understands which solutions to prioritize—creating a powerful tool for Philadelphia and your stakeholders. This isn't just about collecting data—it's about developing a roadmap for cleaner communities across the city.

More on that later.

3. Proposal Body - Section 4 - 3.4.1 - Other

City Litter Index

Litterati will establish a litter baseline across the entire city, measuring three key aspects:

- Litter Composition: A detailed categorization of litter items
- Litter Density (Litter per Mile, LPM): A standardized measurement that calculates the amount of litter present per linear mile at each survey site.
- Survey Site Characteristics: A systematic documentation of each location's key environmental and contextual features, including factors such as land use, population density, proximity to businesses, presence of waste infrastructure, and relevant geographic attributes.

By analyzing our collected data, we can build an extrapolation/interpolation model that estimates litter quantities across Philadelphia's mainland roadways, riverbanks, and parks.

The integration of composition data, density measurements, site characteristics, and researcher observations enables Litterati to construct a comprehensive understanding of the litter landscape. This holistic approach reveals not just what litter exists and where it accumulates, but also suggests why certain patterns emerge, providing crucial geospatial insights that can inform effective intervention strategies.

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Application of AI

We use the Litterati mobile application to photograph litter. Each image captures essential data, including exact location coordinates and timestamps to document where and when litter is found. AI-based object detection models scan the photos, identifying litter objects, and then categorizes them by object type (e.g. bottle, can) and material (plastic, aluminum). Humans then review the AI's work to ensure accurate identification and classification.

Images have multiple advantages:

1

AI-Powered Insights
Images unlock deep insights by allowing AI to identify objects, materials, and brands in litter, delivering precise, data-rich analysis.

2

Environmental Context
Images connect the littered items to their natural surroundings providing detail that numbers alone miss.

3

Speed & Scale
Images replace manual data entry, instantly capturing the context, enabling large-scale collection across cities and states.

4

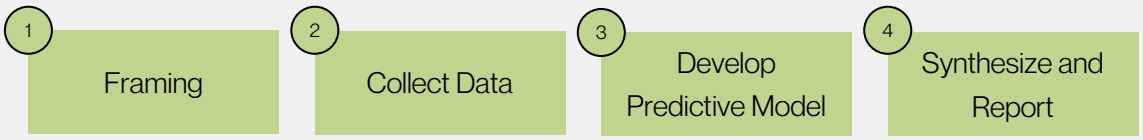
Verified & Trustworthy
Timestamped and geotagged photos create a transparent record, ensuring data integrity for key stakeholders.

Financial Cost of Litter

Litterati team partner RTI will develop a robust and repeatable approach for estimating litter's financial cost. RTI has experience in understanding the direct financial costs of litter (cleanup, prevention, education, and enforcement) for state and local government agencies, businesses, institutions, and non-profits, as well as indirect costs that are not accrued and can include potential financial losses such as reduced property values, negative impacts on tourism, and human and ecosystem health impacts.

Our vision and intent of this component is to establish a systematic and repeatable framework so that it can be used to track whether costs are increasing or decreasing, while also providing Philadelphia with a key tool in informing stakeholders of the cost of the litter problem . The assessment will measure expenditures across four categories related to litter and illegal dumping (prevention, education/outreach, abatement, enforcement) from local government, businesses, institutions, and non-profits.

RTI's four-step approach focuses on collection and reporting of relevant data, engaging Philadelphia stakeholders, to build confidence and conviction in cost estimation.



RTI has developed a General Linear Model (GLM) for predicting litter costs. This methodology incorporates various factors, including other environmental variables such as recycling rates. Developing a similar model for Philadelphia to predict litter costs will greatly improve the city's ability to create comprehensive estimates that are repeatable for future years.

Municipal Solid Waste Decision Support Tool

Developed by RTI International in collaboration with the U.S. Environmental Protection Agency, MSW Decision Support Tool (MSW DST) is a science-based, customizable software platform designed to help city officials make smarter, data-driven decisions about solid waste management. As Philadelphia seeks to modernize its waste infrastructure and meet ambitious sustainability goals, the DST offers a proven framework to evaluate the financial and environmental impacts of waste policies, programs, and technologies.

The MSW DST equips decision-makers with a consistent method to assess waste system performance and model alternatives—such as expanding recycling, managing organic waste, or investing in energy recovery technologies.

- Custom-Tailored Analysis: Adapts to Philadelphia-specific waste streams (residential, commercial), local market conditions, and infrastructure capacity.
- Scenario Modeling: Allows city officials to compare future-looking strategies based on cost, emissions, energy use, and recycling performance.
- Financial Insight: Quantifies both direct and indirect costs, helping Philadelphia evaluate long-term return on investment and prioritize high-impact improvements.
- Risk Assessment: Identifies vulnerabilities in waste systems—such as volatile energy prices or emissions risks—and informs policy resilience.
- Capacity Building: Empowers municipal staff through training and ongoing use, ensuring Philadelphia can manage the tool independently.

Since its launch in 2012, the MSW DST has helped over 100 public and private organizations globally optimize waste systems and avoid costly trial-and-error investments. For Philadelphia, the tool can provide clarity in a complex policy environment—bridging operational realities with environmental goals.

Knowledge Tool

To develop a Knowledge Tool that assists Philadelphia to get to the root cause and understand the relationships between different factors for littering and how to address them. Too often, research and reports—no matter how robust—end up on a shelf rather than dynamically assist in decision making. We believe there's an opportunity to change that with a Philadelphia Knowledge Tool, a dynamic information resource that goes beyond static reporting. By integrating disparate data sources with ongoing litter documentation, we can create an evolving system that provides key stakeholders—government officials, industry leaders, and domain experts—with actionable intelligence. This tool would serve as a live hub of insights, continuously updated to inform smarter policies, industry innovations, and targeted interventions. Rather than a one-time snapshot, we envision an adaptive, decision-making tool that turns data into measurable impact.

Litterati & RTI as a thought partner. We don't just collect data—we help organizations make sense of it. Litterati & RTI is offering our expertise to help design an intentional, systematic approach to litter data collection, analysis, and insight generation. But we know that true impact requires collaboration. As the old adage goes, "If you want to go fast, go alone. If you want to go far, go together." We want to work alongside Philadelphia and other partners to ensure that litter data isn't just gathered but leveraged for real change. Together, we can move beyond static reports to create a sustainable, scalable system that drives cleaner communities and more effective waste solutions.

We propose to work with the Philadelphia experts, affiliates and government officials, to develop this tool over a period of 12-18 months. The process follows four key stages:

- Integrate the various data sources
- Define the key metrics: such as litter density, composition, location patterns, and behavioral triggers.
- Create a decision matrix that categorizes issues based on both their severity and root causes.
- Prioritize actions based on the decision matrix.

This systematic approach ensures resources are directed toward interventions most likely to succeed based on evidence rather than assumptions. It also allows for ongoing measurement and adjustment of strategies as new data becomes available.

Qualifications & Experience

Keep Britain Tidy

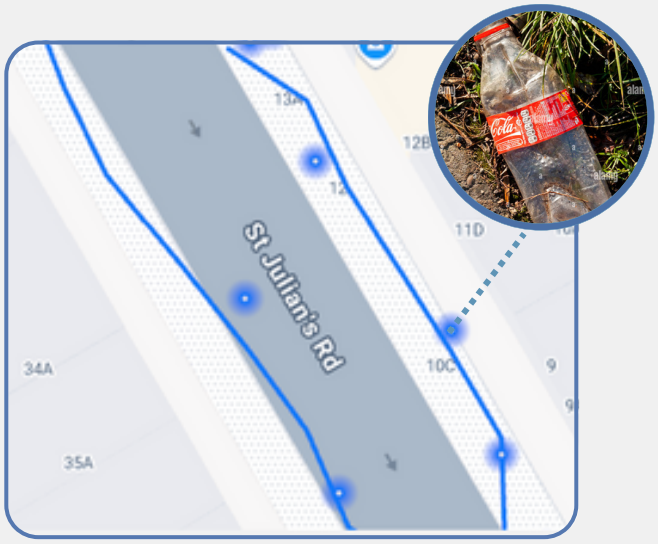
UK Tobacco Litter Study: 2022 Baseline and 2024 Follow-up

In 2022, Litterati conducted a baseline litter study across the United Kingdom to assess the prevalence of tobacco-related products in the environment. Litterati developed a survey framework tailored to the four nations of the UK and determined a sample size that would provide statistical confidence in the selected covariates with Keep Britain Tidy.

The selection criteria used the Lower Layer Super Output Area (LSOA) as the sampling unit. LSOAs are area units designed to maintain consistent population sizes, typically with a minimum population of 1,000 and an average of 1,500. The LSOAs were grouped by region and randomly sampled using two covariates: 1) Index of Multiple Deprivation (IMD) and 2) Urban or Rural classification

A total of 350 LSOAs were selected, and within each LSOA, a spatially balanced sampling approach was applied to allocate 15 locations, resulting in 5,250 total sampling locations. (map link)

In order to sample the 5,250 locations Litterati leveraged its community to identify qualified candidates to perform this research. Each researcher attended training and was certified through our training procedure. Data collection was managed during a two-month period in June and July. All data was subsequently quality assured and verified. The study yielded multiple insights which formed the key components of Keep Britain Tidy's 2023 anti-littering campaigns.



In 2024, Litterati was requested to repeat the study, utilizing the same methodology of the 2022 baseline but in different locations. This ensured the same framework was maintained - including the same nation & regional split, urban-rural ratio and distribution across the five IMD quintiles. The follow-up survey was conducted in the same period of the year enabling Litterati to provide insights where litter density had decreased or increased. This allowed KBT to effectively measure the efficacy of their campaigns, and request further funding to continue their successful programs.

Qualifications & Experience

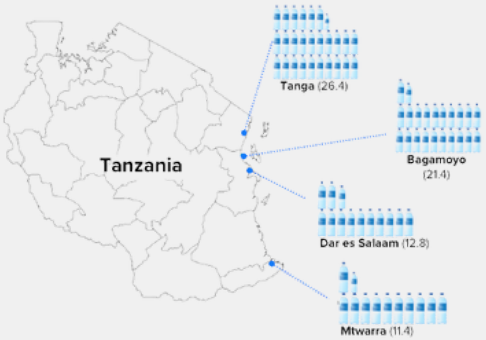
The World Bank

Tanzanian Urban Litter Study: Multi-City Analysis (2022-2024)

In 2022 Litterati conducted litter and waste surveys in three Tanzanian cities (Tanga, Mtwara & Bagamoyo). Each city included approximately 350 survey sites. In 2023, Litterati conducted the same litter study in Dar es Salaam, Tanzania's capital, examining 347 locations across 41 wards. Trained researchers covered two 100-meter transects capturing litter along roads, paths and identified dumpsites. Each piece of litter was photographed, analyzed with computer vision, and verified to ensure 90% confidence in object, material, and brand identification.

The research focused on:

- Categorizing objects and materials, with specific attention to the percentage of plastics
- Mapping dumpsites and hotspots while providing geospatial analyses of high litter density areas
- Visualizing findings through interactive maps, dashboards, and interpolation analyses for better insight, linking litter density to Points of Interest (Pols) such as commercial areas and industrial locations



This visual represents the equivalent number of littered plastic water bottles per capita in these cities (calculated at 15 grams per bottle).

In 2024, Litterati provided the World Bank with a comprehensive analysis of litter and plastic waste across all four Tanzanian cities—Dar es Salaam, Tanga, Mtwara, and Bagamoyo. Having surveyed each city with a consistent and rigorous protocol, we were able to compare and contrast multiple factors across cities including:

- Count, weight and volume of plastic, segmented by dumpsite and general litter
- Litter categories by city
- Drink items by count, road distance and population

These insights have enabled the World Bank to prioritize project types and specific locations, including which wards to focus on. Additionally the litter data has been analyzed alongside the most recent census data significantly enhancing the depth and applicability of the insights.

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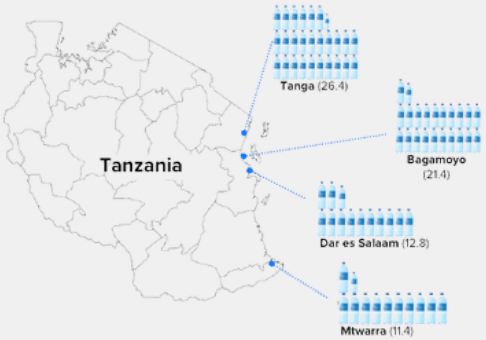

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Qualifications & Experience

City Fingerprint

Multi-City Litter Baseline (2022)

In 2022, Litterati embarked on an ambitious study to establish a litter fingerprint and baseline across three diverse cities: Norfolk, Virginia; Hayward, California; and Memphis, Tennessee. The study was designed to account for seasonal variations, with data systematically collected during Spring, Summer, and Fall. Our team focused on two critical aspects of litter:

- Litter Composition: documenting the general makeup of observed litter
- Litter Density: measured as Identifiable Litter per Meter (iLPM) to quantify litter per square meter

The study was structured in three phases, one for each season, with each phase consisting of a two-week collection period followed by a one-week quality assurance phase. In total, data was gathered from 300 locations in each city. At each location, researchers surveyed an area of 100 linear meters by 4 meters, then normalized the results to establish a standardized litter per linear meter measurement.

We collaborated closely with municipal departments including the Mayor's Office, Solid Waste, Public Works, and Communications. This partnership enabled key decision-makers to monitor litter trends over time and informed future planning. The research was further enhanced by incorporating secondary data sets to provide deeper insights, including Points of Interest and Highways, Places data, and American Community Survey datasets.

Graph shows the iLPM by litter category in each city over the study period

Qualifications & Experience

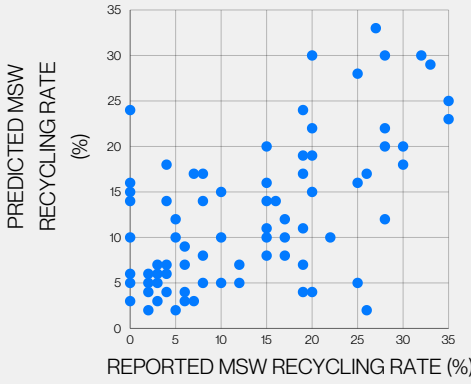
Medtronic

Creating a Dataset to Characterize Global Recycling Rates

For a global medical device company, Medtronic, RTI conducted a study of global recycling to understand whether switching to recyclable packaging would lead to a meaningful diversion from the landfill globally. RTI collected data and information from existing secondary sources to characterize the rate of recycling for plastics, glass, aluminum, and paper. We also conducted primary data collection via interviews with experts and government agencies in different locations to supplement the data and information from secondary sources and verify it's representative of on-the-ground situations.

Many countries do not regularly collect or report recycling data leading to many holes in the dataset. To overcome this, RTI custom-built a general linear model (GLM) using the open-source software, R, to predict recycling rates based on economic, social, and environmental metrics (e.g., GDP, UN Human Development Index). Predictor variables were carefully selected. Multi-collinearity was controlled using variance inflation factors (VIFs), traditionally accepted when under 5, where VIFs were all under 2 for the included predictor variables. Normality was verified using quantile-quantile plots, and Cook's distance was used to identify and validate influential data points. Our team predicted MSW recycling rates for 65 countries within +/-5%, 12 within +/-1%, and 4 exactly correct.

In total, we collected and developed municipal solid waste recycling rates for 204 countries and territories, creating one of the most comprehensive datasets to date. We then conducted deep dives into available recycling infrastructure, global legislation and medical policy change that encourages or challenges recycling initiatives for 18 targeted locations. The team's custom-built model enabled our client to develop a complete and comprehensive dataset for global recycling and provided them with a deeper understanding of recycling opportunities and challenges.



Qualifications & Experience

US Environmental Protection Agency

Cost Modeling for Solid Waste and Litter Management

Collecting and managing municipal solid waste and litter are essential services that cities, states, businesses, institutions and NGOs address. Decision makers make better-informed investment decisions in programs, infrastructure and management strategies when accurate data and effective tools are readily available. Solid waste and litter collection and management requires initial financial investments and annual expenditures that are significant budget line items for public and private entities.

Left unchecked, the environmental and social cost of inaction for dumping and litter prevention and management has been estimated to be 5–10 times more costly than proper management. To address the need for improved cost data and analytical tools to support decision making, RTI—in collaboration with the U.S. Environmental Protection Agency—developed the MSW Decision Support Tool (MSW DST). The RTI led MSW DST launched in 2012 as a free tool to assist communities, cities, states, and others in making more informed decisions about how they manage municipal solid waste, and how they can transition to a circular economy where discards are minimized, and energy and other resource recovery options are optimized. The tool is used by a wide range of stakeholders and has an active and engaged user community.

For more than 3 decades, RTI has been working with state and local government agencies, commercial entities and NGOs in the US to collect data and information to characterize the cost of waste and litter management including capital, labor, and ongoing annual expenses for program management, education and outreach, and maintenance of equipment and management facilities. Our waste analysts collect data and custom-build financial cost models and tools to support analyses of annual financial costs and return on investment for proposed waste and litter programs, strategies and technologies.

RTI's economists are often engaged to estimate indirect costs (and benefits) of waste and litter using tools such as Economic Input-Output to capture economic and employment impacts and indirect economic valuation methods (e.g., Hedonic pricing) to capture financial impacts to communities, businesses and individuals.

To the City of Philadelphia Sustainability Team,

Thank you for the opportunity to respond to the Request for Information on Solid Waste Management. We share your ambitious vision; one rooted in environmental justice, data-driven strategy, and community collaboration.

Litterati and RTI International bring a powerful blend of technological innovation, scientific rigor, and decades of worth of experience, and we are excited to contribute our collective expertise to help the City understand its current waste landscape, and build a smarter, more sustainable system for the future.

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