



Reforestation Hub Assessment

Prepared for the Arbor Day Foundation and New York City Parks



NYC Parks

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Key Terms / Abbreviations

CO₂e

Carbon dioxide equivalent. This is a standard unit of measuring the global warming potential of greenhouse gases, expressed in relation to carbon dioxide emissions.

MT

Metric ton, a unit of mass equal to 1,000 kilograms or 2,205 pounds.

Upcycle

To reuse an object or material in such a way as to create a product of higher quality or value than the original

Executive Summary

The goal of this assessment is to provide an opportunity analysis for wood waste recycling in New York City (the City). This report identifies existing wood waste generation and potential opportunities and barriers around wood reuse, as identified by key local stakeholders.

Between 2015 and 2020, the New York City Parks Department (NYC Parks) removed an average of 12,512 street and park trees each year. The woody biomass resulting from these removals — in addition to routine pruning and hazard work — is generated and managed separately by each of the forestry crews in the five boroughs, in addition to contracted tree service companies. While a small portion of material is ground at Cunningham Park in Queens and reused within the Parks system, most of the material is chipped and removed from the city for disposal as waste.

Our assessment resulted in the following recommendations:

- 1. Centralize wood waste.** At present, generation and management of NYC Parks' wood waste is uncoordinated, spread across a number of public and private sector crews. By centralizing wood waste collection under a single department and one or more collection sites, there is significant opportunity to cut costs and maximize return on investment in wood waste collection and processing infrastructure. Centralization can increase transparency and control over the agency's wood management program while creating new opportunities for secondary use of material.
- 2. Establish a pilot wood waste recycling yard, servicing Brooklyn and Queens.** The greatest opportunity for a successful wood utilization pilot lies in development of an initial reclamation yard serving the boroughs with the highest generation of tree removals. It will take time to work through technical and logistical program challenges but starting with these two boroughs will allow for maximum capture of material while reducing the number of entities involved as well as transportation costs.
- 3. Use policy levers to foster wood utilization.** We reviewed some of the main policy levers available to the City, including contract specifications and city purchasing agreements that prioritize salvaged wood. These actions would complement the additional infrastructure outlined above and ensure the health of the supply chain.
- 4. Engage the private sector.** Many local wood processors and buyers noted a lack of communication channels between the city and the private sector. Increasing visibility of opportunities to participate in wood salvage will be critical to engaging the market and enabling program success.

12,512

Average annual tree removals from NYC Parks

\$3,177,626

Payment to Waste Management for wood disposal from 2014 to 2020

\$7,200,451

Net present value of a wood recycling yard for Brooklyn and Queens

Cambium Carbon developed a financial model outlining four possible scenarios for wood waste collection and processing by NYC Parks. Because most woody debris is generated in Brooklyn and Queens, we focused scenarios on maximizing material collection from those two boroughs. As both city staff and private contractors expressed reluctance to bear the time and cost in moving material across boroughs, the scenarios explored selective processing of material with higher potential return: that is, trees large enough to be milled for slabs or lumber, quality permitting. The scenarios assessed are described below.

- Scenario 1: A single sorting yard servicing all woody debris from Brooklyn and Queens
- Scenario 2: A single sorting yard servicing Brooklyn and Queens, accepting only trees greater than 14 inches in diameter (i.e. of millable size)
- Scenario 3: A single sorting yard servicing all woody debris from Brooklyn and Queens, in addition to large-diameter material from the Bronx and Manhattan
- Scenario 4: Two sorting yards servicing Brooklyn, Queens, Manhattan, and the Bronx

Analysis of the four scenarios for wood waste processing yielded the following results:

KEY RESULTS					
Scenario	Name	10-year NPV (\$)	10-year carbon benefit (MT CO ₂ e)	Initial CapEx (\$)	Year 10 max wood capture (MT)
1	Brooklyn & Queens (all)	7,200,451	21,901	(733,000)	11,482
2	Brooklyn & Queens large-diameter only	6,465,734	20,249	(733,000)	10,616
3	Brooklyn & Queens + large-diameter Bronx & Manhattan	9,081,191	27,526	(864,000)	14,430
4	2 yards, 4 boroughs (Brooklyn, Queens, Bronx, Manhattan)	11,092,678	37,293	(1,466,000)	14,699

In each scenario, the sorting yard's 10-year net present value (NPV) with a discount rate of 10% was more than \$6 million, with the project breaking even by the end of the second year. Cost savings from avoided disposal fees (paid to a contracted waste handler) were excluded from this analysis due to their high variability but should be recognized as an additional financial benefit. Our financial analysis — in addition to interviews with public and private stakeholders in New York City's urban forestry system — suggest significant opportunity for financial and environmental impact from a large-scale wood salvage program. The recommendations outlined in this report have the potential to benefit NYC Parks in the form of cost savings, active revenue generation, and improved resource efficiency — thus advancing the City's zero waste goal. Furthermore, expansion of a waste-to-value salvage program presents an opportunity to create broader economic and workforce development opportunities within New York City while increasing resources available for new tree planting and maintenance.

Project Background/Our Team

Cambium Carbon is a social impact venture working to reforest America by enabling local wood economies. The company is born out of the World Resources Institute and has been developed through Yale University's entrepreneurship program.

This assessment is prepared for the Arbor Day Foundation and NYC Parks, as part of a Reforestation Hub development project funded by The Nature Conservancy's Natural Climate Solutions Accelerator Grant Program. New York City was one of three cities selected from a pool of more than 30 applicants for this project.

Our team draws from a deep network of partners from the fields of environmental science, urban forestry, workforce development, and climate finance. Cambium Carbon has leveraged these networks to produce a detailed plan for NYC Parks. This needs assessment has been conducted to address the facets of Reforestation Hub development most aligned with New York City's local goals and complementary initiatives.

Methodology

Cambium Carbon conducted 27 stakeholder interviews with organizations involved in management of New York City's urban forest, in addition to local millers and wood product buyers. Interviewees included city officials, private arborists, and NGO partners. Our conversations aimed to understand current wood debris management practices, assess local capacity gaps, and identify key opportunities and barriers to wood reuse. The interviews built upon background information provided by NYC Parks and included questions about wood disposal methods, data collection practices, and logistical considerations for new programming.

Tree removal data for fiscal years 2015–2020 were provided by NYC Parks. Data parameters included date, borough, diameter, and condition of removed trees. It should be noted that although current practices for storm removals are considered in this analysis, the baseline economic model focuses on averages from 2015–2020, in which no major storms occurred.

What is Urban Wood?

While at a broad level urban wood waste consists of all wood in the municipal waste stream, two primary sources of material are considered in development of an urban wood salvage and reuse program:

- **Deconstruction** – Material removed from deconstructed buildings (dismantled, rather than demolished), in which lumber is removed for refurbishing and resale.
- **Fresh-Cut** – Material generated from newly fallen trees or urban forestry maintenance activities. This material is often produced as a result of storms, development, hazard maintenance, or proactive mitigation of the spread of pests.

This report focuses exclusively on the category of fresh-cut wood debris generated by NYC Parks operations. However, it should be noted that there is significant potential for future integration of a deconstruction wood salvage program, given the opportunity to leverage shared processing, warehousing, and sales infrastructure across these two waste streams.

Reuse Applications

Fresh-cut urban wood can provide a renewable source of secondary materials at a variety of grades. The following chart outlines a range of potential products that can be derived from different types of urban wood debris:

Source Material	Processing	Product Applications	Value Category
logs (8' length & 12" diameter minimum)	milling, drying, finishing	Dimensional lumber and slabs	High (\$1,200+ per ton)
wood processing byproducts (sawdust, shavings, etc.)	chipping, pressing	Pellets (for biofuel)	Mid-range (\$150+ per ton)
tree limbs, log sections, stumps	splitting, drying	Firewood	Mid-range (\$80+ per ton)
branches, leaves, decomposed material, chips	chipping, grinding, pyrolysis (for biochar)	Chips, mulch, compost, biochar	Low (\$30+ ton)

For additional information on urban wood, see also:

- [The Urban Wood Workbook](#) (from USDA Forest Service, 2020)
- [Urban Wood Use Program Brochure](#) (from Dovetail Partners, 2020)
- [“What is Urban Wood?”](#) (from The Urban Wood Network website)

City Background

New York City is home to more than 5 million trees and 168 different tree species, which make up the approximately 22% canopy cover and have a replacement value of nearly \$5 billion.¹ NYC Parks, one of the largest forestry programs in the country, has jurisdiction over half of this tree canopy and individually manages more than 800,000 street and park trees across NYC's five boroughs. The agency is one of the most forward-thinking, data-driven, and technically advanced programs in the country.

The Nature Conservancy has partnered with NYC Parks, the USDA Forest Service, and 50 other stakeholders to create a comprehensive Urban Forest Agenda for New York City, set for release in 2021.² NYC Parks submitted a letter of interest to Cambium Carbon and the Arbor Day Foundation for additional support around urban wood reutilization and reuse. Our intent is to ensure that our recommendations align with their broader urban forestry goals.

Due in part to the sheer scale of the operation, NYC Parks and other municipal agencies bear significant costs each year with respect to the maintenance of the urban canopy. These costs include proactive tree management through contracted pruning by block, transportation of biomass, and fees for the processing or disposal of material. The current chipping operation in Queens (at Cunningham Park) requires staffing, equipment, and vehicles for transport. Additionally, contracts for wood debris disposal can reach multiple millions of dollars, especially in special instances such as extreme weather events (such as the recent Hurricane Isaias) or pests (such as the Asian longhorned beetle).

Recognizing that some higher-value material is currently being chipped or otherwise underutilized, NYC Parks would like to consider opportunities for the diversion and optimization of this waste stream. This report lays out the initial steps for such a plan, including the economic and environmental benefits of additional wood processing infrastructure.

Woody Debris Generation

In fiscal years 2015–2020, more than 75,000 street and parkland trees were removed across New York City's five boroughs. Despite some year-to-year fluctuation, totals remained consistent over this period, reflecting a substantial and continuous stream of woody biomass coming out of the NYC Parks' forestry operations each year.

It should be noted that major storm events can cause extreme shocks to the quantity of removed trees. The 3,370 trees downed by Hurricane Isaias on August 4, 2020, represented a

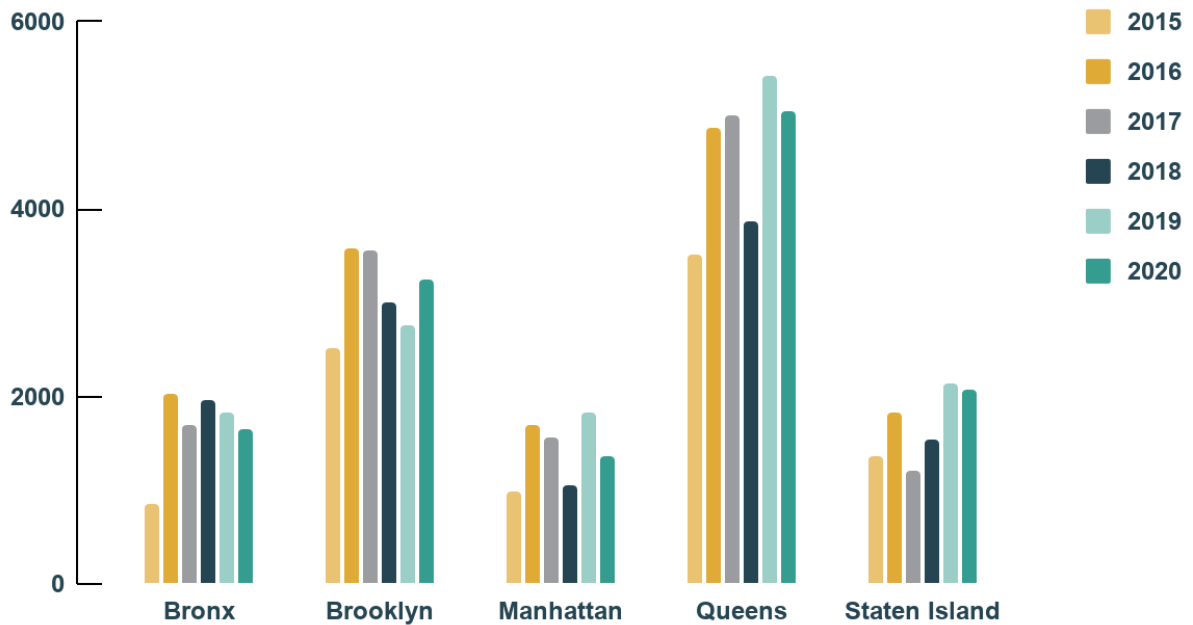
¹ https://www.milliontreesnyc.org/html/urban_forest/urban_forest_facts.shtml

² You can read more about the Urban Forest Task Force here: <https://www.nature.org/en-us/about-us/where-we-work/united-states/new-york/stories-in-new-york/future-forest-nyc/>

25.2% increase over 2020 removals, but the storm occurred just after the end of the 2020 fiscal year. Due to the sharp influx of material and need for rapid management and disposal, storm events pose a massive cost burden beyond normal operating budgets. Storm debris management presents a unique opportunity for large-scale wood utilization and will be addressed later in this report. That said, because no significant storms took place in the assessed six-year period, this analysis focuses on a baseline scenario for public tree removals in the City.

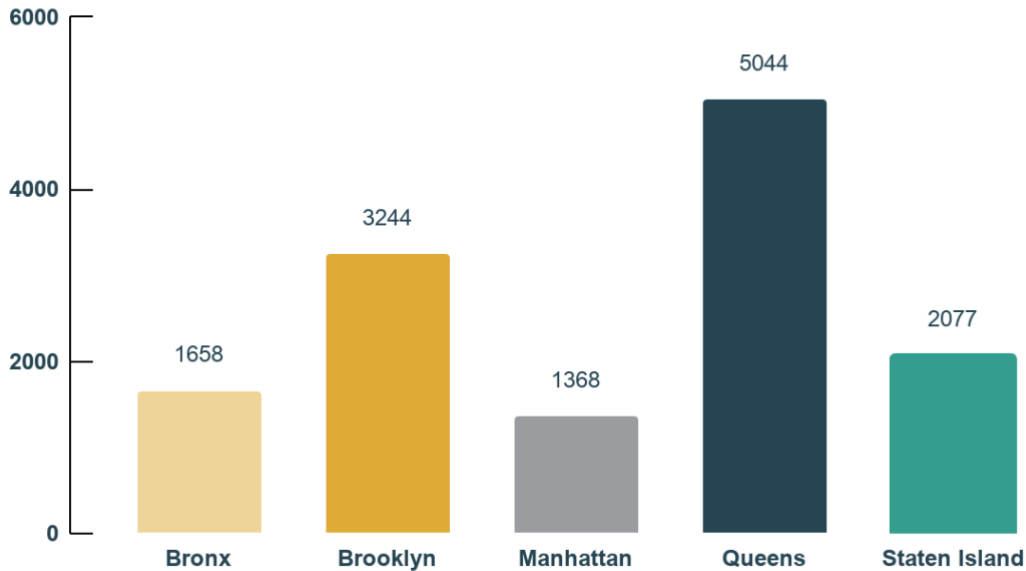
Distribution of removals across the boroughs showed a consistent trend from year to year, with an average 68.1% of total felled trees located in Brooklyn and Queens.

2015-2020 Removals by Borough



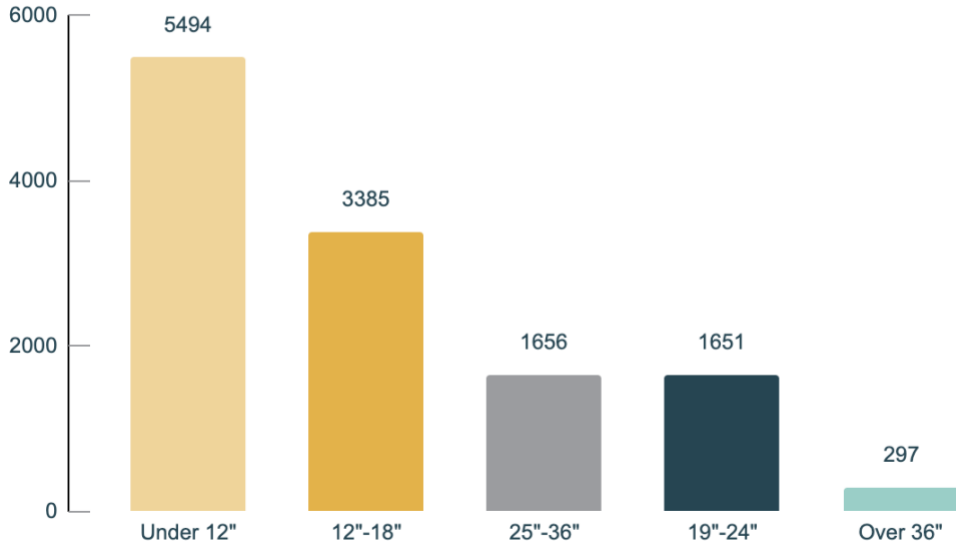
These two boroughs accounted for more than 8,000 removals in 2020 alone. That is 3,000 more trees than were removed in the other three boroughs combined. A single-year breakdown of tree removals by borough is provided below:

2020 Removals by Borough



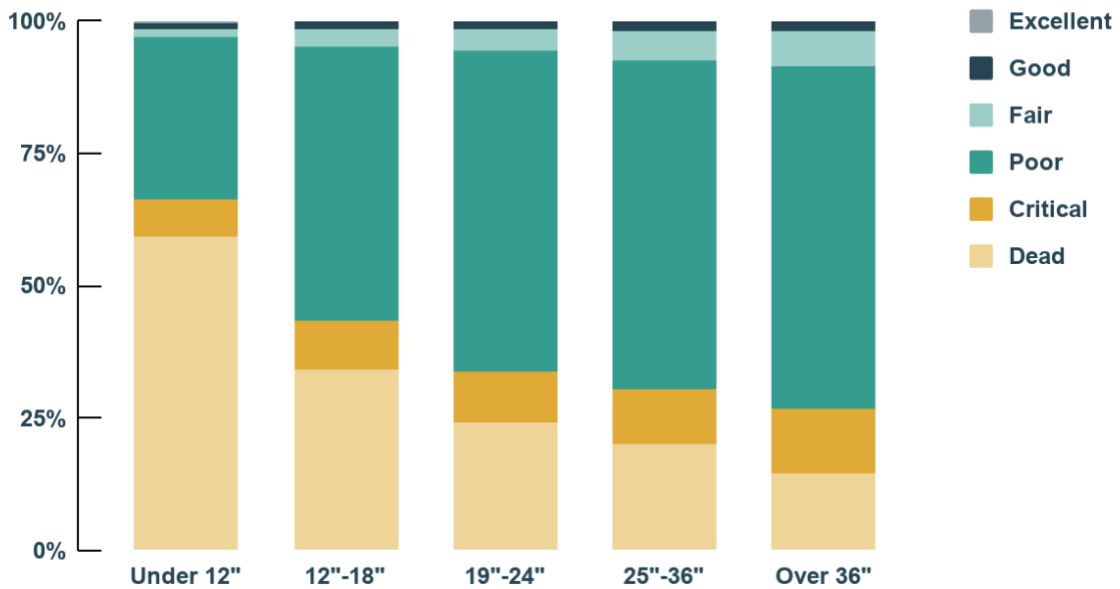
While these totals provide a sense of scale to the proportional number of trees removed across the city landscape, additional information is needed to understand the total biomass and secondary use potential of woody material in each borough. Looking at the size distribution for 2020, a large majority of trees removed citywide have a diameter at breast height (DBH) of less than 12 inches. Trees of this size are generally considered too small for milling. As a result, material is best used for end applications such as firewood, bioenergy, mulch, or compost. Suitability for each of these categories will depend on the condition and species of individual trees. For example, hardwoods may be preferable for sustained burning and rotted material most suitable for compost. By contrast, trees over 12 inches in diameter (particularly those 14 inches and up) may be desirable for milling into slabs or lumber, condition permitting. A breakdown of sizes of trees removed in a single year (FY 2020) is provided below:

2020 Removals by DBH



Another key criterion in assessing salvage potential is the condition of removed trees. The graph below analyzes inspection ratings for condition of trees removed between 2015 and 2020 according to size class:

2015-2020 Removals by DBH Category & Condition



The overwhelming majority of material coming out of the city's urban forest is rated as poor, critical, or dead. As a result, our scenario analysis for a city sorting yard and processing site assumes roughly 5% of material to be considered high-quality for use as premium slabs, consistent with the observed rates of good, fair, and excellent removed trees. A portion of lower-grade material is assumed salvageable for milling, given that inspection ratings reflect overall tree health and do not necessarily reflect the condition of the trunk's core.

It is assumed that most incoming biomass will be best suited for mid- to low-grade end uses such as firewood, pallets, or chips. This is a result of the average quality of removed trees as well as the significant volume of small-diameter brush and limbs generated by routine tree pruning and hazard management throughout the city. While this material is typically too small to be used for milling or woodworking applications, the biomass still presents viable material for chipping, composting, and a potential source of bioenergy/biochar.

Current Wood Utilization

This section looks at the two primary categories of stakeholders involved in wood waste generation and management within NYC Parks: internal city crews and private contractors.

City Crews

Within the Parks system, each of the city's five boroughs operates a forestry division that falls within Maintenance and Operations (M&O). These individual offices are responsible for the teams of arborists and foresters that monitor and maintain each borough's trees. Collectively this staff represents more than 200 employees across the five boroughs.

Jason Conheaney, director of forestry for Brooklyn, noted that while the borough retains some contracts for highly technical removals (as in the case when a tree grows into electrical wires), almost all tree work has shifted internally. While the borough crews try to retain as many trees on the landscape as possible, their active focus is on mitigating hazards. In Brooklyn, all material that results from in-house management of predominantly dead and dying trees goes to **Waste Management**, a private waste handling and recycling company that operates a facility within the borough. Material up to 10 inches in diameter will be run through a chipper, while larger branches and the main stem will be transported via log loader.

For city crews, a consistent hurdle identified with wood reuse is a lack of physical space. Several borough staff noted a surplus of wood chips, with no place to stockpile logs or process material. In Queens, all incoming material is ground at a site within Cunningham Park. With the exception of storm emergencies, all work is performed in-house, and all material is ground as trees are cut/pruned. During storm events, downed trees from across the city are aggregated at temporary debris storage sites (such as parking lots within the Parks system) for removal by contracted cleanup crews.

Phil Sparaccio, deputy chief of operations for Queens, noted that the borough sometimes exceeds its capacity for chips, hauling ground chips and unground hardwood shafts to Waste Management at “considerable expense.” Nevertheless, concern over community pushback to additional material collection within Cunningham Park means that there is a cap on what the site can bear. The borough generates approximately 10 truckloads of wood debris per day (with an additional two or three truckloads coming in from the Bronx each week). Phil and his team estimate that they generate an excess of 20,000 to 30,000 cubic yards of chips per year (roughly 5,000-7,000 tons). Future priorities for the Queens operation included room for expansion and equipment, including two excavators for log splitting, a horizontal grinder, and a walking floor trailer to facilitate cross-borough pickup and delivery of mulch and compost.

The **Department of Sanitation** (DSNY) is another key player in management of the City’s wood waste. DSNY supports NYC Parks through two primary flows: taking excess incoming woody debris in the event of a storm or material overflow in the boroughs and providing finished compost to the various borough forestry divisions as needed. In addition, DSNY supports seasonal collection and chipping of Christmas trees across three sites over a period of two weeks each winter. Records for recent years’ material flows at the department’s Staten Island facility are provided below:

DSNY Inflows and Outflows

Year	Inbound wood chips/ mulch (cubic yards)	Outbound compost (cubic yards)
2018	7,915	28,765
2019	585	30,916
2020	11,222	33,207

Note: These numbers do not include brush (wood under 4 inches).

These numbers reflect total material handled, from sources including city agencies, nonprofits, and private landscapers which often dump brush and stumps at the DSNY facility in Staten Island. While city agencies can drop off at no cost, private companies pay a fee of \$10/cubic yard — the same rate charged to fill up outbound vehicles with mulch. It was noted that the facility often runs at maximum permitted capacity. That said, although the department is seeking to expand, there is limited bandwidth at present to support additional material collection.

DSNY has been successful in finding homes for the compost it generates from the city’s organic waste stream (including leaf and food waste collection). Demand from community gardens and parks is consistent; additionally, a bagging machine is operated on-site to sell and distribute compost more widely. The department’s composting services contract with Denali Water Solutions includes marketing and sale of the city’s compost in Pennsylvania, New Jersey, and New York.

Private Contractors

Most out-of-house tree work falls within two major categories: routine street and park tree pruning and emergency response contracts. Cambium Carbon interviewed eight private NYC Parks contractors:

- Dragonetti Brothers Landscaping, Nursery and Tree Care
- Almstead Tree, Shrub and Lawn Care
- Beucler Tree Experts
- Emerald Tree and Shrub Care Company
- Lewis Tree Service
- Dom's Tree Service
- Waste Management
- Nature's Choice (Reliable Recycling)

Interviewees were asked about standard operating practices, wood waste generation and disposal, and key pain points in performing their work in New York City. A few themes emerged from our conversations:

1. **Most wood debris is currently chipped.** The majority of brush and logs generated by tree work is chipped on-site, as transporting and location of disposal outlets is easier and less costly for chips than whole logs. At Almstead, small-diameter city brush resulting from pruning activity is processed at the company's New Rochelle yard and double ground for mulch. Larger wood is ground to chips before being brought 2.5 hours north to a Columbia County facility for processing into mulch or compost. Although most contractors (with the exception of Dragonetti Brothers) stated that the lifting of the Asian longhorned beetle quarantine³ has not significantly changed their disposal practices, Waste Management has seen a sizable decline in material from the city and private arborists, and a significantly higher proportion of whole logs coming into its Brooklyn facility since the end of the quarantine. All of Waste Management's wood debris is subsequently transported to Nature's Choice (Reliable Recycling), a large organic waste recycler in New Jersey that sells bulk and bagged landscape products such as soils and mulch.

Noted wood debris off-

takers:

Almstead
Benjamin Brothers
Central Park Conservancy
Downes Tree Service
Moriarty Tree & Mulch
Services
Nature's Choice
Premium Mulch
Scott's Material
Vigliotti
Waste Management

³ The ALB quarantine regulated transportation of unprocessed wood/wood products including firewood, logs, and lumber, within New York City. Disposal requirements included chipping of all wood material within the quarantine area to limit further spread of the infestation. These restrictions were lifted in 2018.

2. **Disposal of city wood waste is a chief pain point for contractors.** Throughout the interviews, arborists cited the challenges of moving trucks and wood debris around the city. The team at Beucler noted that transportation considerations such as traffic and tolls will influence what contracts the company pursues and result in a focus on work in the Bronx, Manhattan, and Staten Island. Wood waste disposal options are evaluated as a combination of distance plus cost, with contractors willing to travel further for a lower per-ton tipping fee. Several contractors cited in-borough transfer stations or wood collection yards as a wish-list item from the city, even if a competitive tipping fee was charged. Additionally, it was noted that tree care work could be priced at a lower rate if contractors were able to reduce disposal fees, transportation, and time.

3. **Wood aggregation infrastructure could improve emergency response.** Waste Management handles roughly 200 tons of wood waste per month from public and private sources during normal operations. In the event of a storm, this can reach 250 tons a day. For specific emergency response activities, it typically takes 7–10 days for the company to mobilize its equipment. Because loaders and excavators are only permitted within city streets during specific windows, emergency response is not particularly nimble. Waste Management expressed a desire to establish storage locations in advance, to improve the management of wood debris during emergency events. For example, with more than a dozen temporary sites collecting material after Hurricane Isaias, some locations were impassable with a 100-foot trailer, instead requiring a shorter 40-foot vehicle. Establishing disposal sites and accessibility in advance may improve response strategy and efficiency during storm cleanup. Because storms present such high-volume, high-cost events, expansion of permanent infrastructure for wood aggregation and disposal within the city may reduce cleanup time and reliance on expensive short-term storage and removal contracts.

Wood Utilization: Recommendations

Stakeholder interviews and data analysis suggest that there is a significant opportunity to realize cost savings and environmental benefits by increasing disposal options within New York City and providing opportunities to store carbon in durable products (rather than quickly decomposing mulch). A few recommendations developed from initial research and outreach include:

- **Centralization of collection and management of the City’s wood waste stream.** The current management of wood debris across the boroughs and among private contractors has resulted in little shared infrastructure for wood waste management, increasing costs for individual actors. Multiple borough forestry staff expressed the challenge of expanding the budget for wood debris management (including equipment and transportation costs). A centralized program for wood waste management — particularly

one open to receiving external material from private sources — presents an opportunity to leverage investment to process a larger volume of material and ultimately increase program impact. This program could feasibly be owned by NYC Parks or the Department of Sanitation and could be run internally or bid out to a private contractor. Given DSNY's existing composting infrastructure and successful distribution of processed material, there may be benefits to expanding the department's role in organic waste management and reclamation of low-grade material for the city's compost.

- **Development of city-run collection sites.** This approach can provide aggregation points for public and private-sector wood debris, thereby capturing more material before it is chipped and transported out of the city. Establishment of collection infrastructure may present a revenue stream (in the form of tipping fees), a permanent resource for managing downed trees during extreme weather events, and a central nexus to pull material from the public and private sectors. By developing local sorting yards for wood waste, the City can have direct oversight over the wood waste stream. It can then dictate what products are derived, support its own zero waste goals, reduce emissions caused by transporting heavy biomass, and potentially drive down quotes for contracted tree work by reducing costs borne by private arborists for wood waste disposal.
- **Coordination of data collection.** Interviewees within Parks Capital and Forestry noted that data management systems vary across City agency teams. Although tree removal information often lives in construction contract documents, there is no active database communicating across AutoCAD and Forestry Management System (ForMS). Because construction and development projects often register upcoming tree removals up to a year in advance, there is high potential to leverage a coordinated record system toward selective salvage of viable logs.

The following section identifies specific policy levers and contract mechanisms that NYC Parks might institute to further catalyze urban wood utilization.

Policy Considerations for Enabling Wood Reuse

One of the main levers available to city agencies is the use and enforcement of laws, regulations, and contracts. While this is a broad topic with many avenues outside the scope of this assessment, we highlight several salient to urban wood utilization below.

- **Asset Transfer:** One regulation that affects many U.S. cities interested in wood reuse is around the transfer of public property (such as trees) for processing and resale by a private entity. An important step in opening avenues for wood reuse is making the case that this material presents a cost burden to city government, and consequently has no asset value.

- One unique case study in asset transfer came from a contract between NYC Parks and a nursery for growing of trees. In this case, the city gave liner stock (i.e., very young trees) to the nursery, which in turn grew them into larger trees that could be sold back to the City. This is an interesting precedent that may be replicable for urban wood waste. Instead of liners, high-quality logs could be given away under an agreement with a private miller to process the material to specifications needed for City use.
- **Public Trust Doctrine:** To protect the shared benefits of communal spaces, most cities have a public trust doctrine, which bans commercial activity on public park land. This doctrine is relevant to the location and operation of any urban forestry-related infrastructure. In NYC, a small parcel within Cunningham Park acts as an unofficial site for processing wood. While this area may otherwise have been a prime candidate for expanded wood utilization infrastructure, the Public Trust Doctrine likely rules out this option for using designated park land for operations closed to the public.
- **Tree Salvage Contracts:** NYC Parks often contracts with private arborists to remove trees. This legal agreement presents a great opportunity to further the urban forestry goals of the city and optimize processes. Contracts can specify contractor qualifications and set guidelines around various work processes, such as precautions associated with invasive species (e.g., Asian longhorned beetle).
 - There is precedent within procurement contracts at other municipal agencies to give preference to bidders that follow certain guidelines that an agency looks favorably on. Given that most private sector disposal of wood waste currently goes to low-grade end use (often at considerable transport distance), setting a preference for local disposal of wood waste or higher-value recycling of material could allow NYC Parks to extend its impact beyond its own crews. That said, a requirement to dispose at a city-operated sorting yard may be the easiest way of exercising control over waste management and debris recycling by contractors.
- **City Purchasing Agreements:** Another opportunity for municipal agencies to promote salvaged materials is on the purchasing side. If any construction work done by the city includes a preference for urban, salvaged, or reclaimed wood for its projects, this would create a stable and high-volume demand for underutilized materials. This could be implemented by Parks Capital but is not limited to NYCDPR.

Based on these various contracts and regulations, the following additions are recommended:

1. Incorporate salvage data into the tree removal process. For example, assessing salvage potential as a separate criterion from overall condition can increase opportunities for prioritizing wood recycling.

2. Create a preference or incentive for wood reuse in private arborist contracts. In addition, after adding additional wood utilization infrastructure in NYC, include a requirement for disposal at the new sorting yard into contract specifications.
3. Explore the contract growing model as a precedent for private wood processing and return of products, if such material can be used by the City in processed form (e.g., for capital projects, tree guards, mulch, etc.)

Wood Utilization Infrastructure

Introduction: The Need for Additional Infrastructure

Many of the interviews conducted were with private arborists and crews involved in removals, pruning, planting, and maintenance of New York City's urban forest. Throughout this process we learned about the current life cycle of wood waste in the city. One constant theme was the unique challenge of transportation in NYC. For many crews, the decision between landfilling, burning, chipping, or processing wood did not rest as much on the intrinsic quality of the wood as much as the logistical and cost constraints for each possible end-use. This is where the benefits of additional infrastructure could come in.

We believe the centralization of urban wood waste, at least in the boroughs of Queens and Brooklyn, could capture a sizable amount of the high-quality wood waste stream and pave the way for a significant economic driver (through wood processing and avoided costs) for the City.

Operation:

Before diving into a quantitative analysis, the first major question is around who will own and operate the site. There are three potential models for operation:

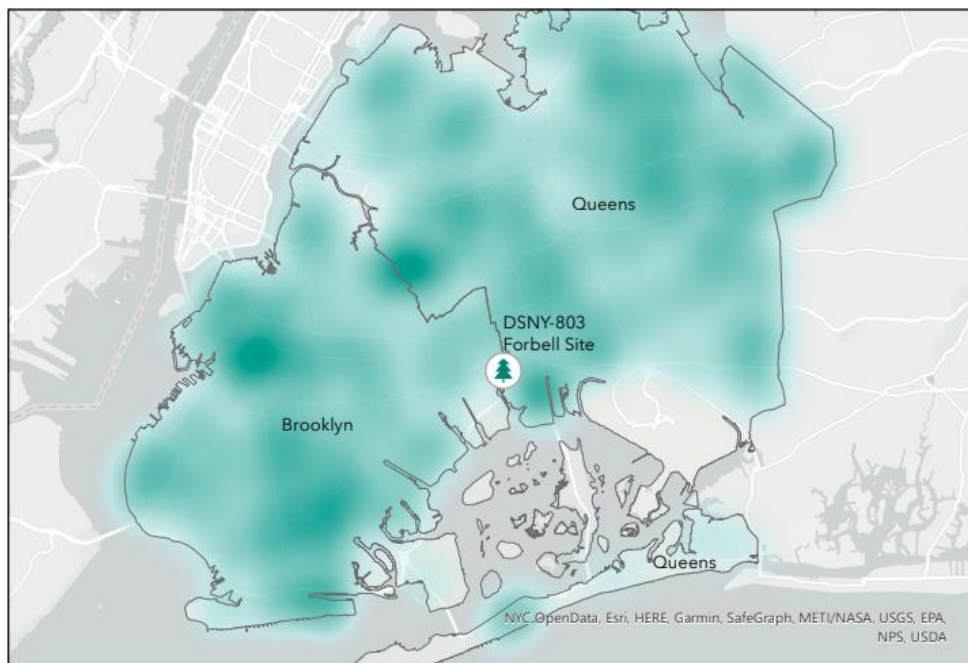
1. A public program, run by NYC Parks or the Department of Sanitation. While Parks plays a primary role in managing street and parkland trees — and consequently significant material generation of wood debris — Sanitation's oversight of the City's waste streams and existing infrastructure may better-position the department to manage a wood waste recycling program.
2. A public-private partnership, in which the city contracts out wood waste recycling operations (as is done with city composting).
3. An entirely private operation. In this scenario, the City could leave processing and reuse of urban wood to the private sector but create enabling conditions to support program success. (See *Case Study: Eau Claire, Wisconsin* in Appendix.)

Location:

Identifying land available for a sorting yard is a key first step toward pilot development. With factors such as cost and zoning making space a precious commodity in New York City, it is likely that existing NYC Parks or New York City-owned land held by other government agencies will be the best choice for an initial low- to no-cost site. While many locations may prove suitable for a pilot wood utilization program, one leading option that emerged in stakeholder interviews is the Department of Sanitation site at 803 Forbell Street.

Located on the border of Queens and Brooklyn, the Forbell Street site hosts a former incinerator and is well-positioned to service the two boroughs that generate the majority of wood debris from tree removals. It also complements the Cunningham Park processing site, which is located in the northeast corner of Queens.

803 Forbell Street Site, mapped against tree removal density in Brooklyn and Queens

**Sorting Yard Activities:**

The primary goal of a sorting yard would be to process a portion of public and private wood waste streams for the purpose of generating sellable material for secondary use. Operations would include milling, chipping, and splitting logs for firewood. A minimum staff of three full-time employees is expected to manage the site, including a yard master, equipment operator, and rotational support crews. The yard master would coordinate with support staff to sort and store incoming material based on quality, species, and size.

Preliminary Modelling of Revenues and Costs:

An exploratory model was built to weigh the economic and impact benefits of a sorting yard. Our model conducts the following steps:

- Forecasts the flow and quality of material from NYC Parks tree removals, based on existing data.
- Estimates capital expenditures (CapEx) such as equipment and vehicles as well as variable costs (e.g., site staffing and power) for a sorting yard.
- Gauges a sorting yard's capture of wood waste from the overall stream.
- Sets prices for the different quality of wood captured to estimate revenues as well as avoided disposal costs.
- Concludes with key outputs around bottom line numbers and total net present value (NPV) for the project.

We included multiple scenarios in the model which change the scope of the project based on certain criteria. Below are the descriptions of each scenario:

- Scenario 1: A single pilot sorting yard servicing Brooklyn and Queens
- Scenario 2: A single pilot sorting yard servicing Brooklyn and Queens, but only accepting biomass from 14-inch+ DBH removals (i.e., millable logs)
- Scenario 3: A single pilot sorting yard servicing all Brooklyn and Queens and additional large-diameter material from Bronx and Manhattan
- Scenario 4: Two sorting yards servicing Brooklyn, Queens, Manhattan, and the Bronx

Key Results

Analysis of the four scenarios for wood waste processing yielded the following results:

KEY RESULTS					
Scenario	Name	10-year NPV (\$)	10-year carbon benefit (MT CO ₂ e)	Initial CapEx (\$)	Year 10 max wood capture (MT)
1	Brooklyn & Queens (all)	7,200,451	21,901	(733,000)	11,482
2	Brooklyn & Queens large-diameter only	6,465,734	20,249	(733,000)	10,616
3	Brooklyn & Queens + large-diameter Bronx & Manhattan	9,081,191	27,526	(864,000)	14,430
4	2 yards, 4 boroughs (Brooklyn, Queens, Bronx, Manhattan)	11,092,678	37,293	(1,466,000)	14,699

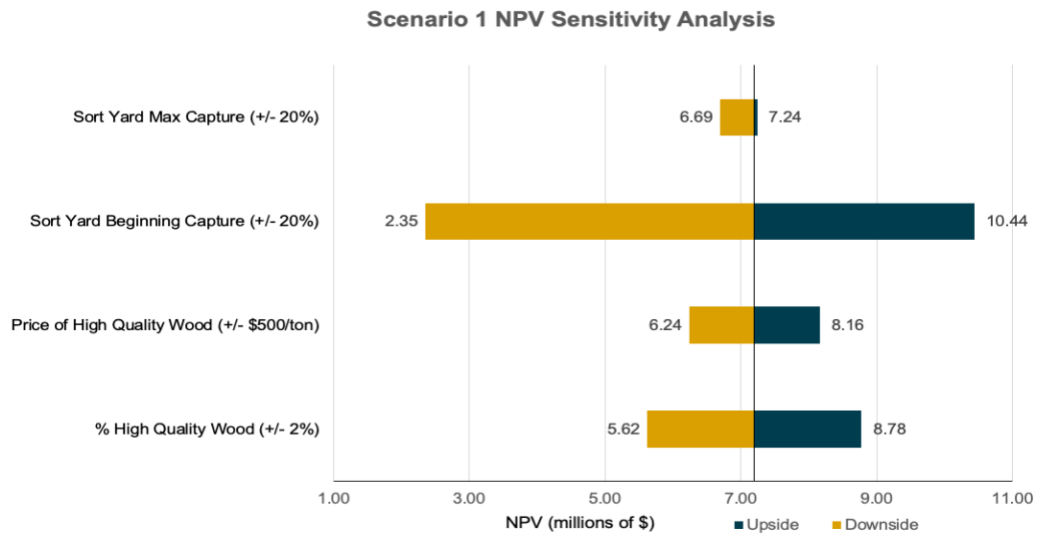
An explanation of each column is provided below:

- **NPV at 10%:** This is the net present value of the project over a 10-year period. Revenues in future years are discounted back to the present day using a rate of 10%, which reflects the general riskiness of the project.
- **MT CO₂e:** This number reflects the total carbon sequestered as a result of recycling operations. We calculated this based on increased storage of wood in durable products, as well as estimated displacement of emissions from conventional wood. While there would likely be significant additional carbon benefit from reduced transportation of debris out of the city for processing, these benefits are considered out of scope for this assessment.
- **Initial CapEx:** This is an estimate for the total amount of fixed costs needed to start the sorting yard. One caveat to this number is that we assumed for each scenario that the land would already be in the City's position and thus be free.
- **Year 10 Max Capture:** This is the total annual tonnage of woody debris that the project would handle at its maximum capacity.

These results approximate the general economic and impact benefits of a sorting yard in NYC. Choosing the project with the highest NPV may not be recommended, as there are nonquantitative logistical challenges for which the model does not account. For example, in Scenario 3, the selective transport of large-diameter material from the Bronx and Manhattan to the site in Brooklyn may prove challenging. **We recommend Scenario 1 for an initial pilot project**, given its reduced degree of complexity and higher potential for early success. The program could then be expanded in subsequent years to include additional boroughs while leveraging insights gained from initial testing and feedback.

Sensitivity Analysis

We recognize that many of the inputs into our model are both difficult to estimate and have a large impact on the key results. This section shows some of the biggest levers for the model and how changes to that value affect the project's net present value. The following chart depicts the effect of four variables on estimated NPV for Scenario 1 (~\$7.2m).



Each chart row reflects how NPV changes when the original input is increased or decreased by the value or percentage noted. For example, the original scenario assumes **5%** of the city’s wood waste stream to be high-quality material. If that assumption increases to 7% (+2%) — with all else held equal — the project NPV would increase by \$1.58 million to a total present value of \$8.78 million.

The sensitivity analysis demonstrates the relative effect of different inputs on financial outcome. As you can see, the amount of material received and processed by the sorting yard in its first year — the Sorting Yard Beginning Capture — is the most important driver. While it is difficult to precisely estimate how quickly city crews and contractors will adapt to bringing material to the new site, it should be noted that the more efficiently this collection can be coordinated, the better the project will perform.

Market Analysis

Successful scaling of an urban wood salvage program depends on the development of a market for reclaimed and processed material. The following section addresses the opportunities and barriers for fostering an urban wood economy.

Lessons from the National Network

Over the past year, Cambium Carbon has worked with urban wood millers and buyers in eight U.S. cities. As a result, our needs assessments are informed by both national-level trends and specific local context. While each city’s regional landscape varies, a few universal themes have emerged in characterizing the state of urban wood utilization. These universal trends can provide valuable context in setting the stage for a wood salvage program in New York City.

- **Small-scale urban wood utilization exists in communities across the country.** These boutique outfits capture only a small portion of available supply and reach a small number of high-end wood product buyers.
- **Education is a key driver of market development.** Our research and interviews have found that wood product buyers have an overwhelmingly positive response to the local and sustainable impact of urban wood. Yet awareness of reclaimed wood (either from deconstruction or fresh-cut salvage) is low, and buyers from architects to individual homeowners struggle to access this sustainable material consistently.
- **Urban wood millers and woodworkers are resource-constrained.** Only in rare cases can these small businesses scale up their salvage, milling, and drying operations while simultaneously developing the comprehensive sales and marketing plans to meet the increased production.

New York City Urban Wood Markets

Cambium Carbon contacted 83 wood millers, product manufacturers, and potential buyers in the New York City area. Two key categories of actors involved in connecting raw urban wood to a higher-value market are outlined below:

Millers

Our interviews identified four local operations with existing infrastructure to mill urban logs.

Big Reuse

While Big Reuse has a mill and staff trained in milling urban wood at its Brooklyn facility, the company noted lack of warehouse space for drying and storage as a chief consideration for taking on salvaged material. Nevertheless, the operation is interested in handling urban wood, and may be a future off-taker of material as the markets for urban wood products continue to develop.

Nature's Choice

A new entrant to the local milling ecosystem, Nature's Choice has been a chief processor of New York City's low-grade chips and mulch, as a subcontractor for Waste Management's processing. While the company's many locations across northern New Jersey can handle massive volumes of wood biomass, the infrastructure for milling whole logs has only been developed in the past year. As a result, it may take some time for the company to build the milling expertise and sales channels required for large-scale processing of city logs.

NYCitySlab

NYCitySlab carries more than 200,000 board feet of lumber from slabs of 25 different species, in addition to reclaimed lumber from deconstructed buildings and water tanks. The company operates a yard in Dover Plains, NY, and runs a 48"x50' capacity mill. NYCitySlab also does

specialized woodworking and would be interested in utilizing smaller 6–12-inch diameter sections, in addition to large millable logs. Owner Robert Rising noted that the company could pick up whole logs from a city recycling yard — taking as much viable material as was generated — but is interested in minimizing costs for its materials. While the milling operation could handle a significant volume of wood debris at zero transportation cost, it may require negotiation of a wholesale agreement for the company to pay for city wood.

Tri-Lox

Although new to fresh-cut urban wood, the milling team at Tri-Lox has built technical expertise in working with reclaimed wood, primarily from former city water towers. While the company is excited to handle New York City's logs, key barriers include infrastructure and transportation. Tri-Lox is currently able to keep 20,000 board feet of wood on hand in its Brooklyn facility, with most of the material stored in a Pennsylvania warehouse. Transportation of material is contracted out to a number of trucking companies and can be a significant expense. As a result, the opportunity to process additional city wood waste will likely require investment in additional storage and milling equipment. In addition, advance notice of material availability can enable the company to move material more efficiently, given its limited inventory and preference to presell and mill to order.

Wood Product Manufacturers

A selection of New York City makers relevant to the secondary processing and sale of sustainable wood products are noted below:

- RE-CO BKLYN
- Recycled Brooklyn
- Sawkill Lumber
- Tri-Lox
- Uhuru

While these companies do not handle primary milling of raw logs, they are important catalysts in growing an urban wood economy. These specialty furniture makers sell premium products made from urban wood and salvaged material and may be the most natural local buyers for New York City-generated slabs. Although key barriers include storage, transportation, and consistency of incoming material, the proximity of these premium manufacturers offers a promising sales outlet for upcycled city logs.

Purchasers

In terms of commercial projects, New York City is home to 1,920 registered architects and interior design firms. Given the density of local commercial development and ongoing need for building finishes and furniture, there is significant opportunity to connect salvaged wood products to local design projects. The team at **Skidmore, Owings, and Merrill**, among the largest international architecture and engineering firms, expressed interest in potential integration of urban wood materials if a consistent supply chain could be developed to meet local project needs.

Within retail channels, the high-end product manufacturers at **Stickbulb** (of Rexius Design Group) see opportunity to use urban wood as a case study in telling the story and marketing the impact of a premium wood product. In addition, education channels present an opportunity to grow awareness around the carbon and local impact story of urban wood. Staff at **The Parsons School of Design** identified several workshops, projects, and competitions that could incorporate salvaged New York City wood into their sustainable materials portfolio and broader design work.

Market Development – Recommendations

Our interviews with local processors and buyers of wood products suggests that many of the underlying conditions are in place to catalyze a robust urban wood economy. That said, activation of local networks will be critical to program success. A city wood processing yard will only generate revenues if private-sector off-takers are aware of material available for sale and educated on the local impact and story of urban wood. Many private companies expressed interest in collaborating with NYC Parks but noted a lack of communication channels to get involved in urban wood salvage projects. Conducting outreach and increasing visibility of wood salvage will be an important step in building a local market and creating new opportunities for public-private partnerships. For example, posting inventories and prices to a live web landing page can help drive sales. Similarly, tying into local initiatives such as the City's zero waste campaign or New York Circular City Initiative can help build collective awareness and markets for wood reuse.

In addition, several millers and makers expressed a desire for advance notice of upcoming removals and the type of material that would be available for secondary use. Establishing a grading system to assess salvageability as a separate inspection criterion for upcoming removals can allow better predictability of available material coming into a city collection yard. Salvage grading could address structural core condition of a tree trunk and site-dependent conditions (such as the ability to cut a log to longer millable lengths). Furthermore, coordinating tree removal tracking across the forest management system (ForMS) and the Parks Capital systems may allow for improved live data on upcoming removals (species, size, and condition parameters).

Next Steps

Research and analysis suggest that there is significant opportunity to develop a large-scale wood utilization program in New York City, with both public and private-sector benefit. To move forward with program development, we recommend two key next steps:

- Identifying a lead operating agency: Discuss options between NYC Parks and DSNY.
- Selection of a pilot program: Establish the sorting yard location and scope.

From there, the city can work to devise a detailed project plan and implement the strategies outlined in this report to support operational success.

Appendix



CASE STUDY: EAU CLAIRE, WISCONSIN

In 2012, the **City of Eau Claire** began thinning local ash trees as a response to detection of Emerald Ash Borer. This process led to questions of how to prevent valuable wood from going to waste. Rather than turn those trees into mulch or pulpwood, the city partnered with members of the nonprofit **Wisconsin Urban Wood** to help local artisans and businesses put culled ash trees to better use.

With support from the **Eau Claire Chamber of Commerce**, the city devised a legal “Use Agreement” allowing Wisconsin Urban Wood members to process and sell logs from the city’s sorting yard within their own businesses. This transfer of title was made possible by an acknowledgement that avoided processing costs on the part of the city were of sufficient value as to be of public benefit. The result was a reduction in chipping and disposal costs, while ensuring the wood was effectively reused within the community.

While the City of Eau Claire was responsible for maintaining the sorting yard and granting access during scheduled hours, Wisconsin Urban Wood members were responsible for any damage incurred. Furthermore, while members could bring portable sawmills on site, the City was not obligated to provide support in handling and processing of material. Logs were allocated to individual local businesses by Wisconsin Urban Wood, and partners were required to report records of species and quantities taken from the site.

Matthew Staudenmaier, Forestry Supervisor of the City of Eau Claire, recently discussed the success of this public-private partnership as a means of limiting city liability while supporting job creation in urban wood processing. Staudenmaier emphasized the importance of creating fewer entities to negotiate with (as opposed to individual end users of urban wood). In addition, collaboration with the State **Department of Natural Resources** was an integral step for Eau Claire in helping to share ideas and bring stakeholders together.

Further Reference:

- <http://wisconsinurbanwood.org/wp-content/uploads/2017/03/4.19.16.Front-Page-Eau-Claire-Leader-Telegram.pdf>
- <http://wisconsinurbanwood.org/sample-municipal-models/>
- <http://wisconsinurbanwood.org/wp-content/uploads/2017/03/WUW.Use-Agreement-Blank.pdf>
- <https://www.youtube.com/watch?v=WGjVXBqEQjU>

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