Pushing the Urban Resource Recovery and Re-use Envelope:
Closing Loops City Program Initiative (URR.8)
or You Can't Have Zero Waste without CDW
URR Working Group
October 13, 2021, from 9:00 a.m. to 1:00 p.m.
Via Microsoft Teams

This event will be recorded for posting to the Town+Gown:NYC webpage.

9:00-9:20 a.m.	**Urban Resource Recovery Working Group's Closing Loops City Program Initiative (CLCPI)** Terri Matthews, Director, Town+Gown:NYC
9:20-10:00 a.m.	**There's a BUD for That: Pratt Communication Design Project and BLS Summer Clinic Project** *Moderator: Kathleen Prather, NYS DEC* Michael Kelly, Pratt/Communications Design Samuel Calderone, Katana Meganck, Kirk Rotger and Katherine Will, Brooklyn Law School (Classes of 2022 and 2023)
10:00-10:30 a.m.	**Where's the Data (And How to Use It): NYU/CUSP Capstone Project** *Moderator: Kathleen Prather, NYS DEC* J.P. McKay, Parth Singhal and Dina Wagdy, NYU/CUSP (Class of 2021)
10:30-10:40 a.m.	**Break**
10:40-11:10 a.m.	**GreenNY Program** *Moderator: Jennifer McDonnell, NYC DEP* Jodi Smits Anderson, Dormitory Authority of the State of New York

11:10 a.m.-12:30 p.m.	**More than a Village** *Moderators: Kathleen Prather NYS DEC and Jennifer McDonnell, NYS DEP* Matthew Adams, New Jersey Institute of Technology Marianna Koval, NYU/Stern Center for Sustainable Business Gretchen Worth, Christopherson Center for Community Planning, CR0WD Program Amanda Kaminsky, Building Product Ecosystems
12:30-1:00 p.m.	**Discussion**

URR.7 Precis

Not Town+Gown's First Rodeo. Today's event, URR.7, represents the URR Working Group's capstone, following almost four years of collaboration involving symposium events, experiential learning projects and many meetings with the agency-only subcommittee to develop the Closing Loops City Program Initiative (CLCPI), which will be revealed to the entire URR Working Group and the rest of Town+Gown members. The subcommittee developed the CLCPI, as an actionable initiative from the City government perspective, with the intent to release it, when it was in a form ready for "prime time," to the wider Working Group members for review and comment. The CLCPI has the potential to generate capital budget savings, and adding CDW to MSW as part of the City's Zero Waste plans will accelerate achievement of zero waste performance goals and benefits.

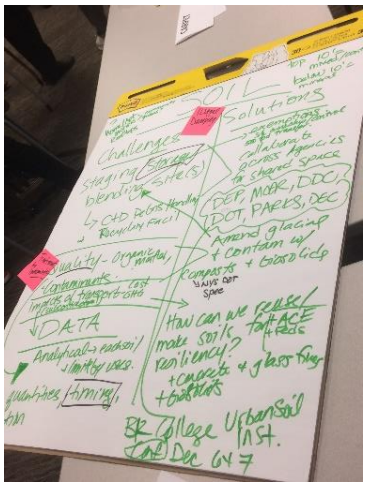
Town+Gown's construction and demolition waste (CDW) recovery and re-use policy development effort began with **CDW.1**, on November 30, 2017, which was a general exploration of the state of academic research, practical considerations and impediments and ideas for future research to advance the recycling and reuse of CDW. [1] CDW.1 was inspired by a 2015-2016 research project involving a partial comparative life cycle assessment (LCA) to compare the environmental impacts of two concrete product systems—concrete with coarse natural aggregate and concrete with coarse recycled aggregate.[2] Various professors presented at this event.

CDW.2, on October 30, 2018, formed working groups to explore ways to close concrete, gypsum, glass and soil material loops within the City, which led to the CDW Working Group, later renamed the Urban Resource Recovery (URR) Working Group.[3] Images from that working group session are below.

[1] See https://www1.nyc.gov/assets/ddc/downloads/town-and-gown/Precis_Final.pdf.

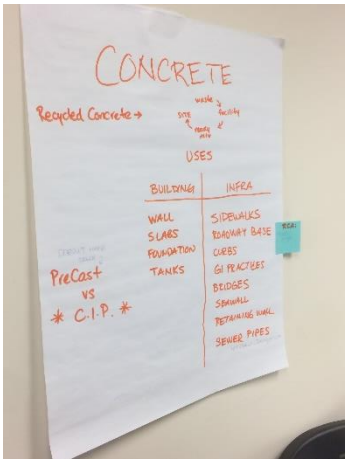
[2] Conducted by a visiting graduate student, Meryl Lagouin, working with Professor Ardavan Yazdanbaksh of CUNY/CCNY and the New York City Department of Sanitation, using data submitted by New York City-located transfer stations.

[3] See https://www1.nyc.gov/assets/ddc/downloads/town-and-gown/CDW.2%20Precis.Final.pdf and https://www1.nyc.gov/site/ddc/about/town-gown-working-groups.page.



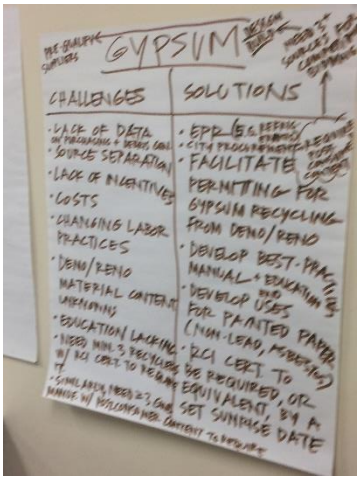
Soil Tear Sheet

Soil Group in Action

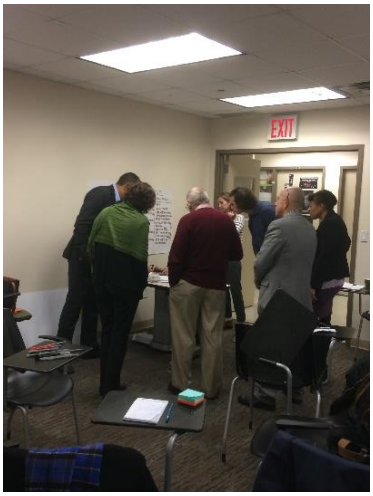


Concrete Tear Sheet

Concrete Group in Action



Gypsum Tear Sheet



Gypsum Group in Action

CDW.3, on August 1, 2019, focused specifically on life cycle cost benefit analysis (LCCBA) modeling applied to recycled concrete aggregate (RCA) that would be used as a basis for providing a LCCBA model template for all CDW material loops. Professor Ardavan Yazdanbaksh of CUNY/CCNY ran through the mechanics of LCCBA modeling for RCA and noted that concrete production firms would require a steady and predictable stream of RCA in order to invest in new equipment because it is not possible to use existing equipment for RCA. The ultimate question to be answered with LCCBA for RCA in new concrete is whether it is worth the additional costs, which has a financial component at the producer firm level in addition to the environmental component.

CDW.4, on October 23, 2019, was a directed exploration, at the request of several CDW Working Group members that focused on how to calculate environmental impacts from recycling and re-using CDW on projects within the Envision framework. Envision is considered the "LEED" for infrastructure projects, which several infrastructure agencies are using on a voluntary basis.[4] Since life cycle analysis (LCA) modeling under Envision requires owners to quantify environmental impacts from reuse of recycled materials, the CDW.3 presentation raised questions about how a public owner wishing to evaluate its infrastructure projects within the Envision framework for eventual Envision credit should assess the environmental impact of reusing recycled materials on its infrastructure projects. Professor Spiro Pollalis of Harvard discussed the Envision framework and Professor Christoph Meinrenken of Columbia presented on available life cycle assessment (LCA) tools that can evaluate system-wide environmental impacts from green technologies, including the re-use of recycled CDW elements. The GHG Protocol, developed by the World Resources Institute in collaboration with the World Business Council for Sustainable Development, seemed to be the optimum methodology for public owners because it can be executed without proprietary software and is appropriately detailed with regard to GHG attribution for recycling for both recycled content and closed loop methods, has a high level of detail, and permits owners to use locally-derived parameters and data.[5]

Prof. Meinrenken ended his **CDW.4** presentation with the open question about other alternatives for low carbon cement, such as using slag cement and fly ash, which led to **CDW.5**, on February 24, 2020, to explore how innovations in technology and materials science can support the increased re-use of recycled CDW elements in new construction materials of higher

[4] LEED has been required for use on public building projects since 2005 as mandated by Local Law 86 of 2005.
[5] See https://ghgprotocol.org/. This is a traditional 1, 2, 3 accounting approach; recent discussion has been focusing on how to move toward a consumption or embedded content approach to account not only for the energy consumed but also for the impact of what is built and/or purchased. See https://www1.nyc.gov/assets/ddc/downloads/town-and-gown/10-23-19-Precis.FINAL.pdf

value to create business incentives among producers. At **CDW.5,** Professor Julio Davalos of CUNY/CCNY discussed how he used New York City as the test bed city in helping to develop ASTM specifications for the use of glass pozzolan in concrete production suitable for municipal infrastructure use. The design, production, and applications of glass-pozzolan concrete can follow standard industry practices and contribute to glass-waste reduction and reuse. While glass pozzolan can be used to create an environmentally preferable supplementary cementitious material (SCM) for the concrete industry it is an expensive process, pointing to the need for creating materials of high value to enable the economics of the recycled CDW market. Professor Weihua Jin of NYU presented on an array of materials science and technology to support up-cycling solid waste, including CDW, to create sustainable building materials for new construction.[6]

On July 29, 2020, Civ:Lab, in collaboration with NCY DEP's Office of Energy and Resource Recovery Programs and Town+Gown:NYC, which are members of Civ:Lab's "Grid", brainstormed and explored, with other Grid members, how to plan for innovative biosolids use outside traditional waste water (WW) industry solutions. Beyond proven uses of biosolids (e.g., direct land application/composting), and subject to federal and state regulation, there are processes available to make biosolids suitable for wider use. Recent industrial design research at Pratt has suggested that it may be possible to expand biosolids use beyond traditional options that may help turn biosolids into a material with value in more commercial applications and thus provide additional revenues to the City in the long-term. New and innovative biosolids use, however, requires tapping into disciplines beyond traditional wastewater competencies (infrastructure engineering, biological and chemical treatment of organic wastes) to include industrial and other designers and accessing the innovative thinking and experience of business enterprises in the Grid and other innovation hubs. This **Civ:Lab Biosolid Brainstorming** event, which led to the rebranding of the CDW Working Group to the URR Working Group, identified broad strokes forward to expand the uses and potential markets for biosolids—biosolids re-use in the construction industry emerged as one urban market with potential.

URR.6, on February 26, 2021, developed from conversations with a Parks member of the URR Working Group. Professors Daniel Barone, Yun Bai and Robert Miskewitz from Rutgers University presented on pneumatic flow tube technology developed at Rutgers that permits beneficial re-use of moderately contaminated sediments dredged closer to the shore and the Rutgers Maritime Asset Management System (MAMS), a decision-support tool, as a foundation

[6] See https://www.billtrack50.com/BillDetail/1140626. See https://www1.nyc.gov/assets/ddc/downloads/town-and-gown/02-24-20-Precis.FINAL.pdf.

for considering the introduction of this recovered urban resource in the URR Working Group's developing CLCPI.[7]

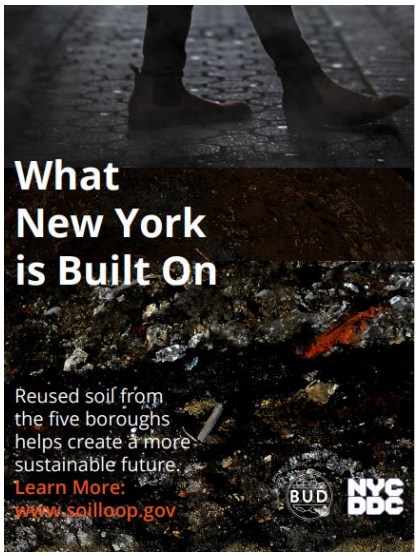
URR.7, on March 25, 2021, introduced the topic of wind turbine blade second-life and sustainability of the wind industry, its challenges and its opportunities for both public agencies and private industry. Various professors associated with the Re-Wind Network discussed the developing technology for re-use and repurposing of wind turbine blades, with multiple re-use options for whole blades and blade segments in various project designs and construction. There are a number of organizations around the world actively looking at how re-use these blades that will be decommissioned and available for re-use with the increasing creation and operation of wind farms, but few public agencies outside of Ireland are actively engaged in this effort. This event was intended to bring this construction material to U.S. public agency attention.[8]

Academic Research for the URR Working Group. URR Working Group members, at events, in agency-only meetings, and in the hallway, have suggested various research ideas. Three ideas led to student-led projects completed in the last two academic years for the agency members of the Working Group. Presentations on all three projects are part of today's event.

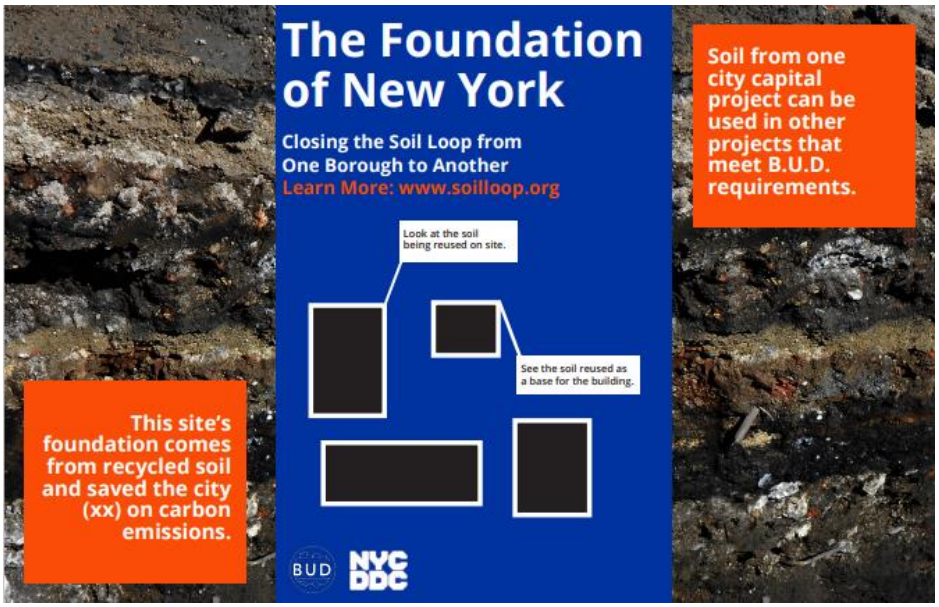
Pratt Institute/Communications Design. A practitioner working on a large infrastructure project requiring importation of a great deal of soil approached Town+Gown with a project idea about how to communicate, to the public, that re-use of excavated soil from other projects would not only be environmentally good, but also safe. Pratt's Design Corps program picked up this idea in fall 2019. The students worked with participating URR Working Group members on the design brief, that expanding from a public safety communication strategy to include a communication to the design and construction professionals working on City construction projects that re-using soil from one project on another project was environmentally and financially sustainable and safe. The students researched NYS DEC's beneficial use designations (BUDs) for excavated soils, the City's capital program processes, and various other recycling programs for soil and other materials to create a communications strategy involving construction hoardings, subway ads, separate brochures for the general public and construction professionals, and a website. The nature of the students' communications strategy and collateral led the URR Working Group members to realize that implementing them required a city-wide program because recovery and re-use involved all construction agencies, which would require a level of governance support that does not exist, leading eventually to the creation of

[7] See https://www1.nyc.gov/assets/ddc/downloads/town-and-gown/Precis_with_Agenda_and_Biographies_FINAL_2.26.21.pdf.
[8] See https://www1.nyc.gov/assets/ddc/downloads/town-and-gown/Agenda_with_precis_and_bios_Final_3.25.2021.pdf

the CLCPI, which expanded to include other CDW materials in addition to soil. This communications design project helped the Working Group conclude it was necessary to go big or go home.



Example of a subway sign



Example of a construction hoarding

New York University/Tandon—Center for Urban Science and Progress. At several Working Group meetings, an active member raised the issue of needing CDW data to inform the group's policy development. The Working Group's sense of City-level data availability, later confirmed during CLCPI development, was that CDW material and volume data exists at different levels at the agencies largely in the form of paper documents in project files. The earlier Pratt project

involving NYS DEC's BUD for soil revealed the existence of NYS DEC's CDW reports that could serve as an initial data source to get a sense of CDW material and volumes generated at the City level. This generated a data science project that NYU/CUSP's capstone program picked up for spring/summer 2021.[9] The project involved extracting CDW trip data from the NYS DEC reports to import into a data visualization tool they created for the URR Working Group to enable "order of magnitude" and directional CDW flow analysis. Initially, the CUSP team spent the spring semester developing code to machine read these reports to create the CDW trip data, but the code could not work due to the variety in form completion (handwritten, typed, "see attached" in fields) and other data aspects. The CUSP team then manually created CDW trip data from the forms to have sufficient data to develop the data visualization tool, which is available at Streamlit.[10] This data visualization tool is an important first step for local governments, including the City, to be able to analyze CDW data to support policy development and estimate savings to the capital budget from CDW recovery and re-use.

Maps of Incoming and Outgoing Concrete CDW 2019

Brooklyn Law School. During development and refinement of the CLCPI, which focuses on recoverable materials in different stages of re-use feasibility with a weak re-use market and leverages NYS DEC regulations as a policy pathway that assumes compliance with the BUDs, it became clear to the Working Group that the BUD regulations were complex and part of a complex set of wider State regulations. It was necessary to have practicing-level knowledge of these regulation and a summer 2021 Brooklyn Law School (BLS) student team[11] researched, for the URR Working Group, NYC DEC's Part 360 regulations and analyzed what actions the City would need to take to recover and re-use each CLCPI recoverable material. The student team researched the legislative history behind the State's regulations as well as the regulations

[9] J.P. McKay, Parth Singal and Dina Wagdy, NYU/CUSP Class of 2021.
[10] See also Mapping CDW: Capstone (accomplishedcode.github.io),
[11] Samuel Calderone, Katana Meganck and Katherine Will, BLS Class of 2023, and Kirk Rotger, BLS Class of 2022.

governing the rest of the participants in the CDW system. The research conducted by the BLS team was contemporaneous with the Working Group's refinement of the CLCPI, which directly reflects their legal and non-legal analyses.


URR Town+Gown:NYC DDC: Closing Loops City Program Initiative

Memorandum: Analysis of 360 Regulations
Closing Loops City Program
Urban Resource Recovery (URR) Working Group in Town+Gown: NYC
New York City's Department of Design and Construction
Samuel Calderone, Kenna Magnuck, Kirk Rotger, Katherine Will

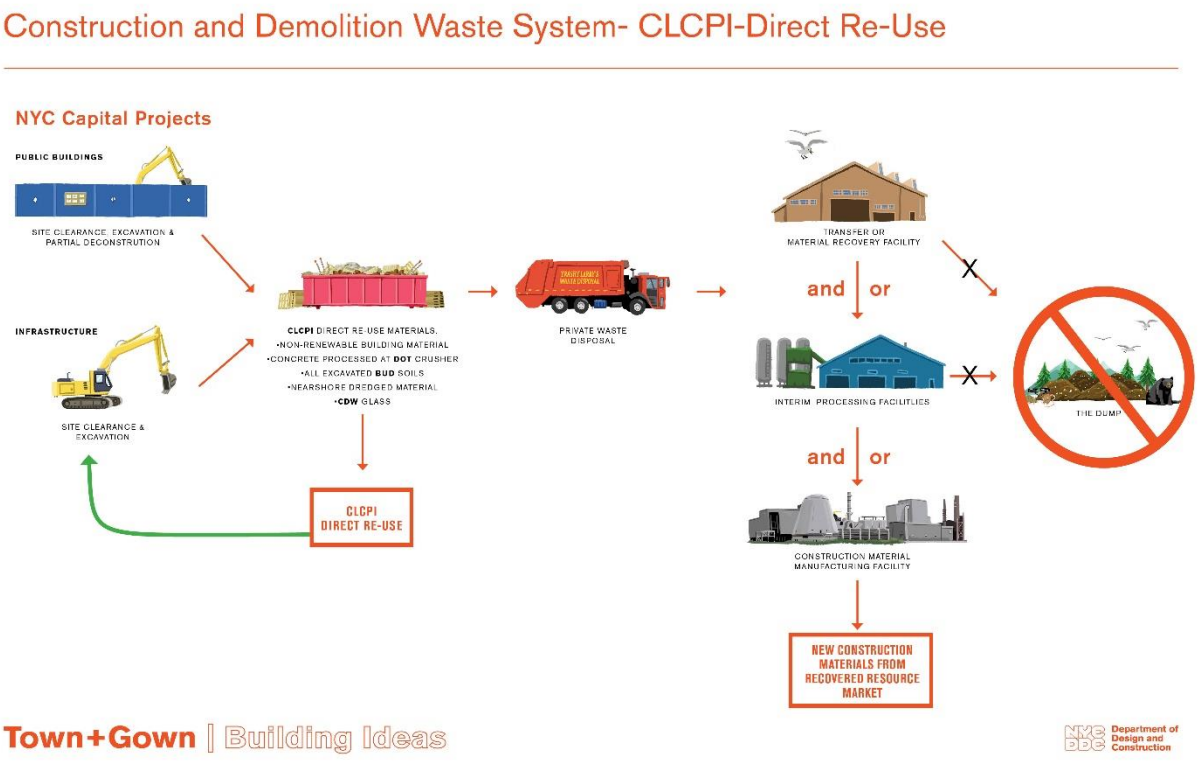
0

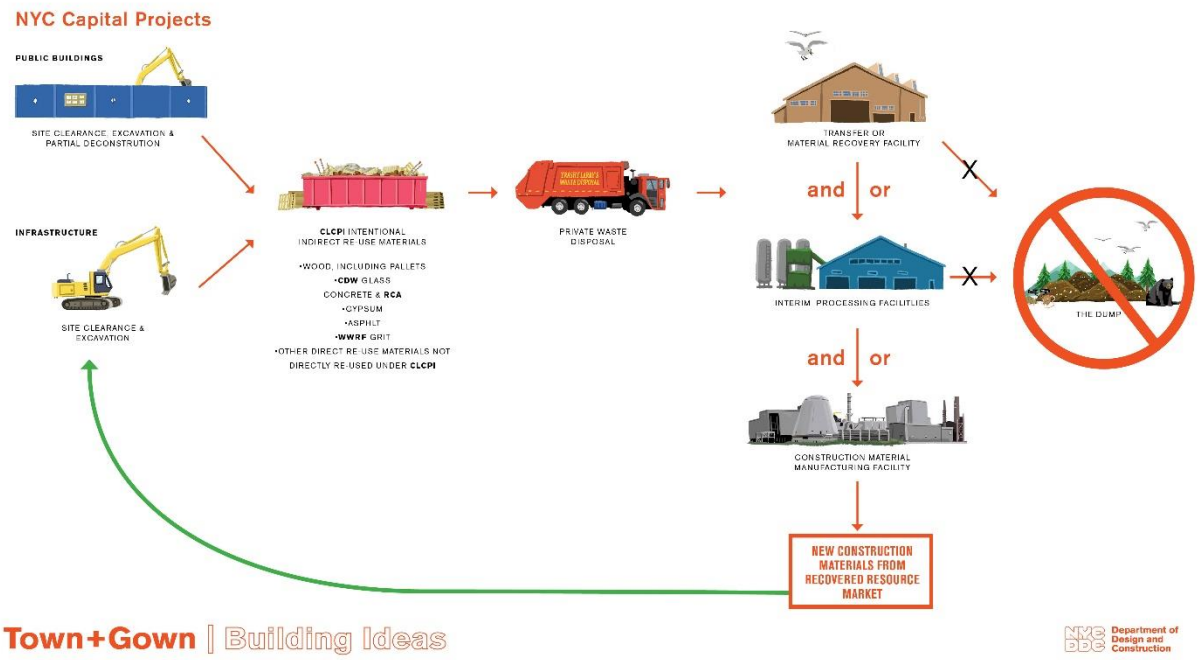
Title page from BLS memo

The Reveal: Closing Loops City Program Initiative (CLCPI) for New York Local Governments Introduction. The Urban Resource Recovery (URR) Working Group in Town+Gown:NYC (https://www1.nyc.gov/site/ddc/about/town-gown.page) has developed the City CLCPI as a pilot initiative that revises City agency construction practices and policies in order to leverage the City's capital program to support the private sector to help close construction and demolition waste (CDW) material loops and re-use certain residuals from the City's wastewater resource recovery facilities (WRRFs) in manufacturing new construction materials (with CDW, CLCPI Recoverable Materials).

Focusing on actions that are completely within the span of any New York local government's authority that can be adapted by any local government to address local conditions and concerns, the CLCPI aims at (1) increasing overall direct re-use of recovered CLCPI Recoverable Materials generated on public capital projects without interim processing as available materials on public capital projects or private construction projects (Direct Re-use) and (2) by intentionally redirecting recovered CDW generated on public capital projects away from landfills to transfer locations for Direct Re-use (either by the local government or private users) or to interim processing facilities for use as feedstock for manufacturing facilities producing new construction materials (Intentional Indirect Re-use).

Direct Re-use and Intentional Indirect Reuse will (1) conserve embodied carbon by recovering and re-using CLCPI Recoverable Materials, (2) reduce Greenhouse Gas (GHG) emissions from extraction, production and transportation of construction materials from virgin materials no longer needed and shorter trips for CDW due to landfill diversion, (3) support private development of interim processing facilities and manufacturing facilities for new construction materials using these recovered resources, which is necessary for the circular economy, and (4) generate local government capital budget savings over time.





All CLCPI activities would be consistent with New York State Department of Environmental Conservation (NYS DEC) beneficial use designation (BUD) regulations and the process to request case specific BUDs where none exist, in the context of an NYS DEC Enforcement Discretion Letter, dated February 12, 2021 (2021 EDL).

The CLCPI can also support a local government's furtherance of the United Nations Sustainable Development Goals 3 (3.9), 8 (8.3 and 8.4) and 11 (11.6) (CLCIP's SDG Goals). While the CLCPI is a local government initiative, its policies, practices and tools would be replicable by private construction owners on their construction projects, and private owner adoption of CLCPI policies, practices and tools would expand the reach and impact of the CLCPI.

Why It's So Hard for Local Governments to Focus on CDW for Urban Resource Recovery. Local governments' solid waste management and long-term sustainability plans tend to speak volumes about municipal solid waste (MSW) but have few specific references to the presence of CDW in their waste streams, much less policies related to recovering and re-using CDW. The reasons for the absence of CDW in local government policies are many and stem from the reality that CDW comes from construction activities.

Unlike the MSW field, the CDW recovery and re-use of field is dominated by State law and regulation, with little effective room for local government regulatory or operational discretion because State CDW regulations govern CDW generation, re-use and disposal in great detail with

little local operational discretion. The State's MSW regulations reflect that local governments conduct MSW collection and recycling as direct traditional municipal functions and permit them wider operational discretion.

Local governments engage in their own construction activities generating CDW through construction contracts, which puts them at a remove from CDW policy making. Construction is conducted by private sector firms under a contract framework with project owners. Typical contract documents largely relegate CDW disposal to a contractor's "means and methods" under which the contractor sends CDW of value to interim processing and transfer stations and retains the compensation, which had been previously calculated in their bid price. Thus, whatever a public or private project owner wants its contractors to do with respect to CDW beyond what is required by minimum legal requirements needs to be specified in the contract and, in the absence of provisions allowing some retention of value, will likely lead to increased prices due to the new specification.

State law and regulations and standard construction contracts, however, assume and rely on a functioning "market" to generate sufficient private firm investment to expand and build necessary interim processing and manufacturing facilities for higher value materials in absence of critical market supports. These supports include a reliable and predictable supply of recovered resources and demand for them to permit firms to plan and invest; real time data matching of supply and demand for market efficiency and project schedule reliability; appropriate subsidies and incentives for initial infrastructure and technology investments; and, a market signal that public policy supports a continued and priority use of materials recovery as a shift from the currently prevalent "path of least resistance" that is disposal.

In the absence of these conditions, existing construction market price signals (i.e., increases in new construction material as compared to recovered and re-usable CDW materials and increases in landfill fees due to capacity and environmental issues at landfills) may not *on their own* be sufficient for efficient recovery and re-use market creation and increased levels of private sector investment.

Other impediments include a dearth lack of local CDW material and volume data to inform policy analysis and implementation. CDW data from projects at local government level may not exist or be difficult to access due to the construction contract framework and the absence of a locality-wide managing office. While there is CDW data at the State level, publicly available reports are in a non-digitized form and the report generated at project sites is not yet publicly available. The additional need to analyze each specific CDW material separately as part of its lifecycle from material generation, physical properties for use and re-use, actual use, recycling and eventual re-use in different applications or new materials increases the complexity of

necessary analysis to support a CLCPI.[12] Finally, there is also the well-documented tendency of land use siting opposition, within metropolitan areas and nearby counties, where new or expanded interim processing and manufacturing facilities should be located to reduce transportation costs and GHG emissions.

Any local government CLCPI policy that pushes the "mandate" pedal first, instead of focusing on conditions within its control that support the private market, will likely increase contract prices paid by a much smaller population of construction owners as compared to the MSW field where local jurisdictional regulations are reflected in tax and price increases that can be spread over the larger population generating MWS. Thus, the CLCPI focuses on actions within a local government's span of control, short of mandates, that largely use the construction contract as the primary implementation tool. By identifying the State's regulatory pathways and its own municipal powers, a local government can work within the State's regulatory pathways to create conditions that change the calculus of individual actors within the local construction and recovery and re-use industries.[13]

The CLCPI: Local Government Levers to Expand Urban Recovery and Re-use:. The State regulatory pathways for local governments begins with NYS DEC's Part 360 regulations for BUDs and the process for requesting case specific BUDs where none exist, in the context of the 2021 EDL.[14] The State's requirement for local governments to create a Solid Waste Management Plan (SWMP) is an additional State regulatory pathway to which local governments can consider adding CDW, which is permitted, supported by a CLCPI. These State regulatory pathways provide a framework within which local governments can identify the individual CDW materials that are feasible within its capital program and develop CDW recovery and re-use policies and practices to support the local construction and recycling industries.

Action 1—Conduct CDW Data Analysis. If the local government does not collect CDW material and data from its capital projects, there is State-level data that can, with work, by disaggregated by location. NYS DEC collects CDW data from carters,[15] transfer stations and landfills that can help a local government begin its analysis to support CLCPI development. Data from the transfer stations (Permitted C&D Debris Handling and Recovery Facility Annual Report) and landfills (Active Construction and Demolition (C&D) Debris Landfill

[12] Sadlek *et al., op. cit.*, p. 19.
[13] Hockett, *op. cit.,* p. 24.
[14] The 2021 EDL deems CDW elements under the control of the generator or persons responsible for the generation, which would be the local government in the case of the CLCPI, not being considered solid waste and provides a "safe harbor" in the context of the Part 360 regulations for Direct Re-use.
[15] The carter report (Part 360 Series Waste Tracking Document-C&D Debris), which represents CDW data at the beginning of the CDW journey and would more easily let local governments identify CDW waste from their own capital projects and private construction projects within their jurisdictions, is not publicly available on NYS DEC's website at the present time.

Annual/Quarterly Report) permits the creation of CDW "trip" data (origin and endpoint) by CDW material and volume. These publicly available reports, which show the middle and end of the CDW journey, are, however, in the form of typed or handwritten forms submitted to and scanned by NYS DEC, so that extracting the CDW trip data for purposes of estimating CDW materials and volumes and potential cost savings has been an initial impediment for the City CLCPI to estimate potential capital cost savings.

To that end, a spring/summer 2021 New York University/Center for Urban Science and Progress (CUSP) capstone team focused on extracting trip data from the NYS DEC reports to import into a data visualization tool they created, for the URR Working Group, to enable order of magnitude and directional CDW flow analysis.[16] For a more detailed summary of this project, please see pp. 8-9 above.

Action 2—Determine the CLCPI Recoverable Materials. The CLCPI Recoverable Materials focuses on those recoverable materials for which a strong re-use market does not currently exist and that are in different stages of feasibility for Direct and Intentional Indirect Re-Use. To that end, a summer 2021 Brooklyn Law School (BLS) student team researched, for the URR Working Group, NYC DEC's Part 360 regulations and analyzed what actions the City would need to take to recover and re-use each CLCPI Recoverable Material. For a more detailed summary of this project, please see pp. 9-11 above. While each local government will need to go through its own analysis to determine the right CDW elements around which to develop its CLCPI, the City CLCPI has three categories of materials within its CLCPI Recoverable Materials:

- The Direct Re-use category:
    - Non-renewable building CDW[17]
    - Concrete processed at NYC DOT's crusher generating recycled concrete aggregate (RCA)
    - All excavated soils permitted under the BUD regulations
    - Nearshore dredged materials
    - CDW glass[18]

- The Intentional Indirect Re-use category:

[16] It should be noted that the CDW "trip" data from these reports reflects the current market, and a portion of the trips terminate out of state, so that any analysis of CDW movement based on these reports will be incomplete.

[17] Non-renewable building CDW consists of building components (e.g., old growth wood joists, old wood doors and marble) from building deconstruction from renovations and possibly demolition that have re-use potential.

[18] From a materials researcher: the chemical compositions of MSW glass and CDW glass are very similar, both being a type of glass called soda-lime glass, and CDW glass does not lose structural integrity, provided it is clean.

- Wood, including wood pallets
- CDW glass
- Concrete and RCA
- Gypsum
- Asphalt[19]
- Grit from DEP's WRRFs[20]
- Other Direct Re-Use materials not directly re-used under the CLCPI

- The Other category includes materials that are outside the other categories but could have a place within CLCPI. They include decommissioned wind turbine blades that will become increasingly available for re-use locally, with little interim processing, as construction materials; and, rubber crumb, itself a re-use on synthetic playing fields that require renewal as they wear out, would involve a secondary re-use.

Action 3—Assess Impact of Local Laws. While the majority of legal issues for a local CLCPI involve State laws, there may be some local law issues that require analysis. The local government should confirm that existing local laws and/or its standard construction contract terms do not deem recoverable materials to be the property of the local government in any way so that any savings and/or fees that contractors may receive from Direct Re-Use or Intentional Indirect Re-Use do not accrue to the local government. The local government should also review any interpretation of regulations of project site stockpiling being deemed not a "transfer station" within its jurisdiction to make sure that it brings, within the exception, stockpiling to support Direct Use and Intentional Indirect Use. Stockpiling under a CLSPI will require expanded separation and segregation of materials on- or near-site to keep them clean, for testing purposes under NYS DEC BUD regulations and for later re-use or interim processing. In the case of Direct Re-Use, stockpiling will need to make the materials available for on-site re-use *or for pick-up and re-use on another site*; and, in the case of Intentional Indirect Re-Use, stockpiling will need to make the materials available for delivery to or pick-up by interim processing facilities. If a local government mandates a minimum LEED rating on its public building projects, it should be aware that using LEED in this way is insufficient because LEED, on its own, does not focus on closing material loops by linking recovery and re-use.

[19] For Direct Re-use of asphalt in the City, see https://www1.nyc.gov/html/dot/html/motorist/sustainablepaving.shtml.

[20] Grit recovered from DEP's WRRFs and dried wastewater biosolids has the potential to be used by cement facilities elsewhere. DEP-recovered grit appears to have value in more local direct construction applications, such as in pothole repair materials. In addition, char resulting from gasification or pyrolysis of biosolids from wastewater biosolids may also be used in Portland cement manufacture.

Action 4—Develop Construction Contract Specifications. A local government's standard construction contract is a significant lever for a CLCPI, and the local government should consider adding new, or revise existing, contract specifications to its standard construction contract to support the CLCPI. These specifications fall into four categories: a CDW reporting specification to increase production of data for City project CDW materials and volumes; a cost savings sharing specification to increase supply for the market without increasing costs on City capital projects; a process to develop agency materials specifications to increase demand for recovered and re-used CDW on future public capital projects; and, a stockpiling specification that makes Direct Re-Use and Indirect Intentional Re-use possible.

- *CLCPI CDW Reporting Specification*. The NYS DEC Part 360 Series Waste Tracking Document, C&D Debris reporting form is completed by carters on all construction projects and lists the project owner, so this form represents the initial leg of the CDW journey by individual project. This reporting specification would require contractors to send these project-level reports to the construction agency project manager, if not a centralized CLCPI implementation office, to generate locality-wide CDW material and volume data to permit estimates of capital cost budget savings.

  CLCPI Cost Savings Sharing Specification. In order to support public contractors' innovation and participation in a CLCPI and avoid an increase in contract prices due to the CLCPI alone, the CLCPI must work within the realities of the public competitive bidding setting and the public construction contract form that delegates the contractor's CDW management functions to their "means and methods" under the contract, which subjects the recovery and re-use of recycled CDW from City capital projects to general CDW market conditions. The contractor's bid price for a project includes its prices for its CDW management functions, which reflects the contractor's ability to offset some costs by any fees it collects for the more marketable CDW elements.[21]

  Since the CLCPI envisions several supporting elements being developed at the same time, adding a cost saving sharing specification to the standard construction contract to permit appropriate sharing of cost savings produced by contractor innovation will incentivize changes in contractor CDW management functions and participation in the CLCPI, minimize the risk that the CLCPI will increase bid prices due to the CLCPI,[22] and provide additional CDW-related data, including costs, during the CLCPI period for post-CLCPI practices and

[21] Once the Virtual CDW Matching Digital Platform is operational and/or some construction agencies have created their own material stockpiles, it may be possible to include recovery and re-use specifications in bid documents without adversely affecting prices received.

[22] Implementation of a Virtual CDW Matching Website will mitigate some, but not all, risk to contractors who see potential savings from changing their CDW Management Functions operational practices.

policies. Adding a standard construction contract specification for sharing cost savings that appropriately shares risk during CLCPI period, will and provide real cost savings data for the post-CLCPI period.

The City CLCPI Cost Savings Sharing Specification is based on the Value Engineering Change Proposal (VECP) provision from the New York State Department of Transportation (NYS DOT).[23] The purpose of the VECP is to encourage contractor's ingenuity and experience *after* contract award to arrive at alternative construction designs, methods and procedures that result in a lower direct cost savings offered by the contractor and approved by the agency after it determines that the proposal produces direct cost savings to the agency and public without impairing essential project functions and characteristics pursuant to a defined process to determine feasibility and direct savings. Once approved by the agency, the VECP becomes a contractor-initiated change order with savings split 50-50 between the agency and contractor.

The first feature is a simple cost savings sharing provision for what is likely to be for the Direct Re-use category of the CLCPI Recoverable Materials and the second is a value engineering-based cost sharing provision for what is likely to be the Indirect Re-Use category of the CLCPI Recoverable Materials. The value engineering element is necessary for contractors to be able to innovate their and CDW Management Functions with respect to demolition of existing structures to approximate deconstruction, within an envelope of the economics of the project under contract. The CLCPI Cost Savings Sharing Specification will support any mandatory LEED standards for public buildings and voluntary use of the Envision framework to apply for innovation credits on infrastructure projects. Over time, the cost savings sharing split could be tailored for each CLCPI Recoverable Material, depending on the existing support elements and market, and the share percentage could decrease by the end of the CLCP Initiative period should the overall change in contractor practices and overall market conditions warrant less incentivization due to normalization of the CDW recovery and re-use practices.

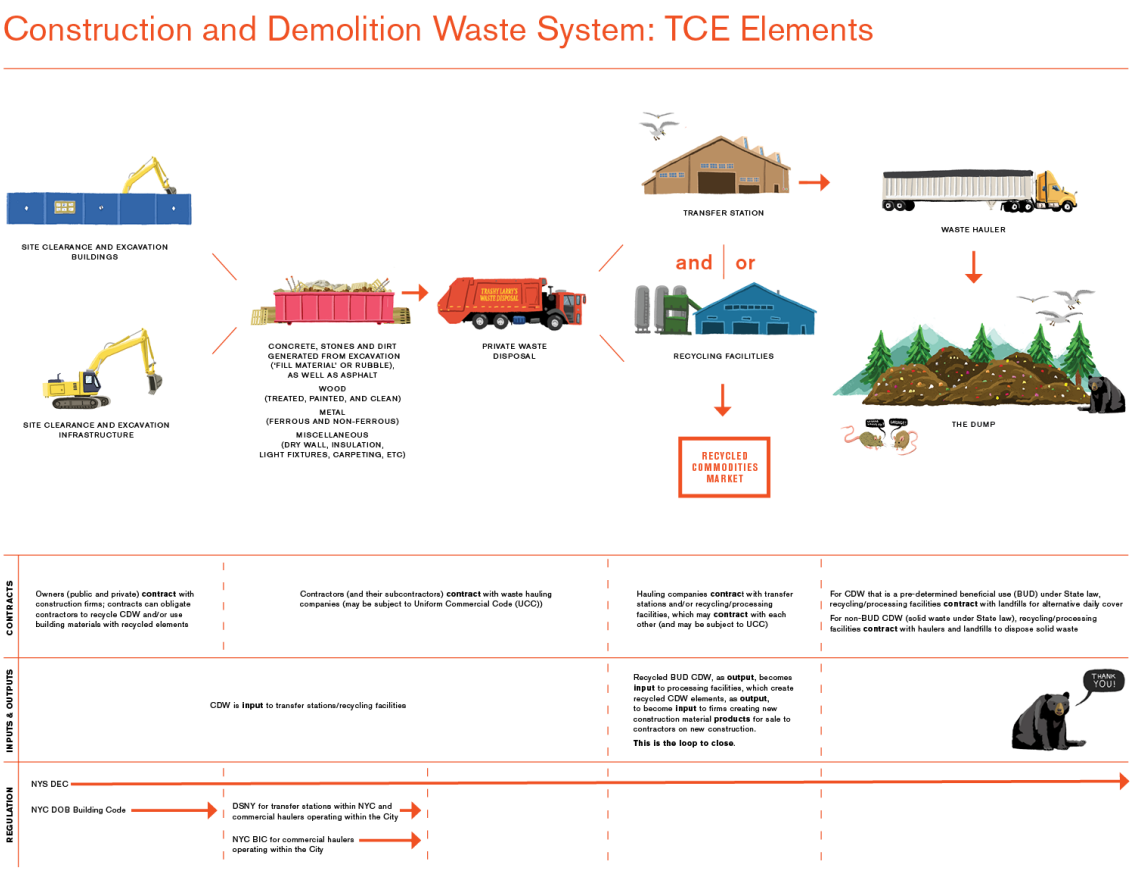
- *Government-Wide Process to Revise Agencies' Construction Materials Specifications*. Local government construction agencies have multiple and independent specifications for construction materials on their capital projects. Revising all construction agency materials specifications is necessary to support the CLCPI and generate increased demand for all CLCPI Recovered Materials. In view of the multiple agencies with multiple materials requirements, this effort requires a government-wide review and revision process to

[23] Section 104-10 of NYS DOT Standard Specifications, Volume 1, dated May 1, 2020.

develop performance-based materials specifications to support the CLCPI and increase demand for re-use of CLCPI Recoverable Materials.

Meanwhile, the State-wide GreenNY process for developing template green materials specifications (see https://ogs.ny.gov/greenny/executive-order-4-tentatively-approved-specifications) is also available to local governments to participate in the development of future specifications or to use specifications developed in GreenNY on their projects regardless of whether they participated in their development.

- *Stockpiling Specification.* Any existing local stockpiling specification would need to be revised to support stockpiling for expanded recovery, source separation, testing, and re-use avenues.



Action 5—Leverage Local Government Market Support Mechanisms. In 2017, NYS DEC updated its BUD regulations to create more beneficial use opportunities for the increasing amount of

CDW materials that originate from construction owners in New York City, although they also apply statewide. The State has continued to refine its environmental regulations to support the CDW recovery and re-use market, which is critical but not sufficient. State regulations and construction owner contracts assume and rely on an efficient and functioning "market" to generate sufficient private firm investment to expand and build necessary interim processing and manufacturing facilities for higher value materials in or near localities generating significant amounts of CDW. Local governments can use their construction activities to drive the State regulatory impact further because in many local construction markets, the public construction spend is an important part of the local construction market.

Local economic supports will increase the efficiency of the CDW materials recovery and re-use market by generating a reliable and predictable supply of recovered resources and demand for these materials in order for firms to plan and invest; by providing real time data matching of supply and demand for market efficiency and project schedule reliability; and, by providing appropriate subsidies for initial expansion investments.

- *Revised Material Specifications Support the Market by Increasing Demand.* The CLCPI will enable a local government to generate a reliable supply of recovered CDW elements for Direct Re-Use and for private firms involved in the Intentional Indirect Re-use market. A locality-wide process to revise agencies' construction materials specifications will enable a local government to generate a reliable demand for CDW element Direct Re-Use and for new construction materials that result from interim processing and manufacturing firms under Indirect Intentional Re-use.

- *A Virtual CDW Matching Digital Platform Increases Market Efficiency*. For a CLCPI to succeed, (1) contractors generating CLCPI Recoverable Materials will need to know *on a real time basis* **what** other construction projects need these materials for Direct Re-use and, most important, **when**, so that the CLCPI effort does not create delay for Direct Re-use on both construction projects and (2) contractors able to use CLCPI Recoverable Materials from interim processing facilities as an Indirect Intentional Re-Use also need this real time basis information for project schedules. This will require a local government to develop or purchase[24] a virtual CDW matching digital platform that public and private contractors can use will solve the immediate problem of efficiently supporting public contractors

[24] CDW matching digital platforms where materials, products and waste streams within a region, city or municipality are registered, and can be exchanged between various departments, locations, or with a consortium of entities are available for subscription. These have been referred to as "dating sites" for secondary materials.

participating in the CLCPI, especially for the Direct Re-use mode, and support wider CDW element recovery and re-use within the local construction market.

- *Tax-exempt Industrial Development Bonds (IDBs) Can Support Private Firm Capital Investment in Expanded and New Facilities and related Technology.* Existing local industrial development authority (IDA) that issue industrial development bonds (IDB) and related revenue bonds can support private sector investment in expanding existing or creating new interim process facilities and manufacturing facilities and related technology through their tax-exempt interest rates and certain local tax features available under current law.[25] Local IDA IDBs and related revenue bonds are suitable to subsidize private firm capital costs and would have little negative impact on the local government's budget. IDBs are an old "work horse", already authorized by State law, that can support the private market manufacturers in connection with the CLCPI with corollary economic and workforce development benefits, otherwise known as the "circular economy". This is basic manufacturing, with real jobs and real economic development, that local IDAs were originally intended to support. While innovative technology is important, basic manufacturing is necessary to support a "green" economy and create "green" jobs. Below are examples of what types of facilities could benefit from IDA IDB or related revenue bond financing.

    - *CDW Storage Sites.* Even with a Virtual CDW Matching Digital Platform in place, CDW inputs may require temporary storage sites and facilities to (1) smooth out timing issues from one capital project to another and (2) store excess materials not needed for public projects that could be available for private projects. While it is possible for a local government to fund such sites, private transfer stations and recycling and processing facilities may have storage space (but need additional equipment, see below) or the potential to create new storage space (with additional equipment needs), but they will need to make capital investments to assure operations comply with NYS DEC regulations.

    - *New Equipment.* Research on using RCA in new concrete indicates that it is critical to consider financial considerations at concrete plants using recovered CDW elements in the production of new concrete. For example, in order for concrete manufacturers to use RCA in new concrete, they would need to invest in new equipment and be assured of a continuous supply of RCA. Increased potential use of glass pozzolan in view of the ASTM standard may also require concrete plants to purchase additional equipment and find additional space for the glass pozzolan.

[25] If a local IDA has the ability to create pooled bond issuances, this tool would be an effective support for a CLCPI.

- *Interim Processing Facilities.* All CDW inputs can be considered as a raw material for the manufacturing of new construction materials. Residuals from the City's WRRFs, such as biosolids and grit, can also be considered as raw material for manufacturing new construction materials.[26] Glass recycling to generate glass pozzolan is another example. Interim processing facilities are necessary in order to derive these "feedstock" materials for re-use in new construction materials to be consumed by City and private construction projects and would require private investment.[27]

- *Construction Materials Manufacturing.* While the CLCPI includes a focus on low value re-use of recycled CDW elements, materials research has opened up realistic opportunities for higher value re-use of recycled CDW elements where construction material manufacturers turn processed CDW into high value construction materials for consumption in building construction. Private firms involved in manufacturing new materials from the CDW and biosolids "feedstock" will need to make capital investments in land and plants.

Action 6—Develop a Governance Structure to Implement the CLCPI. The City CLCPI is envisioned as a five-year pilot program, during which time the various elements become operational. Implementing a CLCPI will require the local government to create a locality-wide implementation that can work across agencies to bring them together to collaborate on the elements and also identify other non-governmental stakeholders and bring them into the effort to gain knowledge and develop support. The pilot format of a CLCPI also permit experimentation and fine-tuning of a CLCPI in anticipation of the local government's next SWMP to enable the local government to CDW to MSW in the SWMP and leverage this State's regulatory pathway to move more CDW away from landfills.

Action 7—Leverage Public and Private Third-Party Resources for Research and Development. Built environment and construction practice points to a need to increase research activities in this area, including the CLCPI. Local government can exercise a role in advancing technology innovation and as an economic policy maker by subsidizing some of the research and development necessary for innovation in construction and related CDW technology. Without some government subsidization of targeted applied research and development activities, the construction and related industries are trapped their well-documented conservative practices,

[26] Residuals from the City's WRRFs can be considered as "feedstock" or raw materials, an asset of value for sale, to supply or fuel a machine or industrial process.

[27] Instead of life cycle assessments currently used in the recycling analysis, accounting for embedded carbon in CDW and new materials created from recycled CDW makes the environmental benefits clearer and helps make the environmental case for CLCPI.

which retards the spread of new learning at socially optimum levels. A program like Town+Gown, which is a pragmatic and integrated approach to increase applied research focusing the City's particular built environment, creates partnerships between academics and practitioners, many of whom work at City construction agencies, to identify practical research projects and conduct data-based research, the results of which are aimed at making changes in practices and policies, such as the City CLCPI. The idea for the City CLCPI developed out of academic research with the URR Working Group members, and, as the idea developed, academic research with the URR Working Group members informed specific aspects of the CLCPI. There are also other research resources from other levels of government and third-party funders, such as the National Science Foundation and the National Institute of Standards and Technology, that a local government-wide office for CLCPI implementation, in conjunction with academic-practitioner partnerships, can leverage to support research and development in the area of construction, resource recovery, and materials technology.

Material Flow Analysis + Transitions Analysis. Most of the world's population lives in cities where, not surprisingly, "the large bulk of resource consumption takes place."[28] Economic production and consumption—including consumption of resources –are concentrated in cites.[29] While urban centers have been growing, the average household size has been decreasing, as a function of income growth due to urbanization.[30] The decreasing trend in household size translates into an increasing demand for housing that increases demand for land and building materials and reduces resource use efficiency.[31] Increasing population growth and number of smaller households further increase demands on public infrastructure and buildings through and in which government delivers its services increasing resource demand. The increase in construction occurs within a global construction industry that "consumes approximately 50% of resources, 40% of water, 70% of timber products, and 45% of energy" and it is "likely to have a major impact on resources."[32]

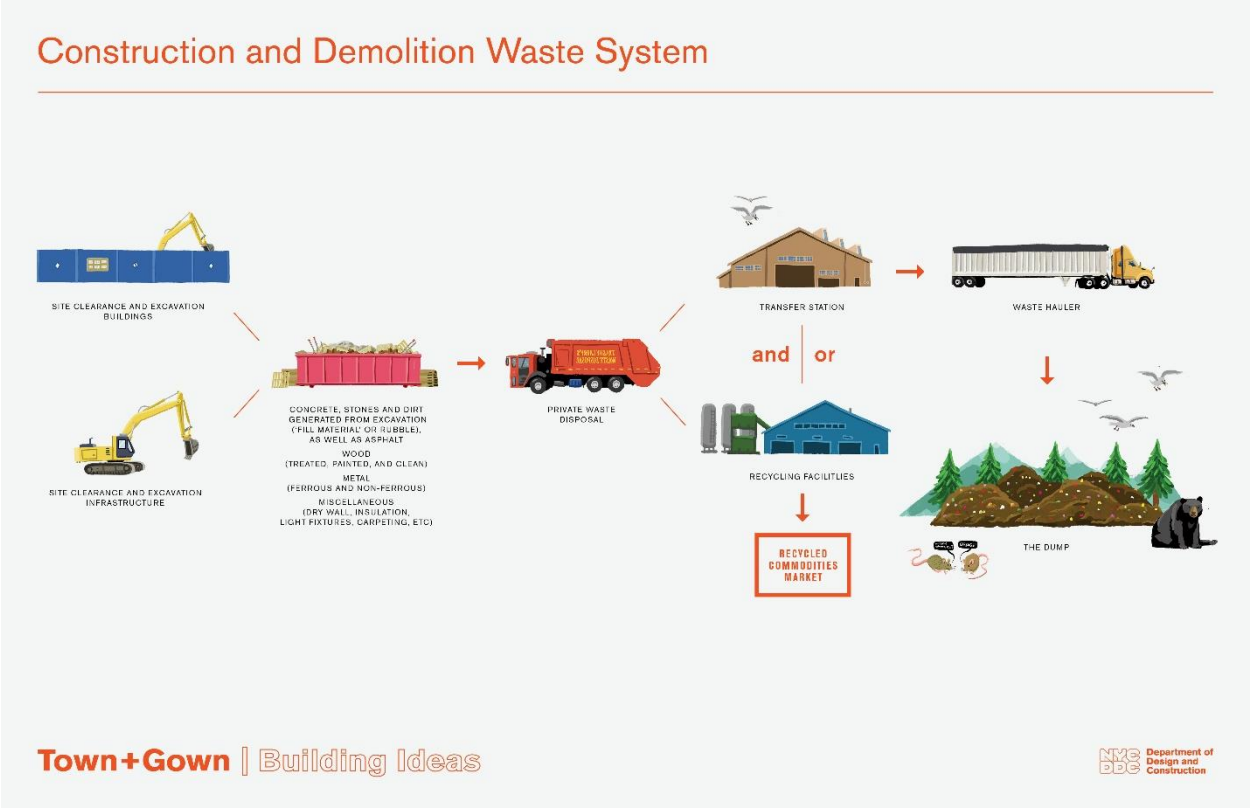
[28] Mike Hodson, Simon Marvin, Blake Robinson, and Mark Swilling, "Reshaping Urban Infrastructure: Material Flow Analysis and Transitions Analysis in an Urban Context," *Journal of Industrial Ecology,* Vol. 26, No. 6 (New Haven, 2012) p. 789. See also Benjamin Sadlek, Ruben Bibas and Jean Chateau, *The Future of Materials Use: Environmental Impacts and Policy Implications*, Organization for Economic Co-operation and Development, , May 2020, pp. 6-11.

[29] *Ibid.*, pp. 789-790.

[30] *Ibid.,* p. 790.

[31] *Idem*

[32] *Idem* See also Sadlek *et al., op, cit.,* pp. 13, 18-19



Macro-level landscape "pressures and potentials to find ways to reconcile economic growth, wellbeing and the sustainable use of resources" happen in cities.[33] In all economic sectors, these macro-level landscape pressures push "systemic change in infrastructure through low-carbon transitions" to create increase sustainability, which becomes an "infrastructure transition."[34] The construction and maintenance of these urban infrastructure systems[35] "are often the largest expenditures at the city government level"[36] and the design, construction and operation these built artifacts "create a sociotechnical environment that plays an important role in shaping, and potentially reshaping, how resources are procured, used, and disposed of by the city."[37]

---

[33] *Ibid.*, p. 789. "The landscape operates at the macro level, focusing on issues such as political cultures, economic growth, macroeconomic trends, land use, utility infrastructures, and so on, and applies to pressures on existing sociotechnical regimes, creating windows of opportunities for responses. Landscapes are characterized as being 'external' pressures that have the potential to impinge upon—but do not determine—the constitution of regimes (meso) and niches (micro)." *Ibid.*, p. 794

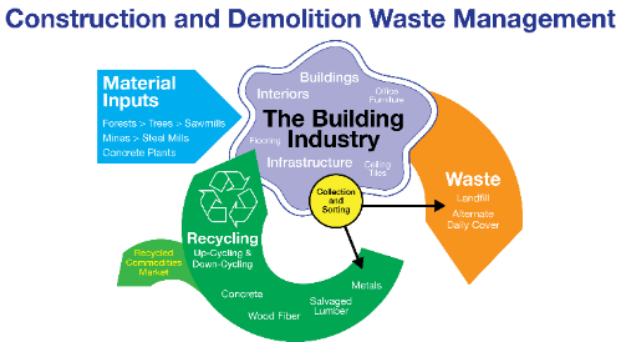
[34] *Ibid.*, p. 791.

[35] Includes energy, waste, water, sanitation and transport infrastructures; should also theoretically include the private and public building systems.

[36] *Ibid.* p. 790.

[37] *Ibid.*, p. 790.

This is transition analysis' meso level sociotechnical regime, and stakeholder interrelationships in the regime, "through regulations, policy priorities, consumption patterns, and investment decisions, . . . hold together to stabilize sociotechnical regimes and their existing trajectories."[38] This stabilization function leads to institutionalization and entrenchment of practices, processes and relationships within construction industry and its CDW systems and its complex and fractured regulatory environment.[39] Reconfiguration the regime will "depend on the decoupling of this economic growth from escalating resource use."[40] Decoupling urban economic growth from the resulting increased demand for resources, many finite, requires analysis of resource flows through the urban space, which "are conducted by complex networked infrastructures which, in turn, have been designed, built, and operated in accordance with a particular set of technical modalities and governance routines that for the most part assume a continuous supply of resources," followed by developing innovative ways to reshape these flows.[41] The first decoupling mode is "[r]esource decoupling or 'dematerialization' involve[ing] reducing the rate at which primary resources are used per unit of economic output," and the second is "[i]mpact decoupling . . . seek[ing] to increase economic activity while decreasing negative environmental impacts like CO2 emissions or the destruction of biodiversity."[42]



Reconfiguration—or transition—to achieve a level of decoupling within a city requires solving the challenges of identifying a transition methodology and its leadership and governance aspects.[43] Uniting material flow analysis (MFA) with transitions analysis (TA) at the city scale, because it is a spatial node of consumption with a capacity for innovation, can provide the

[38] *Ibid*., p. 794.
[39] Tineke Egyedi and Jaroslav Sprico, Standards in transitions: Catalyzing infrastructure change, Futures 43 (20110), p. 947-960; at https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.1057.906&rep=rep1&type=pdf (accessed 10-08-21 @ 5:07 p.m.), p. 1.
[40] *Idem*.
[41] *Idem*
[42] Hodson *et al., op. cit.,* p. 798, Footnote 4.
[43] *Ibid.,* p. 791.

analytical tools to help a city to "structure systemic changes in resource use."[44] While the capacity for innovation is important, "absolute reductions in the use of nonrenewable resources are unlikely to happen without deliberative intervention to stimulate broad, systemic (including behavioral) changes."[45] MFA analysis can suggest directions in improving resource efficiency as a "'first step' toward sustainable resource management" through "engineering and/or institutional solutions to fine tune the components of existing systems to reduce" resource use, but "to achieve resource productivity, a 'whole system' design perspective that can facilitate more radical system changes is necessary," which is the province of TA.[46]

The idea of waste reuse emerges from "[r]eturning to more circular, location-based urban metabolisms [that] is now considered to be a necessity if cities re to survive a future of resource and climate uncertainty," especially because earlier urban assumptions of "an endless supply of resource inputs for consumption and nature's unlimited capacity to absorb the concentrated

[44] *Ibid.*, pp. 790-791.
[45] *Ibid.,* p. 791.
[46] *Ibid.*, pp. 791-792.

wastes it produces" are no longer true.[47] The idea of recycling has moved beyond "the separation and collection of household packaging wastes [to] include consideration of all 'waste' streams generated by urban production and consumption activities in terms of how they might be used as valuable inputs. Even the built fabric of the city has the potential to be reused as buildings are retrofitted instead of being replaced, salvaged bricks and other materials from demolitions are reused as inputs into construction, and rubble is processed for use in road surfacing and other projects."[48]

Reconfiguring the local infrastructure and building construction regime to recover and re-use what has been considered construction "waste" is larger than a single infrastructure system transition. It is a transcending *meta* urban recovery and re-use transition that crosses all infrastructure and building sectors operating in City, amplifying the need for locality-based research and analysis because "generalized knowledge simply will not do."[49] To paraphrase Tip O'Neill, all politics *and urban resource recovery and re-use* is local. Urban practitioners in the construction macro-level regime[50] experience the recovery and re-use of construction waste as exogenous and uncontrollable phenomena, while those in the micro-level niche[51] have pursued the route of agitating for innovative solutions.

In the absence of a landscape level event to galvanize the meta transition,[52] facts on the ground point to a reform process at the regime level, based on localized applied research and with technical actors from the niche level, outlining the required governance to support change within the regime. In public economics terms, government is only actor in the construction regime that can correct negative externalities emanating from private arrangements and decisions in a market that it regulates and contracts with "to change the calculus of each, such that certain erstwhile individually rational decisions that aggregate into collectively irrational outcomes cease to be individually rational."[53] The City, leveraging the State's beneficial re-use regulations and its capital spend that functions as a market-maker in the local construction economy, can begin to change the individual actors' calculus so that contractors' failure to recover and re-use construction waste is no longer individually rational. In addition to

---

[47] *Ibid.*, p. 792.

[48] *Ibid.,* p. 793.

[49] Samuel Tabory, Terri Matthews, Richard Feiock and Anu Ramaswami, "What Cities Want to Know: A Practitioner-Derived Research Agenda for Sustainable Urban Infrastructure Transitions" (unpublished paper conducted through Sustainable Healthy Cities sustainable research network supported by the U.S. National Science Foundation's Sustainability Research Network (SRN) program [Award No.1444745]), p. 7.

[50] Hodson *et al., op. cit.*, p. 794.

[51] Hodson, p. 794.

[52] Landfill capacity issues and resulting fee increases are likely to be insufficient, on their own, as landscape pressures to cause this meta transition.

[53] Robert Hockett, "Recursive Collection Action Problems: The Structure of Procyclicality in Financial and Monetary Markets, Macroeconomics and Formally Similar Contexts," *Journal of Financial Perspectives*, Vol. 3, No. 2, 2015, p. 24.

landscape pressures operating on a regime from without, micro-level sociotechnical niches that "agitate to get new technologies onto the 'agenda' and promote innovation by trying to keep alive novel technological developments" can operate on a regime from within.[54] This is the remit of the URR Working Group.

Terri Matthews
Director, Town+Gown:NYC
October 12, 2021

[54] Hodson *et al., op. cit.*, p. 794.