01 INTRODUCTION

RISING FROM RUINS

Acknowledgement

We would like to thank our supervisors Steffen Wellinger and Stuart Dickinson from NTNU, and our co-supervisor Mykhailo Shevchenko at the Kharkiv School of Architecture for their invaluable guidance and unwavering belief in this project.

Thanks to Hans Skotte and Lucas Scheffer for the ethical discussions over beer and rakfisk.

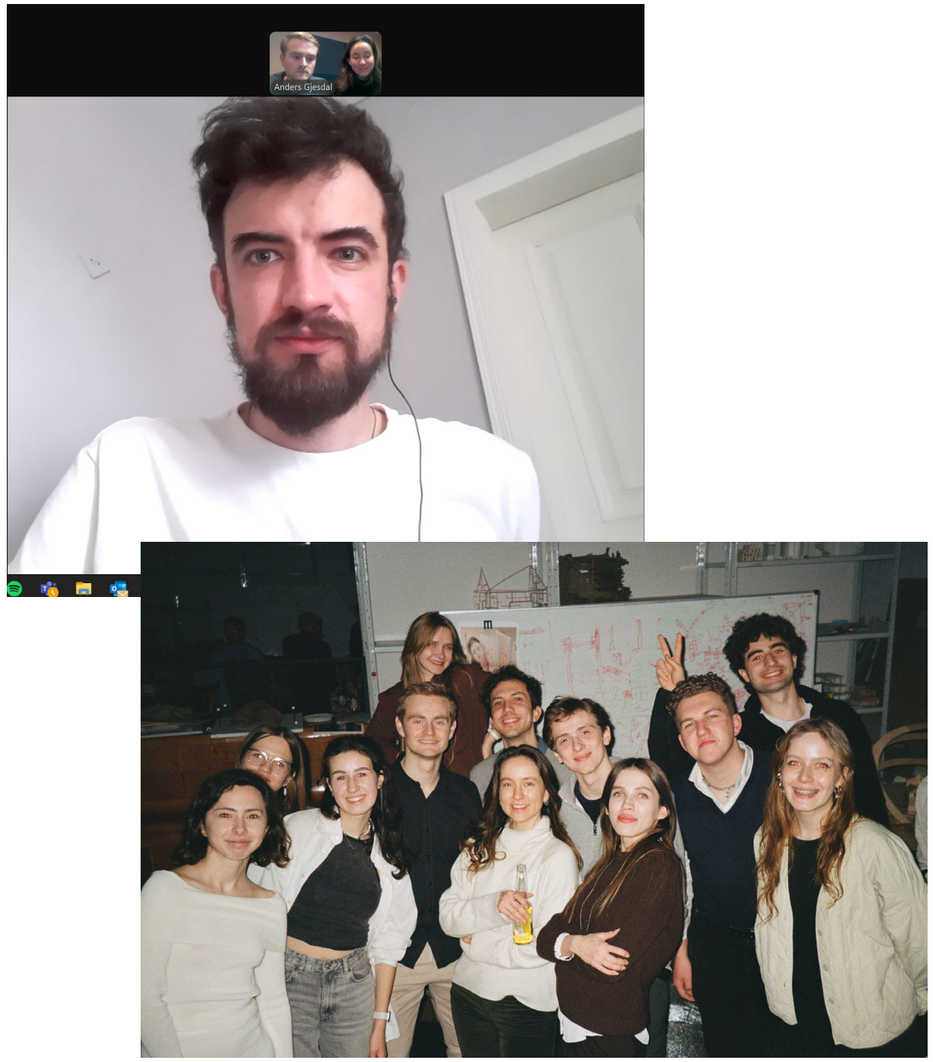
Thanks to Elena Archipovaite for introducing us to different stakeholders in Ukraine and insightful discussions on the situation in Ukraine.

Roman and the rest of the ReThink team for welcoming us in Kyiv, thank you for sharing your knowledge on circular reconstruction, inviting us to the consortium on sustainable rebuilding and allowing us to work from your office space in Kyiv.

A big thanks to Sigrid Vik and Oskar Fahlstedt at Asplan Viak for sharing their research and showing us the innovative projects on material dismantling and reuse.

Thank you to Gregory Meckstroth and Jamie Woods at the UN Habitat, who invited us to their offices and shared their knowledge about Irpin.

And finally, we would like to thank everyone at the Build Back Better workshop at the KhSA for welcoming us with open arms, sharing their knowledge and showing us the best of Ukraine. We are forever grateful and are looking forward to seeing you again.



Build Back Better Workshop, Lviv 2025 © Artem

Abstract

Ukraine faces an immense reconstruction challenge following Russia's full-scale invasion on February 24th, 2022. The scale of destruction has left more than 13% of the country's housing stock damaged or destroyed and over 2.5 million households have been affected. The total rebuilding cost is estimated to exceed NOK 5.8 trillion.1 Beyond the human and cultural loss, the war has left behind vast quantities of materials in the ruins which have a potential for reuse and reintegration into the built environment.

In this thesis we explore how remnants of war can be reclaimed and reused in the rebuilding efforts, guided by principles of circular economy and urban mining. We propose a flexible construction system that combines reused materials from ruins with locally produced supplementary materials. The aim is to maximize reuse, reduce carbon emissions and built up local circular economy systems. The system is designed to adapt to varying material availability, addressing the structural, architectural and emotional aspects of rebuilding after war.

Our design approach draws from both practical necessity and cultural sensitivity. Through fieldwork in Ukraine, we were confronted with the emotional weight that reused materials can carry. This started a reflection on how architecture can help mediate between trauma and recovery. We believe materials can act as silent witnesses, holding the memory of what once was, while contributing to an architectural language rooted in resilience.

We apply this approach to three pilot typologies, serving as test cases to evaluate both the technical feasibility, architectural potential and emotional balance of material reuse. Through the pilot in the city of Irpin, we explore how reused materials can be combined with new materials to avoid overwhelming visual and emotional weight. The balance between reuse and renewal becomes central to the creation of living environments that respect both the cultural memory of place and the needs of the present community. By integrating reused components with new, locally sourced materials, the project offers a proposal for local production to contribute meaningfully to recovery.

Ultimately, we argue that material reuse in post-war reconstruction is not only a sustainable strategy, but also a means of embedding memory and resilience into the rebuilding process. We propose that architecture can become a tool for collective storytelling and cultural continuity.

[1] World Bank, Ukraine RDNA4.

Title
Rising from Ruins: Reuse in Ukraine

NTNU
Faculty of Architecture and Design
AAR4990 Master in Architecture
Spring 2025

Students
Anders Gjesdal
Mille Sofie Hals Richardsen

Supervisors
Steffen Wellinger
Stuart Mcleod Salway Dickson

All illustrations are by us unless otherwise is stated.
Photo front page: The Central House of Culture, Irpin.

Project Reading Guide

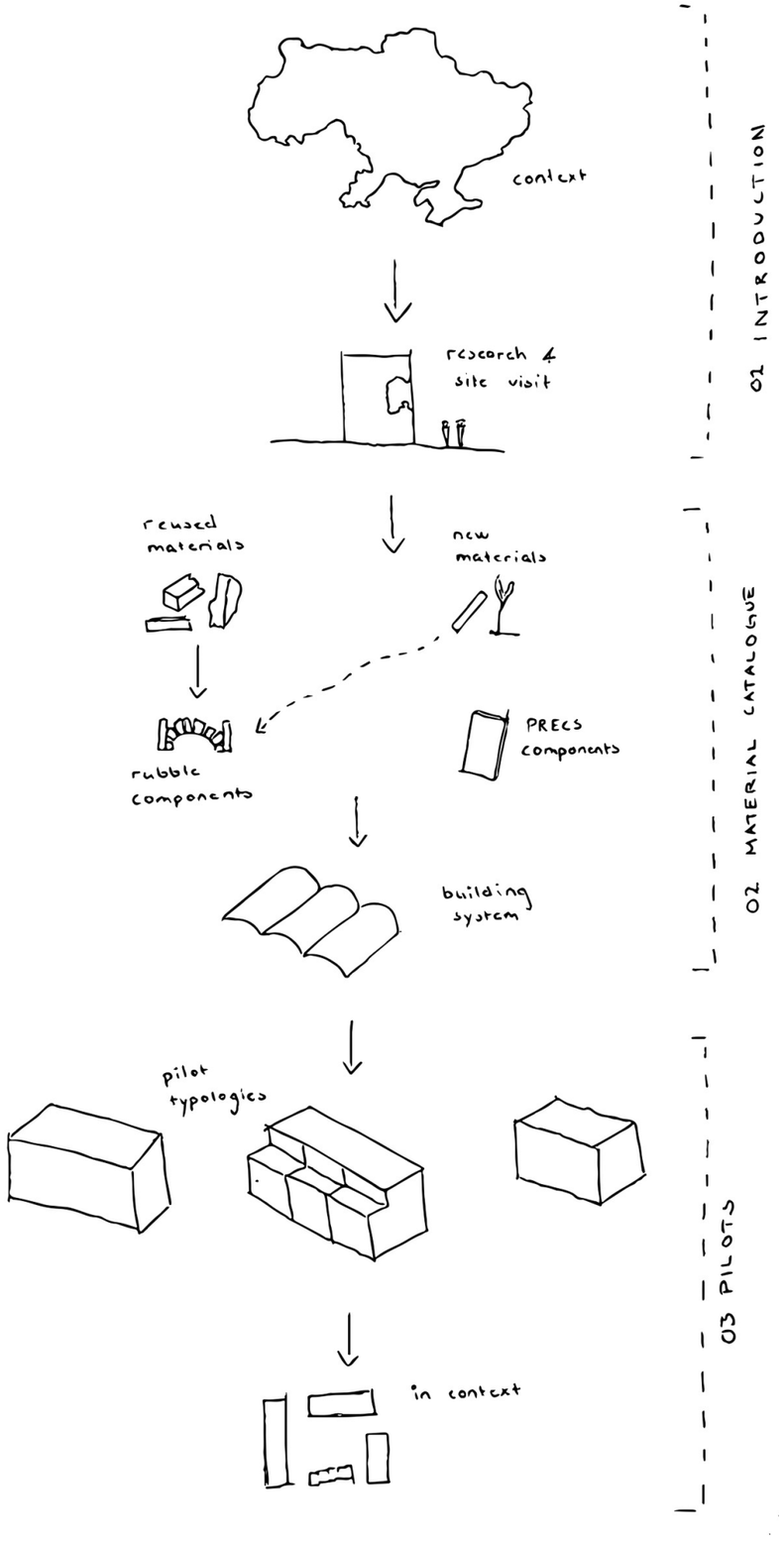
The project is divided into four folders, where each build upon the previous.

01 Introduction defines the scope of the project, placing it in a context and a specific place.

02 Material Catalogue explores and categorizes materials found in ruins, and their potential for reuse.

03 Pilot Typologies uses the findings from the material catalogue, and applies the reused materials in three different pilot typologies.

04 Reflections are our thoughts and reflections from working with this project. The folder also includes an appendix.



Content of the Folder

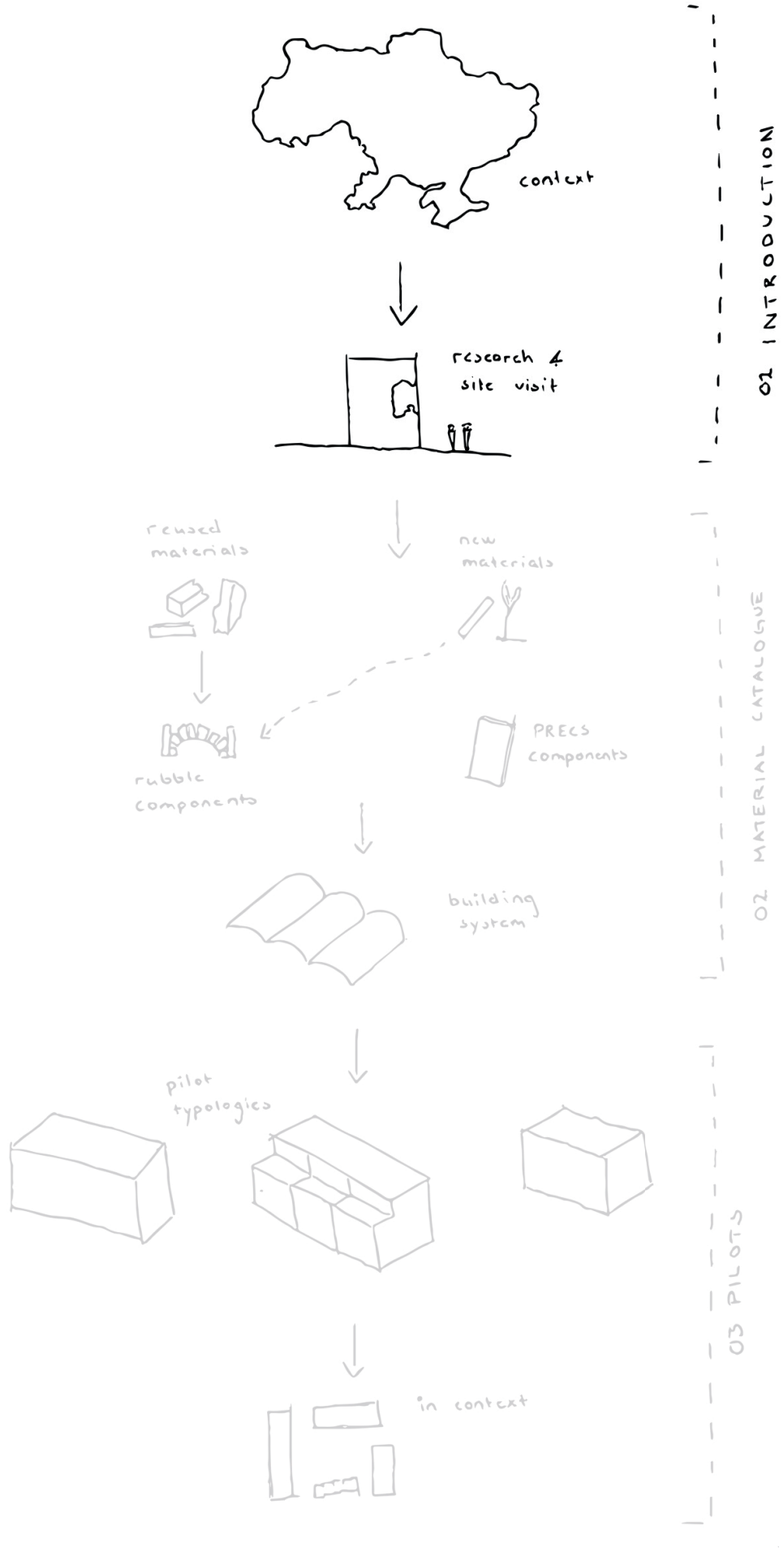
This folder defines the scope of the project, placing it in a context and a specific place. It outlines the theories and methods we have used while working with this project, addressing the ethical engagement, resilience, and the intersection of memory and material reuse. It contains the following sections:

1.1 Overview outlines the scope, intent, and structure of the project. It presents our methodology and key delimitations, framing the work within the context of post-war architectural reconstruction.

1.2 Theory of Reuse introduces the theoretical concepts and references that underpin our approach to material reuse. This includes discussions on circularity, memory, resilience, and the cultural implications of working with salvaged materials.

1.3 Context situates the project within the ongoing reconstruction efforts in Ukraine, with a focus on architectural, social, and political conditions that influence rebuilding strategies today.

1.4 Place zooms in on Irpin as our site of investigation. It presents relevant local conditions (material, urban, and human) through which the project is tested and developed. Together, these sections define a framework that guides the material and design explorations in the following folders.



1.1 OVERVIEW

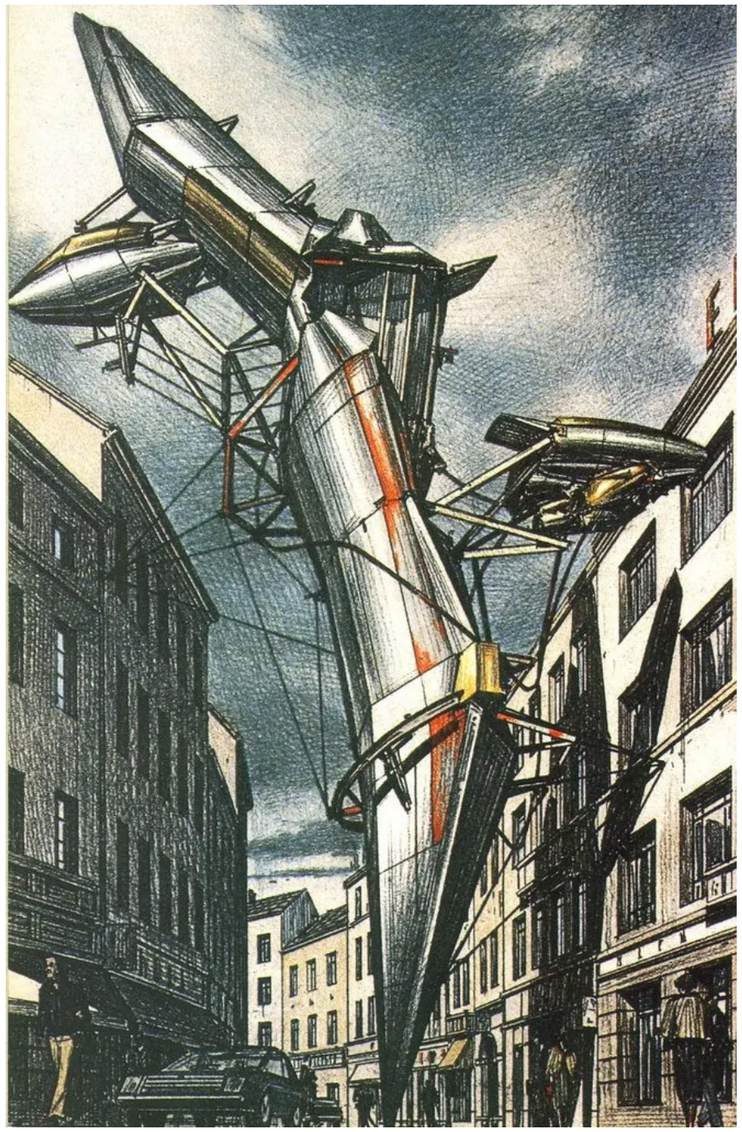
This chapter outlines the scope and our approach to the the project.

Preface

On February 24th, 2022, Russia conducted a full-scale invasion of Ukraine. The destruction brought by the following war has left the country in need of immediate rebuilding. Entire neighborhoods, transport networks, and infrastructure are ruined, depriving millions of safe housing, essential services, and stability.[2] This physical destruction is matched by emotional trauma as well as social and cultural losses, as communities are displaced, and cultural heritage sites are damaged or destroyed. [3]

Aim

The thesis explores a regenerative and circular architectural approach to rebuilding war-damaged areas in Ukraine. The aim is to integrate as much repurposed materials as possible into the design of housing solutions, minimizing environmental impact while addressing community needs. This approach acknowledges the dual challenges of physical reconstruction and socio-environmental sustainability in the reconstruction efforts.



Zagreb Free-Zone, a drawing of a never-built structure. © Lebbus Wood

[2] Yildizel et al., Recycling and Reuse of Construction and Demolition Waste. [3] Charlesworth, Humanitarian Architecture

Research Question

How can circular design principles and material reuse help reconstruct war-damaged areas in Ukraine, reducing carbon emissions and addressing housing needs?

The research hypothesizes that incorporating local, repurposed materials into the design process can significantly reduce the carbon footprint of rebuilding efforts and enhance cultural preservation.

Laura Almarcwgui, 55th biennale di Venezia. 2013 © Claudio Franzini

Visit to Ukraine

To better understand the situation and context, we decided to visit Ukraine in January and February of 2025. The visit was a central part of our methodology and became a turning point in shaping the focus, direction, and depth of the thesis.

The trip began with an invitation to participate in the Build Back Better 2025 workshop in Lviv, hosted by the Kharkiv School of Architecture (KhSA) and UN Habitat. This workshop brought together Ukrainian and international practitioners to explore strategies for sustainable reconstruction. Through lectures, design exercises, and informal conversations, we were introduced to key architectural and ethical questions that continue to influence our work.

The second part of our visit took us to Kyiv, where we met with ReThink Ukraine, UN Habitat, and visited the city of Irpin. The site visit to Irpin provided an understanding of the scale of destruction. It allowed us to assess the architectural typologies in the area and the levels of damage first-hand, as well as to explore landfills and damaged buildings. This has been crucial for our understanding of material availability and reuse potential.

The entire visit significantly shaped our thesis. Not only in terms of design decisions but also in attitude and responsibility. Decisions such as the inclusion of basements for bomb shelters and limiting building height to a maximum of five stories to limit the blast range from explosions, were directly informed by our conversations with people in Ukraine. These choices reflect the lived realities of ongoing war, and the necessity of designing not only for recovery, but for resilience.

Our Role

Working with this topic from afar, we are acutely aware of our position and limitations. This thesis is not an attempt to impose ready-made solutions, but rather a contribution to an ongoing conversation on material reuse in reconstruction. Our intention is to approach the topic with humility, criticality, and with respect for the knowledge and experiences of those directly affected.

Our approach to this project is exploratory and reflective. Rather than offering definitive answers, we aim to investigate the architectural possibilities and challenges of material reuse, and how these possibilities can affect the architecture of reconstruction efforts. By engaging with repurposed materials, objects that carry both trauma and memory, we seek to understand not only how they can be reused, but how their reuse might shape collective narratives of resilience and recovery. This thesis is therefore as much about the process of rebuilding with reused materials as it is about architectural proposals.

The work is rooted in field-based learnings and shaped by discussions with local stakeholders, architects, and residents in Ukraine.

Exploration of rubble reused as a structural vault.

Glossary

To ensure clarity and cohesion in the project, we have included a glossary that serves as a shared language among all participants and readers. By clearly defining key concepts, this glossary establishes a common understanding of terms that are essential to our work. It helps align our methodology with established practices in the field while minimizing the potential for miscommunication.

Ruin: the broken parts that are left of a building or town that has been destroyed by bombs, fire, etc.[4]

Rubble: the piles of broken stone, concrete and bricks, etc. that are left when a building falls down or is destroyed: the bomb reduced the house to rubble.[5]

Waste: any substance or object which the holder discards or intends or is required to discard.[6]

Urban mining: the process of reclaiming raw materials from spent products, buildings and waste.[7]

Spolia: historical practice where fragments of ruined buildings are integrated into new structures. Not just for utility, but for symbolic continuity.[8]

Circular economy: Closed-loop systems that reuse, recycle, and minimize waste.[9]

Soviet-era housing: Refers to the residential buildings constructed during the Soviet period, typically characterized by prefabricated panels.[10]

Khrushchevka: a type of mass produced, soviet housing. Low-cost, concrete or brick apartment buildings. Designed and constructed in the Soviet Union since the early 1960s.[11]

I-464: Spesific type of Kruschevka. Found throughout the soviet union, as well as Cuba, Afganistan and Mongolia.[12]

Equivalent reuse: When requirements for reused components comparable in both the new and old structure, the recovery level corresponds to an equivalent reuse.[13]

Upcycling: The process of increasing the structural utilization of demolition materials, enhancing their structural or functional value without degrading their inherent properties.[14]

Downcycling: The process of reducing the structural or functional value of demolition materials, often involving energy-intensive crushing into aggregates for lower-grade applications.[15]

Building Component: Part of a building, such as columns, beams and prefabricated walls and slabs.[16]

Building Element: Parts of building components, such as brick, stones, rubble, mortar or tiles.[17]

Building System: combination of building components, creating a complete system for building construction.[18]

PRECS: Piecewise Reuse of Extracted Concrete in new Structures.[19]

IDP: Internally Displaced People.[20]

[4_5] Cambridge Dictionary. [6] EU, Waste directive. [7]SINTEF, Recycling and Urban Mining. [8]Stricker, Reuse in Construction. [9]Dryzek, The politics of the earth. [10_11] Ureherit, Hollistic Rennovation. [12] Malaia, Mass Housing in Ukraine.

[13_14_15] Küpfer, Reuse of Concrete Components. [16_17_18] Eversman, Scalable Disruptors. [19] Küpfer, Reuse of Concrete Components. [20]World Bank, RDNA4.

1.2 THEORY OF REUSE

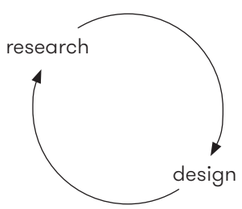
In this chapter we introduce theoretical concepts, methodologies and approaches to reuse relevant to the project.

Methodology

Working with this thesis, we used an iterative approach, integrating research and design in a cyclical process. Central to this approach is the material catalogue, where we compiled data from our findings on reusable resources in the chosen area. The knowledge from the catalogue has helped guide the design, and through design we have found gaps to fill in the material catalogue.

Another important aspect to our approach is our collaboration with local actors, such as the Kharkiv School of Architecture and ReThink. This has helped us develop context-sensitive and technically grounded solutions.

The research part of this process is presented in the following section, containing theories of reuse, approaches and their relevance to our thesis.



A Manifest for Resilience

Material Reuse
The reuse of materials such as brick, concrete, and steel from war-torn buildings has both practical and symbolic significance. Practically, it reduces the need for new resources and minimizes waste, aligning with sustainable reconstruction goals.[22] Symbolically, these materials embody the memory of what once was, serving as a connection between a place's past and its future. By embedding these remnants into new construction, the act of rebuilding can become a narrative of survival and hope. American architect Lebbeus Woods, known for his work on post-war reconstruction, described ruins as opportunities for architecture to become "a manifest for resilience."[23] He envisioned integrating the fragments of the past into new designs, creating structures that not only house people but also tell the story of their perseverance. In Ukraine, the reuse of materials could transform ruins into symbols of collective endurance, reflecting the nation's ability to rise from the ruins of destruction. Incorporating the materials from these ruins into construction also allows for the creation of a material language that communicates resilience. Walls built with reclaimed bricks or structures supported by reused beams can become visible testaments to a community's resilience. This approach transforms materials that might otherwise be seen as waste into structural parts of a new urban landscape, while honoring the memory of a place. [24]

Balancing Trauma and Healing
While reused materials can symbolize resilience, their presence must be carefully considered to avoid overwhelming the affected communities with reminders of trauma. For some, the sight of ruins from the war may evoke painful memories.[25] For others, it can represent strength and continuity. Balancing these responses requires thoughtful design - incorporating reclaimed elements subtly. Blending old materials with new ones to create structures that honor the past without allowing it to dominate.

A New Identity from Ruins
Incorporating reused materials into Ukraine's rebuilding efforts does more than reduce waste; it redefines destruction as a resource for renewal. This approach symbolizes not only recovery but also a collective identity rooted in resilience. At the same time it makes use of an abundant, local material that minimizes the need for new resources and reduces environmental impact. Each repurposed brick or beam becomes a part of the story, turning destruction into an opportunity to rebuild with purpose and pride. By transforming the physical remnants of war into the building blocks of the future, Ukraine can craft an architecture that reflects both its past and its hope for the future.

Building With Memory
In post-war reconstruction, architecture shapes how the past is remembered—or forgotten. Reuse of materials offers a way of anchoring memory in the built environment. Unlike monuments, buildings are lived in. When fragments of war-torn structures are integrated into new architecture, they can quietly carry memory without dominating it.

Rather than erasing all traces of trauma, selective reuse can allow history to remain visible in subtle, meaningful ways. This approach acknowledges that memory is universal. For some, remnants may be painful; for others it can be empowering. Decisions about what to preserve or transform must come from those who lived the experience. As expressed in discussions about Mariupol: "There is a multitude of solutions, and they are best conceived by the owners of these memories." [26]

We acknowledge that reused materials do not have to be monumental. They can serve as quiet, integrated reminders within new structures. This approach opens the door to memorialization through everyday use, not just formal commemoration.

[22] World Bank, Ukraine RDNA4. 23 Woods, Slow Manifesto. [24] UNEP, Beyond Foundations. [25] Weir, How Does War Damage the Environment.

[26] Kryzhanovsky, Architecture After War.

Car Graveyard, Irpin. February 2025.

“This recuperation of debris thus helps to make history visible, acknowledging that both matter and memory are important to build the future in both a social and an architectural sense.”

Gloria Cabral
Debris of History, Matters of Memory

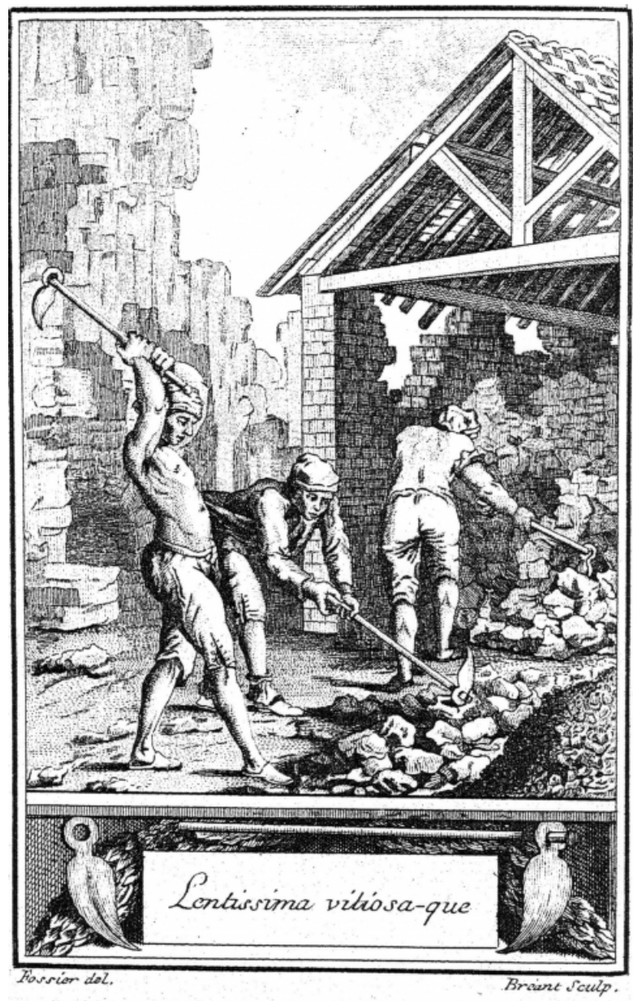
A Brief History of Reuse

In architectural history, building with what is already there is neither a new idea nor a radical one. For much of human history, reuse was not a choice, but a necessity. Looking into the history of reuse in architecture helps laying the foundation for why working with materials from ruins in Ukraine is both historically grounded and relevant today.

From Scarcity to Meaning
Historically, societies practiced reuse out of necessity. Local materials such as stone, timber and clay were repurposed to create tools, shelters, and infrastructure. As Walter Stahel notes in the chapter History of the circular economy, [28] this was a circular logic expressed in the mantra: “use it up, wear it out, make it do, or do without.”

With industrialization, mass production and mechanization replaced scarcity with abundance. Standardized, virgin materials became widely accessible, and as a result reuse declined. This shift weakened the relationship between place and material, severing architectural form from local context. [29] Today, reuse can be seen as both a necessity and a conscious act. Not only to reduce waste, but to reclaim memory, identity, and meaning.

Pragmatic Reuse
Historically, two logics of reuse have shaped architecture. Pragmatic, material driven reuse is led by availability and economy. Medieval builders, for example, incorporated fragments from Roman cities into new walls. Not for symbolic reasons, but to save labor and materials. This approach was seen in the middle-age church of St. Alban Church, which was completed in year 1115, only eleven years after the construction started. This achievement was partially because of the efficient rule of Abbot Richard d’Albini, but mostly due to the available material resources from a nearby ruined roman town. [30]



[28–29] Eisenriegler, The Circular Economy. [30] Perkins, The Cathedral Church of St Albans.

"Perhaps the lesson to be learned from cities destroyed in the Second World War is that an urban society that loses its history is a weakened society."

- Bohdan Kryzhanovsky in Architecture after war

Ideological Reuse

Ideological, meaning driven reuse on the other hand, intentionally preserves and reinterprets materials for their commemorative or symbolic value. Drawing from the theories of Alois Riegl, the aim was to harness the historic value, art value and sensory value of the material. [31] Examples of this type of reuse can be seen in the St. Marks Basilica in Venice, where spolia from Constantinople was used on the facade of the new basilica.[32]

Materials from ruins, regardless of architectural merit, can carry these values. They become unintentional monuments, carrying significance through survival and reinterpretation. In this thesis, we draw from both logics. The reuse of materials from ruins in Ukraine is pragmatic, resourceful, and can help reduce carbon emissions. At the same time, it can be ideological, incorporating memory and history into the very fabric of reconstruction.

Compositional Reuse and Spatial Expression

Beyond function and symbolism, reuse also offers formal and aesthetic value. Architectural history is full of examples where reused elements were celebrated for their texture, irregularity, and character. In Romanesque churches, mismatched columns marked processional paths. In Islamic and Byzantine architecture, spolia added color, rhythm, and symbolism.[33] As seen in contemporary architectural examples, materials from ruins today can create distinct spatial qualities that challenge the uniformity of modern construction. This can be seen in the K118 building in Winterthur, Switzerland. Designed by Baubüro in situ. Here, the available materials have guided the design, creating a unique architectural expression.[34]

Rebuilding in Ukraine

In the context of Ukraine, can become both a practical and symbolic approach. It makes use of immediate, local resources while offering a path to embed memory in new structures. Reuse can break reconstruction efforts from generic, prefabricated housing logic, moving towards tactility, irregularity, and identity.

[31] Riegl, The Modern Cult of Monuments. [32_33_34] Stricker, Reuse in Construction.

Design Approaches for Reuse

When designing with reused materials, the design process can be guided by two opposing design approaches:

Top Down
Top-down approach starts with a fixed concept, incorporating reclaimed materials into this concept. Le Corbusier's Ronchamp Chapel, for example, used reused brick for its sculptural walls. However, the architectural concept was not shaped by the material.[35]

Bottom up
The bottom-up approach begins with the material itself. British architects Alison and Peter Smithson's Hexenhaus was shaped over decades by what was available and meaningful at each moment. The form evolved through small, iterative interventions, prioritizing the process, rather than the final product.[36]

Hybrid Approach
Alternatively, a hybrid approach can be adopted. Such an approach can be seen in Dimitris Pikionis' path leading up to Acropolis.[37] Pikionis designed an overall plan, with a defined layout and viewpoints. However, the drawings stopped at the sketches, leaving room for the workers to make decisions on the go. This required an overall adaptable concept.

In this thesis, we adopt a similar approach to the one used by Pikionis. We allow the reuse of materials from ruins to inform the structural and spatial system yet leave room for ad hoc responses to available materials. This way we can use planning as a principle, creating a system while still leaving room to adapt to available materials and specific needs.

La Chapelle de Ronchamp © Qianqian

Hexenhaus © Axel Bruchhäuser

The path to Acropolis © Kevin Malawski

[35] Boesiger, Le Corbusier et son atelier. [36] Scimemi, An Open Work by the Smithsons. [37] Papageorgiou-Venetas, The Architect Dimitris Pikionis

Urban Mining

The concept of urban mining addresses the urban environments as repositories of material resources. [38] From this perspective, materials from damaged or destroyed buildings are not seen as waste, but rather as resources for new construction. It involves repairing, refurbishing, reusing and recycling existing materials and products to minimize environmental impacts.

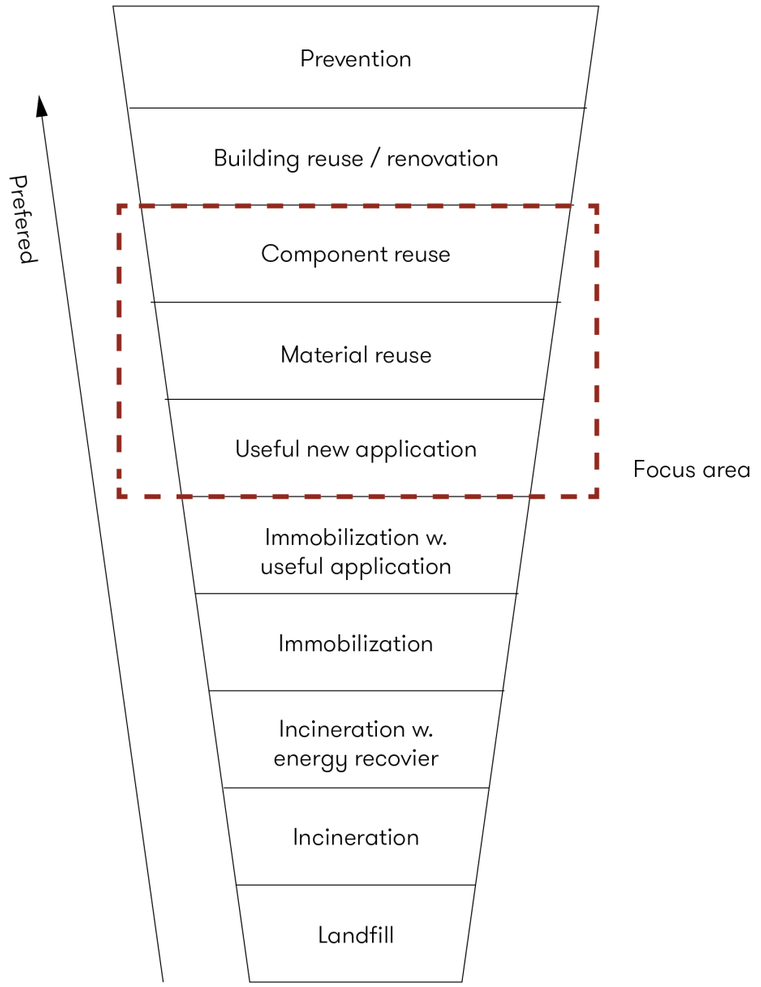
Urban mining offers a contextual, design-driven approach to reuse, embracing material irregularity and history. When the ruins are seen as a material repository, the elements can be systematically recovered, catalogued, and re-integrated into new construction.

Resource Management Strategy

In order to evaluate these resources, a hierarchy is needed. The Delft Ladder is a resource management strategy developed in the City of Delft, Netherlands for handling construction and demolition waste. It creates a hierarchy based on using the materials as close to their original state as possible, prioritizing actions that retain the most value and embedded energy of building components.[39]

According to this hierarchy, the ideal strategy would be to repair or refurbish existing buildings. However, based on damage assessments from UN Habitat, many structures in Irpin (and presumably in other war-affected areas) are beyond repair. Additionally, as argued by Phillip Meuser, there is often an uncertainty in damaged buildings, making reuse of components a safer option.[40]

Considering these conditions, we focus on material and component reuse in new constructions. Our design approach emphasizes the reuse of structural components, reprocessing materials with minimal transformation, and useful new applications for salvaged elements, while working as high up the ladder as possible.



[38] SINTEF, Recycling and Urban Mining. [39] Cucuzzella, The Delft Ladder. [40] Meuser, 2025.

1.3 CONTEXT

Here, we acknowledge the current situation in Ukraine, present building traditions relevant to the project and analyse the chosen area in which we base our project.

The Context

This section is divided into the following subsections:

1.3.1 The Context of Ukraine looking into the current situation in Ukraine, related to rebuilding and reuse.
1.3.2 Building Tradition exploring relevant local construction affecting reuse possibilites
1.3.3 Place outlining why we chose Irpin for testing and developing our strategies, as well as analysis of the area.

Our understanding of the context has been shaped by our visit to Ukraine. Here, we had the opportunity to engage directly with the realities of post-war reconstruction through our participation in the Building Back Better workshop. Organized by the Kharkiv School of Architecture in Lviv, Ukraine, this shaped both our understanding of the challenges and our approach to the project.

In the workshop, we focused on the rebuilding of Odesa, working alongside students, professionals, and civil society representatives. The workshop allowed us to collaborate across borders and disciplines, focusing on both architectural solutions and the emotional and societal dimensions of reconstruction.

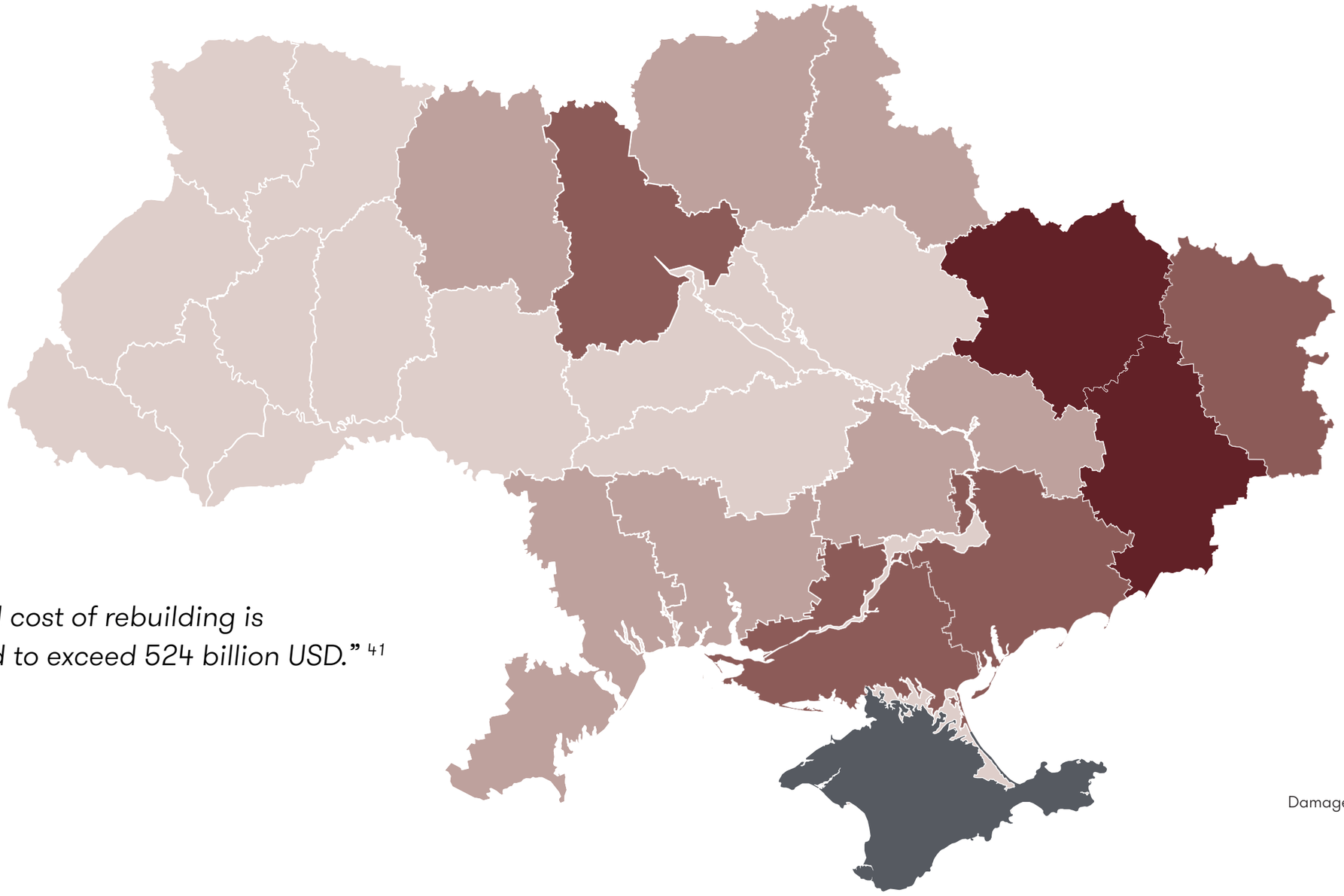
Our presence in Ukraine gave us access to learn directly from those most affected by the war. Conversations with locals, academics, and practitioners provided an insight that would have been impossible to achieve remotely. We got a deeper understanding about the relation between loss, memory, and the urgent practical needs of rebuilding.

Through this engagement, we developed an active network of professionals and organizations, which we have drawn on continuously throughout the project for feedback, dialogue, and support. This direct experience and collaboration became an essential foundation for our work, informing both the practical and conceptual frameworks of our proposal and reinforcing our focus on addressing both the physical and emotional realities of rebuilding.

The outcome of the workshop has been exhibited in Odesa, Lviv, Warsaw and Kyiv. A selection of the work is also presented as a part of the French Pavillion at the 2025 Venice Biennale, focusing on the theme *Living With*.

Outcome of the workshop exhibited in a bomb shelter. Odesa, April 2025 © KhSA

1.3.1 Context of Ukraine



"The total cost of rebuilding is estimated to exceed 524 billion USD." [41]

[41] World Bank, RDNA4.

Legal Framework for Circular Constructions

Historic Precedents of Pragmatic Legislation after War
The legal framework for circular construction and material reuse in Ukraine is evolving rapidly, driven by the urgency of recovery and environmental concerns. While some national regulations exist around demolition, waste management, and health standards, a coherent system for large-scale reuse remains absent.[42]

This section outlines current gaps and challenges within Ukrainian law, with a focus on hazardous materials (such as asbestos), certification and liability for reused components, and regulatory barriers that complicate material recovery. Understanding these conditions is essential for evaluating the feasibility and safety of reusing materials from ruins.

With the current legislative restrictions, the implementation of our proposed reuse-based building system is close to impossible. However, we argue that the urgency of the situation demands a pragmatic shift in legal thinking.

There is precedent for this. After World War II, France adapted its building codes to enable rapid reconstruction allowing for material reuse.[43] Similar regulatory flexibility has been demonstrated in post-crisis contexts in Germany.[44] What's needed is a legal system that's adaptable, responsive, and built for the realities of recovery.

Based on research and pilot projects led by ReThink, along with feedback from other stakeholders, this section outlines the current legal situation and its limitations, with a particular focus on challenges regarding material reuse.

[42]Skat, Perspectives of Urban Mining. [43]Martin Durplantier, 2025. [44]Sulzer, ReThink: Deep-Dive into Circular Construction.

Main Challenges

1. Asbestos: Regulation and Health Hazards
Asbestos-containing materials (ACMs) remain widespread in Soviet-era buildings across Ukraine. Though banned in 2023, they are still embedded in roofing, facade panels, and infrastructure elements. Handling is inconsistently regulated, posing both legal and health challenges for reuse. [45]

While Ukraine has outlined procedures for asbestos handling, including identification and protective equipment protocols, implementation is inconsistent. In practice, most demolition sites rely on visual identification or skip testing entirely, despite international standards requiring laboratory confirmation.

However, field-tested methods demonstrate that safe material reuse is achievable. Neo-Eco Ukraine, for instance, employs a "source separation" approach—removing asbestos components like roofing, followed by careful material sorting. This method has achieved recycling rates of up to 90%, with residual asbestos levels well below EU safety thresholds.[46]

Similarly, Shelter Cluster and Miyamoto International have developed practical guidelines for asbestos risk management during emergency repairs and reconstruction, emphasizing protective equipment, containment zones, and worker training.[47]

These examples illustrate that, with clear protocols and pragmatic legislation, material reuse is not only feasible but essential. Integrating such practices into national policy can transform a significant challenge into an opportunity for sustainable rebuilding.

For us, this means avoiding known ACM components (e.g. slate, pipe insulation), and focusing reuse efforts on clean, verifiable materials while advocating for the rollout of scalable asbestos screening protocols.

[45]Sulzer, ReThink: Deep-Dive into Circular Construction. [46] Euronews, Recycling Rubble with Asbestos. [47]Miyamoto, Pragmatic Guidelines for Handling Asbestos.

2. Lack of Certification for Reused Materials
Without recognized systems for material testing, tracking, and certification, even structurally sound components are excluded from public procurement and formal construction workflows. Stakeholders across sectors, ranging from demolition contractors to architects, reported that the absence of such certification is a major barrier. There are no recognized institutions or protocols in Ukraine to verify the quality, safety, or durability of reclaimed materials. Without such certification, materials cannot meet construction standards or be used in public procurement.[48]

3. Enforcement and Practical Barriers
Despite new laws aiding material reuse, ReThink's assessment of legal enforcement shows a pattern of poor implementation:

- Material separation and sorting are rarely done during demolition, even when legally required.
- Temporary storage and reuse sites are established in some communes but lack safety verification.
- Reuse is largely driven by NGO-led initiatives rather than state incentives.

These aspects directly affect the feasibility of our proposed reuse-based building system. Understanding where interventions are needed and which stakeholders can drive them is essential for moving from theory to implementation.[49]

[48]Skat, Perspectives of Urban Mining. [49]Sulzer, ReThink: Deep-Dive into Circular Construction.

Stakeholder Analysis

There are several stakeholders working within the fields of reuse and rebuilding in Ukraine. The project has been developed in close contact with several of these. The following stakeholder map identifies actors operating in reconstruction, circular economy, and waste resource management. It outlines their work and relevance to our thesis.

From the Build Back Better workshop in Lviv.

Name	Role	Interaction	Relevance to thesis	Contact	Link
ReThink	Ukrainian NGO working on circular economy, waste management, and sustainability. Key voice in environmental debates.	Interviewed and engaged with (in Kyiv).	Provided insights on material reuse, waste management, circular economy and challenges of material reuse.	Roman Puchko	https://www.rethink.com.ua
Kharkiv School of Architecture	Private academic institution. Promoting sustainable design, focusing on the Ukraine's urban environment.	Direct collaboration through workshop.	Helped shape understanding of Ukraine's urban environment.	Ryan Locke, Mykhailo Shevchenko, Oleg Drozdov	https://kharkiv.school
UN Habitat Ukraine	Local and regional recovery planning.	Interviewed and engaged with(in Kyiv).	Reviewed site specific reports, questioners and analysis.	Jamie Woods, Gregory Meckstroth	https://unhabitat.org/ukraine
Global Shelter Clusters Ukraine	Coordinates humanitarian shelters and settlements with local and international actors.	No direct contact.	Reviewed site specific reports, questioners and analysis.	N/A	https://sheltercluster.org/response/ukraine
UNEP (United Nations Environment Programme)	Focuses on environmental recovery. Has conducted environmental assessments in Ukraine.	No direct contact.	Used reports and strategy documents.	N/A	https://www.unep.org
UNDP (UN Development Programme)	Works on governance, recovery, infrastructure, and livelihoods, with projects focused on rebuilding social services and infrastructure.	No direct contact.	Used reports and project databases.	N/A	https://www.undp.org
Ministry of Environment (Ukraine)	Ministery overseeing environmental protection, including waste clearance.	No direct contact.	Reviewed public statements and policy briefs.	N/A	https://rdo.in.ua
Neo-Eco	Private French company piloting circular economy-based material reuse in Ukraine.	No direct contact.	Research and pilot projects regarding bio-based materials, circular economy and rubble cleaning in Ukraine.	N/A	https://neo-eco.com.ua/

Name	Role	Interaction	Relevance to thesis	Contact	Link
Ro3kvit	Urban coalition creating knowledge and methodologies for rebuilding Ukraine.	Interviewed.	Contributed insights on public participation and city-scale planning.	Mykhailo Shevchenko, Oleg Drozdov	http://rotordb.org/
City Lab (Ukraine)	Urbanist think-tank focused on participatory planning and sustainable city models.	No direct contact.	Contributed insights on public participation and city-scale planning.	N/A	https://bcl.com.ua
Rebuild Green UA	National Mapping of Local Resources, listing manufactures of raw materials, bio- and geo-sourced materials, circular reuse companies.	No direct contact.	Shared insight on local resources around Irpin.	N/A	https://www.rebuildgreenua.com
Norwegian Refugee Council (NRC)	Providing legal assistance, shelters and humanitarian aid for conflict affected communities.	Interviewed and guidance on thesis approach.	Guidance on the intersection of policy and reconstruction.	Elena Archipovaite	https://www.nrc.no/countries/europe/ukraine
World Bank	Financial aid, damage assessments, and institutional reform programs aimed at long-term recovery.	No direct contact.	Used World Bank Rapid Damage and needs asessment (RDNA 3&4)	N/A	https://www.worldbank.org/en/country/ukraine
ReBuild UA	Analyzing and visualizing destroyed infrastructure in Ukraine.	No direct contact.	Reviewed damage reports.	N/A	https://eng.rebuildua.net/
Martin Duplantier Architectes	French based architectural firm with rebuilding projects in Ukraine.	Interviewed and participated in lecture on rebuilding strategies.	Rebuilding strategies, reference projects and refections on legislation.	Martin Duplantier	https://martinduplantier.com
Rebuild Green UA	Online platform for mapping of local resources.	Interviewed and engaged with(in Lviv).	Mapping local respurces	Andrii Shtendera	https://www.rebuildgreenua.com

1.3.2 Building Traditions

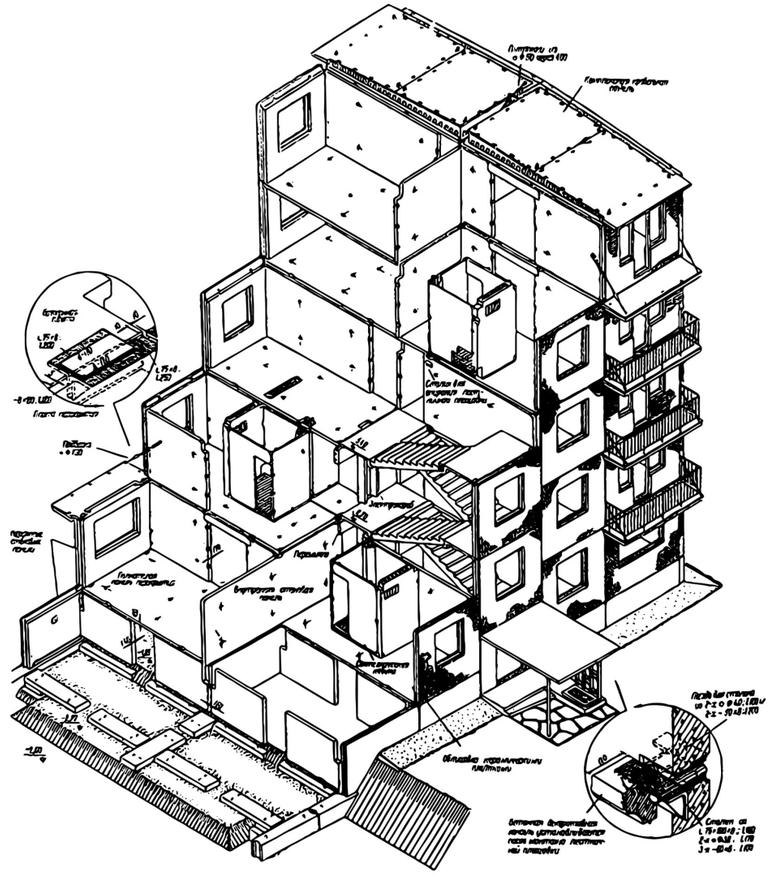
The I-464 Housing System

Following World War II, there was a rapid urbanization across the Soviet Union. This urbanization placed a huge pressure on the housing sector, leading to quick industrialization in construction and prefabrication to meet the demand for residential buildings.[50] As of today, a large portion of the housing stock in Ukraine consists of such Kruschevkas.

The I-464 is a specific type of Kruschevkas. It was introduced in 1958 and quickly became one of the most used typologies across the Soviet Union. Today, this specific type is found in Kyiv and Irpin, and throughout the former Soviet Union, as well as Yugoslavia, Afghanistan, Mongolia, and Cuba.

System Characteristics

- **Precast Concrete Panels:** Entire wall, floor, and ceiling units were produced off-site and assembled on-site.
- **Frameless Load-Bearing Structure:** Relied on internal walls for stability, reducing steel use but increasing panel standardization.
- **Mass Production & Modularity:** Enabled by a strict dimensional systems and jointing logic.
- **Regional Variations:** Adjusted for climate or seismic zones, but with core elements are standardized in all variations.[51]



Overview of the I-464 building system © Angelo Bertolazzi

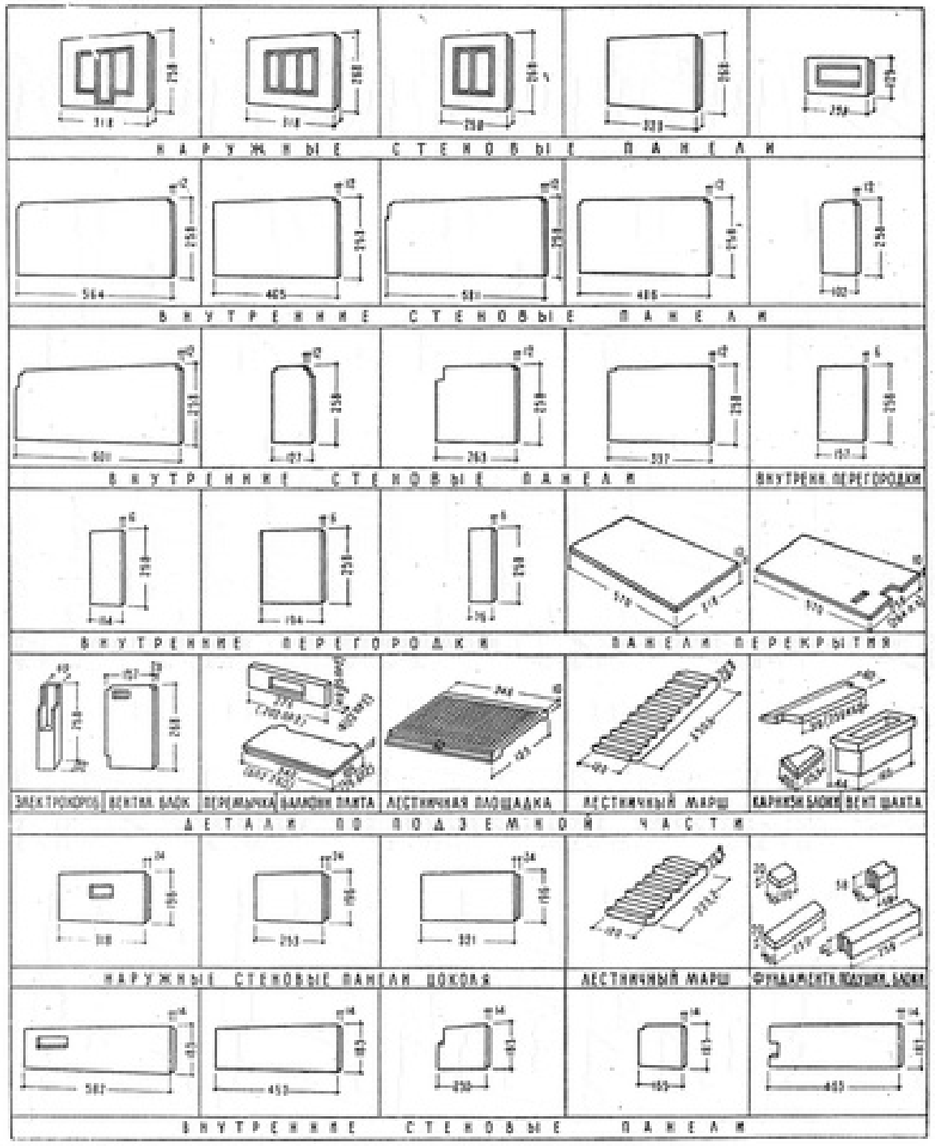
[50] Gorgolewski, Designing with Reused Building Components. [51]Bertolazzi, Refurbishment of prefabricated buildings.

Distribution

The system is found across all of the old Soviet Union, including Ukraine.

The I-464(a) Standarized components

Even though there are local variations in how the I-464 system is implemented, particularly adaptations to local climate, seismic conditions, and available resources,[52] the system is based on a core set of standardized components that remain consistent through all variations. These standardized components allow us to plan for reuse, guiding our design proposal. To follow the principles of the delft ladder, using these components whole are favorable when prevention and building repair is too difficult, which is the case for many of these due to the war and building damage.[53]



Standarized components of the I-464 building system © Angelo Bertolazzi

[52] Erofeev, The I-464 Housing Delivery System [53] UN Habitat, 2025.

1.3.3 Place

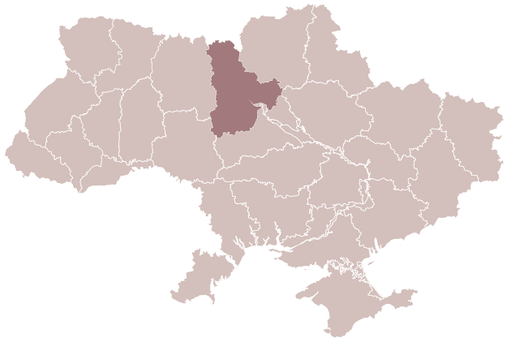
The thesis in its entirety is based on the context of Ukraine. However, in order to explore material availability, specific needs and conduct on site research a specific place is needed. This also allows us to test the approach in a specific context, grounding the project in a real-life situation.

Why Irpin

Irpin presents a balance of safety, accessibility to resources, and the presence of characteristic architectural typologies. The city has experienced extensive destruction, yet its municipality has shown openness toward integrating reuse strategies in rebuilding processes. This makes it an ideal case study for exploring material reuse and circular reconstruction.

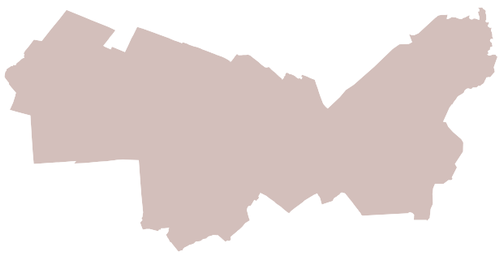
One of the key factors in choosing Irpin is safety. As of January 2025, the city was considered secure, allowing for long-term rebuilding efforts without immediate threats of conflict. This security also allowed us to visit the site and conduct on site research, which has been a essential for the project.

Irpin's proximity to Kyiv provides logistical advantages, as it allows access to the capital's resources, supply chains, and industrial infrastructure. This proximity facilitates local sourcing of materials and helps minimize the environmental impact by long-distance transportation. The area has already received approximately 25,000 internally displaced people (IDPs), and the population is expected to grow, increasing the urgency and relevance of developing adaptable, sustainable rebuilding strategies.[54]



Ukraine

Kyiv Oblast



Hromada of Irpin

[54] UN Habitat, 2025.

Overview of the I-464 building system © Angelo Bertolazzi

Within the ruins. Irpin, February 2025.

The City of Irpin

The recent history of Irpin has largely been shaped by the events of the 2022 Russian invasion of Ukraine. As a key strategic access point to Kyiv, the city became one of the most heavily contested battlegrounds in the early months of the war. Intense fighting and bombardments resulted in widespread destruction, leaving thousands of buildings either severely damaged or completely destroyed. Despite the devastation, Irpin quickly emerged as a symbol of resilience, with its defenders playing a crucial role in halting the advance toward Kyiv.[55]

An important symbol of this resilience is the Bridge of Irpin. During these early stages of the Russian invasion, the bridge was blown up by Ukrainian forces to prevent the enemy's advance toward Kyiv. The destruction of the bridge, which had previously served as a crucial connection between Irpin and the capital, turned the city into a strategic defense point, but also a place marked by isolation and chaos. The ruins of the bridge quickly became a gathering point for fleeing civilians, a place where people crossed under the wreckage while volunteers and soldiers helped them move forward.[56]

In the aftermath, the bridge has taken on new significance in the city's identity. It serves not only as a witness to the brutal realities of war but also as a symbol of Irpin's resilience and determination to rebuild. The debate over how the bridge should be restored was therefore more than just a practical discussion. It became a discussion about how the city relates to its own history.[57]

It was decided that the bridge would remain a ruin and serve as a monument, while a new bridge was built around it.[58]

[55–56] Business Insider, the untold story. [57] Repairing Ukraine, Memories. [58] Milwaukee Independent, Road of Life.

Typologies

Irpin is characterized by a combination of different typologies. In addition to the soviet-era kruschevkas (including the I-464 typology), the main typologies found are detached homes. Due to the area's rich clay deposits, the majority of houses were built in brick, using lime mortar untill the 1960s, and Portland cement from the late 1960s up untill today. There are also newer highrise buildings, buildt mostly in brick and concrete.[59]

[59] UN Habitat, 2025.



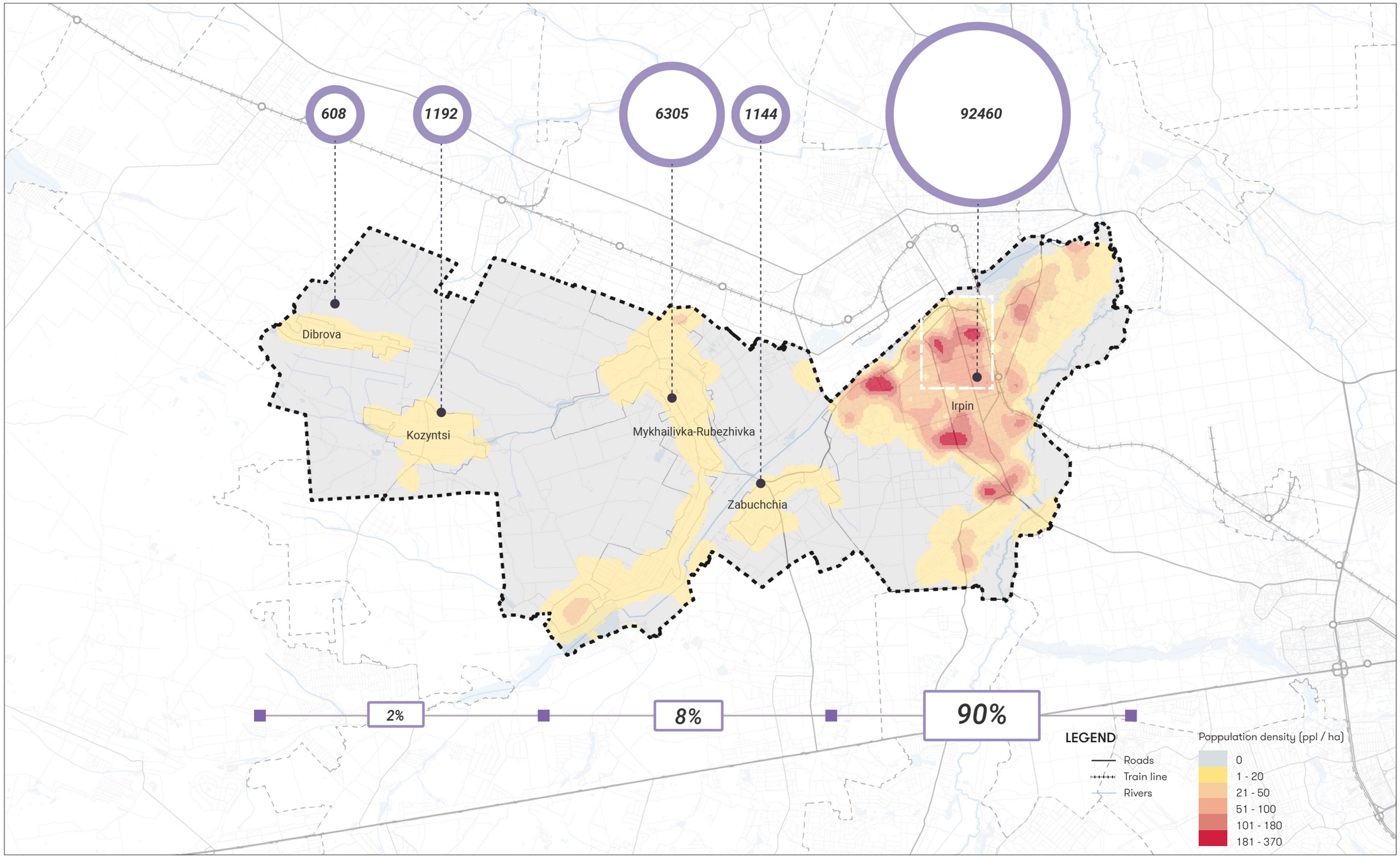



Soviet-era housing in the Kyiv Oblast.



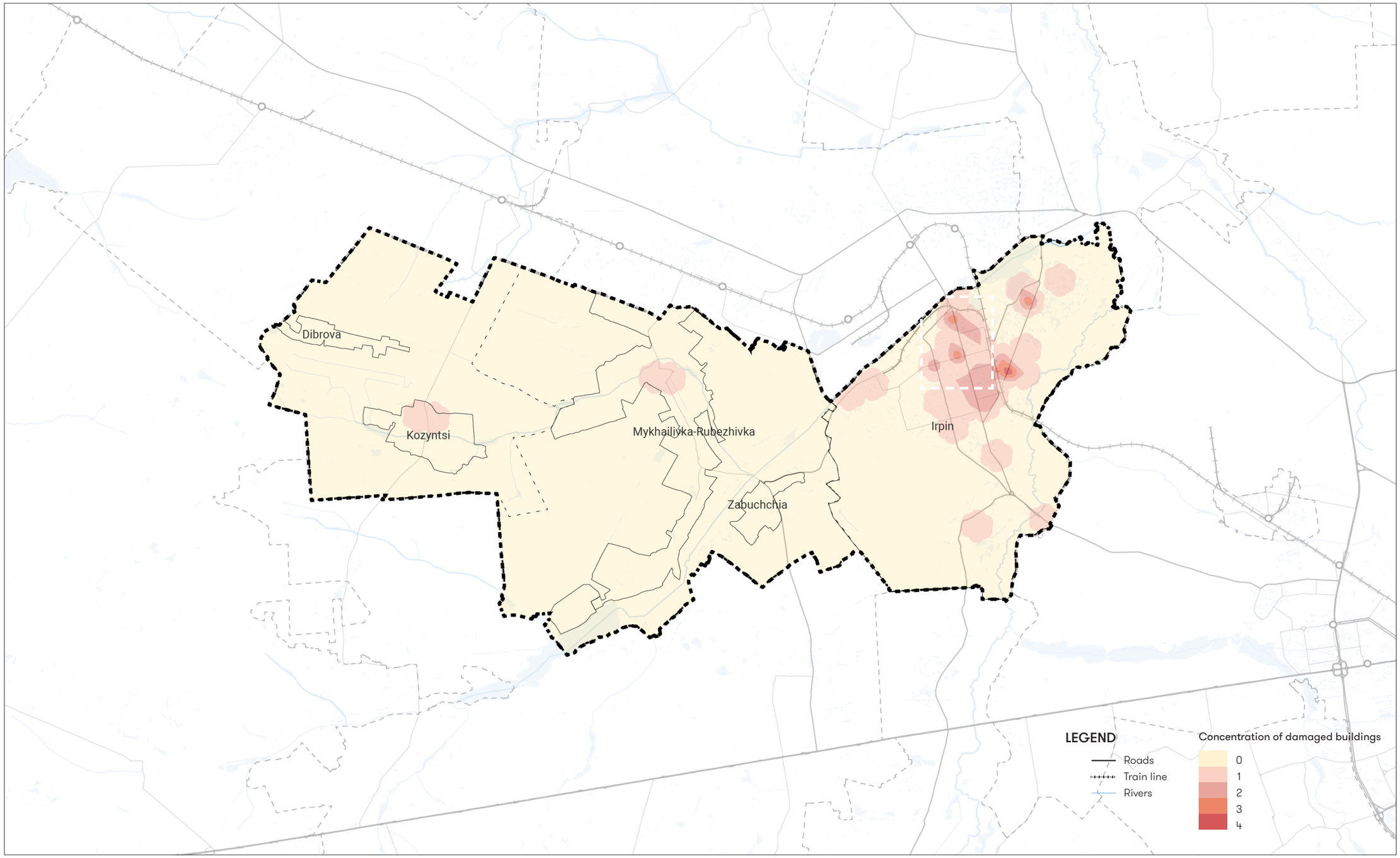



Population Density



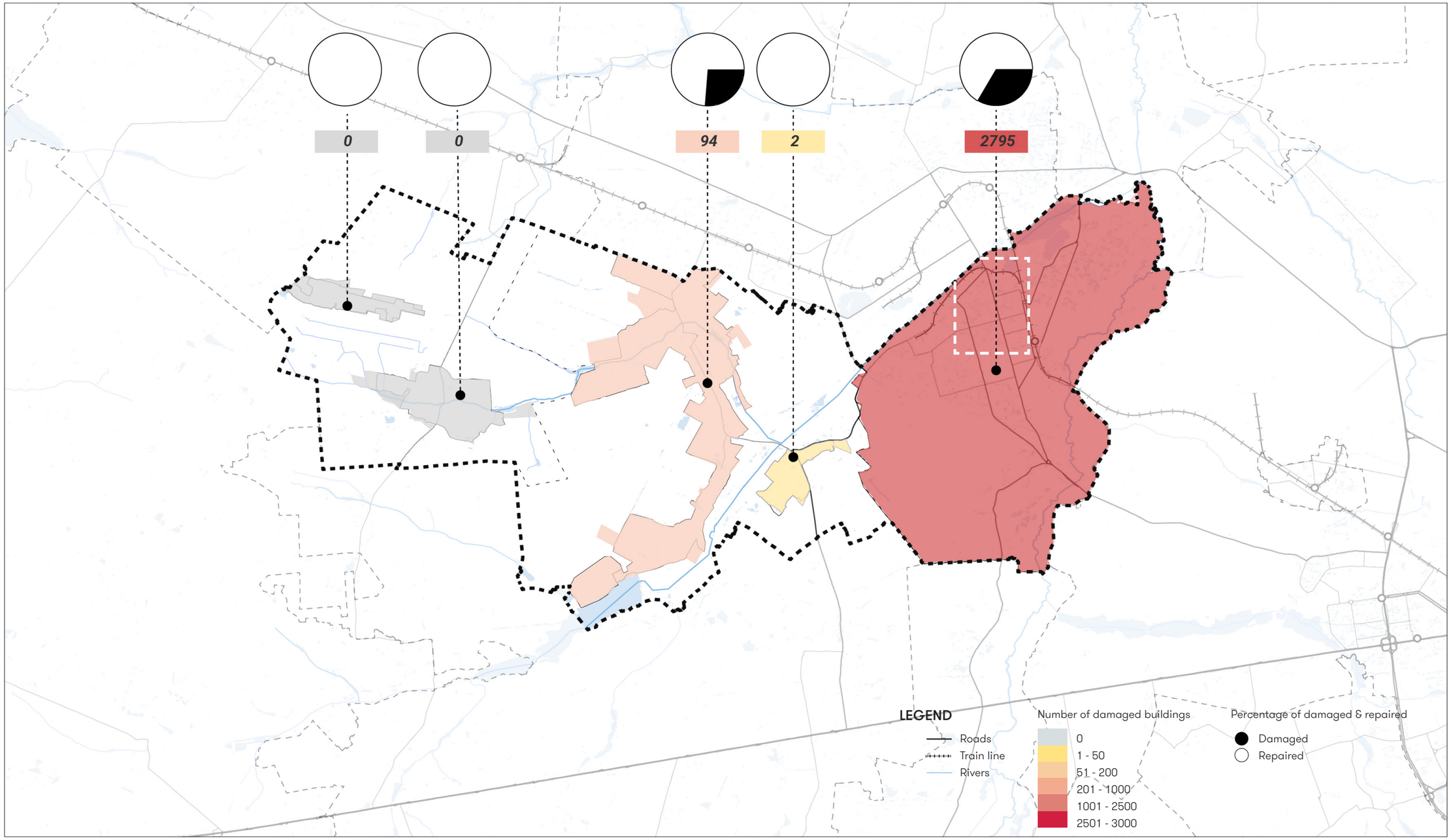
Scale A4: 1:110.000 | Illustration adapted from UN Habitat.

Concentration of damages



Scale A4: 1:110.000 | Illustration adapted from UN Habitat.

Damaged and Reparied Housing



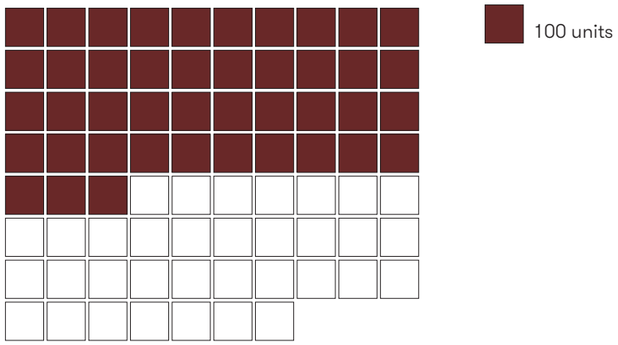
Scale A4: 1:110.000 | Illustration adapted from UN Habitat.

Levels of Destruction

The diagram based on numbers from RebuildUA, illustrates the severe damage on buildings in Irpin. According to RebuildUA, buildings with light damage in affected areas are mostly repaired, while structures with severe damage or total destruction remain standing as ruins. These remaining structures are either too costly to restore or are damaged beyond repair.

Based on this, we have chosen to disregard the repair of existing buildings, and focus solely on developing new housing typologies from reused materials.

Private houses



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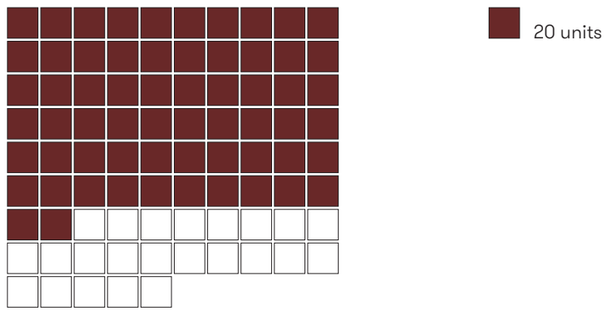
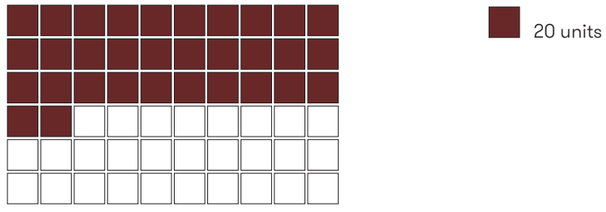
Appartment Buildings



622 / 854

Townhouses and duplexes



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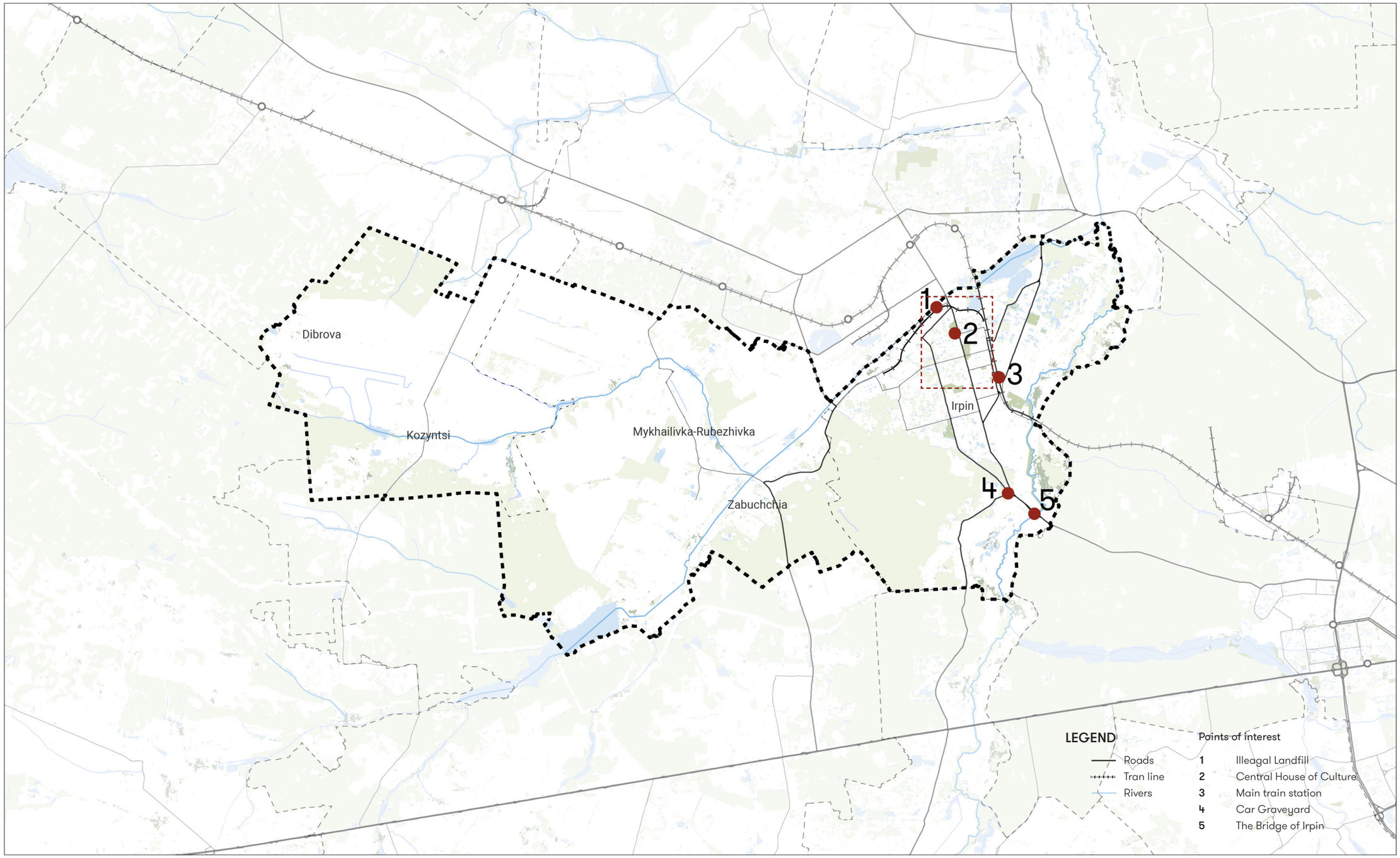
[60] RebuildUA, Irpin Report

Points of Interest



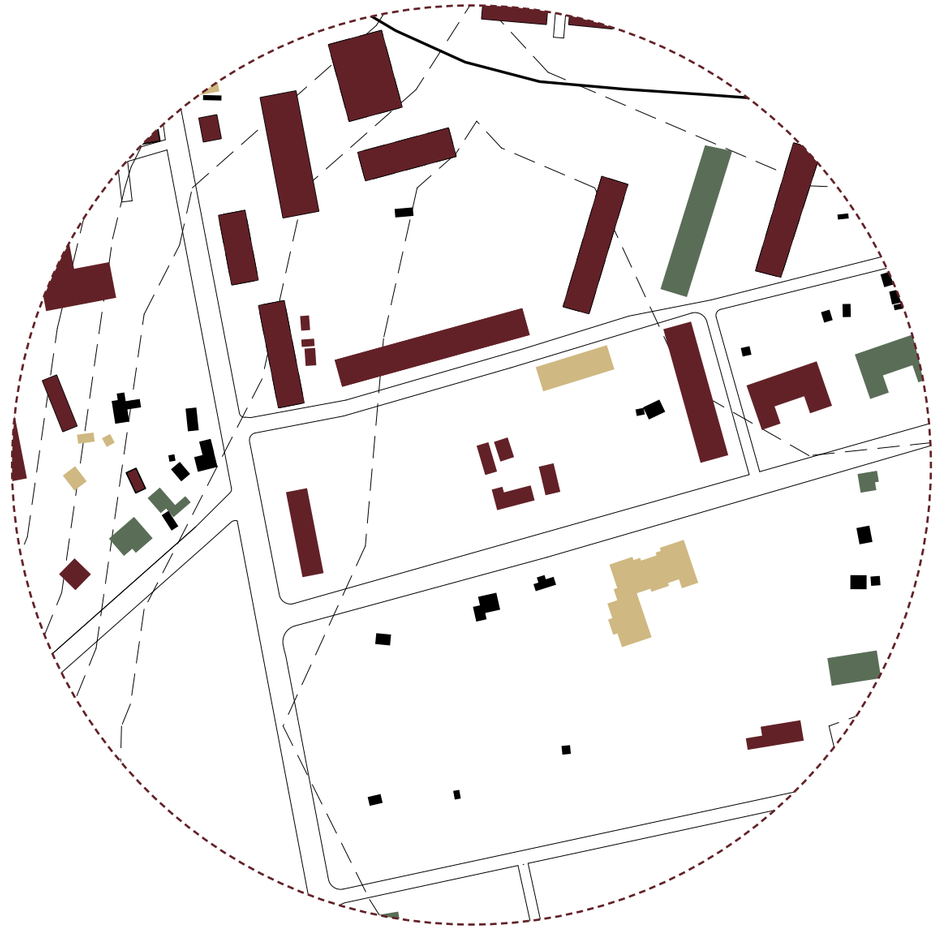
Scale A4: 1:110.000 | Information from UN Habitat

Landfill in Irpin

Square concrete elements

Coarse brick and concrete rubble

Large parallell flat sided concrete elements



Light damage

Considerable damage

Severe damage

No known damage

Summary of the Introduction

The introduction frames the reconstruction of Irpin not just as a technical task, but as a deeply cultural and symbolic one. It outlines the significance of reusing materials with embedded histories and develops the conceptual underpinnings for a circular reconstruction model. This sets up the next folder: 02 Material Catalogue, which operationalizes the ideas introduced here by mapping, categorizing, and exploring the reuse potential of specific materials found on-site in Irpin.

Interior material composition.

The Bridge of Irpin, February 2025.

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Title
Rising from Ruins: Rebuilding in Ukraine

Students
Anders Gjesdal
Mille Sofie Hals Richardsen