

REPORT

WP5
/ APPLIED RESEARCH HUB
// MASTERPLAN OF THE PROJECT AREA

GROUNDING *THE* SUSTAINABILITY *NEW OPPORTUNITIES* *FOR OUR FUTURE*



POLITECNICO MILANO 1863 | MANTOVA
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MILANO 1863**

**MANTOVA
CAMPUS**



Research Team

Carmen Angelillo

George Bernard

Carlo Peraboni

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Submission Date: 30 June 2026

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Booklet

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Chapter 1 - Project framework

“The Goals and targets are integrated and indivisible and balance the three dimensions of sustainable development: the economic, social and environmental.”

United Nations, Transforming our world: the 2030 Agenda for Sustainable Development, 2015.

1. GROUNDING THE SUSTAINABILITY

1.1 The meaning of sustainability

Sustainability is fundamentally about achieving a balance between environmental supervision, economic growth, and social equity. It operates on the foundational belief that decisions made today should not restrict the choices of future generations. Defined in the Brundtland Report as the ability to “meet the needs of the present without compromising the ability of future generations to meet their own needs” (World Commission on Environment and Development, 1987), sustainability integrates long-term ecological health, economic stability, and social equity into a cohesive strategy.

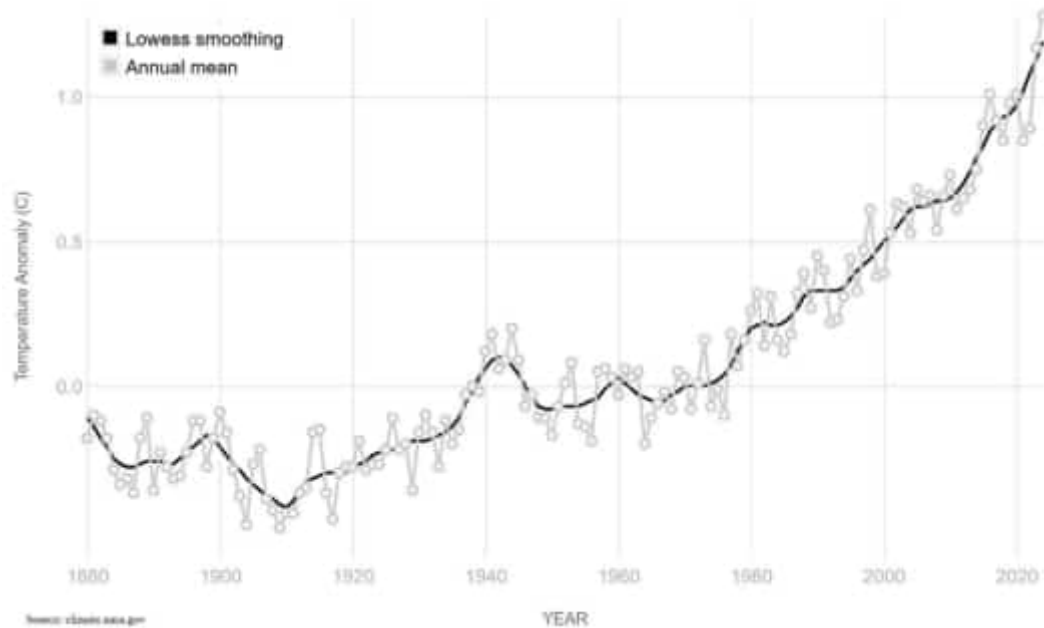
The 20th century marked a period of unprecedented industrialization, which led to significant environmental challenges. The burning of fossil fuels, a central component of industrial activity, releases substantial amounts of carbon dioxide, thereby contributing to the gradual warming of our planet. This phenomenon, known as the greenhouse effect, has resulted in increase of global temperatures significantly; “Earth was about 2.65 degrees Fahrenheit (or about 1.47 degrees Celsius) warmer in 2024 than in the late 19th-century (1850-1900) preindustrial average. The 10 most recent years are the warmest on record” (NASA, 2024).

It has become increasingly clear that economic development and environmental health are inextricably linked. Development practices that degrade the environment can ultimately undermine the economic bases they intend to strengthen, while environmental degradation can limit economic progress. This awareness has spurred the adoption of integrated approaches that address economic, environmental, and social dimensions, aiming to foster sustainable development. These strategies are crucial not only for safeguarding environmental health but also for ensuring fair economic growth and social well-being. They represent the only viable path forward, ensuring that today’s progress does not compromise the well-being of future generations.

Expanding on this framework, sustainable global development requires affluent societies to adopt lifestyles that are within the planet’s ecological means, particularly in their energy usage. Additionally, rapidly growing populations can exacerbate pressure on resources and hinder improvements in living standards. Thus, sustainable development can only be achieved if population growth is in harmony with the changing productive potential of the ecosystem.

Sustainable development is not a static state of equilibrium but a dynamic process of change. It involves the prudent management of resources, strategic investment direction, orientation of technological development, and continuous institutional change, all aligned with the needs of both current and future generations.

Acknowledging the complexity of this process, it is evident that achieving sustainable development is neither easy nor straightforward. It demands a concerted effort and adaptive strategies that can respond effectively to emerging challenges and opportunities.



Global land and ocean temperature index

Source: <https://climate.nasa.gov/vital-signs/global-temperature/?intent=121>



Graph showcasing atmospheric CO2 levels that have risen since the Industrial Revolution.

Source: <https://science.nasa.gov/climate-change/evidence/>

Early Developments and Major Milestones: The Evolution of Sustainability

A major turning point in the recognition of sustainability at the international level occurred with the United Nations Conference on the Human Environment in Stockholm in 1972. This conference was the first global forum to emphasize environmental issues within economic and social development, marking a shift in international perspectives. The discussions held in Stockholm highlighted the necessity of integrating environmental protection into policy-making, reinforcing the idea that economic growth and ecological conservation were mutually inclusive. The conference also led to the establishment of the United Nations Environment Programme (UNEP), which has since played a crucial role in coordinating global environmental efforts (UN, 1972).

Brundtland Commission (1987): Building upon the momentum of Stockholm, sustainability continued to evolve as a global priority. In 1987, the Brundtland Commission, officially known as the World Commission on Environment and Development (WCED), was established by the United Nations to address growing concerns about environmental degradation and its long-term implications for economic and social development. Its report, *Our Common Future*, emphasized the need for a balanced approach that considered environmental, economic, and social dimensions in decision-making. The report's recommendations became a cornerstone for future sustainability policies and played a significant role in shaping international discussions on sustainable development (World Commission on Environment and Development, 1987).

Earth Summit (1992): The next significant milestone was the 1992 Earth Summit, formally known as the United Nations Conference on Environment and Development (UNCED), held in Rio de Janeiro, Brazil. This summit was a landmark event in global sustainability governance, leading to the adoption of Agenda 21, a comprehensive action plan for sustainable development at local, national, and international levels. Additionally, the summit resulted in the establishment of major international agreements, including the United Nations Framework Convention on Climate Change (UNFCCC), which set the stage for future climate negotiations, and the Convention on Biological Diversity (CBD), which focused on the conservation and sustainable use of biodiversity. These agreements laid the groundwork for global cooperation in addressing environmental challenges, demonstrating a growing commitment to sustainability at the highest levels of governance (UN, 1992).

World Summit on Sustainable Development (2002): A decade later, the World Summit on Sustainable Development, held in Johannesburg, South Africa, in 2002, sought to assess and accelerate the implementation of Agenda 21 while addressing new sustainability challenges. This summit reinforced the importance of integrating social and economic dimensions into environmental policies and led to the adoption of the Johannesburg Plan of Implementation, which outlined specific targets and actions to enhance sustainable development efforts worldwide. The summit emphasized the need for stronger partnerships between governments, businesses, and civil society to achieve sustainability goals (UN, 2002).

United Nations Conference on Sustainable Development (Rio+20) (2012): The United Nations Conference on Sustainable Development (Rio+20), held in 2012, marked the 20th anniversary of the 1992 Earth Summit and provided an opportunity to evaluate progress while identifying new strategies for sustainable development. The conference focused on two central themes: the role of a green economy in promoting sustainability and poverty eradication, and the need for an improved institutional framework to enhance global environmental governance. The outcome document, "The Future We Want," reaffirmed global commitments to sustainability and initiated the process of developing the Sustainable Development Goals (SDGs), which would later become a defining framework for global sustainability efforts (UN, 2012).

Sustainable Development Goals (2015): The culmination of these global efforts was the adoption of the Sustainable Development Goals (SDGs) in 2015 at the United Nations Sustainable Development Summit. These 17 interrelated goals were designed to address critical global challenges, ranging from poverty eradication and climate action to gender equality and economic inclusion. The SDGs built upon the foundation laid by the Millennium Development Goals (MDGs) and provided a

holistic framework for guiding sustainable development efforts through 2030. Each goal includes specific targets and indicators to track progress, emphasizing a global commitment to achieving sustainability in an integrated and measurable way (UN, 2015).

Paris Agreement (2015): Adopted the same year as the Sustainable Development Goals, the Paris Agreement became one of the most significant international treaties addressing climate change. Signed at the 21st Conference of the Parties (COP21) under the United Nations Framework Convention on Climate Change (UNFCCC), the agreement aimed to limit global warming to well below 2°C above pre-industrial levels, with efforts to restrict it to 1.5°C. The agreement marked a major step toward global climate governance by fostering international cooperation and encouraging both developed and developing nations to take advanced ambitious actions against growing climate change.

The evolution of sustainability as a global priority has been shaped by a series of international milestones, each expanding the understanding and ensuring application of sustainable development principles. From early resource management practices to comprehensive global frameworks, the journey toward sustainability reflects an increasing recognition of the need to balance economic growth, environmental betterment, and social well-being. As global challenges continue to evolve, sustained international collaboration and policy innovation remains an essential way forward to ensuring a sustainable future for generations to come.



1.2 Sustainability as an operational design issue

Interpreting Sustainability Today: Changes and New Perspectives

Sustainability, once understood primarily as an effort to preserve natural ecosystems, has undergone a significant transformation over the years. Initially, the concept was largely associated with conservation movements, pollution control and the reduction of human impact on the environment. However, in contemporary debates, sustainability is no longer confined to environmental concerns alone. It has evolved into a comprehensive framework that integrates economic resilience, social justice and governance (Sachs, 2015). This broader perspective recognizes sustainability not as a standalone goal, but as a multidimensional approach to the interconnected challenges of climate change, economic stability, technological advancement and social equity.

Today, sustainability is no longer limited to legislative regulation or environmental activism. It extends to corporate strategies, investment policies, technological innovation and everyday consumer choices (United Nations, 2015). Digital tools and technological advancements — from big data analytics and artificial intelligence to blockchain and tracking systems — have also introduced new possibilities for monitoring impacts, improving accountability and supporting more informed decision-making processes (United Nations, 2021).

Within this broader evolution, Bistagnino's contribution is particularly relevant because it shifts the focus from linear production models to a systemic interpretation of sustainability. His methodology of **systemic design** is based on a principle that challenges conventional linear thinking: the outputs of one productive system — waste, by-products or discarded materials — can become inputs for other systems, in the form of material or energy resources (Bistagnino, 2009). This approach anticipates and reinforces many principles of the circular economy, reducing dependence on finite resources, minimizing environmental impacts and generating new economic value through the integration of interconnected productive processes.

Within this evolving framework, two landmark initiatives have played a particularly significant role in shaping the contemporary approach to sustainability:

- 1) the Paris Agreement.
- 2) the Sustainable Development Goals (SDGs);

These initiatives have redefined sustainability governance by introducing structured and actionable goals, while also strengthening global cooperation to address urgent environmental and socio-economic challenges. The Paris Agreement provides a shared framework for climate action and decarbonization, whereas the SDGs offer an integrated agenda through which sustainability can be interpreted, measured and implemented across different sectors and scales.

Paris Agreement

Adopted in 2015 alongside the Sustainable Development Goals (SDGs), the Paris Agreement is one of the most significant international treaties on climate change, bringing together nearly 200 nations in a collective effort to reduce greenhouse gas emissions and mitigate global warming. Negotiated during the 21st Conference of the Parties (COP21) under the United Nations Framework Convention on Climate Change (UNFCCC), the agreement marked a crucial step in strengthening global climate action by replacing the Kyoto Protocol (1997) with a more inclusive and flexible approach (UNFCCC, 2015).

At the core of the agreement is the goal to limit global temperature rise to well below 2°C above pre-industrial levels, with efforts to keep it within 1.5°C to prevent the most severe climate impacts. Exceeding this threshold is projected to lead to increased frequency of extreme weather events, rising sea levels, biodiversity loss, and disruptions to global food and water systems (IPCC, 2018).

Unlike previous climate treaties, which imposed top-down emission reduction targets, the Paris Agreement introduced a bottom-up approach, allowing countries to define their own Nationally Determined Contributions (NDCs)—self-imposed commitments to reduce emissions and transition toward clean energy. Every five years, countries are required to review and enhance their NDCs, ensuring a gradual increase in climate ambition (UNFCCC, 2015).

Beyond emission reductions, the agreement also prioritizes climate adaptation and financial support for developing nations, recognizing that climate change disproportionately affects countries with fewer resources to mitigate its impacts. Developed nations pledged to mobilize at least \$100 billion annually to support climate adaptation and mitigation projects in lower-income countries. Additionally, financial mechanisms such as the Green Climate Fund (GCF) and initiatives for technology transfer aim to ensure that developing economies have access to renewable energy solutions and sustainable technologies (UNFCCC, 2021).

A unique aspect of the Paris Agreement is its emphasis on multi-stakeholder participation, engaging not only governments but also businesses, financial institutions, cities, and civil society organizations. This has led to a rise in corporate commitments to carbon neutrality, increased investments in green technologies, and stronger public-private partnerships aimed at accelerating climate solutions.

While the Paris Agreement is not without limitations, it has set a global precedent for climate governance, embedding sustainability into national policies, corporate strategies, and financial

systems. As countries continue to strengthen their commitments through regular stocktakes and updated NDCs, the success of the agreement will depend on sustained international cooperation, technological innovation, and financial investments in a low-carbon future.

Sustainable Development Goals (SDGs)

The adoption of the Sustainable Development Goals (SDGs) by the United Nations in 2015 was a pivotal moment in the evolution of sustainability. As a successor to the Millennium Development Goals (MDGs), which primarily focused on poverty reduction and basic human needs, the SDGs introduced a broader, more integrated vision that acknowledges the interdependence of environmental, social, and economic sustainability (United Nations, 2015). Unlike earlier models that often tackled sustainability in isolation, the SDGs emphasize that economic growth, social inclusion, and environmental stewardship must advance together.

Comprised of 17 interconnected goals and 169 specific targets, the SDGs provide a global roadmap for addressing a wide range of sustainability challenges, including climate action, poverty eradication, responsible consumption, and access to clean energy. Their strength lies in their comprehensive and measurable approach, ensuring that sustainability is not just an aspirational ideal but a set of concrete objectives that governments, businesses, and organizations can work toward. A crucial aspect of the SDGs is their emphasis on universal commitment.

Unlike previous frameworks that primarily targeted developing nations, the SDGs apply equally to all countries, ensuring that sustainability efforts are not confined to specific regions but pursued on a global scale. This shift has encouraged developed economies to take a more active role in addressing sustainability issues, while also providing developing nations with financial and technical support to achieve their goals (United Nations, 2015).

One of the most transformative aspects of the SDGs has been the growing role of the private sector in advancing sustainability. Businesses and investors are increasingly integrating Environmental, Social, and Governance (ESG) principles into their corporate strategies and financial decisions (World Economic Forum, 2020). Sustainable finance, once considered a niche area, is now central to global economic planning, with rising investments in renewable energy, sustainable agriculture, and circular economies. The transition from linear economic models that rely on mass consumption to circular economic principles emphasizing reuse, recycling, and resource efficiency has further demonstrated the importance of sustainability in shaping the global economy.

The SDGs have also reinforced the transition from short-term environmental initiatives to long-term sustainability commitments. Governments and corporations are no longer addressing sustainability in a reactionary manner but are proactively implementing policies that ensure net-zero carbon emissions, large-scale renewable energy transitions, sustainable urban development, and ecosystem restoration programs (IPCC, 2021). These measures align with international climate agreements, ensuring that sustainability remains a core priority beyond economic and political cycles.



Sustainable Development Goals as a reference framework for assessing the overall sustainability of the project.

The 17 interconnected goals:

- Goal 1. End poverty in all its forms everywhere.
- Goal 2. End hunger, achieve food security and improved nutrition and promote sustainable agriculture.
- Goal 3. Ensure healthy lives and promote well-being for all at all ages.
- Goal 4. Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.
- Goal 5. Achieve gender equality and empower all women and girls.
- Goal 6. Ensure availability and sustainable management of water and sanitation for all.
- Goal 7. Ensure access to affordable, reliable, sustainable and modern energy for all.
- Goal 8. Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all.
- Goal 9. Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation.
- Goal 10. Reduce inequality within and among countries.
- Goal 11. Make cities and human settlements inclusive, safe, resilient and sustainable.
- Goal 12. Ensure sustainable consumption and production patterns
- Goal 13. Take urgent action to combat climate change and its impacts.
- Goal 14. Conserve and sustainably use the oceans, seas and marine resources for sustainable development.
- Goal 15. Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss.
- Goal 16. Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels.
- Goal 17. Strengthen the means of implementation and revitalize the Global Partnership for Sustainable Development.

“The 17 Sustainable Development Goals and 169 targets which we are announcing today demonstrate the scale and ambition of this new universal Agenda. They seek to build on the Millennium Development Goals and complete what they did not achieve. They seek to realize the human rights of all and to achieve gender equality and the empowerment of all women and girls. They are integrated and indivisible and balance the three dimensions of sustainable development: the economic, social and environmental.”

General Assembly on 25 September 2015 (preamble)

Sustainability has evolved from a broad, idealistic concept into a structured framework with well-defined objectives that guide global development efforts. At its core, sustainability is about balancing economic growth, social equity, and environmental responsibility, ensuring that present progress does not compromise the ability of future generations to thrive. The recognition of finite natural resources, the increasing urgency of climate action, and the persistence of global inequalities have shaped this framework, making sustainability an integral part of modern policies, business strategies, and global cooperation. A significant milestone in this journey was the adoption of the 2030 Agenda for Sustainable Development by the United Nations General Assembly in 2015.

This ambitious agenda introduced the Sustainable Development Goals (SDGs), a set of seventeen interlinked objectives that provide a comprehensive blueprint for addressing a wide spectrum of global challenges. Unlike previous sustainability initiatives, which often treated economic, social, and environmental concerns separately, the SDGs emphasize an integrated approach. They acknowledge

that economic progress must go hand in hand with social inclusion and ecological preservation, reinforcing the idea that prosperity cannot come at the cost of environmental degradation or widening social inequalities.

What distinguishes the SDGs is their actionability and measurability. Rather than serving as broad aspirations, each goal includes specific targets and indicators that enable governments, businesses, and organizations to track progress over time. The 2030 Agenda is also universal in scope, applying not only to developing nations but also to industrialized countries, recognizing that sustainability must be a global effort rather than a fragmented set of regional initiatives. This approach fosters international cooperation, encouraging governments, corporations, and communities to work together in addressing some of the world's most pressing challenges.

The Five Core Objectives of Sustainability

The objectives of sustainability, as outlined in the 2030 Agenda, can be understood through five core dimensions: People, Planet, Prosperity, Peace, and Partnership. Often referred to as the “5 Ps of sustainability”, these dimensions reflect the need for a balanced and interconnected approach to global development (United Nations, 2015). These dimensions reflect the need for a balanced and interconnected approach to global development, reinforcing that sustainability extends beyond environmental concerns to include economic stability, governance, and international collaboration.

Advancing Human Well-being - The People Dimension

At its most fundamental level, sustainability is about improving the quality of life for all people, ensuring that individuals can lead healthy, fulfilling, and dignified lives. The eradication of poverty is central to this mission, as extreme poverty remains one of the greatest obstacles to sustainable development. Goal 1 of the SDGs explicitly focuses on ending extreme poverty, defined as individuals living on less than \$1.90 per day . However, sustainability is not just about financial poverty; it also involves expanding access to quality education and opportunities for all, as highlighted in Goal 4. Education is not only a driver of economic growth but also an essential tool for empowering marginalized communities and reducing inequalities.

Universal healthcare is a key component of sustainable development, as good health is both a prerequisite and an outcome of prosperity. Goal 3 of the SDGs aims to improve global health by reducing infant mortality, combating infectious diseases, and ensuring universal healthcare access (United Nations, 2015). Likewise, ensuring food security and sustainable agriculture is critical, as malnutrition and hunger still affect millions worldwide. Sustainable food production systems, which minimize environmental harm while maximizing efficiency, are central to achieving Goal 2, which seeks to eliminate hunger and malnutrition while promoting climate-resilient agricultural practices. In an increasingly volatile world, where climate change threatens food production and water availability, investing in resilient agricultural methods is essential for long-term sustainability.

Protecting the Natural World - The Planet Dimension

Environmental sustainability is a pillar of global sustainability efforts, recognizing that human well-being is intrinsically linked to the health of the planet. Climate change, pollution, deforestation, and biodiversity loss pose existential threats that, if left unchecked, could undermine decades of economic and social progress. The 2030 Agenda highlights the urgent need to combat climate change, protect natural ecosystems, and transition toward sustainable resource management (IPCC, 2021). The rising frequency of climate-related disasters, such as hurricanes, wildfires, and droughts, underscores the necessity of immediate and sustained action to mitigate environmental risks. Sustainable development calls for a shift in consumption and production patterns to reduce environmental harm. Goal 12 of the SDGs emphasizes sustainable consumption and production,

advocating for responsible waste management, efficient use of resources, and the adoption of circular economy principles.

Similarly, Goals 14 and 15 focus on preserving terrestrial and marine ecosystems, emphasizing the protection of biodiversity, sustainable land use, and conservation of oceanic resources. Clean water and sanitation, outlined in Goal 6, are also integral to environmental sustainability, as access to safe drinking water is fundamental to human health and ecosystem stability.

Building a Resilient and Inclusive Economy - The Prosperity Dimension

Economic sustainability is about more than just growth, it is about ensuring that growth is inclusive, equitable, and environmentally responsible. The 2030 Agenda promotes an economic model that prioritizes job creation, access to education and technology, and responsible industrialization without over-exploiting natural resources (World Economic Forum, 2020).

Sustainable economic development includes investments in infrastructure and technological innovation that reduce environmental impact while enhancing efficiency. Goal 9 calls for increased investment in sustainable industries, resilient infrastructure, and scientific research to drive long-term prosperity. At the same time, economic policies must promote fair wages, gender equality, and labour rights, as outlined in Goal 8 and Goal 10, which focuses on sustainable economic growth and decent work for all.

Ensuring Stability and Justice - The Peace Dimension:

Sustainability cannot be achieved without peace, justice, and strong governance structures. Conflict, corruption, and weak institutions hinder development, making it difficult for societies to implement long-term sustainability strategies. The 2030 Agenda acknowledges that strong legal frameworks, human rights protections, and inclusive governance are fundamental to sustainable development (United Nations, 2015).

Goal 16 focuses on reducing violence, human trafficking, and organized crime, while also promoting accountability, transparency, and access to justice. Nations with stable institutions and strong governance are better equipped to address environmental and economic challenges, enforce sustainability regulations, and protect vulnerable populations.

Strengthening Global Cooperation - The Partnership Dimension:

Achieving sustainability on a global scale requires collective action, cross-sector collaboration, and international cooperation. The complexity of sustainability challenges means that no single nation or organization can address them alone. Governments, private sectors, research institutions, and civil society must work together to implement policies, share knowledge, and provide financial and technological support to developing nations (United Nations, 2015). International cooperation is particularly crucial in addressing global crises such as climate change, pandemics, and economic instability, which require coordinated solutions.

Goal 17 of the SDGs highlights the importance of international partnerships in achieving sustainable development. This includes strengthening global trade and financial cooperation, increasing technology transfer, and enhancing capacity-building efforts in low-income countries. Equitable access to clean energy, education, and healthcare requires not only political commitment but also substantial financial investment and resource allocation. Greater involvement from the private sector, including multinational corporations and financial institutions, is also critical in mobilizing resources and driving sustainable investments at scale.

As sustainability continues to evolve, the five key dimensions of People, Planet, Prosperity, Peace, and Partnership serve as guiding principles for ensuring that economic and social progress occurs within planetary boundaries. While challenges remain, the global commitment to sustainability, as outlined in the 2030 Agenda, represents a significant step toward building a future that is resilient, just, and capable of supporting generations to come. The success of this framework depends on the collaborative efforts of governments, businesses, and individuals to implement sustainable practices that align with these objectives and drive meaningful change.



Five Core Objectives of Sustainability

1.3 From global goals to local transformation

The Sustainable Development Goals provide a global framework for addressing the major environmental, social and economic challenges of contemporary development. However, their effectiveness depends on the capacity to translate universal objectives into concrete spatial, institutional and operational actions. Sustainability cannot remain only a strategic horizon defined at the international level; it must be grounded in specific territories, where resources, infrastructures, communities, risks and opportunities take material form.

This passage from global goals to local transformation is particularly relevant for urban and productive areas. Many of the SDGs have a strong territorial dimension: sustainable cities and communities, clean energy, climate action, responsible production, innovation, ecosystem protection and partnerships all require decisions concerning land use, mobility, infrastructures, environmental mitigation and governance. For this reason, international institutions increasingly emphasize the “localization” of the SDGs, understood as the process through which global targets are adapted to

regional and municipal contexts, becoming tools for planning, monitoring and implementation. The United Nations recognizes Voluntary Local Reviews as instruments through which cities and regions bring the 2030 Agenda closer to the people and places it concerns. UN-Habitat also stresses the role of local and regional governments in accelerating SDG localization through planning, data, partnerships and urban policy tools.

In this perspective, the local scale is not simply the final level of application of global strategies. It is the place where sustainability becomes selective, situated and project-based. Each territory has its own environmental conditions, infrastructural networks, productive traditions and social expectations. Therefore, implementing the SDGs requires an interpretative effort: global objectives must be re-read in relation to local constraints and potentials. This is especially true in complex industrial landscapes, where ecological fragility, energy transition, logistics, economic competitiveness and landscape identity coexist and often generate tensions.

The case of Mantova and the HyMantoValley project can be understood as an opportunity to test this translation. The project is not only related to the production and use of green hydrogen, but also to the construction of a new territorial model in which energy innovation, industrial transformation, research activities and environmental regeneration interact.

To fully understand the potential of HyMantoValley, the transition from global goals to local transformation must confront two major issues. On the one hand, it requires a multiscale approach. The project cannot be reduced to the perimeter of the Mantova Est productive pole or to the specific localization of the Research Hub; it must be interpreted within a broader macro-supply chain, where hydrogen production, storage, distribution, mobility, industrial uses, research activities and logistic infrastructures are mutually connected. This macro-supply chain defines the wider framework within which the interventions proposed by the masterplan need to be positioned, tested and verified. At the same time, local micro-supply chains must be identified, since they express the concrete relations among existing infrastructures, productive sites, mobility systems, the port area, research facilities, training activities, services, local actors and possible pilot applications. While the macro-supply chain frames Mantova within broader strategies for energy transition and industrial innovation, the micro-supply chains make it possible to identify where and how transformation can actually take place.

On the other hand, this kind of project necessarily requires working with uncertainty. Energy transition processes, and especially those related to emerging hydrogen economies, depend on technological innovation, regulatory evolution, economic feasibility, institutional decisions and future demand conditions. These factors cannot be fully determined in advance. For this reason, the masterplan cannot be conceived as a fixed and definitive project, but rather as an adaptive framework capable of supporting different possibilities of transformation.

This means developing a masterplan that can be verified at different scales and through alternative scenarios. The territorial scale allows the project to be related to broader energy, logistic and infrastructural networks. The landscape scale makes it possible to evaluate ecological systems, environmental constraints, historical permanence

es and spatial continuities. The urban scale verifies the concrete conditions for the localization of functions, accessibility, compatibility with existing uses and relations with the productive fabric. Scenarios, within this framework, are not secondary representations, but operational tools for testing hypotheses, comparing opportunities and criticalities, and assessing how the project may evolve under changing conditions.

Through this approach, uncertainty is not treated as a limitation, but as a constitutive dimension of the design process. The masterplan becomes a flexible and strategic device: it grounds global sustainability goals in local spatial choices, while keeping open different trajectories for the future transformation of Mantova's productive landscape. In this sense, sustainability becomes an operational design issue: it is no longer only a set of objectives to be achieved, but a method for organizing relations, selecting priorities and giving spatial form to transition.

Grounding the SDGs in Mantova therefore means using global goals as a guiding framework while recognizing the specificity of the place. The local project becomes the arena in which climate objectives, industrial policies, ecological restoration and spatial quality can be made compatible. Through this process, the masterplan can contribute to transforming HyMantoValley from an energy initiative into a broader territorial strategy, capable of producing environmental, economic and social value at the scale of everyday places.

2. A PLACE TO DESIGN SUSTAINABILITY

The following sections introduce three key aspects that are necessary to frame this experimentation. First, hydrogen is discussed as a decarbonization tool through which the complexity of the energy transition becomes evident: its potential depends not only on technological performance, but also on production methods, energy sources, infrastructural conditions, regulatory frameworks and territorial integration. Second, it is considered as an energy carrier, capable of storing, transporting and redistributing renewable energy across different sectors and scales. Finally, the European Hydrogen Backbone is introduced as the infrastructural and strategic framework that connects local hydrogen initiatives to wider European networks, showing how a project such as HyMantoValley can acquire relevance beyond its immediate territorial boundaries.

2.1 HyMantoValley as a field of experimentation

In order to understand the territorial relevance of HyMantoValley, it is necessary to consider the project not only as the introduction of a new energy technology within an existing industrial area, but as the construction of a complex territorial ecosystem. Production processes, storage systems, distribution networks, mobility infrastructures, industrial uses, research activities and environmental objectives are closely interconnected and generate spatial implications that the masterplan must be able to recognize and interpret.

From this perspective, hydrogen is not treated as a neutral or self-sufficient solution. Its contribution to sustainability depends on the way it is produced, the sources of energy used, the infrastructures required for its distribution, the regulatory and economic conditions that support its implementation, and its capacity to become part of existing territorial, productive and environmental systems. This is particularly relevant in areas such as Mantova Est, where industrial functions, logistics, port-related activities, environmental sensitivities and landscape structures coexist within a limited and highly complex space.

HyMantoValley therefore becomes a field of experimentation because it brings together different dimensions of the transition. It connects European decarbonization strategies with local industrial transformation; it links technological innovation with spatial planning; and it tests the possibility of grounding a new hydrogen economy within the specific conditions of the Mantova territory. In this sense, the project does not only concern the production of green hydrogen, but also the reorganization of relations between energy, industry, logistics, research, environment and territory.

This interpretation is essential for the development of the masterplan. Before defining possible locations for the Research Hub or identifying spatial strategies for the project area, it is necessary to clarify the broader role that hydrogen may assume within the transition process. For this reason, the following sections examine hydrogen as a decarbonization tool, as an energy carrier and as part of a wider European infrastructural framework.

Hydrogen as a Decarbonization Tool: Uncovering Complexity

Hydrogen is increasingly recognized as one of the key vectors of the energy transition, particularly in those sectors where direct electrification remains difficult or inefficient. Heavy industry, logistics, long-distance transport, port-related activities and some energy-intensive processes require solutions that can complement electrification and support the progressive reduction of fossil fuel use. In this context, hydrogen offers significant potential because it can be used both as an energy carrier and as a feedstock for industrial processes, contributing to the decarbonization of activities that are otherwise difficult to transform.

However, hydrogen should not be interpreted as an automatically sustainable solution. Its environmental performance depends on the entire production and supply chain: the source of energy used, the production process, the infrastructures required for storage and distribution, the final uses, and the regulatory and economic conditions that support its implementation. For this reason, the role of hydrogen in the energy transition must be understood through a more complex reading, one that considers not only technological efficiency but also territorial, infrastructural and environmental implications.

A first distinction concerns the different ways in which hydrogen can be produced. **Grey hydrogen** is currently the most widespread form and is mainly obtained from natural gas through thermochemical processes, with the consequent production of carbon dioxide emissions. **Blue hydrogen** is produced through similar processes, but is associated with carbon capture and storage systems, which aim to reduce the amount of CO₂ released into the atmosphere. **Green hydrogen**, instead, is produced through the electrolysis of water powered by renewable energy sources. In this case, water is split into hydrogen and oxygen without direct CO₂ emissions at the point of production, making green hydrogen the most relevant option from the perspective of climate neutrality and long-term sustainability.

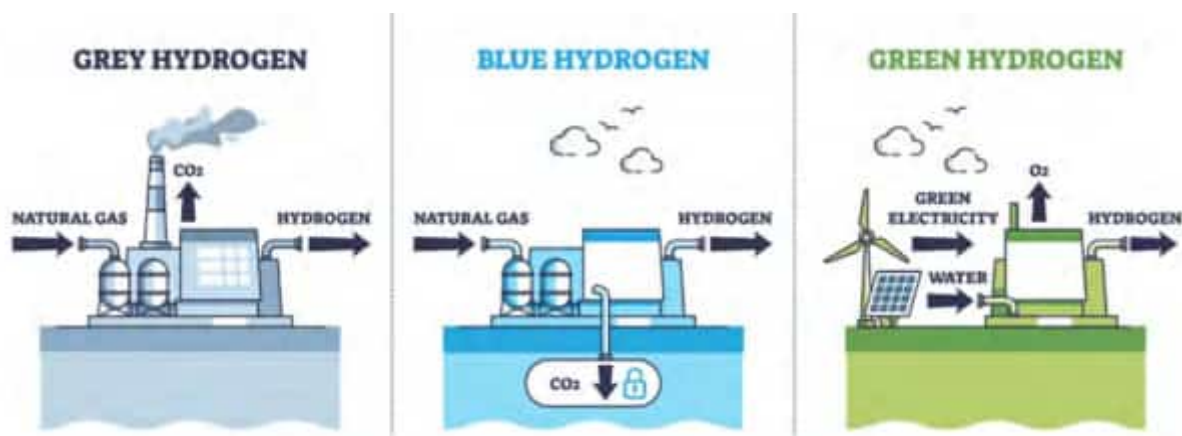


illustration showing difference between Grey, Blue and Green Hydrogen

Source: Author's elaboration based on <https://reports.snam.it/2020/sustainability-report/strategy/new-businesses-le-vers-for-the-energy-transition/hydrogen.html>

At the European level, hydrogen has acquired increasing strategic relevance within decarbonization policies. The European Commission identifies hydrogen as a key component of the future EU energy system, particularly for sectors in which electrification is not technically or

economically feasible. In this framework, renewable hydrogen is expected to contribute to the replacement of fossil fuels in high-emission industrial processes and transport systems, supporting the broader objective of climate neutrality (European Commission, 2023a). The European strategy also sets ambitious targets for renewable hydrogen deployment, including the production of 10 million tonnes of renewable hydrogen within the European Union and the import of an additional 10 million tonnes by 2030 (European Commission, 2023a).

Hydrogen also plays an important role in the storage and redistribution of renewable energy. Through electrolysis, surplus electricity generated from renewable sources can be converted into hydrogen and stored for later use. This function can help address one of the main challenges of renewable energy systems: intermittency. The possibility of storing energy over longer periods and redistributing it across different sectors strengthens the relationship between hydrogen infrastructures and territorial planning, because production, storage, distribution and use require specific spaces, compatible locations and coordinated networks. In this sense, the European Commission also emphasizes the role of renewable hydrogen in balancing energy demand, integrating renewable sources and supporting a more resilient energy system (European Commission, 2023b).

Despite this potential, the large-scale deployment of hydrogen still depends on several critical conditions. Renewable hydrogen production must be scaled up, infrastructures for storage and distribution must be developed or adapted, and production costs must progressively decrease. These aspects are central to European policies, including instruments such as the European Hydrogen Bank, which aims to support investment and reduce the cost gap between renewable hydrogen and fossil-based alternatives (European Commission, 2023a). This confirms that hydrogen is not only a technological issue, but also an economic, infrastructural and governance challenge.

This distinction is essential for a project such as HyMantoValley. The objective is not simply to introduce hydrogen within an existing productive area, but to understand under which conditions it can effectively contribute to a broader territorial transition. The sustainability of hydrogen depends on the availability of renewable energy, the possibility of integrating production and storage systems, the efficiency of distribution networks, and the capacity to connect hydrogen uses with existing industrial, logistic and research activities. In other words, hydrogen becomes a decarbonization tool only when it is embedded within a coherent spatial, infrastructural and productive strategy.

For the masterplan, this means that hydrogen cannot be treated only as a technological component. Its introduction generates spatial questions: where production and storage systems can be located, how they relate to existing infrastructures, which industrial users can be involved, how logistics and mobility systems can be connected, and how environmental and landscape conditions can be respected or improved. In the case of Mantova Est, these questions are particularly significant because the project area is already characterized by strong infrastructural density, productive specialization, port-related activities and environmental sensitivity.

From this perspective, HyMantoValley becomes an opportunity to test how hydrogen can support not only decarbonization, but also territorial regeneration. The project allows the hydrogen value chain to be interpreted as a spatial system, made of relations between energy production, distribution infrastructures, industrial processes, mobility applications, research activities and environmental objectives. The role of the masterplan is therefore to make these relations visible, to verify their compatibility with the existing context, and to identify possible strategies through which hydrogen can become part of a more sustainable territorial transformation.

Hydrogen as an energy carrier

The role of hydrogen as an energy carrier is particularly relevant because it allows energy to be stored, transported and redistributed across different sectors. Unlike primary energy sources,

hydrogen does not constitute an energy source in itself, but a vector through which energy produced elsewhere can be converted, accumulated and used when and where it is needed. This characteristic makes hydrogen especially significant in relation to renewable energy systems, whose production is often variable and dependent on environmental conditions.

In this perspective, hydrogen can contribute to the integration of renewable energy by transforming surplus electricity into a storable and transportable form. Once produced, hydrogen can be compressed, stored and distributed through dedicated infrastructures or, where technically possible, through adapted existing networks. This capacity gives hydrogen a strategic role in connecting production sites, logistics systems, industrial users and mobility applications. For this reason, its relevance cannot be understood only in technological terms, but must also be read through the spatial and infrastructural conditions that make its circulation possible.

The use of hydrogen is particularly significant in sectors where direct electrification remains difficult. Heavy transport, rail systems, port-related activities, maritime applications and some energy-intensive industrial processes require high energy density, long operating ranges or specific thermal conditions. In these cases, hydrogen and hydrogen-derived fuels can support decarbonization by complementing electrification rather than replacing it entirely. This is also the direction identified by European policies, which consider hydrogen especially relevant for hard-to-abate sectors and for transport applications where other low-carbon alternatives are less effective (European Commission, 2023a).

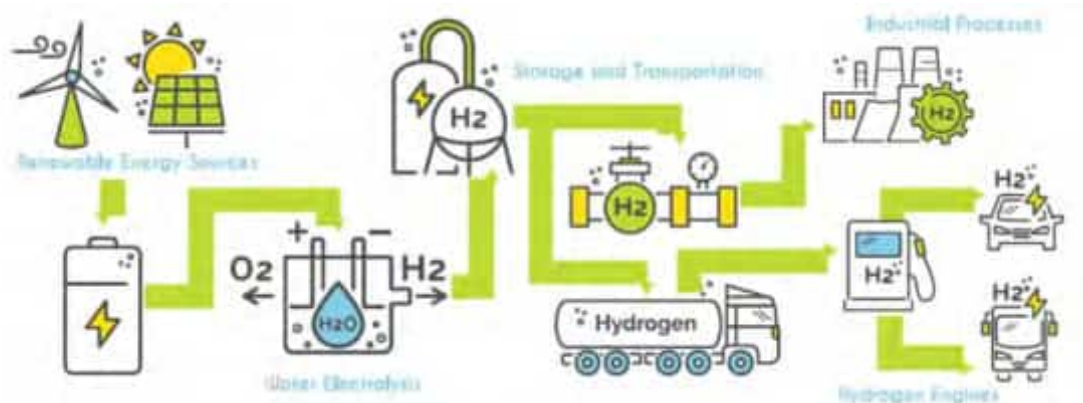
This interpretation is important for the HyMantoValley project because Mantova Est is not a generic industrial area, but a complex infrastructural and productive node. The presence of the Valdaro Port, railway connections, road infrastructures, productive areas and logistics functions creates the conditions for testing hydrogen not only as a fuel, but as a vector capable of connecting different activities within a broader territorial system. In this sense, hydrogen can become a link between energy production, industrial uses, intermodal logistics, port operations and future mobility applications.

At the same time, the transition toward hydrogen-based systems requires significant investments and coordinated planning. Electrolysis capacity, storage facilities, refuelling infrastructure, distribution networks, safety requirements and technical standards must be developed together. These aspects confirm that hydrogen cannot be introduced through isolated interventions. Its effectiveness depends on the construction of a complete value chain, supported by policy frameworks, economic incentives, technological development and territorial compatibility.

Within the Italian framework, the National Recovery and Resilience Plan recognizes hydrogen as one of the strategic fields of the energy transition. Mission 2 of the PNRR, dedicated to green revolution and ecological transition, includes measures aimed at promoting the production, distribution and end uses of hydrogen, with particular attention to industrial areas, transport and hard-to-abate sectors (PNRR, 2021). This national framework reinforces the relevance of projects such as HyMantoValley, which translate broader transition policies into concrete territorial applications.

The role of hydrogen as an energy carrier is also coherent with the Sustainable Development Goals. It directly relates to SDG 7, by supporting access to clean and modern energy systems; to SDG 9, through the development of resilient infrastructures, innovation and industrial transformation; and to SDG 13, through its contribution to climate action and emission reduction. In productive and logistics contexts, it can also support SDG 8 and SDG 12, by promoting new skills, industrial innovation and more responsible production models.

For the masterplan, hydrogen as an energy carrier therefore becomes a spatial and strategic issue. Its implementation requires identifying where production, storage, refuelling, distribution, research and training activities can be located, and how they can interact with existing infrastructures and environmental conditions. The masterplan must therefore verify not only the technical feasibility of hydrogen applications, but also their capacity to generate coherent relations between energy transition, industrial development, logistics, research and territorial regeneration.



Hydrogen as an energy carrier for mobility, industry and renewable energy integration

The European Hydrogen Backbone (EHB)

The European Hydrogen Backbone (EHB) represents one of the main infrastructural frameworks through which the development of a European hydrogen economy is being planned. Launched in 2020 by a group of European Transmission System Operators (TSOs), the initiative aims to define an interconnected hydrogen transport network capable of linking production areas, storage systems, industrial demand centres and cross-border energy corridors. A central aspect of the proposal is the possibility of repurposing parts of the existing natural gas infrastructure, reducing the need for entirely new networks and supporting a more gradual transition towards hydrogen transport.

Since its first publication, the EHB initiative has progressively expanded in scale and ambition. According to the European Hydrogen Backbone initiative, the proposed network could reach approximately 31,500 km of hydrogen pipelines, with a significant part expected to be operational by 2030 (European Hydrogen Backbone, 2023). From an initial group of 11 TSOs, it has grown into a wider platform involving network operators from several European countries, reflecting the increasing importance attributed to hydrogen within European decarbonization strategies.

This framework is particularly relevant for local projects such as HyMantoValley. The development of a hydrogen valley cannot be understood only at the local scale, because production, storage, distribution and final uses depend on broader infrastructural and market conditions. The EHB helps to frame local hydrogen initiatives within a larger European system, where territorial nodes, industrial areas, logistics platforms and energy corridors may become part of an interconnected value chain.

For Mantova Est, the relevance of the European Hydrogen Backbone lies in the possibility of reading the project area not as an isolated productive site, but as a potential node within wider energy and logistics networks. The proximity to transport infrastructures, the presence of the Valdaro Port, the relation with the Mantova–Marghera corridor and the broader productive system of Northern Italy all contribute to strengthening this interpretation. In this perspective, HyMantoValley can be understood as a territorial experiment that connects local transformation with the emerging European hydrogen infrastructure.

At the same time, the EHB also highlights the uncertainty that characterizes the hydrogen transition. The development of corridors, pipelines, demand centres and investment priorities will depend on technological progress, regulatory decisions, market conditions and the effective growth of renewable hydrogen production. For this reason, the masterplan cannot simply assume a fixed infrastructural future. It must instead remain adaptable, capable of positioning Mantova Est within

possible future scenarios while maintaining flexibility in relation to the evolution of the European hydrogen network.

2.2 The role of the Research Hub

Envisioning the Future: Mantova as a Hydrogen Hub

The HyMantoValley project positions Mantova within the broader European transition towards renewable hydrogen and low-carbon industrial systems. Launched in 2023, the project brings together a consortium of public institutions, private companies, logistics operators, universities and research centres, with the aim of developing an integrated hydrogen ecosystem in the Mantova area. Its relevance lies not only in the technological dimension of hydrogen production, storage and use, but also in the possibility of redefining the relationship between energy transition, industrial development, research activities and territorial regeneration.

In this perspective, Mantova can be interpreted as a potential hydrogen hub because of the specific combination of conditions that characterize its territory. The presence of productive areas, logistics infrastructures, port-related activities, rail and road connections, and existing industrial competences creates a context in which hydrogen can be tested as part of a wider territorial system. The project therefore does not simply introduce a new energy technology into an existing industrial area; it opens the possibility of reorganizing relations between production, mobility, research, training and environmental objectives.

The Research Hub plays a central role within this transformation. It is conceived as the place where scientific knowledge, technical experimentation, education and industrial innovation can converge. Its function is not limited to hosting research activities, but extends to supporting the development of skills, testing solutions, connecting actors and translating the objectives of HyMantoValley into operational and spatial strategies. For this reason, the Research Hub becomes one of the key elements through which the hydrogen value chain can acquire territorial consistency.

Strategic Location and Connectivity

The strategic relevance of Mantova is closely related to its position within a system of infrastructural and productive connections. The project area is located in relation to major road and rail networks, the Valdaro logistics and port system, and the wider Mantova–Marghera corridor. These elements make the territory particularly significant for testing hydrogen applications in logistics, freight transport, port-related activities and industrial processes.

This condition is important for the masterplan because the Research Hub cannot be considered as an isolated facility. Its effectiveness depends on its capacity to interact with the surrounding context: productive areas, mobility systems, infrastructures, environmental constraints, existing services and future development opportunities. The localization of the Hub therefore becomes a strategic issue, because different positions within Mantova Est may generate different relationships with the hydrogen value chain.

In this sense, connectivity is not only a question of accessibility. It concerns the possibility of creating functional and spatial relations between research, production, distribution, training and experimentation. The Research Hub must be able to act as an interface between the technical components of the project and the territorial conditions in which they are implemented. Its role is therefore both operational and symbolic: it represents the visible point of contact between the hydrogen transition and the transformation of the Mantova Est area.

Key Pillars of the HyMantoValley Project

HyMantoValley is structured around a set of interconnected objectives that define its long-term relevance. These objectives can be read through **three main fields of action**.

The **first** concerns the development of a green hydrogen ecosystem. This includes the production, storage and distribution of renewable hydrogen, as well as the infrastructures required to support its use. From a planning perspective, this field raises questions about the spatial organization of energy facilities, the relation with existing networks, and the compatibility between new technological systems and the surrounding industrial and environmental context.

The **second** field concerns hydrogen-based transport and industrial applications. The project aims to test hydrogen uses in sectors such as logistics, mobility, port-related activities and hard-to-abate industrial processes. This aspect is particularly relevant for Mantova Est, where productive functions and transport infrastructures are already strongly present. The masterplan must therefore consider how these applications can be integrated into the existing urban and infrastructural fabric, reducing conflicts and enhancing synergies.

The **third** field concerns research, innovation and training. This is the specific domain of the Research Hub. The Hub is expected to support scientific research, technical education, professional training and knowledge transfer between universities, companies and institutions. Its role is essential because the hydrogen transition does not depend only on infrastructures and technologies, but also on the creation of competences, collaborative networks and experimental environments capable of sustaining innovation over time.

A Comprehensive Framework for Hydrogen Development

HyMantoValley is organized through a complex framework of activities that address different components of the hydrogen value chain. Production, storage, distribution, mobility applications, industrial uses, business models, impact assessment, communication, dissemination and third-party involvement are not independent elements, but parts of a single system. For this reason, understanding the internal articulation of the project is a necessary step for the development of the masterplan.

The spatial strategy cannot be based only on the physical localization of the Research Hub. It must consider the wider set of actors, infrastructures, flows and operational requirements activated by the project. Each work package introduces specific needs and possible spatial implications: production and storage require technical areas and safety conditions; distribution and use require networks and connections; mobility applications require interfaces with transport systems; research and training require accessible and flexible spaces; impact evaluation and dissemination require tools for monitoring, communication and stakeholder involvement.

In this sense, the work packages become an interpretative framework for translating the general objectives of HyMantoValley into spatial, operational and design choices. Reading the project through its work packages makes it possible to identify functional needs, technical constraints, strategic opportunities and possible synergies with the existing industrial and infrastructural context. It also helps to distinguish what is already defined from what remains open to future development.

The following overview of the work packages is therefore not only a descriptive step, but a preliminary design operation for the construction of the masterplan.

WP1 – Project management and coordination: This work package ensures the overall coordination of the project, including administrative and financial management, internal communication, meeting organization, reporting activities, monitoring of deadlines, quality control and the definition of corrective measures when needed.

WP2 – Production and Storage: This work package focuses on the production, compression and loading of renewable hydrogen. It includes the management of green electricity supply and the design of the systems required to compress hydrogen and load it into innovative mobile and high-pressure storage solutions.

WP3 – Distribution and Usage: This work package addresses hydrogen distribution and final uses. It includes the pipeline connection between the production plant and the hydrogen refuelling

station, transportable high-pressure storage solutions, and several demonstrators related to mobility, including vessels, trains, buses and fuel cell vehicles. It also considers H2-to-Power applications, such as heating and cooling systems and off-grid energy supply.

WP4 – Business Models and Commercialization: This work package develops business models and commercialization strategies for the whole hydrogen value chain. It considers market opportunities, business cases, synergies between different value chains, distribution and sales models, as well as the policies, standards and economic conditions needed to support green hydrogen deployment.

WP5 – Applied Research Hub: This work package concerns the design and planning of the Applied Research Hub. It includes the masterplan of the project area, the architectural design of the research campus, and the definition of research, educational and technical training activities. It also prepares the basis for future funding opportunities, including Marie Skłodowska-Curie Actions.

WP6 – Performance and Impact Evaluation: This work package evaluates the environmental and social impacts of the project. Environmental performance is assessed through Life Cycle Assessment methodologies, in accordance with ISO 14040 and ISO 14044, while social impacts are considered through Social Life Cycle Assessment tools and databases.

WP7 – H2 Ecosystem: Communication and Dissemination: This work package supports the creation and dissemination of the H2 ecosystem. It includes stakeholder mapping, communication and dissemination activities, exploitation strategies, market readiness assessment and actions aimed at strengthening the use of project results beyond the local hydrogen valley.

WP8 – Financial Support to Third Parties: This work package defines the rules for involving additional companies and new partners in the project, particularly for the development and implementation of small-scale pilot actions.

Taken together, these work packages show that HyMantoValley is not a single technological intervention, but a complex system of activities, actors and spatial implications. The masterplan must therefore interpret the project as a territorial framework, capable of connecting production, infrastructure, research, mobility, environmental evaluation and future implementation scenarios. Within this framework, the Research Hub becomes the element that gives spatial and institutional visibility to the knowledge dimension of the project, linking technological experimentation with territorial transformation.

2.3 Strategic inputs from Planning Activities

Mantova is situated within a complex territorial context, where infrastructural, productive, environmental and cultural systems interact and collectively contribute to the identity of the place. The area is distinguished by its strategic position within Northern Italy and the Po Valley, by the presence of significant infrastructure networks at both national and international levels, and by a rich landscape heritage that includes environmental, historical, cultural and artistic dimensions. These components form the basis for understanding the territorial relevance of the HyMantoValley project and for defining the strategic inputs required by the masterplan.

In this context, HyMantoValley cannot be interpreted only as an energy project or as the localization of a new research facility within an industrial area. Its potential lies in its capacity to activate broader processes of territorial transformation. The project introduces an innovative and sustainable vision within a complex productive landscape, where energy transition, industrial development, environmental regeneration and spatial planning must be considered together. Understanding how this initiative can be embedded within the existing territorial structure therefore becomes a central objective of the research.

The Planning Activities provide a fundamental contribution to this process. They allow the project area to be read not only through its physical conditions, but also through its relations with infrastructures, landscape systems, ecological networks, urban settlements, productive functions

and possible development scenarios. In this sense, they help to define the interpretative framework within which the masterplan can operate. The aim is to understand how HyMantoValley can be developed sustainably, supporting the transformation of infrastructure, environment, landscape and urban settlement in a coherent way.

This becomes particularly relevant because the project introduces industrial, research and training functions within an existing productive area, where new activities must coexist with established uses, logistical flows, infrastructural constraints and environmental sensitivities. The masterplan must therefore work on compatibility, integration and transformation. It has to identify where conflicts may emerge, where synergies can be activated, and where spatial strategies can support the gradual reorganization of the area.

A key question concerns the possibility of redefining the role of the industrial area. Rather than being considered only as a sector separated from the city and the landscape, the productive pole can become a place where different systems enter into dialogue. Industry, infrastructure, ecological networks and urban settlements can be reconnected through spatial strategies capable of reducing conflicts and generating new forms of integration. From this perspective, the masterplan should also consider the potential of circular processes, in which materials, energy flows and by-products are not treated only as waste, but as possible resources within a broader system of exchange.

Another important input concerns the historical and cultural landscape of Mantova. The presence of long-lasting territorial structures, heritage elements and high-permanence landscapes makes the area particularly significant. These permanences are not simply constraints to be preserved, but interpretative keys for guiding future transformation. They help to understand the identity of the territory and to orient design choices in continuity with existing landscape structures.

The relationship between grey and blue infrastructures also plays a decisive role. Mantova is strongly characterized by its lakes, waterways and ecological corridors, which define both the environmental quality and the spatial identity of the city. At the same time, railways, roads, motorways, logistics platforms and productive infrastructures influence the development potential of the area. The interaction between these systems raises a fundamental question: how can industrial transformation contribute to the preservation and enhancement of ecological systems, rather than becoming a barrier or a source of further fragmentation?

For these reasons, the Planning Activities suggest that the masterplan should not be developed as an isolated design exercise, but as a strategic and multiscale process. The territorial scale frames the project within wider infrastructural, economic and energy networks. The landscape scale allows the project to engage with ecological systems, historical permanences and environmental relationships. The urban scale makes it possible to verify local conditions, accessibility, functional compatibility and the concrete localization of the Research Hub.

Through this multiscale approach, the masterplan becomes a tool for translating the general objectives of HyMantoValley into spatial strategies. It connects sustainability, energy transition and territorial regeneration, while recognizing the complexity of Mantova as an evolving cultural, productive and ecological landscape.

2.4 Design principles for the Masterplan

The masterplan for the HyMantoValley project is conceived as a strategic tool capable of translating the objectives of energy transition into spatial, environmental and territorial choices. Its role is not limited to the organization of functions within the project area but extends to the construction of a broader framework in which industrial innovation, ecological regeneration, infrastructure systems and landscape identity can interact. For this reason, the masterplan must be

guided by a set of design principles able to address the complexity of the productive landscape of Mantova Est.

The **first principle concerns** the integration between industrial development and sustainability. HyMantoValley should not be interpreted only as a technological project related to green hydrogen production, but as an opportunity to rethink the role of the industrial area within the wider urban and territorial system. The productive pole of Mantova Est can become a place where energy transition supports new forms of sustainable development, connecting economic innovation with spatial quality and environmental responsibility.

A **second principle is related to** ecological and environmental regeneration. The project area is located within a territory strongly characterized by water systems, ecological corridors and environmental sensitivities. The masterplan should therefore explore how industrial transformation can contribute to the restoration, reinforcement and continuity of these systems. Rather than reinforcing the separation between production and nature, the project should investigate how infrastructure and industry can become active components of a broader ecological strategy, through mitigation, reconnection, landscape enhancement and more responsible use of resources.

The **third principle concerns** the dialogue between industrial areas, urban settlements and landscape structures. The masterplan should not treat the productive pole as an isolated enclave, but as part of a more complex territorial fabric. Accessibility, mobility, service functions, research activities, environmental buffers and open spaces can contribute to redefining the relationship between the industrial system and the surrounding urban and rural contexts. In this perspective, the Research Hub becomes not only a functional element of the hydrogen value chain, but also a possible interface between production, knowledge, institutions and territory.

A further design principle is the recognition of historical permanences and territorial identity. Mantova is a place where contemporary transformation must confront a long-lasting landscape structure, composed of waterways, agricultural traces, infrastructural elements, heritage systems and cultural values. These elements should not be considered only as constraints, but as resources capable of orienting the project. The masterplan should therefore work in continuity with the identity of the place, using existing structures and permanences as interpretative keys for future transformation.

Infrastructure represents another central principle. The strategic position of Mantova within regional, national and European networks gives the HyMantoValley project a relevance that goes beyond the local scale. The presence of road, rail, port and logistics systems offers the possibility to connect hydrogen production, storage, distribution and use within a broader territorial framework. The masterplan should therefore evaluate how existing infrastructures can be adapted, strengthened or reinterpreted to support a low-carbon future, while maintaining economic feasibility and operational efficiency.

Finally, the masterplan must be based on a multiscale and adaptive approach. The transformation of the project area cannot be understood only at the urban scale. It must be verified through different levels of interpretation: the territorial scale, where Mantova is read in relation to energy, logistics and European networks; the landscape scale, where ecological systems and historical permanences become structuring elements; and the urban scale, where specific spatial choices, functional relations and site conditions are tested. At the same time, the project must remain open to uncertainty, using alternative scenarios as tools to compare possibilities, evaluate risks and guide future implementation.

Starting from these principles, the masterplan responds to a limited number of key design questions:

- **How can HyMantoValley transform the productive landscape of Mantova Est into a model of sustainable industrial regeneration?**
- **How can the hydrogen value chain be spatially integrated with existing infrastructures, ecological systems and urban settlements?**
- **How can the Research Hub act as an interface between energy innovation, territorial planning, research activities and local development?**
- **How can the masterplan remain flexible enough to respond to future technological, economic and environmental uncertainties?**

These questions define the operational horizon of the masterplan. They connect the general objectives of HyMantoValley with the specific conditions of Mantova, transforming sustainability from an abstract goal into a set of spatial strategies, design choices and possible future scenarios.

Chapter 2 - Methodology

“Designing, in its broader sense, involves complexity and synthesis.”

Donald A. Schön, The Reflective Practitioner: How Professionals Think in Action, 1983.

The development of a masterplan for the HyMantoValley project requires a clear methodological framework. The complexity of the project does not allow for a linear or purely descriptive approach: the transformation of the Mantova Est productive pole involves different spatial scales, heterogeneous actors, multiple infrastructural systems, environmental sensitivities, technological uncertainties and long-term development scenarios. For this reason, methodology becomes a fundamental part of the research, as it defines how knowledge is collected, organized, interpreted and progressively translated into spatial strategies.

The methodological framework adopted in this report is based on the need to connect analysis and design. The masterplan is not conceived as an isolated final output, but as the result of an articulated process in which territorial readings, planning documents, project materials, GIS-based mapping, site evaluations and strategic scenarios interact. This approach makes it possible to move from the general objectives of HyMantoValley to a more precise understanding of the project area, identifying both constraints and opportunities for transformation.

A central methodological issue concerns the relationship between scales. The project must be understood simultaneously at the territorial, landscape and urban levels. At the territorial scale, Mantova is interpreted in relation to broader energy, logistics and infrastructural networks. At the landscape scale, attention shifts to ecological systems, environmental continuities, historical permanences and spatial relationships. At the urban scale, the research verifies the concrete conditions for localization, accessibility, compatibility with existing uses and possible spatial configurations of the Research Hub. This multiscale approach is necessary because sustainable transformation is not produced by isolated interventions, but by the coherence between decisions taken at different levels.

Another important aspect is the need to work with uncertainty. Projects related to energy transition and hydrogen development are influenced by technological evolution, regulatory frameworks, investment dynamics, market conditions and future demand. These elements cannot be completely determined in advance. Therefore, the methodology does not aim to define a single fixed solution, but to construct an adaptive process capable of comparing alternatives, testing scenarios and supporting future decision-making. Scenario-based planning is particularly relevant in urban and territorial design because it helps planners address complexity and uncertainty, evaluate possible futures and improve adaptive decision-making processes.

The methodological framework is also connected to the broader debate on decision-making under deep uncertainty. In this perspective, strategic plans should not be understood as rigid predictions of the future, but as flexible tools that can be tested, revised and adapted over time. Literature on decision-making under uncertainty highlights the importance of designing strategic plans that can operate under changing conditions and that consider actors, networks, implementation barriers and feedback processes.

Finally, the methodology is consistent with the idea of localizing sustainability goals through integrated urban and territorial planning. The SDGs and the New Urban Agenda emphasize the role of local and regional planning in connecting global sustainability objectives with specific territorial contexts, strengthening synergies between urban and rural spaces and supporting inclusive development. In this sense, the methodology adopted for the HyMantoValley masterplan aims to

“ground” sustainability: it translates general objectives into a structured process of knowledge-building, interpretation, spatial evaluation and scenario construction.

The chapter therefore describes the methodological steps through which the research moves from the collection of documents and data to the construction of a knowledge framework, from multiscalar interpretation to the definition of possible scenarios, and from site assessment to the formulation of design strategies for the masterplan.

3. DESIGN CHALLENGES

The methodological framework of this research is built around the need to translate the general objectives of sustainability into a concrete design process for the HyMantoValley project. The starting point is the recognition that sustainability, today, cannot be treated only as a theoretical principle or as a set of global objectives. It must be grounded in specific places, through spatial decisions, infrastructural choices, environmental strategies and feasible forms of implementation. In this sense, the methodology assumes HyMantoValley as the place where sustainability can be tested, interpreted and progressively transformed into a masterplan.

The scheme developed for the research describes this passage as an articulated process that connects theoretical background, Sustainable Development Goals, local needs and design actions. The SDGs provide a general framework, but their implementation requires a selective and contextual interpretation. For this reason, the research does not simply apply the goals in a mechanical way. Rather, it identifies the most influential SDGs in relation to the project area and uses them to orient the construction of knowledge, the definition of spatial strategies and the formulation of design solutions.

The methodological process is organized through three main operational moments. The first is the Knowledge Phase, in which relevant information is collected, selected and related. This phase includes the identification of territorial, environmental, infrastructural and planning conditions, together with the recognition of the SDGs that can influence the project. The second moment is the construction of a Spatial Strategy, where the information gathered is translated into a general design direction, capable of locating the most relevant sustainability objectives within the project area. The third moment concerns the Design Solution, where site-specific choices, infrastructural frameworks, the localization of the Research Hub and possible implementation strategies are developed.

However, the process is not intended as a rigid sequence from analysis to design. The scheme highlights the need for continuous feedback between analysis, vision, evaluation, adaptation, ideas and implementation. Each step informs the others: knowledge is tested through design hypotheses, strategies are revised according to constraints and opportunities, and design solutions are progressively adapted to the complexity of the context. This circular and iterative structure is essential for dealing with a project such as HyMantoValley, where technological, environmental, infrastructural and territorial dimensions are deeply interconnected.

At the same time, the methodology is based on a multiscalar reading of the territory. The project is investigated through three different levels: the territorial scale, the landscape scale and the urban scale. Each scale is not only a change in representation, but a different way of interpreting the project. At the territorial scale, the focus is on positions, hierarchies, roles and networks. At the landscape scale, the attention shifts to interactions, relationships, identities and links. At the urban scale, the analysis becomes more specific and concerns functions, rules, dimensions and shapes. This approach allows the masterplan to move beyond a single site-based perspective and to understand how local transformations are connected to broader systems.

The methodology also introduces a scenario-based attitude. Concepts such as preparedness, feasibility, capability, potentiality and aptitude indicate that the masterplan should not be understood as a closed and definitive solution. Rather, it should be able to evaluate different possibilities, compare alternatives and remain open to future conditions. This is particularly important for a project

connected to hydrogen development, where technological evolution, regulatory frameworks, economic feasibility and implementation timing are still subject to uncertainty.

Starting from these assumptions, the methodological framework can be formalized through two main challenges.

The **first challenge** is defining an interactive process. The research does not merely follow a linear sequence of steps but aims to maintain coherence between them. Analysis, evaluation, vision, adaptation, ideas and implementation are part of a continuous process in which each phase contributes to refining the others.

The **second challenge** is a multiscale perspective beyond scales: defining interpretive keys for each level. The research does not simply observe the project at different scales but assigns to each scale specific interpretive keys. The territorial, landscape and urban dimensions become complementary lenses through which the masterplan can understand complexity, identify opportunities and construct visions for a sustainable and identity-based future.

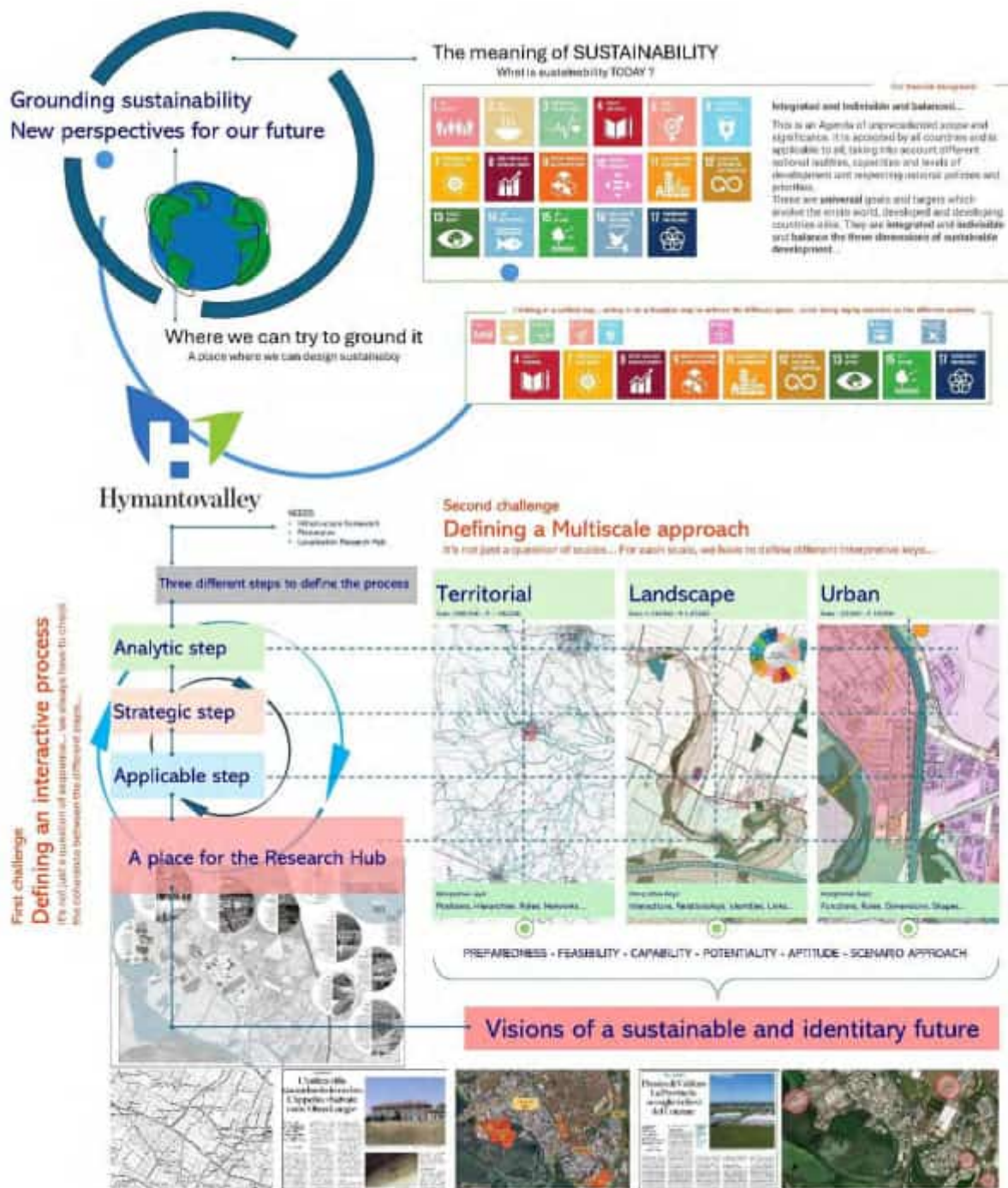
The methodological scheme provides a synthetic representation of the research process and clarifies the logic through which the masterplan is progressively constructed. It shows how the work starts from a theoretical reflection on sustainability and the SDGs, then moves toward the specific needs of the HyMantoValley project: the infrastructure framework, the masterplan itself and the localization of the Research Hub.

The scheme does not describe a simple linear sequence, but an interactive process in which knowledge, strategy and design are continuously connected through moments of analysis, evaluation, vision, adaptation and implementation. At the same time, it highlights the need to verify the project through different scales — territorial, landscape and urban — each one associated with specific interpretive keys. In this sense, the scheme works as a methodological guide for grounding sustainability in a concrete place, transforming general objectives into spatial strategies, design choices and possible scenarios for the future development of the area.

The methodological scheme was discussed and verified in relation to the overall objectives of the project and progressively refined as a common framework for the development of the research activities. It was also shared with the leaders of the different Work Packages during the plenary meetings, becoming a reference tool for aligning the masterplan contribution with the broader structure of HyMantoValley (Healey, 1997)

In this sense, the scheme did not remain an internal analytical device but assumed a more operational and collaborative role. It helped to clarify the sequence of activities, the relationships between scales, the connection between analysis and design, and the way in which the masterplan could interact with the other components of the project. This approach is consistent with collaborative planning perspectives, which emphasize planning as a process of communication, coordination and shared action among different actors operating within complex territorial and institutional contexts.

The scheme therefore acted as a methodological guide for the work developed within the masterplan. It provided a shared language through which objectives, scales, analytical steps and design outputs could be discussed, compared and progressively adjusted. Rather than defining a rigid procedure, it supported an interactive process capable of maintaining coherence between the specific contribution of the masterplan and the wider objectives of HyMantoValley.



Methodological scheme of the research process and working strategies.

3.1 Interactive process: following a flexible itinerary

A major challenge in sustainable urban and territorial planning is the tendency to rely on rigid and static models, which often fail to respond to evolving conditions, uncertain implementation processes and the complexity of contemporary transformations. This issue is particularly relevant for a project such as HyMantoValley, where the masterplan must deal with technological innovation, infrastructural requirements, environmental sensitivities, planning constraints and future development scenarios.

For this reason, the methodology adopts an interactive and adaptive planning framework. The process is not conceived as a linear sequence moving mechanically from analysis to design, but as a flexible itinerary in which each phase informs, tests and refines the others. Knowledge-building,

spatial interpretation, scenario construction and design choices are therefore connected through continuous feedback. Analysis supports the formulation of strategies, but strategies also help to reinterpret the analysis; design hypotheses reveal new constraints and opportunities, while evaluation allows the process to be adjusted over time.

This approach is consistent with the idea that planning should not merely follow a predetermined sequence of steps, but should maintain coherence between different stages, allowing for iterative assessment and adaptation. In this sense, the interactive process becomes a way to manage complexity without reducing it. It allows the masterplan to remain open to change while preserving a clear direction, avoiding both the rigidity of fixed solutions and the fragmentation of disconnected actions.

The research also emphasizes the importance of continuity between the different moments of the process. The framework of knowledge, the reading of permanences, the vision and concept plan, and the final masterplan are not autonomous products, but interconnected steps. Each one contributes to the construction of the next, while remaining available for revision when new evidence, constraints or strategic priorities emerge. This makes the methodology particularly suitable for working with uncertain conditions and for transforming them into design opportunities.

Furthermore, the integration of the SDGs into the process reinforces the need for coherence between global sustainability objectives and local spatial decisions. The interactive framework allows the research to verify how sustainability goals can be translated into concrete choices concerning accessibility, infrastructure, ecological regeneration, landscape continuity, functional compatibility and the localization of the Research Hub. In this way, the SDGs are not applied as abstract targets, but become part of a dynamic process of interpretation, evaluation and design.

By adopting an interactive and adaptive planning framework, the methodology moves beyond static master planning toward a more flexible, resilient and future-oriented approach. The masterplan is therefore understood not as a fixed final image, but as a strategic device capable of guiding transformation, testing alternatives and supporting decisions over time. This enables the project to respond to the complexity of Mantova's productive landscape while maintaining coherence with the broader objectives of sustainability and energy transition.

3.2 Multiscale approach: moving through different perspective thresholds

This research adopts a multiscale approach that integrates territorial, landscape and urban perspectives into a single methodological framework. The aim is not only to observe the project area at different levels of representation, but to move through different perspective thresholds, each one capable of revealing specific relationships, criticalities and opportunities. In this sense, scale is not understood merely as a cartographic measure, but as an interpretative device through which the complexity of the HyMantoValley project can be progressively understood and translated into spatial strategies.

This approach acknowledges the interconnected nature of contemporary urban and territorial transformations. Urbanization is no longer confined within clear administrative boundaries, but operates through complex networks of infrastructures, ecological systems, productive areas, mobility flows and governance structures. For this reason, the transformation of Mantova Est cannot be interpreted only at the local scale. It must be connected to broader territorial dynamics, landscape systems and site-specific conditions, ensuring coherence between strategic vision and concrete design choices.

The multiscale perspective is central to the research because it allows the project to relate large-scale regional dynamics to localized urban conditions. Traditional planning approaches often risk

separating these dimensions, producing fragmented strategies or interventions that are not fully aligned with wider territorial processes. By contrast, a multiscale methodology makes it possible to understand how decisions taken at one level influence the others, and how the masterplan can operate as a connective framework between territorial networks, landscape structures and urban transformations.

At the **territorial scale** — approximately 1:400,000 and 1:200,000 — the research considers the position of Mantova within wider spatial, infrastructural, productive and environmental systems. This scale allows the project to identify roles, hierarchies, networks and strategic connections, including relations with regional mobility systems, logistics corridors, energy infrastructures and broader ecological structures. It is the scale at which HyMantoValley can be understood in relation to the Po Valley, Northern Italy and European hydrogen and transport networks.

At the **landscape scale** — approximately 1:200,000 and 1:25,000 — the focus shifts to the relationships between natural systems, historical permanences, ecological continuities and productive landscapes. This level of analysis makes it possible to recognize the environmental and cultural structure of the territory, including waterways, green and blue infrastructures, agricultural traces, landscape margins and areas of ecological sensitivity. The landscape is therefore not treated as a background condition, but as an active structure that can orient the masterplan and support processes of environmental regeneration.

At the **urban scale** — approximately 1:25,000 and 1:10,000 — the research becomes more specific and operational. It investigates local functions, accessibility, land uses, infrastructural connections, spatial dimensions, constraints and possible sites for the Research Hub. This scale allows the project to verify the concrete feasibility of design choices, testing the compatibility between new functions and existing productive activities, mobility systems, environmental risks and planning regulations.

Each scale is associated with specific interpretive keys. At the territorial level, the research focuses on positions, hierarchies, roles and networks. At the landscape level, it investigates interactions, relationships, identities and links. At the urban level, it examines functions, rules, dimensions and shapes. These interpretive keys allow the masterplan to move beyond a generic multiscale reading and to construct a more precise methodological framework, in which each level contributes differently to the understanding of the project.

This multiscale methodology recognizes that sustainable transformation is the result of overlapping and interdependent spatial processes. The masterplan must therefore be able to move continuously between scales, connecting broad strategies with local conditions and verifying how each decision can produce effects at different levels. In this sense, the multiscale approach becomes a way to ensure coherence, adaptability and territorial relevance, transforming the HyMantoValley project into a spatial strategy capable of acting simultaneously on infrastructure, landscape, production, ecology and urban form.

3.3 Integration of the Sustainable Development Goals (SDGs)

Finally, and not less importantly, the methodological framework must address the integration of the Sustainable Development Goals into the planning process. If the interactive process defines how the research moves between analysis, evaluation, adaptation and design, and if the multiscale approach defines the different perspective thresholds through which the territory is interpreted, the SDGs provide the common reference framework that gives direction and coherence to the whole process.

The SDGs are assumed as a universal framework for sustainable development, capable of orienting spatial policies toward environmental balance, social equity and economic viability.

However, within this research, they are not treated as a generic list of objectives to be mentioned, but as operative references to be selected, interpreted and translated into design choices. As stated in the 2030 Agenda, the goals are “integrated and indivisible” and balance the economic, social and environmental dimensions of sustainable development. For this reason, their application to the HyMantoValley masterplan requires a holistic approach, able to connect global objectives with the specific conditions of Mantova Est.

The workflow follows a progressive structure. The first step consists in identifying the SDGs that are most relevant for the transformation of the project area. In this case, particular attention is given to goals related to sustainable cities and communities, clean energy, innovation and infrastructure, responsible production, climate action and ecosystem protection. These goals are directly connected to the main issues addressed by the masterplan: the localization of the Research Hub, the integration of the hydrogen value chain, the relationship with existing infrastructures, the mitigation of environmental impacts and the enhancement of ecological and landscape systems.

The second step concerns the formulation of spatial strategies. At this stage, the selected SDGs are used to orient planning decisions and to verify whether the proposed strategies contribute to resource efficiency, accessibility, environmental regeneration, industrial innovation and territorial resilience. The SDGs therefore become a tool for connecting different dimensions of the project, avoiding sectoral interpretations and encouraging synergies between energy transition, productive development, ecological continuity and spatial quality.

The final step concerns implementation. The SDGs must be translated into practical and site-specific interventions, rather than remaining at the level of abstract principles. This requires the support of the interactive and multiscale methodology: different scales contribute to identifying opportunities and constraints, while the iterative process allows strategies to be evaluated, adjusted and adapted over time. In this sense, the integration of the SDGs reinforces the need to think in a unified way and to act in an articulated way, pursuing different objectives while remaining highly attentive to the specific context.

The real methodological challenge is therefore to prevent the SDGs from becoming external references detached from the design process. Their role is to guide the construction of the masterplan from within, helping to define priorities, assess alternatives and orient spatial choices. Through this integration, sustainability becomes not only a declared objective, but a working criterion for transforming HyMantoValley into a coherent territorial strategy.

3.4 From analysis to scenarios: to know, to stage, to implement

The methodological framework described in this chapter leads to a final and fundamental issue: the need to work with uncertainty. Projects such as HyMantoValley are not developed within stable and fully predictable conditions. They depend on technological innovation, regulatory evolution, investment dynamics, infrastructural feasibility, environmental requirements, institutional decisions and the progressive consolidation of the hydrogen value chain. These elements cannot be completely defined at the beginning of the planning process. For this reason, the masterplan cannot be conceived as a fixed solution, but as an adaptive device capable of supporting different possible trajectories.

Working with uncertainty does not mean renouncing precision. On the contrary, it requires a stronger and more structured process of knowledge construction. Before imagining future scenarios, it is necessary to understand the existing conditions of the territory, the planning framework, the infrastructural systems, the environmental constraints, the landscape structures and the functional relations that characterize the project area. In this sense, the first methodological action is to know: to collect, organize and interpret the information that can support future decisions.

The second action is to stage. This means transforming knowledge into a strategic representation of the territory. The information collected is not simply archived, but is interpreted in order to reveal relationships, conflicts, potentials and possible directions of transformation. Through maps,

diagrams, interpretive readings and concept plans, the project area can be represented as a field of opportunities and constraints. This staging phase is essential because it makes visible the spatial implications of the project and allows different hypotheses to be compared.

The third action is to implement. Implementation does not refer only to the final construction of the masterplan, but to the progressive translation of analysis and strategy into spatial choices, site-specific solutions and possible development scenarios. In this phase, the masterplan becomes a tool for testing feasibility, evaluating alternatives and defining priorities. It allows the research to verify how the Research Hub, the hydrogen value chain, infrastructural connections, ecological systems and existing productive areas can interact within different future configurations.

The sequence to know, to stage, to implement is therefore not a rigid linear process, but an iterative methodological structure. Knowledge informs scenarios, scenarios test knowledge, and implementation choices can reopen the need for further analysis. This circular movement is particularly important when dealing with complex territorial transformations, where each decision may produce effects at different scales and where future conditions remain partially uncertain.

For this reason, scenarios are not considered as secondary or illustrative outputs. They are methodological tools that help the masterplan deal with uncertainty, compare possible futures and evaluate the consequences of different design choices. Scenario-based work allows the project to remain flexible, while still maintaining coherence with the objectives of sustainability, energy transition and territorial regeneration.

This approach opens directly to the next phase of the research: the construction of the knowledge mosaic. Building the knowledge mosaic means collecting and organizing the documents, plans, cartographic sources, GIS layers, project materials and site information needed to support the masterplan. It is the necessary foundation for moving from uncertainty to informed scenarios, and from general objectives to concrete spatial strategies for the transformation of Mantova Est.

4. BUILDING THE KNOWLEDGE MOSAIC

The construction of the knowledge framework represents a fundamental step in the development of the masterplan. In a complex territorial context such as Mantova Est, the project cannot be based only on design intentions or on the localization of specific functions. It requires a structured understanding of the territory, capable of bringing together different kinds of information: planning documents, infrastructural systems, environmental constraints, landscape structures, productive functions, mobility networks, project materials and local conditions.

For this reason, the knowledge framework is conceived as a mosaic. The term refers to the need to collect, select and relate heterogeneous sources, transforming them into an organized and interpretative system. Each document, map, regulation, GIS layer or project material provides only a partial reading of the area. The value of the knowledge mosaic lies in the possibility of connecting these fragments, identifying correspondences, overlaps, conflicts and opportunities. In this sense, knowledge is not treated as a neutral background, but as an active component of the design process.

Building the knowledge mosaic means creating the conditions for a project that can interact consciously with the territory. The masterplan must be able to recognize what already exists before proposing transformation: infrastructural hierarchies, environmental sensitivities, ecological continuities, historical permanences, land-use patterns, accessibility conditions and strategic development trajectories. Only through this interpretative work can the project avoid isolated or

abstract solutions and instead define choices that are coherent with the specific structure of the place.

The knowledge framework also supports the multiscale approach adopted by the research. At the territorial scale, it helps to understand the role of Mantova within wider infrastructural, productive, energy and ecological networks. At the landscape scale, it allows the recognition of environmental systems, green and blue infrastructures, historical traces and spatial continuities. At the urban scale, it makes it possible to evaluate local accessibility, functional compatibility, available areas, constraints and opportunities for the localization of the Research Hub.

Therefore, the knowledge mosaic is not simply a preliminary analytical phase, but the basis for the whole methodological process. It supports the transition from analysis to scenarios, from interpretation to strategy, and from strategy to design choices. By organizing and relating the different layers of information, the framework allows the masterplan to work with the territory rather than merely on the territory, transforming existing conditions into design resources and guiding the future development of HyMantoValley in a more informed, coherent and adaptable way.

As part of the development of the HyMantoValley project, the territorial scale of research focuses on leveraging key demographic, infrastructural, and geo-graphic elements of northern Italy.

4.1 Territorial significance of Mantova as a Hydrogen Hub

The HyMantoValley project, planned within the Northern Italian context, specifically targets the rich demographic, infrastructural, and geographic tapestry of this densely urbanized area known for its robust industrial activity and extensive transport networks. This region, including the Po River Valley, is crucial for its economic and environmental significance—serves as a strategic fulcrum for advancing a hydro-gen-based economy.

The Po Valley or “La megalopoli padana” as termed by Eugenio Turri in his book (2000), epitomizes the phenomenon of urban amplification that began with Italy’s initial phase of industrialization, which progressively integrated the main settlement axes, creating a continuous urban expanse from Turin through Milan to the cities of Veneto-Friuli, and southward to Bologna and Rimini.

Once predominantly agricultural, these territories have transformed into interstitial zones sandwiched between sprawling urban developments. This transformation underscores the dual functionality of the Po Valley: as both a vibrant, energy-consuming organism and a meticulously designed system. It operates as a highly urbanized mechanism, flexibly responding to the region’s demands while exploiting its abundant resources to support diverse industrial and agricultural output actions deeply influenced by human intervention.

This heterogeneous landscape has historically supported both local and supra-local interactions, generating cultural, economic and productive value. Its position between the Mediterranean and Central Europe has made it a space of exchange, mediation and transition, where infrastructures, settlements, agricultural systems, productive activities and cultural identities have progressively overlapped. However, this richness also produces complexity. The specific characteristics of local territories — their environmental fragilities, historical permanences, productive traditions, settlement patterns and institutional conditions — are not always easily integrated into broader regional, national or international frameworks.

The main challenge is therefore to manage this complexity without reducing it. Sustainable growth cannot be pursued only through large-scale strategies or abstract development models; it must be built through the recognition of local specificities and their connection to wider networks. In this sense, the valley’s strategic position should not be understood only as a geographical advantage, but as a relational condition: a capacity to connect different scales, economies, cultures and infrastructures. Strengthening this role means enhancing the valley as a cultural and economic

mediator, while ensuring that future transformations remain coherent with its territorial identity, environmental limits and long-term sustainability objectives.

“Every landscape is a text to be read and interpreted, where the history and soul of a people are reflected.” - Eugenio Turri (2000)



Illustrated map showing diffused cities in the northern part of Italy.

Source: Turri E. (2000)

Characterized by its strategic significance, Po valley provides a solid foundation for advancing hydro-gen-related innovations, with Mantova emerging as a resourceful location for the development of a hydrogen valley. Its proximity to major industrial clusters, such as Milan and Verona, and accessibility to all major cities within a range of distances, from a minimum of 34 km to a maximum of 131 km positions Mantova as an ideal site for establishing a hydrogen hub. As part of the effort to identify potential hubs for hydro-gen research, production, and storage, the HyMantoValley is part of a broader program that envisions the establishment of an entire hydrogen valley in the province of Mantova, among the first in Europe. Similar production plants of various scales are planned across the country, by reusing brownfield industrial areas as innovative hubs where hydrogen is produced from local renewable resources.

In the context of Mantova and its surrounding blue infrastructures, the Po River plays a significant role. It is more than just a physical network; it's a dynamic system that supports a multitude of functions and comprises a crucial network of waterways, including rivers, canals, and navigation basins, which play a vital role in the region's economic, environmental, and social systems. This network not only supports commercial and industrial activities but also has significant implications for agricultural irrigation, flood management, and ecological sustainability.

As the longest river in Italy, it spans the northern part of the country from east to west, with an extensive network of branches and canals. The key ports include the Cremona Port, which plays a vital role in regional trade by managing industrial and agricultural products, and the Mantovan Port (Porto di Valdarò), which connects inland waterways and facilitates freight operations, linking the Po River to the Adriatic Sea through the Canal Bianco. Additionally, Mantova benefits from the Mincio River, located in the Lombardy region of northern Italy. The river is the main outlet of Lake Garda, which forms the three artificial lakes surrounding the city before joining the Po River to the south of the municipality.

4.2 Documents, plans and institutional sources

The analysis of the Po River basin requires the use of a wide set of documents, plans and institutional sources, because the river system cannot be understood only as a natural element. It is at the same time a hydrological basin, an ecological corridor, an infrastructural axis, a productive landscape and a navigation system. For this reason, the knowledge framework has been built by combining sources related to water management, flood risk, inland navigation, territorial planning and environmental protection.

A first essential reference is the Autorità di Bacino Distrettuale del Fiume Po, which is responsible for planning and coordinating water management within the Po River district. The Authority defines the basin as the territory where rainwater, snowmelt and glacier melt converge into a river system, directly or through tributaries. This definition is particularly important because it shifts the interpretation from the river as a linear element to the basin as a territorial system, involving multiple regions, landscapes, infrastructures and settlements.

The institutional framework is also connected to the Piano di Gestione delle Acque del distretto idrografico del fiume Po, developed in accordance with the European Water Framework Directive 2000/60/EC. The second update of the plan for the 2021–2027 cycle was approved by DPCM on 7 June 2023 and published in the Italian Official Gazette in September 2023. This plan represents a fundamental reference for understanding water quality, ecological status, pressures on surface and groundwater bodies, and measures for the sustainable management of the basin.

A second group of sources concerns flood risk and hydraulic safety. The Piano di Gestione del Rischio Alluvioni del fiume Po addresses the entire district affected by floods from the Po and its tributaries, from the source to the river mouth. This document is particularly relevant because the navigability, ecological continuity and territorial development of the basin are strongly conditioned by hydraulic risk, river dynamics and the need to protect settlements, productive areas and infrastructures.

For the specific issue of navigation, the main reference is the institutional documentation related to the Sistema Idroviario Padano-Veneto. The system, defined by national legislation as being of pre-eminent national interest, is developed along a network of rivers and canals connecting Piemonte, Lombardia, Emilia-Romagna and Veneto to the Adriatic coast. Its management involves the Regions of Emilia-Romagna, Lombardia, Piemonte and Veneto, while operational responsibilities are partly delegated to specialized bodies such as AIPo for Lombardia and Emilia-Romagna.

The documentation provided by AIPo – Agenzia Interregionale per il fiume Po is therefore crucial for understanding the navigable network, its existing sections, criticalities and development perspectives. According to AIPo, the inland navigation system includes several operational waterways, such as the Po from Cremona to Volta Grimana, the Mincio from Mantova to the Po, the Po–Brondolo Canal, the Idrovia Ferrarese and the Fissero–Tartaro–Canalbianco–Po di Levante waterway, which connects Mantova to the sea.

These sources show that the Po basin is not a homogeneous territorial unit, but a complex system involving different regions, institutional responsibilities and infrastructural components. The river, canals, locks, inland ports and navigation routes form a blue infrastructure that supports transport, irrigation, hydraulic regulation, ecological continuity and economic exchange. At the same time, this infrastructure is affected by environmental constraints, water availability, flood risk, sediment dynamics and the need to coordinate different planning levels.

Within the knowledge mosaic, these documents and institutional sources allow the research to interpret the Po River basin as a strategic framework for the HyMantoValley project. They help to clarify the role of Mantova within the wider inland navigation system, the relationship between the productive pole and the blue infrastructure, and the potential connections between hydrogen development, logistics and water-based transport. In this sense, the analysis of documents and plans is not only a

descriptive operation, but a necessary step for understanding how the masterplan can interact with the territorial structure of the Po Valley.

In this sense, the Mantova–Marghera axis can be interpreted as a potential macro-supply chain in which hydrogen production, distribution and use are connected to a wider territorial and infrastructural system. This corridor is strongly related to the Padano-Veneto inland waterway system, which links Northern Italy to the Adriatic coast through a network of rivers and canals involving Piemonte, Lombardia, Emilia-Romagna and Veneto. In particular, the Fissero–Tartaro–Canalbianco–Po di Levante waterway connects Mantova to the sea over approximately 135 km, crossing the provinces of Mantova, Verona and Rovigo.

This route gives the Mantova–Marghera connection a specific territorial relevance. Starting from Mantova and the Valdaro area, the corridor crosses a productive and agricultural landscape characterized by logistics platforms, industrial settlements, irrigation systems, waterways, locks and port facilities. Valdaro is directly connected to the inland port of Mantova and to the Fissero–Tartaro–Canalbianco–Adriatic navigable canal, with year-round navigation between Mantova and Venice. Moving eastwards, the corridor intersects the lower Veronese area and the province of Rovigo, where the Canalbianco and Po di Levante structure a territory marked by agriculture, water management, inland navigation and environmental fragility.

Within this framework, hydrogen could support the activation of local mini-supply chains along the macro-corridor. In Mantova, the presence of HyMantoValley, the productive pole, the Research Hub and the port-logistics system can define a first local ecosystem focused on production, research, training, demonstration activities and industrial applications. In the intermediate territories crossed by the waterway, hydrogen could be linked to agricultural production, logistics services, inland mobility, energy storage and small-scale applications for productive areas or off-grid systems. In the Rovigo and Po Delta area, the relationship with water infrastructure, ecological systems and inland navigation could support experimental uses connected to low-emission transport, environmental management and the decarbonization of river logistics.

At the eastern end of the corridor, Porto Marghera represents a strategic node because of its industrial and port functions. The Port of Venice has promoted initiatives for the development of a green hydrogen hub in the Porto Marghera area, including an electrolyser powered by photovoltaic and other renewable energy sources. The same institutional framework describes Porto Marghera as a suitable location for a hydrogen hub connected to maritime, road and rail systems. This makes Marghera not only a destination point, but a complementary pole within the macro-supply chain, capable of interacting with logistics, energy flows, industrial uses and related activities.

For the masterplan, this interpretation is particularly important. It suggests that HyMantoValley should not be considered only in relation to its immediate project area, but as part of a broader territorial system. The activation of mini-supply chains along the Mantova–Marghera corridor could make it possible to valorize different local potentials: industrial decarbonization, sustainable logistics, inland navigation, renewable energy integration, research activities, training, environmental regeneration and new forms of cooperation between productive territories.

The macro-filiera therefore becomes the strategic structure, while the micro- or mini-filiera become the operational level through which hydrogen can generate concrete territorial value.

The potential of the Mantova–Marghera macro-supply chain therefore lies in its capacity to connect different territorial specializations. Mantova can act as a research, production and inland logistics node; the intermediate territories can host distributed applications and local energy services; Rovigo and the Po Delta can become spaces for testing the relationship between hydrogen, navigation and environmental systems; Marghera can operate as an industrial-port hub connected to maritime

networks. In this perspective, the macro-supply chain does not replace local specificities, but gives them a common framework.

4.3 Provincial planning framework: PTCP and Mantova Est Masterplan

The area of Mantova Est has already been the object of significant planning and regeneration initiatives before the development of HyMantoValley. In July 2020, the Province of Mantova prepared the Masterplan for the territorial regeneration of the productive pole of provincial relevance of Mantova Est and of the National Contaminated Site “Laghi di Mantova e Polo Chimico”. This document represents an important reference for understanding the existing project background of the area and the strategic role already attributed to this productive landscape.

The masterplan was developed within the framework of the Regional Territorial Plan and the Provincial Territorial Coordination Plan, in relation to the theme of territorial regeneration and to the need to reduce land consumption, recover degraded or underused areas, and improve the environmental and landscape quality of already urbanized contexts. The Province identifies Mantova as the only territorial regeneration area of regional relevance within the provincial territory, due to the presence of a high incidence of areas to be recovered, the role of the national petrochemical pole, and the inland navigation system connecting the Po River to the Adriatic Sea.

This previous masterplan is particularly relevant because it recognizes the strategic complexity of Mantova Est. The area includes several elements of supra-local importance: the National Contaminated Site, the Port of Valdaro, the productive pole of provincial relevance, the Mantova Nord motorway tollgate, the railway system, the inland navigation infrastructure and several areas affected by incomplete or underused urbanization processes. For this reason, the document already proposed the need for a coordinated planning process involving the Province of Mantova, the Municipality of Mantova, the Municipality of San Giorgio Bigarello and the companies operating in the area.

For the HyMantoValley masterplan, this background is important because it shows that several territorial conditions and project trajectories are already in place. The hydrogen project can therefore be interpreted not as an isolated intervention, but as a further step within a broader process of regeneration. It can build upon existing planning directions concerning intermodality, environmental remediation, productive redevelopment, sustainable mobility, port development and the reuse of already transformed areas.

Although this planning framework was not directly developed around the hydrogen economy, it introduced several themes that are strongly connected to the objectives of HyMantoValley. First, it emphasized the need to strengthen the intermodal role of Valdaro, based on the integration of road, rail and water transport. The infrastructural system of the area is described as a tri-modal structure composed of the motorway and road network, the Mantova–Monselice railway line and the waterway system connected to the Mincio, the lakes of Mantova and the Fissero–Tartaro–Canalbianco canal.

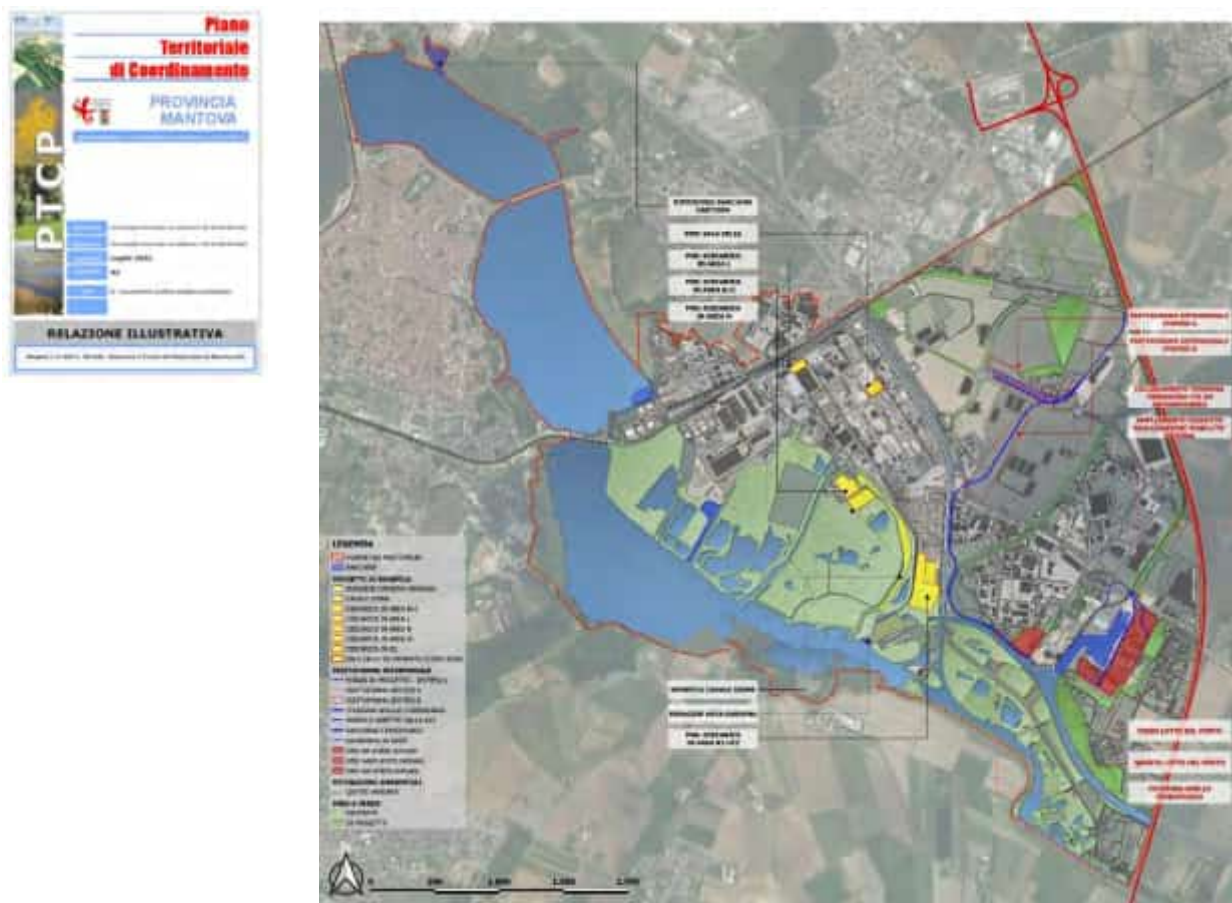
Second, the 2020 masterplan highlighted the importance of the Port of Mantova-Valdaro as a strategic logistics node. Several projects were already considered or under development, including the third lot of the port, new railway connections, the strengthening of the intermodal platform and the improvement of road accessibility. These projects aimed to support the transfer of goods between water, rail and road transport, reinforcing the role of Mantova Est as a productive and logistics platform of supra-local relevance.

Third, the document placed strong emphasis on environmental regeneration. The area is affected by the presence of the National Contaminated Site “Laghi di Mantova e Polo Chimico”, whose remediation processes are a fundamental condition for any future transformation. At the same time, the proximity of the Parco del Mincio, the Vallazza nature reserve and the Natura 2000 areas requires

that productive and infrastructural development be accompanied by mitigation, compensation and ecological reconnection strategies.

In this perspective, HyMantoValley may act as a catalyst capable of connecting these partially independent initiatives into a more coherent territorial strategy. While the 2020 masterplan focused on the regeneration of the productive pole, the improvement of infrastructure and the mitigation of environmental impacts, the hydrogen project introduces a new energy dimension. This dimension can strengthen the existing framework by linking industrial transformation, logistics, research, clean energy production and low-carbon mobility. The relevance of HyMantoValley therefore lies not only in the introduction of hydrogen technologies, but also in its capacity to give new meaning and operational coherence to a set of planning processes already active around Mantova Est.

In synthesis, the 2021 provincial masterplan demonstrates that Mantova Est is already a territory in transition. HyMantoValley enters this context as a new strategic layer, capable of reinforcing and reorienting previous regeneration initiatives toward the objectives of energy transition, territorial sustainability and industrial innovation.



Masterplan for the territorial regeneration of the productive pole of provincial relevance of Mantova Est and of the National Contaminated Site “Laghi di Mantova e Polo Chimico”

Source: Provincia di Mantova (2021) - https://www.architettimantova.it/wp-content/uploads/2021/12/RI_ALL1.4-Masterplan_Rigen_Mantova_Est_c.pdf

4.4 Municipal planning framework: PGT, Piano dei Servizi, Piano delle Regole, VAS

The municipal planning framework represents a necessary step for translating the territorial strategies identified at the provincial scale into more specific and operational design conditions. If the provincial masterplan recognizes Mantova Est as a strategic area for regeneration, logistics, intermodality and environmental recovery, the municipal planning instruments define the local rules, constraints and opportunities within which the masterplan for HyMantoValley must operate.

The main reference is the Piano di Governo del Territorio (PGT) of the Municipality of Mantova. Through the PGT, the project area can be read in relation to land-use designations, existing and planned productive functions, infrastructural provisions, environmental constraints and areas subject to implementation plans. In particular, the area of Valdaro and Olmo Lungo is already characterized by planning processes connected to productive development, logistics and intermodal accessibility. The provincial masterplan recalls that the PGT assumes the previous planning framework of PA 5.1 Comparto di Valdaro and identifies PA 13 Olmolungo as an area subject to further planning, also in relation to the possible development of an intermodal logistics platform.

Within this framework, the Piano dei Servizi is relevant because it helps to identify the system of public facilities, collective services, mobility infrastructures, green areas and ecological connections that can support the transformation of the productive pole. For the HyMantoValley masterplan, this means verifying how the Research Hub and the related functions can be connected to accessibility systems, sustainable mobility, environmental buffers and possible public or collective spaces. The Piano dei Servizi therefore contributes to reading the project not only as an industrial or technological intervention, but as part of a wider system of services and territorial relations.

The Piano delle Regole provides another essential layer of interpretation. It defines the regulatory conditions for the consolidated urban fabric, the existing productive areas, the compatibility of land uses, building constraints, environmental protections and local transformation rules. For this reason, it is fundamental for assessing the possible localization of the Research Hub, the compatibility with existing industrial activities, the relationship with port and logistics functions, and the limits imposed by environmental or landscape sensitivities. In the context of Mantova Est, where productive areas, contaminated sites, ecological systems and settlements coexist, the Piano delle Regole becomes an important tool for verifying the feasibility of design choices.

Finally, the Valutazione Ambientale Strategica (VAS) provides the environmental evaluation framework associated with planning decisions. Its role is particularly important in a context such as Mantova Est, where future transformations must confront the presence of the SIN “Laghi di Mantova e Polo Chimico”, the proximity of the Parco del Mincio, the Vallazza nature reserve and Natura 2000 areas, as well as issues related to traffic, emissions, hydraulic risk, soil consumption and ecological continuity. The VAS allows the project to be assessed in terms of environmental compatibility, mitigation measures and long-term sustainability.

Reading these municipal instruments together makes it possible to build a more precise knowledge framework for the masterplan. The PGT defines the general planning structure; the Piano dei Servizi clarifies the system of public and collective functions; the Piano delle Regole identifies regulatory and spatial constraints; and the VAS verifies environmental coherence. For the HyMantoValley project, this integrated reading is essential to understand where transformation can take place, which conditions must be respected, and how the Research Hub can be inserted within the existing urban, productive, infrastructural and environmental system.

In this perspective, the municipal planning framework becomes the level at which broader territorial strategies are tested against local feasibility. The objectives defined at the provincial and strategic scale — regeneration, intermodality, environmental mitigation, productive development and energy transition — must be verified through the concrete conditions established by municipal planning instruments. Land-use regulations, accessibility, existing services, environmental

constraints, implementation plans and compatibility with surrounding functions determine whether and how these strategies can actually be translated into spatial interventions.

For the HyMantoValley masterplan, this verification is particularly important. The project cannot rely only on its strategic relevance within the hydrogen value chain but must demonstrate its capacity to fit into the local urban structure and to interact coherently with the existing productive, infrastructural and environmental systems. The municipal framework therefore acts as a bridge between vision and implementation: it allows the project to move from general objectives to feasible choices, from territorial potential to site-specific design conditions, and from strategic ambition to operational transformation.

A particularly relevant document within this framework is Tavola PR1, which defines the land-use designations for the different areas involved in the project. This map provides an essential reference for understanding the regulatory structure of Mantova Est and for verifying the compatibility between the proposed masterplan and the existing municipal planning framework. The project area is not homogeneous: it includes productive zones, port-related areas, infrastructural spaces, environmental systems, agricultural margins, areas subject to implementation plans and spaces characterized by different degrees of transformation or constraint.

For this reason, Tavola PR1 must be assumed as one of the main references for the development of the masterplan. Its indications do not simply describe the current planning status of the area but define the conditions within which future transformations can take place. The localization of the Research Hub, the organization of connections, the relationship with productive and logistics functions, the possible integration of green and blue infrastructures and the identification of compatible uses must all be evaluated in relation to this complex set of land-use provisions.

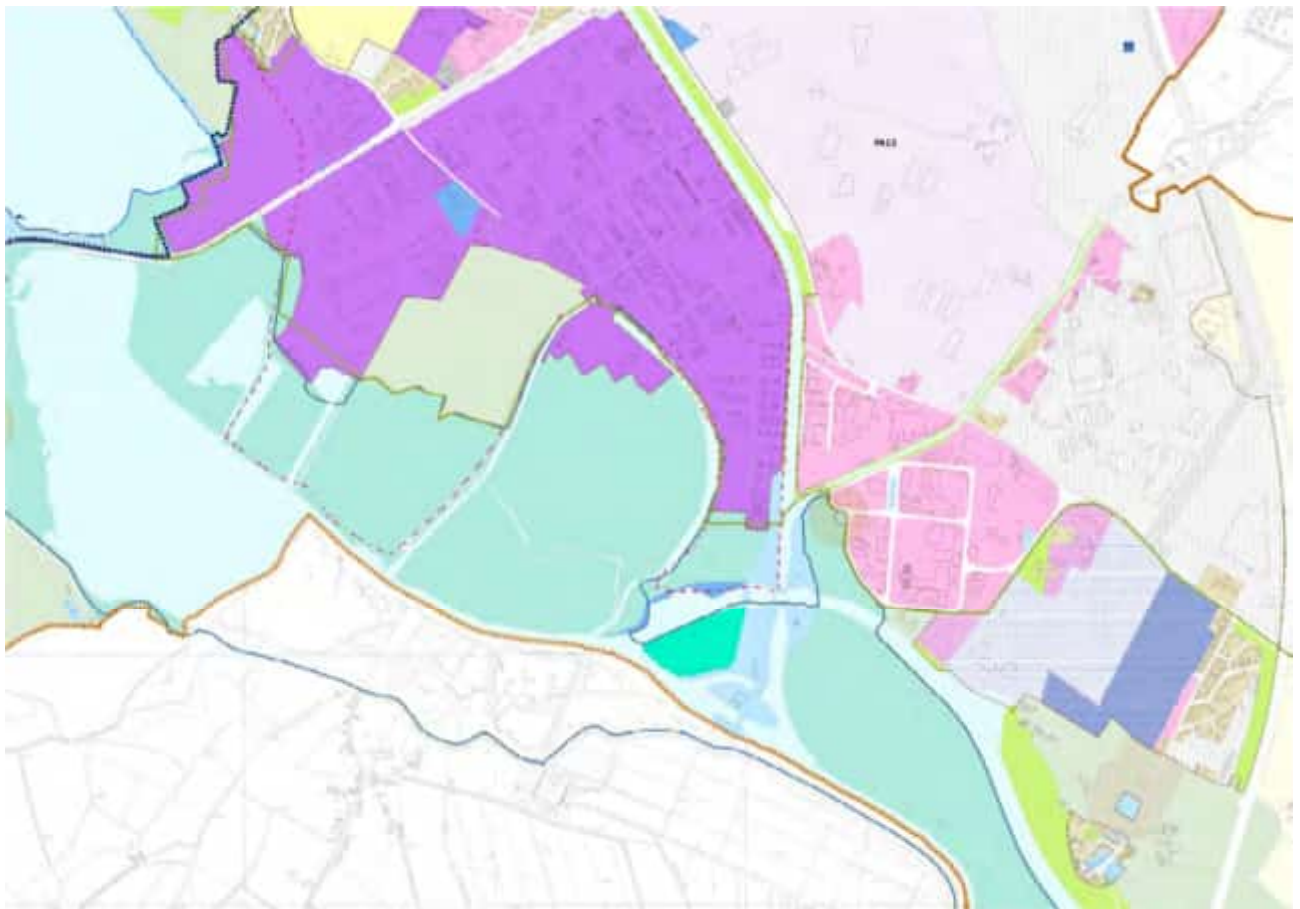
In this sense, the masterplan does not start from an empty or neutral space, but from a territory already shaped by planning rules, functional expectations, implementation procedures and regulatory constraints. Tavola PR1 is particularly relevant because it makes these conditions visible: it identifies land-use categories, planned transformations, productive areas, infrastructural spaces, environmental components and areas subject to specific planning provisions. Reading this document therefore allows the project to understand the existing framework within which any future transformation must be positioned.

At the same time, Tavola PR1 should not be interpreted only as a list of limitations. It also reveals the latent opportunities of the area: available or underused spaces, relationships between productive and infrastructural systems, possible connections with the port and logistics areas, and margins where new functions could be integrated with existing urban structures. For the HyMantoValley masterplan, this reading becomes essential in order to verify the compatibility between the project's strategic objectives and the concrete regulatory and spatial conditions of Mantova Est.

The role of the masterplan is therefore twofold. On the one hand, it must respect and interpret the local planning framework, avoiding abstract or disconnected design choices. On the other hand, it can use this framework as a basis for opening new perspectives of regeneration, identifying where existing rules and functional structures can support innovation, environmental improvement and spatial reorganization. In this way, Tavola PR1 becomes not only a technical planning reference, but also a tool for transforming regulatory knowledge into site-specific design opportunities.



The four documents that make up the Territorial Government Plan of the Municipality of Mantova



Extract from PR1 Planning Map showing the designated land uses

Source: Comune di Mantova - PGT 2012 - <https://www.comune.mantova.it/it/page/153909>

Chapter 3 - Design process

“The object of design is form. The problem of design is to fit the form to its context.”

Christopher Alexander, Notes on the Synthesis of Form, 1964.

5. TERRITORIAL SCALE

5.1 Supra-local relations and territorial connections

The supra-local dimension of the HyMantoValley project is strongly defined by the Mantova–Marghera axis, a plurimodal corridor that connects the productive and logistics system of Mantova Est with the Adriatic gateway of Porto Marghera. This axis is not only a transport connection, but a strategic territorial structure in which road, rail and water infrastructures interact. In particular, the presence of the Canal Bianco and the Po River gives this corridor a specific relevance within the broader system of inland navigation, linking the Po Valley to the Adriatic Sea and opening potential connections between industrial production, logistics, energy transition and sustainable mobility.

Within this framework, the Port of Valdaro assumes a role of exceptional interest. Located in the eastern sector of Mantova, close to the productive pole, the railway network and the A22 motorway, it represents a key intermodal node where water, rail and road transport can converge. Its position allows Mantova Est to be interpreted not as an isolated industrial area, but as part of a wider territorial and infrastructural network. The port becomes the point where the local hydrogen ecosystem can connect to broader logistics flows, energy strategies and possible low-carbon transport chains.

For this reason, the Mantova–Marghera corridor provides an essential interpretive key for the masterplan. It makes it possible to read HyMantoValley beyond the boundaries of the project area, understanding its potential role within a larger macro-supply chain. At the same time, it highlights the possibility of activating local mini-supply chains along the corridor, where hydrogen-related applications could support port activities, inland navigation, logistics services, industrial processes and new forms of territorial cooperation.

In this perspective, supra-local relations are not external to the project but become a condition for its feasibility and relevance. The masterplan must therefore consider how the Research Hub, the productive pole, the port area and the existing infrastructural systems can interact with the Mantova–Marghera axis, contributing to the transformation of Mantova Est into a strategic node for energy transition and territorial regeneration.

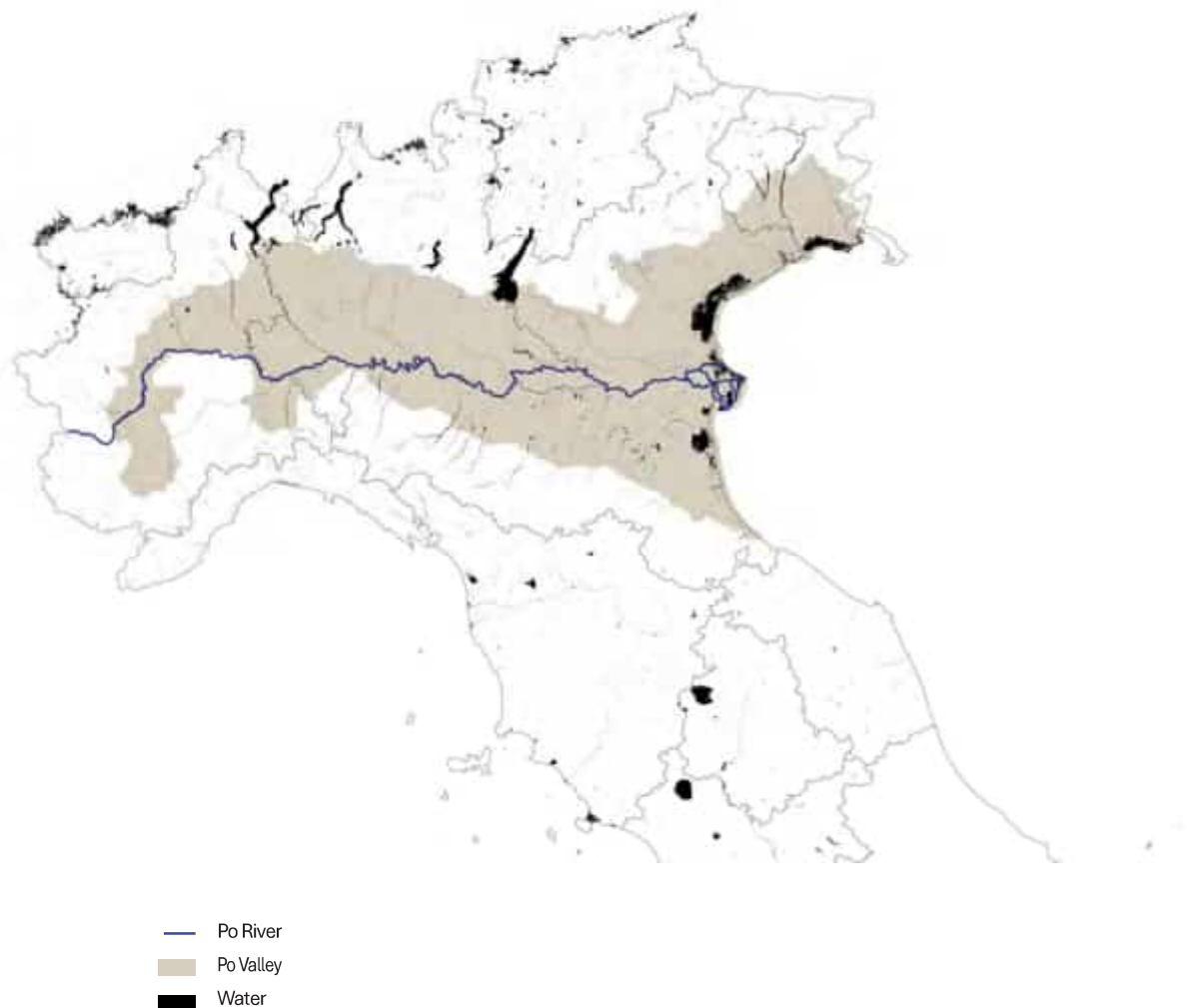
The blue infrastructure of the Po River Valley is composed of a heterogeneous and highly interconnected system of natural, artificial, functional and ecological components. Its complexity derives from the coexistence of different roles: water management, navigation, irrigation, logistics, environmental protection and landscape identity. The Po River represents the main backbone of this system. It structures the valley both physically and symbolically, providing essential water resources for agriculture, supporting industrial and commercial transport, and sustaining ecological habitats along its banks.

Around this main river corridor, a dense network of navigation systems, canals, locks and inland ports contributes to the functioning of the broader territorial infrastructure. The navigation system, managed by the Autorità Interregionale per il fiume Po (AIPO), includes existing routes as well as sections under development, with the aim of improving river navigability and strengthening the role of water transport within the regional economy. This system is supported by a series of artificial elements, such as canals and locks, including the Canal Bianco, the Conca di Valdaro and the Conca

di Governolo. These infrastructures regulate water levels, manage hydraulic flows, reduce flood risks and ensure the continuity of navigation and irrigation.

The presence of inland ports adds a further level of complexity. Facilities such as Ferrara Banchina and Porto Tolle CTE operate as logistical nodes where river, road and rail systems can interact. They connect inland production areas with maritime routes and wider national and international markets, transforming the blue infrastructure into an economic and transport network as well as an environmental system.

At the same time, the Po Valley's blue infrastructure cannot be understood only through its technical and productive functions. Rivers, canals, wetlands and riparian areas also support biodiversity, ecological continuity and landscape quality. Their management plays a crucial role in preserving aquatic habitats, protecting wetlands and maintaining environmental balances within a territory strongly affected by agriculture, industry and urbanization. For this reason, the blue infrastructure should be interpreted as a complex territorial system, where hydraulic regulation, logistics, ecological protection and landscape values are deeply interdependent.



Major water networks, River Po and Po valley

Scale-Specific Issues and SDG Coherence

At the territorial scale, the HyMantoValley project can be read in relation to a selected group of SDGs that are particularly relevant to the transformation of Mantova Est and to its role within wider regional and infrastructural systems. The aim is not to associate the project mechanically with the SDGs, as if they were a checklist to be applied externally to the territory. Rather, the objective is to verify how the main territorial issues emerging from the analysis — brownfield regeneration, infrastructural integration, energy transition, logistics, innovation and governance — can be interpreted through the sustainability framework.

This approach is consistent with the idea of a **territorial approach to the SDGs**, according to which sustainability goals become effective only when they are translated into place-based strategies, capable of responding to the specific conditions, resources and challenges of cities and regions. In this perspective, the SDGs are not used only to measure compliance with global objectives, but to support a broader interpretation of territorial development, connecting environmental, economic, social and institutional dimensions (OECD. 2020).

For HyMantoValley, this means identifying those SDGs that are most closely connected to the spatial and strategic role of Mantova Est. The project area is not only a productive site, but a node within a wider system of infrastructures, logistics networks, energy flows, environmental constraints and institutional relations. The SDG framework therefore helps to clarify which dimensions of sustainability are most relevant at the territorial scale and how they can orient the construction of the masterplan.

In this sense, the selected SDGs act as interpretative keys. They make it possible to relate the regeneration of already urbanized or compromised areas to responsible land use; the development of hydrogen technologies to innovation and infrastructure; the reorganization of logistics and energy systems to climate action; and the governance of a complex territorial transformation to cooperation among institutions, companies, research bodies and local actors. The territorial scale thus becomes the level at which sustainability is understood not as a generic principle, but as a framework for reading and orienting the transformation of Mantova Est within broader regional dynamics.

The adaptive reuse of already urbanized or compromised productive areas is strongly connected to **SDG 12 – Responsible Consumption and Production**. By working on existing industrial and infrastructural sites, the project supports a more responsible use of land and resources, reducing the need for new land consumption and limiting the environmental impacts associated with new development. In this perspective, the reuse of brownfield areas becomes part of a broader circular approach, where existing territorial assets are reinterpreted as resources for the construction of a new hydrogen ecosystem.

The focus on hydrogen production, distribution systems, transport networks and research facilities is directly related to **SDG 9 – Industry, Innovation and Infrastructure**. HyMantoValley promotes innovation in green hydrogen technologies while reinforcing the role of Mantova Est as an infrastructural and productive node. At the territorial scale, this means connecting industrial development with resilient infrastructure, logistics systems, port facilities and research activities, supporting a more integrated model of sustainable industrial transformation.

The project also contributes to **SDG 13 – Climate Action**, as green hydrogen can support the reduction of greenhouse gas emissions in sectors where decarbonization is more difficult. Its potential relevance increases when hydrogen production and use are connected to industrial clusters, logistics networks and mobility systems. From this point of view, the territorial dimension of HyMantoValley is

essential: climate action is not addressed only through a technological solution, but through the reorganization of energy and transport relations at a broader scale.

In relation to **SDG 8 – Decent Work and Economic Growth**, the project may support the development of new skills, qualified employment and local economic resilience. The establishment of production facilities, research activities, technical training and hydrogen-related services can generate opportunities in sectors such as renewable energy, engineering, logistics and environmental innovation. This aspect is particularly relevant for a productive area that is already characterized by industrial and logistics activities and that can be reoriented toward new forms of sustainable growth.

Finally, the territorial scale highlights the importance of governance and cooperation, connecting the project to **SDG 17 – Partnerships for the Goals** and, to a lesser extent, to **SDG 16 – Peace, Justice and Strong Institutions**. HyMantoValley requires coordination among public authorities, private companies, research institutions, European programmes and local stakeholders. Its implementation depends on shared objectives, transparent decision-making, institutional accountability and the capacity to align different planning, financial and operational tools.

Through this SDG-based reading, the territorial scale shows that HyMantoValley is not only an energy project, but a possible model of sustainable regional transformation. It connects land reuse, infrastructural networks, industrial innovation, climate action, economic development and multi-actor governance, offering a framework through which the masterplan can contribute to a more resilient and integrated future for Mantova Est.



To make the relationship between the scale of investigation and the SDGs involved more explicit, this graphic was developed to highlight two aspects: on the one hand, the indivisibility of sustainability-related considerations; on the other hand, the emergence of specific SDGs that become particularly relevant in relation to the topics addressed.

5.2 Energy, logistics and infrastructure networks

At the territorial scale, the HyMantoValley masterplan must be understood through the interaction between energy, logistics and infrastructure networks. The project is not located in an isolated productive area, but within a complex infrastructural system where road, rail and water connections already support industrial activities, freight transport and territorial relations. This condition represents one of the main potentials of Mantova Est and defines the strategic relevance of the area for the development of a hydrogen-based ecosystem.

The existing infrastructural framework is characterized by the coexistence of three main transport systems. The road network connects the productive pole to the A22 motorway through the Mantova Nord tollgate and to the local and provincial road system. The railway network is based on the Mantova–Monselice line and on a system of public and private tracks serving the productive areas and the Port of Mantova-Valdaro. The waterway system is structured by the Mincio, the lakes of Mantova

and the Fissero–Tartaro–Canalbianco canal, which links Mantova to the Adriatic navigation system. This trimodal condition — road, rail and water — is one of the key elements that has historically supported the development of the productive pole and that can now support its transition toward more sustainable logistics and energy systems.

Within this framework, the Port of Valdaro assumes a central role. It is not only a logistics facility, but a territorial interface where different flows can converge: goods, energy, infrastructure, industrial production and future hydrogen-related applications. Its position along the Mantova–Marghera axis makes it possible to interpret the port as a strategic node within a broader macro-supply chain. This axis can connect the hydrogen ecosystem of Mantova with the inland navigation network, the Po Valley productive system and the Adriatic port platform.

For the masterplan, this means that energy transition and logistics transformation must be considered together. Hydrogen production, storage, distribution and use require physical infrastructures, accessible sites, safety conditions, proximity to users and connections with mobility systems. At the same time, logistics activities can become one of the first fields of application for hydrogen, especially in relation to heavy transport, port operations, inland navigation, rail-related services and local industrial uses. The integration between the hydrogen value chain and the existing logistics system is therefore a decisive condition for the feasibility of the project.

The territorial network also opens the possibility of activating local mini-supply chains connected to the wider Mantova–Marghera macro-supply chain. Around Mantova Est, hydrogen could support industrial processes, logistics services, port activities, public or freight mobility, off-grid applications and research-based experimentation. Along the corridor, other local contexts could develop specific applications according to their own productive, infrastructural or environmental characteristics. In this sense, the macro-supply chain provides the strategic structure, while the mini-supply chains represent the operational level through which hydrogen can generate concrete territorial value.

This interpretation is particularly relevant for the localization of the Research Hub. The Hub should not be conceived as an isolated building or campus, but as a node embedded within this wider system of relations. Its position must allow interaction with the productive pole, the port, the railway system, the road network, possible hydrogen production and distribution facilities, and the environmental systems that structure the area. The choice of location must therefore respond not only to spatial availability, but also to accessibility, proximity, safety, compatibility and the capacity to activate synergies with existing and planned infrastructures.

From this point of view, the masterplan becomes a tool for connecting networks that are often planned separately. Energy infrastructures, logistics platforms, mobility systems, industrial areas and ecological corridors must be read together in order to define a coherent strategy for territorial regeneration. The objective is not only to improve the efficiency of existing networks, but to reinterpret them as part of a broader transition toward low-carbon production, sustainable mobility and integrated spatial development.

The analysis of energy, logistics and infrastructure networks therefore provides a necessary territorial basis for the following design steps. It allows the research to identify the main strategic relations that structure Mantova Est and, at the same time, prepares the transition toward the landscape and urban scales, where these relations will be verified in terms of ecological continuity, spatial compatibility, accessibility, site conditions and possible localization of the Research Hub.

5.3 Scale-Based Outputs: mapping, interpretation and design inputs

At the territorial scale, the cartographic outputs were developed to support the construction of a broad framework of knowledge and to clarify the position of Mantova within wider infrastructural, productive, environmental and logistical systems. These maps do not simply represent the territory as a background for the project but identify the main relations that define the strategic role of Mantova Est and the potential development of HyMantoValley as part of a broader territorial system.

The territorial-scale maps therefore act as interpretative tools. They make it possible to read distances, networks, hierarchies, infrastructures, waterways and urban polarities, providing a spatial basis for understanding the macro-relations that may influence the masterplan. In this sense, they contribute to defining the territorial conditions within which the hydrogen value chain, the Research Hub and the possible macro- and micro-supply chains can be positioned.



Board 1. Framework of Knowledge – Territorial Scale

The first map, Framework of Knowledge – Territorial Scale, developed at the scale of 1:400,000, provides a synthetic reading of Mantova's position within the broader regional context of Northern Italy. The map represents the main infrastructural and settlement systems, including railways, primary roads, canals, rivers, water bodies, building elements and the planned hydrogen pipeline. It also highlights the main urban centres surrounding Mantova and classifies them according to population ranges and distance from Mantova, distinguishing cities located within 60 km, between 60 and 100 km, and beyond 100 km.

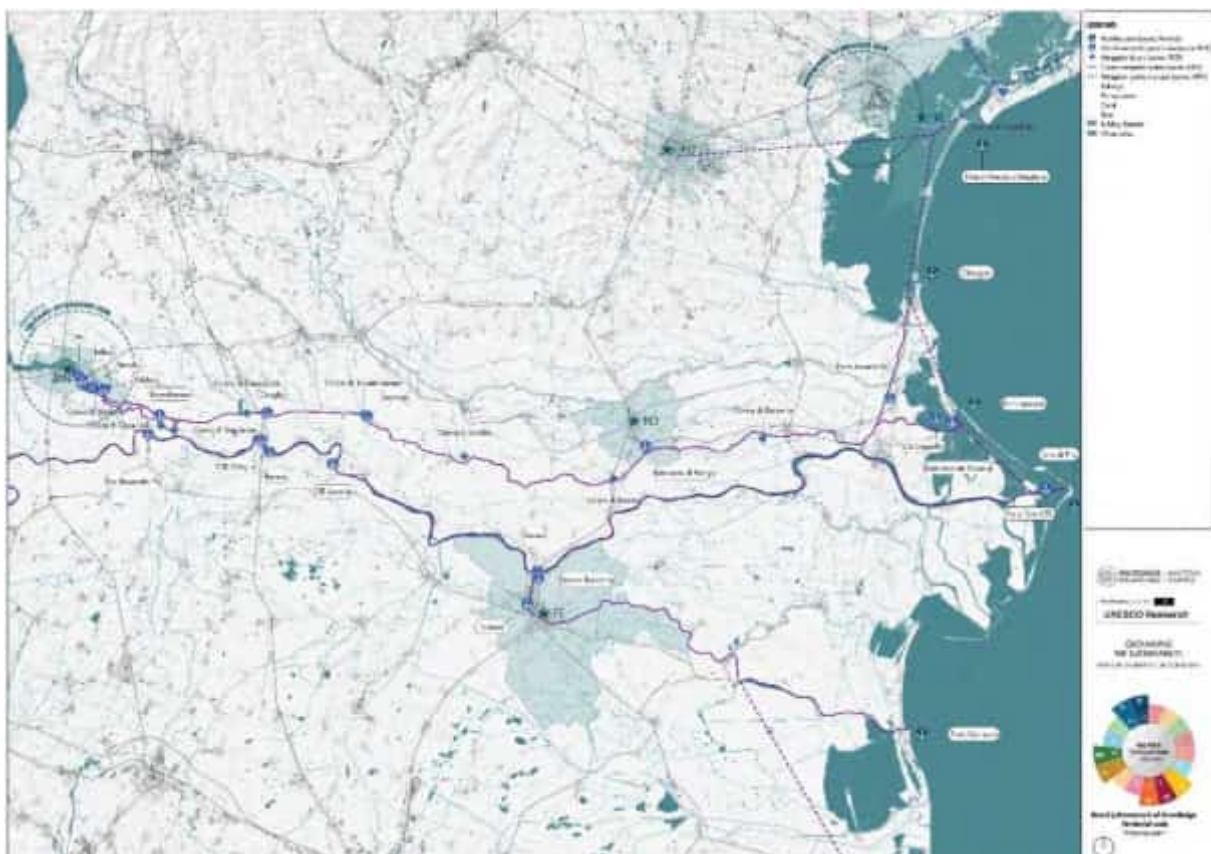
This representation is relevant because, on the basis of the information collected at this stage of the research, it suggests that Mantova Est should not be interpreted as an isolated productive area. Rather, it can be read as part of a wider system of territorial relations connecting it to several regional poles and productive contexts in Northern Italy. The map does not define a catchment area in terms of precise travel-time isochrones; instead, it provides a first spatial approximation based on distance ranges and on the presence of road, rail and waterway infrastructures. In this sense, the 60 km and 60–

100 km distance bands are used as preliminary indicators to identify the potential territorial reach of HyMantoValley and to highlight the urban and productive systems that could be considered in subsequent accessibility analyses.

Within this preliminary framework, the most relevant connections are those linking Mantova Est to the main regional and interregional systems: the road and motorway network toward Verona, Modena, Brescia, Cremona and the wider Po Valley; the railway connections that support productive and logistic relations; and the inland waterway system that links the Port of Valdaro and Mantova to the Adriatic corridor and to Porto Marghera. These connections are relevant not only as transport infrastructures, but also because they may support different forms of interaction between hydrogen production, logistics, industrial uses, research activities and low-carbon mobility.

Mantova can therefore be interpreted as an intermediate node not simply because of its position within the map, but because it lies between different territorial specialisations. To the north and west, it relates to the productive and metropolitan systems of Lombardy and the central Po Valley; to the east, it is connected to the Veneto waterway and port system through the Mantova–Marghera corridor; to the south, it is linked to the Emilia productive platform and to broader manufacturing and logistics networks. Compared with larger metropolitan centres, Mantova has a smaller demographic and urban dimension, but its role becomes significant precisely because it combines a productive pole of supra-local relevance, an inland port, railway and road infrastructures, the planned hydrogen pipeline, and ongoing regeneration processes in Mantova Est.

For the masterplan process, this interpretation should be understood as an initial hypothesis to be further verified through more specific accessibility, market and stakeholder analyses. Nevertheless, it provides a useful basis for positioning HyMantoValley within a broader geography of opportunities. The hydrogen value chain can be read not only within the local perimeter of the project area, but as a possible macro-supply chain interacting with regional mobility, logistics, energy and productive networks. From this perspective, Mantova Est may act as a strategic node where industrial innovation, infrastructure integration, research activities and sustainable regeneration processes can converge.



Board 2. Framework of Knowledge – Waterway System

The second map, Framework of Knowledge – Waterway System, developed at the scale of 1:200,000, focuses on the waterway and port system connecting Mantova to the Adriatic area. The map identifies the current and planned navigation systems, navigation basins, canals, rivers, railways, primary roads, inland commercial ports, maritime ports and water bodies. It also highlights the relation between the Valdaro Hydrogen Hub and the Marghera Hydrogen Hub, making visible the potential territorial corridor between Mantova and Venice/Porto Marghera.

This cartography is particularly important because it shifts the reading of the territory from a general infrastructural framework to a more specific interpretation of the waterway system as a strategic asset. The map shows the sequence of ports, locks, navigation nodes and productive places distributed along the Mantova–Adriatic corridor, including Valdaro, Ostiglia, Revere, San Benedetto Po, Ferrara, Rovigo, Porto Levante, Chioggia, Porto di Venezia e Marghera and other relevant nodes. It also identifies elements such as the Conca di Valdaro, Conca di Governolo, Conca di San Leone, Conca di Trevenzuolo, Conca di Canda, Conca di Bussari and Conca di Baricetta, emphasizing the infrastructural complexity of the inland navigation system.

For the HyMantoValley masterplan, this map has a strategic meaning because it provides a first spatial basis for interpreting the Mantova–Marghera axis as a possible territorial corridor for hydrogen-related activities. At this stage of the research, the map does not demonstrate the existence of an already structured macro-supply chain. Rather, it suggests the possibility of reading the corridor as a potential macro-supply chain, where hydrogen production, storage, distribution and use could interact with inland navigation, port logistics, industrial activities, energy services and low-carbon transport scenarios.

This interpretation is based on the presence of a sequence of relevant infrastructural and territorial elements, including the inland port of Valdaro, the navigable waterway system, logistics platforms, productive areas, intermediate nodes and the industrial-port system of Porto Marghera. These elements do not automatically define a functioning supply chain, but they indicate spatial and infrastructural conditions that may support future cooperation between different territories and actors.

In the same perspective, the map allows the research to formulate a preliminary hypothesis concerning possible micro-supply chains along the corridor. These should be understood as potential local applications to be further verified in relation to specific economic, productive and social conditions, rather than as already defined operational systems. They may concern port operations, logistics platforms, industrial uses, energy services, mobility applications, research and training activities, and forms of territorial cooperation connected to the hydrogen value chain.

In general terms, the localisation of distribution-system utilities related to a hydrogen value chain should follow a set of planning criteria concerning proximity to demand areas, accessibility, connection to logistics and transport networks, land-use compatibility, safety conditions, environmental constraints, availability of suitable areas and possibilities for future expansion.

From this perspective, the identification of two main poles and a sequence of smaller hubs can be interpreted as a possible organisational principle for the Mantova–Marghera corridor. Mantova/Valdaro and Marghera may act as strategic anchors of the system, due to the concentration of port, logistics, industrial and infrastructural functions. Smaller hubs along the corridor should instead be understood as possible intermediate utilities or service points, to be further verified in relation to local needs, such as inland navigation, logistics services, productive areas, low-carbon mobility, energy services and small-scale industrial uses.

The map therefore does not define a final distribution system, but provides a first spatial framework for exploring where such utilities could be located. In this sense, the two main poles may provide the strategic backbone of the potential macro-supply chain, while the smaller hubs may support distributed applications and local forms of experimentation along the corridor.

In this sense, the waterway system is not only an infrastructural component, but also a design and planning resource. It helps to connect the project area with broader territorial dynamics and can support the construction of a masterplan able to work across scales: from the local configuration of Mantova Est and the Port of Valdaro to the wider regional corridor toward Porto Marghera and the Adriatic system. The map therefore contributes to considering the blue infrastructure not merely as a background condition, but as a potentially active element of the HyMantoValley spatial strategy.

6. LANDSCAPE SCALE

6.1 Landscape Framework: relations and continuities

The landscape scale represents the intermediate threshold between the territorial framework and the urban dimension of the masterplan. It is the scale at which the broad infrastructural, productive and ecological systems identified at the territorial level begin to take spatial form, and where they can be read in relation to the specific morphology, identity and environmental structure of the place. In this sense, the landscape scale is not conceived as a merely visual or aesthetic level of interpretation, but as the field in which human action and natural evolution continuously interact. This interpretation is consistent with the definition provided by the European Landscape Convention, according to which landscape is “an area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors” (Council of Europe, 2000).

Starting from this perspective, the landscape scale becomes a critical level of investigation for the HyMantoValley masterplan. It allows the project to recognize landscape not as a background to transformation, but as a dynamic structure shaped by ecological processes, infrastructural systems, productive activities, historical permanences and cultural perceptions. This approach is consistent with the principles of the European Landscape Convention, which defines landscape as a part of territory as perceived by people, whose character results from the action and interaction of natural and/or human factors. The Convention also extends the concept of landscape to the entire territory, including natural, rural, urban and peri-urban areas, as well as ordinary or degraded landscapes. This is particularly relevant for Mantova Est, where industrial areas, waterways, ecological corridors, agricultural traces, infrastructure and historical settlements coexist within a complex and often conflictual spatial condition. Within this research, the landscape scale therefore becomes the level at which the project confronts the long-term structure of the territory. It allows the masterplan to move beyond the functional reading of the productive pole and to recognize the deeper relationships between water systems, ecological networks, infrastructural traces, agricultural patterns, settlement margins and areas of environmental sensitivity. These elements are not external to the project but form the spatial and cultural framework within which any future transformation must be interpreted and tested.

A central role is played by the reading of permanences and by the recognition of the territory as a palimpsest. Following André Corboz's interpretation, the territory can be understood as a layered construction, shaped over time by successive actions, transformations and meanings. The existing landscape is therefore not a blank surface available for new interventions, but a complex text made of traces, sediments, erasures and continuities. Reading this palimpsest means identifying the elements that have resisted change and that still organize the territory: waterways, canals, roads, agricultural plots, infrastructural alignments, ecological margins and historical signs.

For the HyMantoValley masterplan, this interpretation is essential. The project does not aim to impose a new order disconnected from the existing landscape, but to work with the structure of the place. The landscape scale makes it possible to understand which elements can guide transformation, which relationships should be reinforced, and which conflicts between production,

ecology and settlement need to be mitigated. In this perspective, permanences become design resources: they help to orient connections, define margins, identify ecological continuities, structure open spaces and support the integration of the Research Hub within a broader territorial identity.

The landscape scale thus acts as a critical and projective moment of the research. It translates the strategic relations identified at the territorial scale into a more situated understanding of space, while preparing the transition toward the urban scale, where these relationships will be verified through specific functions, accessibility conditions, spatial dimensions and possible localization choices. Through this passage, the masterplan can interact more consciously with the territory, recognizing landscape not as a background to development, but as an active structure for sustainable transformation.

Starting from this interpretation, the landscape-scale analysis becomes a way to recognize both the values and the transformability of the territory. In examining the strategic location of the HyMantoValley project, the analysis at the landscape scale draws on existing infrastructures, urban settlements, landscape structures and environmental characteristics in order to recognize the intrinsic values of the territory. These interconnected elements contribute to the identity of the area, revealing its historical, cultural and ecological significance. By synthesizing these layers of information, the landscape-scale approach enables a deeper understanding of the current configuration of the territory and provides a basis for considering its sustainable future transformation.

This method does not only assess the existing attributes of the landscape but also identifies opportunities for strategic intervention. It helps to recognize where transformation may be possible, which areas require preservation or careful mitigation, which relationships should be maintained, and where new connections can be created. By mapping these dynamics, the project aims to establish a balanced relationship between preservation and innovation, supporting sustainable development while respecting the territorial identity of Mantova Est.

At the same time, this reading prepares the transition toward the scenario-based phase of the work. The identification of landscape values, constraints, continuities and possible transformations provides the interpretive basis for constructing alternative future scenarios. In this sense, scenarios are not conceived as abstract visions, but as tools for testing how different design choices may interact with the existing landscape structure. They allow the masterplan to compare possible trajectories of transformation, evaluate their effects on ecological systems and territorial identity, and support more informed decisions for the future development of the area.

Scale-Specific Issues and SDG Coherence

At the landscape scale, the relationship between the HyMantoValley project and the SDGs can be understood through the interaction between natural systems, historical permanences, agricultural structures and cultural identity. The aim is not only to identify protected areas or environmental constraints, but to recognize the landscape as a complex framework where human action and natural evolution have continuously shaped the territory. In this perspective, SDG coherence is verified by observing how transformations can preserve, reinterpret and strengthen the landscape structure.

The territory of Mantova is deeply influenced by the presence of the Mincio River, its hydrological network and the system of lakes that surrounds the historic city. These water bodies have shaped settlement patterns, agricultural organization, ecological continuity and the identity of Mantova as a water-based landscape. The relationship between the city and its surrounding waters is therefore central to **SDG 11 – Sustainable Cities and Communities**, particularly in relation to the protection of cultural and natural heritage, the quality of urban environments and the need to guide transformation without compromising the historical and landscape character of the place.

Agriculture remains one of the predominant land uses in the province of Mantova and represents a key component of the landscape structure. The territory has been shaped by historical reclamation processes that transformed marshy areas into productive farmland, leaving visible traces in canals, hydraulic works, rural settlements and agricultural plots. These elements form part of the territorial

palimpsest and reveal the long-term relationship between human intervention and natural conditions. Their recognition is relevant to **SDG 12 – Responsible Consumption and Production**, as it supports a more careful use of land and resources, and to **SDG 15 – Life on Land**, by highlighting the importance of soil protection, biodiversity and ecological continuity.

The geomorphology of the area also plays a significant role in the landscape reading. The forms related to the Mincio River, including paleo-riverbeds, natural depressions, water margins and artificial canals, have influenced both settlement patterns and ecological dynamics. These elements help us to understand why certain areas have been urbanized, cultivated, preserved or used for productive purposes. From a planning perspective, they become important interpretive keys for identifying where transformation may be possible, where mitigation is required, and where landscape continuity should be preserved or reinforced.

The presence of the Parco del Mincio, the Vallazza wetland system and other ecological components further strengthens the relevance of **SDG 15**. These areas represent not only environmental constraints, but also active structures for biodiversity conservation, ecological connection and landscape quality. For the masterplan, this means that industrial and infrastructural transformation must be evaluated in relation to the capacity to protect and enhance green and blue infrastructures, reduce fragmentation and create new forms of connection between productive areas and ecological systems.

At the same time, the landscape scale highlights the importance of balancing preservation and innovation. The area is not a static landscape to be conserved unchanged, nor a neutral space available for unrestricted transformation. It is a layered territory in which historical traces, agricultural uses, ecological systems, water infrastructures and productive functions coexist. This condition requires a careful interpretation of **SDG 11**, **SDG 12** and **SDG 15**, ensuring that future interventions contribute to sustainable development while respecting the identity of the place.

Through this SDG-based reading, the landscape scale provides essential inputs for the masterplan. It helps to identify the elements that should be preserved, the relationships that should be strengthened, and the areas where transformation can be guided by ecological, cultural and spatial criteria. In this sense, the landscape analysis becomes a bridge between territorial strategies and urban design choices, supporting scenarios that are not only technically feasible, but also coherent with the long-term structure and identity of Mantova's landscape.

Through this SDG-based reading, the landscape scale provides essential inputs for the masterplan because it makes explicit the relationship between sustainability objectives and the specific qualities of the place. The analysis does not simply identify environmental or historical elements as constraints, but interprets them as active components of the future spatial strategy. Water systems, ecological continuities, agricultural patterns, historical permanences and landscape values become criteria through which the transformation of the project area can be oriented.

This reading helps to distinguish what should be preserved, what should be reinforced and what can be transformed. Some elements require protection because they contribute to the ecological balance and cultural identity of the territory; others suggest opportunities for reconnection, mitigation or enhancement. In this sense, the landscape scale allows the masterplan to work selectively, avoiding generic solutions and defining interventions that respond to the actual structure of the territory.

The landscape analysis therefore acts as a bridge between territorial strategies and urban design choices. It translates broad objectives — such as ecological continuity, climate resilience, responsible land use and landscape quality — into spatial criteria that can guide the following design phases. By

doing so, it supports the construction of scenarios that are not only technically feasible, but also coherent with the long-term structure, environmental sensitivity and identity of Mantova's landscape.



To make the relationship between the scale of investigation and the SDGs involved more explicit, this graphic was developed to highlight two aspects: on the one hand, the indivisibility of sustainability-related considerations; on the other hand, the emergence of specific SDGs that become particularly relevant in relation to the topics addressed.

6.2 Reading of permanences

Landscapes are inherently dynamic, and change is a fundamental aspect of their existence. Throughout history, humans have continuously modified their environment to align with evolving societal needs, reshaping landscapes in response to shifting economic and social structures.

Geographers define a cultural landscape as “a concrete and characteristic product of the interplay between a given human community, embodying certain cultural preferences and potentials, and a particular set of natural circumstances. It is a heritage of many eras of natural evolution and of many generations of human effort.” (Mitchell, Rössler, & Tricaud, 2009).

While this process has always been present, the pace and scale of transformation intensified dramatically from the eighteenth century onward, as urbanization and industrialization accelerated changes that disrupted long-standing land management traditions. By the early twentieth century, concerns about the loss of natural and cultural heritage began to emerge, reflecting the realization that rapid modernization was erasing landscapes that had endured for centuries. These concerns grew stronger toward the end of the twentieth century, as environmental degradation and the erosion of ancestral ties became increasingly apparent. Traditional land management practices, refined over generations, were inherently more sustainable than many modern developments, as they were deeply rooted in local knowledge and ecological balance. Today, greater attention is being given to the scattered remnants of these historical landscapes, recognizing their cultural, ecological, and aesthetic significance. These landscapes serve as tangible witnesses to ancestral values, offering insights into the lived experiences of ordinary people and the wisdom embedded in historical land-use traditions. Beyond their symbolic and cognitive value, they provide inspiration for sustainable territorial management, offering lessons that are still relevant for contemporary planning.

While landscapes of the past cannot be fully restored, efforts must be made to preserve valuable elements and integrate them into modern urbanized and globalized societies. Studying these landscapes not only allows for their conservation but also helps in shaping sustainable planning strategies that harmonize past traditions with present and future needs. Understanding how historical land-use systems functioned and why they endured for centuries provides a strong foundation for making informed decisions about landscape restoration, adaptive reuse, and the creation of new sustainable territorial models.



Lombardy, Venice, Parma, Modena (1818–1829) Second military survey of the Habsburg Empire

The landscape of Mantova is the result of a long process of interaction between natural forces and human actions. Over the centuries, water dynamics, soil conditions, agricultural practices, political decisions, infrastructural works and military strategies have progressively shaped the territory, producing a complex and layered landscape. Its present configuration cannot be understood as the outcome of a single phase of development, but as the result of successive transformations, each leaving traces that still influence the spatial structure and identity of the area.

The history of the region is therefore embedded in its territorial composition. Remnants of former landscapes coexist with more recent interventions: watercourses, canals, rural patterns, settlement traces, defensive structures, productive areas and infrastructural systems overlap and interact. These elements reveal how the territory has continuously adapted to changing needs, from cultivation and water management to defence, mobility, production and urban expansion.

In this sense, the landscape is not a static heritage to be merely preserved, but a dynamic palimpsest. Its evolution has been shaped both by the necessity to sustain livelihoods and by deliberate projects of transformation, including land reclamation, agricultural organization, hydraulic regulation, infrastructural planning and strategic territorial control. Recognizing this layered condition is essential for the masterplan, because it allows future transformations to be designed in continuity with the long-term structure of the place, while also responding to contemporary challenges of sustainability, resilience and territorial regeneration.



Map by the Italian Military Geographic Institute – 1885



Map by the Italian Military Geographic Institute - 1935



Map by the Italian Military Geographic Institute – 1954



Map by the Italian Military Geographic Institute - 1970

Evolution and permanence of landscape features in the research area through IGM map sequences

Historically, the region's countryside was characterized by rural estates, intricate water management systems, and agricultural fields that followed the natural contours of the land. These landscapes were primarily dictated by subsistence farming, with settlements arranged around watercourses and fertile soil patches to optimize productivity. Over time, major economic and political transformations redefined the region's spatial organization.

The nineteenth and twentieth centuries marked a period of revolutionary change, as agricultural mechanization, infrastructural modernization, and extensive land reforms introduced new territorial structures. These changes gradually reshaped the historical patterns of rural life, transitioning from localized, traditional land management to large-scale, industrialized agricultural systems. The postmodern era further accelerated this transformation, with urban expansion, industrialization, and contemporary infrastructure projects fragmenting the landscape and disconnecting many of its historical elements.

While agricultural practices played a crucial role in shaping Mantova's landscape, the forces driving territorial change extended beyond cultivation. Political reformations and military strategies significantly influenced land use, often following how land was divided, owned, and regulated. These changes were driven by shifting economic models, strategic defense needs, and broader geopolitical developments that left a lasting imprint on the region.

To understand the permanence of Mantova's historical landscape, an analysis was conducted using the Second Military Survey of the Habsburg Empire, a cartographic source from 1818–1829 that provided valuable insights into how the region's territorial structure was organized before modern industrialization. The comparison between this historical map and contemporary landscape features allowed for a comprehensive assessment of which territorial elements have remained unchanged, and which have been significantly transformed. By overlaying current rural breaklines with those found in the historical survey, it was possible to determine the degree of continuity between past and present land patterns.

That is to say, understanding the landscape as a whole cannot be done merely by analyzing its elements. The interaction of the elements must be considered, especially the interaction of natural and cultural ones. It follows that landscape history must also take a holistic view of a landscape, integrating natural and human activity as parts of a single evolving system Marcucci, D. J. (2000). The level of permanence was classified based on the presence of key landscape elements that had withstood the test of time. Fields that retained their original shape were identified by comparing the extent of existing land divisions with historical ones. The presence of one high-permanence element, either linear or punctual, indicated a lower level of landscape permanence. When a combination of two elements remained, the permanence status was considered medium.

However, even in cases where multiple historical elements were detected, some fields were assigned low or no permanence value due to extensive transformations in their surrounding context caused by urbanization.

This method of analysis revealed that while certain regions within Mantova have preserved their historical rural layout, others have undergone modifications. The expansion of urban areas, the introduction of new road networks, and the industrialization of key zones contributed to the fragmentation of historical land structures, resulting in the gradual disappearance of some original territorial features. At the same time, remnants of historic irrigation canals, ancient property boundaries, and rural pathways still define major portions of the landscape, indicating continuity that remains embedded in the contemporary spatial organization. With the adoption of the cultural landscape categories in 1992 and their incorporation into the Operational Guidelines, the way has been opened to include cultural landscapes in the World Heritage (Mitchell, Rössler, & Tricaud, 2009). The cultural landscape is fashioned out of the natural landscape by a culture group. Culture is the agent, the natural area is the medium, the cultural landscape is the result. (Sauer, 1925).

Understanding Landscape Permanences for Sustainable Planning

The study of landscape permanences in Mantova provides essential insights for sustainable urban and territorial planning. Recognizing how historical land-use patterns persist despite urbanization helps integrate cultural and ecological heritage into modern development strategies. The coherence of properties defines identity. Changing the characteristics and coherence leads to loss of identity or its change into a new one (Antrop, 2005). This approach ensures that historical landscapes remain an active part of the region's identity, rather than relics of the past.

The landscape permanences of Mantova reflect the long-term interaction between human activities and the natural environment. The careful organization of agricultural fields, irrigation systems, and rural settlements has shaped the region for centuries, creating a structured yet adaptable territorial framework. Contemporary urban expansion and industrial development can fragment these landscapes and is evident that not all practices produce good landscapes. This growing tension between conservation and modernization necessitates a deeper understanding of how landscapes can be adapted to contemporary needs while retaining their fundamental characteristics.

One of the key challenges in sustainable planning is recognizing the value of landscape permanence beyond historical interest. According to the European Landscape Convention, landscape protection implies all 'actions to conserve and maintain the significant or characteristic features of a landscape' and landscape planning is a 'strong forward-looking action to enhance, restore or create landscapes (Council of Europe, 2000). Landscapes are not static artifacts but living environments that continue to evolve.

Integrating historical land structures into modern planning enhances ecological resilience, promotes responsible land use, and ensures that urban environments respect cultural continuity. Identifying areas with high historical permanence allows for the development and conservation policies, preventing unchecked urban sprawl and the loss of historically significant areas.

Beyond preservation, landscape permanence plays a crucial role in shaping sustainable agricultural practices. Traditional land-use patterns in rural Mantova were based on long-standing knowledge of soil conditions, water management, and crop cycles. By incorporating this historical understanding into contemporary agricultural planning, food security and sustainability can be enhanced.

The presence of historical irrigation canals presents an opportunity to rethink water management practices in a way that may be both ecologically sound and economically viable. This does not mean restoring the canals only as historical traces, but considering them as part of a possible blue-green infrastructure able to support different environmental and territorial functions. For example, if properly maintained and integrated into the masterplan, the canal network could contribute to the regulation of surface water runoff, reducing the need for entirely new drainage infrastructures and supporting more adaptive responses to heavy rainfall events. At the same time, canals and their vegetated edges could strengthen ecological continuity, providing linear habitats and connecting fragmented green areas within the agricultural and productive landscape. In some sections, they could also support nature-based water treatment solutions, such as vegetated buffer strips or phytoremediation areas, helping to improve water quality before it reaches larger water bodies.

From an economic point of view, the reuse and enhancement of existing water infrastructures may reduce the need for new artificial systems and can support local agricultural practices, landscape maintenance, irrigation management and climate adaptation measures. In this sense, historical canals may become multifunctional elements: they preserve the identity of the rural landscape, contribute to ecological regeneration, support water management and offer a spatial structure for future landscape-oriented interventions.

For these reasons, within the HyMantoValley masterplan, the irrigation canal system should be understood not only as a permanence to be preserved, but as a potential operational resource. Its actual role will require further technical verification concerning hydraulic capacity, water quality, maintenance conditions, ownership, ecological value and compatibility with future land uses.

The concept of permanence also aligns with broader sustainability goals, supporting regional planning approaches that integrate cultural, ecological, and economic considerations. Cultural landscapes are increasingly recognized as essential components of sustainable development because they embody both ecological and social values. As noted in previous research, “cultural landscapes provide an important bridge between the past and the future, allowing communities to maintain their identity while adapting to change”. Understanding landscape permanence contributes to heritage conservation while also ensuring that planning strategies promote long-term sustainability.

By integrating historical land structures into contemporary planning methodologies, urban expansion can be guided in a way that respects environmental and cultural continuity. This knowledge is essential for infrastructure development, land-use planning, and ecological restoration, ensuring that modern interventions align with Mantova’s long-established spatial framework.

Recognizing landscape permanence as a tool for sustainable planning extends beyond conservation efforts. It represents an opportunity to design cities and rural areas deeply rooted in their historical and environmental context, creating spaces that acknowledge the past while responding to the needs of the future. In this perspective, permanences are not understood only as isolated historical traces or protected elements, but as parts of a broader territorial structure that continues to influence the identity, perception and transformation potential of the landscape.

In order to better understand and represent the value of these elements, a specific map was developed and will be presented in Section 6.4, Scale-Based Outputs: Mapping, Interpretation and Design Inputs. Produced at the scale of 1:25.000, the map makes it possible to identify those parts of the territory where landscape permanences are still clearly perceivable as systems of relations and identity-forming elements. Rather than simply recording the presence of single traces, the cartography highlights areas in which historical, environmental, agricultural, infrastructural and settlement structures continue to define the character of the place.

This mapping operation is therefore essential for the masterplan. It allows the project to recognize where the inherited structure of the landscape can become a design resource, where continuity should be preserved or reinforced, and where future transformations must be carefully calibrated in relation to the long-term identity of the territory.



Permanence Landscape Analysis

6.3 Ecological, environmental and landscape systems

The waterways of Mantova, including the River Mincio, artificial lakes, and canal networks, play an integral role in defining the city’s identity and functionality. These aquatic systems are intrinsically linked to the settlements and surrounding environments, with bike routes along embankments and the Paleoalveo valley enhancing connectivity and promoting sustainable engagement with the region’s

ecological settings. Functioning as ecological corridors, these waterways support biodiversity while simultaneously sustaining essential urban and agricultural activities.



River Mincio and Mantova

Ecological network and landscape-environmental systems

The Province of Mantova has included an articulated ecological network within its planning framework since the first approval of the Provincial Territorial Coordination Plan in 2002. This early choice anticipated subsequent regional orientations and introduced a systemic vision of ecological corridors aimed at connecting protected areas and strengthening the environmental structure of the provincial territory.

The first PTCP, approved by the Provincial Council in 2002, developed a project-based reference framework for the identification of the provincial ecological network. This framework was supported by an integrated analytical process that led to the creation of the Atlas of Environmental Information, a collection of thematic maps used to interpret the Mantovan territory. The atlas organized environmental knowledge through three complementary phases.

The first phase focused on the identification of landscape and environmental values, producing thematic cartographies related to the physical and natural system. These included maps of elevation, land use and land cover, landscape units, aquifer vulnerability, agricultural land capability, the main hydrographic network and irrigation systems. The second phase addressed factors of disturbance and environmental degradation generated by human activities, summarized in a map of urbanized areas and critical elements. This tool made it possible to identify potential crisis areas and to orient future interventions for environmental recovery and improvement. The third phase considered supraordinate planning instruments, including regional landscape planning, park and nature reserve plans, river basin plans and previous provincial planning documents, in order to integrate their environmental indications and prescriptions.

With reference to the Municipality of Mantova, this first planning framework identified a primary naturalistic structure composed of extensive natural areas and important biodiversity reservoirs. These areas are characterized by the presence of differentiated habitats, ecological continuity and significant relationships between ecosystem units. This reading is particularly relevant for the HyMantoValley masterplan, since the project area is located in a context where productive, infrastructural and ecological systems are closely interwoven.

In 2010 PTCP Variant, the ecological network acquired a more strategic role, in coherence with the indications of the Regional Territorial Plan. The Provincial Ecological Network evolved into the Provincial Green Network, a planning structure with a double function: ecological and landscape recreational. The green network was conceived as an evolution of the ecological network already

identified in the PTCP and as a common reference for initiatives aimed at protecting and enhancing the natural heritage of the province.

A fundamental assumption of this evolution is that the ecological and green-network perspectives, although characterized by specific objectives, are complementary. An ecosystem cannot be effectively governed without recognizing its cultural and landscape values. At the same time, landscape policies that do not consider the ecological functions of the territory risk depending on artificial maintenance processes and may lack long-term environmental self-sufficiency.

For this reason, the planning framework introduces the need for an integrated eco-landscape perspective, in which specific actions may still be defined for ecological or landscape objectives, but unitary planning actions should be encouraged whenever possible, especially at the local scale. These actions can bring together ecosystem functions, cultural values, landscape quality and environmental resilience within a single interpretative and operational framework.

The 2010 Variant also highlighted the need to align provincial and regional ecological planning. Although the Regional Ecological Network was developed in parallel with the revision of the PTCP and was approved only at the end of 2008, the provincial planning process verified the correspondence between the two frameworks. This comparison revealed several elements of coherence and continuity, together with some differences requiring further alignment. In this perspective, municipal planning instruments were identified as an important level for horizontal verification, capable of bringing together regional and provincial indications.

More recently, during the preparation of the 2022 Variant, developed in accordance with the Regional Territorial Plan integrated under Regional Law 31/2014, the Provincial Ecological Network and the Provincial Green Network were replaced by a synthetic and integrated framework: the Provincial Eco-Landscape Network. This new structure aims to respond simultaneously to the ecosystem-service objectives of the ecological network and to the more specifically landscape-oriented objectives of territorial planning.

For the HyMantoValley masterplan, this evolution is particularly significant. It shows that ecological and landscape systems are not marginal constraints, but structural components of the planning framework. The transformation of Mantova Est should therefore not be evaluated only in terms of productive efficiency or infrastructural performance, but also in relation to its capacity to interact with ecological systems and landscape values. The eco-landscape network becomes a key reference for orienting design choices that are environmentally functional, spatially coherent and culturally consistent with the identity of the territory.

The masterplan must therefore interpret the project area in relation to existing ecological corridors, biodiversity reservoirs, water systems, agricultural landscapes, areas of environmental vulnerability and opportunities for reconnection. In this sense, the eco-landscape network provides an essential reference for defining mitigation strategies, strengthening green and blue infrastructures, and integrating industrial transformation within the broader environmental structure.

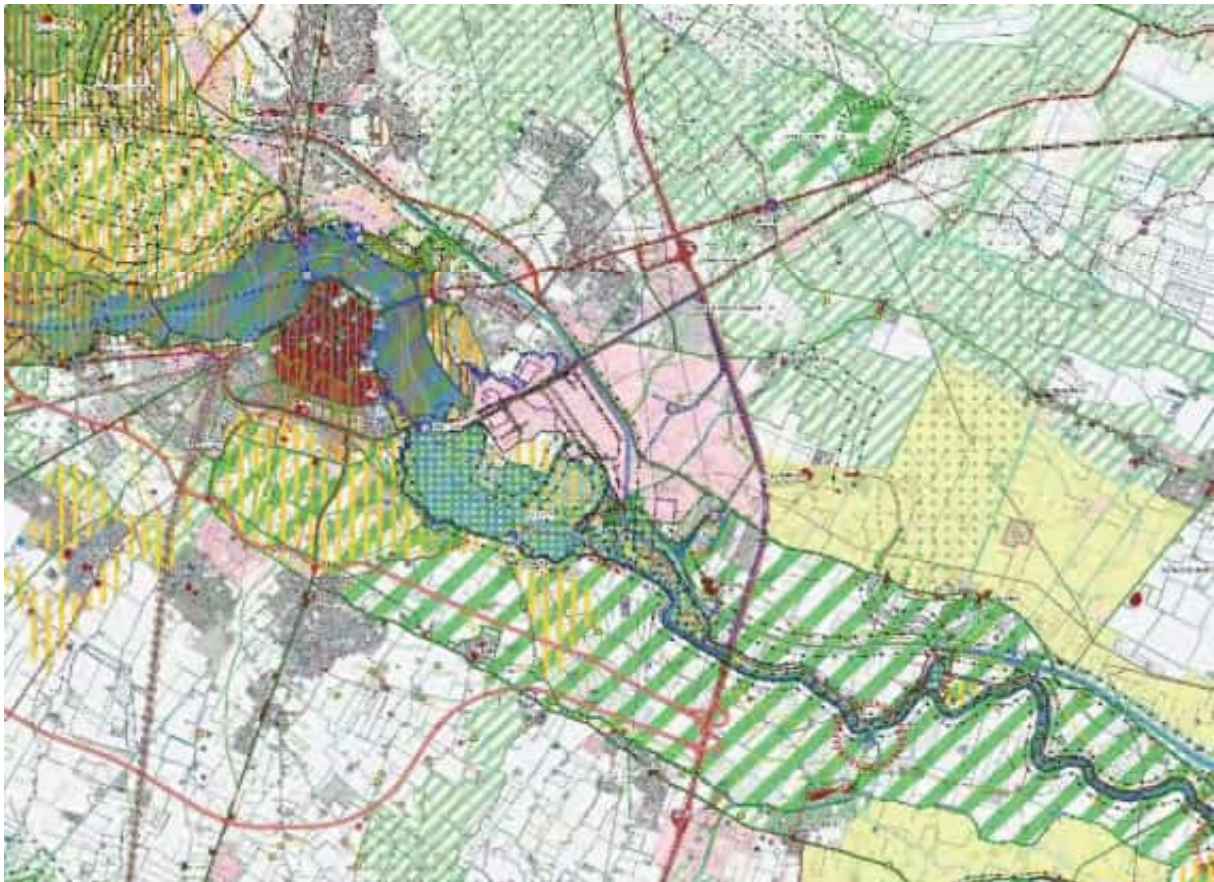
As shown in Map 1 – Landscape and Environmental Guidelines, the project area is characterized by a high degree of complexity, resulting from the coexistence of protected areas, historical and architectural elements, relevant geomorphological features, ecological structures and landscape values. This complexity, emerging at the landscape scale, inevitably affects the urban design process, orienting the localization of functions, the design of connections, the treatment of margins and the relationship with green and blue infrastructures.

This complexity, emerging at the landscape scale, inevitably affects the urban design process. The elements identified by the map do not simply describe the environmental and historical character of

the area; they define a set of spatial conditions that the masterplan must interpret in operational terms. Protected areas, ecological corridors, geomorphological structures, historical and architectural elements, agricultural traces and water systems become both constraints and opportunities: they influence where new functions can be located, how connections should be designed, how urban and productive margins should be treated, and where mitigation, preservation or ecological reconnection strategies are required.

In this sense, the landscape framework becomes a necessary reference for the urban-scale project. It allows environmental and historical values to be translated into concrete spatial choices, preventing the masterplan from treating the site as a neutral surface for development. This approach is consistent with ecological planning traditions, particularly with Ian McHarg's idea that planning and design should be guided by the interpretation of natural processes and environmental suitability. At the same time, it is coherent with the European Landscape Convention, which frames landscape as a field of protection, management and planning, and therefore as an active component of territorial transformation rather than a merely aesthetic background.

For the HyMantoValley masterplan, this means that the passage from landscape scale to urban scale is not a simple reduction of scale, but a translation process. The landscape reading identifies values, sensitivities and continuities; the urban project must transform them into decisions concerning accessibility, functional compatibility, public and ecological spaces, green and blue infrastructures, buffers, edges and possible development areas. In this way, the landscape framework supports a form of urban design that is more selective, adaptive and context-sensitive.



Extract from Map 1 – Landscape and Environmental Guidelines (PTCP 2022)

6.4 Scale-Based Outputs: Mapping, Interpretation and Design Inputs

At the landscape scale, the cartographic outputs were developed to deepen the framework of knowledge constructed at the territorial scale and to move from the reading of supra-local relations toward the interpretation of the specific landscape structure of the project area. While the first two maps clarify the position of the area, within broader infrastructural, logistical and waterway systems, the third and fourth maps focus on the intermediate scale at which environmental systems, historical traces, agricultural patterns, settlement forms and landscape values become clearly recognizable.

The landscape-scale maps therefore act as interpretative tools. They make it possible to identify the elements that define the continuity and identity of the territory, to recognize the relationship between natural and human-made systems, and to understand how these elements can influence the masterplan.

In this sense, they provide a spatial basis for translating the broader territorial strategy into more specific design inputs related to preservation, ecological continuity, mitigation, landscape coherence and future transformation.



Board 3. Framework of Knowledge – Permanences Reading

The third map, Board 3. Framework of Knowledge – Permanences Reading, developed at the scale of 1:25,000, focuses on the identification and interpretation of landscape permanences. The map distinguishes different categories of elements — linear, punctual and natural — and classifies them according to their degree of permanence, from high to medium and low levels. Water courses and rural breaklines are also represented as relevant components for reading the long-term structure of the territory.

This representation is relevant because it shows that the landscape around Mantova Est is not only the result of recent transformations, but also of historical and environmental structures that continue to shape the identity and perception of the place. Linear traces, punctual elements, rural structures and water systems make visible the persistence of territorial relationships that still influence the spatial organization of the area.

The map therefore helps to identify those parts of the territory where permanences are still perceivable as systems of identity-forming elements rather than as isolated traces. In this interpretation, permanences are not understood only as single historical features, but as spatial structures that continue to organise the landscape and to make its long-term evolution readable.

For example, the irrigation canal network and the related rural plots reveal the persistence of an agricultural structure that has shaped the territory over time. Even where industrial and infrastructural transformations have modified the landscape, these elements still make it possible to recognise the historical relationship between water management, agricultural production and settlement patterns. Similarly, historical road alignments, field divisions, tree rows and vegetated margins can be read as a continuous texture that links different parts of the landscape and supports its visual and ecological continuity.

The relevance of these permanences lies in their capacity to provide orientation for the masterplan. They can suggest where ecological connections may be reinforced, where landscape buffers may be introduced, where existing rural or hydraulic traces may be enhanced, and where new interventions should avoid interrupting still recognisable territorial structures. In this sense, the identification of permanences is not only a descriptive operation, but also a design-oriented reading: it allows the masterplan to work with the existing identity of the place, rather than superimposing new transformations without considering the historical and spatial structure of the territory.

Within the masterplan process, this map provides an important design input. It allows the project to recognize where future transformations should reinforce existing structures, where continuity should be preserved, and where new interventions must be carefully calibrated in relation to the inherited character of the landscape. The permanence reading therefore supports a site-sensitive approach to sustainability, in which historical and environmental traces become resources for orienting the spatial strategy of the masterplan.

The fourth map, Board 4. Framework of Knowledge – Landscape Elements, also developed at the scale of 1:25,000, follows and complements the previous analysis of permanences by broadening the reading of the project area. While the permanence map focuses on the long-term traces that still structure the territory, this board investigates the current and future configuration of the landscape, considering the coexistence of environmental systems, infrastructural networks, settlement patterns, productive areas and planned transformations. In this sense, the map does not only record inherited elements, but also helps to understand how the landscape is presently used, transformed and potentially reconfigured by ongoing and future processes.

The map brings together several layers of information, including hydraulic artifacts, architectural heritage, monumental trees, rows of trees, rural buildings, historic canals, buffer areas, UNESCO sites, geomorphological shapes, ancient formation nuclei, the Mincio Park and agricultural land. It also represents environmental components such as contaminated sites, embankments, high-vulnerability areas, water surfaces, robinia formations, relevant vegetation and woods. Through this composite representation, the map makes it possible to observe how natural, historical and environmental values are distributed across the territory and how they interact with areas affected by vulnerability, contamination or transformation pressures.

At the same time, the map relates these landscape and environmental elements to the infrastructural and urban systems, including railway stations, commercial and touristic ports, railways, main roads, planned roads, cycling routes, navigable and planned navigable networks, building elements, industrial areas, urbanized areas and different categories of existing and planned buildings. This allows the landscape scale to be interpreted not as a separate environmental layer, but

as a field of interaction between ecological structures, historical values, productive settlements, mobility systems, urban growth and environmental constraints.

The inclusion of both existing and planned elements is particularly relevant for the masterplan process. It enables the analysis to move from the recognition of what already characterizes the area to the identification of possible future conditions of change. Existing agricultural land, industrial areas, urbanized settlements, infrastructural corridors and environmental systems are therefore read together with planned roads, planned navigable networks and planned buildings, highlighting the potential tensions and opportunities generated by future transformations. In this perspective, the map supports a more integrated understanding of the project area, where landscape quality, environmental fragility, accessibility, productive functions and transformation scenarios must be considered jointly.



Board 4. Framework of Knowledge – Landscape Elements

For the HyMantoValley masterplan, this board has a strategic meaning because it provides a necessary transition between the reading of permanences and the subsequent urban-scale analysis. It makes visible the complexity of the project area by identifying the elements that may become constraints, resources or opportunities for transformation. Protected and sensitive areas, ecological corridors, water systems, contaminated sites, infrastructural nodes, productive areas, settlement margins and landscape values are not read separately, but as part of a single landscape framework.

This integrated reading helps to identify where landscape elements can support ecological continuity, where environmental constraints require specific design precautions, where productive and infrastructural systems overlap with sensitive areas, and where future developments may influence the spatial strategy of the project. The map therefore supports the transition from landscape interpretation to urban-scale design, helping to orient decisions concerning functional localization, accessibility, green and blue infrastructures, mitigation strategies, edge treatment and the relationship between new transformations and the existing identity of Mantova Est.

7. URBAN SCALE

7.1 Urban Framework: Local Conditions and Functional Relations

The urban scale represents the final and most operative threshold of the multiscale approach. After the territorial and landscape readings, the project reaches the level at which strategic relations, environmental structures and planning indications must be translated into concrete spatial choices. At this scale, the masterplan is no longer concerned only with understanding broader systems, but with verifying how these systems can interact within the specific conditions of Mantova Est.

The issues introduced at the beginning of the methodology — multiscalarity and the need for an interactive process — become particularly relevant here. The urban scale is the place where the coherence between the different levels of analysis must be tested. The territorial scale has clarified the role of Mantova Est within wider energy, logistics and infrastructure networks; the landscape scale has revealed the importance of ecological continuities, historical permanences, environmental sensitivities and landscape values. The urban scale must now bring these dimensions together and verify their implications in terms of accessibility, functions, land-use compatibility, constraints, safety, spatial organization and possible locations for the Research Hub.

For this reason, the urban-scale analysis cannot be considered as a simple zoom into the project area. It is a moment of synthesis and verification. The broader strategic framework must be confronted with local conditions: existing productive activities, port and logistics functions, road and rail connections, available or underused areas, environmental constraints, planning rules, property conditions, margins and relationships with surrounding settlements. These elements define the real field of action of the masterplan and determine which transformations are feasible, which require mitigation, and which should be avoided or reconsidered.

At the same time, the urban scale confirms the need for an interactive process. Design choices cannot be derived automatically from previous analyses; they must be tested, compared and progressively adjusted. The localization of the Research Hub, the organization of connections, the relationship with the hydrogen value chain, the integration with the port area and the treatment of ecological and infrastructural margins all require continuous feedback between analysis, evaluation and design. In this sense, the urban scale becomes the place where the masterplan tests different possibilities and prepares the construction of alternative scenarios.

This passage is essential because it prevents the project from remaining at the level of general vision. The urban scale transforms territorial strategies and landscape interpretations into operational design conditions. It allows the research to understand how HyMantoValley can be physically grounded in Mantova Est, how the Research Hub can interact with existing systems, and how the masterplan can organize a coherent relationship between energy innovation, industrial functions, infrastructure, landscape and local spatial quality.

*At this scale, the masterplan requires a distinctly **site-specific approach**. The urban framework is not interpreted as a generic field of intervention, but as a set of precise spatial, functional and environmental conditions that must be carefully recognized before any design strategy can be defined. Existing productive areas, port-related functions, road and rail accessibility, planning regulations, environmental constraints, available or underused plots, ecological margins and relationships with surrounding settlements all contribute to defining the specific character of Mantova Est.*

A site-specific approach therefore means grounding the objectives of HyMantoValley in the actual conditions of the project area. The hydrogen value chain, the Research Hub and the related innovation activities cannot be located or organized independently from the existing urban structure. They must

be tested in relation to accessibility, compatibility with productive activities, proximity to infrastructure, environmental sensitivity, safety requirements and opportunities for regeneration.

In this sense, the urban scale becomes the level at which the general vision is transformed into an operational design framework. The site is not treated as a neutral support for the project, but as an active component of the design process. Its constraints, permanences, infrastructures and latent potentials become the basis for defining coherent spatial choices and for identifying the specific design opportunities that will be explored in the following section.

Through this approach, the urban scale becomes the level at which the project demonstrates its feasibility and its capacity to act on the territory. It is here that the multiscale framework and the interactive methodology find their most concrete expression, guiding the transition from interpretation to design, and from design to possible future scenarios.

The urban-scale investigation also represented the opportunity to develop a specific survey activity connected to WP 5.3. This activity was aimed at producing an accurate and updated representation of the project area, capable of supporting the site-specific interpretation required by the masterplan.

The survey was carried out through UAS acquisition, with a flight altitude of 100 metres and a Ground Sample Distance of 2.5 cm. The data were referenced to the UTM 32N – WGS84 datum, with orthometric heights. Starting from these acquisitions, a 3D photogrammetric model was produced, together with a relative classification of the detected elements. This process made it possible to obtain a highly detailed spatial base for reading the actual configuration of the site, including built and open spaces, infrastructural elements, margins, accessibility conditions and areas potentially involved in future transformations.



Overall model of the research area – UAS survey with Matrice 300

Within the masterplan process, this survey activity played an important role. It allowed the urban-scale analysis to move beyond general planning information and to rely on a more direct and updated knowledge of the physical conditions of the area. In this sense, the UAS survey supported the site-

specific approach of the project, helping to verify settlement and infrastructural assumptions, refine the base maps and prepare a more accurate framework for the following design scenarios.

Although it is presented in a necessarily concise form within this first report, the UAS survey represents a relevant knowledge infrastructure for the overall development of the project. It will accompany the different phases of WP5 and WP6, working at different scales and supporting both masterplan development and subsequent design activities. The acquired data will be progressively processed, interpreted and integrated with the other planning, cartographic and design materials, and will be presented in a more organic and complete form in the following deliverables.

Scale-Specific Issues and SDG Coherence

At the urban scale, the relationship between the HyMantoValley project and the SDGs must be verified through the concrete spatial conditions of Mantova Est. While the territorial scale highlights the role of the area within broader energy, logistics and infrastructural networks, and the landscape scale reveals the ecological and cultural structures that shape the territory, the urban scale focuses on the operational field of transformation. It is here that productive functions, accessibility, port-related activities, environmental constraints, remediation processes and possible locations for the Research Hub must be evaluated together.

Industrial development has played a decisive role in shaping the eastern sector of Mantova. The productive area, located beyond the historic city and in relation to the River Mincio, is characterized by a complex coexistence of industrial, artisanal, logistics and infrastructural functions. This condition makes Mantova Est a strategic place for testing the integration between energy transition and urban-industrial regeneration. At the 1:10,000 scale, the analysis makes it possible to understand how existing land uses, mobility systems, available areas, infrastructural connections and environmental sensitivities can influence the future configuration of the masterplan.

In this context, **SDG 11 – Sustainable Cities and Communities** is particularly relevant. The project must contribute to a more sustainable organization of the urban and productive fabric, improving the relationship between industrial areas, infrastructure, settlements and environmental systems. This means not only locating new functions, but also redefining accessibility, managing margins, reducing conflicts between incompatible uses and strengthening the spatial quality of an area that has historically developed as a productive enclave.

The presence of the Port of Valdaro and of road, rail and water connections connects the urban scale to **SDG 9 – Industry, Innovation and Infrastructure**. The masterplan must verify how these infrastructural assets can support the hydrogen value chain and the Research Hub, while also improving the efficiency and sustainability of local logistics. The urban scale is therefore essential for understanding where innovation can physically take place and how it can be connected to existing productive and transport systems.

A key issue is also represented by the environmental condition of the area. The presence of the Site of National Interest “Laghi di Mantova e Polo Chimico” introduces constraints, risks and responsibilities that directly affect any future transformation. For this reason, the project is connected to **SDG 12 – Responsible Consumption and Production**, particularly in relation to the reuse of already transformed areas, the reduction of environmental impacts, the transition toward cleaner production processes and the possibility of reinterpreting industrial spaces through circular and low-carbon strategies.

The relationship with water systems and ecological components remains relevant, but at the urban scale it must be interpreted in terms of compatibility, mitigation and reconnection. The proximity of the River Mincio, the canal network, the Vallazza wetland system and the surrounding ecological corridor requires attention to water quality, hydraulic safety, environmental buffers and the

protection of sensitive habitats. In this sense, the project relates to **SDG 6 – Clean Water and Sanitation** and **SDG 15 – Life on Land**, as future interventions must avoid further fragmentation and contribute, where possible, to ecological continuity and environmental regeneration.

Finally, **SDG 13 – Climate Action** provides an important framework for interpreting the urban transformation of Mantova Est. The introduction of hydrogen-related functions, the improvement of intermodal logistics, the reduction of fossil-fuel dependency, the reuse of brownfield areas and the integration of mitigation measures can contribute to a more climate-oriented redevelopment strategy. At the urban scale, climate action becomes concrete through spatial choices: accessibility, land reuse, green buffers, energy-efficient functions, sustainable mobility and the reduction of environmental pressures.

Through this SDG-based reading, the urban scale becomes the level at which sustainability goals are tested in relation to feasibility and design. The masterplan must translate broad objectives into site-specific decisions, verifying how the Research Hub, the hydrogen value chain, existing productive areas, mobility systems and ecological constraints can coexist within a coherent spatial framework. In this sense, the urban scale closes the multiscale process by transforming territorial strategies and landscape values into operational choices for the future regeneration of Mantova Est.



To make the relationship between the scale of investigation and the SDGs involved more explicit, this graphic was developed to highlight two aspects: on the one hand, the indivisibility of sustainability-related considerations; on the other hand, the emergence of specific SDGs that become particularly relevant in relation to the topics addressed.

7.2 Urban Systems and Site-Specific Design Opportunities

Contemporary urban systems are increasingly difficult to read through linear or sectoral interpretations. Productive areas, infrastructures, logistics networks, environmental systems and research activities are no longer defined only by local dynamics but are influenced by broader and often unstable processes: international interdependencies, changing markets, technological innovation, energy transitions, regulatory frameworks and environmental risks. These dynamics make urban transformation more complex but also require planning to become more capable of recognizing relations, dependencies and potential conflicts across different systems.

This condition is particularly evident in Mantova Est, where industrial production, port activities, logistics infrastructures, contaminated areas, ecological systems and future innovation functions coexist within a limited urban field. Their relationship should not be understood as a fully integrated functional system, but as a set of spatial, infrastructural and planning interdependencies that directly influence the future transformation of the area.

These interdependencies concern, first of all, the sharing of accessibility networks and service infrastructures. Industrial, port-related and logistics activities rely on the same road connections, railway links, port facilities and technical networks, and their efficiency depends on the capacity of these systems to support different forms of movement, supply, loading, unloading and maintenance. In this sense, the localisation of new functions cannot be evaluated only in relation to the availability of land, but must also consider how each site interacts with existing infrastructural systems.

A second level of interdependence concerns planning and land-use conditions. The concentration of productive, logistics and port-related functions in Mantova Est is also the result of urban planning choices that allow or encourage these uses within specific areas. This means that future transformations, including the possible localisation of the Research Hub, must be assessed in relation to existing zoning, planned developments, compatibility with productive activities, accessibility requirements and the possible coexistence between research, innovation, industrial operations and service functions.

A third level concerns environmental and landscape conditions. Contaminated sites, high-vulnerability areas, water systems, ecological corridors and landscape margins do not affect only the individual plots on which they are located, but influence the organisation of the whole area. They may determine where new functions can be located, where mitigation measures are required, where green-blue infrastructures should be strengthened, and where buffers or transition spaces are needed between productive activities, sensitive areas and future public or research-oriented uses.

For these reasons, the design opportunities identified at the urban scale are site-specific. Each possible intervention must negotiate between shared infrastructures, planning rules, environmental constraints, productive functions and future innovation objectives. The Research Hub, in particular, cannot be considered as an isolated facility, but as a function whose localisation and spatial configuration depend on its relationship with the productive system, the port and logistics infrastructure, environmental conditions, accessibility networks and the broader regeneration strategy for Mantova Est.

A direct consequence of this complexity is the need to confront planning with uncertainty. The future development of HyMantoValley depends on several variables that cannot be fully controlled in advance, including the evolution of the hydrogen market, the timing of investments and infrastructure implementation, technological innovation, remediation processes, environmental regulations, stakeholder decisions and possible changes in logistics and energy demand. For this reason, the masterplan cannot be conceived as a fixed solution, but rather as a flexible and adaptive framework capable of responding to different possible trajectories.

In this perspective, **preparedness** becomes a key design attitude. It does not mean predicting a single future but preparing the project area to face multiple possible futures. Within a context marked by infrastructural, environmental, productive and institutional uncertainty, preparedness implies the capacity to anticipate change without reducing the project to a predetermined solution. It requires the masterplan to identify which spatial choices are sufficiently robust to remain valid under different conditions, and which elements should instead remain open, adaptable and progressively adjustable.

At the urban scale, preparedness implies identifying robust spatial choices, safeguarding strategic opportunities, improving accessibility, reducing conflicts between uses, strengthening environmental resilience and defining adaptable areas that can accommodate different phases or configurations of the project. This is particularly relevant for Mantova Est, where the future development of HyMantoValley may depend on different combinations of actors, investments, technological solutions, remediation processes, logistic requirements and energy-related demands. The design process must therefore distinguish between stable structuring elements — such as accessibility systems, environmental buffers, green-blue infrastructures, strategic connections and areas of potential integration — and more flexible components that may change according to future decisions.

The objective is therefore to define a masterplan capable of identifying possible strategies rather than imposing a single fixed configuration. In this sense, the masterplan becomes a framework for

experimentation: it allows strongly oriented working paths to be developed in relation to the overall objectives of HyMantoValley, while remaining largely redefinable according to the specific actions, actors, constraints and opportunities that may emerge over time.

This approach directly supports the choice, developed in the following phases, to work through scenarios. The scenarios are not conceived as definitive alternatives, but as exploratory configurations that make it possible to test different localisation choices, spatial relationships and development trajectories. They allow the project to compare how the Research Hub may interact with the productive system, port infrastructure, accessibility networks, environmental interfaces and regeneration opportunities of Mantova Est.

Through this scenario-based approach, preparedness becomes an operational design tool. It allows the masterplan to work with uncertainty, keeping together strategic vision and flexibility, long-term objectives and short-term feasibility, territorial ambition and site-specific constraints.

*This approach is particularly relevant in relation to the structure of the hydrogen value chain. The main HyMantoValley project can be understood as the reference **macro-supply chain**, connecting hydrogen production, storage, distribution, research, training, mobility, logistics and industrial applications within a broader territorial system. At the same time, this macro-supply chain may activate different and heterogeneous **micro-supply chains**, each linked to specific uses, actors, places and implementation phases. These may concern, for example, port logistics, public or private mobility, industrial energy uses, research activities, training programs, environmental remediation, circular processes or local services.*

For this reason, the masterplan must be able to support both the coherence of the overall strategy and the adaptability of its specific components. Experimentation does not imply uncertainty as a weakness, but rather the possibility of testing different spatial solutions, evaluating their effects and progressively adapting the project to changing technological, economic and environmental conditions. In this sense, the urban scale becomes the place where the macro-supply chain is translated into site-specific opportunities, and where multiple micro-supply chains can be explored as possible fields of action.

The following subsections investigate the main urban systems through which this site-specific preparedness and experimental approach can be constructed: productive, infrastructural and port-related systems; accessibility, mobility and local connections; and environmental constraints, risks and regeneration opportunities. Together, these dimensions define the operational field within which the HyMantoValley masterplan can transform uncertainty into a design resource.

Productive, Infrastructural and Port-Related Systems

The first step of the urban-scale work concerned the updating of settlement and infrastructural assumptions. Regarding the settlement framework, particular relevance was given to the approval of the implementation plan known as “**Olmo Lungo**”, named after the historic building, located within the development area. This planned update made it possible to revise the base maps and to distinguish more clearly between existing buildings, buildings under construction and planned buildings.

A particularly relevant step in the urban-scale investigation was the analysis of the **Olmo Lungo implementation plan variant**. This document represents an important and unavoidable reference for understanding the transformation potential of the areas involved in the HyMantoValley masterplan, because it defines a set of updated spatial, infrastructural and environmental conditions that directly affect the future organization of Mantova Est.

The relevance of the Olmo Lungo variant lies first in its strategic position. The technical report describes the area as located between the A22 motorway access, the Enichem industrial pole and the beginning of the Fissero–Tartaro–Canalbianco waterway system, in close relation with the Port of Valdaro. It also underlines the accessibility of the area through the former SS 482, SP 28, the Mantova Nord motorway tollgate, the railway system and the wider road and logistics network. In this sense, Olmo Lungo is not only a local development area, but a key component of the broader productive and intermodal system of Mantova Est.



Location and spatial articulation of the variant in relation to the Valdaro Port areas

The variant is also significant because it updates the settlement, productive and infrastructural framework according to the contemporary needs of logistics and intermodal transport. The graphic representation shown above is not intended to be read as a cartographic elaboration or as an autonomous planning map and, for this reason, it does not include a specific legend. Its purpose is interpretative: it highlights the settlement and infrastructural relations between the two areas included in the Olmo Lungo implementation plan. In the municipal planning documents, this plan is identified as P.A. 13, where P.A. stands for *Piano Attuativo* and 13 indicates the sequential number of the plan.

The graphic representation helps to clarify the strategic position of the Olmo Lungo implementation plan within the Valdaro–Olmo Lungo framework. It makes visible the proximity between the two implementation areas, the existing productive fabric, the intermodal railway platform, road and railway infrastructures and the broader logistics system. In this sense, the Olmo Lungo implementation plan is not considered as an isolated development site, but as a planning component that may influence accessibility, functional organisation and future transformations within Mantova Est.

The reference to the variant remains significant because it shows how the municipal planning framework already recognises the need to reorganise and complete this part of the productive area, improving the implementation plan, the intermodal railway platform, road infrastructures and essential underground services in coherence with the broader public strategy for the Valdaro–Olmo Lungo area.

With specific reference to the productive organization of the area, the Olmo Lungo variant defines a planning framework within which the different opportunities for the possible localization of the Research Hub can be verified. It clarifies the distribution of productive and logistics functions, the role of the planned intermodal platform, the hierarchy of road and rail connections, and the relationship between existing buildings, planned developments and residual areas. For this reason, it provides an essential basis for understanding which parts of the area are already committed to specific productive transformations and which spaces may still offer potential for integration with HyMantoValley-related activities.

This aspect is particularly relevant because the Research Hub cannot be considered as an isolated building or as an autonomous function. Its localization must be evaluated in relation to the productive structure of Mantova Est: proximity to logistics and industrial activities, accessibility from the main infrastructural network, compatibility with existing and planned uses, relationship with environmental mitigation areas, and possible synergies with the hydrogen value chain.

The Olmo Lungo variant therefore becomes a tool for testing the feasibility of different localization hypotheses, helping the masterplan to compare alternatives and to identify where research, innovation, training and productive experimentation can be most effectively integrated.

A further relevant aspect concerns environmental mitigation. The Olmo Lungo variant does not only define a productive or logistics layout, but also includes references to mitigation areas, standard areas, accessibility from the underpass of Via Ostigliese, possible public and cycling connections along the Mincio diversion canal, and the implementation of environmental mitigation measures. The report also refers to the identification of an experimental lot intended as an **ecologically equipped productive area** and to design principles related to energy efficiency, reduction of consumption and closure of natural cycles.

In this sense, the Olmo Lungo variant becomes a necessary planning layer for the HyMantoValley masterplan. It allows the project to move from a general urban reading to a more precise site-specific interpretation, where planned buildings, infrastructural alignments, mitigation areas, public standards and environmental requirements are considered as active components of the design process. The masterplan must therefore engage with this framework not simply as a constraint, but as a basis for identifying possible synergies between logistics, hydrogen-related functions, intermodal accessibility, environmental mitigation and urban-industrial regeneration.

Environmental Constraints, Risks and Regeneration Opportunities

A further element to be considered is the **Municipal Ecological Network project**, currently under development. Within this framework, **Ecological Corridor no. 8** has been identified as a relevant component for the project area. The corridor develops within the urbanized fabric, particularly through the industrial zone, and runs parallel to the **Diversivo canal**. It connects the agricultural area of **Borgo Virgilio** with the **Vallazza Regional Reserve**, using ecological elements that are already present.

The corridor sheet shows that this ecological connection is structured through a combination of existing and project elements. The constitutive elements include complex vegetation formations, tree rows, the water network, the rural/inter-farm layout, underpasses and ecological landing points within the nodes. At the same time, the project identifies elements to be reinforced or newly introduced, such as new connections, strengthening of existing links, access hubs and ecological waiting points. The map also highlights several barriers and interference levels, distinguishing first, second and third-degree interferences, as well as potential connections and underpass works.

This reading is particularly important because it shows that Corridor no. 8 is not a continuous and fully consolidated ecological structure, but a system that requires selective reinforcement. Its continuity depends on the capacity to work on critical points, especially where infrastructural barriers and intersections with local roads interrupt the linear development of the corridor. These interferences suggest the need for specific design actions, such as the possible creation of ecological underpasses and the reinforcement of tree rows along the corridor.

At the points where the corridor connects with ecological nodes, the project also identifies the need to create **ecological hubs**. These spaces may become strategic places for reinforcing ecological continuity and improving the relationship between biodiversity, slow mobility and landscape accessibility. The presence of existing or potential cycle-pedestrian routes gives these hubs a dual role: ecological, because they support habitat continuity and biodiversity; and anthropic, because they can improve the environmental quality and usability of the industrial landscape.

This aspect is particularly relevant for the HyMantoValley masterplan. The Municipal Ecological Network project finds a direct relationship with the compensation and mitigation areas already envisaged by the Olmo Lungo variant. As a result, Ecological Corridor no. 8 becomes an important reference for the masterplan, because it allows environmental mitigation to be interpreted not only as a compensatory measure, but as part of a broader ecological strategy. It can help orient the design of green connections, buffers, ecological hubs and landscape interfaces between the industrial area, the Diversivo canal and the Vallazza system.



Extract from the Municipal Ecological Network map



Project sheet for Ecological Corridor no. 8

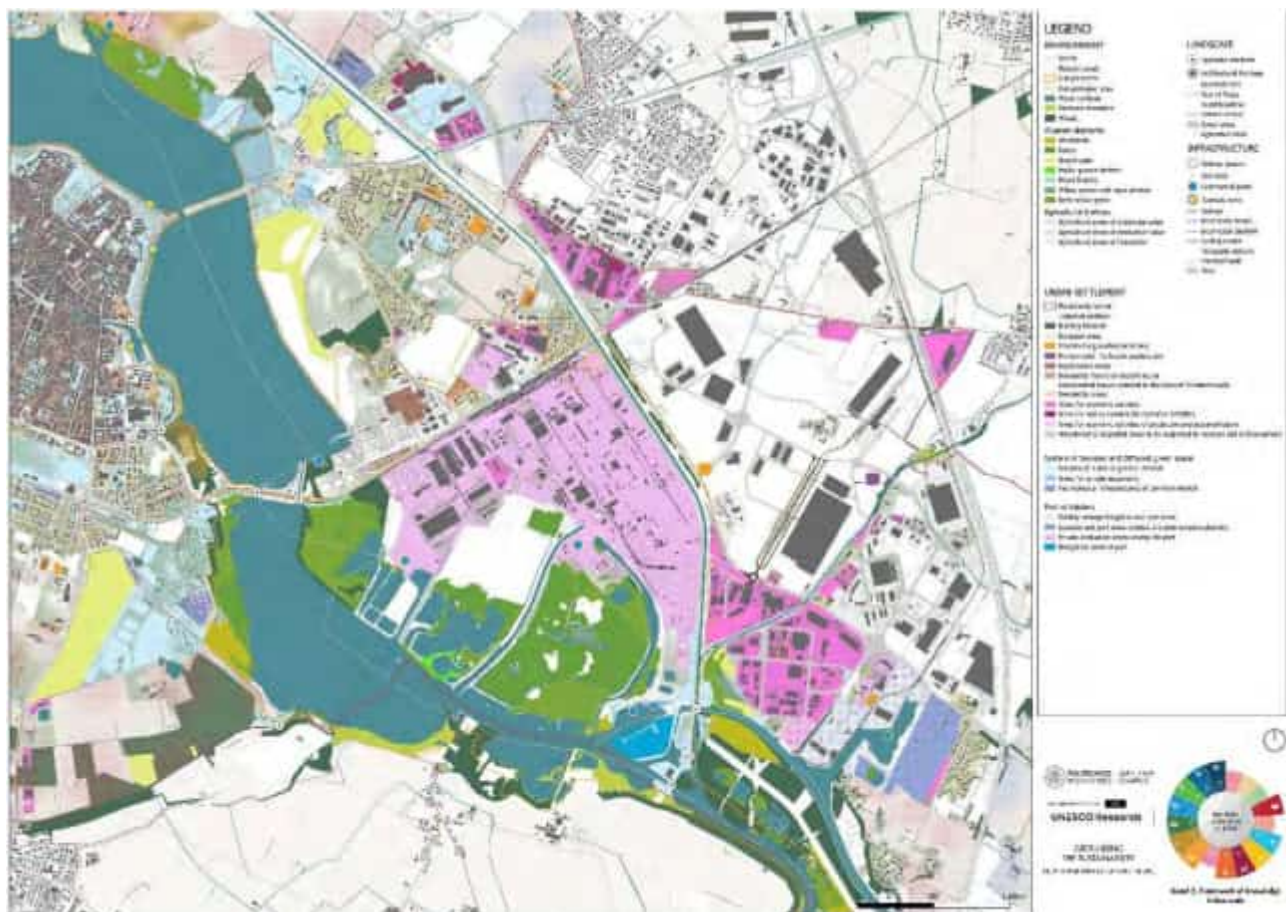
7.3 Scale-Based Outputs: Mapping, Interpretation and Design Inputs

At the urban scale, the cartographic outputs were developed to bring together the territorial and landscape readings and translate them into a more operational framework for the masterplan. The previous maps clarified the broader position of Mantova Est within infrastructural, logistical and waterway systems, and identified the landscape structures, ecological continuities and historical permanences that shape the project area. The fifth and sixth maps move one step further, focusing on the scale at which these elements become concrete design conditions.

At this level, the project area must be read through the coexistence of multiple urban systems: existing productive and logistics functions, port-related spaces, road and rail infrastructures, environmental constraints, contaminated or sensitive areas, accessibility networks, settlement margins and possible sites for the Research Hub. These elements cannot be considered separately, because their interaction defines the real field of action of the masterplan.

For this reason, the urban-scale maps act as tools of synthesis and verification. They make it possible to understand how the systems identified in the previous phases are spatially organized at the local level, where they overlap, where they generate conflicts, and where they may produce opportunities for transformation. The maps therefore support the transition from interpretation to design by helping to identify site-specific opportunities, functional compatibilities, environmental limits and possible localization strategies.

In this sense, the urban-scale cartographic outputs do not simply describe the existing situation. They provide a working base for testing the future development of HyMantoValley, verifying how the Research Hub, the hydrogen value chain, port activities, productive areas, infrastructures and ecological components can be integrated within a coherent spatial strategy.



Board 5. Framework of Knowledge – Urban Scale

The fifth map, Board 5. Framework of Knowledge – Urban Scale, developed at the scale of 1:10,000, provides a detailed reading of the urban and environmental structure of Mantova Est. The map brings together several layers of information related to the environment, landscape, infrastructure, urban settlements, services, port areas and diffuse open spaces. It includes canals, historic canals, SIN perimeter, contaminated sites, water surfaces, protected areas and woodland; riparian elements such as shrubs, reeds, uncultivated land, poplar groves, mixed robinia and willow groves; agricultural areas of landscape or productive value; and landscape components such as hydraulic artefacts, architectural heritage, isolated trees, rows of trees, rural buildings, historic canals and green areas.

At the same time, the map represents the main urban and infrastructural components of the area, including railways, roads, planned roads, cycling routes, navigable and planned navigable networks, bus stops, railway stations, commercial and touristic ports, industrial areas, urbanized areas, residential and service areas, abandoned or degraded areas, and the port-related spaces of Valdaro. The legend also identifies areas of economic activity, ecological interest and fragmented spaces that may be subject to recovery or redevelopment.

This combination of layers makes it possible to interpret different types of relationships that are relevant for the masterplan. First, it highlights the relationship between productive areas, port-related spaces and transport infrastructures, showing where industrial and logistics functions depend on road, rail and waterway accessibility. Secondly, it makes visible the relationship between existing or planned mobility networks and possible future functions, helping to understand where accessibility could support the localisation of new activities, including the Research Hub. Thirdly, the map allows the relationship between degraded or contaminated areas and redevelopment opportunities to be assessed, identifying where future transformations may require remediation, mitigation or specific design precautions.

The representation also helps to read the relationship between ecological and water systems, settlement margins and productive areas. These relations are relevant because they indicate where green and blue infrastructures could be strengthened, where landscape buffers may be necessary, and where conflicts between industrial activities, environmental components and existing urban uses should be carefully managed. In this sense, the map supports a relational interpretation of the urban field: each element is not considered in isolation, but in terms of its proximity, compatibility, accessibility and possible interaction with the other components of Mantova Est.

This representation is relevant because it shows the complexity of the urban field in which the HyMantoValley masterplan must operate. Mantova Est is not a homogeneous productive area, but a place where industrial activities, logistics infrastructures, water systems, ecological areas, contaminated sites, settlement margins and cultural landscape elements coexist in close proximity. The map therefore helps to clarify the actual conditions of the site and to identify the relationships that must be considered when defining future transformations.

Within the masterplan process, this map provides the main knowledge base for the urban scale. It supports the verification of accessibility conditions, functional compatibility, environmental constraints, connections with the Port of Valdaro, and the possible integration between hydrogen-related activities and existing productive systems. In this sense, Board 5 translates the previous territorial and landscape interpretations into a more precise site-specific reading, allowing the project to understand where opportunities, conflicts and limits of transformation are located.

8. MASTERPLAN DEVELOPMENT: SITE-SUITABILITY ASSESSMENT FOR THE RESEARCH HUB

Building on the analytical phase described above, this chapter introduces the transition from the development of the knowledge framework to the formulation of the masterplan. Whilst the first phase was aimed at gathering, organizing and systematizing knowledge relating to the territorial, landscape and urban context, **this second phase takes on a predominantly interpretative and strategic character**. The information gathered no longer constitutes merely a body of knowledge but becomes the basis for guiding decisions and subsequent phases. In this sense, the masterplan is understood as the moment in which the different readings developed at the territorial, landscape and urban scales begin to converge into a more selective and design-oriented framework.

More specifically, building on a comprehensive and coherent knowledge framework, the masterplan translates the outcomes of the analytical and interpretative phase into a development strategy capable of putting the project into practice. The aim of this process is the establishment of the Research Hub dedicated to the hydrogen value chain. Faced with a complex territorial context, the research first had to examine the planning tools and methodologies. From the outset, the need arose to critically reflect on the effectiveness of traditional planning approaches, which, whilst retaining a fundamental role, can reveal certain limitations when applied to particularly dynamic contexts.

This is particularly relevant in relation to Mantova Est, where infrastructural conditions, productive activities, environmental constraints and future innovation processes require a planning approach able to compare different possibilities before defining a preferred direction.

For this reason, the work aims to construct a comparative framework of alternative scenarios, assessing their compatibility with the local context, their capacity for integration with the existing production system, and their potential contribution to the development of the hydrogen value chain. From this perspective, the research project has a dual purpose: on the one hand, it serves as an operational tool to support future decisions on site selection and development; on the other, it

provides an opportunity for methodological experimentation, aimed at exploring planning approaches that are more flexible, adaptive and capable of responding to the complexity of contemporary territorial transformation processes.

8.1 To implement: Masterplan strategy

As mentioned in the description of the design challenges, the development of the masterplan is confronted with a situation that characterizes the entire HyMantoValley project: the need to operate within a complex, evolving context characterized by a high degree of uncertainty.

The evolution of the hydrogen value chain depends, in fact, on technological, regulatory, economic and infrastructural factors that are still in the process of consolidation, making the definition of a rigid and definitive settlement plan not entirely appropriate.

In this context, uncertainty does not represent a constraint on the design process, but rather a condition to be embraced as a structural element of planning. The transformations linked to the energy transition unfold through gradual processes, influenced by external variables that evolve over time and cannot be fully anticipated at the time the project is defined. Consequently, the development of territorial strategies requires tools capable of supporting this evolution.

This reflection inevitably leads us to question the role of planning tools. Traditional approaches, geared towards defining long-term spatial frameworks, prove particularly effective when applied in relatively stable contexts. However, they may encounter difficulties in addressing transformation processes characterized by technological innovation, regulatory changes and constantly evolving economic scenarios.

For these reasons, this study adopts a scenario-based strategic planning approach. From this perspective, the masterplan is not conceived as the representation of a definitive solution, but as a dynamic framework capable of comparing alternatives, testing different development scenarios and progressively guiding planning decisions.

The aim is not to eliminate uncertainty, but rather to incorporate it into the decision-making process, prioritizing adaptable solutions capable of evolving over time. This interpretation is consistent with Albrechts and Balducci's understanding of strategic planning, according to which "strategic planning is not a single concept, procedure or tool, but a dynamic and creative process" (Albrechts & Balducci, 2013).

This type of approach involves a number of fundamental advances, including moving beyond a view based on the existence of a stable condition, in favor of an approach capable of dealing with alternative scenarios, variable conditions and critical thresholds; the shift from a single solution to a system capable of incorporating different degrees of feasibility, reversible options and adaptability; the replacement of a static vision with process-based plans that are monitorable, updatable and capable of learning from experience.

Operating under conditions of uncertainty requires that every decision be based on an in-depth knowledge base and stem from an integrated analysis of the territory, capable of linking environmental, infrastructural, productive and settlement systems. In this sense, flexibility must not be confused with vagueness: it is precisely the rigor of the analytical phase that enables the construction of credible and comparable scenarios, transforming the knowledge acquired into a decision-support tool.

From this perspective, the masterplan is not intended as a representation of a final configuration, but as a strategic tool capable of guiding the decision-making process. Its aim is to assess the feasibility of different location options, compare alternative scenarios and define priorities for action,

whilst evaluating how existing transport infrastructure, settlement systems, ecological networks and industrial areas might interact within new territorial configurations linked to the introduction of a new energy technology into the area.

The scenario-based approach thus allows the project's potential for evolution to remain open without compromising its coherence. **Each scenario represents a different interpretation of the area's potential**, offering a tool for comparing alternatives and supporting a progressive definition of design choices. The masterplan therefore assumes the role of a dynamic framework of reference, capable of guiding subsequent development phases whilst firmly maintaining the pursuit of the objectives of sustainability, energy transition and territorial regeneration that underpin the entire project.

Building on the theories developed by Gaston Berger in the 1950s and subsequently explored in the field of strategic planning and foresight studies, the project adopts a forward-looking approach that does not aim to predict the future but rather contributes to its conscious shaping in the present. Unlike forecasting, which tends to identify a single probable scenario based on the evolution of current conditions, the approach adopted explores a range of possible futures, constructed on the basis of the main variables of uncertainty that characterize the context.



Preparing for the future through forecasting.

Source: <https://futurestation.ro/scenario-planning-navigating-uncertain-futures/ro>

When applied to the HyMantoValley project, this approach enables the development of a masterplan capable of guiding decisions without restricting them, keeping various development pathways open for the research hub and strengthening the project's long-term strategic resilience. With this vision, HyMantoValley is not merely a process for implementing new technologies in the manufacturing sector of the city of Mantua but rather functions as an experimental laboratory in which technological innovation, research and strategic planning work together to define new models of territorial development.

8.2 Mapping possible Research Hub locations

Building on the content of the first chapter, which sets out the context of the study, this section focuses on one of the project's key objectives: the creation of a center for innovation and research into hydrogen. The research hub represents a valuable asset for Mantua's manufacturing sector. Acting as a catalyst, it ensures the establishment of collaborations between various stakeholders operating at different levels, such as universities, technology institutes and industry leaders; it facilitates the progressive growth of hydrogen research, which requires continuous updates and experimentation; it ensures the provision of appropriate training for the next generation of specialists and technicians in

the sector; finally, it enables the development of innovative business models that can be adapted to different European contexts.

Furthermore, the design of a research hub ensures the integration into the hub's framework of a function not previously identified. During the spatial planning phase, the function dedicated to learning, experimentation and the promotion of hydrogen requires particular attention focused on understanding its potential relationships with the surrounding context and the associated impacts. In all this, an important role is played by the individuals who will be called upon to come here and the tasks they will hypothetically have to undertake. The project addresses all these questions by drawing on the insights gained from the previous Work Packages and from other in-depth analyses conducted in parallel.

In line with the methodological approach described in the preceding paragraphs, rather than identifying a single site for the research center, the project constructs a framework of possible location alternatives. In this regard, the aim is to assess how different areas of the territory – which are relatively close to one another but differ in form and function – might meet the development needs of the future research infrastructure. Based on the analyses carried out at various scales, the project identifies **seven potential sites**, selected for their ability to integrate with the existing territorial system, in terms of both productive and infrastructural aspects, as well as natural and environmental considerations. Although all seven sites are currently undeveloped or occupied by buildings awaiting new uses, each represents a different interpretation of the relationship between the research hub and the surrounding area, highlighting specific strengths and challenges that may influence feasibility and development prospects.

The mapping of the seven alternatives does not constitute a ranking of suitable options, but rather a tool for comparing seven different spatial scenarios. Each of these possible solutions introduces different strategies, expressed in terms of opportunities and challenges, which depend on the relationship with the various elements of the context: proximity to the industrial area, proximity to residential areas, connection to the intermodal transport system, proximity to waterways, etc.



Mapping of the possible research hub locations

In terms of methodology, the search for a site for the research hub began with an initial assessment of the project guidelines, which envisaged locating the facility in the port area. This proposal is based on the desire to situate the research center near future hydrogen production, storage and distribution activities, thereby capitalizing on the logistical links and the strategic role of the port infrastructure within the supply chain.

However, one of the objectives of the research was precisely to critically examine this approach, avoiding treating the initial solution as a definitive assumption but, on the contrary, as a starting point for developing further hypotheses. The approach adopted therefore extended the scope of the investigation to the entire area east of the lakes, which includes not only the port area but also the industrial area and the adjacent area, which is primarily dedicated to production and logistics.



Three areas of investigation.

This process identified seven potential locations spread across three different areas: **the industrial area**, where only one site has been identified; **the transition area**, which contains the largest number of potential locations – four in total; and, finally, **the port area**, which includes two of the sites explored.

Site 1 | *Historic Olmo Lungo farmhouse, located in the transition zone between the productive district and the rural landscape*

Site 2 | *Former industrial site within the regenerated industrial area*

Site 3 | *Site along the Ostigliese corridor, adjacent to the main road infrastructure*

Site 4 | *Site located near the residential settlement of Formigosa*

Site 5 | *Site within the Port of Valdaro, integrated with the intermodal logistics system*

Site 6 | *Site within the core of the consolidated productive district*

Site 7 | *Site along the “Acque Alte Mantovane” canal, at the interface between productive and environmental systems*

Industrial Area [Site 02]

The area forms part of the city’s industrial sector, characterized by the presence of industrial sites that are either partially derelict or completely abandoned, and which are currently undergoing major environmental remediation work. Having undergone numerous transformations over time – largely due to the stop-start nature of certain industrial activities – the area now offers a significant opportunity for regeneration. Despite these various changes, the area has retained one constant over time which can now be seen as a defining feature to be enhanced: its relationship with water.

The area overlooks the southern part of Lago Inferiore, near its confluence with the Vallazza wetland, one of the most significant natural areas within the Mantua lake system. The water levels in this part of the territory are regulated by the Masetti dam, a piece of infrastructure that plays a strategic role both in terms of water management and transport. Indeed, the Mantua–Peschiera railway line and the provincial road pass through the dam, forming a major transport hub that ensures accessibility to the area and its connection to the wider regional network.

This area corresponds to a fragment of an existing industrial district, already occupied by productive settlements and therefore characterised by a consolidated functional identity. Its relevance for the HyMantoValley masterplan does not derive from the presence of immediately available land or from a predefined role within the hydrogen supply chain, but from a set of potential spatial and infrastructural conditions that may be further explored. In particular, the area benefits from its proximity to the Mantova–Monselice railway line, which represents a significant infrastructural opportunity for future connections with the wider logistics and productive system.

List of possible locations involved in the area:

Site 2 | Former industrial site within the regenerated industrial area



Visual overview of the Industrial Area.

Transition Area [Site 01, 03, 06, 07]

The area forms a transition zone between the industrial area of the city of Mantua and the rural area extending beyond the Brenner motorway (A22), the main transport link between northern Italy and central Europe. This intermediate position gives it a strategic role, linking it both to the existing industrial sector and to the main regional and international transport routes. The gradual transformation of the urban fabric is clear in the area's settlement pattern. Moving from the industrial sector towards the agricultural land, the density of industrial sites gradually decreases, whilst the size of individual buildings increases, often organized into larger plots. At the same time, there is an increasing presence of open spaces and green areas, some of which are still used for agricultural activities, helping to define a landscape characterized by a balance between productive functions and rural features. From a settlement perspective, the context is complemented by scattered residential settlements and the historic Olmo Lungo residence, which is of significant historical and architectural value. As part of the HyMantoValley project, the area will play a predominantly logistical and productive role within the future hydrogen supply chain. The planned developments include the construction of an intermodal hub, refueling stations for road and rail transport, and a hydrogen production plant.

List of possible locations involved in the area:

Site 1 | Historic Olmo Lungo farmhouse, located in the transition zone between the productive district and the rural landscape

Site 3 | Site along the Ostigliese corridor, adjacent to the main road infrastructure

Site 6 | Site within the core of the consolidated productive district

Site 7 | Site along the Acque Alte Mantovane canal, at the interface between productive and environmental systems



Visual overview of the Transition Area.

Port Area [Site 04, 05]

The area corresponds to the Port of Valdaro, the most important intermodal hub in eastern Lombardy and one of the most significant logistics facilities in the Mantua region. Thanks to its strategic location and multimodal connections, the port is a key hub for freight handling and plays a central role in the development prospects of future energy supply chains. The surrounding area is characterized by a variety of functions, making it a link between residential, industrial and environmental systems. To the north, the area borders a transitional zone where various commercial and service activities are concentrated; to the east, it connects with the town of Formigosa, the main residential centre in the area; to the south, it opens out onto an agricultural landscape of great scenic beauty and high environmental value; to the west, it interacts with settlements primarily dedicated to commercial activities.

From an infrastructure perspective, the area benefits from a particularly efficient transport network. The direct link to the Brenner Motorway (A22) and the presence of the railway junction serving the Mantua–Monselice line enables the integration of road, rail and river transport, reinforcing the port's role as an intermodal hub serving the entire region. It is precisely for these reasons that the HyMantoValley project envisages the construction of a refueling station for the port in this area, as well as the Research Hub, the beating heart of the project.

List of possible locations involved in the area:

Site 4 | Site located near the residential settlement of Formigosa

Site 5 | Site within the Port of Valdaro, integrated with the intermodal logistics system



Visual overview of the Port Area.

8.3 A first range of possibilities: opportunities and critical issues

The mapping of the seven alternatives does not constitute a ranking of more or less optimal solutions, but rather a tool for critical comparison between seven different spatial scenarios. The various possibilities were, in fact, initially mapped and, in parallel, examined in depth through a detailed analysis designed to highlight the **opportunities** and **critical issues** involved.

The comparative analysis was carried out by first assessing the relevant sector – industrial, transitional or port-related – and then the individual sites. In this way, on the one hand, broader aspects were assessed, such as the relationship with accessibility, the relationship with the environment and the relationship with the landscape; on the other hand, the specific characteristics of each plot were analyzed, verifying their capacity to accommodate the research hub dedicated to the hydrogen value chain.

The result is a qualitative assessment, constructed using a coherent set of analytical criteria applied to all alternatives. This is not merely a list of advantages or disadvantages, but rather a methodological tool for understanding the spatial implications associated with each potential site.

The results of this exploration are summarized in a table which forms the interpretative basis for comparing the different scenarios and for developing the subsequent project phases. For a general overview, a summary is provided below of the opportunities and challenges that each of the three areas (industrial, transitional and port) presents in relation to the establishment of a new hydrogen-based research hub.

Industrial Area

Opportunities. The proximity to the Mantua lake system and the ecological areas of the Vallazza nature reserve, combined with the presence of industrial sites undergoing regeneration, offers the opportunity to experiment with a settlement model in which technological innovation, research and environmental regeneration can coexist. From this perspective, the Research Hub can act as a link between industrial development and landscape enhancement.

Challenges. The very proximity to these environmental systems, which is one of the area's main strengths, requires particular care in the design of the project. The presence of highly valuable ecological and landscape features, which are currently heavily contaminated, means that the new development must be accompanied by appropriate mitigation and integration strategies, capable of limiting impacts and ensuring a balance between transformation, environmental protection and landscape quality.

Transition Area

Opportunities. Its location halfway between the industrial area and the rural countryside, combined with good accessibility provided by the main transport infrastructure, offers favorable conditions for the establishment of a Research Hub capable of acting as a link between research, logistics and the industrial sector. The availability of open spaces and the presence of areas suitable for redevelopment also represent an opportunity for future developments of the project.

Challenges. The coexistence of industrial activities, agricultural land, residential areas and elements of the historical heritage makes this area particularly complex from a territorial perspective and highly stratified in terms of landscape and identity. The integration of the Research Hub must therefore be carefully calibrated, avoiding interference with existing functions and ensuring the right balance between development, landscape conservation and the quality of settlements.

Port Area

Opportunities. The Port of Valdaro is the main logistics and intermodal hub in the Mantua area, thanks to the integration of road, rail and river transport. This ensures excellent accessibility and makes the area particularly well-suited to hosting a research center closely linked to hydrogen

production, distribution and testing activities, thereby promoting technology transfer and collaboration with operators throughout the supply chain.

Challenges. The area's high degree of specialization in logistics and manufacturing, combined with the presence of diverse functions in the immediate vicinity, requires careful planning of the Research Hub to ensure it can integrate with existing activities without compromising the efficiency of the port system or relations with the surrounding residential, commercial and agricultural areas.

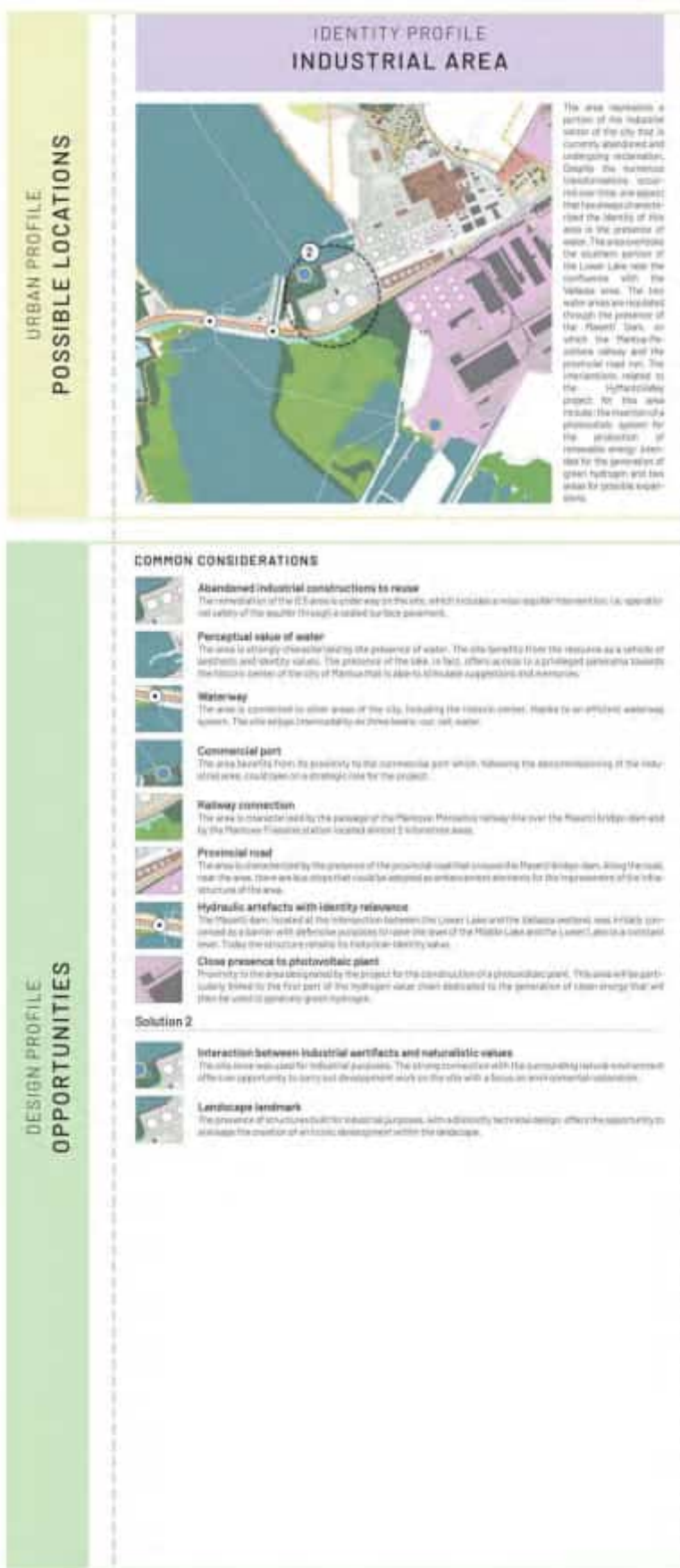
The following assessment sheets should be understood as a preliminary comparative tool developed to support the transition from the mapping of seven possible locations to the selection of the three sites considered most suitable for further investigation. They do not constitute a final design choice, nor do they replace the more detailed Site Assessment Booklet. Their role is to make explicit the first level of evaluation carried out during the masterplan process, highlighting the main opportunities and critical issues associated with each site.

The sheets allow the reader to understand how each possible location was interpreted in relation to its wider area of reference — industrial, transition or port-related — and in relation to its specific spatial conditions. For each site, the assessment considers aspects such as accessibility, proximity to existing or planned infrastructures, relationship with productive and logistics systems, environmental and landscape conditions, possible constraints, compatibility with surrounding uses, and potential contribution to the hydrogen value chain. In this sense, the sheets provide a synthetic but comparable reading of the seven alternatives, allowing similarities, differences, strengths and weaknesses to emerge more clearly.

These pages therefore represent an intermediate step within the decision-making process. They explain the rationale that led from a broader range of possible locations to a more restricted set of sites deserving further analysis. The comparison is not intended to establish a rigid ranking, but to support an informed selection process, consistent with the interactive and scenario-based methodology adopted by the research. The aim is to identify those locations that appear more promising in relation to the objectives of HyMantoValley and that can become the basis for subsequent design explorations.

The reason why these preliminary sheets have not been included in the Site Assessment Booklet is related to the different purpose of the two documents. The sheets presented here document the first comparative screening of all seven possible locations, while the booklet focuses only on the three selected sites. The booklet is conceived as a more operational and design-oriented dossier, intended to provide a structured knowledge base for the following phases of the project. For this reason, it contains more detailed information, cartographic extracts, quantitative data, planning references and site-specific considerations concerning the three locations that have been retained for further development.

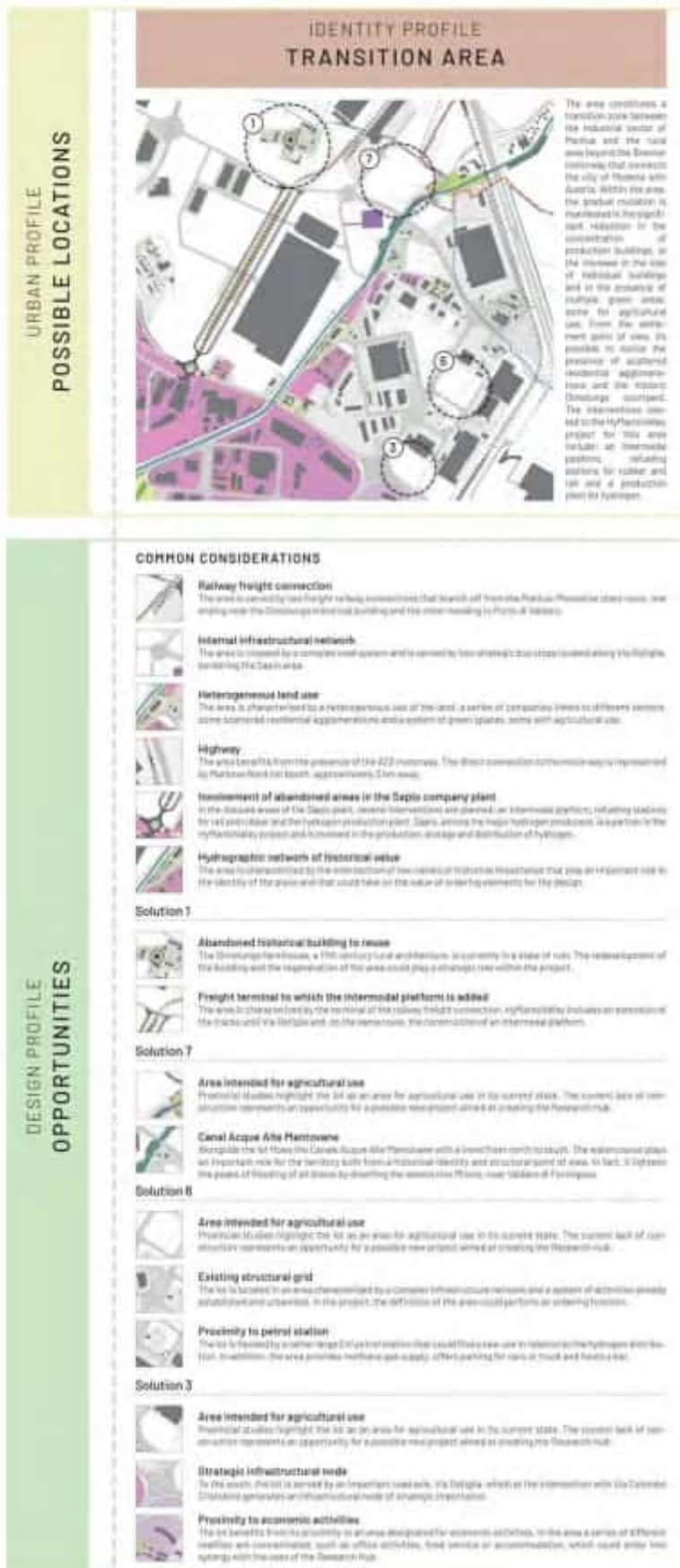
In this perspective, the preliminary assessment sheets and the Site Assessment Booklet should be read as complementary tools. The former explains how the selection process was constructed and why some sites were considered more suitable than others; the latter provides the more detailed information needed to support the future architectural and spatial design of the Research Hub. Together, they create a bridge between the masterplan developed in WP5.1 and the subsequent design activities foreseen in WP5.2, offering a structured basis for evaluating localisation choices, functional requirements, accessibility conditions, environmental precautions and possible design scenarios.



Reading of urban profile and opportunities for the **INDUSTRIAL AREA** and for the different locations within it.



Reading of critical issues for the **INDUSTRIAL AREA** and for the different locations within it.



Reading of urban profile and opportunities for the **TRANSITION AREA** and for the different locations within it.

DESIGN PROFILE CRITICAL ISSUES	COMMON CONSIDERATIONS	
		Area enclosed between infrastructural barriers The freight railway connection to the east, parallel to the Danube riverway and the presence of the Pfaffa- Thamesen in the area, constitute potential limitations for the construction of effective connectivity with the neighbouring areas.
		Scattered presence of vulnerable elements In light of the vulnerability that hydrogen entails, the coexistence of an element of historical architectural value and several other residential agglomerations could prove to be a critical aspect.
	Solution 1	
		Restricted real estate The proximity to urban infrastructure is subject to necessary planning interventions that may partially help complex and delicate.
		Area subject to implementation planning The area is subject to an implementation plan. Any architectural project conceived in the area must be based on the guidelines of the indicators of the plan. This could lead to limitations on the design choices of the site.
	Solution 7	
		Possible ongoing transformation on the area The evolution of use in the actual state reported in the maps drawn up by the Province must necessarily be ver- ified. Any changes that have occurred over the years could have given rise to new activities in the area.
		Threat to well-being due to the proximity of an high concentration of heavy infrastructure The area is quite close to the route of the railway intended for freight transport and the Danube riverway. Two rather significant infrastructures in environmental terms with significant repercussions on the physical and well-being of potential users.
	Solution 8	
		Possible ongoing transformation on the area The evolution of use in the actual state reported in the maps drawn up by the Province must necessarily be ver- ified. Any changes that have occurred over the years could have given rise to new activities in the area.
		Area surrounded by the presence of different companies The presence of several companies around the site could represent a risk to the design of the development. The design will have to face the challenge of studying the viability and sustainability of the site within an ever-evolving context.
	Solution 3	
		Possible ongoing transformation on the area The evolution of use in the actual state reported in the maps drawn up by the Province must necessarily be ver- ified. Any changes that have occurred over the years could have given rise to new activities in the area.

Reading of critical issues for the **TRANSITION AREA** and for the different locations within it.



Reading of urban profile and opportunities for the **PORT AREA** and for the different locations within it.



Reading of critical issues for the **PORT AREA** and for the different locations within it.

The diagram compares the three selected study areas, making their different locations and spatial conditions immediately visible. It acts as a transition between the preliminary screening of seven possible sites and the more detailed site assessment developed in the booklet.



Overview of the assessment of the seven sites for the three different areas.

8.4 Selection of three suitable locations

The next step involves selecting a smaller group of sites which, based on the assessments carried out, exhibit characteristics that distinguish them from the other alternatives under consideration. These three locations are the most suitable for hosting the future Research Hub, presenting themselves as credible options for the establishment of a research campus capable of bridging the gap between the academic world, the professional sphere and the city.



Three suitable locations for the Research Hub.

The selection reflects the intention to keep three possible development strategies open, each consistent with the project's objectives but characterized by different strengths and challenges. From this perspective, the selected sites represent three credible design scenarios on which to focus the subsequent project phases, ensuring the flexibility that has guided the entire process, from establishing a knowledge framework to drawing up the masterplan.

Before examining the three scenarios in detail – and thus the three territorial identities explored – it is important to explain the rationale behind the exclusion of the industrial area, given the greater prevalence of the transition area, which accounts for two out of the three sites. Although the industrial context has undoubted strengths, such as the significant co-existence of high-quality infrastructure and environmental systems, the analysis highlighted certain challenges that influenced its exclusion.

Given that the research campus was conceived from the outset as a genuine hub – that is, an infrastructure closely integrated with the operation of the supply chain – the ability to establish direct links with the production system was one of the main selection criteria.

Site 1 | Olmo Lungo Research Hub

The site identified at Corte Olmo Lungo covers an area of approximately 38,000 m² and is situated within the transition zone **between the industrial area and the rural landscape**. Unlike other alternatives analyzed, the plot is not an open space but is characterized by the **presence of an existing building** of significant **historical and architectural value**. Corte Olmo Lungo is, in fact, recognized by provincial planning authorities as a rural courtyard of historical and cultural interest at provincial level and, in the Rules Plan of the Mantua Municipal Territorial Governance Plan (PGT), is classified as a **cultural asset subject to direct protection**. This status represents one of the site's defining features and constitutes the main design challenge that the future Research Hub will have to address.

From a functional perspective, the site occupies a strategic position in relation to the developments envisaged by the HyMantoValley project. The site is in fact situated close to **the area earmarked for future hydrogen refueling infrastructure** and benefits from its proximity to the new intermodal hub envisaged in the provincial planning scheme, which also includes the upgrading of the freight rail link. This configuration ensures a good level of accessibility and facilitates the integration of the campus with the future logistics and infrastructure network of the supply chain.

Planning strategies also confirm the role of territorial hub assigned to this sector. The provincial masterplan provides for the creation of **new green spaces** adjacent to Corte Olmo Lungo and the introduction of tree screens to mitigate visual impact, helping to strengthen the relationship between the new industrial development and the surrounding rural landscape. At the same time, the Territorial Governance Plan (PGT) classifies the area within the system of 'Production Hubs' as a **chemical cluster**, recognizing its strategic importance in relation to the productive and industrial activities of the Mantua region.

A further significant factor is the existence of an **implementation plan** covering the entire farmstead complex and neighboring areas, involving a complex network of businesses and properties. The potential development of the Research Hub will therefore need to align with an already established planning framework, coordinating the project with the planned transformations and the requirements of the various stakeholders involved.

Overall, the site stands out for its ability **to integrate the production system**, the new **hydrogen supply chain infrastructure** and the **existing historical and rural heritage**.

Site 6 | Productive Core Research Hub

The site covers an area of approximately 24,000 m² and is situated within the Mantova Est industrial estate, in an area characterized by the presence of **well-established productive sites** and **strategic infrastructure for the movement of goods**. Its main feature is its high degree of integration with the existing industrial fabric, acting as a natural extension of an area that has progressively consolidated its **industrial identity** over time.

From an infrastructure perspective, the plot benefits from **a good level of accessibility**. Its direct access to a strategically important provincial road, its proximity to the freight rail link and plans for a possible new direct connection to the motorway ensure a particularly efficient transport network, facilitating both passenger and freight transport. Added to these conditions is the proximity to the area designated for the distribution of hydrogen for waterborne transport, a factor that helps to strengthen the site's role within the future energy supply chain.

A further point of interest is the presence, on the adjacent plot, of the **ENI refueling station**, an infrastructure which, as part of the developments envisaged by the HyMantoValley project, could be progressively integrated into the future hydrogen distribution network. This proximity opens interesting prospects for collaboration between research, experimentation and industrial applications, fostering the creation of an ecosystem strongly geared towards innovation.

The site is characterized by the **presence of industrial buildings of various sizes and types**. The integration of the new complex would therefore not represent a disruption, but rather the completion of an area that is becoming increasingly saturated, consolidating its industrial vocation and helping to strengthen its functional identity.

Overall, the site represents the solution best suited to **integration with the existing production system**. Its location enables direct links to be established with businesses and the infrastructure of the hydrogen supply chain, capitalizing on its proximity to key logistics hubs and future distribution networks.

Site 5 | Valdaro Port Research Hub

The site covers an area of approximately 42,000 m² and is situated within the Valdaro port system, in a location of particular significance in relation to the infrastructure envisaged by the HyMantoValley project. Its proximity to the area designated for **hydrogen refueling for shipping** and to the **main logistics facilities** makes this location one of the most closely integrated with the future hydrogen value chain. The Research Hub would therefore could become directly involved in the production, distribution and testing of this new energy carrier.

From a territorial perspective, the area is recognized in provincial planning as part of the **Valdaro intermodal hub**, a strategic infrastructure for the integration of road, rail and river transport. The context is characterized by the presence of a commercial port, private industrial areas serving port activities, and buildings used for economic and craft-based activities, forming a system strongly oriented towards logistics and the handling of goods. This concentration of functions represents one of the site's key attractions, fostering collaboration between the Research Hub, businesses and operators within the future hydrogen supply chain.

However, this strong focus on infrastructure is accompanied by a **high-value environmental context**. Although not directly part of the provincial ecological landscape network, the site is situated close to the green corridors of the **ecological network** and overlooks an area comprising **agricultural land** that cannot be converted, natural and semi-natural habitats, and agricultural areas of **landscape interest**. The entire site also lies within the Mincio Park, a factor that calls for further consideration from a landscape and environmental perspective.

Adding to this complexity is the presence, a short distance away, of the established urban fabric of the hamlet of Formigosa. The **proximity of residential settlements** makes it necessary to design the Research Hub as a mediating element between the logistics-port system and the urban context, through appropriate solutions for landscape integration, environmental mitigation and the enhancement of open spaces.

Overall, the site offers the location that guarantees the **highest level of integration with the port's logistics and production system**. Its positioning within a highly specialized and protected system – within the port area and in a zone very close to the infrastructure dedicated to waterborne trade – makes this site very different from the others.

8.5 Site assessment booklet: approach and contents

The process of selecting the three sites deemed most suitable did not follow a linear sequence but rather an iterative process, in which analysis, evaluation and in-depth study fed into one another. The identification of the sites and the development of the relevant knowledge base were carried out in parallel: a deeper analysis of the available information progressively guided the evaluation of the alternatives, whilst the potential sites that emerged required further verification and detailed examination.

From this perspective, the profiling of the three sites served as a tool that accompanied the entire decision-making process.

For each of the three locations, a preliminary design study was carried out, integrating qualitative aspects with those of a purely quantitative nature. On the one hand, the dossier compiles and presents a systematic overview of the main sources consulted during the research, including provincial and municipal planning documents and the HyMantoValley project documentation; on the other hand, it highlights certain numerical data relating to the plot's area and the distances from the main areas of intervention planned for the future roll-out of hydrogen. Among the qualitative assessments, there is also a summary of the opportunities and challenges that have already emerged during the initial assessment phase.

The full set of analyses and in-depth studies developed for each of the three sites has finally been compiled and organized within a **Site Assessment Booklet**, designed as a support tool for subsequent design phases. The booklet serves as an information dossier, providing, in a structured and easily accessible format, the elements deemed essential for a thorough understanding of each site. It acts as **a potential link between the territorial analysis and the future architectural design** of the research hub, providing the design team with a body of knowledge that is already structured and tailored to the project's requirements.

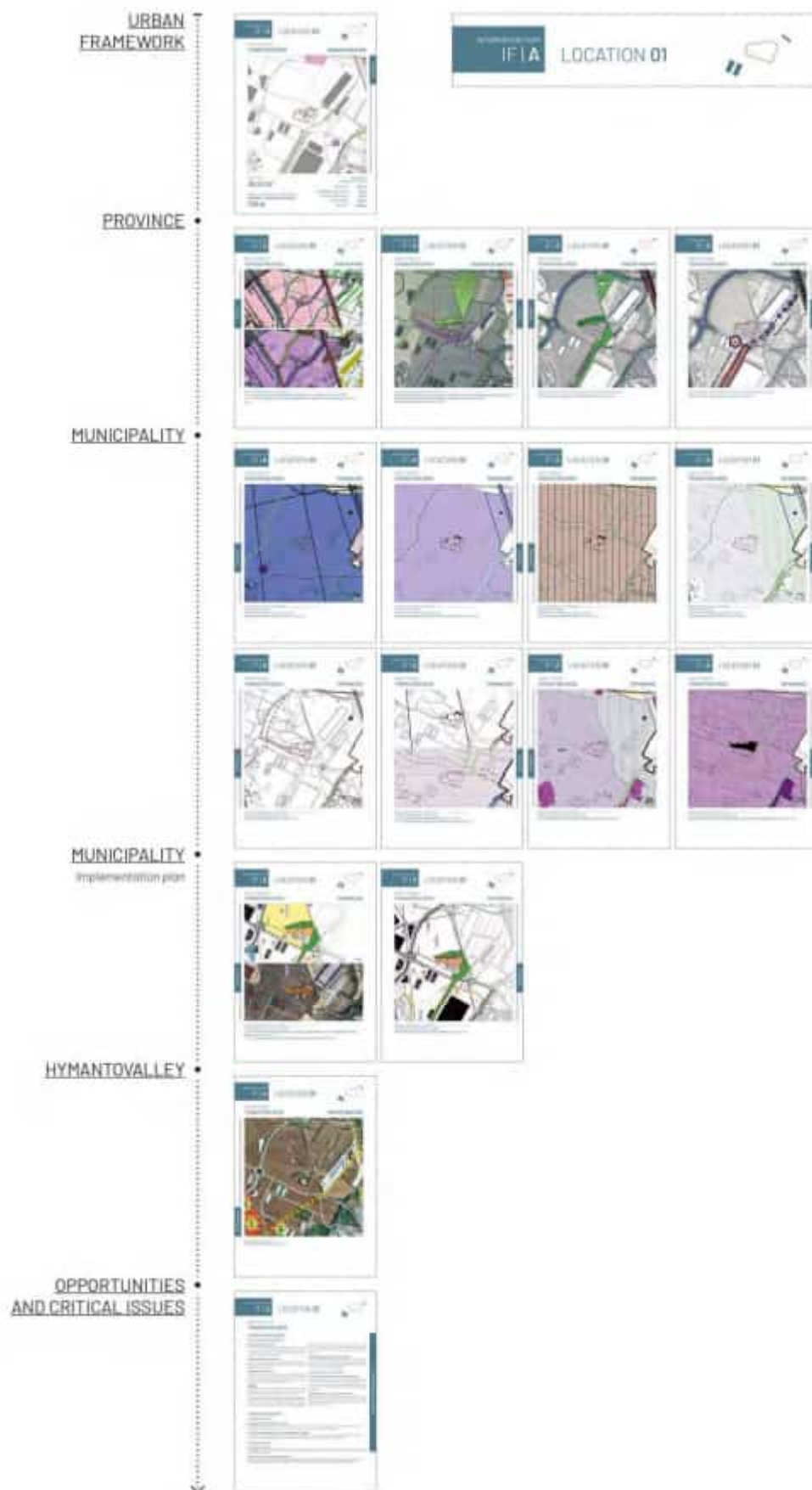
Beyond its descriptive function, the Site Assessment Booklet is intended to support comparison, discussion and decision-making. By applying the same structure to the three possible locations, it allows the different alternatives to be evaluated through a shared set of criteria, making similarities, differences, strengths and criticalities more explicit. In this sense, the booklet does not select a final solution, but provides the necessary basis for orienting future choices in a more transparent and informed way.

The document is also useful as a working interface between the different actors involved in the project. It translates the outcomes of the masterplan into a format that can be used by planners, architects, technical consultants, institutional partners and project stakeholders. The booklet therefore helps to keep together strategic vision and operational feasibility, ensuring that future architectural design phases remain grounded in the territorial, infrastructural, environmental and functional conditions identified during the research.

For this reason, the Site Assessment Booklet should be understood as an intermediate design tool: not a final project, but a structured knowledge base capable of accompanying the transition from site selection to design development.



Cover of the site assessment booklet: a tool to guide the future design of the research hub.



Structure of the information form realized for each of the three suitable locations. Extract from the booklet.

8.6 Scale-Based Outputs: Mapping, Interpretation and Design Inputs

The process of analyzing, evaluating and progressively refining the site options is summarized in the final masterplan, which is the last of the project documents, entitled “Board 6. Masterplan Strategy – Urban scale”.

The masterplan presents the outcome of the research process through three settlement strategies, each offering a different interpretation of the relationship between the future Research Hub and the Mantova Est area. These strategies are not intended as simple localization hypotheses or as alternative plots to be compared only in technical terms. Rather, they represent **three possible development scenarios**, each generated by the territorial, infrastructural, productive and landscape conditions that emerged during the **multiscale analysis**.

The three selected sites therefore become a way to test different roles for the Research Hub within the broader HyMantoValley system. Depending on its location, the Hub could act more directly as an interface with the productive core, as a catalyst for the transformation of the Olmo Lungo area, or as a strategic node connected to the port and logistics system of Valdaro.

Each scenario emphasizes different relationships, opportunities and criticalities, and each one suggests a specific way in which research, innovation, training and hydrogen-related activities could be integrated with the surrounding context.

In this sense, the scenarios are not final design solutions, but strategic interpretations. They make it possible to compare different forms of integration between the Research Hub, the hydrogen value chain, existing infrastructures, productive activities, environmental systems and future regeneration processes. Through this comparison, the masterplan does not simply identify where the Hub could be located, but explores what kind of territorial role it could assume within the future transformation of Mantova Est.

Olmo Lungo – Research Hub interprets the Research Hub as a connecting element between the industrial system and the rural landscape, enhancing the dialogue with the historic farmstead and the open spaces that characterize the edge of the area.

Industrial Core – Research Hub situates the campus at the heart of the production sector, prioritizing proximity to businesses, energy infrastructure and the facilities of the future hydrogen supply chain, with the aim of fostering technology transfer and industrial innovation.

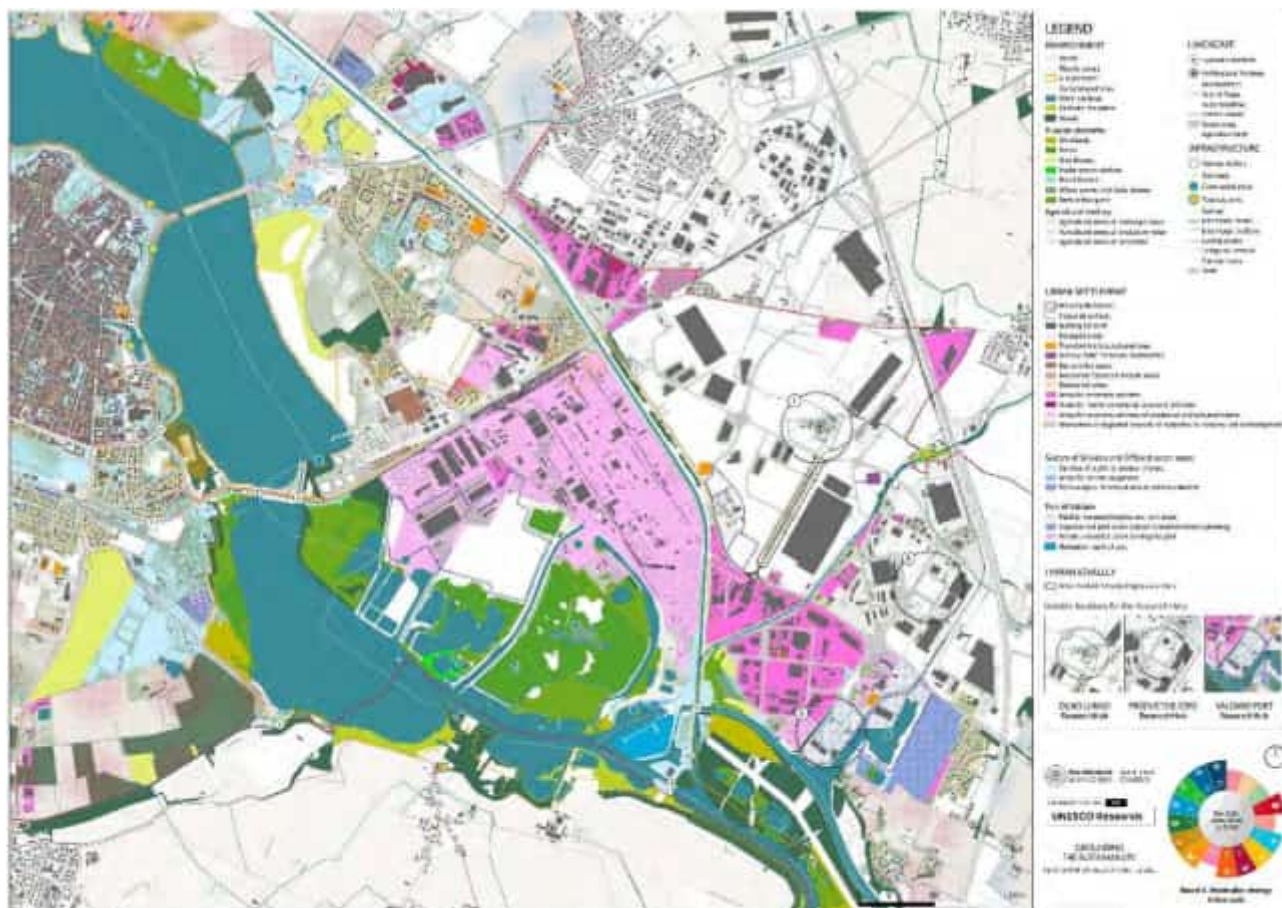
Valdaro Port – Research Hub proposes a direct integration between research and the intermodal logistics system, making the port and the infrastructure dedicated to freight handling the main link between the Research Hub and the hydrogen value chain.

From this perspective, the masterplan defines a strategic framework capable of orienting the subsequent design phases while keeping different evolutionary possibilities open. Its role is not to close the decision-making process with a single predetermined solution, but to provide a structured field of alternatives within which future choices can be progressively tested, compared and refined.

The three site development strategies therefore have a double value. On the one hand, they represent the outcome of the research process, because they synthesize the territorial, landscape and urban analyses carried out throughout the masterplan. On the other hand, they constitute the starting point for the architectural development of the Research Hub, offering different spatial and functional conditions with which the future project can engage.

In this sense, the architectural design of the Research Hub will be able to respond differently to each scenario, depending on the evolution of HyMantoValley, the priorities of the hydrogen supply chain, the needs of research and training activities, and the implementation opportunities that may emerge over time. The masterplan thus acts as an adaptive tool: it establishes coherence but does not

eliminate flexibility; it identifies possible directions but allows the project to evolve in relation to future technical, economic, institutional and territorial conditions.



Board 6. Masterplan Strategy – Urban scale.

9. MICRO-SUPPLY CHAINS AS AN ADDITIONAL FIELD OF EXPERIMENTATION

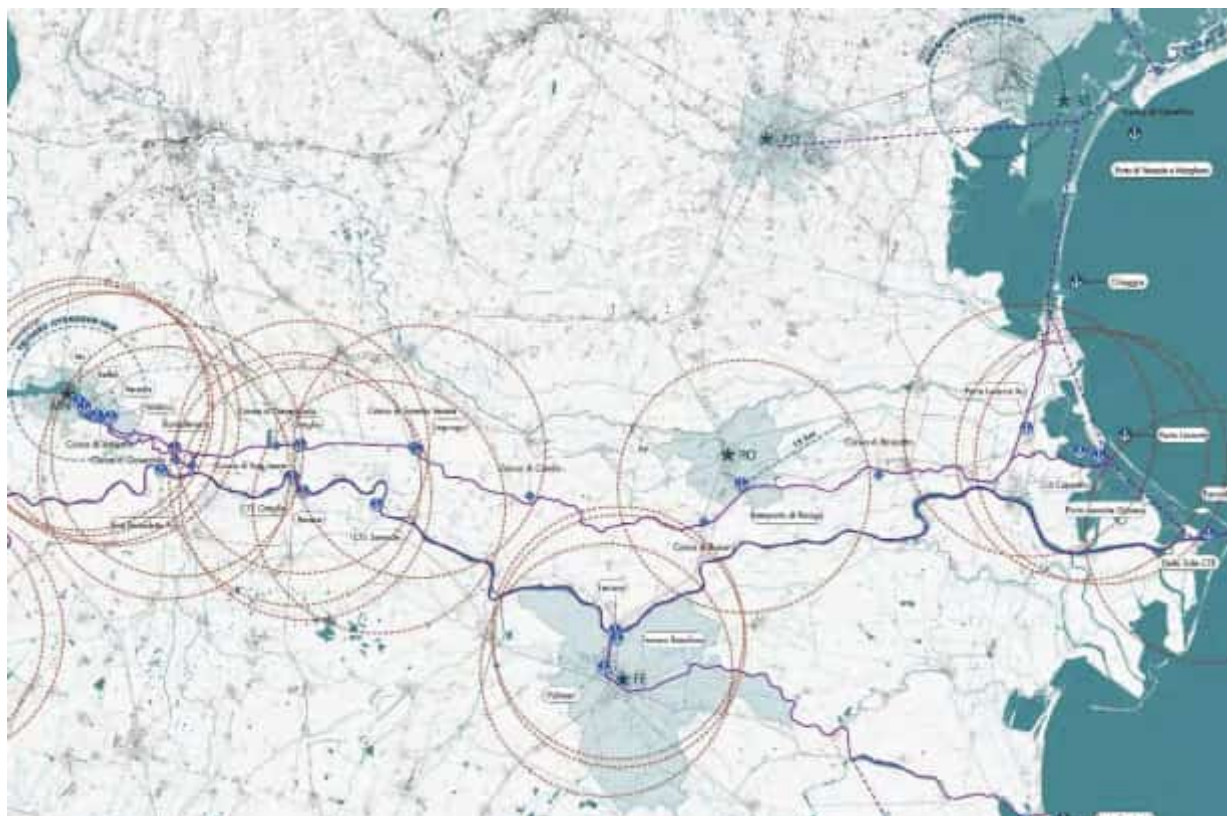
Micro-supply chains represent a possible operational derivation of the HyMantoValley project. If the macro-supply chain defines the main framework of the project, connecting hydrogen production, distribution, research, logistics and uses within a broader territorial system, micro-supply chains make it possible to verify more precisely how this strategy can be translated into concrete, circumscribed and experimental applications.

In this sense, a micro-supply chain should not be interpreted as a secondary or marginal intervention, but as a field of experimentation through which the potential of hydrogen can be tested in relation to specific uses, actors, places and operational conditions. It allows the project to move from a general infrastructural vision to a more targeted application, capable of assessing the technical, economic and territorial feasibility of solutions that could also be replicated in other contexts.

This approach is particularly relevant because HyMantoValley is located within a context characterized by strong complexity and uncertainty. The evolution of the hydrogen market, the availability of infrastructures, the needs of companies, energy costs and logistics conditions may change over time. Micro-supply chains therefore become tools of preparedness and experimentation: they allow working paths to be activated in relation to the general objectives of the project, while remaining flexible enough to be redefined according to the specific opportunities that emerge across the territory.

9.1 Mapping the Potential of the Experimentation

In order to identify possible areas for the activation of these micro-supply chains, a specific territorial-scale map was developed. The map takes as its reference the docks and landing points located along the Mantova–Marghera navigable corridor and defines around them possible areas of “active gravitation”, based on a radius of 15 km. This choice is not intended to establish rigid boundaries, but rather to identify areas that could potentially be involved in the project because of their proximity to the waterway system, logistics infrastructures and productive nodes distributed along the corridor.



Potential area for the localization of hydrogen-related micro-supply chains

The map therefore makes visible a possible operational geography of the micro-supply chains. Along the Mantova–Marghera system, several areas emerge around ports, landing points, locks, logistics platforms and productive poles, including Valdaro, Ostiglia, Revere, Ferrara, Rovigo, Porto Levante, Chioggia and Porto Marghera, among others.

These areas can become testing grounds for differentiated hydrogen applications related to logistics, mobility, production processes, energy services, inland navigation or specific business needs. Their importance does not concern only the possibility of experimenting with individual technological applications, but also their capacity to generate new economic and territorial relations starting from the main project.

From this perspective, micro-supply chains can be interpreted as local value systems that develop around the HyMantoValley macro-supply chain. The macro-supply chain defines the strategic infrastructure of reference: hydrogen production, distribution, research, logistics and uses. Micro-supply chains, instead, make it possible to articulate this general structure into more circumscribed applications, linked to specific territories, companies, infrastructures and operational needs. They therefore work as devices for bringing the general strategy closer to the concrete conditions of places.

This approach finds a useful reference in the economic literature on clusters and value chains. From Porter's perspective, the competitive value of a territory does not depend only on the presence of individual companies, but on the density of relations among firms, suppliers, infrastructures, services, institutions and skills. Geographical proximity can support productivity, innovation and new entrepreneurial opportunities. Applied to the HyMantoValley case, this interpretation, still highly relevant today, makes it possible to read micro-supply chains as potential hydrogen "experimental clusters": areas in which the technology is not simply introduced, but tested through concrete relations between local actors, existing infrastructures and new energy demands.

A second useful reference is provided by the concept of global value chains, which shows how contemporary economic activities are organized through articulated networks of production, distribution, coordination and governance. Gereffi, Humphrey and Sturgeon (2005) highlighted that value chains are not only productive sequences, but systems of relations governed by different degrees of coordination among actors. This perspective is useful for distinguishing the macro-supply chain, understood as the general strategic structure, from micro-supply chains, understood as operational articulations capable of adapting to specific local conditions.

Micro-supply chains can also generate value because they allow forms of integration between production processes, energy flows, logistics and the environment to be tested. In this sense, the reference to industrial symbiosis is particularly relevant: Chertow (2007) defines industrial symbiosis as a set of physical exchanges among different firms, involving materials, energy, water and by-products. Although hydrogen micro-supply chains do not necessarily coincide with this model, they can open similar spaces of cooperation, in which an innovative energy vector becomes an opportunity to rethink consumption patterns, supply systems, shared services, mobility and possible circular processes.

For this reason, the mapping of active gravitation areas does not have only a locational value. It makes it possible to identify the territories where proximity to docks, landing points, logistics infrastructures and productive systems may support the activation of experimental micro-supply chains. Each 15 km area can be interpreted as a potential field of relations: not a rigid boundary, but a space within which to verify the presence of companies, functions, energy needs, accessibility, infrastructural connections and possibilities for cooperation.

In this sense, the micro-supply chain adds value to the initial project because it expands its capacity for territorial grounding. HyMantoValley does not remain only a project concentrated around the main node of Mantova Est, but can generate a constellation of local experimentations along the navigable corridor. These experimentations make it possible to test different hydrogen use models, assess their feasibility, build skills, involve new actors and produce replicable knowledge. The micro-supply chain therefore becomes a device for territorial learning: it tests specific solutions, while at the same time contributing to the construction of a broader, adaptable and transferable model for other productive and infrastructural contexts.

The objective of the map is therefore not only descriptive. It allows the corridor to be read not simply as a macro-infrastructure, but as a system capable of generating possible fields of local experimentation. Each gravitation area can be interpreted as a potential territorial laboratory, where it is possible to verify whether and how hydrogen can contribute to the decarbonization of existing activities, the reorganization of logistics systems, the creation of new relations between companies and infrastructures, and the definition of models that may be replicated in other productive and territorial contexts.

9.2 To implement: the experimentation strategy

The experimentation illustrated below can be understood as an opportunity that progressively emerged during the development of the project. It was not an application defined in advance, but a possibility that matured along the way, through the interaction between the general objectives of HyMantoValley, the potential offered by hydrogen technology and the specific needs of a local productive context.

This opportunity was provided by NUTRITECH ([NUTRITECH Srl – HyMantoValley](#)), a company located in Villimpenta, which represents a first concrete case through which to verify the potential role that micro-supply chains can assume within the HyMantoValley project in terms of territorial grounding. The case makes it possible to observe how the general strategy of the project can move beyond the main perimeter of the macro-supply chain and be translated into a situated experimentation, connected to the characteristics, needs and operational possibilities of a specific productive context.

From this perspective, the micro-supply chain is not only a local application of hydrogen technology but becomes a device through which the project can build more direct relations with the territory. It allows new actors to be involved, real productive demands to be intercepted, differentiated uses of hydrogen to be tested, and the capacity of the project to generate value beyond its main core to be assessed. Territorial grounding therefore does not concern only the physical localization of an intervention, but the possibility of activating functional, economic, environmental and social connections between the HyMantoValley macro-supply chain and the productive realities distributed across the territory.

The NUTRITECH case thus becomes a useful testing ground for understanding whether and how a micro-supply chain can contribute to expanding the impact of the project, making it more adaptable, recognizable and replicable. Through this experimentation, HyMantoValley can be interpreted not only as an energy and innovation infrastructure concentrated in Mantova Est, but as a platform capable of generating differentiated territorial applications, built in relation to the opportunities that progressively emerge throughout the process.

In this sense, the NUTRITECH case represents the passage from mapping potential to concrete experimentation. After identifying, through the active gravitation areas, the territories potentially involved along the navigable corridor, the project finds in Villimpenta a first field of application. The experimentation makes it possible to verify how hydrogen can be integrated into a specific productive context, generating energy, environmental, logistical and educational value at the same time.

NUTRITECH, a company that has been operating for many years in the livestock sector, now presents itself as an innovative actor capable of reinterpreting the relationship between agricultural production, energy and sustainability. Within HyMantoValley, the company introduces a model of industrial symbiosis between productive activities and energy production. The company site is interpreted as a possible circular ecosystem, in which the electrolysis process does not only produce hydrogen, but activates a chain of relations among different uses and by-products.

In this framework, the oxygen generated as a by-product of electrolysis is not considered waste, but a resource to be reintegrated into the production cycle. It can be used to oxygenate the tanks within an advanced aquaponic greenhouse, contributing to the quality of the aquatic environment and to the well-being of the farmed organisms. Hydrogen, in turn, assumes a dual function: on the one hand, it is tested as a possible biological stimulant for fish health; on the other hand, it fuels a small fully decarbonized internal logistics fleet, replacing fossil fuels in vehicles such as a forklift and a light commercial vehicle.

The value of the experimentation lies precisely in this articulation. The NUTRITECH micro-supply chain does not simply test a single technology, but builds an integrated system in which energy, food production, internal logistics and environmental innovation mutually reinforce one another. In this

sense, the case demonstrates how hydrogen can become not only an energy vector, but also an element capable of reorganizing productive relations, reducing environmental impacts and opening new possibilities for the circular management of resources.

A further significant aspect concerns the educational and demonstrative dimension of the project. NUTRITECH intends to open its site to the community as a synergistic laboratory for environmental education, in collaboration with Politecnico di Milano and the University of Modena e Reggio. Through educational visits and training routes, the site will be able to show younger generations how technology, production and environmental respect can be integrated within a single system. The collaboration with Diamant, through routes supported by hydrogen-powered bicycles, further expands this dimension, connecting technological experimentation, sustainable mobility and dissemination.

For the masterplan, the NUTRITECH case is important because it makes the transition from potential to experimentation visible. The micro-supply chain becomes a learning device: it makes it possible to verify the feasibility of specific hydrogen applications, to observe the relationships between different actors, to assess benefits and critical issues, and to produce transferable knowledge. Its value does not lie only in the specific results obtained in Villimpenta, but also in the possibility of building a model that can be replicated in other productive, agricultural, logistical or port-related contexts.

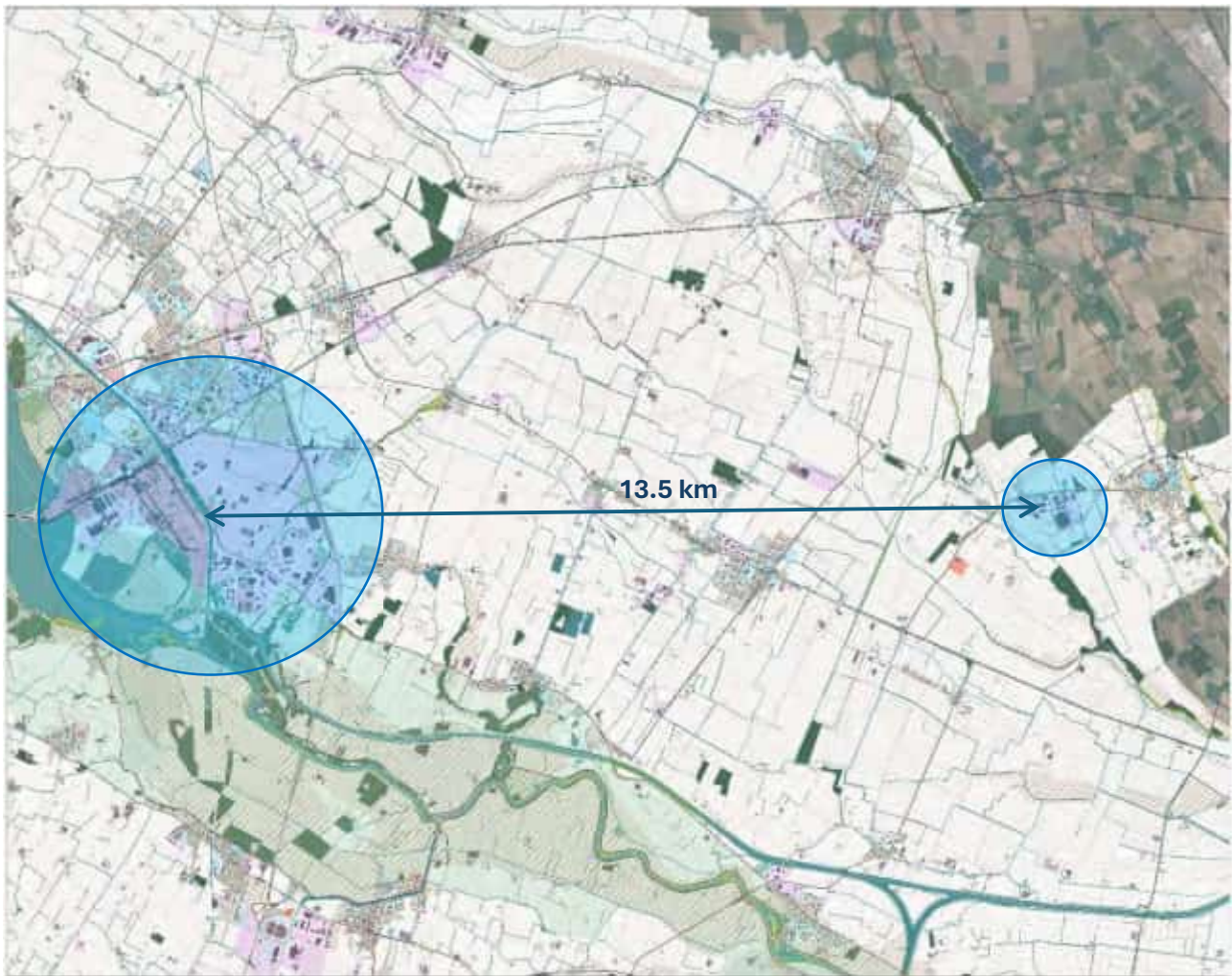
From this perspective, NUTRITECH represents a possible operational derivation of the HyMantoValley macro-supply chain. The main project provides the strategic, technological and territorial framework; the micro-supply chain tests a concrete declination of it, adapted to the conditions of a specific company. This relationship between macro-supply chain and micro-supply chain reinforces the experimental character of the masterplan: not a closed vision, but a platform capable of activating different experiences, comparing them, learning from their results and assessing their possible replicability within the broader territorial system.

9.3 Spatial effects of the strategy

The experimentation does not produce effects only at the technological or functional level; it also modifies the way in which the project must be observed and interpreted. The activation of a micro-supply chain linked to a specific productive context makes it necessary to broaden the perspective beyond the individual company site, searching for wider analytical and design frameworks. Even if the application of hydrogen originates from a specific need, its potential effects involve a broader network of relations: accessibility, infrastructures, landscape, environmental systems, internal and external logistics, educational routes and connections with the territory.

In this sense, the micro-supply chain opens up a more articulated field of operations than the energy issue alone. Hydrogen is not considered exclusively as a vector for decarbonization, but as an opportunity to connect production processes, energy services, company mobility, circular resource management, environmental quality and demonstrative activities. The experimentation therefore assumes a spatial value, because it requires understanding where these relations can take place, which spaces they involve, which connections need to be strengthened, and which landscape or environmental conditions can orient the project.

For this reason, the need emerged to expand the reference framework to the landscape scale. The landscape scale makes it possible to read the site not as an isolated point, but as part of a wider context characterized by agricultural structures, water networks, ecological elements, territorial permanences, local accessibility and relationships with the navigable corridor. This step is fundamental because it allows the project to understand whether the micro-supply chain can become rooted in the territory without being reduced to a technical installation, but instead becoming part of a broader strategy of enhancement, mitigation and connection.



Extension of the landscape-character reading area

Starting from this need, a targeted survey of the area potentially involved in the intervention was carried out. The survey aimed to verify the physical and relational conditions of the site: the structure of open spaces, the presence of ecological or agricultural elements, connections with existing infrastructures, access possibilities, relationships with the productive context, and possible opportunities to integrate energy, environmental, logistical and educational functions. In this way, the experimentation becomes not only a technological application, but also an opportunity to construct a more articulated design reading of the territory.

The value of the experimental case therefore lies in its capacity to generate effects beyond the perimeter of the intervention. The activation of the micro-supply chain requires different scales to be related to one another: the productive site, the landscape context, the infrastructural system and the broader territorial corridor identified through the mapping of active gravitation areas. This opening confirms the role of micro-supply chains as devices for learning and experimentation: they make it possible to test specific solutions, while at the same time producing useful knowledge for orienting strategies that may be replicated in other contexts.

At the local scale, a preliminary investigation was carried out to verify the existing availability of spaces that could potentially be used in relation to the project. This phase represented a necessary step for understanding whether the micro-supply chain hypothesis could find a concrete spatial translation within the productive site and its immediate context.

A site visit and a first rapid survey made it possible to assess the system of relationships, the environmental features involved and the physical conditions of the available spaces. The analysis focused not only on the areas that could directly host the technological components related to hydrogen, but also on internal and external connections, site margins, open spaces, relationships with existing productive activities, and possible interferences or compatibilities with the surrounding agricultural and landscape context.



Images from the survey recordings

The site covers an area of more than 6,000 square metres and is already partly equipped to host activities connected to the hydrogen value chain. For this reason, it represents a potentially suitable space for the development of experimental functions related to the project.

This reading made it possible to interpret the site not simply as a technical support for the intervention, but as a small territorial system in which productive functions, accessibility, environmental components, potentially transformable spaces and opportunities for educational use are intertwined. In this sense, the preliminary investigation aimed to recognize the starting conditions of the experimentation, identifying both the constraints to be considered and the spatial and relational resources that could support the activation of the micro-supply chain.

The local survey therefore plays a complementary role in relation to the landscape-scale reading. While the latter allows the site to be positioned within a broader context of environmental, agricultural and infrastructural relations, the local investigation makes it possible to verify how these relations can be translated into operational choices: the localization of equipment, the organization of routes, functional connections, possible demonstrative spaces, mitigation areas and integration with existing company activities.



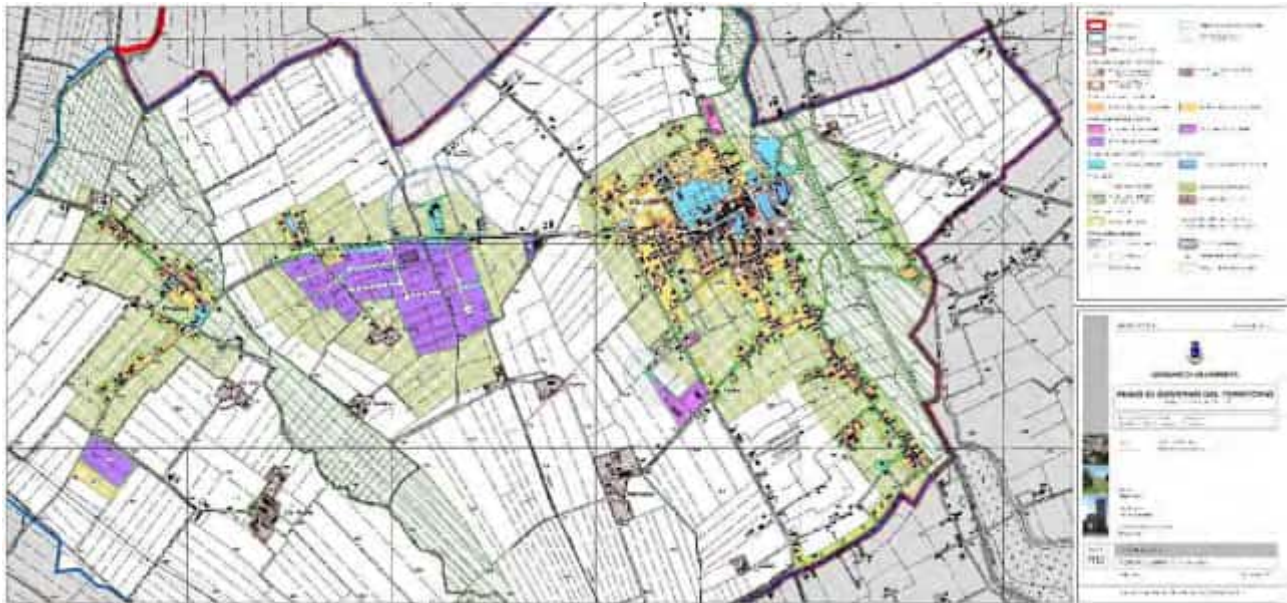
Images from the survey recordings

In this way, the experimentation is progressively brought back to a concrete design dimension. The preliminary investigation does not yet define a final configuration, but constructs the initial framework within which the spatial, environmental and functional feasibility of the intervention can be assessed, confirming the role of the micro-supply chain as a field of experimentation adaptable to the specific conditions of the place.

A further investigation concerned the urban-planning dimension, with specific reference to the land-use designations established by the municipal planning instrument. In this case as well, the objective was to verify the compatibility of the proposed interventions with the local planning framework.

This step was necessary because the experimentation cannot be considered only from a technological or functional point of view. The possible introduction of hydrogen-related equipment, educational spaces, internal logistics functions or demonstrative routes must also be assessed in relation to the regulatory conditions that govern the site. Land-use designations, permitted functions, constraints, implementation rules and possible limitations therefore become essential elements for

understanding whether and how the micro-supply chain can be integrated within the existing planning framework.



PR_2 Map – Land-Use and Territorial Regulations

https://www.comune.villimpenta.mn.it/it/documenti_pubblici/pgt

The urban-planning analysis thus complements the local survey and the landscape-scale reading. While the survey verifies the physical availability of spaces and the landscape reading situates the site within a broader environmental context, the planning analysis assesses the formal compatibility of the intervention with the municipal regulatory system. This makes it possible to identify not only potential constraints, but also the margins within which the experimentation can be developed coherently with the existing land-use framework.

In this sense, the micro-supply chain is progressively tested through different levels of verification: spatial, environmental, functional and regulatory. This confirms the need for an integrated approach, capable of transforming an experimental opportunity into a feasible and context-sensitive project.

9.4 From experimentation to implementation: strategies and design precautions

The activation of the Villimpenta micro-supply chain, requires moving from the reading of potential to the definition of specific implementation strategies and design precautions. The experimentation cannot be understood as the simple insertion of hydrogen-related technologies into an existing productive site. Rather, it should be interpreted as a process of progressive integration between energy functions, company activities, available spaces, environmental relations and possible educational or demonstrative uses.

A first strategy concerns the gradual implementation of the project. The intervention should be developed through phases, distinguishing actions that can be implemented in the short term from those requiring further technical, regulatory or managerial verification. This approach makes it possible to reduce risk, progressively test the proposed solutions and adapt the micro-supply chain according to the results obtained. In this sense, phased implementation is coherent with the experimental nature of the project: not a rigid configuration, but an evolutionary process capable of learning from its own applications.

A second precaution concerns the spatial and functional compatibility between the new components of the micro-supply chain and the existing organization of the site. Technical equipment, operational areas, logistics routes, educational spaces and demonstrative functions should be

located in such a way as not to compromise the ordinary functioning of the company, while also making the relationships between energy production, hydrogen use, oxygen recovery and circular processes clearly understandable. The quality of the experimentation depends not only on its technical performance, but also on the capacity to make the system legible.

A third issue concerns safety, regulation and spatial management. The use of hydrogen requires specific technical, regulatory and authorization checks, especially in relation to storage, distribution, vehicle refuelling and the coexistence of productive activities, company staff, visitors and educational routes. For this reason, the project should clearly distinguish technical areas, operational spaces and areas potentially accessible to the public, defining thresholds, routes, safety distances and management procedures consistent with the experimental nature of the intervention.

A further strategy concerns environmental and landscape integration. The micro-supply chain should be inserted into the site by considering not only technical requirements, but also the relationship with open spaces, agricultural areas, ecological components and the margins of the surrounding landscape. Mitigation measures, green areas, educational routes and demonstrative spaces can contribute to strengthening the environmental quality of the intervention, transforming the experimentation into an opportunity for contextual enhancement rather than a simple technical addition.

Finally, the micro-supply chain should be supported by a system of monitoring and evaluation. Since the intervention is experimental, it will be essential to collect data on hydrogen uses, energy and environmental benefits, operational criticalities, management costs, the effectiveness of circular processes and the response of the actors involved. This monitoring will make it possible to understand whether the model can be consolidated, modified or replicated in other productive and territorial contexts.

From this perspective, the implementation of the Villimpenta micro-supply chain assumes a value that goes beyond the single intervention. It becomes a testing ground for HyMantoValley, capable of verifying how a general strategy can be adapted to a specific context, which conditions are necessary to make it operational, and which forms of knowledge can be transferred to other micro-supply chains. The passage from experimentation to implementation therefore confirms the role of the masterplan as an open tool, capable of orienting concrete actions while maintaining the flexibility required to deal with uncertainty, technological innovation and the complexity of the territories involved.

Chapter 4 – Conclusions

“The future cannot be predicted, but futures can be invented.”

Dennis Gabor, Inventing the Future, 1963.

10. VISIONS OF A SUSTAINABLE FUTURE

The final chapter summarizes the main findings of the research and reflects on the role of the masterplan within the broader HyMantoValley project. The work presented in this report does not lead to a single definitive solution, but rather to **a strategic and adaptive framework** capable of guiding future transformations. In this sense, the masterplan is intended as **a tool for shaping visions of a sustainable future**: not abstract scenarios detached from reality, but possible trajectories rooted in the specific conditions of East Mantua, its production and infrastructure systems, its ecological and landscape values, and the opportunities generated by the hydrogen value chain.

To achieve this, the development of these visions has been continually informed by a dialogue between what East Mantua is today, what it retains of its history and identity, and what it can become through the ongoing transition processes. Within this framework of **constant dialogue between past, present and future**, the masterplan serves as the **link between the definition of a territorial strategy** and the **subsequent design phases**, acting as a bridge to the work of those who will be called upon to translate these guidelines into design solutions at the architectural scale.

The masterplan therefore does not mark the end of the design process, but rather heralds a new phase, in which the strategy developed through research becomes the guiding principle for the design and implementation of future transformations.

10.1 Research outcomes

By taking a broader view that captures the full scope of the research, it is possible to describe the results achieved by examining several fundamental issues.

Firstly, the study has shown that HyMantoValley cannot be interpreted merely as a technological or infrastructural project, nor simply as the physical location of a research hub. It must be understood as a process of territorial transformation, in which the hydrogen value chain activates spatial, productive, environmental and institutional relationships on various scales. Following this work, it emerges very clearly that the value of ‘green’ hydrogen should therefore not be considered solely in its energy dimension, but in its capacity to stimulate a new era of planning, in which decarbonization infrastructure acts as an active component of territorial transformations. The challenge lies in steering this evolution by avoiding purely engineering-based approaches and instead promoting integrated energy landscapes capable of combining climate neutrality, quality of space and territorial justice.

Secondly, the research has produced a multi-scale knowledge framework. The territorial scale has clarified the role of Mantova Est within broader networks of infrastructure, logistics, energy and governance. The landscape scale has revealed the importance of ecological corridors, water systems, historical continuity and landscape values. The urban scale has translated these interpretations into operational terms, highlighting accessibility, land-use compatibility, environmental constraints, production systems and site-specific opportunities for transformation. The value of the information system produced is further enhanced through an integrated analysis across the different levels and by adopting an iterative approach. The various scales have, in fact, fed into one another: the interpretations developed at the territorial scale guided subsequent in-depth analyses, whilst the findings that emerged at the landscape and urban scales helped to reconsider and refine the overall understanding of the territory. The result is a unified knowledge framework, in which an understanding

of the relationships between the various components of the system becomes the prerequisite for the development of coherent and shared design strategies.

Thirdly, the research highlighted the importance of uncertainty as a constitutive dimension of the design process. Rather than producing a fixed final configuration, the master plan defines a flexible framework based on preparation, experimentation and adaptability. This approach allows the project to remain strongly focused on the objectives of HyMantoValley, whilst remaining open to different implementation pathways, technological developments, decisions by stakeholders and possible micro-supply chains. In doing so, it provides a robust strategic reference that combines long-term vision with the flexibility required to respond to changing territorial, economic and technological conditions.

Finally, the research demonstrated that sustainability must be rooted in the local context. The Sustainable Development Goals were not treated as a generic reference, but as an interpretative and planning framework through which territorial, landscape and urban issues could be identified, compared and translated into spatial strategies. In this sense, the project contributes to the localization of sustainability objectives within a complex productive territory, with its own specific characteristics and development trajectories. Rooting sustainability in the local context means understanding and working with the identity of the place rather than imposing abstract models of development. In the case of Mantua East, this required engaging with the historical stratification of the productive district, its existing industrial and logistics infrastructure, and its strong environmental and landscape value.

Furthermore, in relation to the same theme, the research highlighted the need to interpret SDG 7 – Affordable and Clean Energy from a systemic perspective. Clean energy cannot be considered as an isolated objective, especially within a project such as HyMantoValley, where the development of a hydrogen research hub in the Mantova industrial cluster activates a broader set of territorial, environmental, social and economic implications.

From this point of view, SDG 7 becomes the entry point for a wider framework of sustainability goals. The transition toward clean energy is closely connected to SDG 4, because the Research Hub can support education, training and knowledge transfer; to SDG 6, due to the role of water resources and their sustainable management in hydrogen production and environmental quality; and to SDG 8, as the project may contribute to qualified employment, innovation-oriented economic growth and new professional skills.

At the same time, the project directly relates to SDG 9, through the development of resilient infrastructures, industrial innovation and technological experimentation, and to SDG 11, because the transformation of Mantova Est concerns the future of a complex urban and productive area. The integration of hydrogen technologies also raises issues connected to SDG 12, particularly in relation to responsible production models, circular processes and more sustainable resource use.

The systemic reading of SDG 7 also opens to broader environmental objectives. SDG 13 is involved through the contribution of hydrogen to climate action and decarbonization strategies, while SDG 15 becomes relevant in relation to ecological systems, landscape continuity and the protection or restoration of terrestrial ecosystems. Finally, SDG 17 plays a fundamental role, since the implementation of HyMantoValley depends on cooperation among public institutions, private companies, research bodies and local stakeholders.

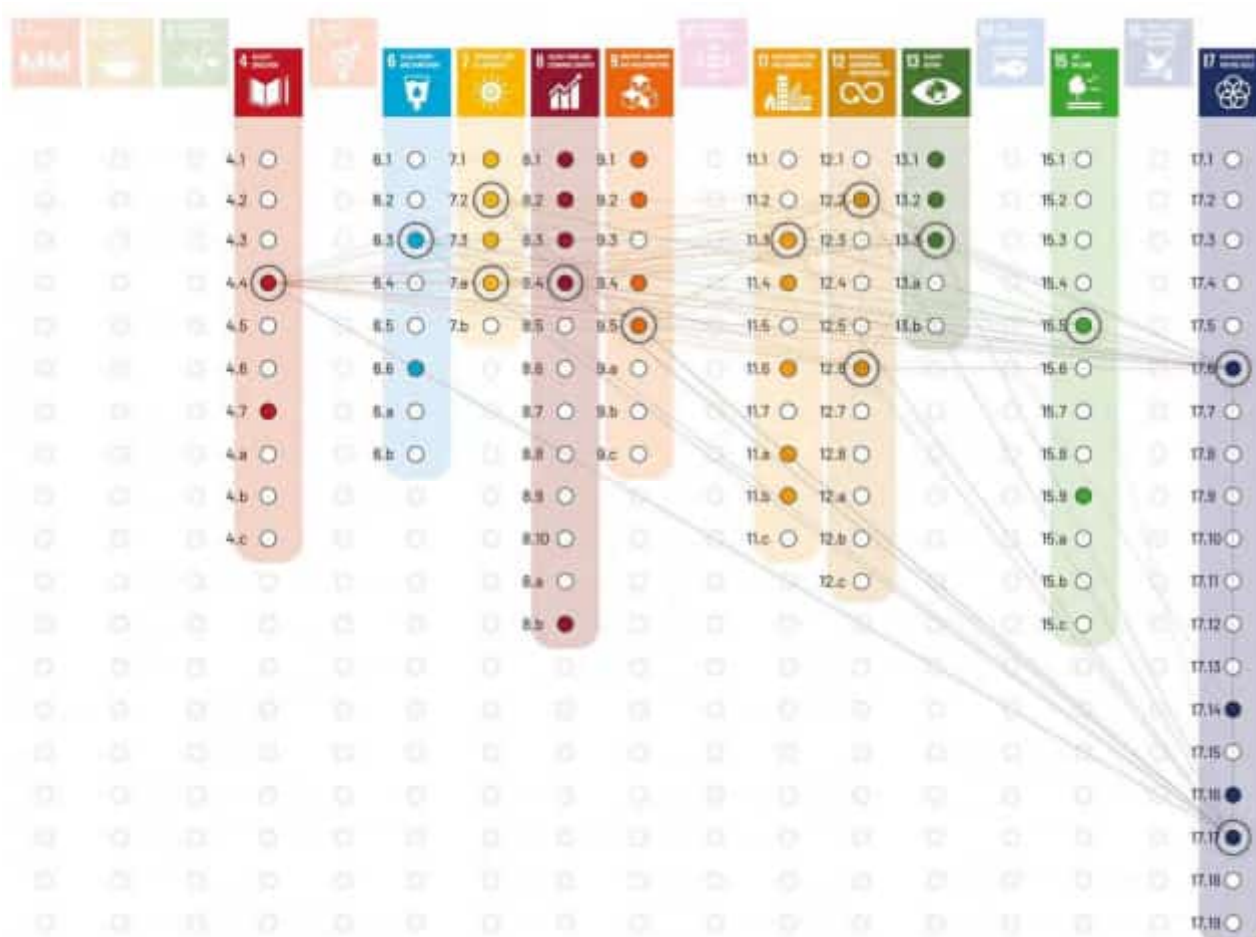
In this sense, the project shows that clean energy is not only a technological goal, but a relational framework. SDG 7 acts as a catalyst through which multiple sustainability objectives can be connected, allowing the masterplan to interpret the hydrogen hub not as a single-sector intervention, but as part of a broader strategy for territorial transition.

The future of Mantua East depends not only on hydrogen technologies, but on the capacity to integrate them within a place-based territorial strategy.

The work developed through the masterplan shows that sustainability cannot be reduced to the adoption of a single technological solution, nor to the mechanical application of global objectives. It requires a process of interpretation, selection and translation, capable of relating the SDGs to the specific conditions of the territory.

The following diagram summarizes this approach. It shows how the project interacts with a selected set of SDG targets, making visible the multiple relationships between energy transition, innovation, infrastructure, responsible production, climate action, ecological protection, governance and education. The value of the diagram lies precisely in this relational reading: the SDGs are not treated as isolated goals, but as an interconnected framework through which the masterplan can orient priorities, evaluate coherence and support future decisions.

In this sense, HyMantoValley becomes more than a hydrogen project. It becomes a territorial experiment in which global sustainability targets are grounded in local spatial choices, productive systems, environmental conditions and possible future scenarios.



HyMantoValley: using sustainability targets as a framework.

10.2 Contribution of the Masterplan to HyMantoValley

The master plan contributes to the HyMantoValley project by translating its strategic objectives into a spatial and operational framework. The project is not limited to the development of hydrogen technologies, but requires suitable locations, connections, interfaces and conditions in which production, storage, distribution, research, training and application can interact. The masterplan provides the tool through which these components can be understood as a whole and organized within the specific context of East Mantua.

One of its main contributions is the spatialization of the hydrogen value chain. The masterplan enables us to understand how the Research Hub can relate to existing production areas, the Port of Valdaro, road and rail infrastructure, environmental constraints, ecological systems and potential areas for regeneration. In this sense, it transforms the project's abstract structure into a set of possible spatial strategies.

The masterplan also supports coherence between the macro-supply chain and the potential micro-supply chains activated by HyMantoValley. The macro-supply chain defines the overall strategic framework, linking hydrogen production, logistics, mobility, research and industrial applications. At the same time, the urban and site-specific analysis allows for the emergence of various micro-supply chains, each linked to specific stakeholders, uses, locations and implementation phases. These may relate to port logistics, public and private mobility, industrial energy uses, research and training activities, environmental remediation, circular processes or local services.

For this reason, the masterplan serves **as a platform for experimentation**. It does not impose a single development path but identifies a range of possible strategies that can be tested, adapted and progressively implemented. This is particularly important in a context characterized by technological innovation, market volatility, environmental constraints and institutional complexity. The masterplan therefore enhances HyMantoValley's ability to remain consistent in its objectives whilst remaining flexible in its implementation.

Furthermore, the masterplan contributes to the **creation of a shared vision for East Mantua**. By integrating energy transition, industrial regeneration, landscape values, environmental mitigation and research activities, it offers a common spatial framework for public institutions, private stakeholders, research partners and local actors.

Finally, the masterplan defines and **sets out a possible role for the Research Hub** within Mantua's industrial hub. The aim of the research was not to anticipate architectural choices or to define the building's formal configuration, but rather to **clarify its territorial significance**, the relationships it is intended to foster, and the contribution it can make to the transformation processes triggered by the HyMantoValley project. The Research Hub is therefore interpreted as something that goes far beyond a mere container of functions; rather, it is a strategic infrastructure capable of linking research, the production system, logistics, the landscape and innovation, whilst playing an active role in the development of the future hydrogen supply chain.

Building on this framework, the subsequent design development will translate these guidelines into an architectural proposal, whilst maintaining as key references certain fundamental requirements that emerged during the research: the ability to integrate functionally with the hydrogen value chain, providing spaces for research, experimentation and demonstration; the flexibility of the system, so that it can evolve over time through adaptable configurations and progressive extensions; integration with the infrastructure and intermodal transport systems; the establishment of a balanced relationship with the landscape and environmental factors; and, finally, the ability to foster collaboration between disciplines, institutions, businesses and research, establishing the Research Hub as a place for collaboration and the transfer of innovation.

10.3 Open issues and future developments

The outstanding issues identified by the research do not represent a limitation of the masterplan but rather confirm **its strategic and adaptive nature**. HyMantoValley operates in a context characterized by technological innovation, environmental complexity, regulatory requirements, market uncertainty and the presence of multiple institutional stakeholders. For this reason, various aspects will require further review during the subsequent phases of the project.

A first open issue concerns **implementation**. The masterplan identifies possible strategies and territorial opportunities, but their development will depend on phasing, funding, administrative procedures, agreements with stakeholders and technical feasibility. Setting priorities will therefore be essential to distinguish between short-term actions, enabling interventions and longer-term transformations.

A second issue concerns the **evolution of the hydrogen value chain**. Future technological developments, changes in energy demand, logistical requirements and market conditions could influence the role of Mantova Est and the specific micro-supply chains that may be established. The master plan must therefore remain sufficiently flexible to adapt to different configurations without losing consistency with the overall objectives of HyMantoValley.

Environmental and remediation issues also remain central. The presence of contaminated sites, ecological sensitivities, hydraulic conditions and landscape constraints require ongoing coordination between planning, environmental assessment and design. Future developments will need to examine how regeneration, mitigation and remediation strategies can be integrated with production and research functions

Governance represents another crucial dimension. The project's success will depend on the ability to coordinate public institutions, private companies, research bodies, infrastructure operators and local communities. The master plan can provide a shared spatial framework, but its implementation will require ongoing negotiations, monitoring and adjustments.

In conclusion, the future of HyMantoValley should be understood as **an open-ended process** rather than a predetermined outcome. The value of the master plan lies precisely in its ability to guide this process: making complexity comprehensible, organizing possible strategies, supporting experimentation and preparing East Mantua for a range of sustainable futures.

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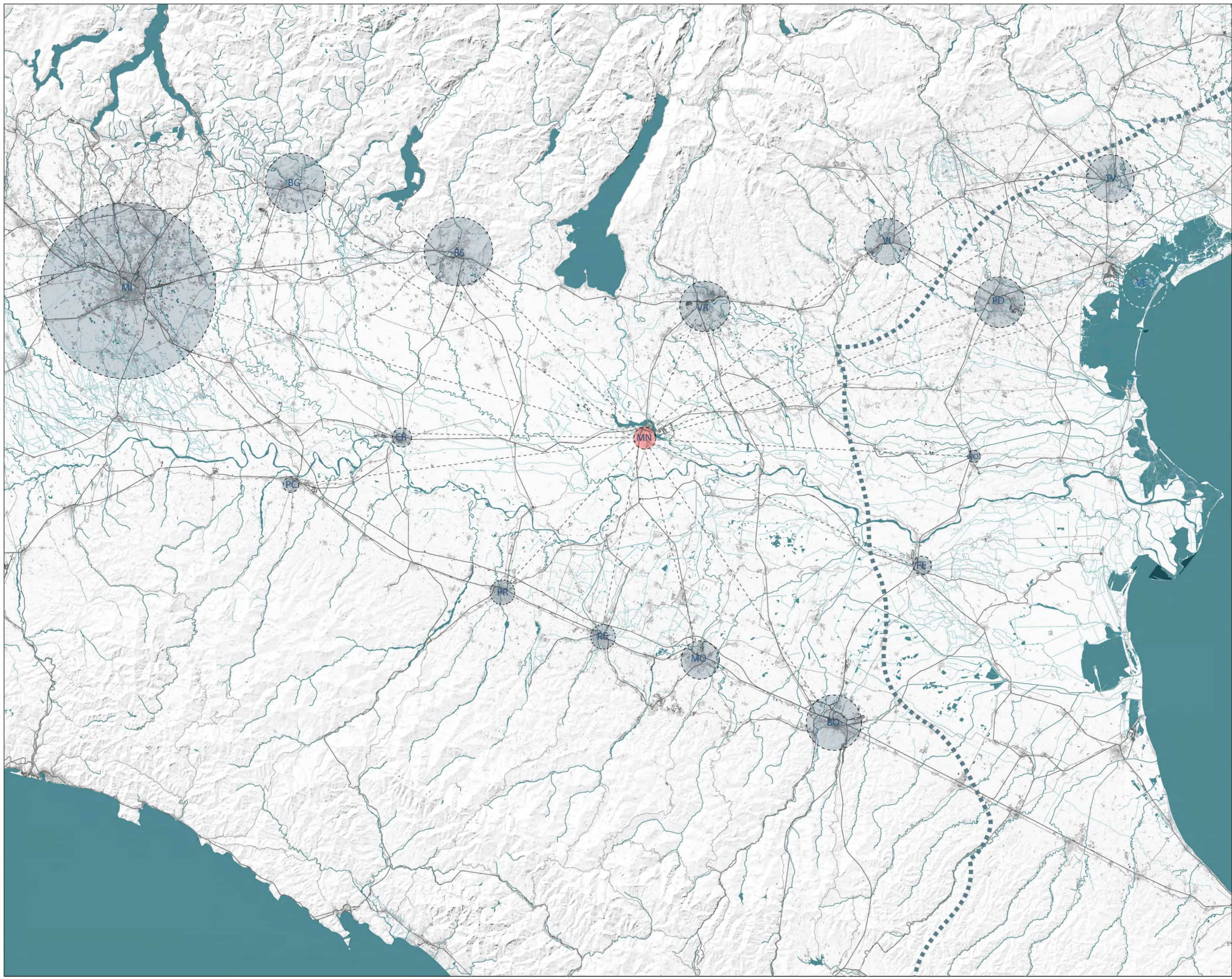
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POLITECNICO | MANTOVA
MILANO 1863 | CAMPUS

POLITECNICO MILANO 1863 **LAB**

UNESCO Research



- LEGEND**
- Railways
 - Primary roads
 - Canal
 - River
 - Building elements
 - Waterbodies
 - Planned Hydrogen pipeline

131km	MN-MI
127km	MN-TV
123km	MN-VE
106 km	MN-BG
89km	MN-PD
88km	MN-PC
85km	MN-BO
78km	MN-RO
74km	MN-FE
73km	MN-VI
61 km	MN-BS
60km	MN-CR
58km	MN-RE
57km	MN-MO
53km	MN-PR
34km	MN-VR

- Population > 3000000
- Population : 800000-1300000
- Population : 200000-800000

 **POLITECNICO MILANO 1863** | MANTOVA CAMPUS

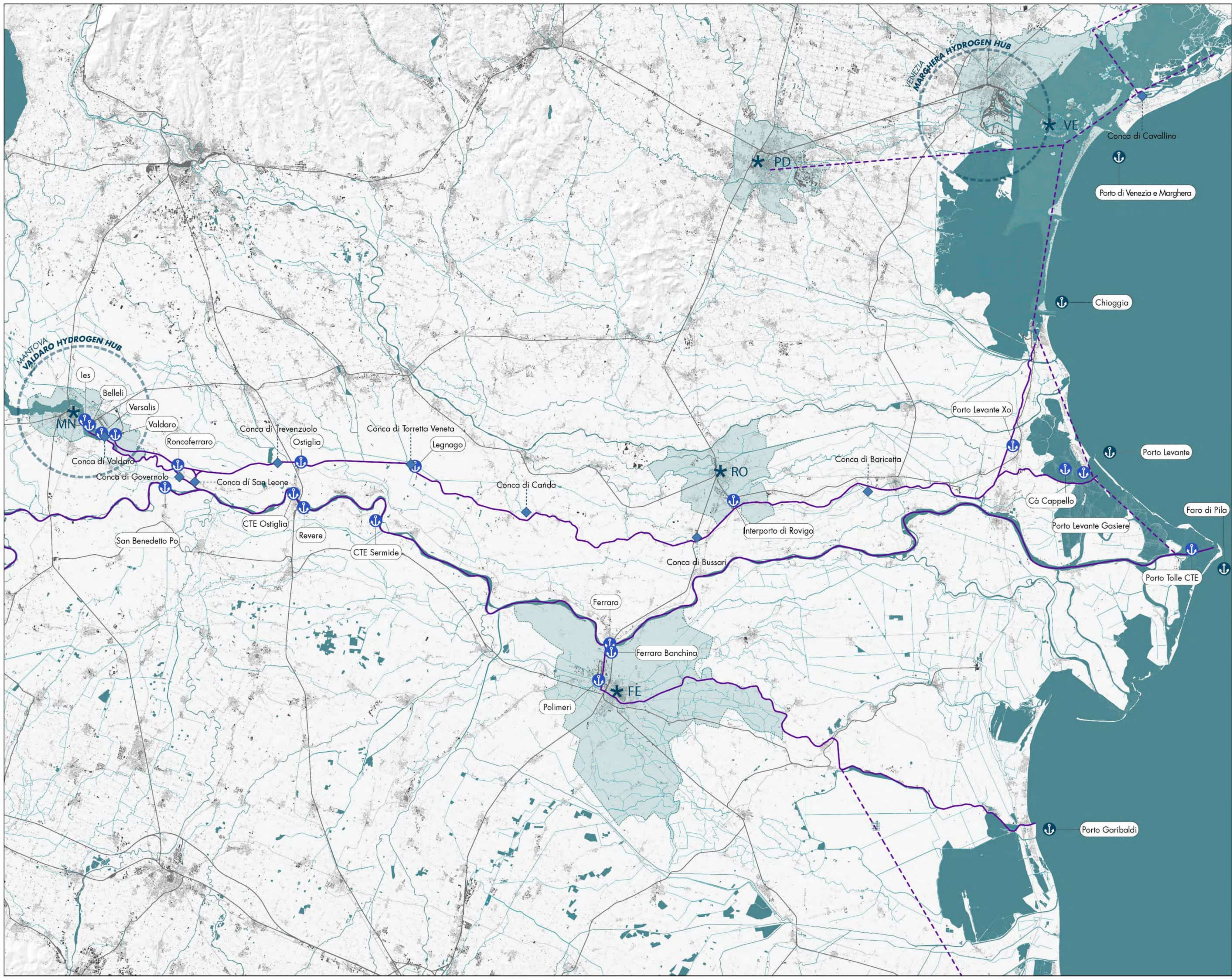
 **UNESCO Research**

GROUNDING
THE SUSTAINABILITY.
NEW OPPORTUNITIES FOR OUR FUTURE.



Board 1. Framework of Knowledge
Territorial scale





- LEGEND**
- Maritime ports (source: Province)
 - Inland commercial ports in use (source: PTCP)
 - Navigation basins (source: PTCP)
 - Current navigation system (source: AIPO)
 - Navigation system in project (source: AIPO)
 - Railways
 - Primary roads
 - Canal
 - River
 - Building elements
 - Waterbodies

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Board 2. Framework of Knowledge
Waterway system





LEGEND

Linear elements

- High level of Permanence
- Medium level of Permanence
- Rural Breaklines

Punctual elements

- High level of Permanence
- Medium level of Permanence
- Low level of Permanence

Natural elements

- WATER COURSES

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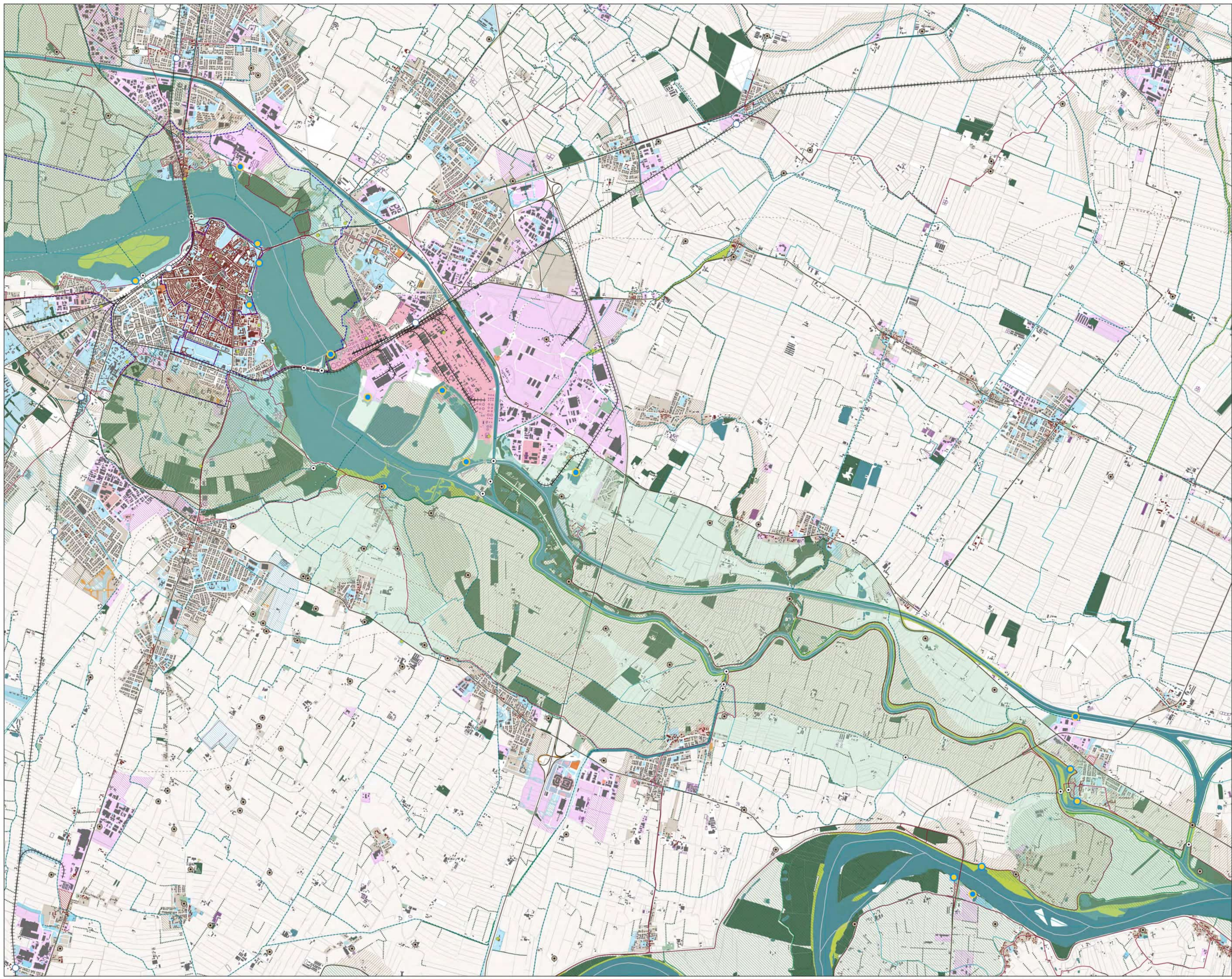
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THE SUSTAINABILITY.
NEW OPPORTUNITIES FOR OUR FUTURE.



Board 3. Framework of Knowledge
Permanences reading





LEGEND

Landscape

- Hydraulic artefacts
- Architectural Heritage
- Monumental Trees
- Row of Trees
- Rural breakline
- Historic canals
- Buffer zone UNESCO sites
- UNESCO sites perimeter
- Geomorphological shape
- Ancient formation nucleus
- Mincio Park
- Agriculture land

Environment

- Contaminated sites
- Canals
- Embankments
- High vulnerability
- Water surfaces
- Particular formation
- Relevant vegetation
- Woods

Infrastructure

- Railway station
- Commercial ports
- Touristic ports
- Railway
- Main roads
- Planned roads
- Cycling routes
- Navigable network
- Planned Navigable network

Urban settlement

- Building element
- Plants at risk
- Transforming/unstructured area
- Industrial artifacts

Residential Buildings	Tertiary buildings
Existing	Existing
Prevision	Prevision

Industrial Buildings	Service Buildings
Existing	Existing
Prevision	Prevision

 **POLITECNICO MILANO 1863** | MANTOVA CAMPUS

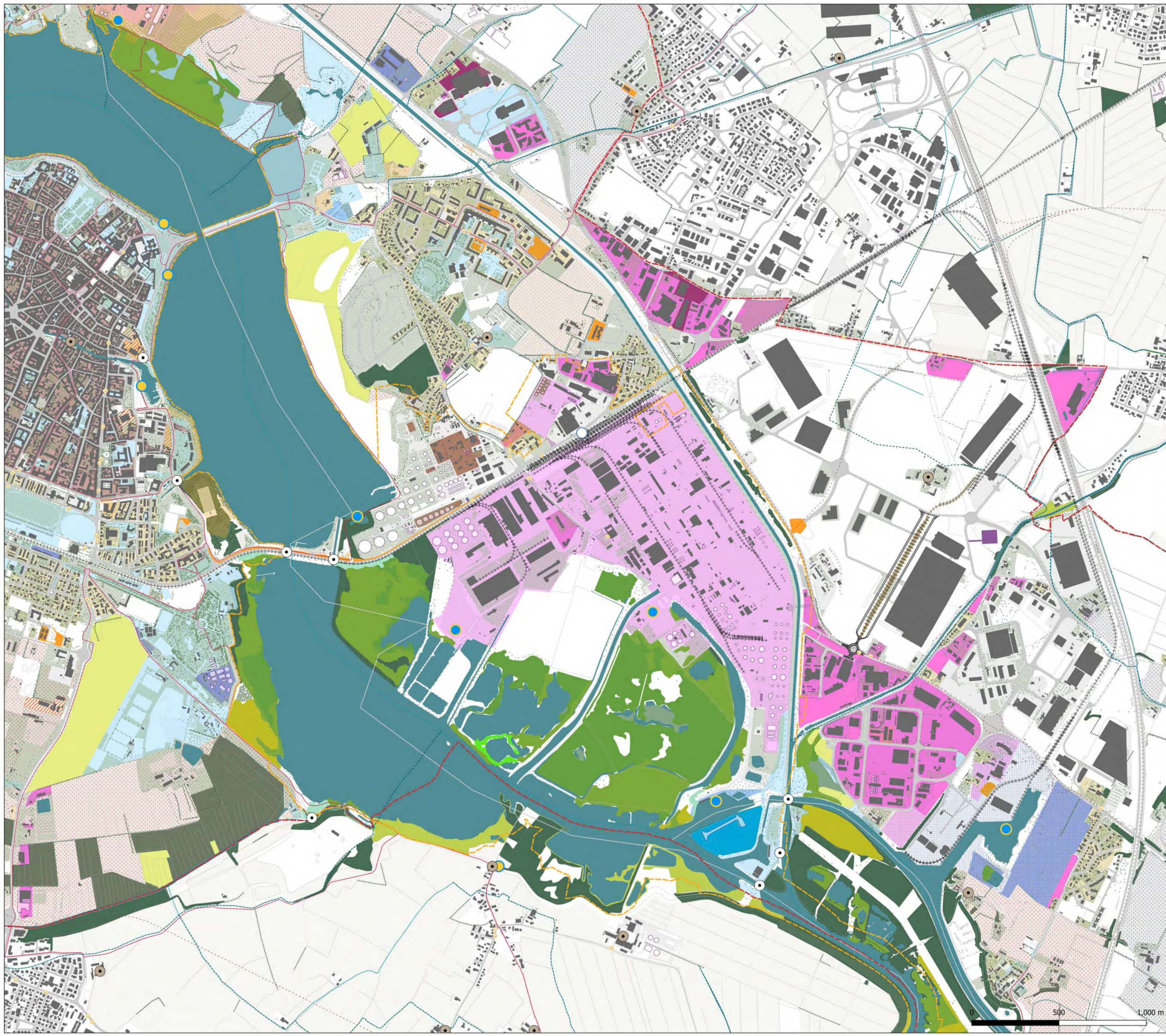
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NEW OPPORTUNITIES FOR OUR FUTURE.



Board 4. Framework of Knowledge Landscape element





LEGEND

ENVIRONMENT

- Canals
- Historic canals
- SIN perimeter
- Contaminated sites
- Water surfaces
- Particular formation
- Woods

Riparian elements

- Shrublands
- Reeds
- Uncultivated
- Poplar groves shelters
- Mixed Robinia
- Willow groves with Salix cinerea
- Bank willow grove

Agricultural territory

- Agricultural areas of landscape value
- Agricultural areas of productive value
- Agricultural areas of interaction

LANDSCAPE

- Hydraulic artefacts
- Architectural Heritage
- Isolated trees
- Row of Trees
- Rural breakline
- Historic canals
- Green areas
- Agriculture land

INFRASTRUCTURE

- Railway station
- Bus stops
- Commercial ports
- Touristic ports
- Railway
- Intermodal tracks
- Intermodal platform
- Cycling routes
- Navigable network
- Planned roads
- Road

URBAN SETTLEMENT

- Municipality border
- Industrial artifacts
- Building Element
- Equipped areas
- Transforming/unstructured area
- Primary cabin for future construction
- Reclamation areas
- Residential fabrics of ancient nuclei
- Consolidated tissues external to the ancient formation nuclei
- Residential areas
- Areas for economic activities
- Areas for mainly commercial economic activities
- Areas for economic activities of productive and artisanal nature
- Abandoned or degraded areas to be subjected to recovery and redevelopment

System of Services and Diffused green space

- Services of public or general interest
- Areas for private equipment
- Technological infrastructures of common interest

Port of Valdarò

- Publicly managed logistics and port areas
- Logistics and port areas subject to implementation planning
- Private production areas serving the port
- Navigation basin of port

POLITECNICO MILANO 1863

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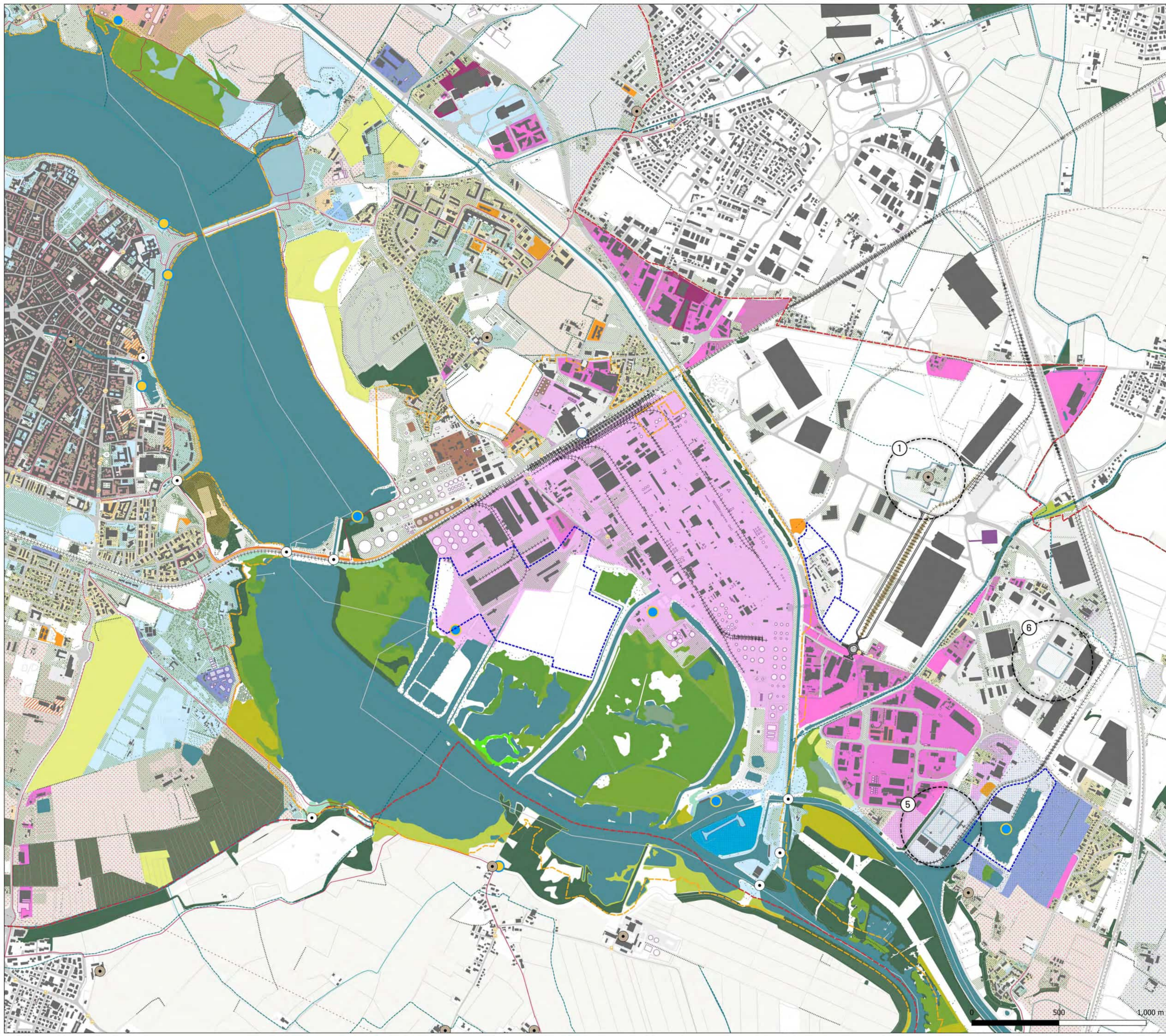
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GROUNDING THE SUSTAINABILITY.
NEW OPPORTUNITIES FOR OUR FUTURE.

Board 5. Framework of Knowledge
Urban scale





LEGEND

ENVIRONMENT

- Canals
- Historic canals
- SIN perimeter
- Contaminated sites
- Water surfaces
- Particular formation
- Woods

Riparian elements

- Shrublands
- Reeds
- Uncultivated
- Poplar groves shelters
- Mixed Robinia
- Willow groves with Salix cinerea
- Bank willow grove

Agricultural territory

- Agricultural areas of landscape value
- Agricultural areas of productive value
- Agricultural areas of interaction

LANDSCAPE

- Hydraulic artefacts
- Architectural Heritage
- Isolated trees
- Row of Trees
- Rural breakline
- Historic canals
- Green areas
- Agriculture land

INFRASTRUCTURE

- Railway station
- Bus stops
- Commercial ports
- Touristic ports
- Railway
- Intermodal tracks
- Intermodal platform
- Cycling routes
- Navigable network
- Planned roads
- Road

URBAN SETTLEMENT

- Municipality border
- Industrial artifacts
- Building Element
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System of Services and Diffused green space

- Services of public or general interest
- Areas for private equipment
- Technological infrastructures of common interest

Port of Valdaro

- Publicly managed logistics and port areas
- Logistics and port areas subject to implementation planning
- Private production areas serving the port
- Navigation basin of port

HYMANTOVALLEY

- Areas involved in the hydrogen value chain

Suitable locations for the Research Hub:

OLMO LUNGO
ResearchHub

PRODUCTIVE CORE
ResearchHub

VALDARO PORT
ResearchHub

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GROUNDING
THE SUSTAINABILITY.
NEW OPPORTUNITIES FOR OUR FUTURE.

Key SDGs
Urban Scale
1:10,000

Board 6. Masterplan strategy
Urban scale

BOOKLET

SITE ASSESSMENT

*THREE
POSSIBLE
LOCATIONS
FOR THE
RESEARCH HUB*

GROUNDING THE SUSTAINABILITY.
NEW OPPORTUNITIES FOR OUR FUTURE.

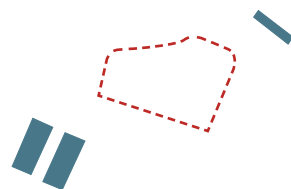


POLITECNICO
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POLITECNICO MILANO 1863

LAB

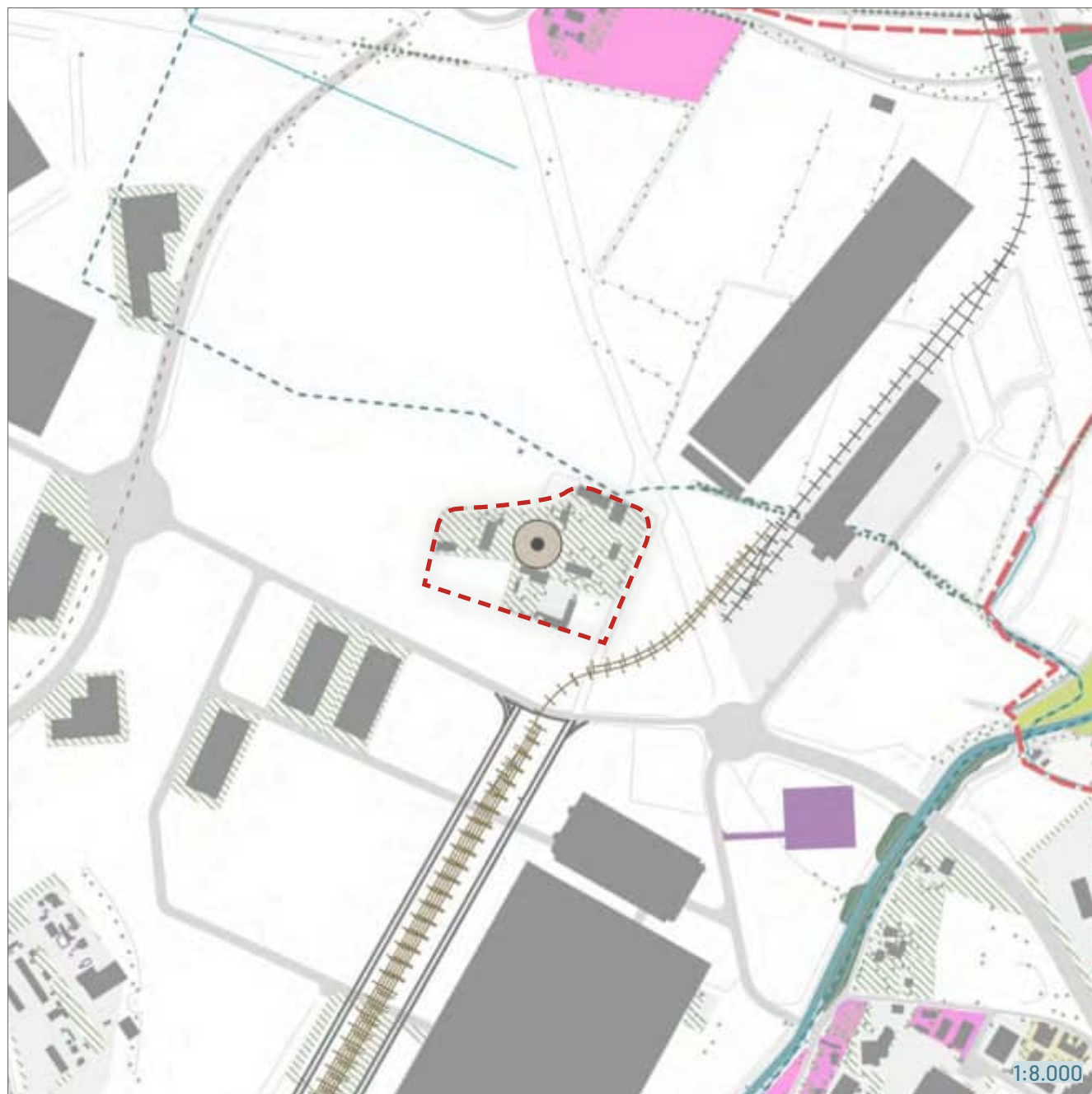
UNESCO Research



IDENTITY PROFILE

TRANSITION AREA

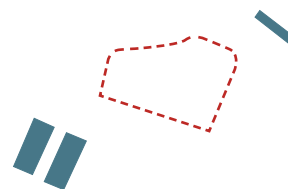
URBAN INTRODUCTION



AREA SIZE

38.511 m²MOST INFLUENTIAL PROJECT AREA
DISTANCE TO HRS ROAD VEICHLES**730 m**DISTANCES
TO PROJECT AREAS

PV PLANT	2.557 m
H2 PRODUCTION PLANT	815 m
HRS ROAD VEICHLES	730 m
HRS RAILWAY	942 m
HRS PORT	2.002 m



IDENTITY PROFILE

TRANSITION AREA

PTCP ANALYSIS

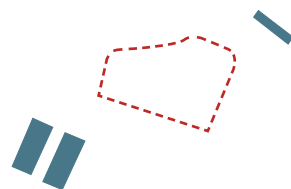
PROVINCE



PIANO DI COORDINAMENTO PROVINCIALE / PROVINCIAL TERRITORIAL COORDINATION PLAN

Top / Tavola 1 | Indicazioni Paesaggistiche e Ambientali | Circondario D (Approvazione 2022)

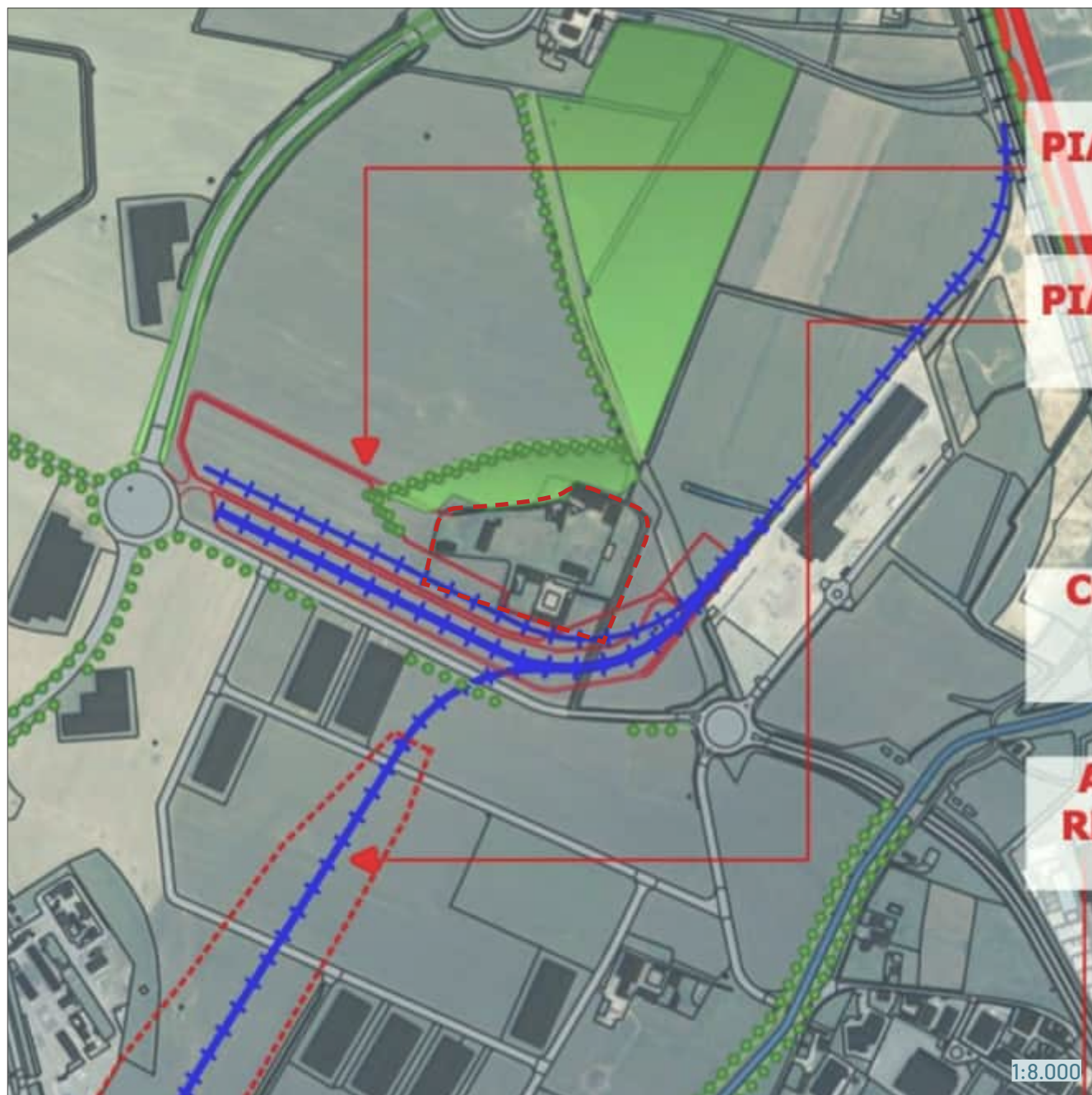
Bottom / Tavola 2 | Indicazioni Insediative Infrastrutturali e Agricole | Circondario D (Aggiornamento 2024)



IDENTITY PROFILE

TRANSITION AREA

MASTERPLAN ANALYSIS

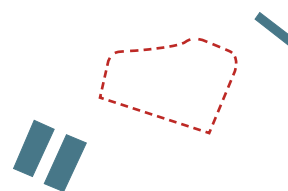


PROVINCE

PIANO DI COORDINAMENTO PROVINCIALE / PROVINCIAL TERRITORIAL COORDINATION PLAN

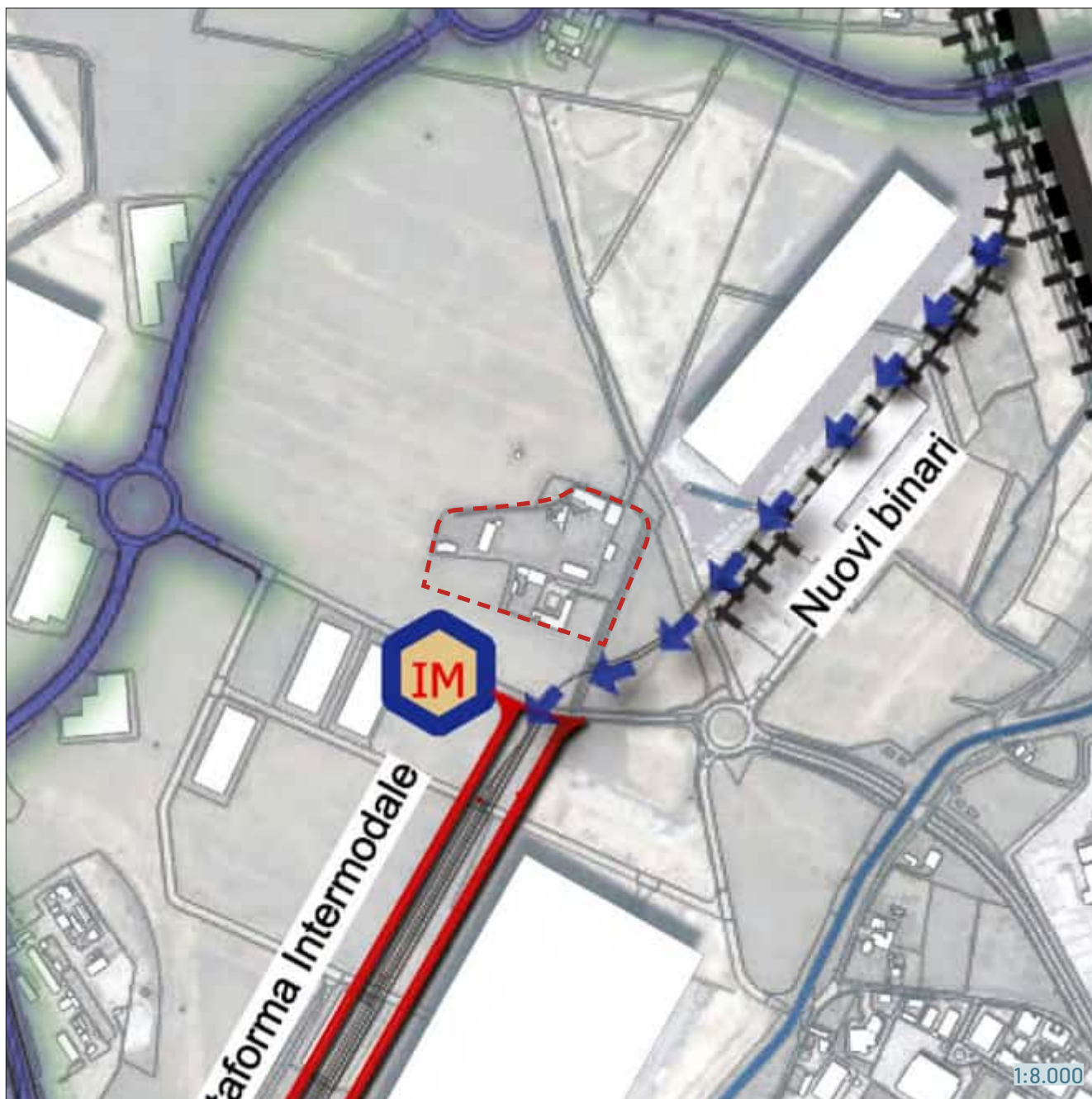
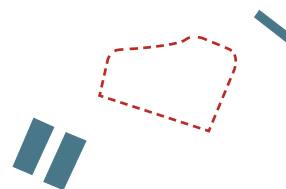
Tavola 2 | Masterplan per la rigenerazione territoriale del polo produttivo di livello provinciale di Mantova Est e del sito inquinato di interesse nazionale - Laghi di Mantova e Polo Chimico.

Sintesi degli interventi proposti (Anno 2020)



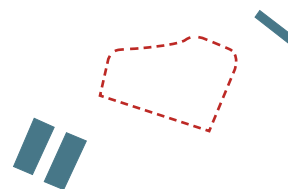
IMPLICATIONS OF THE PROVINCIAL PLAN FOR THE HYMANTOVALLEY AREA

Tavola 4 | Sistema Ecologico | Analisi dello stato di fatto (Anno 2023)



IMPLICATIONS OF THE PROVINCIAL PLAN FOR THE HYMANTOVALLEY AREA

Tavola xx | Abaco della mobilità di progetto (Anno 2023)



IDENTITY PROFILE

TRANSITION AREA

PGT ANALYSIS



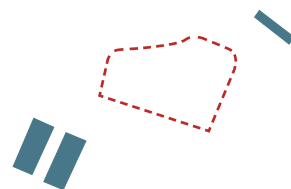
MUNICIPALITY

PIANO DI GOVERNO DEL TERRITORIO / MUNICIPAL SPATIAL PLAN

DOCUMENTO DI PIANO

QUADRO CONOSCITIVO (Approvazione 2012)

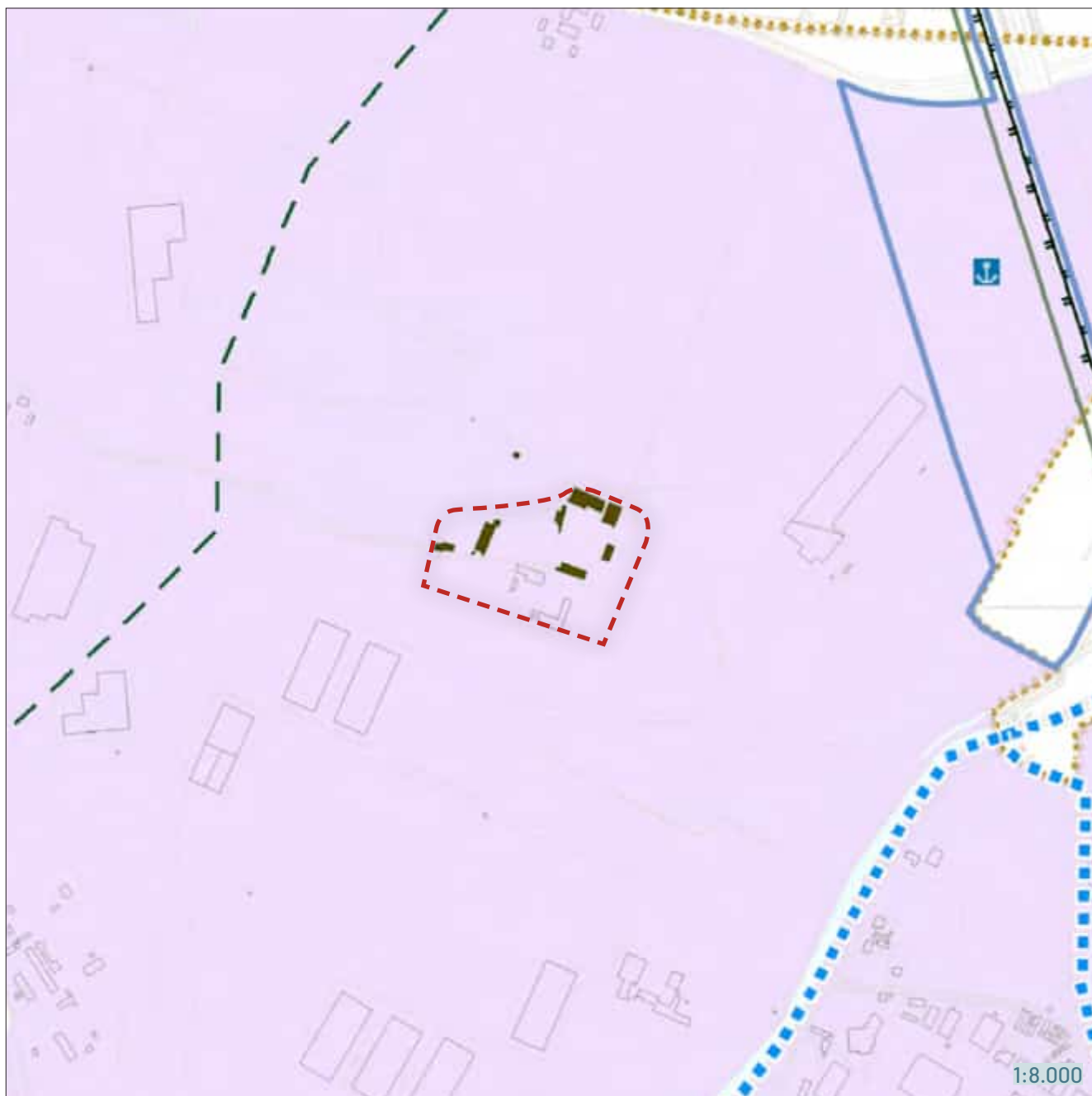
Tavola DP1b | La città e le imprese (Approvazione 2012)



IDENTITY PROFILE

TRANSITION AREA

PGT ANALYSIS



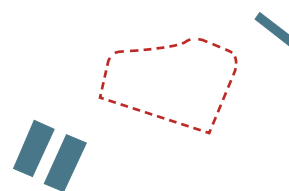
MUNICIPALITY

PIANO DI GOVERNO DEL TERRITORIO / MUNICIPAL SPATIAL PLAN

DOCUMENTO DI PIANO

QUADRO STRATEGICO (Approvazione 2012)

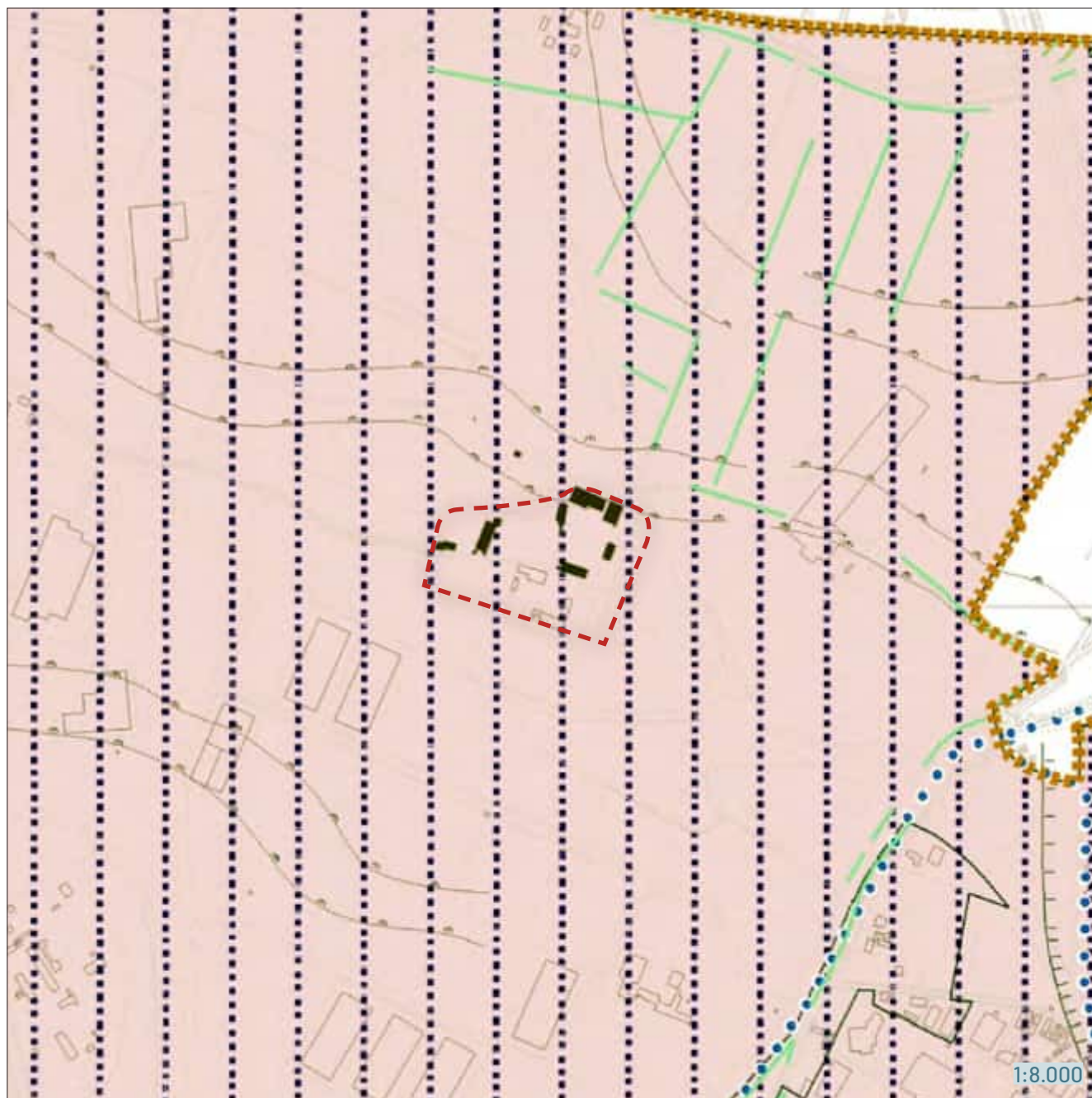
Tavola DP4 | Strategie trame trasformazioni e progetti (Approvazione 2012)



IDENTITY PROFILE

TRANSITION AREA

PGT ANALYSIS

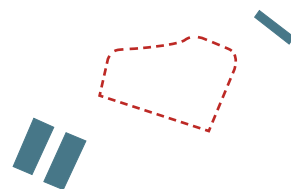


PIANO DI GOVERNO DEL TERRITORIO / MUNICIPAL SPATIAL PLAN

DOCUMENTO DI PIANO

QUADRO PROGRAMMATICO (Approvazione 2012)

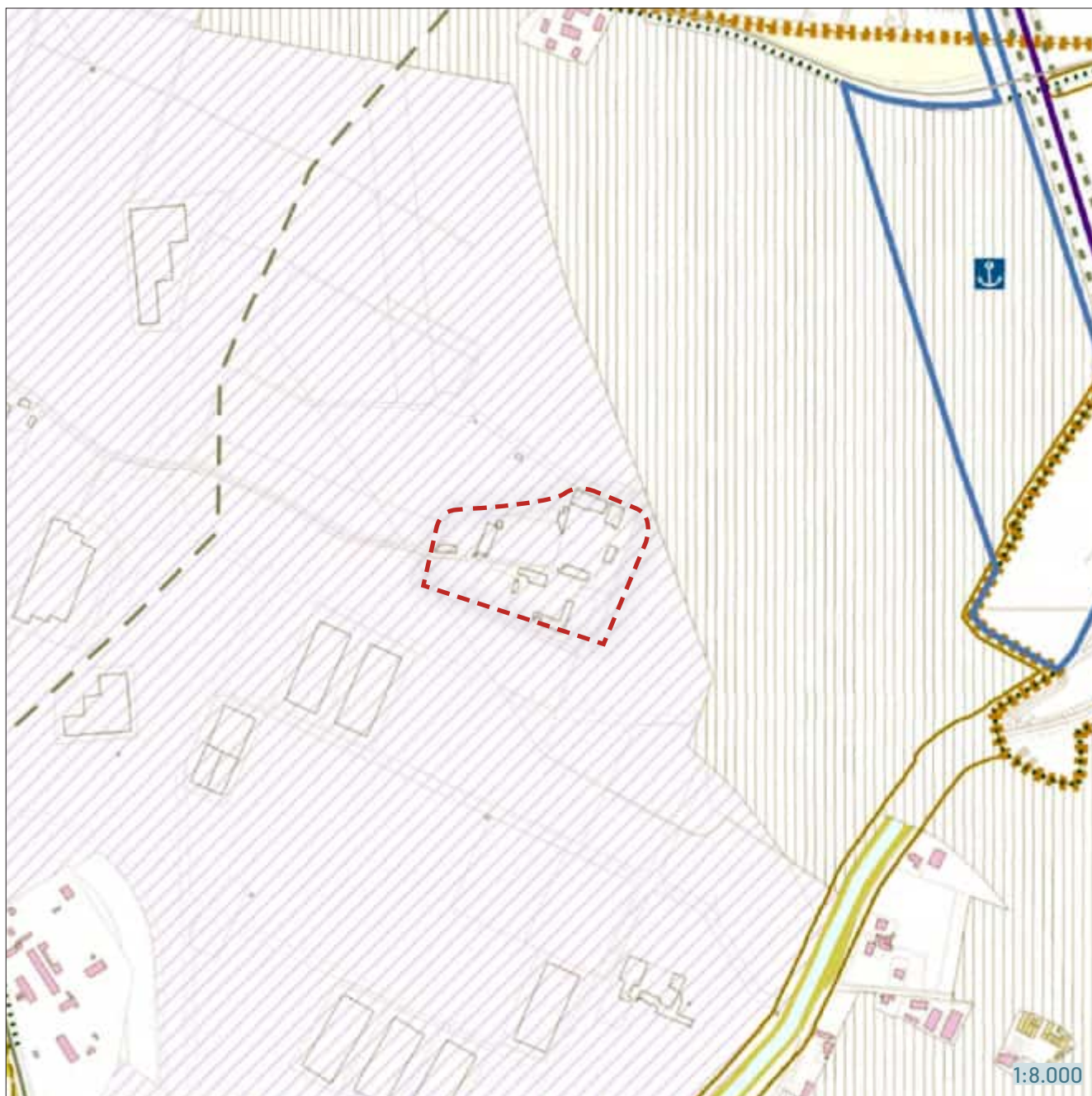
Tavola DP5 | Sensibilità paesistica (Approvazione 2012)



IDENTITY PROFILE

TRANSITION AREA

PGT ANALYSIS



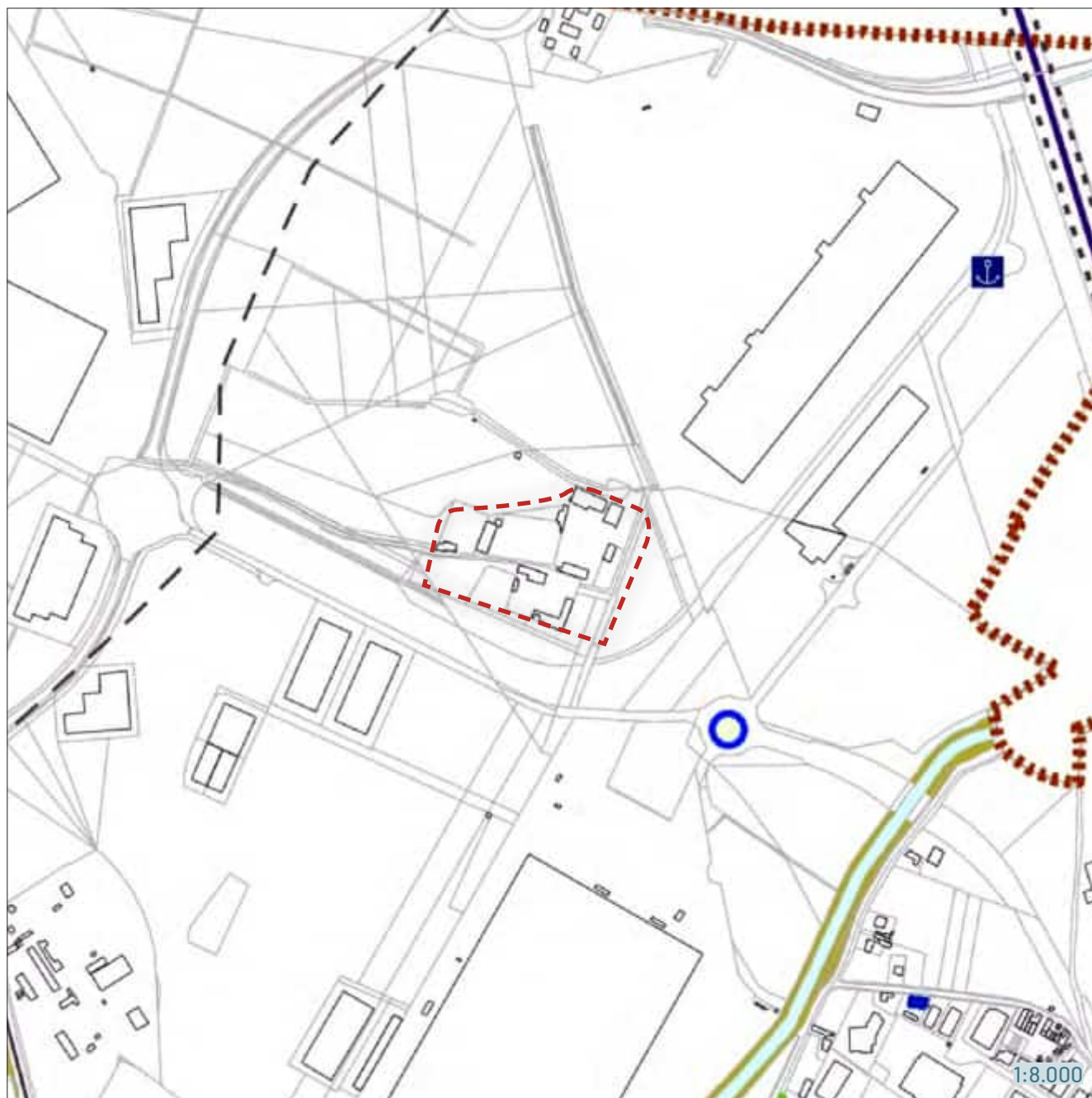
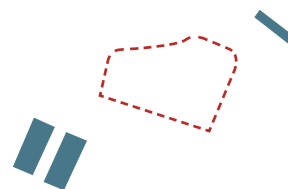
MUNICIPALITY

PIANO DI GOVERNO DEL TERRITORIO / MUNICIPAL SPATIAL PLAN

DOCUMENTO DI PIANO

QUADRO PROGRAMMATICO (Approvazione 2012)

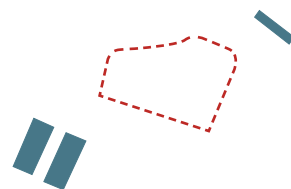
Tavola DP6 | Previsioni di Piano (Approvazione 2012)



PIANO DI GOVERNO DEL TERRITORIO / MUNICIPAL SPATIAL PLAN

PIANO DEI SERVIZI (Approvazione 2012)

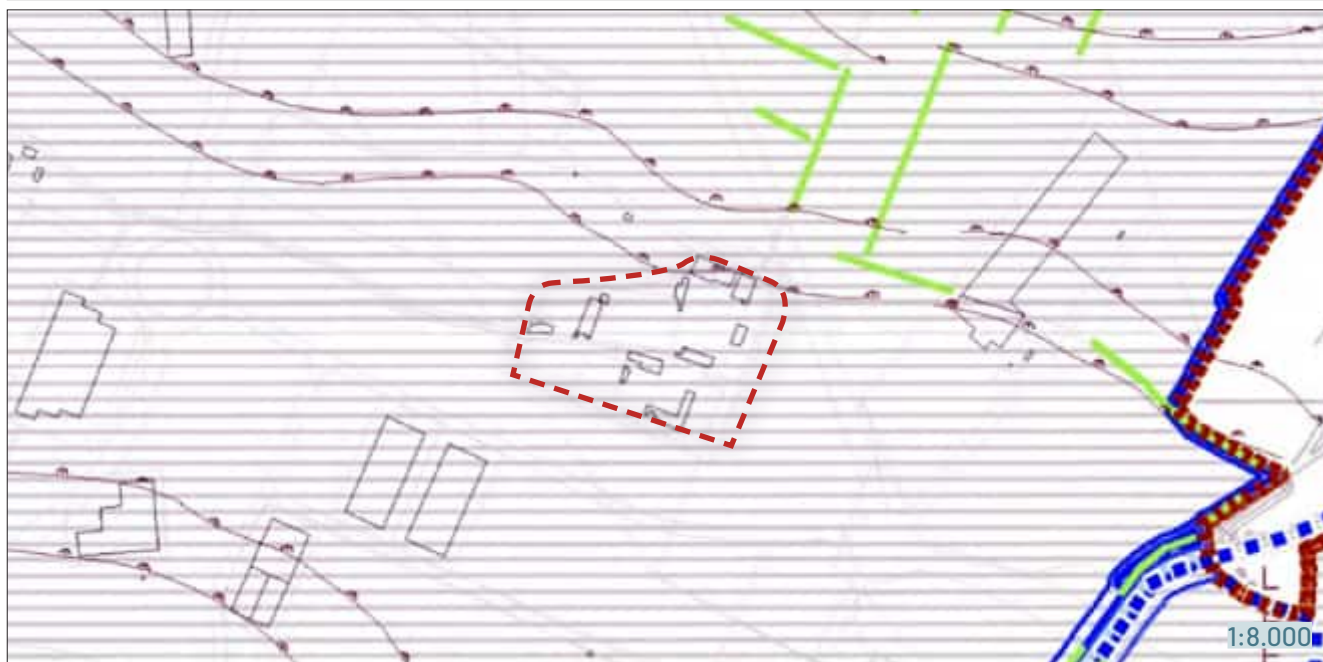
Tavola PS2 | Sistema dei servizi (Variante 2024)



IDENTITY PROFILE

TRANSITION AREA

PGT ANALYSIS



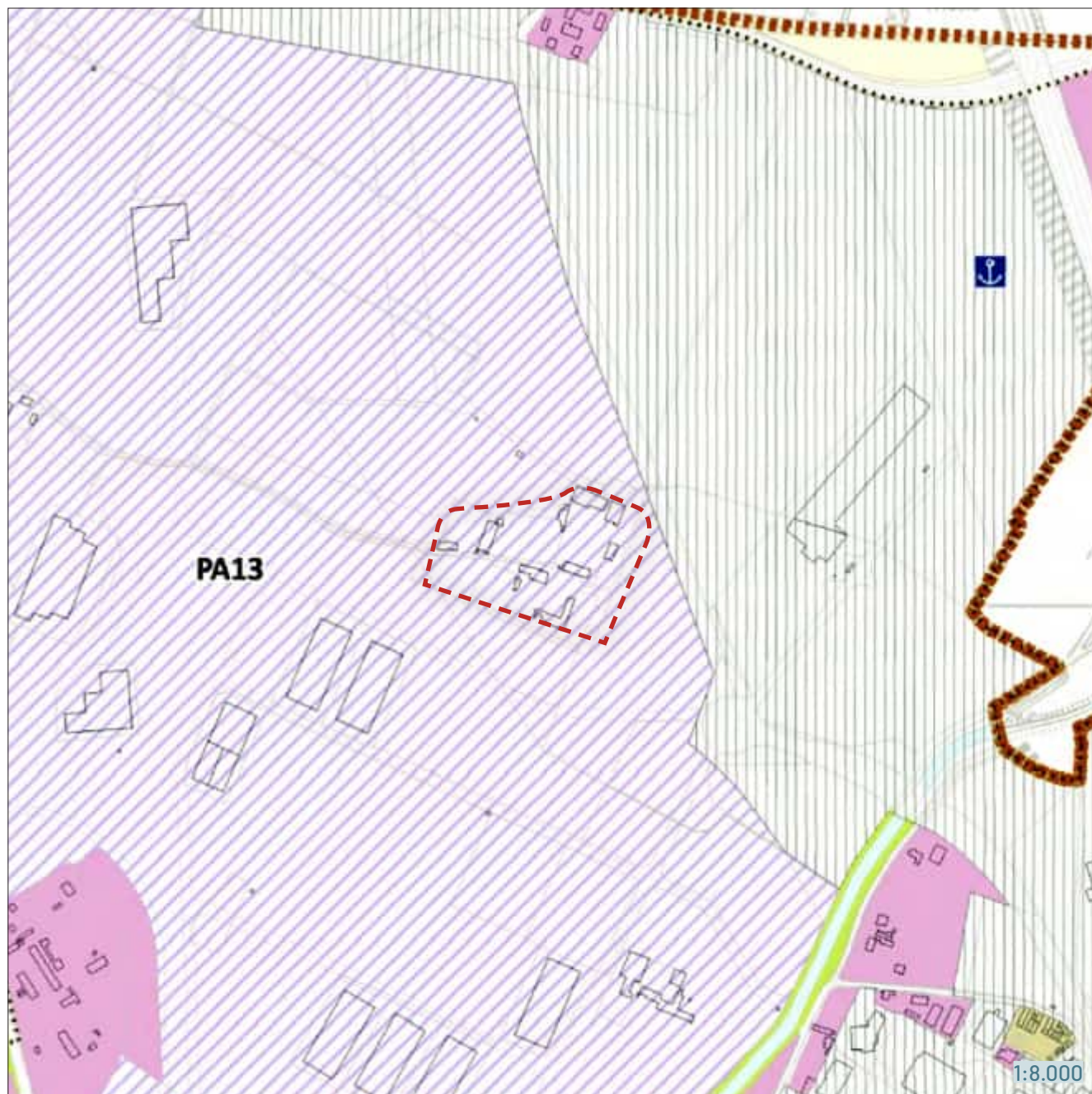
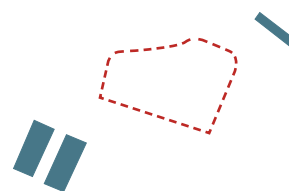
MUNICIPALITY

PIANO DI GOVERNO DEL TERRITORIO / MUNICIPAL SPATIAL PLAN

PIANO DEI SERVIZI (Approvazione 2012)

Top / Tavola PS3 | Mobilità sostenibile (Approvazione 2012)

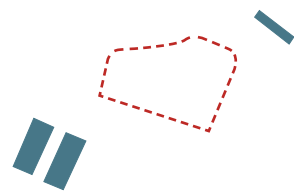
Bottom / Tavola PS4 | Rete ecologica comunale (Approvazione 2012)



PIANO DI GOVERNO DEL TERRITORIO / MUNICIPAL SPATIAL PLAN

PIANO DELLE REGOLE (Approvazione 2012)

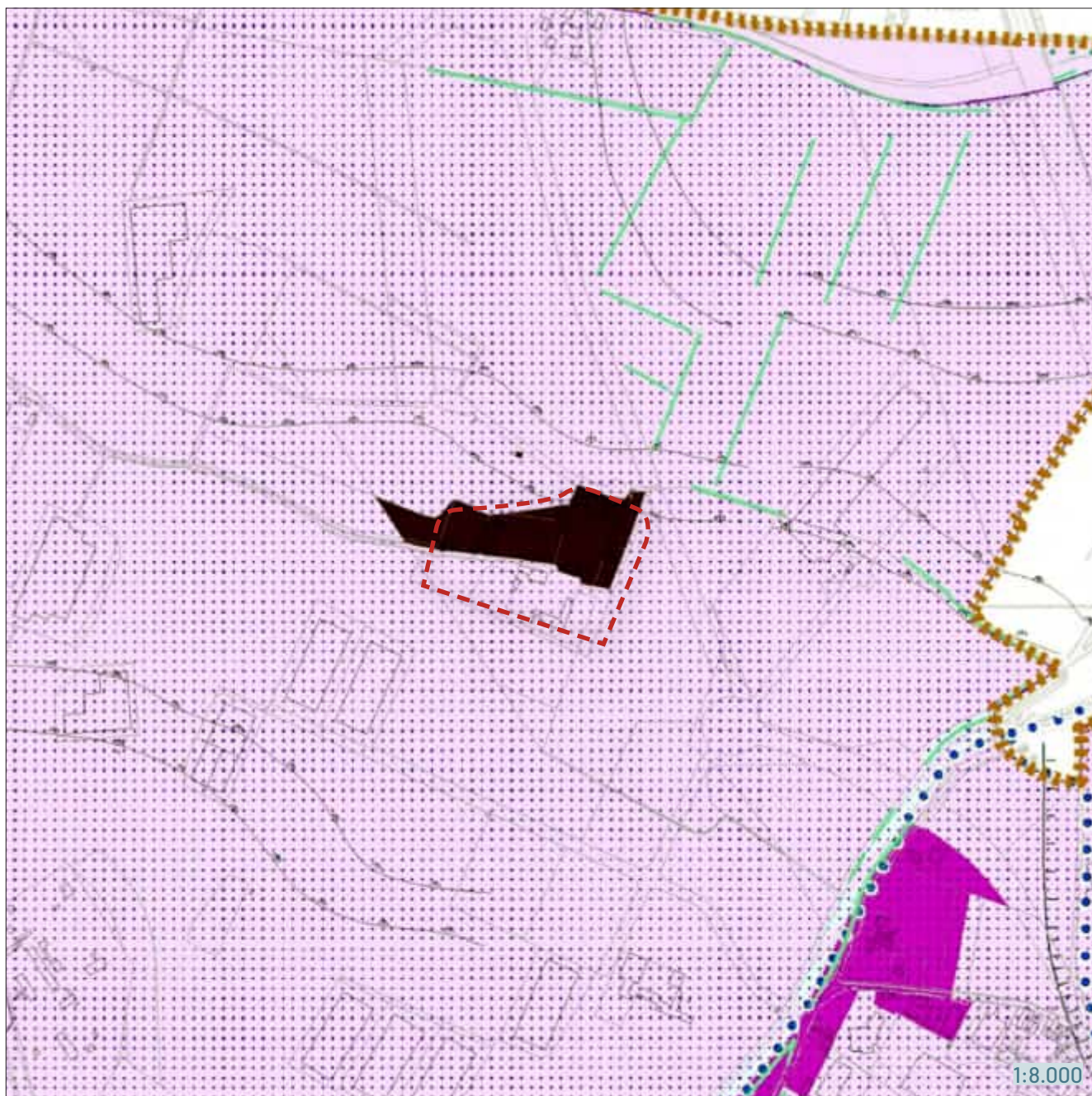
Tavola PR1 | Modalità di intervento per destinazioni d'uso (Variante 2024)



IDENTITY PROFILE

TRANSITION AREA

PGT ANALYSIS

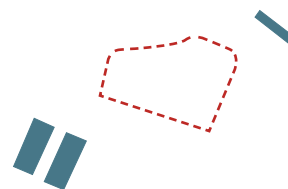


MUNICIPALITY

PIANO DI GOVERNO DEL TERRITORIO / MUNICIPAL SPATIAL PLAN

PIANO DELLE REGOLE (Approvazione 2012)

Tavola PR2 | Modalità di intervento per ambiti di sostenibilità paesaggistica (Approvazione 2012)



IDENTITY PROFILE

TRANSITION AREA

PGT ANALYSIS

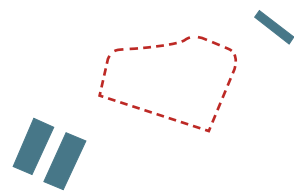


PIANO DI GOVERNO DEL TERRITORIO / MUNICIPAL SPATIAL PLAN

PIANO ATTUATIVO P.A. 13 "OLMO LUNGO"

Top / Tavola A3a | Planimetria generale con aree proprietà BS INVEST S.R.L. e Azienda Agricola San. Bernardino (Variante 2023)

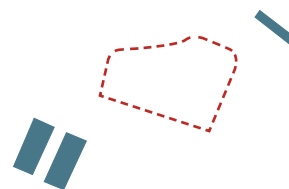
Bottom / Tavola A9 | Raffronto tra esistente e demolito/costruito (Variante 2023)

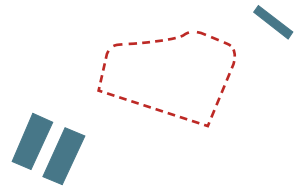


PIANO DI GOVERNO DEL TERRITORIO / MUNICIPAL SPATIAL PLAN

PIANO ATTUATIVO P.A. 13 "OLMO LUNGO"

Tavola A14 | Verde di progetto e delle mitigazioni (Variante 2023)





IDENTITY PROFILE

TRANSITION AREA

TRANSITION AREA OVERVIEW

> COMMON OPPORTUNITIES

Railway freight connection.

The area is served by two freight railway connections that branch off from the Mantua-Monselice state route, one ending near the Olmolungo historical building and the other heading to Porto di Valdaro.

Internal infrastructural network.

The area is crossed by a complex road system and is served by two strategic bus stops located along Via Ostiglia, bordering the Sapio area.

Heterogeneous land use.

The area is characterized by a heterogeneous use of the land: a series of companies linked to different sectors, some scattered residential agglomerations and a system of green spaces, some with agricultural use.

Highway.

The area benefits from the presence of the A22 motorway. The direct connection to the motorway is represented by Mantova Nord toll booth, approximately 3 km away.

Involvement of some areas in the Sapio company plant.

In the disused areas of the Sapio plant, several interventions are planned: an intermodal platform, refueling stations for trains and road vehicles and the hydrogen

production plant. Sapio, among the major hydrogen producers, is a partner in the HyMantoValley project and is involved in the production, storage and distribution of hydrogen.

Hydrographic network of historical value.

The area is characterized by the intersection of two canals of historical importance that play an important role in the identity of the place and that could take on the value of ordering elements for the design.

> COMMON CRITICAL ISSUES

Area enclosed between infrastructural barriers.

The freight railway connection to the east, parallel to the Brenner motorway, and the presence of the Mincio Diversion to the west, constitute potential limitations for the construction of effective connections with the surrounding areas.

Scattered presence of vulnerable elements.

In light of the various risks that hydrogen entails, the co-existence of an element of historical architectural value and several small residential agglomerations could prove to be a critical aspect.

LOCATION 01 DESCRIPTION

> OPPORTUNITIES

Abandoned historical building to reuse.

The Olmolungo farmhouse, a 17th century rural architecture, is currently in a state of ruin. The redevelopment of the building and the regeneration of the area could play a strategic role within the project.

Freight terminal to which the intermodal platform is added.

The area is characterized by the terminal of the railway freight connection. HyMantoValley includes an extension of the tracks until Via Ostiglia and, on the same route, the construction of an intermodal platform.

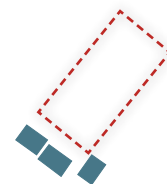
> CRITICAL ISSUES

Restricted real estate.

The constraint to which the Olmolungo farmhouse is subject makes any possible intervention in the area particularly complex and delicate.

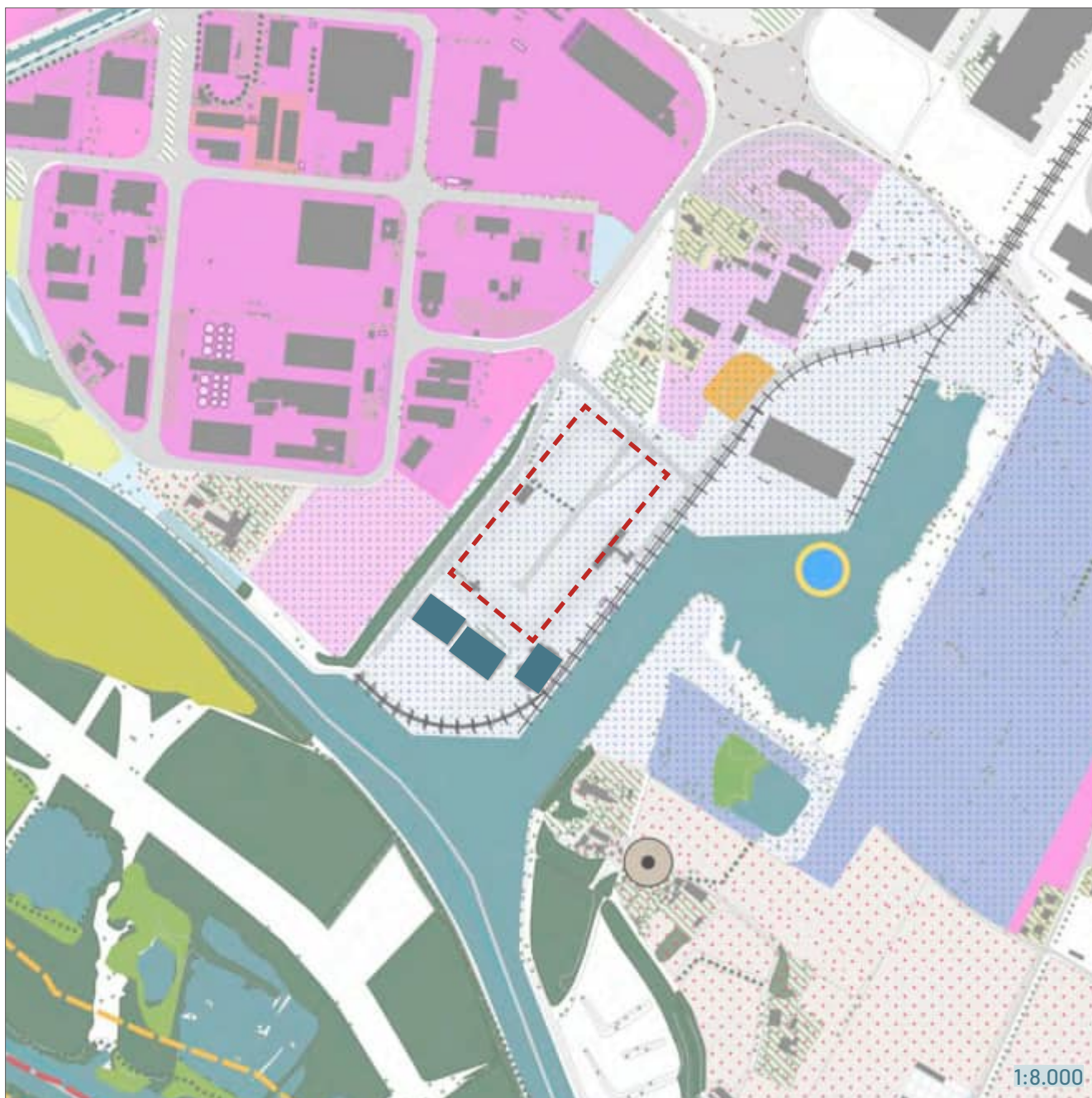
Area subject to implementation planning.

The area is subject to an implementation plan. Any architectural project conceived in the area must be based on the verification of the indications of the plan. This could lead to limitations on the design characteristics.



IDENTITY PROFILE PORT AREA

URBAN INTRODUCTION



AREA SIZE

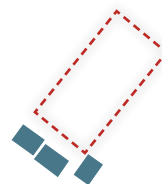
42.341 m²

MOST INFLUENTIAL PROJECT AREA DISTANCE TO HRS PORT

343 m

DISTANCES TO PROJECT AREAS

PV PLANT	2.924 m
H2 PRODUCTION PLANT	1.580 m
HRS ROAD VEICHLES	1.826 m
HRS RAILWAY	1.345 m
HRS PORT	343 m

IDENTITY PROFILE
PORT AREA

PTCP ANALYSIS

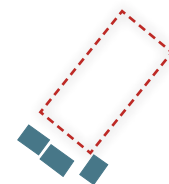
PROVINCE



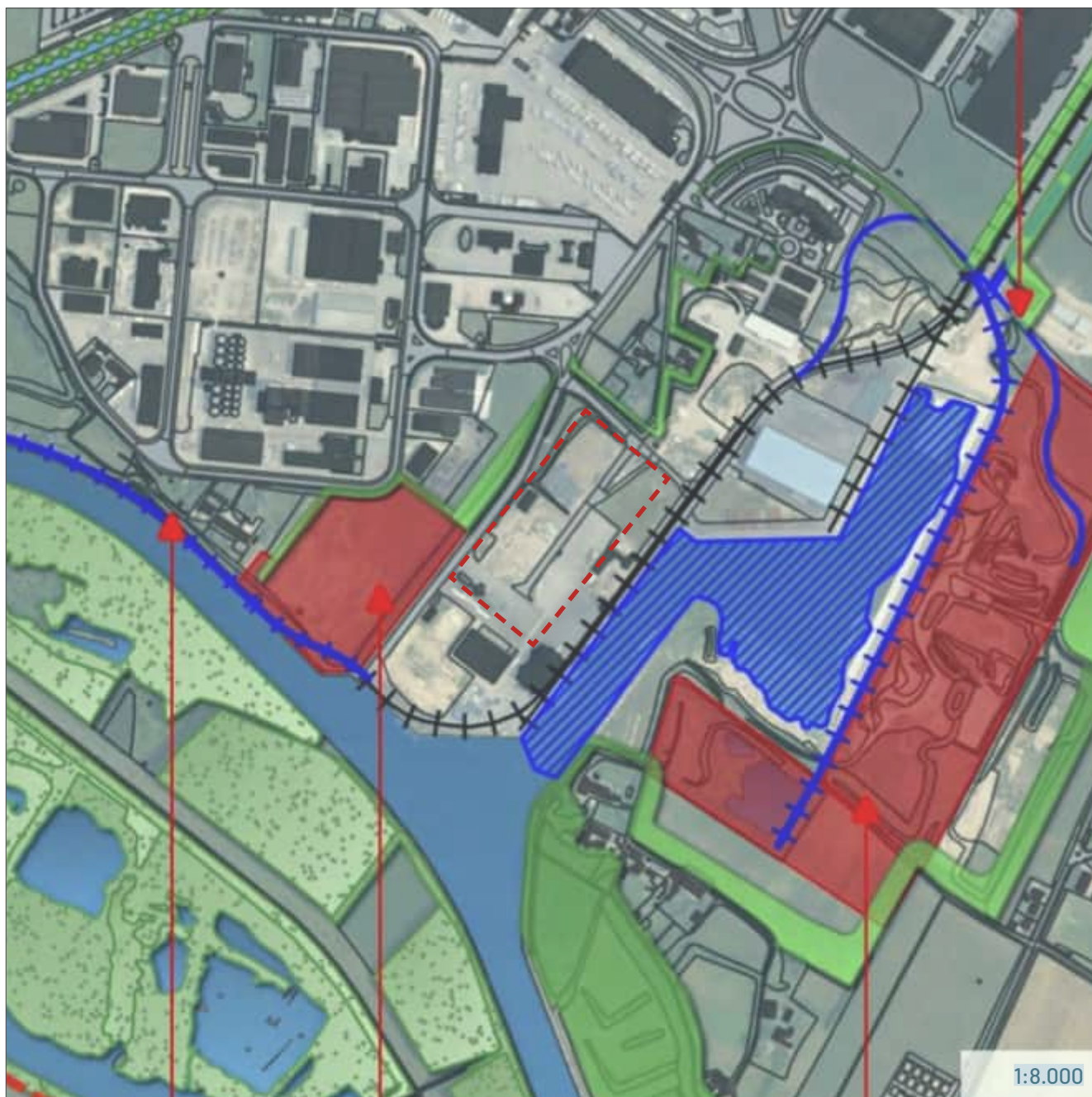
PIANO DI COORDINAMENTO PROVINCIALE / PROVINCIAL TERRITORIAL COORDINATION PLAN

Top / Tavola 1 | Indicazioni Paesaggistiche e Ambientali | Circondario D (Approvazione 2022)

Bottom / Tavola 2 | Indicazioni Insediative Infrastrutturali e Agricole | Circondario D (Aggiornamento 2024)

IDENTITY PROFILE
PORT AREA

MASTERPLAN ANALYSIS

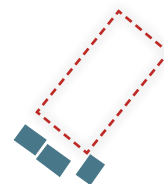


PROVINCE

PIANO DI COORDINAMENTO PROVINCIALE / PROVINCIAL TERRITORIAL COORDINATION PLAN

Tavola 2 | Masterplan per la rigenerazione territoriale del polo produttivo di livello provinciale di Mantova Est e del sito inquinato di interesse nazionale - Laghi di Mantova e Polo Chimico.

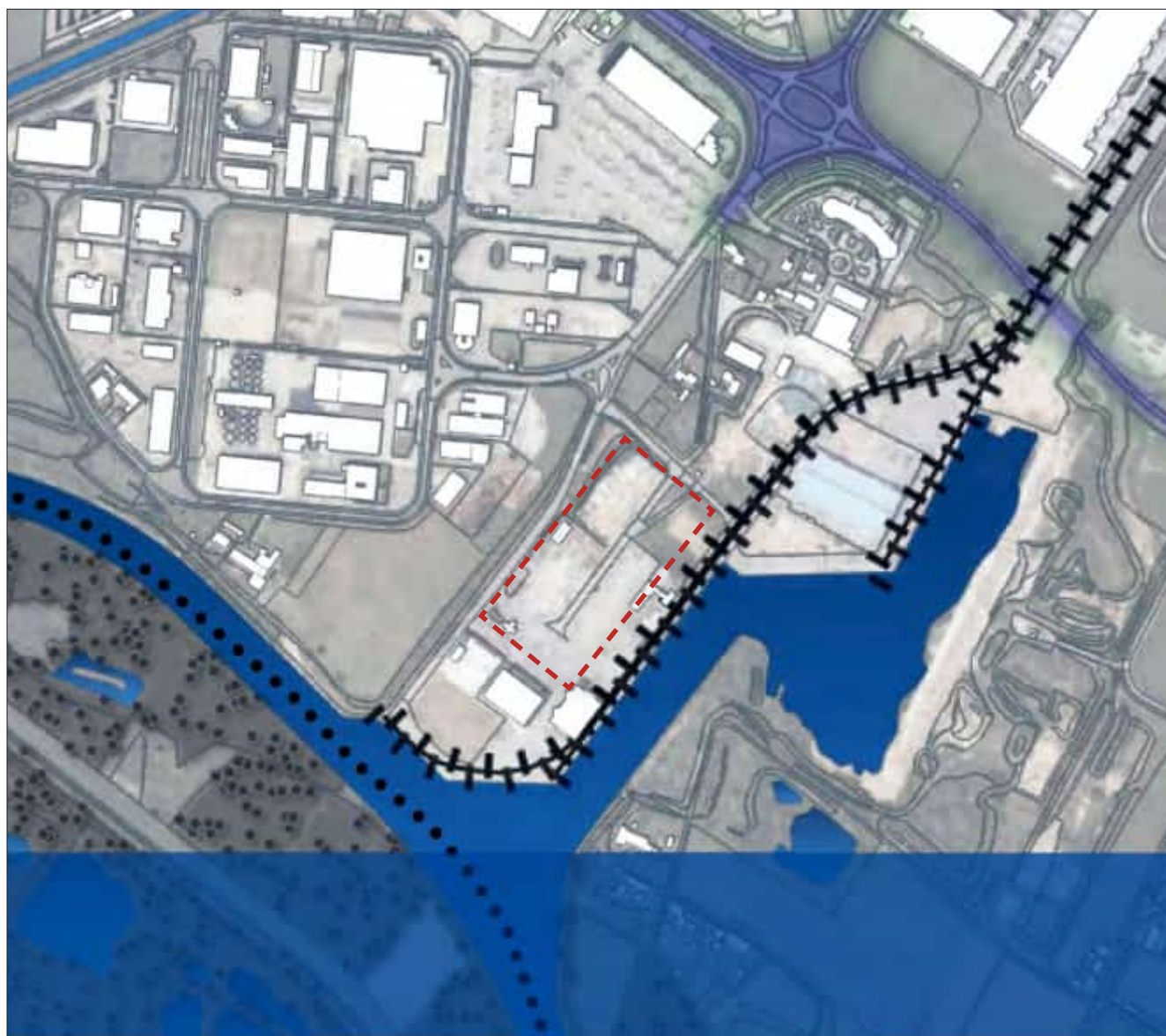
Sintesi degli interventi proposti (Anno 2020)



IDENTITY PROFILE
PORT AREA

PROJECT ANALYSIS

PROVINCE

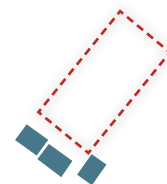


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view*

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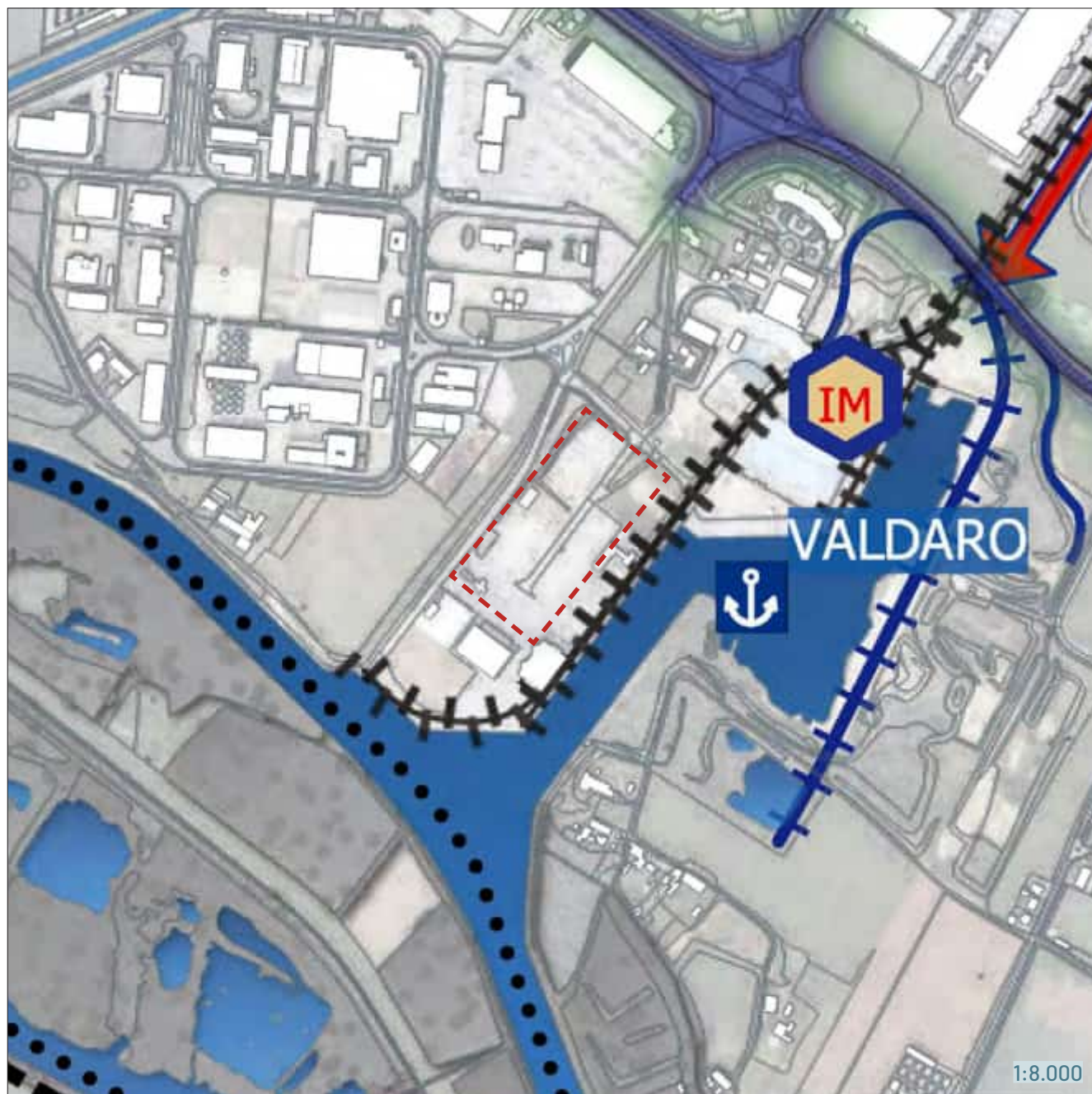
IMPLICATIONS OF THE PROVINCIAL PLAN FOR THE HYMANTOVALLEY AREA

Tavola 4 | Sistema Ecologico | Analisi dello stato di fatto (Anno 2023)



IDENTITY PROFILE
PORT AREA

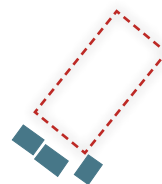
PROJECT ANALYSIS



PROVINCE

IMPLICATIONS OF THE PROVINCIAL PLAN FOR THE HYMANTOVALLEY AREA

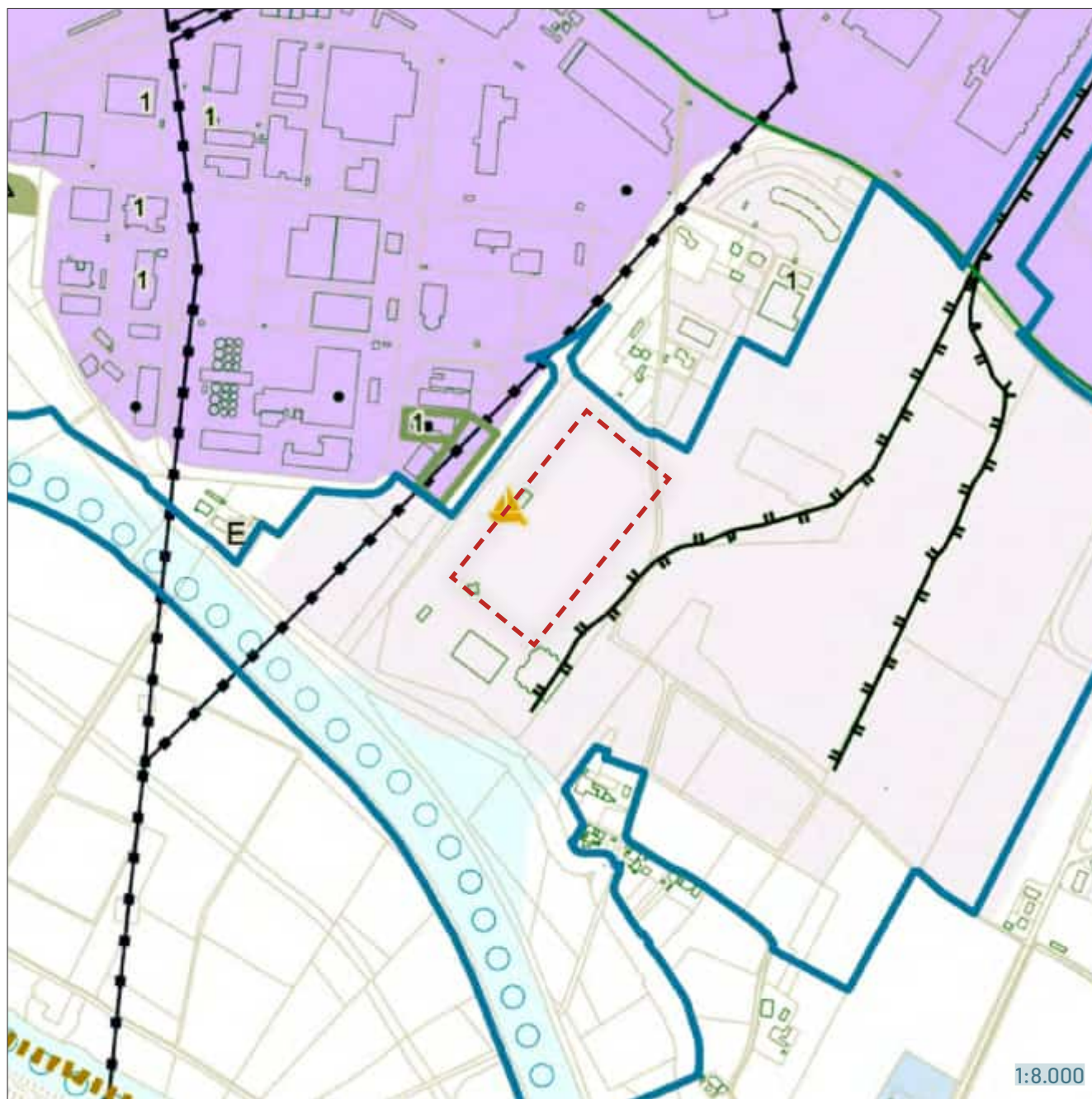
Tavola xx | Abaco della mobilità di progetto (Anno 2023)



IDENTITY PROFILE

PORT AREA

PGT ANALYSIS

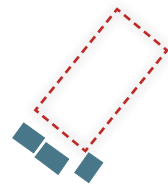


PIANO DI GOVERNO DEL TERRITORIO / MUNICIPAL SPATIAL PLAN

DOCUMENTO DI PIANO

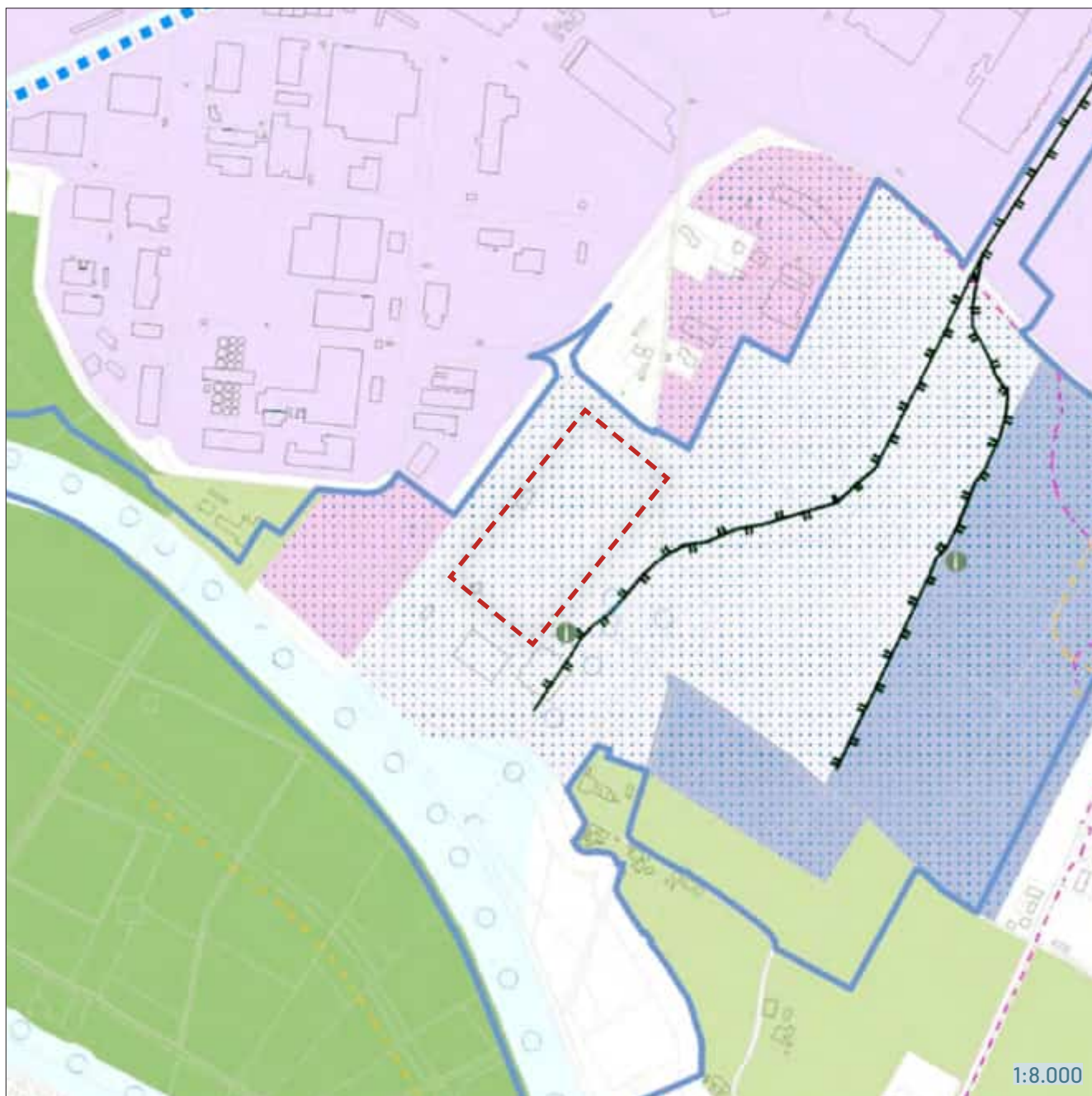
QUADRO CONOSCITIVO (Approvazione 2012)

Tavola DP1b | La città e le imprese (Approvazione 2012)



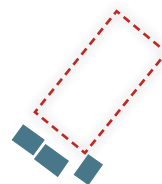
IDENTITY PROFILE PORT AREA

PGT ANALYSIS



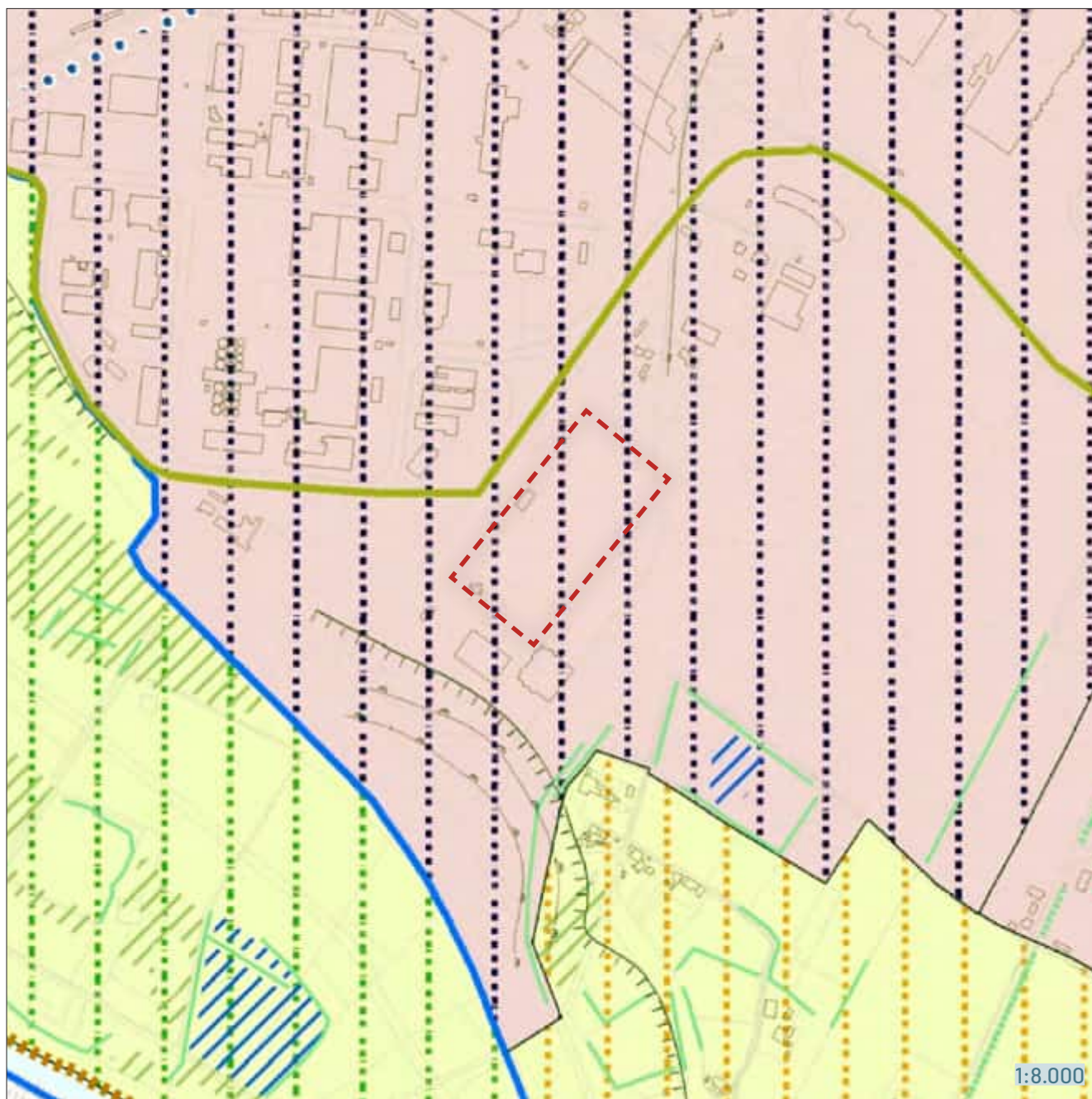
MUNICIPALITY

PIANO DI GOVERNO DEL TERRITORIO / MUNICIPAL SPATIAL PLAN
DOCUMENTO DI PIANO
QUADRO STRATEGICO (Approvazione 2012)
Tavola DP4 | Strategie trame trasformazioni e progetti (Approvazione 2012)

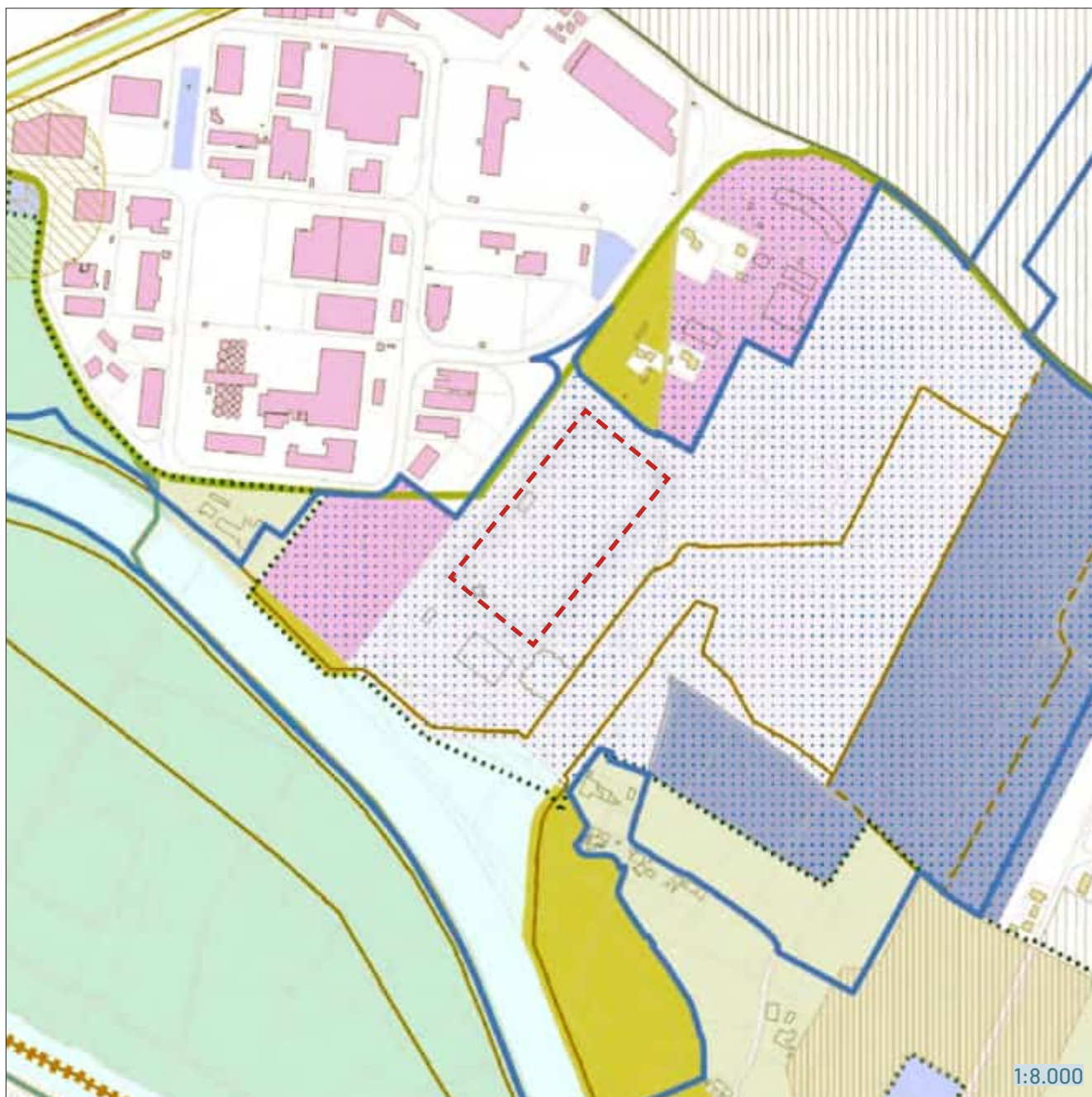
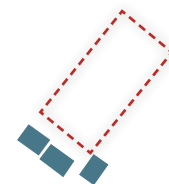


IDENTITY PROFILE
PORT AREA

PGT ANALYSIS



PIANO DI GOVERNO DEL TERRITORIO / MUNICIPAL SPATIAL PLAN
DOCUMENTO DI PIANO
QUADRO PROGRAMMATICO (Approvazione 2012)
Tavola DP5 | Sensibilità paesistica (Approvazione 2012)

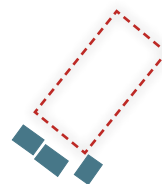


PIANO DI GOVERNO DEL TERRITORIO / MUNICIPAL SPATIAL PLAN

DOCUMENTO DI PIANO

QUADRO PROGRAMMATICO (Approvazione 2012)

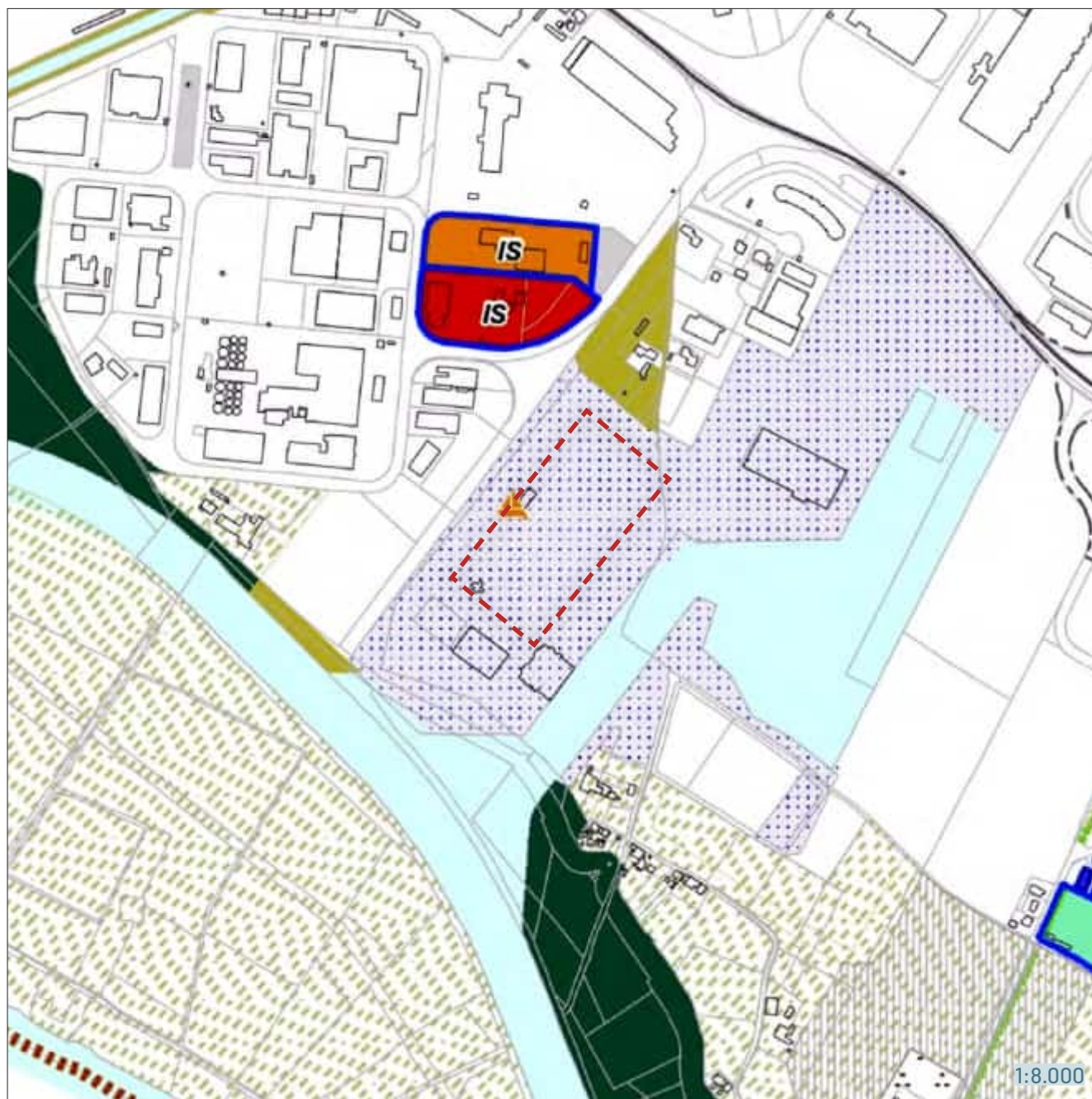
Tavola DP6 | Previsioni di Piano (Approvazione 2012)



IDENTITY PROFILE

PORT AREA

PGT ANALYSIS

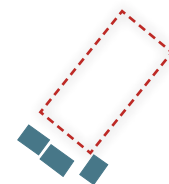


MUNICIPALITY

PIANO DI GOVERNO DEL TERRITORIO / MUNICIPAL SPATIAL PLAN

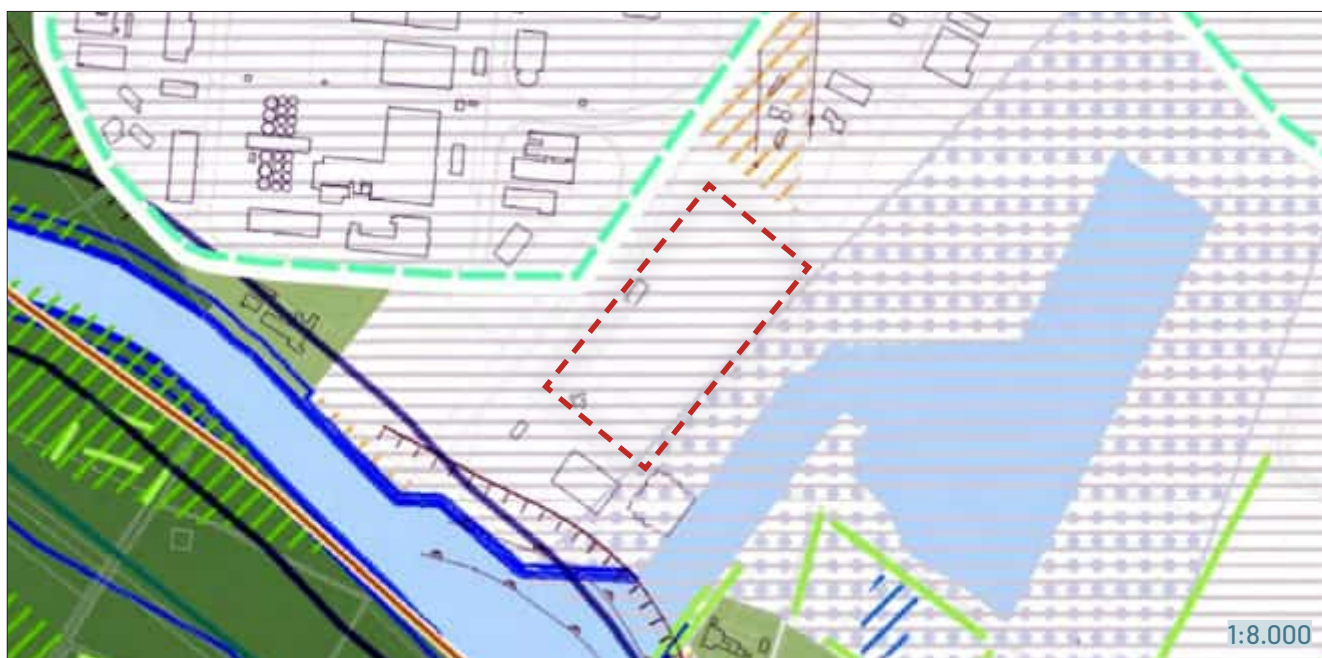
PIANO DEI SERVIZI (Approvazione 2012)

Tavola PS2 | Sistema dei servizi (Variante 2024)



IDENTITY PROFILE PORT AREA

PGT ANALYSIS

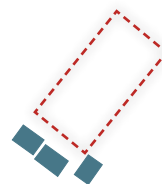


PIANO DI GOVERNO DEL TERRITORIO / MUNICIPAL SPATIAL PLAN

PIANO DEI SERVIZI (Approvazione 2012)

Top / Tavola PS3 | Mobilità sostenibile (Approvazione 2012)

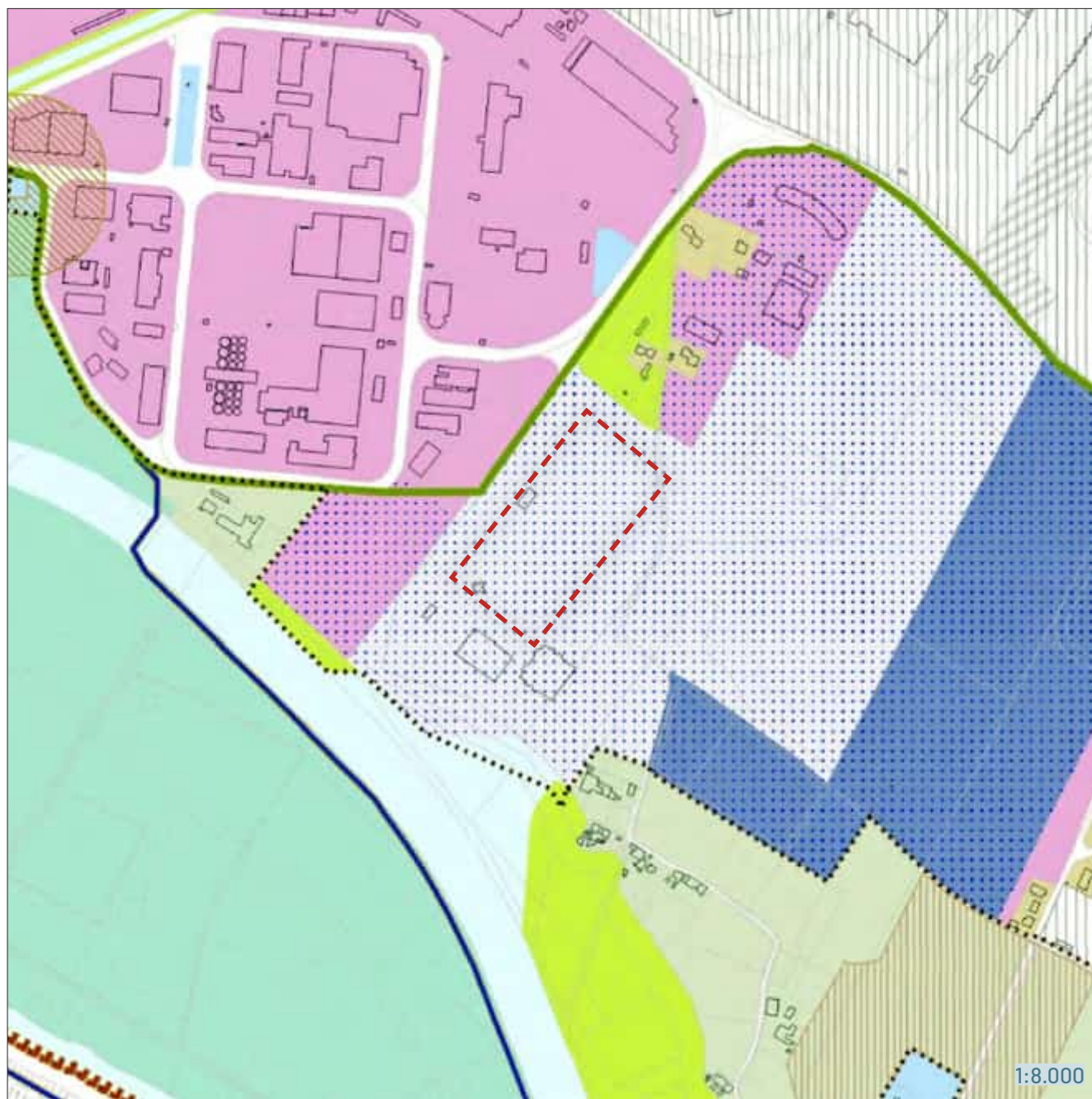
Bottom / Tavola PS4 | Rete ecologica comunale (Approvazione 2012)



IDENTITY PROFILE

PORT AREA

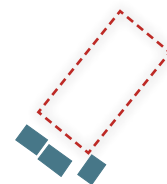
PGT ANALYSIS



PIANO DI GOVERNO DEL TERRITORIO / MUNICIPAL SPATIAL PLAN

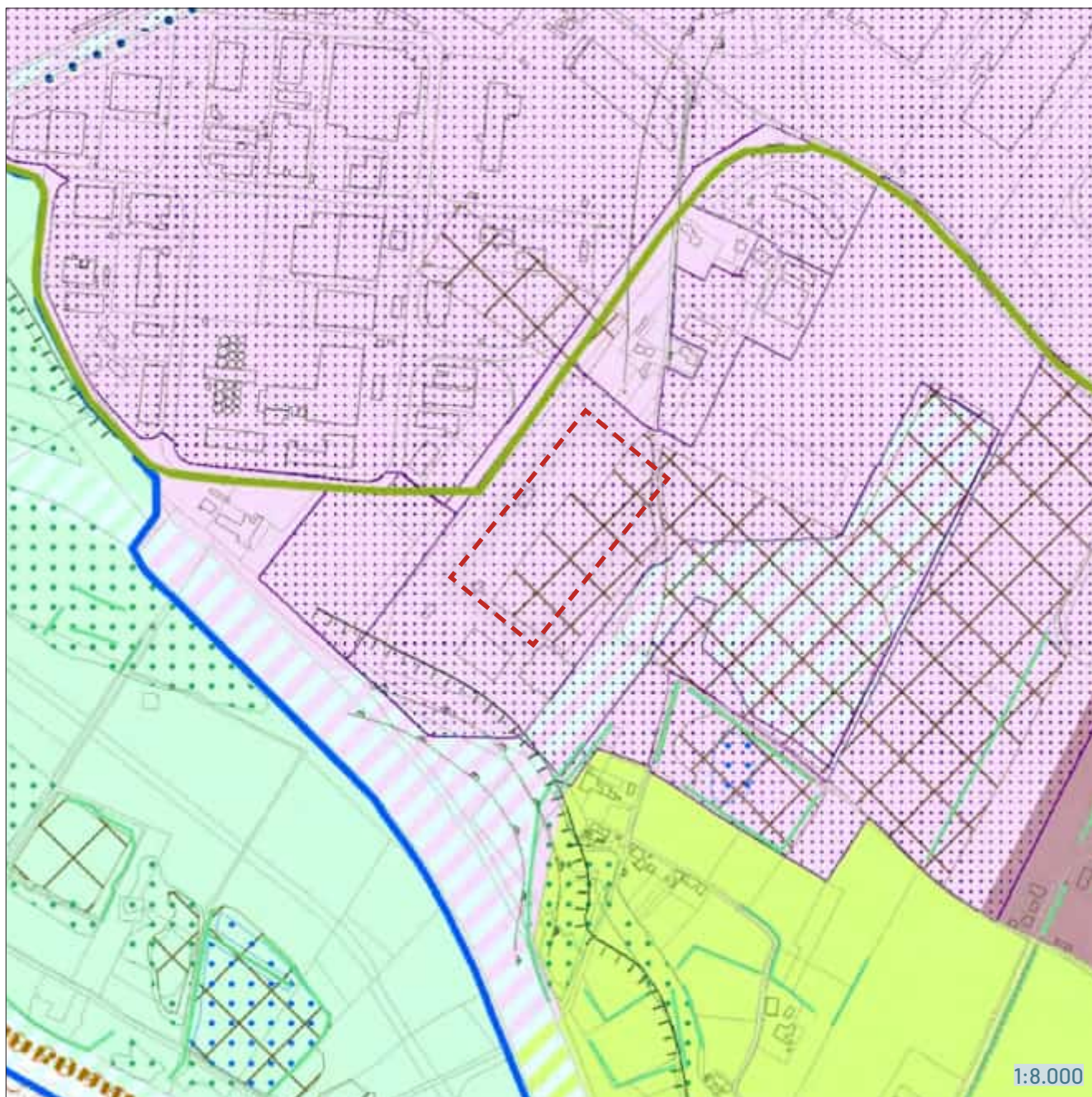
PIANO DELLE REGOLE (Approvazione 2012)

Tavola PR1 | Modalità di intervento per destinazioni d'uso (Variante 2024)



IDENTITY PROFILE
PORT AREA

PGT ANALYSIS

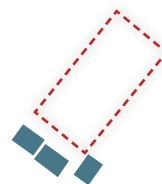


MUNICIPALITY

PIANO DI GOVERNO DEL TERRITORIO / MUNICIPAL SPATIAL PLAN

PIANO DELLE REGOLE (Approvazione 2012)

Tavola PR2 | Modalità di intervento per ambiti di sostenibilità paesaggistica (Approvazione 2012)



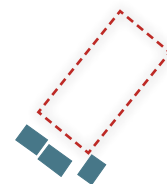
IDENTITY PROFILE
PORT AREA

PROJECT ANALYSIS



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view

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IDENTITY PROFILE

PORT AREA

PORT AREA OVERVIEW

> COMMON OPPORTUNITIES

Railway freight connection.

The area is served by two railway freight connections that branch off after passing the intersection with Via Ostiglia. One branch ends in the innermost part of the port and the other ends further south, at the point overlooking the Tartaro-Canalbianco-Po di Levante waterway.

the port, which instead presents specific spatial and functional needs.

Waterway.

The area is connected to other areas of the city, including the historic center, thanks to an efficient waterway system. The site enjoys intermodality on three levels: car, rail, water.

Highway.

The area benefits from the presence of the A22 motorway. The direct connection to the motorway is via the Mantova Nord toll booth, approximately 5 km away.

> COMMON CRITICAL ISSUES

Areas serving port activities.

The area is composed of different areas serving the activities (both logistic and productive) of the Valdaro port. The creation of a research hub in this area could be interpreted as a desire to hinder the future development of

LOCATION 05 DESCRIPTION

> OPPORTUNITIES

Freight terminal.

The area is characterized by the close presence of the terminal section of the railway freight connection. The infrastructural element could assume a strategic role in the development of intermodality in the area.

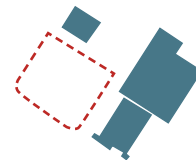
Interaction between port activities and the tasks of the research lab.

The interaction between the port's logistics activities and the tasks related to the Research Hub could generate an interesting theory-practice interaction. It is no coincidence that in the HyMantoValley project this area has been proposed as a possible location for the Research Hub.

> CRITICAL ISSUES

Limited access.

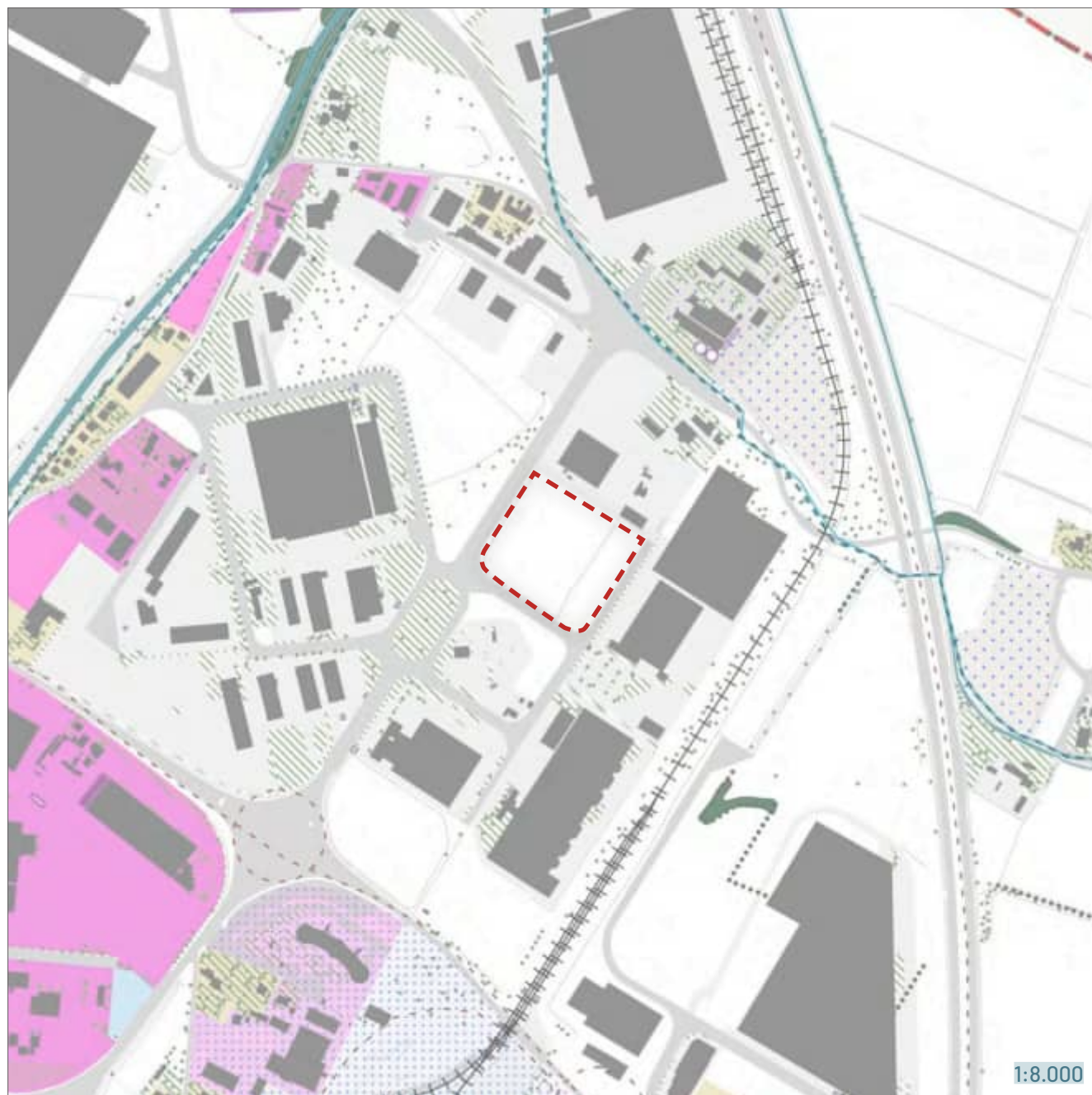
Since the area is mainly intended for the activities of the Valdaro port, effective access to the area is currently rather limited. Today, the external road network, coming from the west from the adjacent production area, does not proceed equally within the area.



IDENTITY PROFILE

TRANSITION AREA

URBAN INTRODUCTION



AREA SIZE

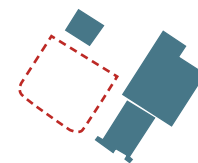
24.205,29 m²

MOST INFLUENTIAL PROJECT AREA
DISTANCE TO HRS PORT

962,52 m

DISTANCES
TO PROJECT AREAS

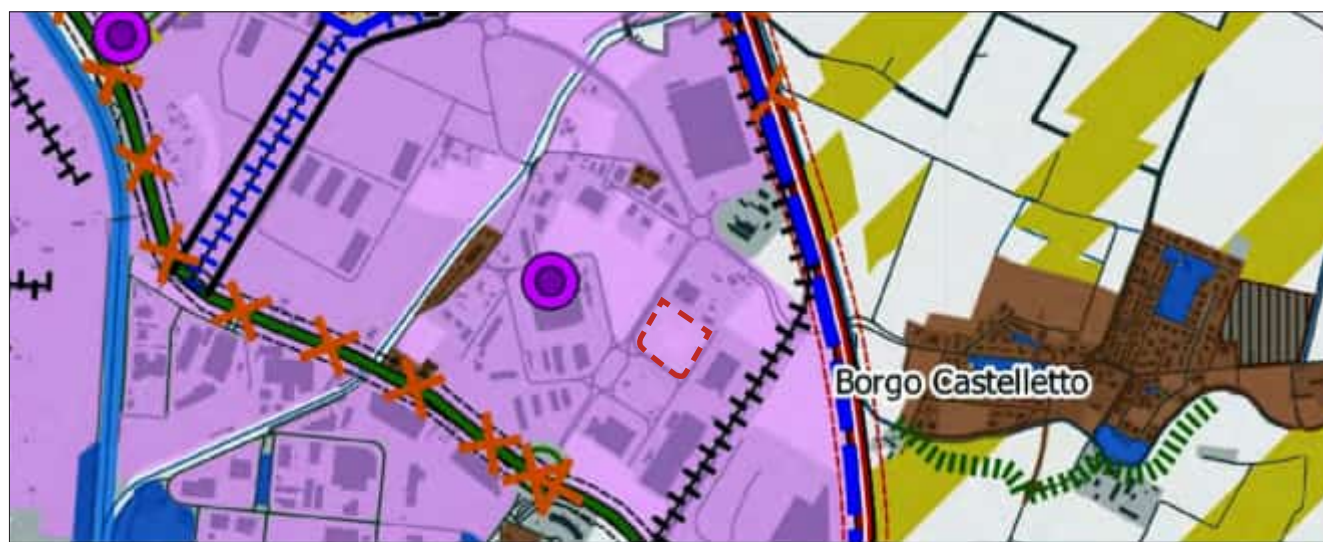
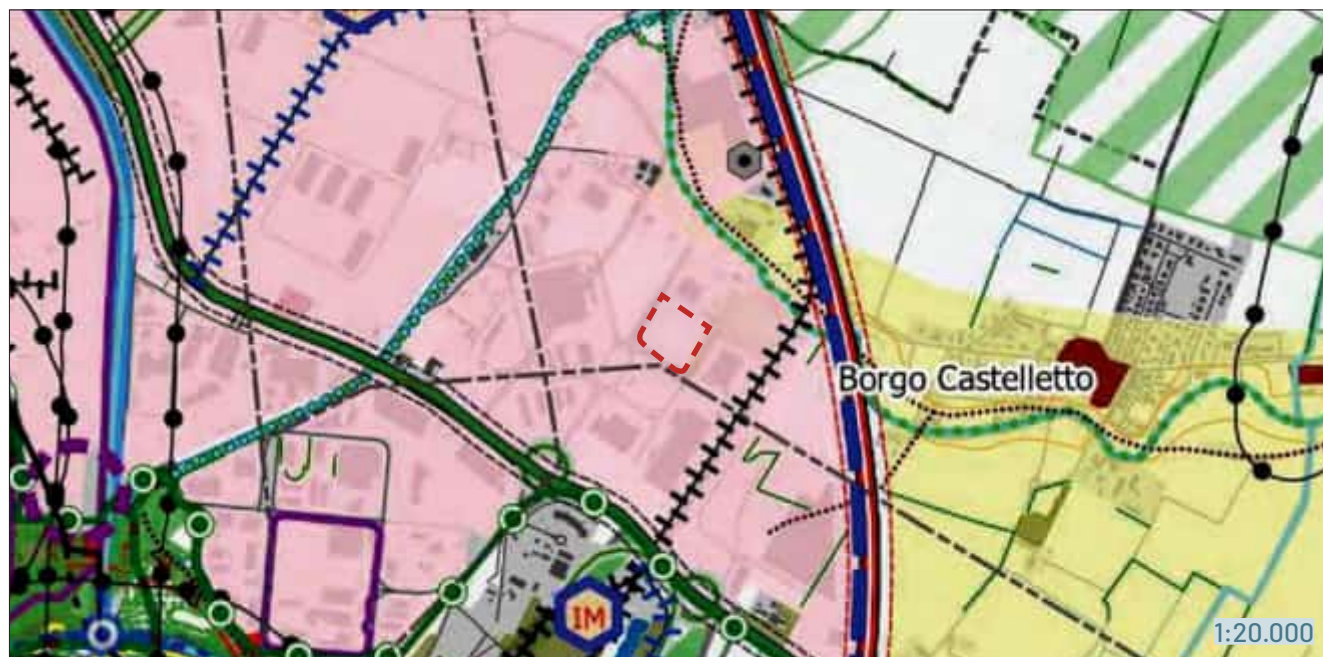
PV PLANT	3.224,1 m
H2 PRODUCTION PLANT	1.409,2 m
HRS ROAD VEICHLES	1.550,54 m
HRS RAILWAY	1.258,83 m
HRS PORT	962,52 m



IDENTITY PROFILE

TRANSITION AREA

PTCP ANALYSIS



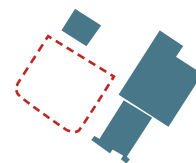
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view

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PIANO DI COORDINAMENTO PROVINCIALE / PROVINCIAL TERRITORIAL COORDINATION PLAN

Top / Tavola 1 | Indicazioni Paesaggistiche e Ambientali | Circondario D (Approvazione 2022)

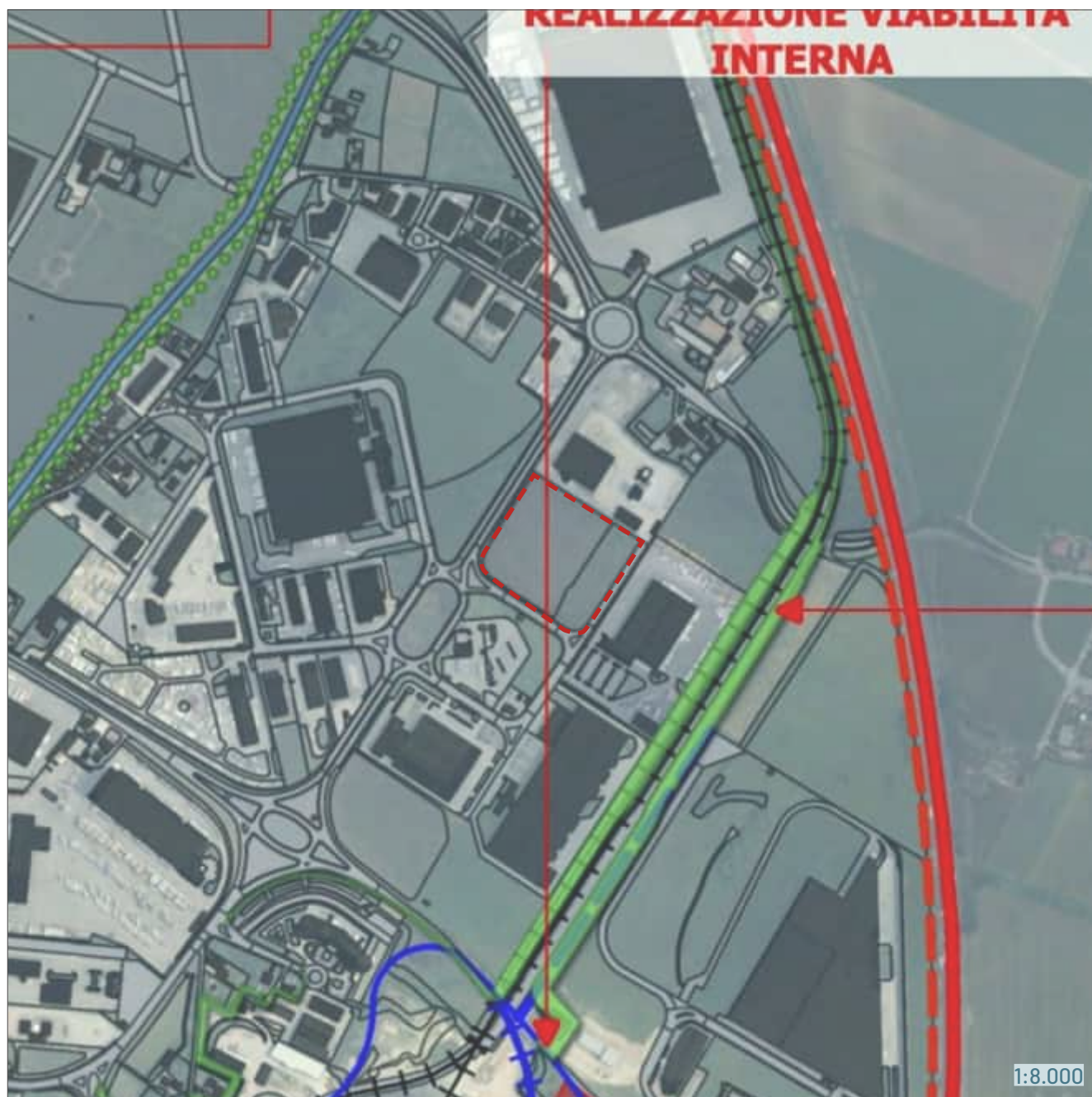
Bottom / Tavola 2 | Indicazioni Insediative Infrastrutturali e Agricole | Circondario D (Aggiornamento 2024)



IDENTITY PROFILE

TRANSITION AREA

MASTERPLAN ANALYSIS

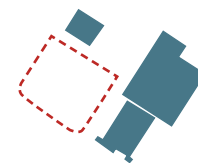


PROVINCE

PIANO DI COORDINAMENTO PROVINCIALE / PROVINCIAL TERRITORIAL COORDINATION PLAN

Tavola 2 | Masterplan per la rigenerazione territoriale del polo produttivo di livello provinciale di Mantova Est e del sito inquinato di interesse nazionale - Laghi di Mantova e Polo Chimico.

Sintesi degli interventi proposti (Anno 2020)



IDENTITY PROFILE

TRANSITION AREA

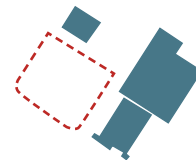
PROJECT ANALYSIS

PROVINCE



IMPLICATIONS OF THE PROVINCIAL PLAN FOR THE HYMAN VALLEY AREA

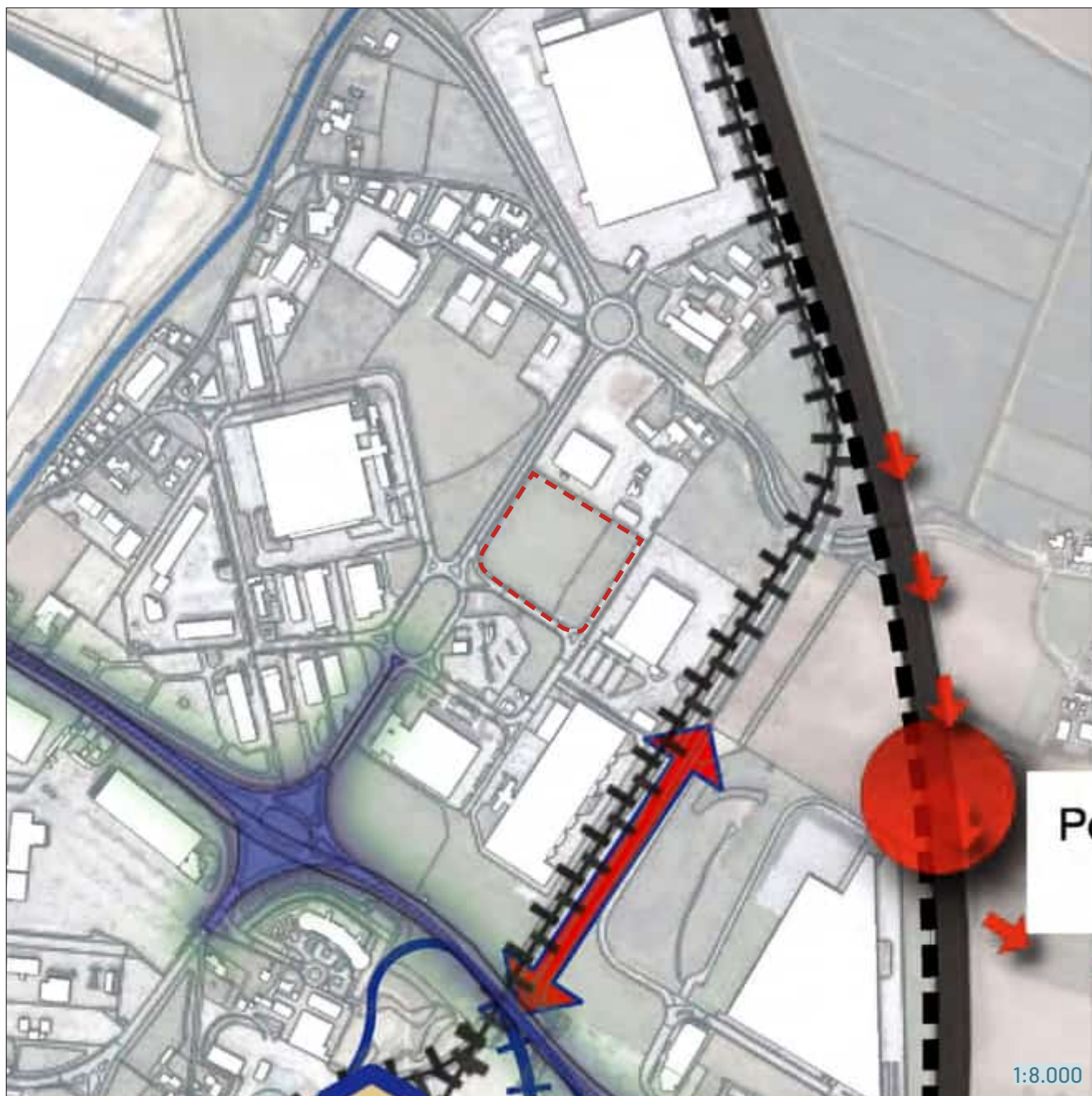
Tavola 4 | Sistema Ecologico | Analisi dello stato di fatto (Anno 2023)



IDENTITY PROFILE

TRANSITION AREA

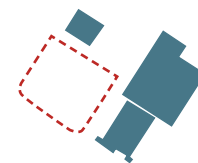
PROJECT ANALYSIS



PROVINCE

IMPLICATIONS OF THE PROVINCIAL PLAN FOR THE HYMANTOVALLEY AREA

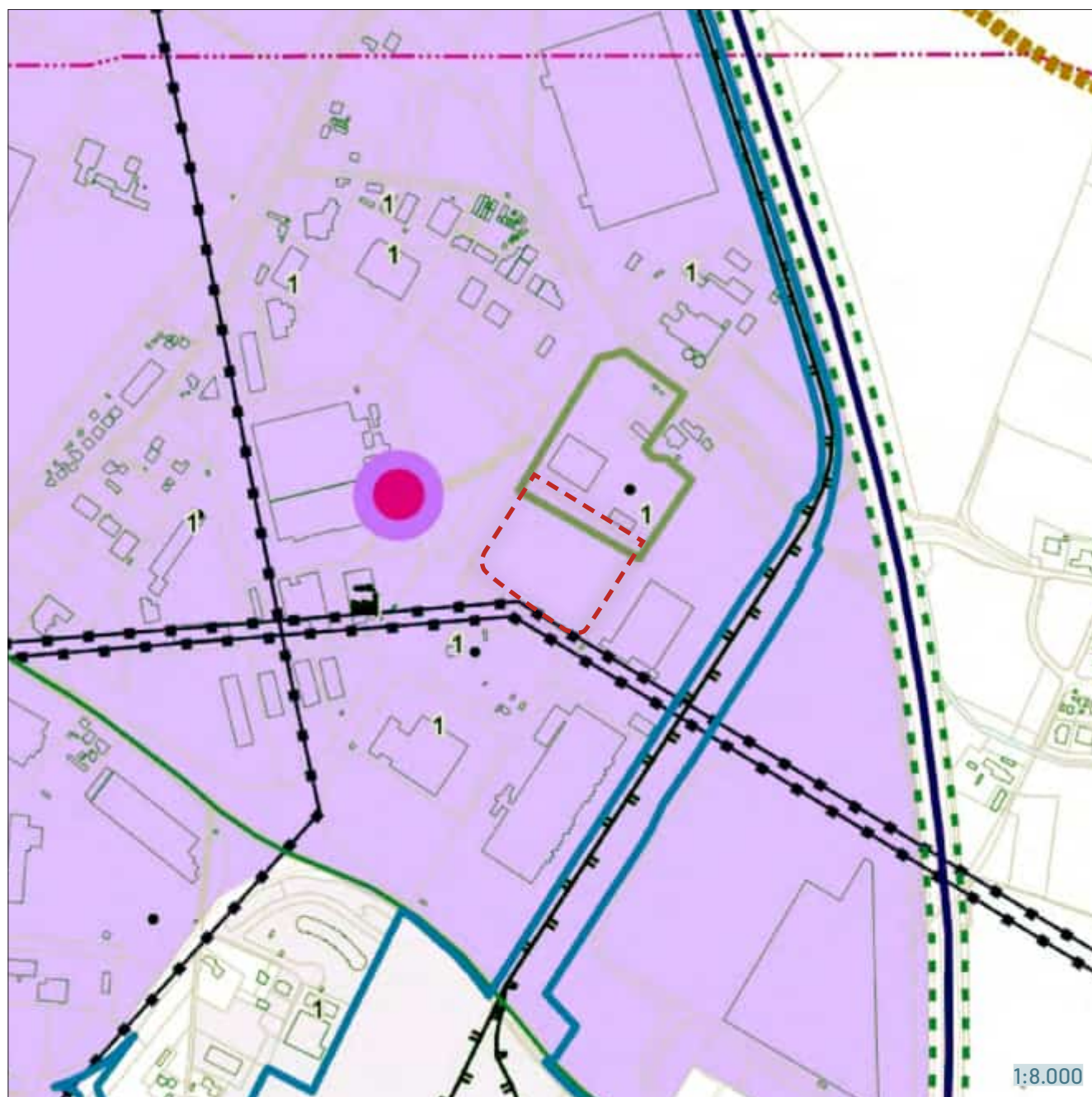
Tavola xx | Abaco della mobilità di progetto (Anno 2023)



IDENTITY PROFILE

TRANSITION AREA

PGT ANALYSIS

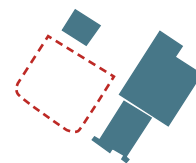


PIANO DI GOVERNO DEL TERRITORIO / MUNICIPAL SPATIAL PLAN

DOCUMENTO DI PIANO

QUADRO CONOSCITIVO (Approvazione 2012)

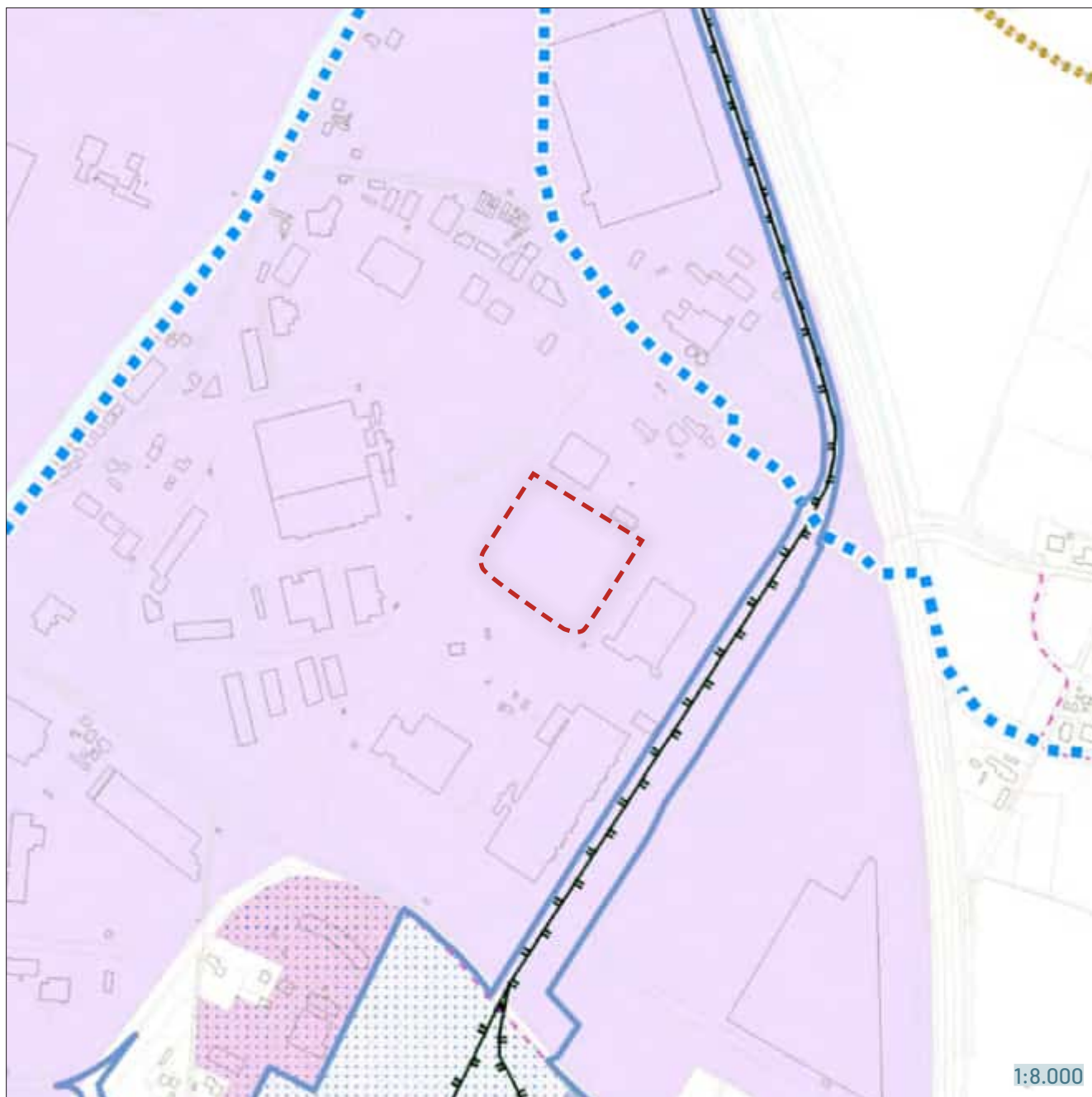
Tavola DP1b | La città e le imprese (Approvazione 2012)



IDENTITY PROFILE

TRANSITION AREA

PGT ANALYSIS



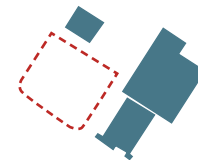
MUNICIPALITY

PIANO DI GOVERNO DEL TERRITORIO / MUNICIPAL SPATIAL PLAN

DOCUMENTO DI PIANO

QUADRO STRATEGICO (Approvazione 2012)

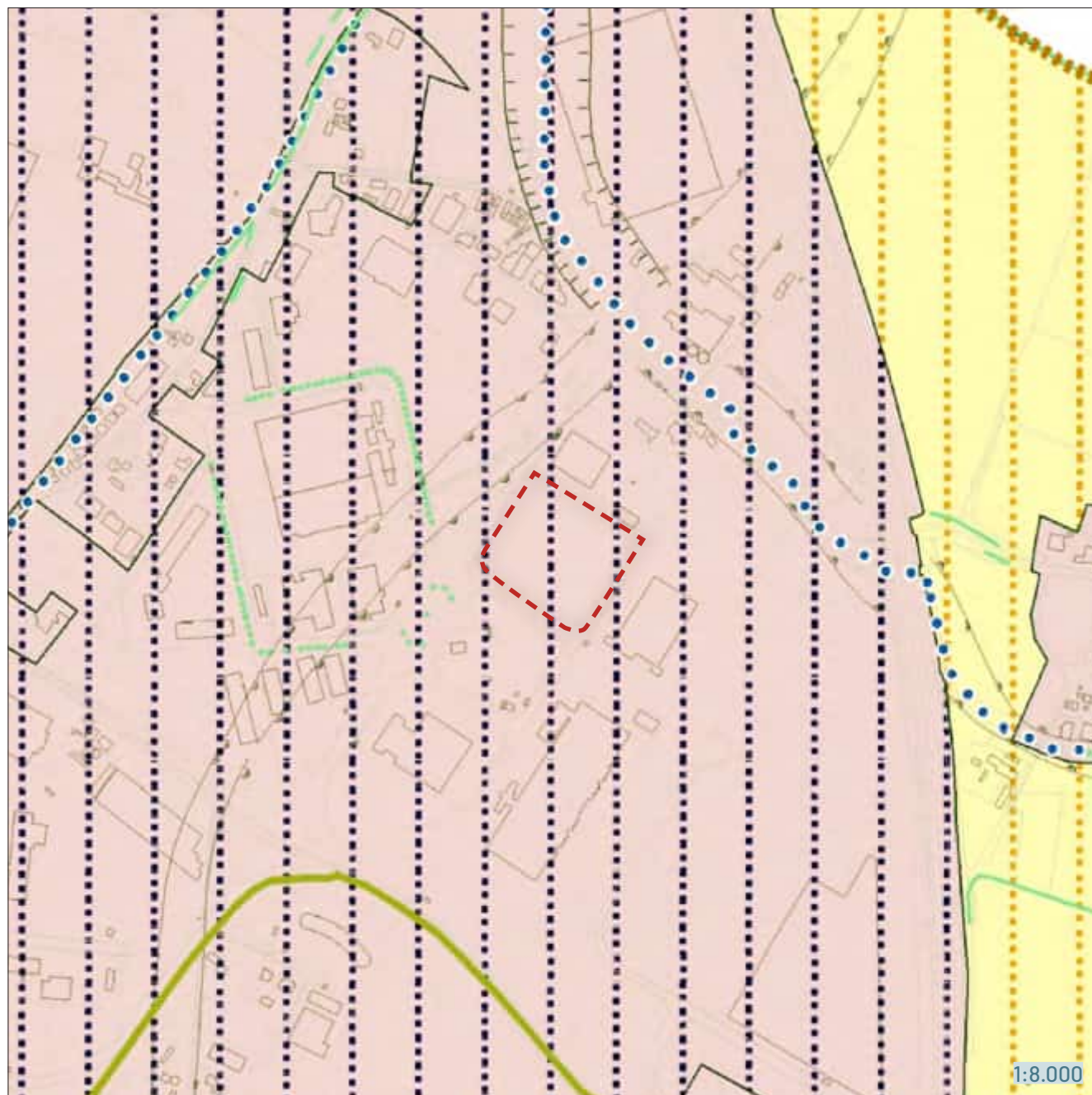
Tavola DP4 | Strategie trame trasformazioni e progetti (Approvazione 2012)



IDENTITY PROFILE

TRANSITION AREA

PGT ANALYSIS



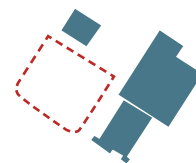
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PIANO DI GOVERNO DEL TERRITORIO / MUNICIPAL SPATIAL PLAN

DOCUMENTO DI PIANO

QUADRO PROGRAMMATICO (Approvazione 2012)

Tavola DP5 | Sensibilità paesistica (Approvazione 2012)



IDENTITY PROFILE

TRANSITION AREA

PGT ANALYSIS



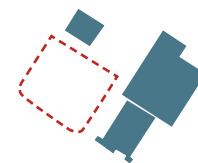
MUNICIPALITY

PIANO DI GOVERNO DEL TERRITORIO / MUNICIPAL SPATIAL PLAN

DOCUMENTO DI PIANO

QUADRO PROGRAMMATICO (Approvazione 2012)

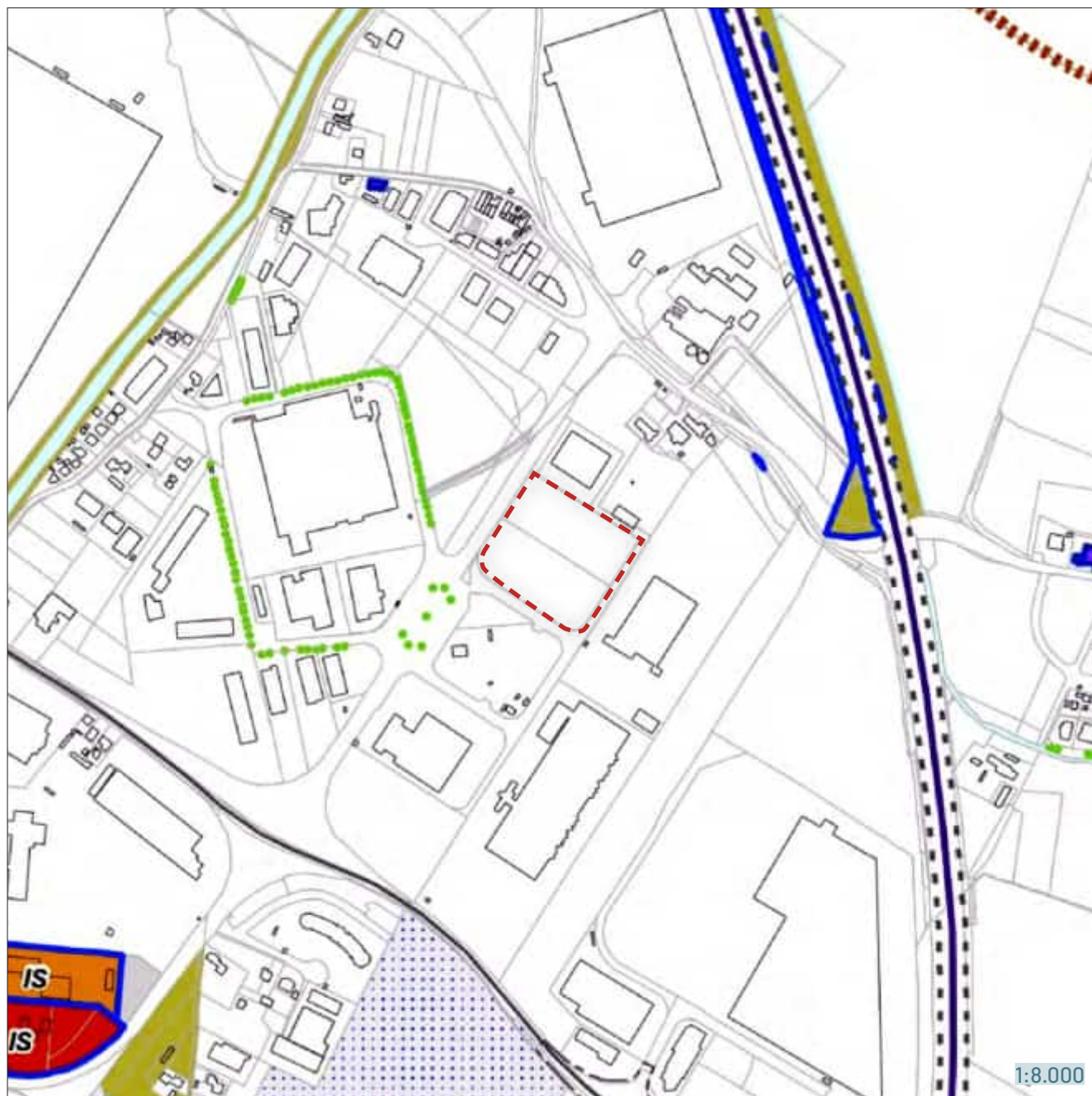
Tavola DP6 | Previsioni di Piano (Approvazione 2012)



IDENTITY PROFILE

TRANSITION AREA

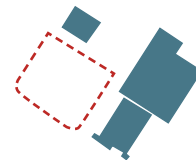
PGT ANALYSIS



PIANO DI GOVERNO DEL TERRITORIO / MUNICIPAL SPATIAL PLAN

PIANO DEI SERVIZI (Approvazione 2012)

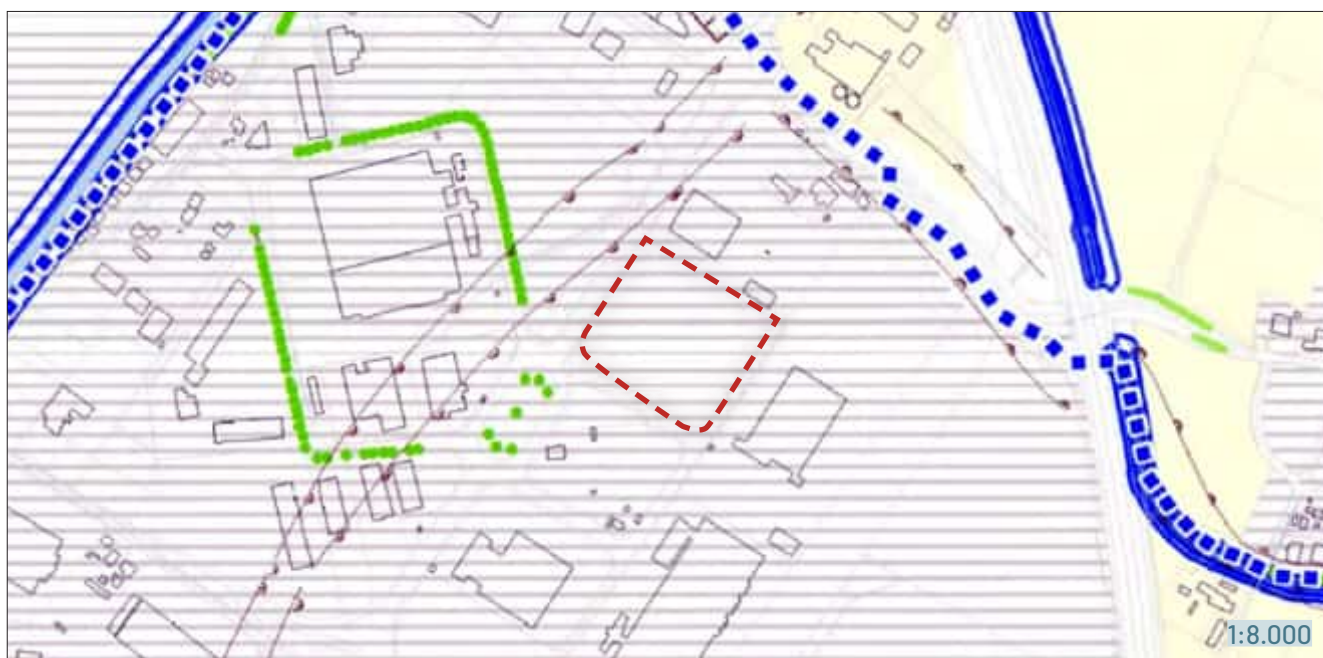
Tavola PS2 | Sistema dei servizi (Variante 2024)



IDENTITY PROFILE

TRANSITION AREA

PGT ANALYSIS



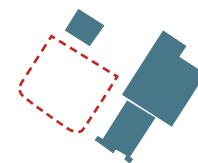
MUNICIPALITY

PIANO DI GOVERNO DEL TERRITORIO / MUNICIPAL SPATIAL PLAN

PIANO DEI SERVIZI (Approvazione 2012)

Top / Tavola PS3 | Mobilità sostenibile (Approvazione 2012)

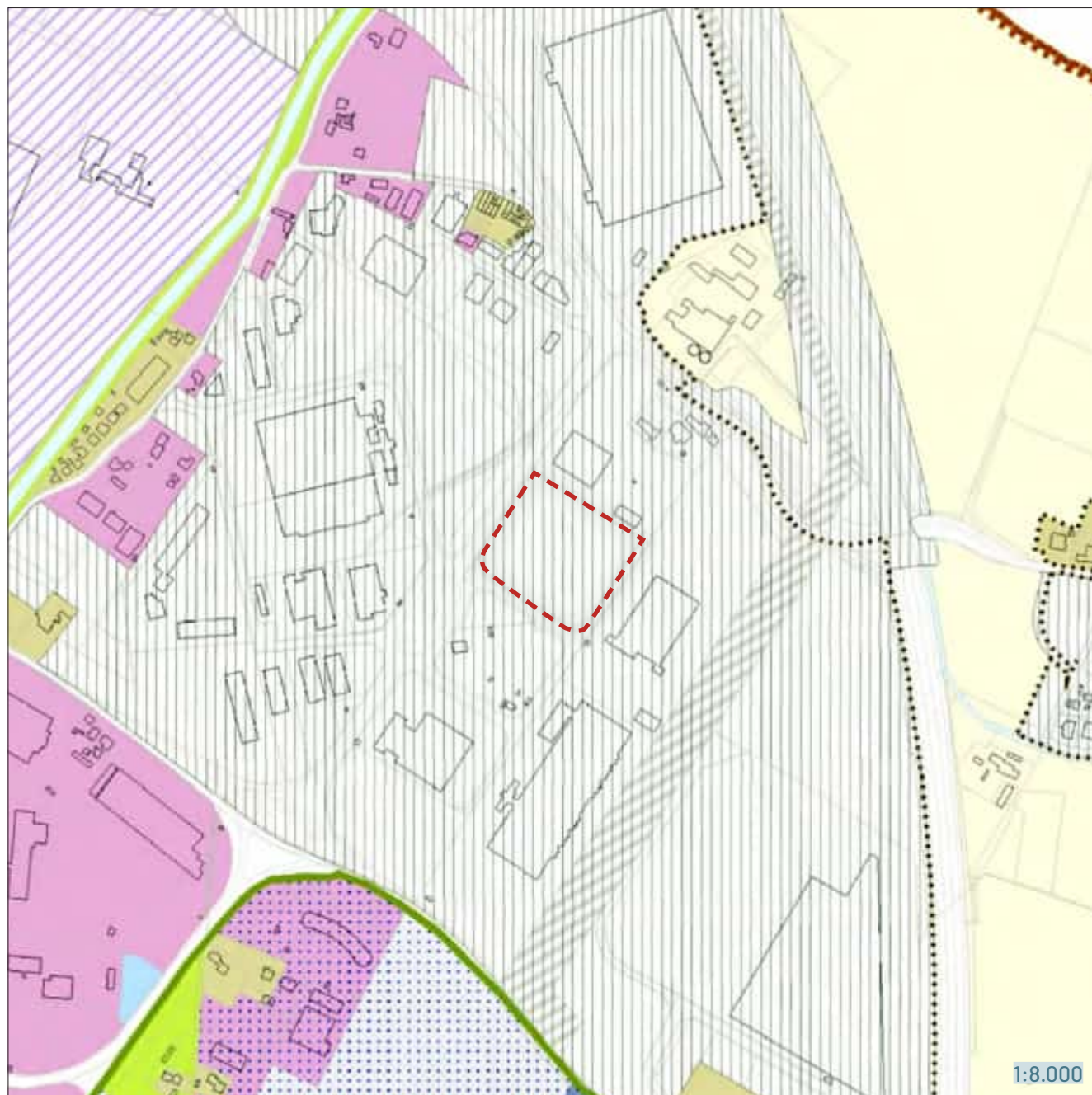
Bottom / Tavola PS4 | Rete ecologica comunale (Approvazione 2012)



IDENTITY PROFILE

TRANSITION AREA

PGT ANALYSIS

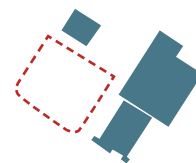


MUNICIPALITY

PIANO DI GOVERNO DEL TERRITORIO / MUNICIPAL SPATIAL PLAN

PIANO DELLE REGOLE (Approvazione 2012)

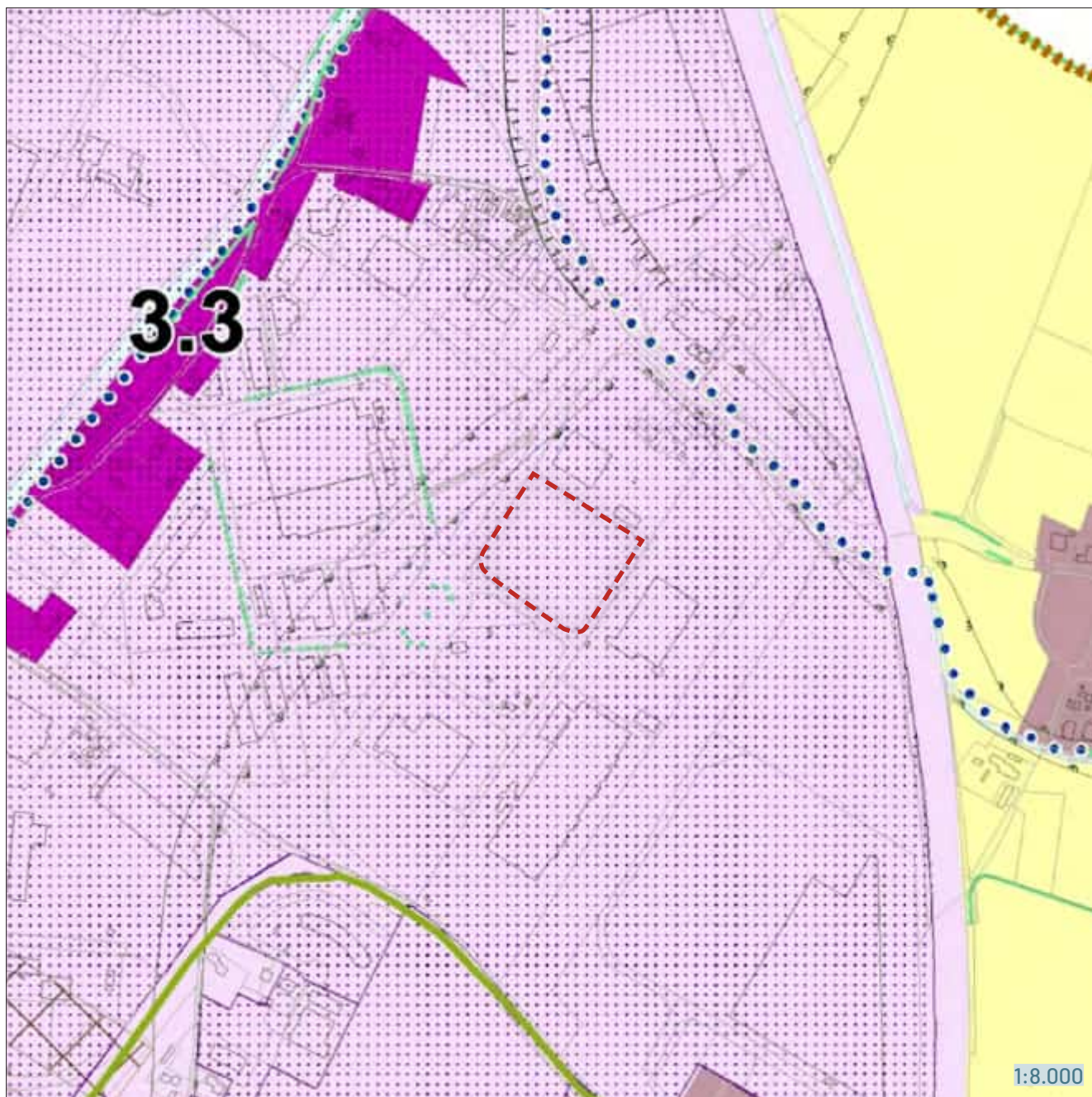
Tavola PR1 | Modalità di intervento per destinazioni d'uso (Variante 2024)



IDENTITY PROFILE

TRANSITION AREA

PGT ANALYSIS

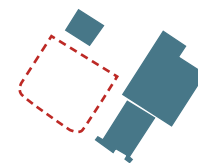


MUNICIPALITY

PIANO DI GOVERNO DEL TERRITORIO / MUNICIPAL SPATIAL PLAN

PIANO DELLE REGOLE (Approvazione 2012)

Tavola PR2 | Modalità di intervento per ambiti di sostenibilità paesaggistica (Approvazione 2012)



IDENTITY PROFILE

TRANSITION AREA

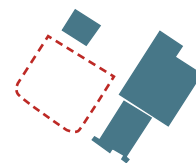
PROJECT ANALYSIS



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HYMANTOVALLEY PROJECT
Tavola | Project Overview (Anno 2023)



IDENTITY PROFILE

TRANSITION AREA

TRANSITION AREA OVERVIEW

> COMMON OPPORTUNITIES

Railway freight connection.

The area is served by two freight railway connections that branch off from the Mantua-Monselice state route, one ending near the Olmolungo historical building and the other heading to Porto di Valdaro.

Internal infrastructural network.

The area is crossed by a complex road system and is served by two strategic bus stops located along Via Ostiglia, bordering the Sapio area.

Heterogeneous land use.

The area is characterized by a heterogeneous use of the land: a series of companies linked to different sectors, some scattered residential agglomerations and a system of green spaces, some with agricultural use.

Highway.

The area benefits from the presence of the A22 motorway. The direct connection to the motorway is represented by Mantova Nord toll booth, approximately 3 km away.

Involvement of some areas in the Sapio company plant.

In the disused areas of the Sapio plant, several interventions are planned: an intermodal platform, refueling stations for trains and road vehicles and the hydrogen

production plant. Sapio, among the major hydrogen producers, is a partner in the HyMantoValley project and is involved in the production, storage and distribution of hydrogen.

Hydrographic network of historical value.

The area is characterized by the intersection of two canals of historical importance that play an important role in the identity of the place and that could take on the value of ordering elements for the design.

> COMMON CRITICAL ISSUES

Area enclosed between infrastructural barriers.

The freight railway connection to the east, parallel to the Brenner motorway, and the presence of the Mincio Diversion to the west, constitute potential limitations for the construction of effective connections with the surrounding areas.

Scattered presence of vulnerable elements.

In light of the various risks that hydrogen entails, the co-existence of an element of historical architectural value and several small residential agglomerations could prove to be a critical aspect.

LOCATION 06 DESCRIPTION

> OPPORTUNITIES

Area intended for agricultural use.

Provincial studies highlight the lot as an area for agricultural use in its current state. The current lack of construction represents an opportunity for a possible new project aimed at creating the Research Hub.

Existing structural grid.

The lot is located in an area characterized by a complex infrastructure network and a system of activities already established and urbanized. In the project, the definition of the area could perform an ordering function.

Proximity to petrol station.

The lot is flanked by a rather large Eni petrol station that could find a new use in relation to the hydrogen distribution. In addition, the area provides methane gas supply, offers parking for cars or truck and hosts a bar.

> CRITICAL ISSUES

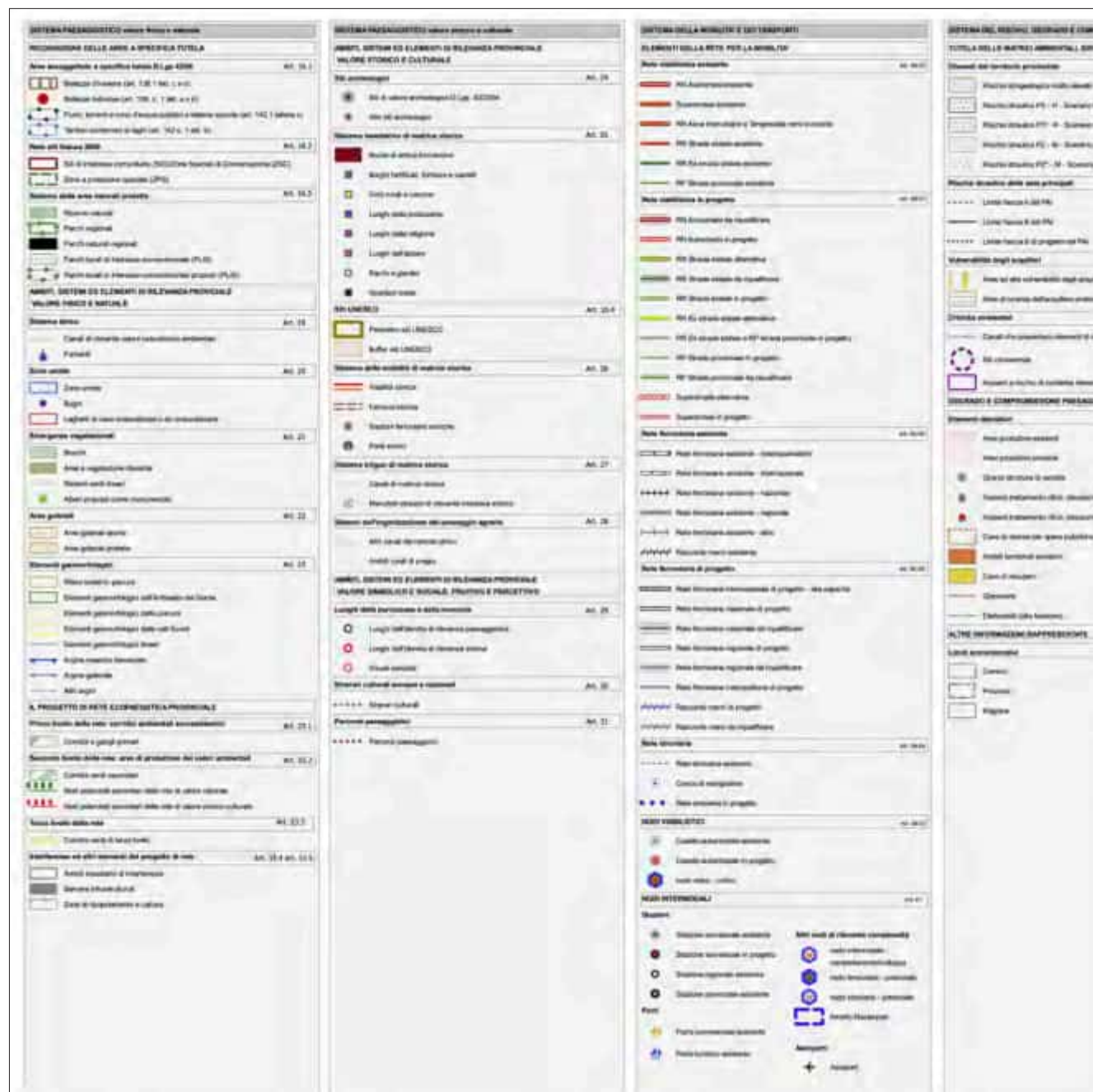
Possible ongoing transformation on the area.

The agricultural use in the actual state reported in the maps drawn up by the Province must necessarily be verified. Any changes occurred over the years may have given rise to new activities that the project will have to deal with.

Area surrounded by the presence of different companies.

The presence of several companies around the lot could represent a limit in the design of the Research Hub. The design will have to face the challenge of studying the visibility and traceability of the site within an overwritten context.

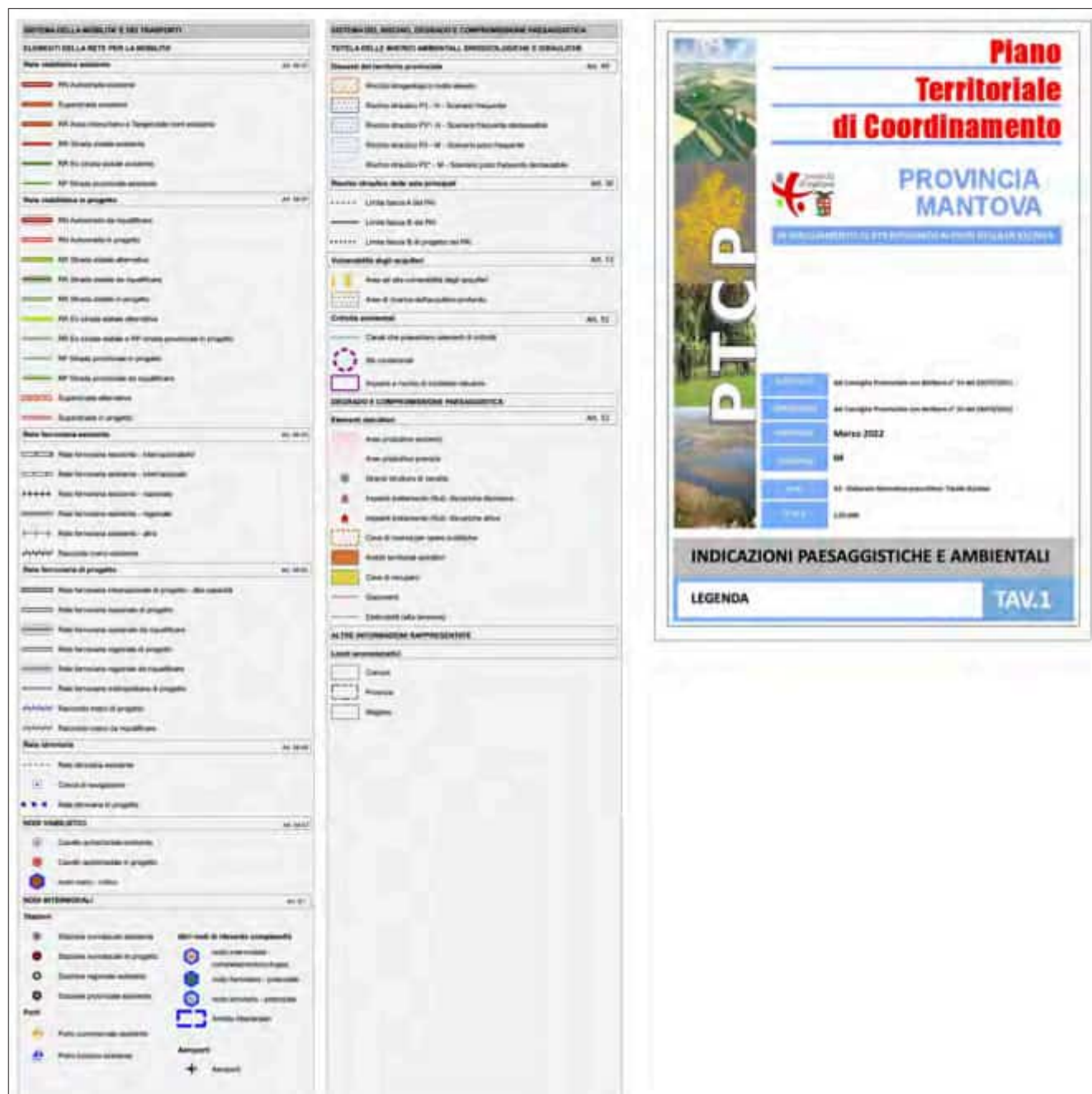
MAP LEGENDS



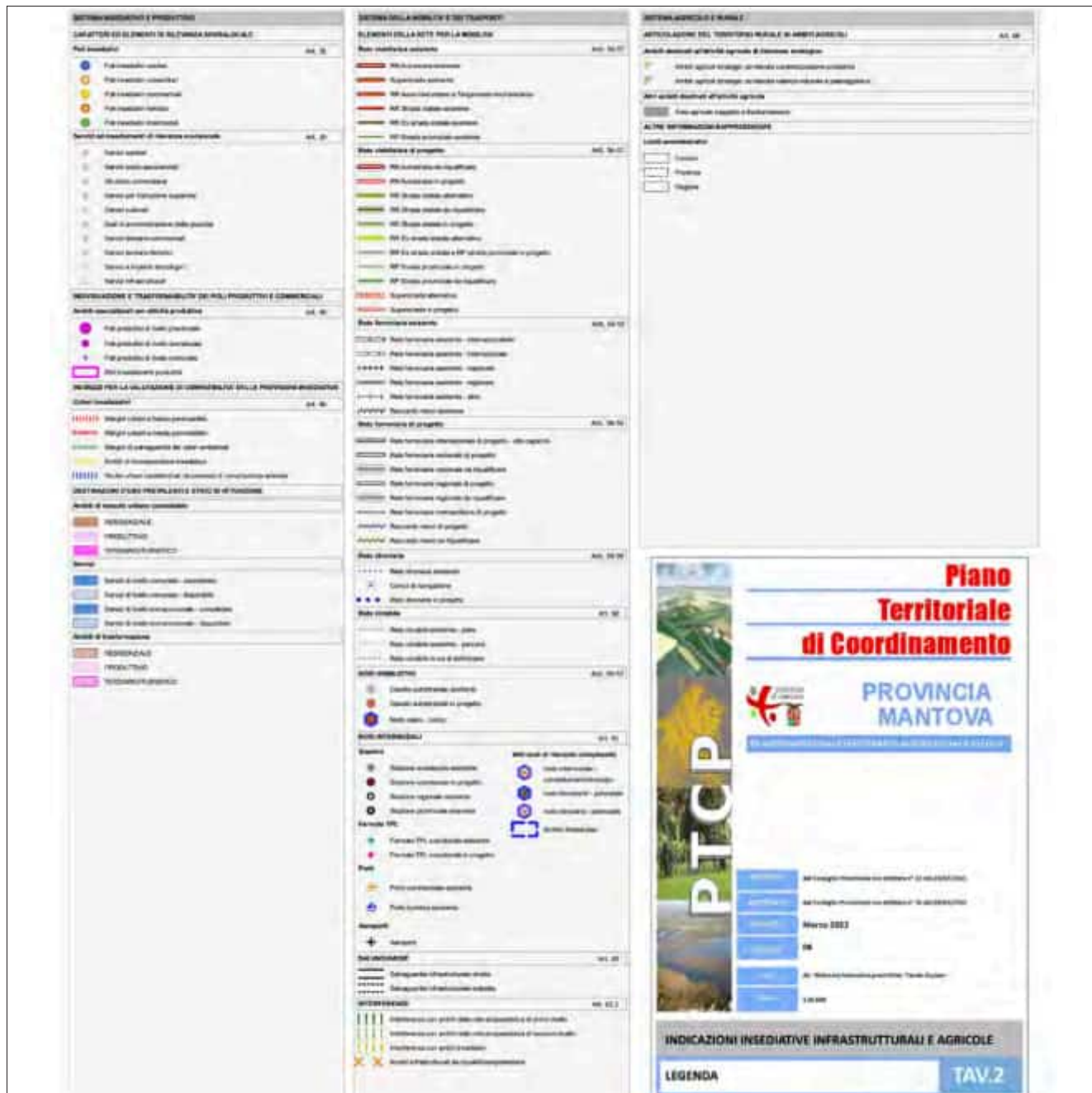
PIANO DI COORDINAMENTO PROVINCIALE / PROVINCIAL TERRITORIAL COORDINATION PLAN
Tavola 1| Indicazioni Paesaggistiche e Ambientali | Circondario D (Approvazione 2022)

IDENTITY PROFILE TRANSITION AREA

PTCP ANALYSIS



PIANO DI COORDINAMENTO PROVINCIALE / PROVINCIAL TERRITORIAL COORDINATION PLAN
Tavola 1 | Indicazioni Paesaggistiche e Ambientali | Circondario D (Approvazione 2022)



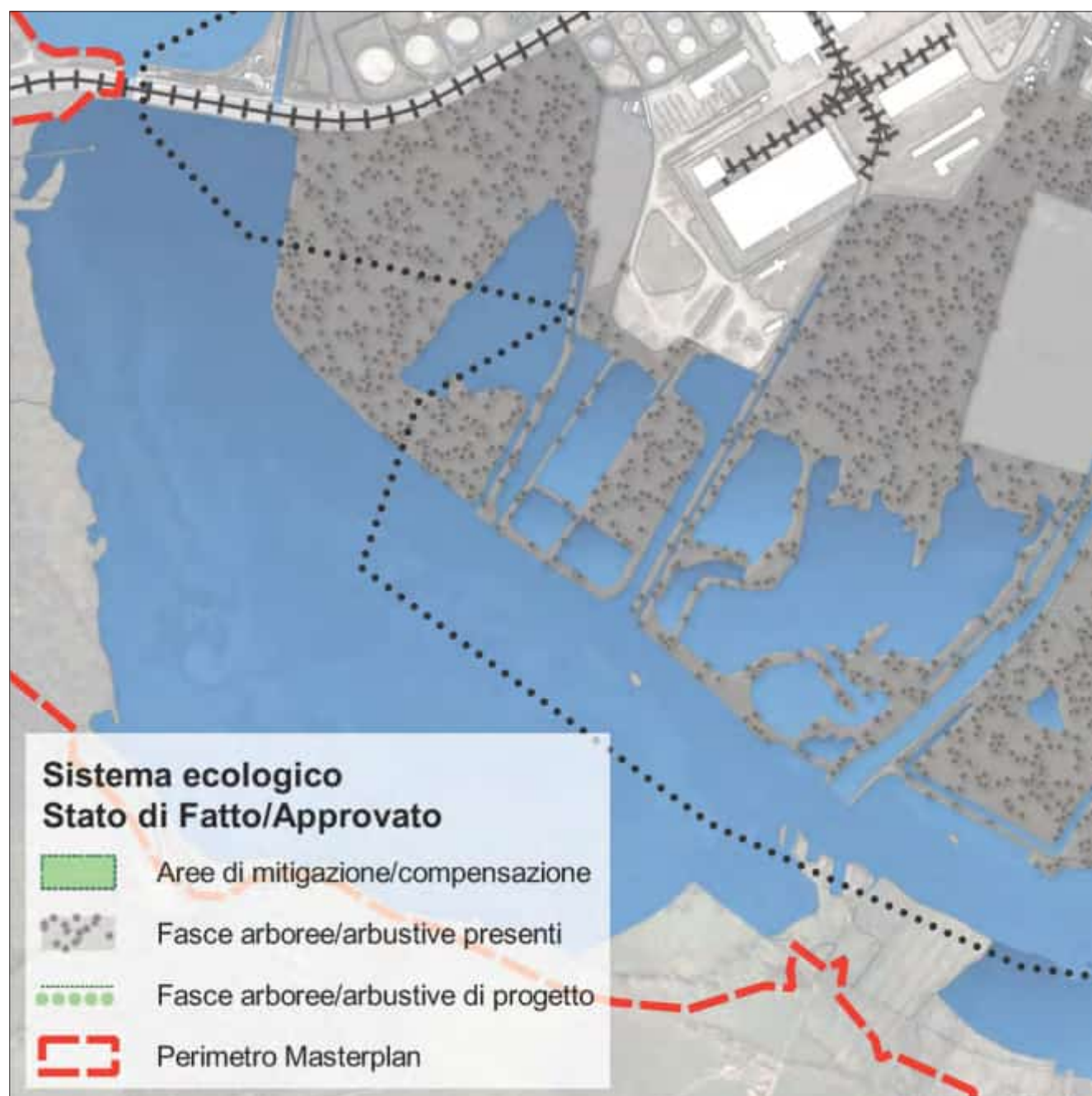
PIANO DI COORDINAMENTO PROVINCIALE / PROVINCIAL TERRITORIAL COORDINATION PLAN
Tavola 2 | Indicazioni Insediative Infrastrutturali e Agricole | Circondario D (Aggiornamento 2024)



PIANO DI COORDINAMENTO PROVINCIALE / PROVINCIAL TERRITORIAL COORDINATION PLAN

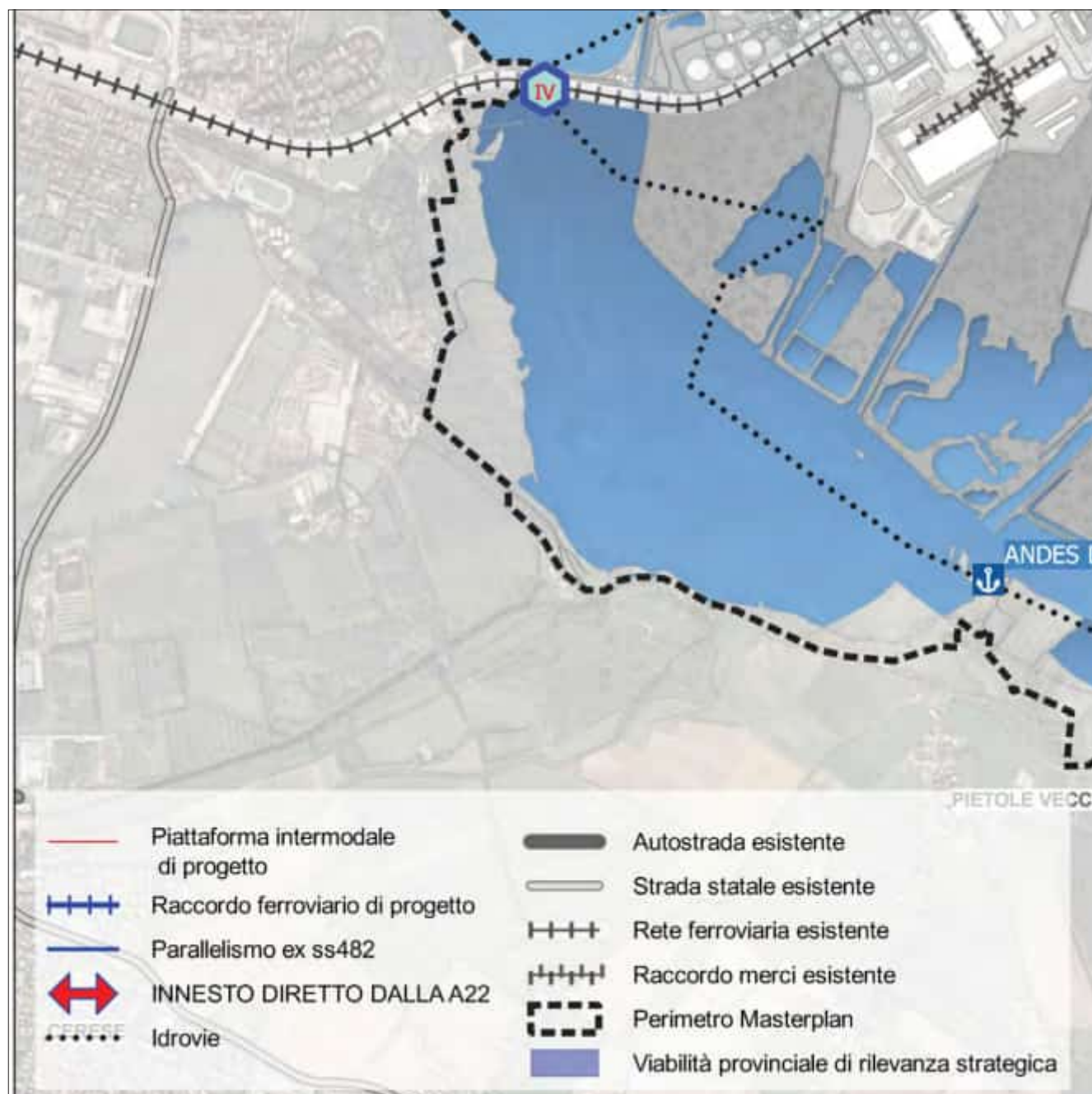
Tavola 2 | Masterplan per la rigenerazione territoriale del polo produttivo di livello provinciale di Mantova Est e del sito inquinato di interesse nazionale - Laghi di Mantova e Polo Chimico.

Sintesi degli interventi proposti (Anno 2020)



IMPLICATIONS OF THE PROVINCIAL PLAN FOR THE HYMAN VALLEY AREA

Tavola 4 | Sistema Ecologico | Analisi dello stato di fatto (Anno 2023)



IMPLICATIONS OF THE PROVINCIAL PLAN FOR THE HYMAN VALLEY AREA

Tavola xx | Abaco della mobilità di progetto (Anno 2023)

IDENTITY PROFILE TRANSITION AREA

PGT ANALYSIS

POLARITA' DEL SISTEMA PRODUTTIVO SOVRALocale

- Poli produttivi di livello provinciale
- Poli produttivi di livello sovralocale
- Poli produttivi di livello comunale
- Polo fieristico
- Poli commerciali e grandi strutture di vendita

SPECIALIZZAZIONI DEL SISTEMA PRODUTTIVO IN COMUNE DI MANTOVA

Capisaldi della produzione

- Polo chimico
- Cartiera Burgo
- Polo produttivo di livello provinciale
- Porto di Valdaro

Altri insediamenti per attività economiche

- Poli artigianali di livello comunale
- Poli direzionali
- Poli misti con quote importanti di commerciale
- Insediamenti isolati
- Aree o edifici dismessi e/o da riqualificare

Tipologia di aziende

- Aziende RIR
- Impianti di trattamento rifiuti
- Aziende soggette ad AIA
- † Industrie insalubri di prima classe
- Aziende certificate EMAS
- Distributori di carburante
- △ Depuratori

Servizi e impianti

- Servizi pubblici o di interesse pubblico e generale
- Impianti tecnologici

SPECIALIZZAZIONI DEL SISTEMA PRODUTTIVO DEI COMUNI CONTERMINI

- Aree produttive industriali e artigianali consolidate
- Aree produttive industriali e artigianali disponibili
- Aree commerciali, direzionali e terziarie consolidate
- Aree commerciali, direzionali e terziarie disponibili

SISTEMA INFRASTRUTTURALE E LOGISTICO

Mobilità su gomma

- Autostrade esistenti
- Viabilità di connessione interregionale
- Viabilità di connessione interprovinciale
- Autostrade programmate
- Viabilità regionale e provinciale di progetto
- Interventi di riqualificazione su viabilità esistenti

Mobilità su ferro

- Linee ferroviarie
- raccordi merci
- Poli intermodali

Mobilità su acqua

- ○ ○ Sistema idroviario fluviale padano
- Porti commerciali

- Porti commerciali
- Porti turistici

Porto di Valdaro

- Ambito portuale di Valdaro
- Centro intermodale di Valdaro

Salvaguardie come individuate nel PTCP vigente

- Interventi con salvaguardia diretta
- Interventi con salvaguardia indiretta

SISTEMA DELLE RETI

- Elettrodotti
- Metanodotto
- Pipeline (Polimeri)

Piano Governare Territorio



Elaborato approvato con D.C.C. n. 60 del 21.11.2012

DP

Analisi territoriale

1b

LA CITTA' E LE IMPRESE

Scala 1:15.000
novembre 2012

IDENTITY PROFILE TRANSITION AREA

PGT ANALYSIS

Trame

T1_UNESCO

-  Art. 10 e 12 D.Lgs 42/2004 - Tutela diretta e verifica di interesse culturale
-  Edifici in zona di tutela Unesco
-  Edifici nella buffer zone Unesco
-  Piazze, percorsi e camminamenti storici
-  Sistema delle fortificazioni

Centralità e percezione

-  Luoghi della percezione e della memoria di rilevanza storica
-  Luoghi della percezione e della memoria di rilevanza paesaggistica
-  Percezione dinamica da percorso paesaggistico
-  Percezione dinamica da percorso viabilistico
-  Visuali aperte

T2_SPECIALIZZAZIONI

Capisaldi della produzione

-  Polo chimico
-  Cartiera Burgo
-  Polo produttivo di livello provinciale

Altri insediamenti per attività economiche

-  Poli artigianali di livello comunale
-  Poli direzionali
-  Poli misti con quote importanti di commerciale
-  Insediamenti isolati
-  Polo fieristico

T3_RETE ECOLOGICA E CONNESSIONI VERDI

-  Ganglio della rete ecologica regionale
-  Varchi da mantenere e/o deframmentare

Primo e secondo livello

-  Aree di non trasformazione: corpi idrici
-  Aree di non trasformazione: habitat naturali e seminaturali
-  Aree agricole di valenza paesaggistica

Terzo livello: corridoi verdi di supporto

-  Fasce di tutela dei canali di valore naturalistico e ambientale
-  Fasce di mitigazione e inserimento delle infrastrutture
-  aree agricole di interazione fra ambiti urbanizzati

Terzo livello: verde di continuità in ambito urbano

-  Parco periurbano e verde dei laghi
-  Verde urbano e di quartiere



IDENTITY PROFILE TRANSITION AREA

PGT ANALYSIS

AMBITI DI PAESAGGIO

Ambiti a sensibilità paesaggistica molto alta

-  - con tessuti ed elementi di valore storico-culturale
 - A1 : "Civitas Vetus" città della prima cerchia
 - A2 : Suburbi della prima e della seconda cerchia
 - A3 : ambiti di continuità con l'area Unesco
 - A4 : Borgo Angeli
 - A5 : Valletta Paiolo, Valletta Valsecchi e Viale Risorgimento
-  - con valore naturalistico e percettivo
-  - con valore agricolo

Ambiti a sensibilità paesaggistica alta

-  - con valore naturalistico e percettivo
-  - con valore agricolo
-  - con elementi di pressione antropica

Ambiti a sensibilità paesaggistica media

-  - con valore agricolo
-  - con elementi di pressione antropica
-  - con elevati fattori di compromissione e di rischio

TUTELE PAESAGGISTICHE E AMBIENTALI

Beni culturali

-  Art. 10 comma 1 D.Lgs 42/2004 (ex art. 1 L. 1089/39) - Tutela diretta
-  Art. 12 D.Lgs 42/2004 (ex art. 4 L. 1089/39) - Verifica di interesse culturale
-  Art. 45 D.Lgs 42/2004 (ex art. 21 L. 1089/39) - Tutela indiretta

UNESCO

-  Zona di tutela Unesco
-  Buffer zone Unesco

Altre tutele

-  Parco regionale del Mincio
-  Zone di protezione speciale
-  Siti di interesse comunitario
-  Ambito di salvaguardia e riqualificazione dei laghi di Mantova (PTR art. 15)

AMBITI ED ELEMENTI DI VALORE PAESAGGISTICO

Valore simbolico e percettivo

-  Luoghi della percezione e della memoria di rilevanza storica
-  Luoghi della percezione e della memoria di rilevanza paesaggistica
-  Visuali aperte

-  Percezione dinamica da ambito o percorso paesaggistico
-  Percezione dinamica da ambito stradale

Valore geomorfologico

-  Paleovalvei
-  Scarpate

Valore naturalistico

-  Canali di valore naturalistico-ambientale
-  Vegetazione forestale
-  Vegetazione idrofita e prati umidi
-  Alberi monumentali

-  Siepi filari e formazioni lineari
-  Viali alberati
- Valore storico**
-  Sistema delle fortificazioni
-  Ferrovie storiche

Piano Governò Territorio



Elaborato approvato con D.C.C. n. 60 del 21.11.2012

DP

Quadro programmatico

5

SENSIBILITA' PAESAGGISTICA

Scala 1:12.000
novembre 2012

IDENTITY PROFILE TRANSITION AREA

PGT ANALYSIS

SISTEMA INSEDIATIVO CONSOLIDATO

Perimetro del tessuto urbano consolidato

Nuclei di antica formazione

Perimetro dei nuclei di antica formazione

Edifici dei nuclei di antica formazione e delle relative aree di continuità

Tessuti consolidati a destinazione residenziale prevalente

Edifici di Valletta Paiolo, Valletta Valsecchi e Viale Risorgimento

Edifici delle aree residenziali

Tessuti consolidati a prevalente uso per attività economiche

Edifici artigianali e per attività economiche

Edifici industriali e produttivi

Edifici produttivi da riconvertire

SISTEMA INSEDIATIVO CONSOLIDATO IN TRASFORMAZIONE

Tessuti consolidati in trasformazione

Comparti assoggettati a strumento attuativo approvato e convenzionati

Comparto oggetto di Decreto di vincolo del 15.05.2009

Ambiti interessati da programmi negoziali

Comparti da assoggettare a pianificazione attuativa:

Piani di completamento in ambito urbano

Ambiti dismessi o degradati da assoggettare a recupero e riqualificazioni

Piano a destinazione produttiva prevalente

Porto di Valdaro

Ambito portuale

Aree logistiche e portuali a gestione pubblica

Aree logistiche e portuali soggette a pianificazione attuativa

Conca di navigazione

Aree produttive private a servizio del porto

Centro intermodale di Valdaro

AMBITI DI TRASFORMAZIONE

Aree di trasformazione per la ricucitura dei margini urbani

ATR1 Te Brunetti

ATR2 Ghisiolo

SISTEMA DEI SERVIZI E DEL VERDE DIFFUSO

Aree per attrezzature pubbliche di interesse pubblico o generale

Aree per attrezzature private di interesse pubblico o generale

Verde territoriale: Parco periurbano e verde dei laghi

Verde urbano

Verde di quartiere

Spazi verdi per lo sport

Piazze, percorsi e camminamenti storici

Verde di arredo stradale

TERRITORIO AGRICOLO

Aree agricole di valenza paesaggistica

TERRITORIO AGRICOLO

Aree agricole di valenza paesaggistica

Aree agricole produttive

Aree agricole di interazione

AREE DI NON TRASFORMAZIONE

Laghi e corsi d'acqua

Habitat naturali e seminaturali

Verde di mitigazione ambientale

SISTEMA DELLA MOBILITA'

Servizi per il trasporto pubblico

Eliporto

Autostrade esistenti

Viabilità di connessione interregionale

Viabilità di connessione interprovinciale

Autostrade programmate

Viabilità regionale e provinciale di progetto

Interventi di riqualificazione su viabilità esistenti

Innesto provvisorio sulla rotatoria tangenziale sud di Mantova - compari

Linee ferroviarie

TUTELE PAESAGGISTICHE SOVRAORDINATE

Zona di tutela Unesco

Buffer zone Unesco

Parco regionale del Mincio

Ambito di salvaguardia e riqualificazione dei laghi di Mantova (PTR art.

SALVAGUARDIE E ALTRE TUTELE

Fascia di rispetto del depuratore

Fascia di rispetto del cimitero

Salvaguardia della variante alla SS10 (opera connessa alla Mantova Cre

Zone di protezione speciale (ZPS)

Siti di interesse comunitario (SIC)

CLASSI DI FATTIBILITA' GEOLOGICA

Classe 2 - Fattibilità con modeste limitazioni

Classe 3 - Fattibilità con consistenti limitazioni

Classe 4 - Fattibilità con gravi limitazioni

IDENTITY PROFILE
TRANSITION AREA

PGT ANALYSIS

AREE ED ATTREZZATURE PUBBLICHE O DI INTERESSE PUBBLICO O GENERALE (ARTT. C7, C8, C9)

Servizi per l'assistenza all'infanzia e l'istruzione obbligatoria

- Scuole per l'infanzia
- Scuole primarie

Servizi per l'istruzione superiore, universitaria e la ricerca scientifica

- Scuole superiori di primo grado
- Scuole superiori di secondo grado
- Tutti i gradi scolastici
- Università
- Servizi per la ricerca scientifica e Centri di ricerca
- Servizi per lo sviluppo, formazione, innovazione e creazione di una nuova impresa

Presidi per la sicurezza pubblica

- Servizi per la sicurezza

Servizi pubblici o di interesse generale quali uffici e altre strutture da destinare a enti pubblici e pa

- Istituzioni e servizi amministrativi e giudiziari
- Altri uffici pubblici o di interesse pubblico

Servizi per lo sport, lo spettacolo, la cultura, la persona e il tempo libero

- Servizi per la cultura
- Musei
- Teatri
- Biblioteche e archivi
- Servizi per il tempo libero e il turismo
- Attrezzature sportive

Servizi per l'alloggio e l'ospitalità

- Edilizia residenziale pubblica
- Studentato

Servizi per la salute e attrezzature sanitarie

- Presidi ospedalieri o sanitari sovracomunali
- Presidi, distretti e servizi ASL
- Residenze sanitarie per anziani
- Altri servizi sanitari e sociali

Verde pubblico naturale ed attrezzato

- Verde urbano
- Verde territoriale: parco periurbano e verde dei laghi
- Verde di quartiere

Verde diffuso

- Verde di arredo stradale
- Verde di mitigazione ambientale

Mercati su area pubblica

- Mercato

Servizi per la mobilità

- Piazze, percorsi e camminamenti
- Parcheggi e aree di sosta
- Servizi per il trasporto pubblico
- Eliporto

Attrezzature religiose

- Attrezzature religiose

Altri servizi e impianti di interesse pubblico

- Infrastrutture tecnologiche
- Opere idrauliche
- Cimiteri
- Cimiteri - area sacra ex cimitero ebraico
- Aree pubbliche di riserva

Aree per attrezzature private

- Servizi pubblici esistenti in immobili disciplinati nel PR

Rete ferroviaria

- Stazioni di livello provinciale
- Stazioni di livello sovralocale
- Stazioni di livello metropolitano in progetto

Trasporto pubblico locale

- Fermate sovrallocali esistenti
- Fermate sovrallocali di progetto

Navigazione

- Porti commerciali
- Porti turistici

SERVIZI PER LE IMPRESE

- Centro intermodale di Valdaro
- Viali alberati

CORRIDOI ECOLOGICI

- Laghi e corsi d'acqua
- Aree rurali e naturali di valenza paesaggistica ed ecologica
- Aree agricole di interazione

SISTEMA INFRASTRUTTURALE

- Autostrade esistenti
- Viabilità di connessione infraregionale
- Viabilità di connessione infraprovinciale
- Autostrade programmate
- Viabilità regionale e provinciale di progetto
- Interventi di riqualificazione di livello infraregionale o infraprovinciale (da PTCP)
- Salvaguardia della variante alla S.S. 10 nei comuni di Curtatone e Montanara (opera co
- Rotatorie
- Linee ferroviarie

FASCE DI RISPETTO

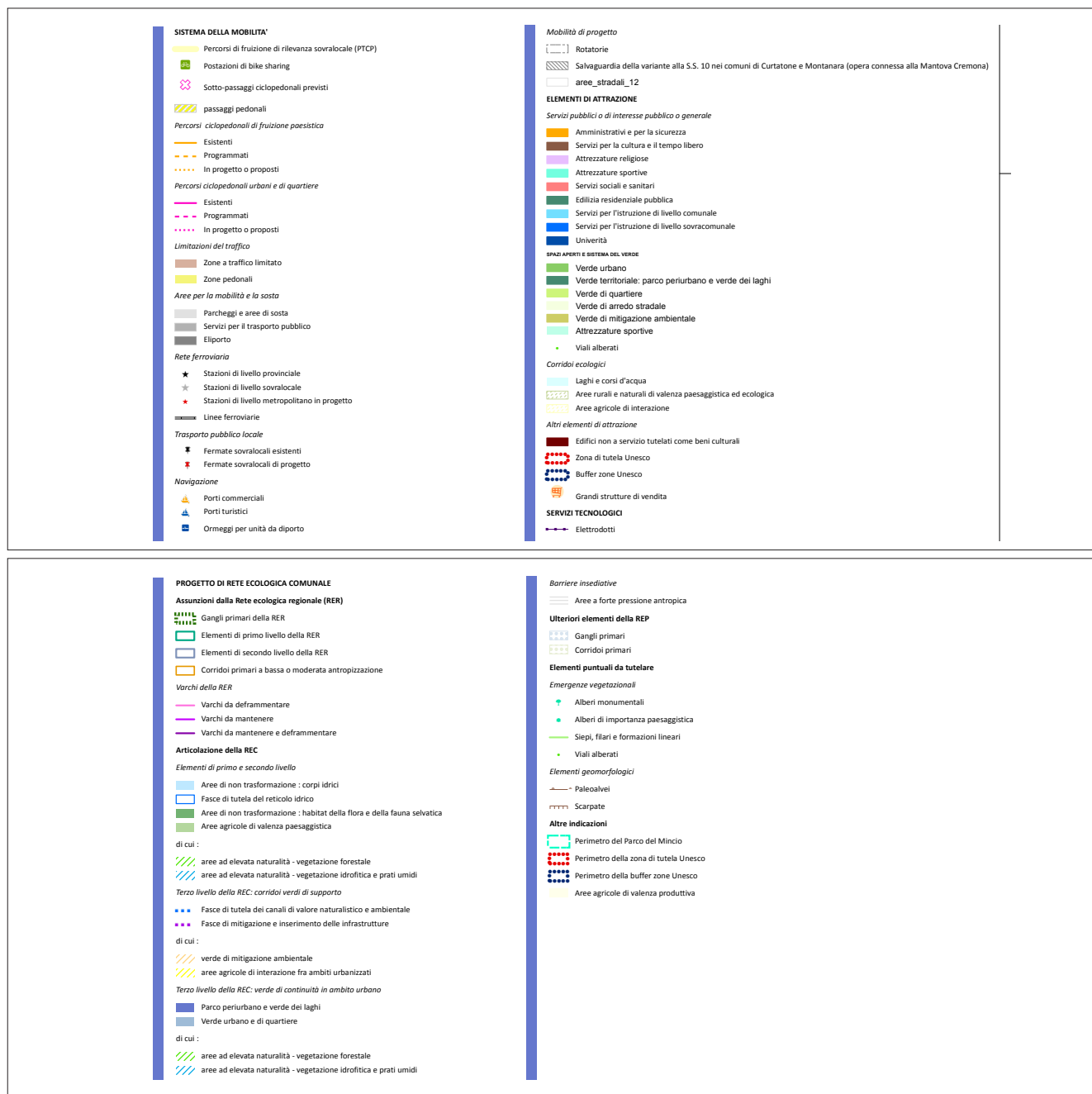
- Fasce di rispetto dei cimiteri
- Fasce di rispetto per impianti tecnologici
- Area di rispetto assoluto dei pozzi
- Area di rispetto dei pozzi

VARIANTE A PS E PR

- n. - ambiti modificati con la presente variante

IDENTITY PROFILE TRANSITION AREA

PGT ANALYSIS



PIANO DI GOVERNO DEL TERRITORIO / MUNICIPAL SPATIAL PLAN
PIANO DEI SERVIZI (Approvazione 2012)
Top / Tavola PS3 | Mobilità sostenibile (Approvazione 2012)
Bottom / Tavola PS4 | Rete ecologica comunale (Approvazione 2012)

IDENTITY PROFILE
TRANSITION AREA

PGT ANALYSIS

SISTEMA INSEDIATIVO CONSOLIDATO

 Perimetro del tessuto urbano consolidato

Nucleo di antica formazione e relative aree di continuità

 Perimetri dei nuclei di antica formazione

A1 : "Civitas Vetus" città della prima cerchia (XI-XII sec.)

A2 : Suburbio della prima (XIII – XIV sec.) e seconda cerchia (XV-XIX sec.)

A3 : Aree con caratteristiche di continuità con l'area Unesco

A4 : Borgo Angeli

 Tessuti residenziali dei nuclei di antica formazione

Tessuti consolidati esterni ai nuclei di antica formazione

 Aree residenziali di Valletta Paiolo, Valletta Valsecchi e Viale Risorgimento

 Aree residenziali

 Aree per attività economiche

 Aree per attività economiche di tipo produttivo e artigianale

Trasformazioni del tessuto consolidato

 Comparti assoggettati a strumento attuativo approvato o a titolo edilizio convenzionato

 Comparto oggetto di Decreto di vincolo del 15.05.2009

 Comparti da assoggettare a pianificazione attuativa :

 Piani di completamento in ambito urbano

 Ambiti dismessi o degradati da assoggettare a recupero e riqualificazione

 Piano a destinazione produttiva prevalente

 Immobili da assoggettare a titolo edilizio convenzionato :

 Edifici produttivi da riconvertire

Porto di Valdarò

 Aree logistiche e portuali a gestione pubblica

 Aree logistiche e portuali soggette a pianificazione attuativa

 Aree produttive private a servizio del porto

 Conca di navigazione

 Centro intermodale di Valdarò

TERRITORIO AGRICOLO

 Aree agricole di valenza paesaggistica (Artt. D27, D28, D29)

 Aree agricole di valenza produttiva (Artt. D27, D28, D30)

 Aree agricole di interazione (Artt. D27, D28, D31)

 Aree agricole soggette a trasformazione (Artt. D32, B5)

AREE DI NON TRASFORMAZIONE

 Laghi di Mantova e principali corsi d'acqua (Art. D33)

 Habitat naturali e seminaturali (Art. D33)

 Verde di mitigazione ambientale (Art. D33)

 Punti di approdo turistici (Art. D33)

SISTEMA DELLE INFRASTRUTTURE

 Aree per la viabilità (Artt. C6, D9)

 Infrastrutture ferroviarie (Art. D34)

 Distributori di carburante (Art. D35)

SISTEMA DEI SERVIZI E DEL VERDE DIFFUSO

 Aree per attrezzature pubbliche e di interesse pubblico o generale (Art. C8)

 Aree per attrezzature private di interesse pubblico o generale (Art. C9)

TUTELE PAESAGGISTICHE SOVRAORDINATE

 Zona di tutela Unesco

 Buffer zone Unesco

 Ambito di salvaguardia e riqualificazione dei laghi di Mantova: PTR art. 19 comma 2 (Art.

 Parco regionale del Mincio (Art. D2)

 Zone di protezione speciale (Art. D2, D39)

 Siti di interesse comunitario (Art. D2, D39)

ALTRE TUTELE

 Fascia di rispetto del depuratore (Art. D10)

 Fascia di rispetto del cimitero (Art. D11)

 Area di rispetto assoluto dei pozzi (Art. D10)

 Area di rispetto dei pozzi (Art. D10)

 Salvaguardia variante S.S. 10 (opera connessa alla Mantova Cremona) (Art. D9)

IDENTITY PROFILE TRANSITION AREA

PGT ANALYSIS

AREE E BENI DI VALORE PAESAGGISTICO ED ECOLOGICO

Patrimonio culturale

Beni culturali:

-  Art. 10 comma 1 D.Lgs 42/2004 (ex art. 1 L. 1089/39) - Tutela diretta
-  Art. 12 D.Lgs 42/2004 (ex art. 4 L. 1089/39) - Verifica di interesse culturale
-  Art. 45 D.Lgs 42/2004 (ex art. 21 L. 1089/39) - Tutela indiretta

 Bellezze d'insieme (Art. D38)

 Zona di tutela Unesco

 Buffer zone Unesco (Art. D2)

 Parco regionale del Mincio (Art. D2)

Rete Natura 2000

 Zone di protezione speciale (Art. D2, D39)

 Siti di interesse comunitario (Art. D2, D39)

 Ambito di salvaguardia e riqualificazione dei laghi di Mantova (PTR art. 19) (Art. D2, D4)

Elementi di valore paesaggistico

Valore simbolico e percettivo

-  Luoghi della percezione e della memoria di rilevanza storica (Art. D42)
-  Luoghi della percezione e della memoria di rilevanza paesaggistica (Art. D42)
-  Visuali aperte (Art. D42)

 Percezione dinamica da ambito o percorso paesaggistico (Art. D42)

 Percezione dinamica da ambito stradale (Art. D42)

Valore geomorfologico

 Paleoalvei (Art. D42)

 Scarpate (Art. D42)

Valore naturalistico

 Canali di valore naturalistico-ambientale (Art. D42)

 Vegetazione idrofita e prati umidi (Art. D42)

 Vegetazione forestale (Art. D38, D42)

 Alberi monumentali (Art. D42)

 Alberi di importanza paesaggistica (Art. D42)

 Siepi filari e formazioni lineari (Art. D42)

 Viali alberati (Art. D42)

Valore storico

 Sistema delle fortificazioni (Art. D42)

 Immobili meritevoli di tutela (Art. D42)

Percorsi storici e paesaggistici

 Tracciati guida paesaggistici (Art. D42)

 Percorso gonzaghese (Art. D42)

 Assi storici e itinerari culturali europei (via Carolingia) (Art. D42)

 Strade panoramiche (Art. D42)

 Ferrovie storiche (Art. D42)

 Cave cessate (Art. D42)

 Siti contaminati di interesse nazionale (Art. D42)

 Aree industriali, logistiche e portuali (Art. 42)

 Insediamenti produttivi isolati (Art. 42)

 Poli commerciali (Art. 42)

 Principali centri commerciali (Art. 42)

CLASSI DI SENSIBILITA' PAESAGGISTICA

Ambiti della città storica: sensibilità paesaggistica molto alta

 A1 : "Civitas Vetus" città della prima cerchia

 A2 : Suburbi della prima e della seconda cerchia

 A3 : ambiti di continuità con l'area Unesco

 A4 : Borgo Angeli

 A5 : Valletta Paiolo, Valletta Valsecchi e Viale Risorgimento

Ambiti a sensibilità paesaggistica molto alta

 5.1 : Sistema verde del Mincio e dei laghi

 5.2 : Ambiti agricoli interni al Parco del Mincio

 5.3 : Ambiti di interazione visuale con la città storica

Ambiti a sensibilità paesaggistica alta

 4.1: Trincerone e Valle del Paiolo

 4.2: Ambiti agricoli di continuità

 4.3: Ambiti consolidati di sud-ovest della città con destinazioni e tipologie miste

Ambiti a sensibilità paesaggistica media

 3.1: Cittadella e frazioni a nord

 3.2: Aggregati minori

 3.3: Edificio isolato in contesto produttivo

 3.4: Polo produttivo

 3.5: Aree agricole intercluse

IDENTITY PROFILE TRANSITION AREA

PGT ANALYSIS



PIANO DI GOVERNO DEL TERRITORIO / MUNICIPAL SPATIAL PLAN

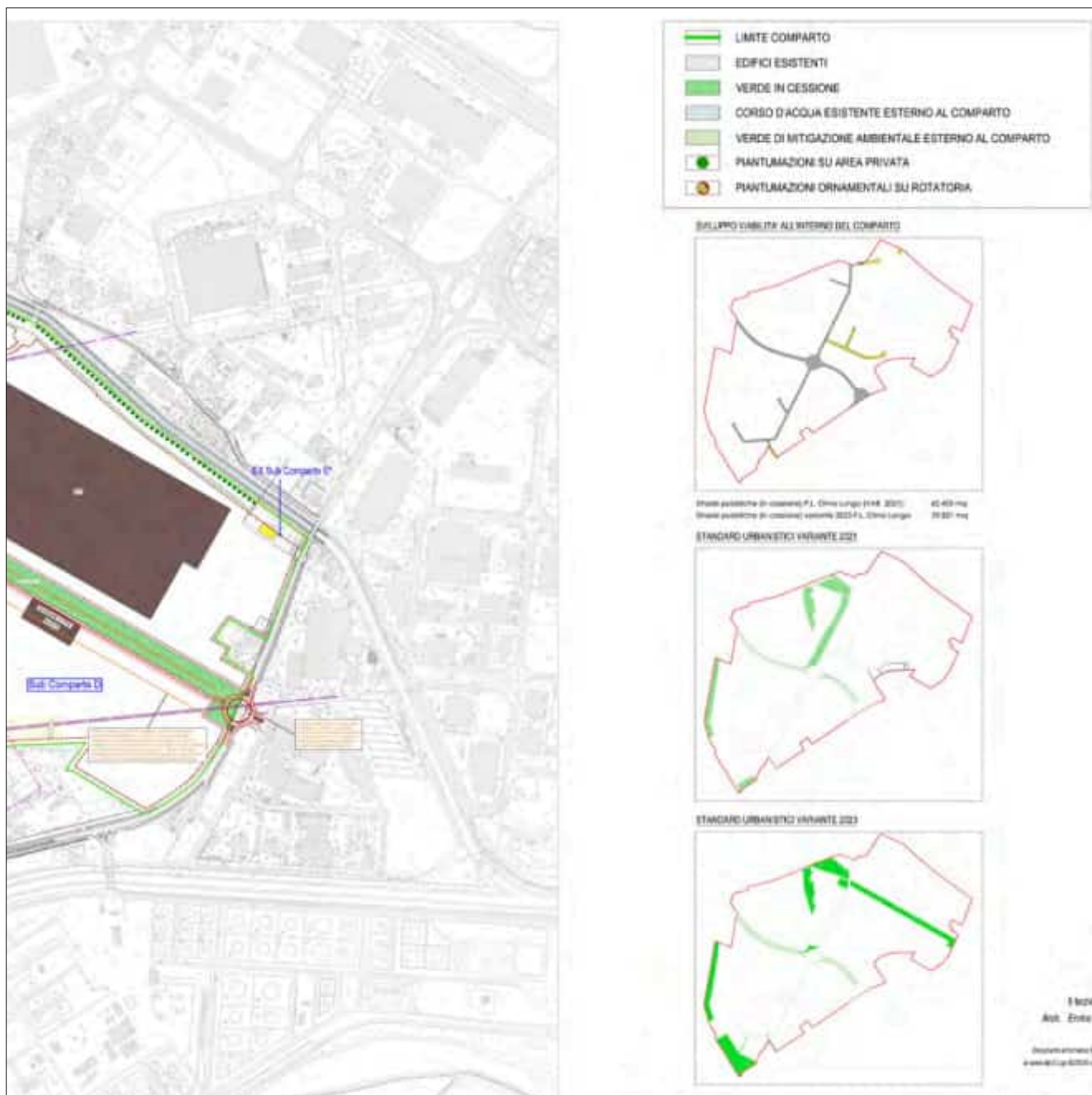
PIANO ATTUATIVO P.A. 13 "OLMO LUNGO"

Top / Tavola A3a | Planimetria generale con aree proprietà BS INVEST S.R.L. e Azienda Agricola San. Bernardino (Variante 2023)

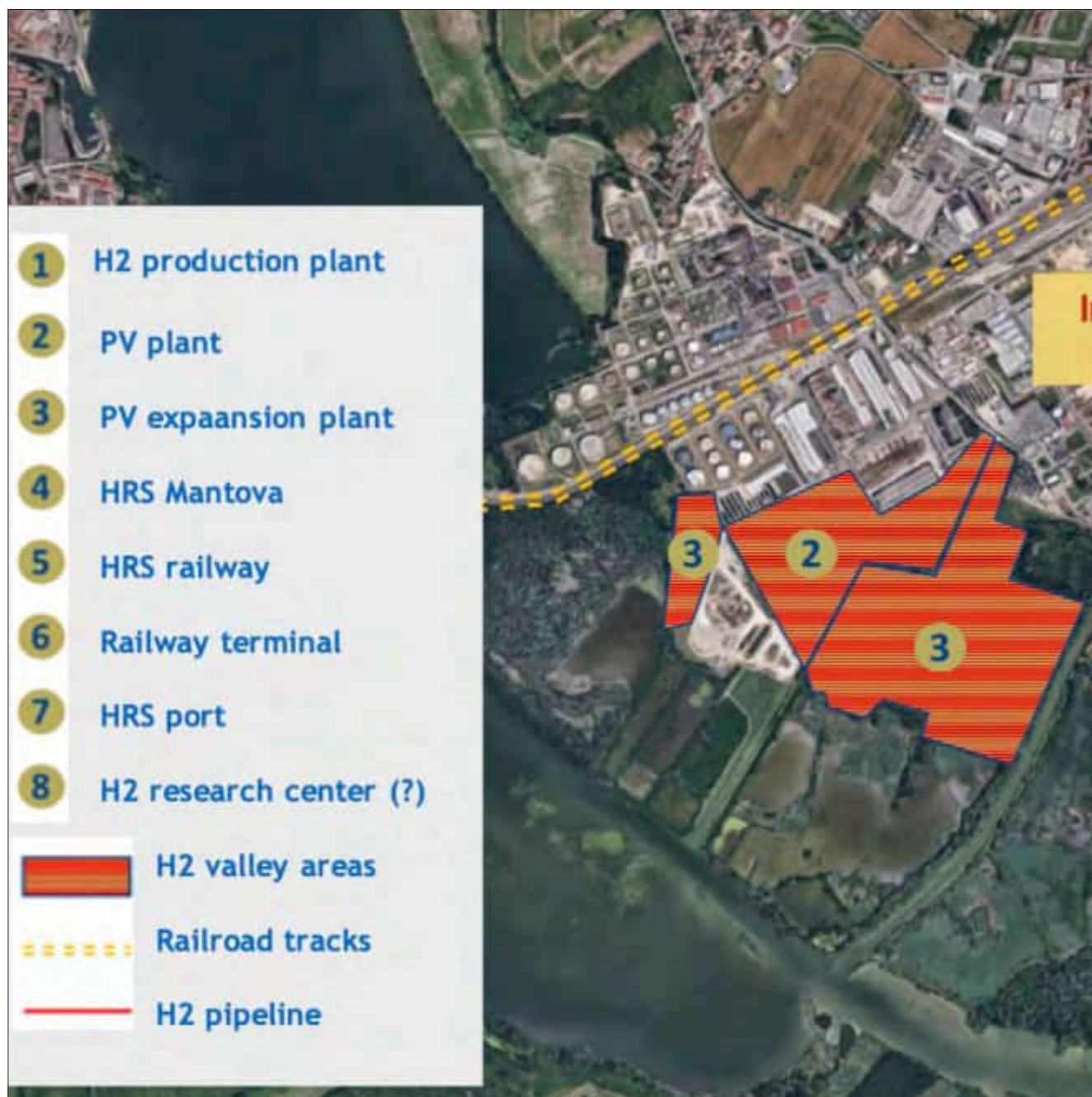
Bottom / Tavola A9 | Raffronto tra esistente e demolito/costruito (Variante 2023)

IDENTITY PROFILE
TRANSITION AREA

PGT ANALYSIS



PIANO DI GOVERNO DEL TERRITORIO / MUNICIPAL SPATIAL PLAN
PIANO ATTUATIVO P.A. 13 "OLMO LUNGO"
Tavola A14 | Verde di progetto e delle mitigazioni (Variante 2023)



**All map extracts and legends
are based on the latest official versions
available at the time of report preparation.**

For further consultation, refer to the following websites:
https://www.provincia.mantova.it/context_docs.jsp?ID_LINK=1338&area=8
https://www.comune.mantova.it/it/documenti_pubblici/pgt-approvato



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