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**ADVANCING SUSTAINABLE LAND USE AND INTEGRATED
ROAD TRANSPORT SYSTEMS: CONCEPTUAL PARADIGMS,
GOVERNANCE MECHANISMS AND IMPLEMENTATION
PRACTICES**

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The monograph is devoted to a comprehensive study of theoretical, methodological and applied aspects of sustainable land use in the field of road transport and road management. Conceptual approaches to the formation of an effective land resources management system used for road transport infrastructure are considered, and the environmental, economic and social consequences of land use in this area are analyzed. Particular attention is paid to the integration of sustainable development principles into the planning, design and operation of transport and road facilities. Practical recommendations are given on improving legal regulation, increasing the efficiency of land use and minimizing the negative impact on the environment. The monograph is addressed to scientists, specialists in transport, land use, ecology, state authorities and local governments.

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INTRODUCTION

In the context of sustainable development of Ukraine, the problem of effective use of land for road transport and road management occupies an important place. In the context of the integration of Ukrainian transport infrastructure with the European network, ensuring environmentally balanced development, increasing competitiveness and developing transit transportation are strategically important. The growing load on roads and the active expansion of the road network require new approaches to the rational use of land, which is the basis for the functioning of the country's transport infrastructure. The transformations taking place in the domestic road system lead to significant changes in the composition of land for road transport and road management. The issue of rational, effective use and protection of these lands is a component of the problem of environmental safety, the guarantee of which is an extremely important priority task today, as well as the duty of the state.

The integration of Ukrainian transport infrastructure into the European network requires environmentally balanced development, increased competitiveness and expansion of transit traffic. The growing load on highways and the active expansion of the road network require new approaches to the rational use of land, which is the basis for the functioning of the country's transport infrastructure.

Roads play an important role not only in the economic activity of the state, but also form the basis of the social and ecological structure of the country. At the same time, the issues of environmental safety and rational use of road land are becoming extremely relevant. Today, there are certain gaps in the regulation of land used for road management, which require addressing the issue of effective management of such land, environmental protection and ensuring sustainable development of infrastructure.

The monograph is devoted to the consideration of conceptual approaches and practical aspects of sustainable development of land use for road transport and road management. It is aimed at a detailed analysis of existing problems and possible ways to improve the use of road land in Ukraine, taking into account modern environmental and socio-economic requirements.

Separately, it is necessary to note the challenges facing Ukraine due to the military conflict, which significantly affected the country's infrastructure, in particular, roads and land resources of the road sector. The destruction of part of the transport infrastructure, the need to restore destroyed roads and the allocation of land for the restoration of road facilities in wartime conditions pose serious challenges to the state. The post-war restoration of transport infrastructure requires an integrated approach to the restoration and modernization of roads, as well as ensuring effective land management. The monograph aims not only to solve current problems, but also to lay the foundations for the development of long-term strategies for the sustainable development of road infrastructure and land use, which should become an important stage in the process of Ukraine's integration into the single European transport space.

■ Section 1

CONCEPTUAL APPROACHES TO SUSTAINABLE DEVELOPMENT OF LAND USE IN THE SPHERE OF ROAD MANAGEMENT AND ROAD TRANSPORT

1.1. History of the formation and development of the road industry in Ukraine

The unique geographical and geopolitical location of Ukraine in Europe, numerous transport links that have passed through Ukraine since ancient times, have always required, and now, and even more so in the future, require intensive development of communication routes, including highways. It is believed that the first roads built in Slavic lands specifically as engineering structures were voloks - strips of land cleared of stones and vegetation, bypassing river rapids and in places where it was necessary to transport boats from one river to another (See Fig. 1.1).



Fig. 1.1. The streets of Pompeii were paved with stone ¹

¹ https://maximum.fm/yak-remontuvali-dorogi-v-drevnih-pompeyah-cikave-doslidzhennya_n160478

The need for equipped roads arose in the 9th century, when a large number of urban fortified settlements appeared, designed to protect the rural settlements of one clan-tribe from numerous enemies eager for plunder - the Varangians, eastern nomads - the Magyars, the warlike Khazars, who had subdued the Black Sea region to their power [1]. In these fortified settlements, the inhabitants of the clan escaped with their treasures and livestock, including on carts. More or less equipped roads were needed for their movement [2]. This is how the first roads appeared, which can be called intra-tribal.

An important factor that contributed to the creation of the first intertribal, main roads was the so-called "polyuddya", that is, a detour by a prince with a large retinue of lands subject to him with the main goal of collecting tribute in the form of food, furs, etc. It is clear that in many places, in order to pass the prince's "expedition", it was necessary to improve the passage, to pave certain sections of the roads. The chronicle contains the famous order of Prince Volodymyr the Saint of Kiev to his servants, "Terebite puti i mosti mostite." "Terebite" or "torit" a road meant to cut new forest roads or clear those that were overgrown with undergrowth. "To pave" bridges meant not only to build them across rivers, but also to pave wooden slats across swamps. The length of the routes of the Kiev princes already reached 1500-1600 km, and each daily crossing (about 30 km.) led to a position - a specially equipped and fortified place, where behind the fence were located the premises of the prince's guards and servants, pens for livestock, stables, barns and warehouses for the collected tribute. Local roads led to this place from nearby cities and villages, along which the tribute prepared for the prince was transported in advance. The "Word about Igor's Campaign" mentions one of the first roads, which already had its own name "Borychiv Uzviz" and served as an ascent to the city gates of Kiev from Podol to the Harbor, which was called Pochaina. "Igor is traveling along Borychiv to the holy virgin Pirogoshcha."

Thus, from the 9th century, a significant expansion of the network of not only internal, tribal and inter-tribal land routes, but also inter-tribal and international trade routes across the territory of Ukraine begins. A system of land routes is being formed. From this time, the glorious era of the great Kievan Rus begins. Approximately in the 7th-8th centuries, in the Middle Dnieper region, under the influence of various factors of a socio-economic and political nature, the unification of Slavic tribes around Kiev and the Kievan principality began. This led to the formation in Eastern Europe on the border of the first and second millennia of a huge and powerful state - Kievan Rus, which became one of the leading countries of the Middle Ages, with developed agriculture, crafts and trade [3].

Kyiv had extensive foreign and trade ties. The famous routes "from the Varangians to the Greeks", "Iron", "Salt", "Silk" passed along the Dnieper and overland. This contributed to the development of cities located on the high banks of rivers, the emergence of craft centers. A developed network of land roads was formed, along which Kyiv carried out trade relations in six main trunk directions: Western (Lyada), Southern (Greek), South-Eastern (Tmutarakan, today's Kuban), North-Eastern (Murom), Northern (Novgorod and Suzdal), as well as to Lithuania through Polissya and Pripyat.

The chronicles of 1168 and 1170 mention the Iron Route, which connected Kyiv with Tmutarakan, Asia Minor and the countries of the East. Various assumptions have been made about the direction of this path and the origin of its name, but most researchers believe that it went to the Sea of Azov and further to Tmutarakan.

The name of one of the streets in Kyiv - Dorogozhytska - contains a reference to the historical area of Dorogozhychi on the northern outskirts of Kyiv, where roads from Vyshgorod, Chernigov, Novgorod, Smolensk and other ancient Russian cities converged, in particular the great road that led to the northern gate - the so-called Dorozhyshche. This area was more than once the

site of military clashes between warring princes (980, 1146, 1169). From the chronicles of those times it is known that already in the 10th century in Kyivan Rus there were paved roads and bridges in Ovruch, Novograd, Vasyliv, and the first bridge (floating) across the Dnieper in Kyiv near the Vydbetsky Monastery was laid in 1115 . [4,5]

Thus, roads began to acquire the status of a state affair, which had to be regulated by the state administration. The first document of such regulation is one of the articles of the first code of laws of Ancient Rus, which was initiated by Yaroslav the Wise in 1015. This article was called "A Lesson to Bridge Builders" and was directly related to the road business, because "bridge builders" is a general definition of all masters of the construction and repair of bridges and overpasses, that is, the first road builders in our history. The article regulated the cost of work on the arrangement of supports and platforms of wooden bridges. The specified article was somewhat corrected, clarified by Yaroslav's grandson Vladimir Monomakh in 1113, and in the 60s of the 13th century, Vladimir's great-great-grandson, Prince Yaroslav Yaroslavovich, who reigned in Veliky Novgorod, compiled a Statute dedicated to the paving of city streets and access roads.

It is believed that the provisions of this Statute regarding the mandatory participation of the entire population, even the prince, in paying for work and materials for covering roads and building bridges, that is, general road duty, were characteristic of all lands of Kievan Rus. The first mentions in the chronicles of special officials "mostniks" and "octomynniki", who were in charge of managing roads and bridges, date back to those times. Only with the presence of these persons could the order of Prince Volodymyr be implemented: "trebite puti y mostite mosty.", as well as the appearance in the legislation of Kievan Rus of the aforementioned "lesson of mostniks" and "Statute of Prince Yaroslav on bridges".

These officials, apparently, enjoyed great respect and belonged to the highest circles, because Prince Yuri Dolgoruky even feasted at the Kiev "octomynniki" Petry 1, as one of the chroniclers testifies. Thus, in the conditions of Kievan Rus, bridges and gates were of great importance, including military importance, "for the enemy will accidentally destroy the bridge or burn it, and there is no further way," it is noted in the chronicles. Thus, although the land routes of Kievan Rus were poorly arranged dirt roads, society had already begun to take care of their condition in settlements and the most strategic directions.

At the end of the 11th century, after the death of Yaroslav the Wise, Kievan Rus began to disintegrate into separate principalities [6]. The collapse of the Kievan state, the emergence of independent feudal principalities (Novgorod, Rostov-Suzdal, Smolensk, Volyn, Galicia, Kiev-Chernigov and others), between which there were continuous internecine wars, constant wars with eastern nomads (Pechengis, Polovtsians) and the Mongol-Tatar invasion negatively affected the development of roads in these centuries. During this period, the importance of large "direct" roads, which they had during Kievan Rus, was largely lost. Roads within individual feudal principalities began to play a more significant role. The development of communication routes was also negatively affected by the fact that after liberation from the Tatar-Mongol yoke, a significant part of the territory of modern Ukraine (Kyiv region, Eastern Volyn, Podillia) was (until 1569) part of the Grand Duchy of Lithuania [6].

As the borders of Ukraine moved south, with the emergence of new cities and settlements, new roads appeared, which, connecting with the old routes, formed the country's road network. Many of these roads became part of the modern network of Ukrainian roads. The state's attention to roads grew. Local authorities even began to report on the condition of the roads and the implementation of orders to improve them. In 1784, the Akhtyrsk mayor reported to the "General - Lieutenant of the Kharkov Viceroyalty that the roads

"although they were repaired in some places, but from the current weather the roads could be damaged"[6].

The laying of the postal route St. Petersburg - Kyiv by the Belarusian Governor-General Count Chernyshov also dates back to those times. The paved St. Petersburg route was, according to contemporaries, extremely colorful.

Unique routes of communication such as "Milky Ways" (tracts) developed on the territory of Ukraine. The emergence of these routes was associated with the growth of salt transportation from Crimea and Galicia to the central regions of Ukraine and Russia. Wheat, industrial and other goods were transported in the opposite direction. The network of these routes was finally formed at the beginning of the 16th century and existed until the 1990s. The most famous Milky Ways: to Odessa via Katerynoslav; to Crimea via Kolomak, Karlivka, Sirogozy, Perekop; to the Don via Kolomak, Berestyanka, Radivka to Rostov; to Kolomyia (Carpathians). The final destination of the Chumash routes in the northeast was Moscow, and in the east - Nizhny Novgorod. The condition of these routes was given due attention.

It should be noted that by the beginning of the 1830s, the condition of roads in Ukraine and in was extremely unsatisfactory. In particular, in the territory that at that time belonged to the Russian Empire, almost all land roads did not have artificial surface. Only some roads near large cities, such as St. Petersburg and Moscow, had a surface that could be called at least partially civilized, while other roads were in a neglected state [7]. An important reason for this situation was the lack of an organized system of road maintenance, which made it difficult to move goods and people around the empire. In order to improve the situation and create the necessary infrastructure, the tsarist government in 1833 was forced to adopt a law that regulated the construction of roads in the empire. This law became the basis for the development of the transport network and the classification of roads, which was in effect until the October Revolution of 1917. According to this law, roads were divided into five

classes, depending on their significance and importance for the state. Such measures were aimed not only at improving transport connections between cities, but also at promoting economic development by facilitating the delivery of goods.

The first class of roads included the main roads that were most important for the empire. Their construction and maintenance were entrusted to the treasury through the Main Directorate of Communication Roads. These roads were supposed to be the best in the country, but, unfortunately, there were no such roads in Little Russia. The second class included important roads that connected large cities, such as St. Petersburg and Kiev, Kiev and Odessa, and Kiev and Moscow. These roads were strategically important for the development of trade and postal communications, since the main flow of goods and messages passed through them [8,9].

The roads of this period were not only means of transportation, but also became important elements of the development of socio-economic infrastructure, connecting different parts of the empire and contributing to the growth of trade, mobility, and urbanization [10, 11]. The development of the road sector in Ukraine was an important factor in the overall context of the country's modernization, but many aspects of this process, in particular the level of maintenance and development of the road network in some regions, remained underdeveloped.

Thus, the classification of roads, introduced in the middle of the 19th century, was an important step in the development of transport infrastructure, which was to contribute to the growth of the state. At the same time, it should be noted that although many roads were identified as important for economic and social development, the actual condition of the roads and the level of their maintenance remained quite uneven, reflecting not only the technical, but also the administrative level of development in different parts of the country.

The first significant road construction in Ukraine was the construction of roads in Crimea, which began in 1820. The first of them was the southern coast - from Simferopol to Alushta and further to Sevastopol, with a length of 136 versts. Its construction was carried out at the expense of the Tatar collection (45 kopecks from each Tatar soul per year). Later, roads were built to the residences of the nobles [12-15].

The beginning of the 20th century was marked by the transition to the rapid spread of automobiles in industrial activities, the army and everyday life. In Ukraine, the first automobile appeared in Odessa, then several dozen in Kyiv. Already in 1902, the Kyiv City Duma adopted a resolution on the "Procedure for Passenger and Freight Traffic in the City of Kyiv by Automobiles". In 1906, a bus service was opened on the Kyiv - Zhytomyr route, in 1910 the route was extended to Rivne. Bus traffic was also organized on the Kyiv - Chernihiv, Kamianets - Podolsky - Proskuriv (now Khmelnytskyi) directions, in 1911 - along the entire Kyiv - Brest highway. Only on some, more important at that time, directions did the roads have a continuous hard surface over a relatively long length: from Kyiv to Chernihiv, Zhytomyr, Novograd - Volynskyi, Berdychiv and others. Some cities - Kharkiv, Vinnytsia, Poltava, Proskuriv, Kamianets-Podilskyi, Katerynoslav (now Dnipropetrovsk) had small access roads with hard surfaces ranging from 5 to 20 km in length [16].

The large volume of road and bridge work that the Ministry of Transport had to carry out on military orders, and the growing role of roads in the life of the country, required the creation of a strong centralized organization within the ministry system to manage the road sector. At the end of 1916, the Highways Department (Upshos) was created as an independent department of the Ministry of Transport, and in mid-1917, when highways were separated from the Kyiv District of Transport, the Southwestern Highways Department (Pivdezhakhidshos) was organized [16,17].

The experience of road construction during the war years, in conditions of rapid growth in the carrying capacity and volume of use of road transport, found its embodiment in the new technical rules and instructions developed in 1917. In particular, such as "Temporary Instructions for Repair and Maintenance of Highways", "Temporary Rules for the Production of Research on Highways and Paved Roads of the Main and Local Type". These standards covered the main issues of designing and building roads and road structures. After the October Revolution, the state's attention to the organization of road management, issues of construction and operation of highways did not decrease. In 1918, road sections were created under the provincial and district councils, under the Supreme Council of the National Economy - the Committee of State Structures, and under it - the Department for the Construction of Highways, Unpaved and Narrow-Gauge Roads (UPSHOS), in Ukraine (YuzSHOS). Their duties included maintaining the existing roads in working condition. At that time, there were few roads: about 4 thousand versts of stone-paved roads, mostly in separate sections built in low places or on steep climbs and descents, in hard-to-reach areas. Others were dirt roads, at best equipped with drainage ditches, bridges and other artificial structures, and were intended for horse-drawn transport [17,18.]

In 1921, the Department was transferred to the Central Department of Local Transport (CUMT) of the NKPS. It included the Ukrainian Department of Local Transport (Ukrumt). Roads of state importance were under the jurisdiction of district departments of local transport, roads of local importance were under the jurisdiction of inspections at the provincial executive committees. The Ukrainian Department of Local Transport, which was responsible for 5906 versts of highway and dirt roads, was classified as category I. The Department for the Restoration of the Navodnytsky and Chain Bridges in Kyiv was renamed the Ukrumta Construction Company, which carried out tasks related to the design and construction of large bridges in Ukraine.

Since 1928, the CUMT of the NKPS was reorganized into the Central Department of Highways and Dirt Roads and Motor Vehicles (Tsudortrans). In the union republics, the management of road transport was entrusted to the main departments of highways and dirt roads and road transport - the Golovdortrans under the Councils of People's Commissars. The construction, repair and maintenance of all roads of state and local importance in Ukraine were entrusted to the Golovdortrans of the Ukrainian SSR.

Later, in 1936, Golovdortrans was reorganized into the Ushosdor of the NKVD of the Ukrainian SSR. This department was responsible for all-Union, republican and regional roads until 1938. The construction, repair and maintenance of district and village roads were entrusted to local Councils of Deputies, and regional roads were established in the regions. In 1938, the construction and operation of roads of republican, regional and local importance was transferred to the newly organized Main Road Department under the RNK of the Ukrainian SSR (Golovdorupr), which carried out management through subordinate road departments within the regional executive committees.

The construction of roads of all-Union importance was left under the jurisdiction of the Gushosdor of the NKVD of the USSR, and the repair and maintenance of these roads in Ukraine was entrusted to the Ushosdor of the NKVD of the Ukrainian SSR and regional roads, as well as to the management of individual roads. At that time, 89 road maintenance sections (DEU) were organized in Ukraine. At the same time, separate bypasses were created within the DEU to service large bridges.

After the end of the Great Patriotic War, the road workers of the republic were given new difficult tasks - to complete the restoration of the road infrastructure as soon as possible and at the same time to begin the construction of new highways. At the same time, the primary task was to improve the main roads. By mid-1945, the Main Road Directorate included 25 regional road departments with 795 district road departments, 90 road maintenance and

three bridge maintenance sections, republican trusts of subsidiary enterprises and Ukrdorbud, the Ukrproektdor design office, the Ukrdorpost supply office, the Research Institute of Road Infrastructure and the Road Technical School. The Ushosdor system of the NKVD of the Ukrainian SSR included eight oshosdors, one road department, 80 road maintenance, bridge maintenance and bridge construction sections, as well as a logistics office.

The construction of roads of national importance was carried out mainly by specialized construction departments of the Gushosdor of the NKVD of the USSR. In 1947, the republican trust Mekhzemrobit was organized as part of the Main Directorate of Road Construction under the Council of Ministers of the Ukrainian SSR, which carried out large concentrated volumes of earthworks on the construction of highways and other facilities, in particular approaches to bridge crossings, dams, and ponds for agriculture. To carry out road construction work on the arrangement of road surfaces and the construction of artificial structures, where a high level of mechanization and the availability of specialized equipment were required, 24 machine-road stations (MDS) were created, which became part of the republican trusts Mekhzemrobit and Ukrdobud [19-24].

In 1958, the Decree of the Presidium of the Supreme Soviet of the USSR “On the Participation of Collective Farms, State Farms, Industrial, Transport and Other Enterprises and Economic Organizations in the Construction and Repair of Motor Roads” and the corresponding Decree of the Presidium of the Supreme Soviet of the Ukrainian SSR were issued [24]. These decrees established the procedure, terms and forms of participation of collective farms, state farms, enterprises and economic organizations in the construction, repair and maintenance of local motor roads. The increase in the intensity of traffic on motor roads, the development of motorization of the country required the concentration of road management in a single management body on a national and republican scale. As a result, the motor transport sector and road organizations were united into a single union-republican ministry, and the

Ministry of Motor Transport and Highways of the Ukrainian SSR was established at the republican level.

In order to further develop the republic's road network, the Republican Ministry of Construction and Operation of Roads of the Ukrainian SSR was established by the Decree of the Presidium of the Supreme Soviet of the Ukrainian SSR of October 16, 1968. The ministry included five contracting road construction trusts, about 40 industrial enterprises, nine road departments, research and design and prospecting institutes, the Central Institute of Road Transport and Highways, regional design bureaus, and other organizations [19].

The development of local, regional and republican roads was carried out by 25 regional departments and 475 district departments of construction and operation of automobile roads, subordinate to the ministry and the corresponding regional and district executive committees of the Soviets. By 1970, five more contracting road construction trusts were organized, and the Ukrdorbudmaterialy, Zakhiddorbudmaterialy and Ukrdorbudindustry trusts were created. The separated design bureaus and groups of road organizations were reorganized into branches of the Ukrdiprodor institute, and a specialized design and research institute, Ukrremdorproekt, was created. Issues of introducing new equipment and advanced technologies were concentrated in the newly organized Orgdorbud trust. A supply system for road organizations, Obldorpostach, was created in each region. The ministry, in addition to functional departments and divisions, included five main departments: the Main Directorate, which was subordinate to the regional departments; the Main Highway, which was subordinate to the departments; the Main Construction Department, which was subordinate to the contracting organizations; the Main Directorate of Industrial Enterprises and the Main Post Office, which was subordinate to the regional suppliers.

In such conditions, it was extremely difficult for the ministry to manage the further development of the road sector. In order to improve the

management of the road sector in Donetsk, Dnipro-Petrov, Zaporizhia, Ivano-Frankivsk and Kyiv regions, an economic experiment was conducted in 1971-1974, during which the regional departments of construction and operation of highways within the executive committees of regional councils and the corresponding rayon departments that were part of them were liquidated. Instead, self-supporting regional production departments of construction and operation of highways were created as repair and construction trusts (obldorbudy). In the regions, depending on the volume of work performed, road repair and construction departments (rayDRSU) or sections (rayDU) were created. Based on the positive results of the experiment, in 1975 the local road sector of the republic was transferred to a new management structure.

In order to separate the functions of the customer and the contractor, highway construction directorates (customer) were created in all regions. Four republican associations were created at the same time: Ukrdorbud, which included road construction and bridge construction contracting trusts; Ukravtodor, which united regional highway construction and directorates of highways being built in the regions; Ukrmagistral with highway construction departments and DRSU; Ukrdorbudindustria with production associations (combinations) and industrial enterprises. In the central apparatus of the ministry, all main departments were liquidated, functional departments, as well as departments, were strengthened. Improving the structure of road organizations contributed to the reduction of management levels and the transition of the entire ministry system to a three-level management structure. The highest level of management was the ministry, the middle level was the republican associations, the primary level was the trusts, regional construction companies, industrial associations (combinations), industrial enterprises.

In 1977, nine regional construction companies were already operating under the new management conditions, and since 1978, others have also switched to the new system. The work carried out by the Ministry of Road

Construction and Operation of the Ukrainian SSR to improve the structure of road management in the republic allowed us to accumulate rich management experience and create the necessary economic prerequisites for the further transition of the entire system of the ministry, including the central apparatus, to a complete economic calculation [19].

With Ukraine's secession from the USSR and its independence, there was a need to reorganize the management of the road infrastructure of Ukraine. The new management structure was approved by the Decree of the President of Ukraine dated September 8, 1994 “On the Ukrainian State Corporation for the Construction, Repair and Maintenance of Motor Roads” and the Resolution of the Cabinet of Ministers of Ukraine dated October 18, 1994 No. 717 “Issues of the Ukrainian State Corporation for the Construction, Repair and Maintenance of Motor Roads”.

By the Decree of the President of Ukraine dated November 8, 2001 No. 1056/2001 “On measures to improve the efficiency of the management of the road infrastructure of Ukraine”, the State Road Service of Ukraine (Ukravtodor) was established as the central executive body to carry out the functions of road infrastructure management [25-27].

Since the early 2000s, Ukraine has been gradually modernizing its road infrastructure. New construction technologies are being introduced, cooperation with international financial organizations (World Bank, EBRD) is being strengthened, and attention to road safety is growing. It should be noted that until 2014, road management was centralized — all highways (even local ones) were managed by the State Road Agency of Ukraine ("Ukravtodor") and its regional divisions. This system turned out to be ineffective (See Fig. 1.2).

After 2014, a large-scale administrative and territorial reform, known as decentralization of power, began in Ukraine. One of its key components was the redistribution of powers in the field of infrastructure management, in particular, local roads. Thus, a significant part of the powers for the management of local roads was transferred to the regional level.

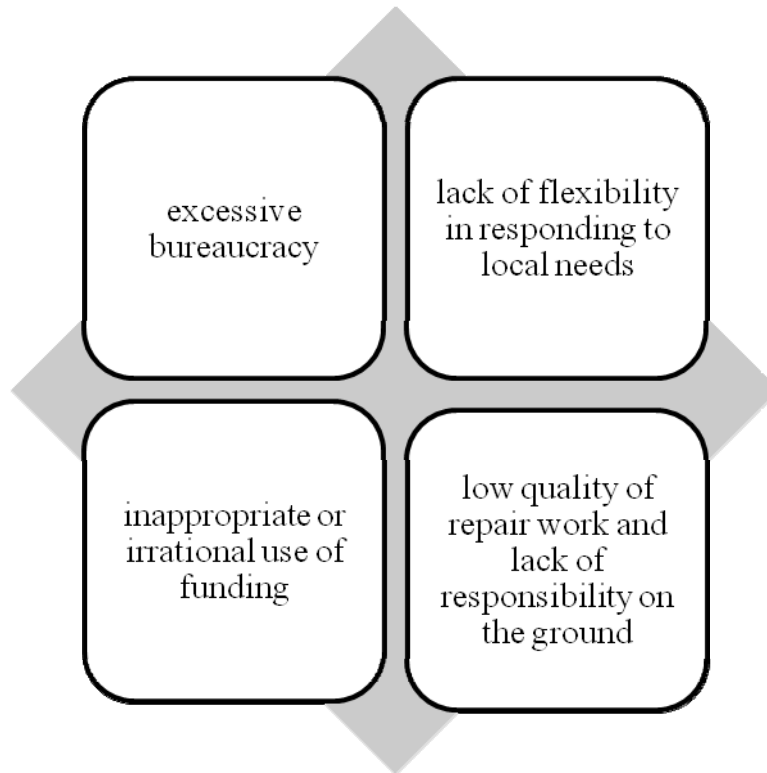


Fig. 1.2. Reasons for inefficient road management as of 2014

The Resolution of the Cabinet of Ministers of Ukraine “On Approval of the Regulations on the State Agency for the Restoration and Development of Infrastructure of Ukraine” dated September 10, 2014 No. 439 approved the Regulations on the State Agency for the Restoration and Development of Infrastructure of Ukraine [23].

In 2018, the Cabinet of Ministers of Ukraine adopted Resolution No. 106, which approved a new division of roads into state and local importance.

As part of this reform:

- ✓ About 123 thousand km of roads were transferred from the subordination of "Ukravtodor" to regional state administrations (RSA);
- ✓ Roads of state importance (about 47 thousand km) remained under the subordination of "Ukravtodor";
- ✓ The Road Fund of Ukraine was created (since 2018) - a targeted mechanism for financing road works, including at the expense of excise duty on fuel (See Fig. 1.3).

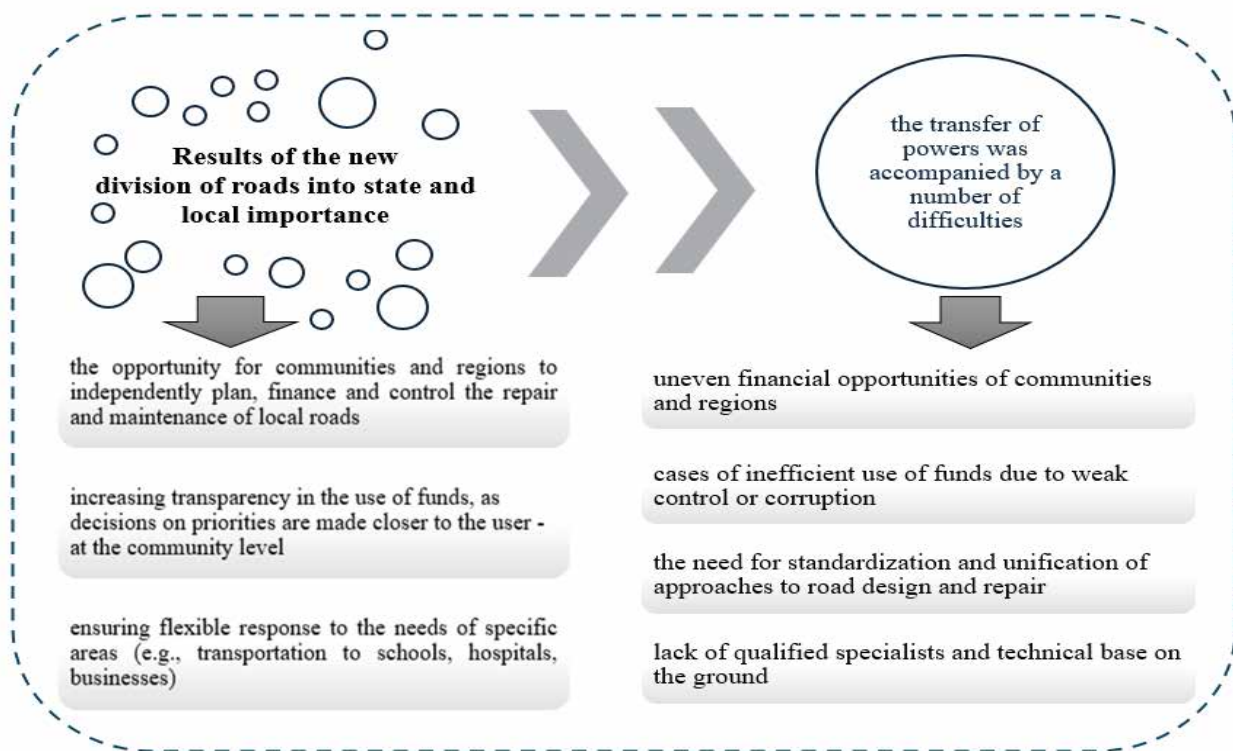


Fig. 1.3. The essence of the reform of the new division of roads into state and local importance

One of the tasks of overcoming the above difficulties was the adoption of the National Transport Strategy of Ukraine until 2030, which became an important step towards the systemic transformation of the road industry [28-30].

At the same time, today the road industry of Ukraine remains a strategic area of infrastructure development, which is of key importance for the economy, defense capability, and integration of the country into the European space.

1.2. Structure, classification, and legal status of lands of automobile transport and road management

The primary natural resource utilized by humankind since the earliest times of its existence is land. This process is always accompanied by the satisfaction of human needs. In this context, land is defined as the territorial basis for all types of human activity – a means of agricultural and forestry production, the possibility of movement over any distance with specific characteristics, spatial certainty, constancy of size, absence of wear and tear, as

well as the foundation of statehood and sovereignty. Therefore, land is one of the main and most important objects of the material world and a universal means of social life support [31].

To satisfy the material, spiritual, and social needs of the population, it is necessary to create conditions for the development of a complex of factors (economic, demographic, ecological, infrastructural) that influence this. Among the main indicators of the population's living standards is the state's provision of transport networks, linear objects, highways, and engineering structures that determine the functioning of the socio-economic system.

Currently, the process of integrating the national transport infrastructure with the European one is underway, which creates conditions for accelerated socio-economic, environmentally balanced development of the country, strengthening its economic security, increasing the competitiveness of the road network for increased transportation and tourism development, and thus, for the maximum use of the state's transit potential [32].

A developed transport infrastructure is a necessary prerequisite for economic and social development at both local and national levels, as it enables the satisfaction of the needs of enterprises and the population in the transportation of goods and passengers, the establishment of stable production and cooperative ties, the achievement of balanced spatial development, and the increase of local accessibility of all territories, their investment attractiveness, and competitiveness [33].

The development of transport is one of the most important directions of economic policy, linking the full functioning of various sectors of the economy as a whole and determining the level of socio-economic stability of the country [34].

The role of transport as an integral component of socio-economic upliftment lies in ensuring economic ties, the exchange of products and the transportation of passengers, creating conditions for the integrated development of the

state's economy, influencing the specialization and pace of development of economic activity in territories, the location of productive forces, etc.

However, the main condition for the proper functioning of material production is the efficient operation of transport. In the context of deregulation of the system of socio-economic relations and territorial management, the adoption of balanced decisions is increasingly determined by the availability and possibilities of attracting resources for territorial development.

Traditionally, the composition of such resources includes: natural (land – territory, water, forest, minerals, ecological situation, etc.); technogenic (energy resources, material and tangible, engineering and transport infrastructure); social (labor resources); organizational and personnel (administration, scientific and project support); economic (investment and material and technical support); legal (legislative acts, norms and rules of construction), etc. Together, they form a resource potential, the preservation and expansion of which is the main task of territorial management [35].

For the functioning and development of the state's transport system, land is the only necessary spatial basis, a foundation that cannot be replaced by any other resource. The size of capital investments, maintenance and servicing costs of road management facilities largely depend on the location of the land, the road, the parameters of its right-of-way, soil and engineering characteristics, and the ecological condition of the territory.

The works of such scholars as V.K. Andrieiev, N. V. Vashchenko, A. M. Kublii, E.F. Demskyi, V.M. Kondratiev, N.F. Lopatina, and others are devoted to defining the completeness of the concept of a transport system.

V.K. Andrieiev expresses the opinion that a transport system can be defined as an interconnected organizational structure of enterprises and organizations that specialize in the transportation of goods and passengers, as well as independent structural units and production associations of industry, construction, and other sectors of the economy [36].

N. V. Vashchenko and A. M. Kublii [37] consider the transport system as a set of means of transportation, communication routes, means of management and communication, and technical structures that ensure their operation.

E.F. Demskyi notes that a transport system is a set of internally coordinated, interconnected, socially homogeneous modes of transport, through which an organizing and stabilizing influence is ensured in the performance of the main tasks during transportation [38].

According to V.M. Kondratiev, a transport system is understood as a unified economic complex based on the use of a certain mode of transport, created for the planned conduct of transport and economic activities and their management [36].

Thus, a transport system is a set of all modes of transport that interact with each other, ensuring the efficient functioning of the entire economic complex of the country, regardless of the type, form of ownership, departmental subordination, and communication routes.

International transport corridors were defined by three main declarations of the European Conferences on Transport in Prague (1991), Crete (1994), and Helsinki (1997), where the routes of the Trans-European Transport Corridors were finally approved, four of which pass through the territory of Ukraine, namely:

№ 3 – Berlin/Dresden – Wrocław – Katowice – Kraków – Lviv – Kyiv;

№ 5 – Venice – Trieste/Koper – Ljubljana – Maribor – Budapest – Uzhhorod – Lviv – Kyiv;

№ 7 – Danube (waterway); (Austria, Hungary, Yugoslavia, Bulgaria, Romania, Moldova, Ukraine);

№ 9 – Helsinki – Vyborg – Saint Petersburg – Pskov – Moscow – Kaliningrad – Kyiv – Liubashivka/Rozdilna – Chisinau – Bucharest – Dimitrovgrad – Alexandroupolis [36].

Not all of these international transport corridors meet the requirements, norms, and standards of the European Union. Unfortunately, this applies to the communication routes that pass through the territory of Ukraine, so the situation with most of Ukraine's highways generally requires significant improvement on a modern innovative basis. The transport capabilities of our state are used only by 70%, and it does not fully and adequately provide transport services to all spheres of the population's life.

In addition, land use issues in automobile transport are becoming increasingly important, where land is a spatial (territorial), operational basis and plays an important technological role – it ensures the functioning and development of the state's transport system as a whole, which cannot be replaced by any other resource.

Structural problems in the field of transport land use do not lie in the surplus of territories, but in the insufficient development of the network of transport communications, which necessitates the allocation and development of additional territories for both new construction and reconstruction, especially of highways.

The analysis of global and national experience in the field of land ownership and land use, especially in the context of further development of settlements, the location and reconstruction of transport infrastructure facilities, taking into account the formation of the land relations system in Ukraine, provides grounds for the following conclusions:

- Using global experience, our state has opportunities to create an effective system of legislation on the regulation of land relations aimed at ensuring public interests in the field of rational use and protection of land;
- The lack of clear rules of land ownership is the main deterrent to attracting foreign investment into our economy;
- Increasing the efficiency of land use in cities, industry, transport, and other non-agricultural purposes, further accumulation of financial resources, and

rational development of transport infrastructure facilities require optimization of the ratio of land ownership forms, promoting the attraction of private capital for investment;

- Effective land use is impossible without a socially just and economically justified redistribution of land and the creation of equal conditions for all forms of land management;

- Ecologization of land use should become the main direction of land resource protection.

Since the functioning of transport is inextricably linked with the use of appropriate land plots, it is necessary to clearly understand and use them for their intended purpose.

The classification of lands by their intended purpose was first introduced by the Fundamentals of Land Legislation of the USSR and Union Republics (1968) and confirmed by the Land Code of the Ukrainian SSR (1970). According to these legislative acts, the land fund was formed from six categories of land, namely:

1. Agricultural land provided for the use of collective farms, state farms, and other land users for agricultural purposes;
2. Settlements (cities, urban-type settlements, and rural settlements);
3. Industry, transport, resorts, reserves, and other non-agricultural purposes.
4. State forest fund.
5. State water fund.
6. State reserve [39].

The belonging of land to these categories was determined in accordance with their main intended purpose, and the transfer from one category to another was carried out in cases of changes in their main intended purpose by the bodies that made decisions on the provision of land for use, and in cases not related to the provision of land – by the bodies that approved land management projects.

The Land Code of Ukraine of 1970 [39] clearly established the priority of agricultural land, limited the allocation of valuable land for non-agricultural needs, and stipulated that power lines, communication lines, and other communications should be laid mainly along paths and existing roads.

In order to create conditions for the operation of certain modes of transport, where necessary, on adjacent lands (without including them in the right-of-way), the possibility of establishing zones with special land use conditions was provided, containing restrictions stipulated by the regulations on lands granted to these modes of transport.

The Land Code of Ukraine of 1992 [40] additionally established a category of lands of nature conservation, health-improving, recreational, and historical-cultural purposes, in connection with which the lands of resorts and reserves were excluded from the third category that existed in the previous Land Code. This decision is entirely justified, since specially protected lands are included in one separate category of land.

The category of lands of industry and transport was supplemented by lands of communication and defense. Thus, seven categories of land were created within the land fund.

According to the 1992 Code, the lands of transport, communication, and other purposes are lands granted for the use of enterprises and organizations of railway, automobile, sea, inland waterway, air, and pipeline transport, as well as enterprises and organizations that operate power lines and communication lines [39].

In accordance with the Constitution of Ukraine and the Land Code of Ukraine, which came into force on January 1, 2002 (2768-III), the classification of the land fund by land categories was significantly changed. Since settlements (cities, towns, villages) have become units of the administrative-territorial structure of the state, within the boundaries of cities and towns, the main part of their area belongs to the lands of residential and public development, and the rest is represented by the lands of eight other categories.

Currently, the structure of the state's land according to current legislation is based on the types of intended purpose, according to which the land fund is divided into the following nine categories [40].

- a) Agricultural land.
- b) Lands of residential and public development.
- c) Lands of the nature reserve fund and other nature conservation purposes.
- d) Lands of health-improving purposes.
- e) Lands of recreational purposes.
- f) Lands of historical and cultural purposes.
- g) Lands of forestry purposes.
- h) Lands of the water fund.
- i) Lands of industry, transport, communication, energy, defense, and other purposes.

Each category of land has a special legal status, according to which their protection is carried out, as well as combining the specifics of land use as a territorial basis, a natural resource, a basic means of production, and realizing the priority of environmental safety requirements.

The intended purpose of the lands of industry, transport, communication, energy, defense, and other purposes is reflected in the name of each sub-type, which is entirely logical and regulated by relevant laws and regulations. An analysis of this category of land according to the Land Code of Ukraine [40] (Table 1.1).

Thus, it can be stated that the legislation clearly defines which lands belong to each sub-category of lands united in one category, and what form of ownership they can have. Regarding the lands of other purposes, which are the final name of the specified category, it is unclear and not considered separately in the Land Code and other regulatory and legislative acts.

Table 1.1.

**Analysis of the land category of industry, transport, communication,
energy, defense, and other purposes***

<i>Name of Land Sub-category</i>	<i>Lands Included in the Sub-category</i>	<i>Form of ownership</i>
Lands of Industry	Lands provided for the placement and operation of main, auxiliary, and supporting buildings and structures of industrial, mining, transport enterprises, their access roads, utility networks, administrative and amenity buildings, other structures; lands of industrial parks	State, communal, private
Lands of Transport	Lands provided to enterprises, institutions, and organizations of railway, automobile transport and road management, sea, river, aviation, pipeline transport, and urban electric transport for the performance of their assigned tasks regarding the operation, repair, and development of transport facilities	State, communal, private
Lands of Communication	Land plots provided for overhead and cable telephone and telegraph lines and satellite communication facilities	State, communal, private
Lands of Energy	Lands provided for electricity generating facilities (nuclear, thermal, hydroelectric power plants, power plants using wind and solar energy and other sources), facilities for the transmission of electricity to the consumer	State, municipal, private
Lands of Defense	Lands provided for the deployment and permanent activity of military units, institutions, military educational institutions, enterprises, and organizations of the Armed Forces of Ukraine, other military formations created in accordance with current legislation	State
Lands of Other Purposes	None	Absent

** Source: compiled by the authors based on data from [40].*

Lands of automobile transport and road management are a component of the category of lands of industry, transport, communication, energy, defense,

and other purposes, and at the same time an independent type of this category, which was not previously distinguished in land legislation.

The main intended purpose of these lands is the placement, construction, operation, repair, and development of relevant linear objects.

The category of lands of industry, transport, communication, energy, defense, and other purposes, characterized by the distinct intended purpose of individual types, has a number of common features, namely:

a) these lands are used as a spatial (territorial) basis, the location and functioning of various industrial, transport, energy, defense, and other facilities, and do not perform the functions of a means of production inherent in agricultural and forestry activities;

b) except for defense lands, which are state property, all of them can be in state, communal, and private forms of ownership;

c) industrial, transport, energy, and defense facilities pose an increased environmental hazard, in connection with which special zones with restrictions on land use conditions are created around them.

In our opinion, it is advisable to separate transport lands, which are combined in legislation into one category with lands of industry, communication, energy, defense, and other purposes, into a separate category, since according to Article 67 of the Land Code of Ukraine, there are seven types of transport, each of which has its own subtypes and intended purpose of land plots. For example, only the lands of automobile transport include 13 names of land plots, and road management – five.

Assigning transport lands to a separate category would enable state authorities and local self-government bodies to resume their accounting, obtain more reliable information about land plots, and make standardized management decisions during the construction or reconstruction of highways, etc.

According to Article 67 of the Land Code of Ukraine, transport lands include lands granted to enterprises, institutions, and organizations of railway,

automobile transport and road management, sea, river, aviation, pipeline transport, and urban electric transport for the performance of their assigned tasks regarding the operation, repair, and development of transport facilities (buildings, structures, etc.) [40]. This article is generalized, as it combines all types of transport.

Article 71 of the same document directly states that the lands of automobile transport include lands under the structures and equipment of energy, garage and fuel-dispensing facilities, bus stations, linear production structures, service and technical buildings, maintenance stations, gas stations, motor transport and freight forwarding enterprises, auto repair plants, bases, freight yards, container and transshipment areas, service and cultural and amenity buildings, and other facilities that ensure the operation of automobile transport [40]. The lands of road management include lands under the carriageway, shoulders, roadbed, decorative landscaping, reserves, ditches, bridges, tunnels, interchanges, culverts, retaining walls, and other road structures and equipment located within the right-of-way, as well as lands outside the right-of-way if they contain structures that ensure the functioning of highways [40].

Depending on the nature of the structures, they can be conditionally divided into four groups:

I – parallel bypass roads, ferry crossings, snow protection structures and plantings, avalanche and mudflow protection structures, runaway truck ramps;

II – transport and recreation parking areas, enterprises and facilities of road service;

III – buildings (including residential) and structures of the road service with production bases;

IV – protective plantings [40].

The structure of transport lands of Ukraine according to the State Geocadaastre (Fig. 1.4) is presented below.

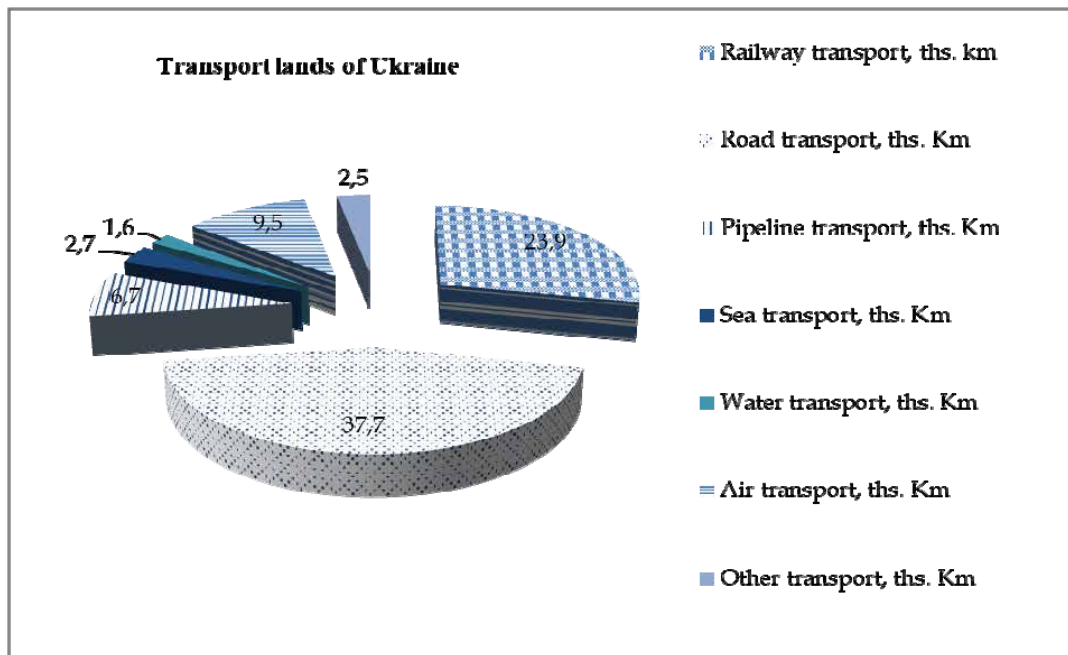


Fig. 1.4. Structure of transport lands of Ukraine, year, thousand km *(compiled by the authors based on data from source [41])*

A significant share of transport lands (37,7 ths. km) as a whole falls on the lands of automobile transport and road management, without which the full functioning of the country's transport network is impossible (See Fig. 1.5).

The concept of a land category represents a part of the land fund of Ukraine, which is characterized by its main intended purpose and features of the legal regime [40].

The intended purpose implies their distribution according to the most characteristic features. According to land legislation, this is the normative intended use, the legally established regulatory regime of use depending on land plots, the types of activities of land owners and land users, or public interests.

In accordance with the Order of the State Committee for Land Resources No. 548 dated July 23, 2010, the Classification of Types of Intended Use of Land (hereinafter referred to as CTVIL) of the state was approved, which covers all categories of land in Ukraine and divides them into 18 main classification groups, namely:

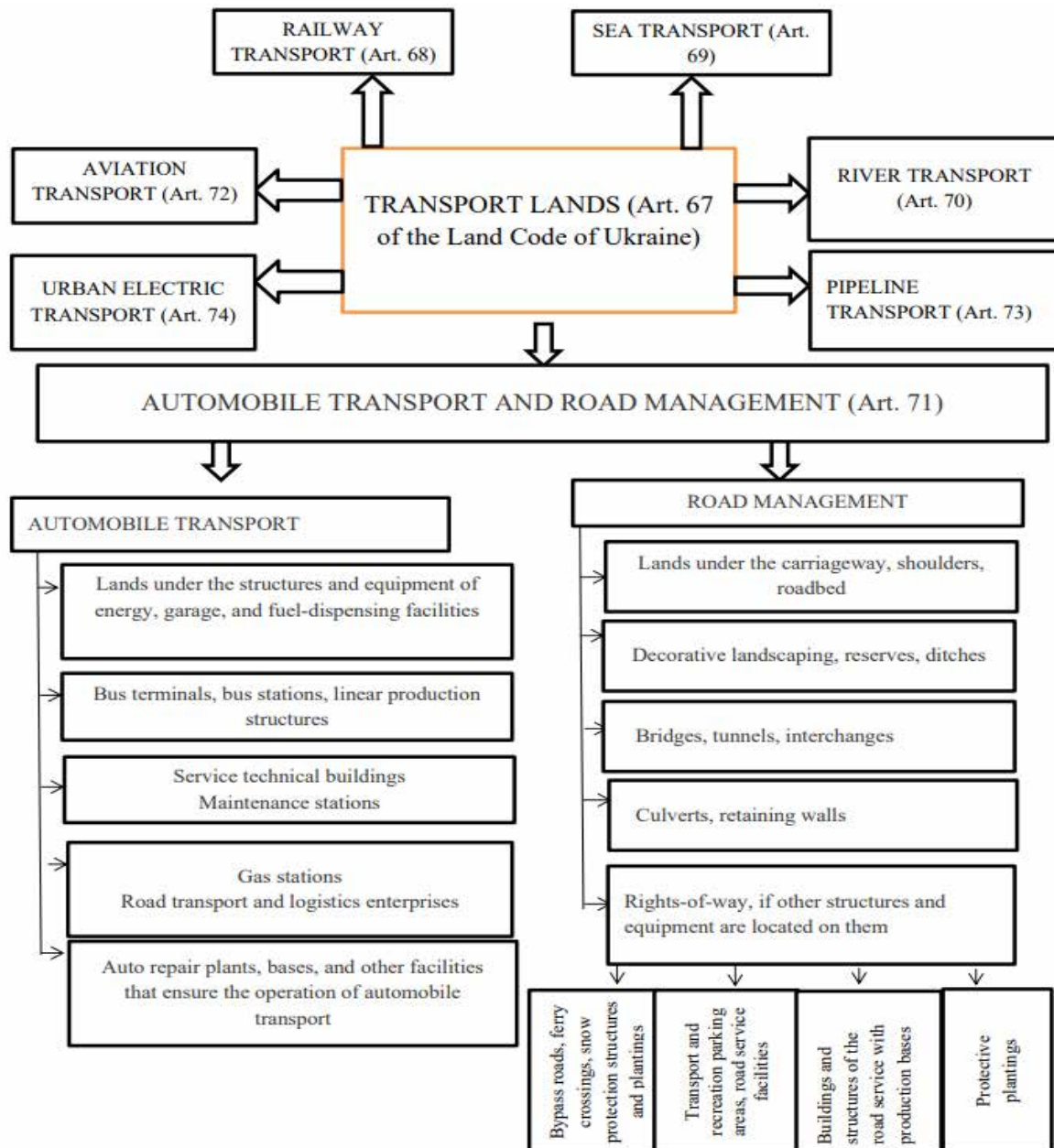


Fig. 1.5. Extensive structure of transport lands of Ukraine *(developed by the authors based on data from [39])* However, despite the scale, these lands, according to current legislation, belong to one category – lands of industry, transport, communication, energy, defense, and other purposes.

1. Agricultural land.
2. Residential development land.
3. Public development land.
4. Land of the nature reserve fund and other nature conservation purposes.
5. Land of health-improving purposes.

6. Land of recreational purposes.
7. Land of historical and cultural purposes.
8. Land for forestry and related services.
9. Land for water management.
10. Land of the mining industry.
11. Land of the processing industry.
12. Land for transport activities.
13. Land for postal and communication services.
14. Land of the energy system.
15. Land of defense.
16. Land for the production and distribution of gas and water.
17. Land for construction.
18. Reserve land, reserve fund land, and land of common use.

To highlight the expanded categories of land by classification groups to which the classification objects belong, "Sections" were introduced, and for their deeper detailing – "Divisions" and "Subdivisions," which are indicated by numerical codes.

Road management lands are indicated in Section J and are not separated into a separate subdivision according to the classification but are combined with automobile transport lands and together are included in the "Land for Transport Activities" division (code 12) under classification code 12.04 (Table 1.2).

The issue of land classification in Ukraine has been the subject of research by such scholars as O.S. Budziak, D.S. Dobriak, T.O. Yevsiukov, A.H. Martyn, L.Ya. Novakovskiy, M.M. Panocho, and others.

A.H. Martyn notes that the presented classification does not fully comply with the norms of the current Land Code of Ukraine, primarily Article 18, which states that all lands within its territory, including islands and lands occupied by water bodies, belong to the lands of Ukraine. These lands are divided into nine categories according to their main intended purpose.

Table 1.2

Classification of Types of Intended Use of Land*

<i>Code RCCP</i>		<i>Title</i>	<i>Section code according to NACE</i>
<i>Division</i>	<i>Subdivision</i>		
12		<i>Transport lands (lands granted to enterprises, institutions, and organizations of railway, automobile transport and road management, sea, river, aviation, pipeline transport, and urban electric transport for the performance of their assigned tasks regarding the operation, repair, and development of transport facilities)</i>	
	12.01	<i>For the placement and operation of buildings and structures of railway transport</i>	60
	12.02	<i>For the placement and operation of buildings and structures of sea transport</i>	61
	12.03	<i>For the placement and operation of buildings and structures of river transport</i>	61
	12.04	<i>For the placement and operation of buildings and structures of automobile transport and road management</i>	60
	12.05	<i>For the placement and operation of buildings and structures of aviation transport</i>	62
	12.06	<i>For the placement and operation of pipeline transport facilities</i>	60
	12.07	<i>For the placement and operation of buildings and structures of urban electric transport</i>	60
	12.08	<i>For the placement and operation of buildings and structures of additional transport services and auxiliary operations</i>	63
	12.09	<i>For the placement and operation of buildings and structures of other land transport</i>	60
	12.10	<i>For the purposes of subdivisions 12.01–12.09 and for the preservation and use of lands of the nature reserve fund</i>	–

*Source: compiled based on data from [42]

Therefore, the classification of types of intended use of land does not correspond to the number of categories into which lands are divided according to current legislation, so he proposes his own system of land plot classification (Table 1.3) [43].

Table 1.3

Classifier of the intended purpose of land plots

Land Category Code	Land Group Code	Land Type Code	Land Plot Intended Use Code	Name of Land Plot Intended Use
09	09.02			Transport lands
		09.02.01		<i>for railway transport lands</i>
			09.02.01.01	for the placement and operation of the railway right-of-way under the railway track and its infrastructure, stations
			09.02.01.02	for the placement and operation of protective and reinforcing plantings, service, cultural, and amenity buildings, and other structures necessary for ensuring the operation of railway transport
		09.02.02		<i>for the placement, operation, repair, and development of sea transport</i>
			09.02.02.01	for the placement and operation of sea port facilities
			09.02.02.02	for the placement and operation of sea pier facilities
			09.02.02.03	for the placement and operation of sea terminal facilities
			09.02.02.04	for the placement and operation of marine hydraulic structures
			09.02.02.05	for the placement and operation of marine hydraulic structures
			09.02.02.06	for the placement and operation of marine aids to navigation, lighthouse, radio center
			09.02.02.07	for the placement and operation of marine hydraulic structures
			09.02.02.08	for the placement and operation of a ship repair plant, workshop, base, warehouse
			09.02.02.09	for the placement and operation of service, cultural, and amenity buildings and other structures serving sea transport

Continuation of the table 1.3

		09.02.03		<i>for river transport lands</i>
			09.02.03.01	for the placement and operation of river port facilities
			09.02.03.02	for the placement and operation of structures of a specialized river pier
			09.02.03.03	for the placement and operation of structures of a river landing stage, backwater
			09.02.03.04	for the placement and operation of structures of a river passenger terminal, pavilion, pier
			09.02.03.05	for the placement and operation of a navigable canal
			09.02.03.06	for the placement and operation of navigation, energy, and hydraulic structures of river transport
			09.02.03.07	for the placement and operation of service and technical buildings of river transport
			09.02.03.08	for the placement and operation of bank protection structures and plantings
			09.02.03.09	for the placement and operation of a communication hub, radio center, radio station of river transport
			09.02.03.10	for the placement and operation of buildings, coastal navigation marks, and other structures for servicing waterways
			09.02.03.11	for the placement and operation of a ship repair plant, repair and maintenance base, workshop, shipyard, layup and repair point of river transport
			09.02.03.12	for the placement and operation of a warehouse, material and technical base, utility networks, service and cultural and amenity buildings of river transport
		09.02.04		<i>for lands of automobile transport</i>
			09.02.04.01	for the placement and operation of structures and equipment of energy, garage, and fuel-dispensing facilities
			09.02.04.02	for the placement and operation of a bus terminal

Continuation of the table 1.3

			09.02.04.03	for the placement and operation of a bus station
			09.02.04.04	for the placement and operation of linear production structures of automobile transport
			09.02.04.05	for the placement and operation of service and technical buildings of automobile transport
			09.02.04.06	for the placement and operation of a maintenance station
			09.02.04.07	for the placement and operation of a gas station
			09.02.04.08	for the placement and operation of a maintenance station
			09.02.04.09	or the placement and operation of a motor transport enterprise
			09.02.04.10	for the placement and operation of a freight forwarding enterprise
			09.02.04.11	for the placement and operation of an auto repair plant
			09.02.04.12	for the placement and operation of a base, freight yard, container area, transshipment area
			09.02.04.13	for the placement and operation of service, cultural, and amenity buildings of automobile transport
		09.02.05		<i>for lands of road management</i>
			09.02.05.01	for the placement and operation of the road right-of-way, other road structures and equipment
			09.02.05.02	for the placement and operation of a parallel bypass road
			09.02.05.03	for the placement and operation of a transport and recreation parking area
			09.02.05.04	for the placement and operation of a building, residential building, structure of the road service with a production base
			09.02.05.05	for the placement of protective plantings of road management

As can be seen, lands are classified according to the number of their categories defined by legislation. A.H. Martyn notes that the proposed classifier will provide state authorities and local self-government bodies, as well as other information users, with objective data on the composition of the state's land fund and administrative-territorial units, including for the correct adoption of management decisions regarding the rational use and protection of land [43].

In our opinion, A.H. Martyn's classification is quite relevant, provided that transport lands are separated into a separate category.

At the same time, it is necessary to expand road management lands with such plots as those for road service enterprises, advertising media, etc. O.S. Budziak indicates that the classification of lands by categories according to their intended use currently does not reflect the diversity of their functional use, which complicates the division and establishment of clear boundaries of lands of different categories in kind. Inaccuracies in the accounting of land plots lead not only to environmental but also to legal and economic problems.

Individual lands can fall under two regimes of intended use, resulting in inconsistency that complicates their accounting. For example, if a historical and cultural heritage site is found on the territory of a historical and cultural park, then the land plot under it is subject to classification as land of historical and cultural purposes; if defense lands include lands of the forest and water fund, agricultural land, etc. This indicates the inefficiency of state policy in the field of land use. To solve these problems, as well as environmental, economic, and social ones, O.S. Budziak proposes a somewhat different classification option, the basis of which is the separation of lands by functional use, in particular, ecological, economic, and social [44].

Lands that have primary properties and can return to a state of natural equilibrium or restore their natural properties after certain minor anthropogenic interventions, perform the function of an ecological stabilizer, and maintain the ecological balance of the surrounding natural environment are

combined into a group of natural-type lands (forests, lakes, rivers, swamps, natural meadows and floodplains of rivers, sands, reserves, etc., i.e., the ecological function of environmental improvement and land quality preservation dominates) [44].

Landscapes that have lost the properties of natural ecosystems due to prolonged and constantly changing anthropogenic pressure, which mainly constitute the main share in the structure of landscapes and are responsible for providing the population with food, are recommended by O.S. Budziak to be combined into a group of productive-type lands (lands with partially altered landscapes – arable agricultural landscapes – the economic function dominates) [44].

The remaining lands are technogenic-type lands, that is, lands with radically altered ecosystems and significantly disrupted energy connections in them [8], namely, those that experience the most powerful technogenic load and are characterized by a highly altered flora and fauna, deteriorated composition of atmospheric air due to high saturation with liquid, solid, and gaseous waste from industrial production and transport, as well as deformed, and in some places completely destroyed, asphalt, buildings, concrete, etc. [44]. For this group of lands, it is important to ensure an optimal combination of natural and anthropogenic components in order to preserve the integrity of ecosystems and their ability to self-regulate and self-restore. The basis of such separation is the multifunctional social purpose – primarily urban settlements (land under residential development), industrial lands (under sub-industrial enterprises, factories), lands used both for transport and communication and for the development of technical infrastructure (under transport routes, power plants) [44].

In our opinion, the land classification proposed by O.S. Budziak is not based on the intended purpose and contradicts the basic legislative principle of Article 19 of the Land Code as the basis for the formation of land classification by categories.

The type of land as a natural-type category according to O.S. Budziak is based on the ecological features of landscapes that are combined into one type but used for different needs (for example, forests, lakes, natural meadows, reserves). They have one function – ecological, but these lands, according to land legislation, belong to different categories: forestry, agricultural, nature conservation, and water fund.

The classification of lands as productive type causes misunderstanding, given that the economic function highlighted by O.S. Budziak is not clear, since the economic component can be found in agricultural land (cultivation of agricultural crops), water fund land (fishing and its sale), forestry land (gathering berries, mushrooms, etc.) [44].

As for technogenic-type lands, given the level of urbanization in large cities, the mass construction of residential areas, the development of transport routes, and the laying of communication networks, it is impossible to assign them the status of social purpose lands, since these processes are regulated by different legal regimes, belong to different legal fields of activity, and the lands used have different intended purposes.

T.O. Yevsiukov notes that land classification is designed to solve two main tasks: to present the entire spectrum of studied objects in a reliable and convenient form for familiarization and cognition; and to contain the most complete information about them. Land classification is an extremely important and necessary condition for solving the problems of their environmentally safe use at all levels (from global to local). It is the main condition for their in-depth study and the creation of a system of information about land resource potential, the foundation of rational, comprehensive, and effective use of land resources. The consolidation of lands different in intended purpose and qualitative characteristics into a common category must be carried out according to their value [44].

Thus, having studied numerous views on land classification, it is necessary to agree that it is advisable to classify lands according to their functional purpose, especially automobile transport and road management, which, according to Article 19 of the Land Code of Ukraine, are assigned to one category together with lands of industry, transport, communication, energy, defense, and other purposes.

The use and determination of the legal status of lands of automobile transport and road management is carried out according to the requirements of the Land Code of Ukraine and other regulatory legal documents, in particular, the Laws of Ukraine "On Transport," "On Automobile Transport," "On Highways," "On Road Traffic," "On Concessions for the Construction and Operation of Highways," State Building Codes of Ukraine, the National Transport Strategy until 2030, and others.

As defined by Article 11 of the Law "On Transport," transport lands include lands granted for the use of enterprises and organizations of the industry in accordance with the Land Code for the performance of their assigned tasks regarding the operation, repair, improvement, and development of transport facilities [45].

The sizes of land plots provided for the establishment of road management facilities are determined in accordance with approved norms or project and technical documentation in accordance with the current procedure.

Transport enterprises are obliged to use the land plots provided to them rationally, not to violate the interests of other land users (including tenants), not to allow waterlogging, deterioration of land quality, and pollution of land with industrial and other waste, untreated runoff, to take measures to protect soils from erosion, to strengthen ravines, steep slopes, sands, and to comply with other land protection requirements [45].

Responsibility for maintaining the land provided for the use of transport enterprises and organizations in proper condition and using it for its intended purpose rests with the heads (owners) of these structures.

According to Article 21 of the Law "On Transport," the unified transport system of Ukraine consists of: public transport (railway, sea, river, automobile, and aviation, as well as urban electric transport, including the subway), industrial railway, departmental, pipeline transport, public communication routes [45,46].

Ownership of transport lands is very closely related to ownership relations regarding the property of transport enterprises, institutions, and organizations.

Article 9 of the said law defines that transport vehicles, structures, financial resources, transport equipment, communication routes assigned to enterprises, associations, institutions, and organizations of the Ministry of Infrastructure of Ukraine are state property and belong to the unified transport system [45,46]. Thus, the lands of these enterprises, institutions, and organizations are also state property and belong to them by the right of permanent use.

Road management facilities, vehicles, linear structures, financial resources, transport equipment assigned to motor transport and road enterprises, institutions, and organizations of the respective councils are communal property, as are the lands they use.

Vehicles, structures, and transport equipment may be owned by enterprises, associations, institutions, organizations, and citizens, and the land under these facilities may be in private ownership [40,46].

At the same time, certain restrictions are established on the transfer of transport lands to private ownership. Thus, Article 84 of the Land Code prohibits the transfer to private ownership of state-owned land under state railways, state-owned facilities of air and pipeline transport, and Article 83 – the transfer of communal property land to private ownership under railways, highways, air and pipeline transport facilities.

According to Article 30 of the Law "On Transport," the composition of automobile transport includes enterprises that carry out the transportation of

passengers and goods, auto repair and tire repair enterprises, rolling stock, freight forwarding enterprises, as well as bus terminals and bus stations, educational institutions, repair and construction organizations, and social facilities, other enterprises, institutions, and organizations, regardless of ownership forms, that ensure the operation of motor transport.

In fact, the Land Code of Ukraine establishes two independent legal regimes of land – automobile transport and road management.

According to the Law of Ukraine "On Highways" No. 2862-IV dated September 8, 2005, a classification of public roads is approved, according to which highways are divided into roads of state and local significance, but all of them consist of a roadbed, carriageway, pavement, traffic lane, road diversion structures, and water treatment facilities, noise protection structures, etc. (See Fig. 1.6).

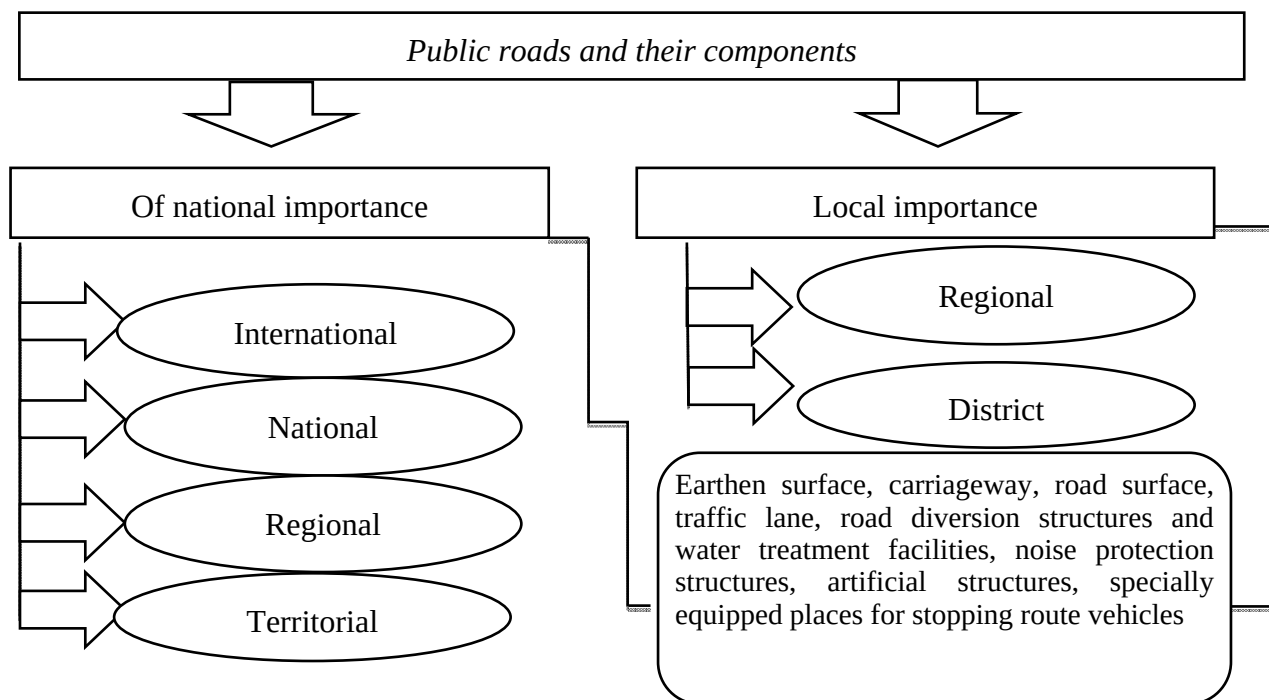


Fig. 1.6. Composition and structure of public roads in Ukraine (compiled by the authors based on data from [110])

In turn, highways of state significance are divided into international, national, regional, and territorial [47, 48].

International highways include roads that are combined with international transport corridors and/or are part of the European network of main, intermediate, connecting highways and branches, have the corresponding international indexing "M," and ensure international road transport. In total, Ukraine has 29 international highways with a total length of 8,200 km, which is 4.9% of the length of all highways in the state [50]. A list of international highways is provided (Appendix A).

"National highways include roads that are combined with national transport corridors and are not international highways, and highways that connect Kyiv, the administrative center of the Autonomous Republic of Crimea, administrative centers of regions, the city of Sevastopol with each other, large industrial and cultural centers with international highways [47- 49]. Their number is 23 units, length – 4,811 km, or 2.9% of the total length of roads. They are designated by the letter "H" and a two-digit index [50]. A complete list of national highways is provided (Appendix B).

Regional highways include highways that connect two or more regions with each other, main international border crossing points, seaports and airports of international importance, and the most important objects of national cultural heritage, resort areas with international and national highways [47,49]. Regional roads have a length of 7501 km, or 4,7%, their number is 79 units. They are designated by the letter "P" and a two-digit index (Appendix C).

Territorial roads include roads that connect the administrative centers of Crimea and regions with district centers, cities of regional significance, cities of regional significance – with each other, and administrative centers of districts – with each other. They also include highways that connect with state highways the main airports, seaports and river ports, railway junctions, objects of national and cultural heritage, resort and nature reserve fund, international and interstate automobile border crossing points. The total length of territorial roads is 27312 km, or 52, 0% of the total length of state highways. They are

designated by the letter "T" and a four-digit numerical index, in which the first two digits are the region index, and the second two are the road number [47,49]. Their complete list is provided (Appendix D).

Local highways are divided into regional and district highways.

Regional highways are highways that connect the administrative centers of the Autonomous Republic of Crimea and regions with other settlements within Crimea or the region with each other and with railway stations, airports, river ports, border crossing points, and recreation areas that do not belong to state highways. Their total length is 52085 km. On average, there are 106,3 km of regional highways per district. Regional highways account for 30,7% of Ukraine's roads. They are designated by the letter "O" and, usually, a six-digit numerical index, in which the first two digits are the region number, and the second two are the district number in the alphabetical list, for example, the highway "O 212004" Lozova-Blizniuky-Barvinkove [47-49].

District highways connect district administrative centers with other settlements, and the latter – with each other, with enterprises, cultural objects, and other public roads within the district. Their length is 6969513 km. According to statistics, on average, there are only 2,44 km of district highways per rural settlement, which should ensure the livelihoods of its 555 residents (average number). District roads account for 41% of roads in Ukraine [47-49].

Lists of state and local roads, including their sections that coincide with the streets of cities and other settlements, are approved by the Cabinet of Ministers of Ukraine and the Council of Ministers of the Autonomous Republic of Crimea and regional state administrations once every three years.

In turn, according to SOU 45.2 – 00018112 – 038: 2009 "Highway Passport," a highway as an object of state ownership consists of the following elements:

a) land plot within the right-of-way;

b) roadbed, including: transition-speed lanes, bus stop complexes, parking lots and recreation areas, exits and entrances to it that do not belong to interchanges;

c) carriageway, including under transition-speed lanes, bus stop complexes, parking lots and recreation areas, exits and entrances to it that do not belong to interchanges;

d) large artificial structures (bridges, overpasses, flyovers, tunnels, galleries, wildlife crossings, underground and aboveground pedestrian crossings, avalanche protection, landslide protection, and mudflow protection structures, culverts) and small artificial structures (retaining walls, gutters, chutes, drops, roadside ditches, drainage structures, pile fields) located within the right-of-way, as well as artificial structures outside the right-of-way that ensure the functioning of the road;

e) interchanges at different levels with exits, entrances, and their transition-speed lanes assigned to this road;

f) elements of engineering and transport infrastructure (road barriers, guide devices, road signs, road markings, noise barriers, vibration barriers, and glare screens, snow protection, erosion protection, and decorative landscaping located within the right-of-way);

g) service facilities (road service facilities, bus pavilions, and small architectural structures);

h) road communications (own power lines and lighting, communication lines and their components that are owned by the road management and assigned to this road);

i) road sensors (traffic counters, weather and climate installations, video cameras);

j) traffic management system [51].

In accordance with DBN V.2.3-4: 2015, a technical classification of highways by categories depending on the calculated average annual daily prospective traffic intensity has been carried out (Table 1.4) –[52].

Table 1.4

Technical classification of highways, in vehicles per day*

Road Category	Calculated Prospective Traffic Intensity	
	in transport units	in passenger car equivalents
I	Over 10 000	Over 14 000
II	From 3 000 to 10 000	From 5 000 to 14 000
III	From 1 000 to 3 000	From 2 500 to 5 000
IV	From 150 to 1 000	From 300 to 2 500
V	Up to 150	Up to 300

*Source: based on data from [52]

According to information from the State Agency of Automobile Roads, the direct area occupied by road management facilities is 358,6 ths. km. Most of these lands are located within the administrative boundaries of the Poltava and Vinnytsia regions – 228,9 and 222,8 ths. km, respectively.

It should be noted that the accounting of lands separately in the city of Kyiv and the Kyiv region is not carried out, and the total area of road management lands in them is 179,6 ths. km. Of the total area of lands used by road management, 834,1 ths. km are occupied by state roads, and 275,2 ths/ km by local roads [50].

The distribution of highways into categories depending on capacity is directly related to the classification of settlements in Ukraine, which is approved by the State Building Codes "Urban planning. Planning and development of urban and rural settlements" (DBN-360-92) of April 17, 1992 [52] (See Fig. 1.7).

According to the given data, it can be observed to what extent the classification of settlements, the population in them, the category of the road, and its capacity are interconnected. The indicators of highway construction, terms, complexity, etc., are determined and can be calculated based on these characteristics.

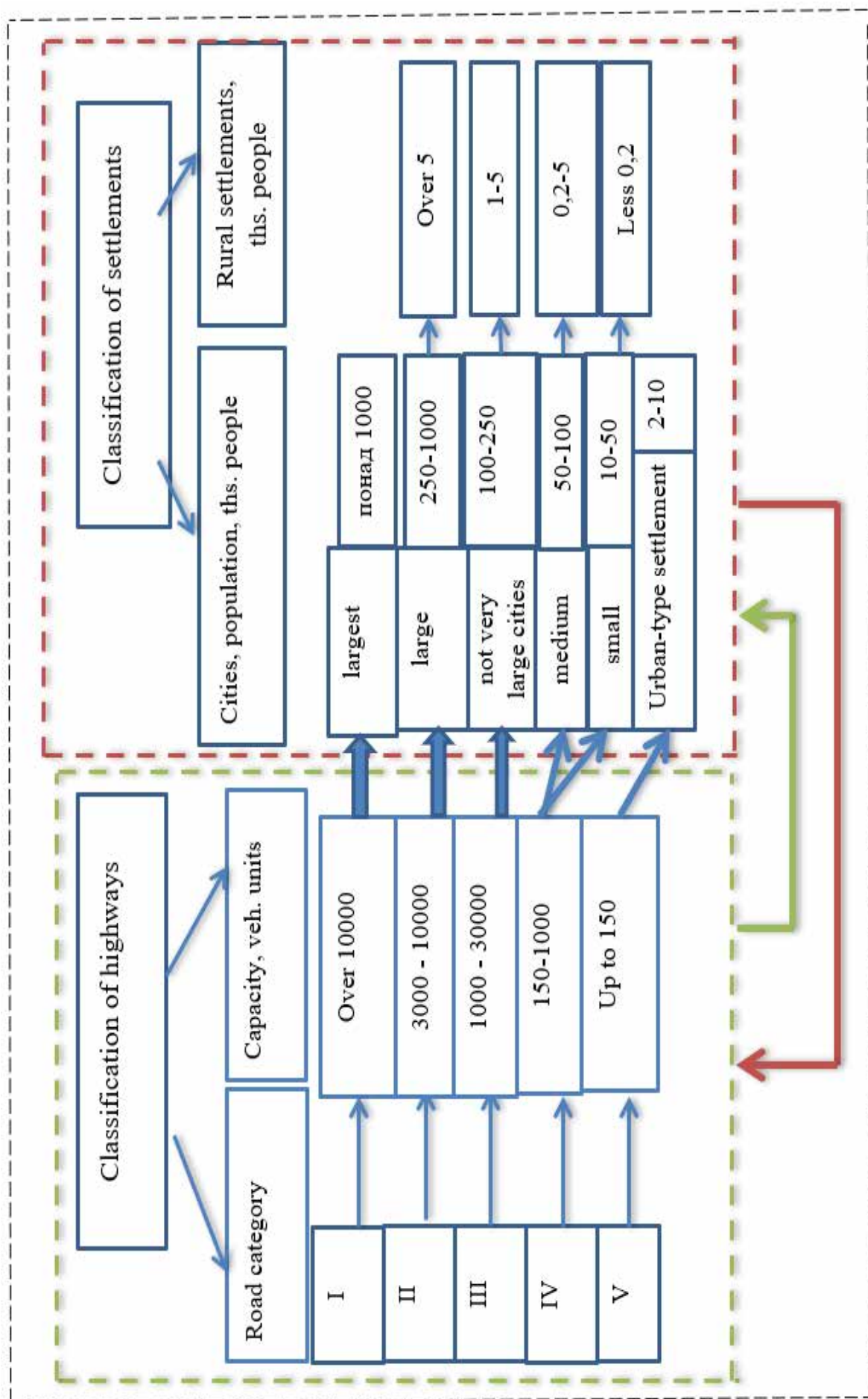


Fig. 1.7. Dependence of highway construction on the classification of settlements (developed by the authors)

The largest length in Ukraine is occupied by highways of category IV (64,9%), and the smallest – by category I (only 1,5%), that is, motorways (Table 1.5).

Table 1.5

Distribution and length of highways in Ukraine by category*

Significance of Highways	Total Length, km	Distribution by Category, km				
		I (1,5 %)	II (7,4 %)	III (16,6 %)	IV (64,9 %)	V (9,6 %)
Total in Ukraine	169 422	2 616	12 945	29 112	105 956	15 189
Of state significance						
International	8 200	1 768	4 621	1 716	89	6
National	4 811	514	2 810	1 380	107	0
Regional	7 501	224	2 556	3 734	986	1
Territorial	27 312	60	2 152	13 505	11 094	403
Of local significance						
Regional	52 085	5	382	6 704	41 228	2 656
District	69 513	11	204	2 330	52 351	12 015

*Source: developed by the authors based on data from [50]

The data in Table 1,5 indicate that the largest length of highways in Ukraine is represented by roads of category IV (64,9%), and the smallest – by roads of category I, that is, motorways, and they make up only 1,5%.

The data in Figure 1.8 indicate that roads of raion significance have the greatest length and make up 69513 ths. km, while roads of national significance are the shortest, their length is 4811 ths. km.

Depending on the type, roads of district significance are characterized by the greatest length – 69513 ths. km, and national roads – by the smallest – 4811 ths. km.

Roadside territories, that is, those adjacent to them, are formed along all types and categories of highways. According to DBN V.2.3-218-007:2012. Design [53].

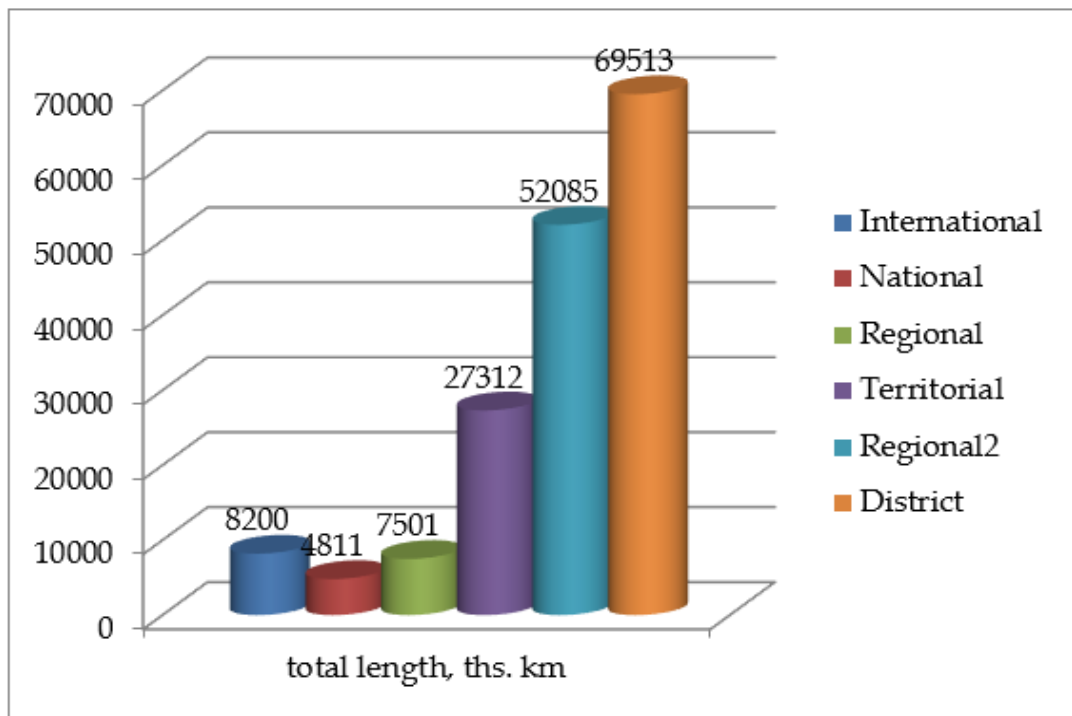


Fig. 1.8. Length of highways of state significance

The zone of influence is the territory adjacent to the highway, within which the impact on the environment occurs as a result of the construction and operation of highways.

The protection zone is the territory adjacent to the permanent land allocation strip, within which the exceedance of the regulatory permissible limits of impact is recorded for one or more indicators.

The reserve-technological zone is the territory directly adjacent to the highway, within which there is a constant exceedance of the regulatory permissible levels of noise, concentration of pollutants in the atmospheric air and soils; the vegetation cover and landscape are completely or partially transformed. These are lands unsuitable for agricultural use, where residence is prohibited and the stay of people is restricted [53].

Among the regions of Ukraine, roads of state significance occupy the largest area in the city of Kyiv and the Kyiv region (5870 ha), and the largest area of local roads (18,826,55 ha) – in the Poltava region. The area of road management lands by region of Ukraine is presented below (Table 1.6).

Table 1.6

Area of road management lands by region of Ukraine*

Region, Oblast	Total Land in Use, ha	Including Roads	
		state	local
ARK	11 923,80	2 940,60	8 983,20
Vinnytsia Region	22 281,62	3 941,32	18 340,30
Volyn Region	12 068,80	2 407,90	9 660,90
Dnipropetrovsk Region	17 810,18	4 366,68	13 443,50
Donetsk Region	16 115,42	2 541,11	13 574,31
Zhytomyr Region	17 895,00	5 274,70	12 620,30
Zakarpattia Region	6 163,40	1 406,40	4 757,00
Zaporizhzhia Region	14 685,64	2 715,28	11 970,36
Ivano-Frankivsk Region	8 890,00	2 282,00	6 608,00
Kyiv Region and the city of Kyiv	17 960,40	5 870,00	12 090,40
Kirovohrad Region	12 457,03	2 824,98	9 632,05
Luhansk Region	11 843,20	2 651,60	9 191,60
Lviv Region	15 842,56	4 501,20	11 341,36
Mykolaiv Region	10 385,95	1 875,29	8 510,66
Odesa Region	16 788,90	2 938,70	13 850,20
Poltava Region	22 896,00	4 069,45	18 826,55
Rivne Region	10 501,20	1 675,20	8 826,00
Sumy Region	16 972,20	3 914,20	13 058,00
Ternopil Region	12 300,00	2 702,60	9 597,40
Kharkiv Region	18 078,50	3 736,90	14 341,60
Kherson Region	10 018,80	2 463,20	7 555,60
Khmelnyskyi Region	18 104,90	5 789,10	12 315,80
Cherkasy Region	13 773,70	3 836,10	9 937,60
Chernivtsi Region	5 160,05	1 551,53	3 608,52
Chernihiv Region	16 760,59	4 600,68	12 159,91
City of Sevastopol	930,8	533,35	397,45
Total	358 608,6	83 410,07	275 198,60

* Source: data from the State Agency of Automobile Roads [28].

The total length of highways of state significance is 51,7 ths. km, of which: international – 8,5; national – 4,8; regional – 10,1; territorial – 28,3 ths. km.

The length of public roads with hard surface is 166 ths. km, and dirt roads – 3,6 ths. km. Roads are categorized as follows: first – 2,7 ths. km; second – 13,3; third – 28,8; fourth – 106; fifth category – 15,2 ths. km.

To overcome natural and artificial obstacles, 16191 bridges have been built, of which 82 are wooden. Information about highways, their quality condition by surface type, and categorization by region of Ukraine is provided (Appendix E).

Thus, land is one of the main and most important objects of the material world and a universal factor of social life support, and in the field of land use of automobile transport, it is a spatial (territorial) operational basis, performing an important technological role that ensures the functioning and development of the state's transport system as a whole. Highways are a kind of artery that provides for the material, spiritual, and social needs of the population.

The proposals for dividing the category of lands of industry, transport, communication, energy, defense, and other purposes into separate categories deserve attention. Within the unified category of land, its elements have more differences than common features. This is especially true for the lands of defense, energy, and transport, whose legal statuses are fundamentally different. Within the lands of automobile transport and road management, as a component of transport lands, there is a significant difference, in particular, regarding the structure of these two components of Article 71 of the Land Code of Ukraine, the regulation and nature of their land use, and the peculiarities of their legal status.

Road management lands in the said article are an independent second part. Their legal regime is based on the components of highways, which have independent legal regulation (the Laws "On Highways," "On Road Traffic," "On Concessions for the Construction and Operation of Highways," etc.). According to the Tax Code of Ukraine (Article 283), tax is not paid for road management lands

of public highways. The regulation of their use and protection as an independent object of land relations is provided for by other regulatory legal acts.

Therefore, the division of Article 71 "Lands of Automobile Transport and Road Management" into two articles – 71. Lands of Automobile Transport and 71-1. Lands of Road Management, would make it possible to regulate the issues of land reservation, the establishment of protection zones, and other special requirements for the use and protection of road management lands, as well as to amend the State Land Cadastre by introducing independent accounting of the lands of this component of transport lands.

1.3. Directions of automobile network development

Okay, I understand. You're starting a new section about the development of the automobile network, its importance, and factors influencing its development. Here's the English translation of the provided Ukrainian text:

"The system of highways is an integral part of the unified transport system of the country, which has begun to develop in recent years, leading to an increase in the composition of automobile flows moving along the roads of Ukraine. Their network is expanding, equipment is improving, the network of international and national transport corridors is increasing, and road infrastructure is being modernized. The transformations taking place in the highway system of Ukraine cause significant changes in the composition of automobile transport lands.

The automobile transport network is one of the most important sectors of the economy, which functions as a kind of artery in the complex organism of the country. It not only contributes to meeting the needs of the economy and the population in transportation but, together with cities, forms the so-called framework of the entire territory, which creates conditions for the accelerated development of all sectors [54].

In scientific and legislative literature, there is no clear definition of the concept of automobile network development. As a result of the analysis of

scientific works by A.A. Burmaka, I.A. Dmitriev, V.P. Miklovda, V.H. Shynkarenko, and others, it can be noted that the development of the automobile network and public highways, which constitute the country's automobile network, are identified.

V.H. Shynkarenko indicates that the development of the highway network is based on solving the problems of the transport and road complex as a whole [55,56].

According to V.P. Miklovda, it should be directed towards the European transport system, its technical standards in terms of quality and axle loads, road safety, and the volume of investment in road construction [57].

According to legislative acts, the development of the automobile network consists in the construction of new and bringing existing highways into compliance with the requirements for traffic intensity, axle loads, road widening, and the elimination of dangerous sections [28].

M.M. Burmaka considers the development of the automobile network as bringing its transport and operational condition and engineering structures into compliance with international requirements and standards depending on traffic intensity [58].

Therefore, summing up, it can be noted that the development of the automobile network is a process of certain regularities aimed at improving the quantitative and qualitative changes in the parameters of highways to achieve improved motor transport traffic, its safety and speed, comfort, and economic efficiency of transportation, which will ensure the integration of the national transport network into European highways.

The automobile networks of Ukraine are a network of roads on its territory that connects settlements, individual objects, and is intended for the movement of vehicles, transportation of passengers and goods [50]. Motor transport is a key element of the transport system of Ukraine, whose share in

2018 was 134398,22, in international traffic – 7277,22 thousand tons of transit cargo, and GDP from transport activity increased by 6,4% [49].

Land use of automobile transport and road management is aimed at increasing the economic indicators of motor transport activity, improving the social standard of living of the population, its environmental safety, and meeting material needs, creating ecological balance.

Transport ensures the movement of people and material values, thereby creating more comfortable living conditions.

The main criteria for evaluating the work of transport are: the volume of freight transportation, freight turnover, the ratio of modes of transport in freight transportation, the volume of passenger transportation, passenger turnover, etc. Freight turnover is the total volume of freight transport work, which is equal to the sum of the products of the transported cargo by the distance of transportation for each of its batches [59]. As evidenced by the dynamics of freight turnover and the volume of freight transportation (Table 1.7), they are constantly growing."

Table 1.7

**Dynamics of freight turnover and freight transportation in Ukraine,
2015–2017 years***

Transport mode	2015 year		2016 year				2017 year			
	Freight turnover, million t·km	Freight transported, million t·km	Freight turnover		Freight transported		Freight turnover		Freight transported	
			million t·km	% to 2015 p.	million t·km	% to 2015 p.	million t·km	% to 2016 p.	million t·km	% to 2016 p.
Total	315341,8	601,0	323473,9	102,4	624,5	103,8	343057,1	105,8	635,9	101,8
Railway	194321,6	350,0	187215,6	96,0	344,1	98,3	191014,1	102,3	339,5	89,9
Road	34431,1	147,3	37654,9	109,1	166,9	112,7	41178,8	108,4	175,6	104,7
Water	5434,1	6,4	3998,6	73,6	6,7	103,5	4257,1	196,3	5,9	88,1
Aviation	210,9	0,1	225,9	107,0	0,07	107,4	272,7	120,5	0,1	110,5

**Source: compiled by the authors based on data from [41]*

***Excluding the temporarily occupied territory of the Autonomous Republic of Crimea, the city of Sevastopol, and part of the area of the anti-terrorist operation.*

****Including data on pipeline transport.*

Thus, freight turnover by road transport in 2016 increased by 9,1% compared to 2015, and in 2017 compared to 2016 – by 8,4%. A similar trend is observed in the share of freight turnover of this mode of transport. If in the general structure of transport it was 10,9% in 2015, that is, it occupied the second place after railway transport (61,6%), then in 2017 – it increased to 12,0%, and the share of freight turnover of railway transport decreased (to 55,7%).

There is also a positive trend in the share of freight transported by road transport in the structure of all its modes, which in 2015 was 24,5%, and in 2017 – 27,6% of all freight transport.

An important indicator of the role of transport in the life of the population is the volume of passenger transportation and passenger turnover. Passenger movement is characterized by such an indicator as the transport mobility of the population, which reflects the degree of urbanization, the level of migration, and the dynamics of movement. The transport mobility of the population is a complex social and economic phenomenon caused by a complex of factors of a cultural, political, and demographic nature. Passenger turnover is the total volume of passenger work, which is equal to the sum of the products of the number of passengers transported by the distance of their transportation. The dynamics of the volume of passenger transportation and passenger turnover by various modes of transport are presented below (Table 1.8).

As can be seen, in recent years there has been a trend of decreasing volumes of passenger transportation by all modes of transport, except for aviation. Despite this, in 2017, the share of passenger turnover by road transport in the structure of all modes of transport was 35,7, and passenger transportation – 43,4%, which indicates the important role of road transport in the functioning of the country's economy and the life of the population.

Table 1.8

Dynamics of passenger transportation in Ukraine, 2015–2017 years *

Transport mode	2015 year		2016 year				2017 year			
	Passenger Turnover, million passenger-km	Passengers Transported, million	Passenger turnover		Passengers transported		Passenger turnover		Passengers transported	
			million passenger-km	to 2015 p., %	million	to 2015 p., %	million passenger-km	to 2016 p., %	million	to 2016 p., %
Total	97280,7	5157,7	102239,4	105,4	4854,4	94,0	99277,7	107,4	4647,2	100,3
Railway	35425,6	389,8	36954,0	104,5	389,5	99,9	28043,4	103,6	165,0	98,0
Road	34775,6	2259,8	34488,0	99,7	2025,0	90,0	35412,4	102,5	2018,7	99,7
Water	22,3	0,6	30,4	136,3	0,5	83,1	30,3	99,8	0,6	122,9
Aviation	11362,4	6,3	15525,1	136,6	8,3	131,3	20345,7	131,0	10,6	127,5

*Source: compiled by the authors based on data from [41]

**Excluding the temporarily occupied territory of the Autonomous Republic of Crimea, the city of Sevastopol, and part of the ¹ area of the anti-terrorist operation.

***Including data on pipeline transport.

The dynamics of freight turnover and volumes of freight and passenger transportation in recent years (2015-2017) by modes of transport were generally positive, with the exception of the number of passenger transportations, which decreased for all modes of transport except aviation. Regarding road transport, its freight turnover and volumes of freight transportation were constantly growing, and passenger turnover remained unchanged (34,8–35,4 billion passenger-km).

To achieve positive results, it is necessary to take into account the national peculiarities of the formation of the industry management system as a whole.

The main constraining factors for the development of demand and the deterioration of the quality of freight and passenger transportation services are:

- untimely and insufficient renewal of fixed assets of road management and vehicles;
- low level of coordination of transport infrastructure development, which leads to inefficient use of resources;
- insufficient use of transport communications and the country's geopolitical location;

- ineffective application of financial mechanisms to attract investment in the development of the transport industry;
- low rates of development and implementation of state and industry programs compared to the activities of individual industries.

The highway network must meet modern requirements of social development and production, national security, and have a developed infrastructure to provide a full range of transport services to ensure the country's foreign economic relations.

The regulation of land relations in the transport sector has a complex legal character, which determines the relevance of solving the problems of rational use of these lands, the legal principles of which require further study and implementation in economic activity.

In this context, the issue of forming directions for the development of the automobile network in accordance with the regulatory legal framework occupies a significant place.

The reforms of recent years, related to the state's attempt to ensure the development of export of transport services in the market not only of our country but also of the European Union, increasing the efficiency and competitiveness of domestic transport in international transport service markets, improving legal mechanisms of public-private partnership taking into account transport specifics, strengthening the interaction of the state and private sectors, state authorities and state self-government, which can be realized through the implementation of the National Transport Strategy of Ukraine until 2030, the implementation of the Association Agreement between Ukraine and the EU, which provide for a deep and comprehensive free trade area, indicate the external and internal priority of our state regarding the development of transport, the creation of a free competitive market of transport services [28,54].

Today, the length of the public highway network in Ukraine is 169,5 thousand km, and the density per 1,000 km² of territory is 281 km. Our state ranks 30th in

the world in terms of the length of highways and 11th in Europe. At the same time, the length of highways per unit area in Ukraine is 0,3 km/km², which exceeds the indicator only of Russia (0,06 m/km²) and is tens of times lower compared to the average in Central Europe. There are only 3,8 m of highway per Ukrainian, while in Sweden – 61,6; France and Spain – 15; the Czech Republic and Austria – 12,2 and 12,9 m, respectively (Table 1.9) – [54].

Table 1.9

Length of highways in European countries*

Country	Area, km ²	Population, million people	Length of Highways		
			Total, ths. km	per unit area, km/km ²	per person, m
France	647 685	65,1	1027,2	1,5	15
Russia	17 075 400	143,0	940,0	0,06	6,5
Spain	504 645	45,2	681,3	1,7	15
Germany	357 021	81,7	644,5	1,8	7,8
Sweden	449 964	9,3	572,9	1,3	61,6
Italy	301 230	60,4	487,7	1,6	8,1
Poland	312 685	38,2	423,9	11,1	11,1
United Kingdom	244 101	62,0	394,4	1,6	6,3
Turkey	780 580	72,5	352,1	4,8	4,9
Romania	237 500	21,5	198,8	0,8	9,2
Ukraine	603 628	45,8	169,5	0,3	3,7
Hungary	93 030	10,0	160,0	1,7	16
Belgium	32 545	10,8	153,3	4,7	14,2
Netherlands	41 526	16,6	136,8	3,2	8,2
Czech Republic	78 866	10,5	128,6	1,6	12,2
Greece	131 940	11,3	117,5	0,9	10,4
Austria	83 871	8,3	107,3	1,3	12,9

*Source: compiled by the authors based on data from [60]

As practice shows, the development of the economy of countries around the world depends on the intensity and development of transport infrastructure, primarily automobile and road infrastructure.

Unfortunately, the condition of Ukrainian roads is the worst in Europe in terms of all parameters, which is largely due to the lag in the development of public highways and road service from the pace of the country's motorization. Today, insufficient budget funds are allocated for the maintenance and development of highways. In addition, there is a low level of development of transport connections of our state compared to European countries.

The modern network of public highways in Ukraine was formed to ensure the functioning of the national economy of the former USSR [61]. Today, their technical standards do not meet European standards in terms of either quality or axle loads. To improve the situation, it is necessary to amend the Rules for the Carriage of Dangerous Goods and the Rules for the Carriage of Heavy Goods in accordance with the conventions of the UN Economic Commission for Europe and EU directives [61].

Trends in the development of Ukraine's transit potential should include the development of modern highways along all transport corridors passing through its territory, in accordance with the National Transport Strategy of Ukraine until 2030, the Concept of the State Target Economic Program for the Development of Public Highways, the Transport Policy of Ukraine, and its approximation to EU norms [28, 62].

Reforming the system of state management of the industry and forming state policy in the industry, increasing the effectiveness of state control over road transport should be based on the best practices of the EU, provide for specific strategic goals and measures for their implementation.

According to the Transport Development Strategy until 2030, which is the main document in the field of transport and which all subsequent regulatory

legal and program documents in this area must comply with, directions for solving these problems are proposed (Appendix Zh) [28], namely:

- competitive and efficient transport system;
- innovative development of the transport industry and global investment projects;
- safe for society, environmentally friendly and energy-efficient transport
- unimpeded mobility and interregional integration.

The implementation of the outlined tasks will contribute to bringing Ukraine's transport complex closer to the European Union, improving the quality of transport services, effectively implementing administrative reform, combating corruption, transparency of decision-making, monitoring the implementation of activities, clear separation of functions and distribution of powers between authorities and economic entities, and ensuring equal conditions for the provision of transport services. The implementation of the provisions of the strategy for the development of Ukraine's transport system for the long term will ensure the transformation of transport into a system-forming sector of the national economy, which will develop at an accelerated pace.

The implementation and implementation of the tasks of developing Ukraine's automobile network are influenced by external factors, which can be conditionally divided into four groups: legislative, financial, managerial, and production. Each group has constraining factors for development (See Fig. 1.9), the rapid and high-quality overcoming of which will determine the further development of the highway network.

Analyzing the presented factors, it can be stated that legislative and financial factors have the greatest impact, overcoming which is a complex and lengthy process that causes harm and losses to the entire transport system of the country – one of the most important sectors of the country's economy.

In general, the development of the potential of Ukraine's transport network, in our opinion, can be considered in several aspects (See Fig. 1.10).

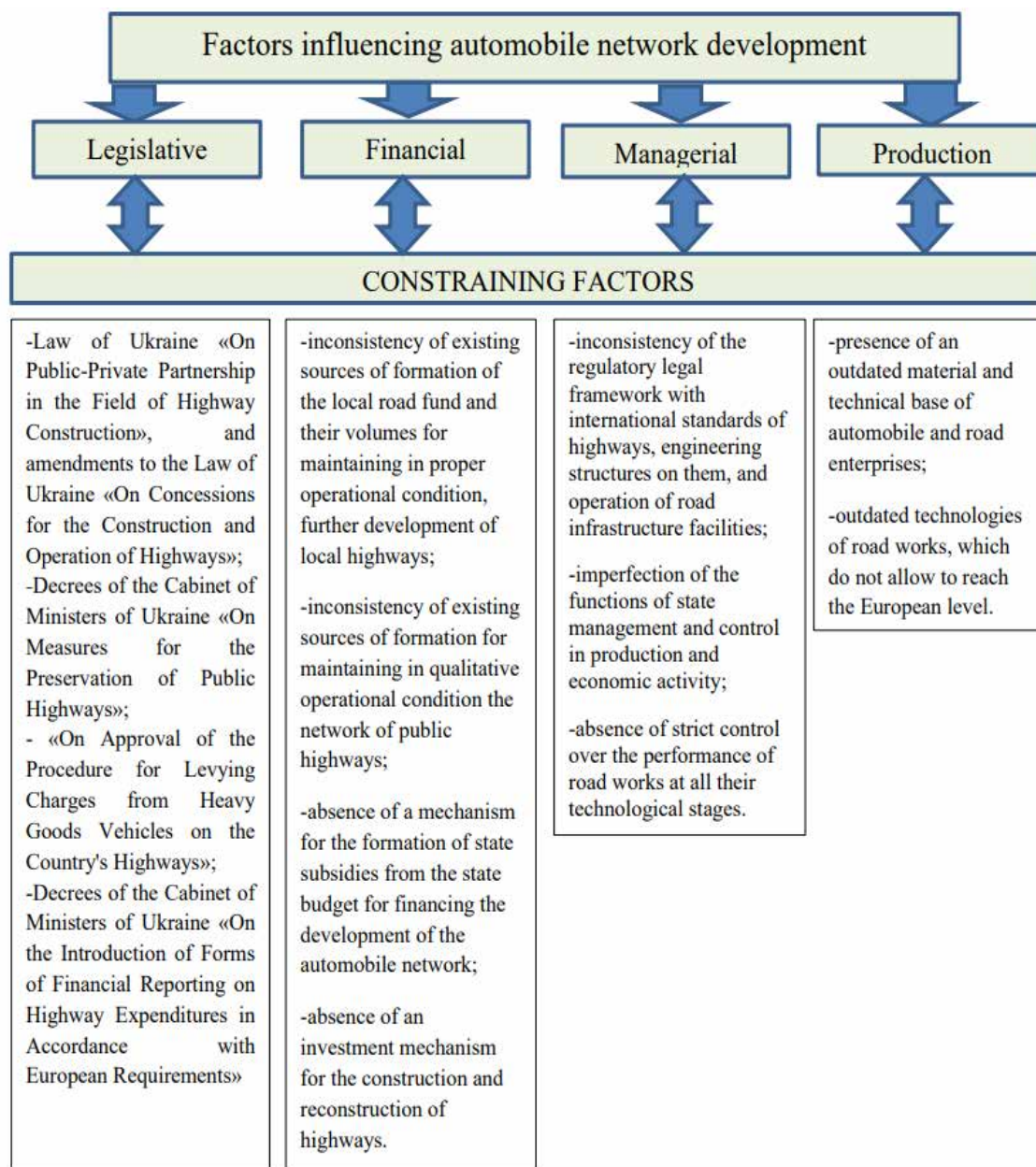


Fig. 1.9. Factors influencing automobile network development (compiled by the authors based on data from [58])

The result of the development of the domestic transport sector is the formation and functioning of an efficient and competitive transport system capable of ensuring the operation of a high-performance, high-tech, and safe transport infrastructure, and providing high-quality transport services [63].

The transport sector of Ukraine's economy for the period until 2030 will develop in the following directions:

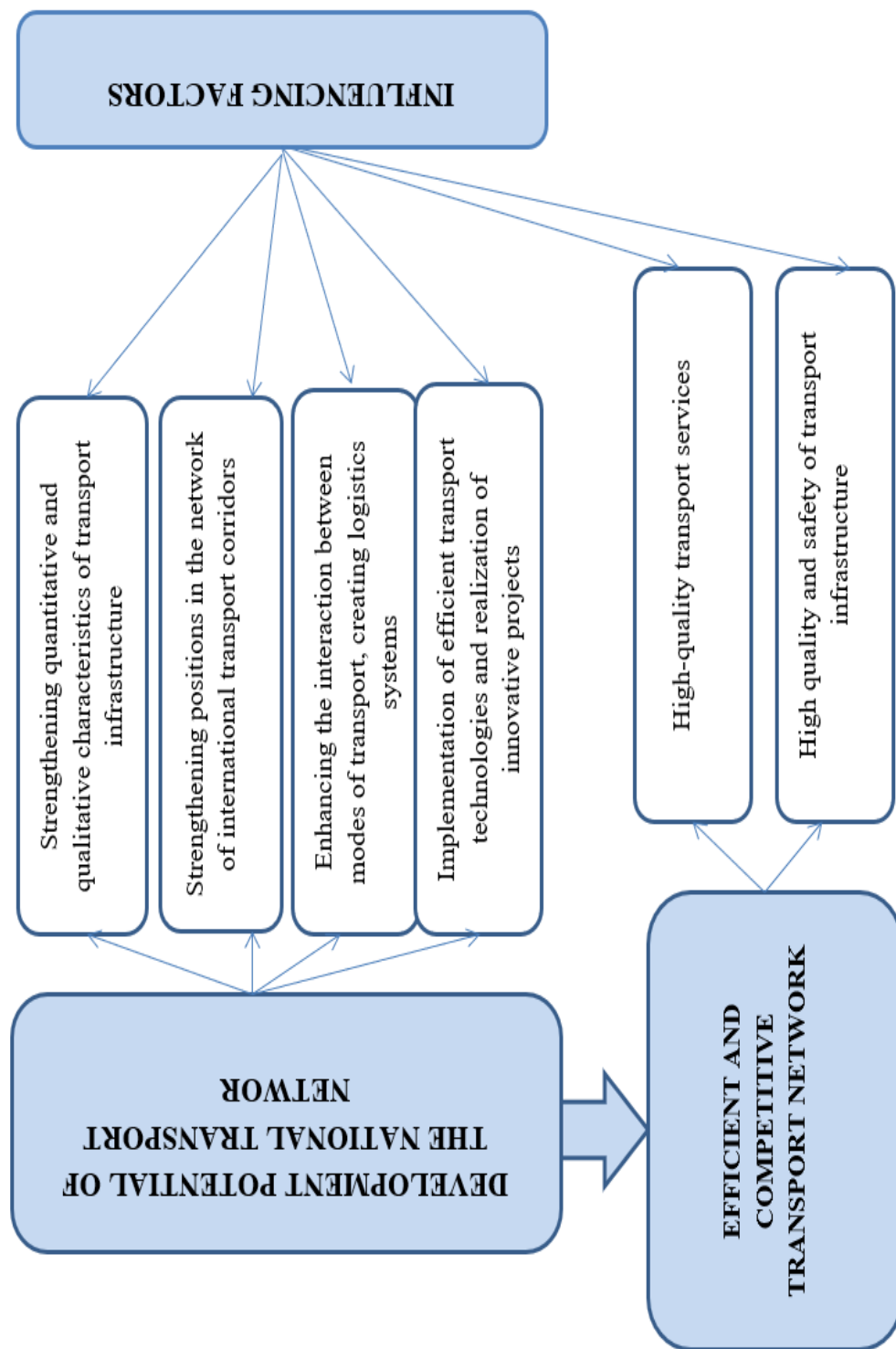


Fig. 1.10. Development of the potential of Ukraine's national transport network (compiled by the authors based on data from [28])

- improvement of transport infrastructure and modernization of rolling stock to ensure the growing mobility of the population and to accelerate the movement of goods flows;
- achieving competitiveness and quality of transport services for the economy;
- ensuring accessibility and quality of transport services for the population;
- integration into the European Union and development of transport services export;
- increasing the efficiency of public administration and development of a competitive environment;
- growth of environmental friendliness, energy efficiency of transport processes, and safety of passenger and cargo transportation [28,63].

Achieving the strategic goal of transport system development is primarily possible with appropriate financial support and an effective investment policy, the implementation mechanism of which, in our opinion, should include the following directions:

- use of various sources of financing for the transport sector – own financial resources, opportunities of investors, concessionaires, state budget subsidies, attracting credit funds from commercial and international banks;
- introduction of a public-private partnership mechanism;
- investment in innovative development and technological modernization of the industry;
- lending for resource- and energy-saving equipment and technologies with the maximum possible terms and minimum interest rates;
- wide application of the "user pays" principle in transport infrastructure.

The formation of a unified transport space, regional and international integration of the national transport system will ensure increased efficiency of

transport services, growth in their exports, and improved utilization of transit potential. The country's transport system will fully meet not only the basic needs of the national economy and population, but also correspond to global standards in terms of speed, timeliness, safety, and environmental sustainability of transportation, creating conditions for more intensive innovation-driven development of the country.

The above necessitates the advance reservation of appropriate land plots to fully ensure the prospective development of road transport and road infrastructure, their reconstruction, and improvement.

1.4. Ecologically safe land use of automobile transport and road economy

Ecologically safe land use is a set of economic, environmental, and social measures aimed at increasing the efficiency, rational use, protection, and restoration of land resources.

Economic indicators usually characterize the outcomes of economic activity, while environmental indicators reflect the state or changes in the natural environment. The land use associated with automobile transport combines both of these aspects.

On the one hand, transport is an important component of a country's economic development in the fields of infrastructure, logistics, production of transport equipment, and systems for managing the transportation of passengers and cargo. These areas create the necessary preconditions for meeting user demand for transport services and for the development of all sectors of the economy.

On the other hand, transport is one of the biggest polluters of the environment and has a negative impact on human health (see Fig.1.11).

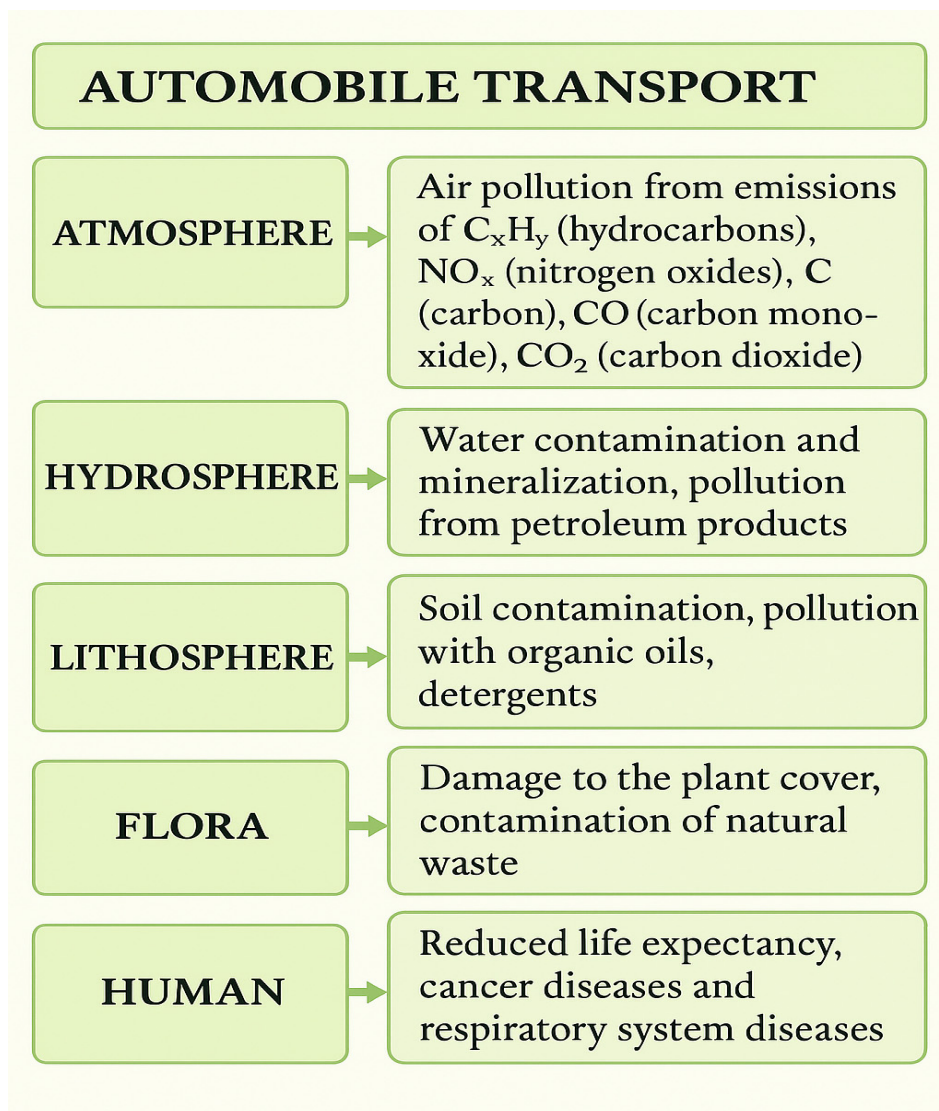


Fig. 1.11. Impact of Automobile Transport on Biosphere Components

(compiled by the authors based on data from [64])

Harmful substances during the operation of motor vehicles enter the air through exhaust gases, fuel system vapors, and also during the process of refueling vehicles.

Analyzing the volumes of harmful emissions by different types of transport (Table 1.10), it should be noted that the largest share — 64% — comes from automobile transport.

Table 1.10

Emissions of Major Harmful Substances by Different Types of Transport*

Harmful Substance	Type of Transport	Tons	%	Total, tons**
	Automobile	1452477	97,76	
CO	Railway	33578	2,24	
	Water	15453	1,10	1501508
	Automobile	27644	97,50	
CxHy	Railway	6998	2,50	
	Water	3838	1,34	284480
	Automobile	130,125	88,90	
NOx	Railway	16233	11,10	
	Water	3429	17,20	176787
	Automobile	10325	79,25	
C	Railway	2735	20,75	
	Water	2424	15,60	15184
	Automobile	10002	73,65	
SO ₂	Railway	3578	26,35	
	Water	2039	13,10	15619

* Source: compiled from [65]

** Excluding air and pipeline transport

Emissions of carbon oxides (carbon dioxide and carbon monoxide) are also influenced by the road relief, driving mode, and vehicle speed. The largest number of pollutants is emitted during acceleration and at low speeds. For example, if the vehicle speed increases and then decreases sharply during breaking, the amount of carbon oxides in the exhaust gases increases eightfold. Their relative share (of the total mass of emissions) is highest during breaking and idling, while the share of nitrogen oxides is highest during acceleration.

These data indicate that vehicles pollute the air most intensely during frequent stops and low-speed movement [64].

Below are the indicators of the specific share of motor transport in atmospheric pollution by combustion products (Table 1.11).

Table 1.11

Volume of Combustion Product Emissions by Motor Transport, million tons/year*

Combustion Product	Source of Emissions	
	Automobiles	Power Plants and Industry
Carbon monoxide (CO)	59,7	5,2
Hydrocarbons and other organic compounds	10,9	6,4
Nitrogen oxides (NO _x)	5,5	6,5
Sulfur-containing compounds	1,0	22,4
Particulates	1,0	9,8

** Source: based on data from [65]*

It should be noted that the main contribution to atmospheric pollution comes from gasoline-powered vehicles (75%), followed by diesel-powered vehicles (about %).

Motor transport emits heavy metals such as nickel, mercury, chromium, cadmium, zinc, iron, arsenic, manganese, and beryllium. Some of these (arsenic, mercury, cadmium, lead) can be highly toxic even in very small concentrations. The accumulation of heavy metals in soil alters its chemical and biological properties. Metals accumulate in living organisms and enter food chains. Heavy metals can remain in the atmospheric air for up to 10 days and be transported up to 2000 kilometers.

Through food chains and air pollution, motor vehicle emissions harm public health, causing various types of dangerous diseases. It has been proven that people living in areas with high traffic density get sick more often and more seriously than those living far from industrial zones. This is influenced by the presence of various types of toxins and solid particles released during vehicle

operation, which enter the human body mainly through the respiratory system, since exhaust gases accumulate in the lower layers of the atmosphere, i.e., in the human breathing zone.

The range of human diseases caused by the impact of motor vehicle exhaust gases is quite broad — from mild cough or rhinitis to pulmonary edema, respiratory disorders, asthma, and even fatal outcomes (Table 1.12).

Thus, all substances released into the environment from motor vehicle operation have a significant negative impact on human health. Emissions that enter the atmosphere have a high or very high level of toxicity.

Table 1.12

Impact of Emissions from Mobile Sources on Human Health*

Harmful Substance	Toxicity Level	Effect on Human Health
Lead	High	Affects the nervous and circulatory systems, disrupts oxygen supply to the brain
Cadmium	Very high	Accumulates in kidneys, liver, and bones; provokes bronchitis, intestinal bleeding, reproductive disorders, and even cancer
Hydrocarbons	High	Cause headache, dizziness, nausea; lower blood pressure, cause sluggishness and slow pulse; disrupt the cardiovascular system
Carbon monoxide (CO)	Very high	Causes oxygen starvation, disrupts the central nervous system; slows reflexes, may cause loss of consciousness and death
Nitrogen oxides (NO _x)	High	Slight irritation of eye and nose mucous membranes; at higher concentrations may cause pulmonary edema
Particulates (soot, dust, aerosols)	Medium	Can remain in the lungs; damage upper respiratory tract, eye and nasopharyngeal mucous membranes
Ozone (O ₃)	Medium	Decreases resistance to colds; may exacerbate chronic heart diseases, asthma, and bronchitis

** Source: compiled by the authors based on data from [64]*

According to morbidity indicators among the general population of Ukraine (Fig. 1.12), despite a decrease in recent years, the largest proportion

continues to be diseases of the respiratory system: 44,27% in 2015, 45,98% in 2016, and 45,22% in 2017.

These illnesses arise as a result of people inhaling air that is heavily polluted with various harmful substances from numerous sources — primarily from motor vehicle emissions and the transport sector overall.

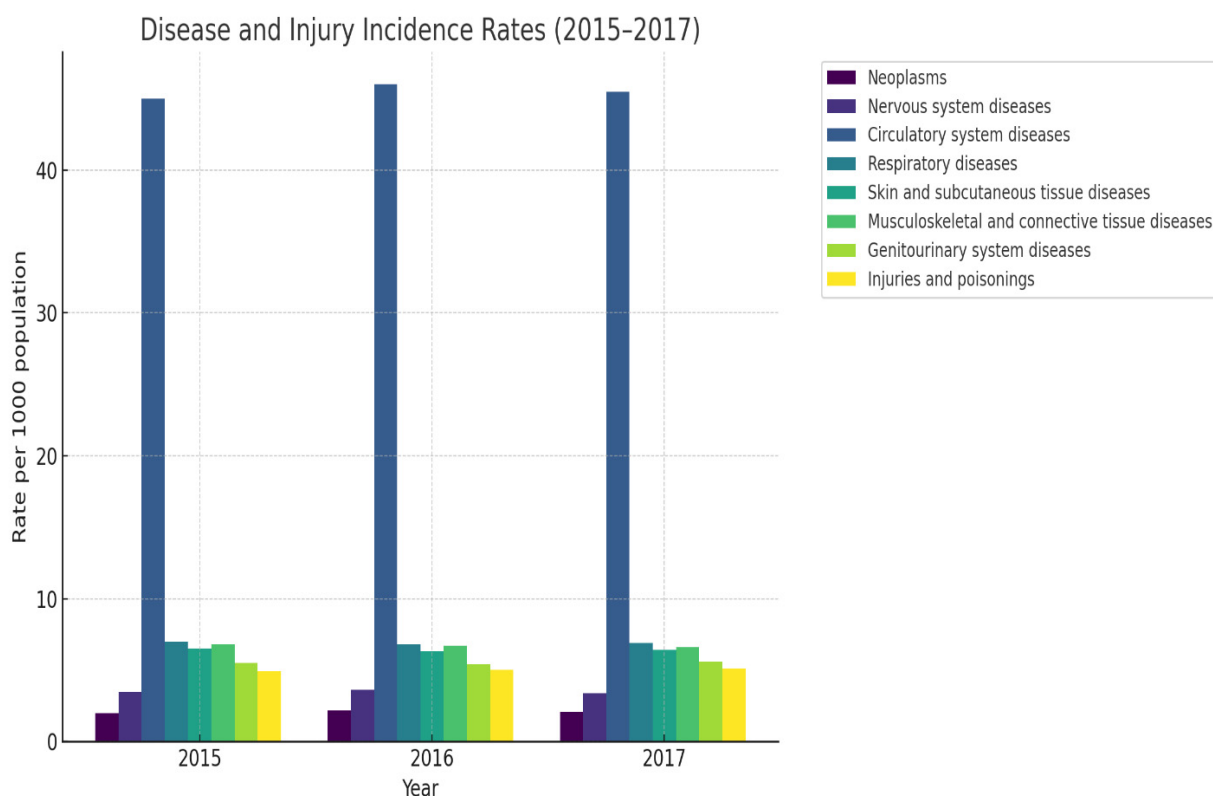


Fig. 1.12. Structure of Morbidity in the Population of Ukraine, 2015–2017, %
(compiled by the authors based on data from [66])

According to the data from the State Statistics Service of Ukraine [29], the emission levels of harmful substances such as carbon dioxide (CO₂) and nitrogen oxides (NO_x) — both of which are highly toxic — have shown a downward trend in recent years (Table 1.13).

Table 1.13

Carbon dioxide emissions into the atmosphere, 2010–2017, million tons*

Year	Carbon Dioxide Emissions			Nitrogen Oxide Emissions		
	Total	Stationary Sources	Stationary Sources	Total	Stationary Sources	Stationary Sources
2010	198,2	165,0	33,2	603,7	310,5	293,2
2011	236,0	202,2	33,8	663,0	33,0	300,0
2012	232,0	198,2	33,8	634,6	332,5	302,1
2013	230,7	197,6	33,1	633,4	333,3	300,1
2014	194,7	166,9	27,8	541,4	288,1	253,3
2015	162,0	138,9	23,1	453,0	233,8	219,2
2016	150,6	150,6		240,2	240,2	
2017	124,2	124,2				

* Source: compiled by the authors based on data from [66]

** Data for 2007 includes emissions from road, rail, air, and water transport, as well as industrial machinery.

*** Excluding the temporarily occupied territory of the Autonomous Republic of Crimea, the city of Sevastopol, and part of the anti-terrorist operation zone.

As can be seen, the level of carbon oxide emissions from mobile sources in 2015 compared to 2010 decreased by 67%, and nitrogen oxide emissions — by 71,79%.

One of the reasons for this trend is the growing use of vehicles equipped with environmentally friendly engines, namely gas turbine and electric motors.

The use of gas turbine engines leads to a significant reduction in harmful emissions into the air, contributing to the overall improvement of the environmental situation (Table 1.14).

Table 1.14

Concentration of Major Harmful Emissions by Different Engine Types*

Engine Type	Concentration of Harmful Substances in Exhaust Gases		
	CO, %	NO _x , мг/л	C _x H _y , мг/л
Gasoline	3,6	4,0	1,79
Diesel	0,2	2,7	0,09
Gas Turbine	0,003	0,1	0,000078

* Source: compiled by the authors based on data from [65]

Currently, Ukraine's state policy regarding electric vehicles actively supports and encourages the population to use electric cars.

According to the Law of Ukraine "On Amendments to the Tax Code and Some Other Legislative Acts of Ukraine to Improve Administration and Revise Certain Tax and Fee Rates" dated May 22, 2019 [114], the provision exempting the import of electric vehicles from VAT and excise tax was extended until the end of 2022.

As a result, an increase in electric vehicle imports and sales is expected. For example, in 2017, 3,256 electric vehicles were sold, while in 2018 that number increased by 207% (see Fig. 1.13), even without government support.

As prices continue to fall, demand for such vehicles will grow, leading to increased use of electric cars, and therefore, a reduction in environmental impact and improvement in the ecological safety of land use.

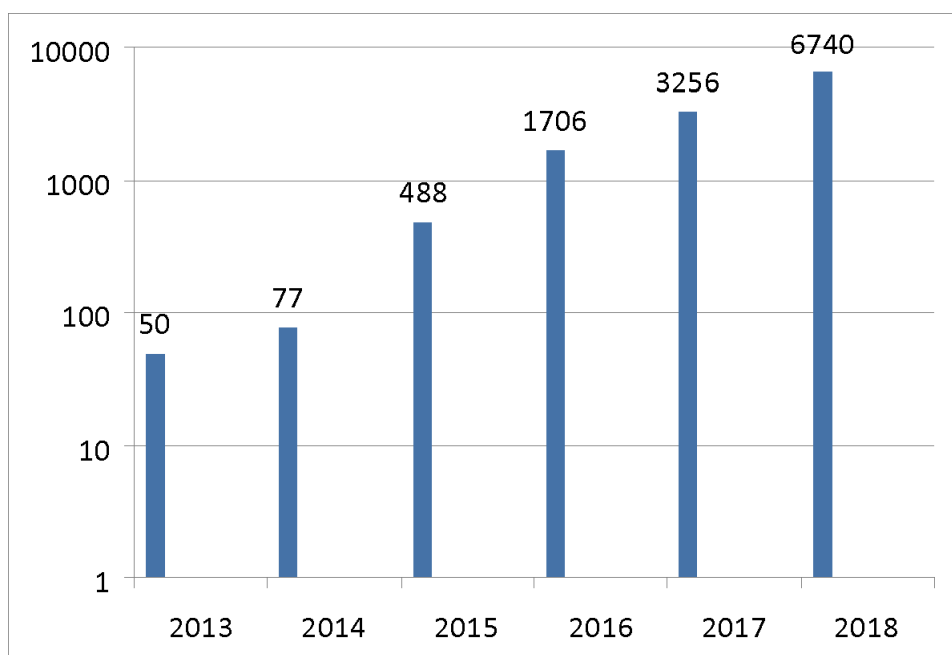


Fig. 1.13. Dynamics of Electric Vehicle Sales in Ukraine, units
(compiled by the authors based on data from [41, 67])

Studying international experience in maintaining environmental quality amid vehicle emissions shows that, in addition to the production and use of electric cars, certain countries — including the United States, Canada, Australia,

Brazil, and several EU member states — are actively implementing programs for the production and use of alternative fuels (from Latin *alter* — “other”), specifically biofuels derived from plant-based raw materials (see Fig. 1.14).

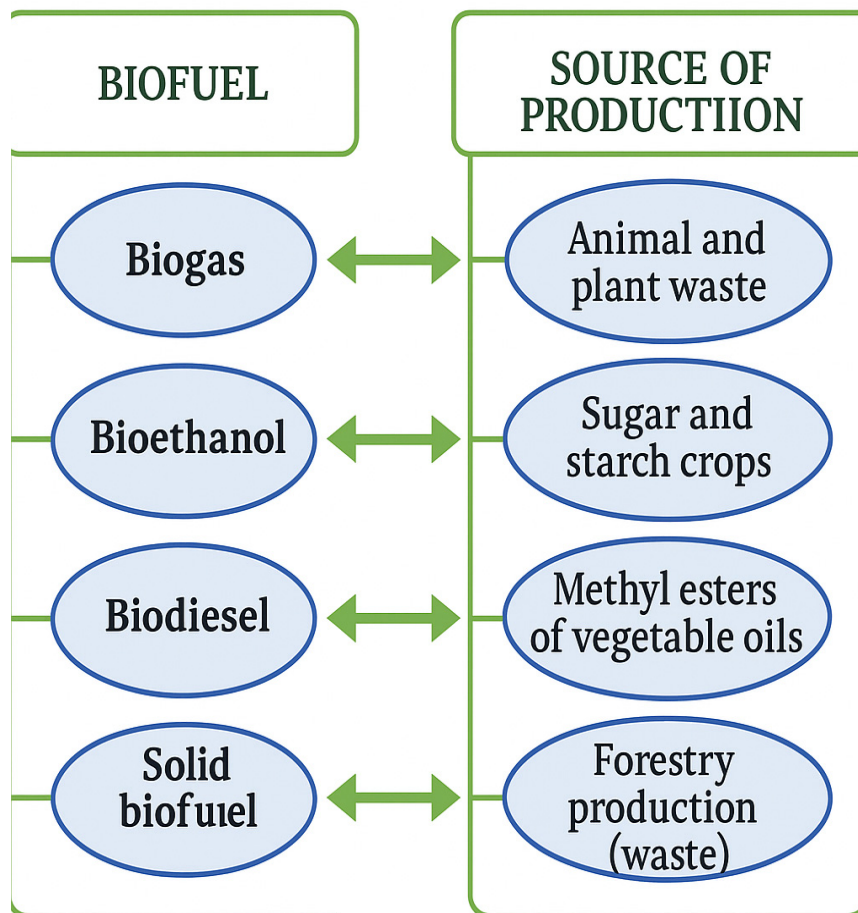


Fig. 1.14. Types and Sources of Biofuel Production Abroad
(compiled by the authors based on data from source [68])

Currently, two types of biofuels are widely used in EU countries:

- o bioethanol – for gasoline engines, and
- o biodiesel – for diesel engines.

Global corporations such as DuPont and British Petroleum are introducing a new type of fuel — biobutanol.

Bioethanol and biobutanol can be produced from plant-based raw materials (corn, wheat, sugar beets, sugarcane, sorghum, barley) and agricultural waste (dry sunflower stalks, corn cobs, or various types of straw).Some

producing countries, such as Spain, Greece, and Italy, use sunflower oil, while most European countries use rapeseed oil.

When burning biofuel, CO₂ is also released, but it does not harm plants or animals, and when it enters soil or water, it is almost completely biodegradable: within 28 days, up to 99% of biofuel is broken down by microorganisms [69].

As for Ukraine, almost all the necessary crops — primarily rapeseed, sunflower, and mustard — are cultivated domestically. The annual demand for petroleum products is 24–28 million tons, and for natural gas — 85 billion m³. Ukraine covers 80–90% of its need for petroleum products through imports. From just 1 ton of rapeseed, around 270 liters of biodiesel can be obtained [69].

The use of this type of fuel would lead to improvements both in the ecological situation (primarily by reducing emissions into the environment) and in the economic situation (through market expansion, increased production volumes, job creation, etc.).

The relevance of developing and producing alternative fuel sources in Ukraine has been supported by government authorities and was already discussed in 2003, which was reflected in Presidential Decrees:

- o “On Measures for the Development of Fuel Production from Biological Raw Materials” dated September 26, 2003 [70],
- o “On Amendments to Certain Laws of Ukraine Regarding the Promotion of the Production of Motor Blended Gasolines” dated January 1, 2011 [71].

Due to the current environmental situation, transport policy reform is ongoing.

The EU has set a goal to reduce the use of traditional-fuel vehicles in urban transport by 50% by 2030 and to completely abandon them by 2050.

According to the National Transport Strategy of Ukraine until 2030 [28], the following objectives must be achieved:

- o reduce greenhouse gas emissions from mobile sources by 60% compared to 1990;

- o increase the share of public, electric, and muscle-powered (bicycle) transport;
- o reduce overall air emissions from mobile sources (converted to CO based on the relative aggressiveness of pollutants) by up to 70% of 2015 levels;
- o increase the use of electric vehicles and electric public transport, with electric transport comprising 75% of domestic routes by 2030;
- o increase the use of alternative fuels from 10% to 50%;
- o develop an action plan to reduce transport's impact on the environment, aligned with energy-saving technologies, alternative motor fuels, and the revival and expansion of electric transport infrastructure;
- o reduce specific fuel consumption per 10 ton-km by 30% by 2030.

Despite the high indicators of electric vehicle use and the implementation of alternative fuel sources, the majority of vehicles still run on gasoline and diesel engines. Therefore, significant attention must be paid to the toxicity of exhaust gases, which are mostly trapped and deposited along the roadside strips of highways.

The content of emissions in soil samples taken 50–200 meters from the road axis may exceed the maximum permissible concentrations several times. This complicates the use of roadside land for:

- o livestock grazing,
- o hay harvesting,
- o and the cultivation of agricultural products [72].

In the current context of rapid technical, technological, and scientific progress, with the growing number of vehicles, expansion of international and national highway corridors, and ongoing construction and repair of roads — it is critically important to comply with environmental standards, especially given the difficult ecological conditions in the country.

According to DBN V.2.3-4:2015. Automobile Roads. Part I: Design. Part II: Construction [52] the presence of green plantings on the shoulders and slopes of

public roads is not permitted. The minimum distance from the nearest row of green plantings to the roadway outside settlements, in the absence of first-class protective road barriers, must comply with the standards outlined in Table 1.15.

Table 1.15

Requirements for the Distance from the Edge of the Roadway to Green Plantings, m*

Road Category	Distance from the Roadway	
	Edge to the Nearest Tree Trunk (min)	To the Edge of Shrub Plantings (min)
International	10,0	7,0
National, Regional	9,0	5,0
Territorial, District, Local	7,0	4,0
the root collar diameter of shrub plantings must not exceed 5 cm		

** Source: compiled by the authors based on data from [64]*

The presented data indicate that the distance from the edge of the roadway must be no less than 4 meters from the edge of shrub plantings and no less than 10 meters from the nearest tree trunk, as heavy metal pollution along road-adjacent areas is most intense in the 50 to 200 meter roadside zone.

In these areas, the so-called edge effect is observed — with an average width of 10 meters, and it tends to expand depending on:

- o the road category,
- o service life of the road,
- o traffic intensity, which leads to an increase in disturbed ecosystem areas.

The factors influencing ecosystems in edge-effect zones are divided into barrier zones and disturbance zones.

Barrier zones include factors that hinder the natural migration of animals to their permanent or temporary habitats and feeding areas, disrupting natural trophic chains.

The disturbance zone is formed by factors that scare away animals and interfere with their natural territory — for example:

- o noise from vehicle operation,
- o chemical pollution affecting both plants and animals (e.g., vehicle exhaust gases, acoustic pollution) [65].

In these areas, the concentration of pollutants exceeds maximum permissible limits by dozens of times, making the land unsuitable for livestock grazing, hay harvesting, and especially for growing agricultural products.

Currently, regulatory characteristics of the impact of chemical pollution on roadside land use cannot be considered fully reliable, so we will rely on the existing normative requirements to estimate the extent of influence of major pollutant concentrations along highways.

To predict pollution of roadside areas with CO (carbon monoxide) and NO₂ (nitrogen dioxide)

To predict the pollution of roadside areas by CO (carbon monoxide), NO₂ (nitrogen dioxide), and the concentration of Pb (lead), current standardized methodologies for environmental impact assessment in road design are applied [65].

$$C_{CO} = -0,1 \times d + 0,0127 \times N + 3,55, \quad (1.1)$$

$$C_{NO} = 2,5 \times 10^{-2} \times N \times n \times \exp - 0,148 \times H \times \exp - 0,021d, \quad (1.2)$$

$$C_{Pb} = \frac{P_H}{(p \times \rho)}, \quad (1.3)$$

where:

C_{CO} – concentration of carbon monoxide at any given point, mg/m³;

d – distance from the emission source to the calculation point on the terrain, m;

N – traffic intensity in both directions, vehicles/hour;

C_{NO} – concentration of nitrogen dioxide at any given point, mg/m³;

H – height of the roadway above ground level, m;

C_{Pb} – lead contamination level in the surface soil layer, mg/kg;

h – thickness of the soil layer where lead accumulates, m;

ρ – soil density, kg/m³;

P_H – lead fallout on the ground surface, mg/m².

The presented data indicate that for almost all road categories, the predicted concentration of carbon monoxide (CO) exceeds the maximum permissible concentration (MPC), while nitrogen dioxide (NO₂) exceeds the MPC only within 30 meters of Category I and II roads.

The background concentration of lead at 30 meters from Category III roads exceeds the permissible level by nearly 2,5 times, and at 40 meters — by 1,5 times, given that the accepted background level for lead in soil is 10 mg/kg (see Table 1.16).

Table 1.16

Concentration of Harmful Emissions in Air and Soil*

Carbon Monoxide (CO), mg/m ³							
Road Category	Distance from Roadway Edge, m						
	30	50	60	80	100	120	150
I	14,5	12,5	11,5	9,5	7,5	5,5	2,5
II	8,2	6,2	5,2	4,2	3,2	–	–
III	4,4	2,4	1,4	–	–	–	–
MPC	5,0						
Nitrogen Dioxide (NO ₂), mg/m ³							
I	0,055	0,035	0,032	0,029	0,027	0,025	0,019
II	0,042	0,030	0,027	0,018	0,013	0,012	0,010
III	0,039	0,028	0,024	0,017	0,012	0,010	0,08
MPC	0,04						
Lead in Soil (Pb), mg/kg							
	Distance from Roadway Edge, m						
	30	40	60	80	100		
I	18	12	6	4	2		
II	22	18	8	6	4		
III	70	52	18	9	5		
Background Level	32						

* Source: compiled by the authors based on data from [53]

In addition to forecasting soil and air pollution in roadside areas, an important indicator is the pollution of water bodies by road runoff. Various pollutants settle on the road surface, including:

- o particles from pavement wear,

- o tire and brake pad residue,
- o road dust,
- o and de-icing agents.

These substances are washed off by rainfall and snowmelt, enter the surface runoff, and eventually flow into watercourses. Therefore, forecasting the condition of surface and groundwater is no less relevant than predicting air and soil pollution [73].

To assess the state of surface waters, a Water Pollution Index (WPI) is used, which is calculated based on several parameters, including:

- o ammonium nitrogen,
- o petroleum products,
- o phenols,
- o dissolved oxygen, and
- o biochemical oxygen demand (BOD).

The water pollution index is calculated using the following formula [73]:

$$I_{3B} = \frac{\sum_{i=1}^4 \frac{C_i}{ГДК} + \frac{H_{02}}{C_{02}} + \frac{C_{02}}{H_{02}}}{6} . \quad (1.4)$$

Green plantings can play an important protective role in roadside areas, serving as natural barriers that help limit the spread of pollution into adjacent zones.

Studies show that needles, branches, and leaves of trees and shrubs on the side facing the road contain 1.5 to 3 times more iron, lead, and cadmium than those on the opposite side [65].

In addition, roadside greenery can protect roads from:

- o snow accumulation,
- o sand and dust,
- o air pollution,
- o noise,

and can also serve as architectural and aesthetic elements in road design.

For green plantings to provide effective protection:

- o the height of tree belts should range from 5 to 8 meters,
- o and the age of the trees should be between 15 and 20 years, as young trees lack the necessary protective properties.

For example, the noise-reducing effectiveness of green plantings depends on the species and planting pattern of trees (Table 1.17). Since the effects of green plantings emerge only several years after planting, it is recommended to use:

- o fast-growing young trees,
- o shrubs,
- o and bushes that are resistant to local climate conditions.

Adhering to well-justified parameters for protective forest belts can significantly improve the transport carrying capacity of areas with dense road networks.

Table 1.17

Noise Reduction by Green Plantings*

Type of Planting	Strip Width (m)	Noise Reduction Level (dBA)
Single-row with staggered tree arrangement in the middle of the strip	10–15	4–5
	16–20	5–8
Double-row with 3–5 m spacing between rows	20–26	8–10
Double- or triple-row with 3 m spacing between rows	26–30	10–12

** Source: based on data from [2]*

The rapid growth in the number of automobiles, traffic intensity, and the expansion of international and national transport corridors has a dual effect: on one hand, it positively influences the country's economic indicators, and on the other — it leads to a negative impact on various ecological systems.

The impact of automobile transport on ecologically safe land use today causes numerous problems, the solution to which is impossible without constant attention and control from both local governments and national authorities.

A significant improvement in the ecological situation in the road sector can be achieved through the implementation of a comprehensive set of measures, including:

- ✓ the development and creation of environmentally safe construction materials used in road building;
- ✓ improvement of vehicle design to reduce harmful emissions;
- ✓ development of an environmental monitoring algorithm for the natural environment and roadside zones (reserve-technological and protective strips, impact zones);
- ✓ enhancement of methods for managing environmental protection activities and traffic flows to reduce vehicle emissions, with a special focus on the production of electric vehicles;
- ✓ encouraging internal public motivation toward the use of green transport;
- ✓ development of electric vehicle service infrastructure;
- ✓ institutional incentives for the implementation of innovations

1.5. Foreign experience in sustainable development of automobile infrastructure: best practices and lessons for Ukraine

Sustainable development of road infrastructure is an important aspect of modern transport policy aimed at increasing transportation efficiency, reducing environmental impact and improving the quality of life of the population. The experience of developed countries shows the effectiveness of the introduction of environmentally friendly materials, smart technologies and the development of alternative modes of transport. Ukraine, which is in the process of modernizing its road network, can use these approaches to improve the quality and safety of the transport system.

One of the key areas is the use of environmentally friendly materials and technologies in road construction.

Thus, the Netherlands actively uses recycled materials, which allows reducing the impact on the environment; Sweden is implementing energy-efficient lighting technologies on roads and developing innovative asphalt coatings that reduce noise levels. In more detail, aspects of WEEE collection and recycling in different countries are presented in the table 1.18.

Table. 1.18

Main aspects of WEEE collection and recycling in different countries *

Country	E-waste Recycling Rate	Key Features of the Collection and Recycling System
Sweden	80%+	Retail stores are required to accept old devices; tax incentives for repairs; deposit-refund system; high level of environmental awareness.
Bulgaria	65%	Waste Management Act (2012); National Waste Prevention Program (2014); 11 kg of e-waste collected per capita (2021); implementation of WEEE Directive standards.
Germany	45%	Extensive network of municipal and commercial collection points; producers register with the EAR Foundation and fund recycling processes; active public awareness campaigns.
France	40%+	Non-profit organization "Ecosystem" coordinates collection and recycling; Extended Producer Responsibility (EPR) principle; educational programs to raise awareness.
Norway	High level	National take-back system; incentives for recycling old equipment when purchasing new; municipal and commercial collection points.
Switzerland	One of the most efficient systems	"Eco-logistics" system allows free return of old electronics at points of sale; producers are responsible for the entire product lifecycle.
Netherlands	85% (recycling or reuse)	Single organization OPEN Foundation coordinates collection and recycling; producers are required to join OPEN and pay contributions; over 50 million kg of e-waste collected (2022).

** Formed by source [74 -76]*

Intelligent transport systems (ITS) play a key role in modern transport infrastructure, helping to optimize traffic, reduce congestion and improve road safety. The use of advanced technologies, including artificial intelligence (AI), automated control systems and electronic regulation tools, helps to effectively manage traffic flows [77-81].

One of the most prominent examples of ITS implementation is Japan, where AI algorithms are used to analyze traffic conditions in real time. Such systems allow predicting possible congestion and adjusting traffic lights accordingly to minimize waiting times at intersections. This ensures smoother traffic flow and reduces emissions [82]¹⁰

Another successful example is Singapore, which operates an electronic road pricing (ERP) system. It uses sensors and automated cameras to adjust tolls based on road traffic levels. This encourages drivers to use alternative routes or public transport, which helps reduce traffic congestion during peak hours [83].

Thus, smart technologies in transport infrastructure not only improve mobility in cities, but also have a positive impact on the environmental situation. Their further development and implementation can be a decisive factor in creating sustainable urban transport systems of the future.

Reducing dependence on private cars is a key strategy of many countries aimed at increasing population mobility, reducing emissions of harmful substances and improving the quality of life in cities. The use of public and alternative transport contributes to the development of sustainable urbanism and the efficient use of urban space.

One of the most successful examples of the development of alternative transport is Denmark, which has created an extensive system of cycle paths [84]. This has contributed to a significant increase in the number of cyclists, a reduction in congestion and an improvement in the environmental situation in cities. Bicycles have become not only a means of transportation, but also part of the culture and identity of urban life.

France is also actively implementing environmental initiatives in the field of transport. In particular, many cities in the country are switching to electric buses, which allows reducing air pollution and reducing dependence on fossil fuels. The introduction of electric transport is one of the steps towards achieving climate neutrality.

In addition, in many countries of the world, public transport systems are actively developing, in particular metros, trams and bus routes with priority traffic. An important direction is the creation of intelligent transport systems that optimize transport traffic and increase its efficiency[85].

The successful development of public and alternative transport requires a comprehensive approach, including improving infrastructure, encouraging environmentally friendly modes of transport, and creating a conscious transport culture among the population. This contributes to sustainable urban development and creates a comfortable living environment [86-89]. One of the key mechanisms for financing and developing automotive infrastructure in many countries around the world is Public-Private Partnership (PPP). Several examples of successful application of this approach are presented in table 1.19.

Table. 1.19

**Use of Public-Private Partnership (PPP) in different countries for
developing automotive infrastructure**

Country	Models/Financing	Project	Description
USA	Flexible PPP models, financing through TIFIA	I-495 Express Lanes (Virginia)	Concession for the construction and operation of a toll road.
United Kingdom	Green Infrastructure Investment, environmental projects	M6 Toll (toll road)	Implementation of environmentally friendly transport solutions using private company investments.
France	Motorway concessions	A89 (Lyon – Bordeaux)	Private companies build and operate motorways, generating income through toll collection.

Germany	A-Model concession model with private companies	A8 (Munich – Augsburg)	Private financing; tolls from freight trucks are collected through the Toll Collect system.
Australia	Innovative concession models	CityLink (Melbourne), WestConnex (Sydney)	Private companies build and operate roads, earning profits from toll revenues.

The following key development directions can be identified for Ukraine (See Fig.1.15)

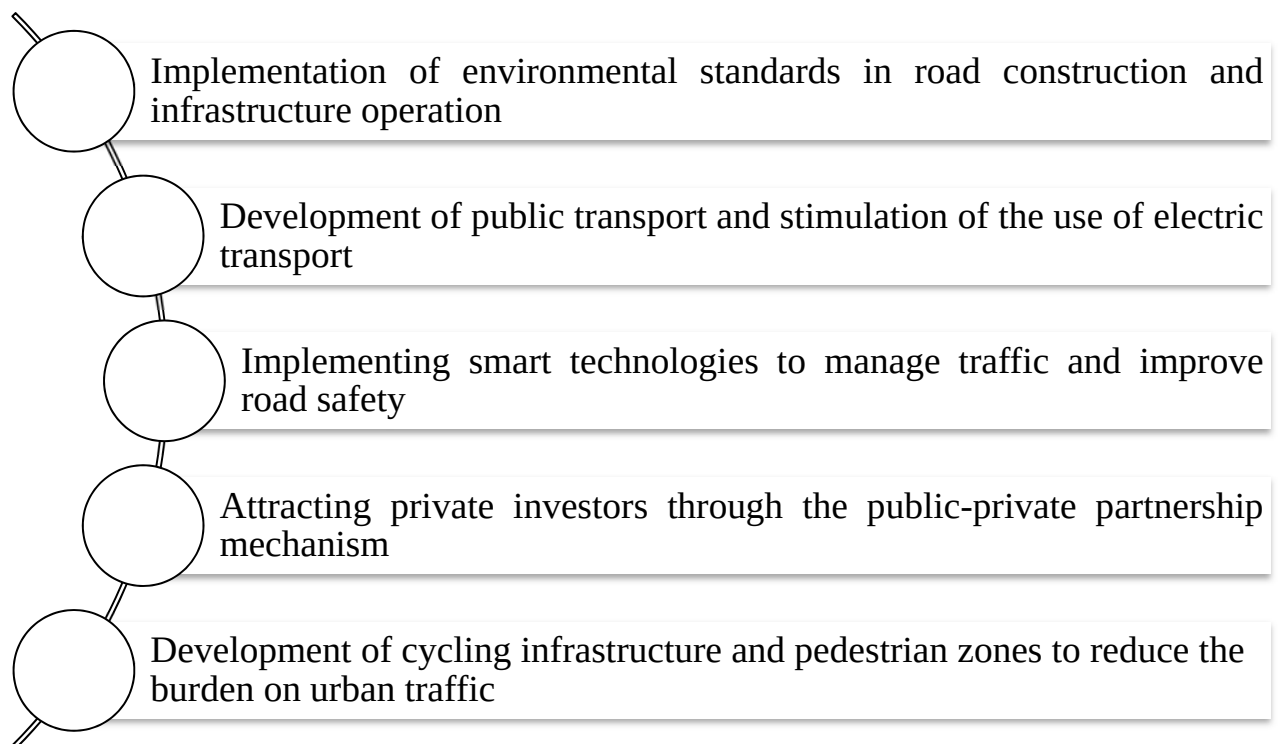


Fig 1.15 Key development directions for Ukraine

Foreign experience demonstrates that sustainable development of automotive infrastructure is possible thanks to an integrated approach that includes environmental technologies, smart solutions, and effective financing [90]. For Ukraine, it is relevant to implement these practices, taking into account national characteristics and economic realities. For example, there are currently no toll roads in Ukraine. However, the government is considering the possibility

of implementing them to improve infrastructure and attract investment [91].
(See Fig. 1.16.)



Fig. 1.16. Potential routes for toll roads [90]

Ukrainian legislation provides that toll roads can be built under concession terms, meaning that the investor finances the construction and receives the right to collect tolls for a specified period. In this case, the availability of an alternative free route is mandatory [90] (See Fig. 1.17.)

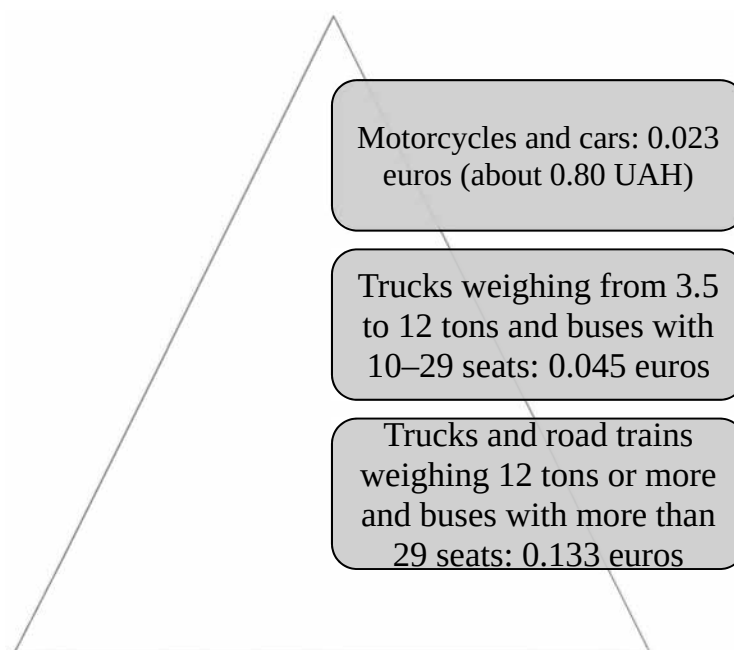


Fig. 1.17. Approximate fare (per 1 km) [90]

It is worth noting that as of April 2025, these projects are at the discussion and planning stage, and the exact timing of their implementation has not yet been determined.

Appropriate reforms can significantly improve the state of road infrastructure and contribute to the sustainable development of the country's transport system.

CONCLUSIONS TO SECTION I

The land fund of Ukraine, associated with transport infrastructure, occupies an important place in the system of rational land use. The largest component of this category remains the lands of road transport and road management, which is due to the high mobility of the population, the growing volume of transportation and the development of interregional and international transport corridors. Analysis of the technical classification and capacity of roads allows us to better understand the functional role of each type of road in the overall transport system of the country.

Of particular importance is the legal regulation of lands in this category. Classification by purpose demonstrates differences between subspecies of lands combined into a common category, which indicates the need to separate transport lands into separate, more detailed categories. Such an approach will allow improving the accounting, use and protection of lands, as well as increasing the efficiency of land management.

The rationalization of the legislative framework, in particular, the division of Article 71 of the Land Code of Ukraine into two independent norms - on land for motor transport and land for road management - creates the potential for resolving important issues related to land reservation, the organization of protected areas and ensuring environmental and technical requirements for the operation of infrastructure facilities. This also opens up the possibility of maintaining separate accounting for such lands within the State Land Cadastre.

Within the framework of the implementation of the National Transport Strategy until 2030, promising directions for the development of the transport network have been outlined. This primarily concerns the development of state financing mechanisms, investment support, the development of public-private partnerships and the attraction of resources for technical modernization of the industry. At the same time, significant attention is paid to energy saving, the transition to environmentally friendly technologies and the reduction of the negative impact of transport on the environment. At the same time, a number of constraining factors have been identified that slow down the implementation of innovative solutions.

In the context of environmental safety of the transport sector, it is necessary to implement a set of measures aimed at reducing the harmful impact on the environment. This includes improving the design of vehicles, using new, environmentally friendly materials in road construction, and establishing an environmental monitoring system. Rational management of environmental protection activities in the transport sector should become part of the overall strategy for sustainable development.

Thus, the development of land legislation regulating the use of transport land, combined with the modernization of transport infrastructure and strengthening environmental standards, are key factors in the formation of an effective and safe transport system in Ukraine.

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■ Section 2

SPECIFICS OF ALLOCATION AND USE OF LANDS FOR AUTOMOTIVE TRANSPORT AND ROAD MANAGEMENT

2.1. Standardization of land plots allotment for the needs of automobile transport land and road economy

Regulation of land plot sizes is a type of rational use of natural resources aimed at establishing norms, rules, and requirements for environmental protection, land use, and ensuring ecological safety. Under rational use, the beneficial properties of land constitute an inexhaustible resource.

In a spatial sense, land resources that can be used to meet human needs are limited, particularly land areas designated for specific purposes, primarily agricultural production [1].

The restriction of fertile land use for other purposes is not only a principle of Ukrainian land law, as indicated in Article 23 of the Land Code of Ukraine, but also a condition for sustainable development and the survival of humanity as a whole, in accordance with the Declaration on Environment and Development of the United Nations Conference on Environment and Development (Rio de Janeiro, June 1992) [2].

Thus, the primary objective of land use regulation is to maximize the preservation of fertile land and other categories (forests, water bodies, nature reserves, etc.) and to use land as an operational base only within the minimally necessary limits. This regulation aims to prevent the unjustified withdrawal of land from agricultural, forestry production, and other priority uses.

The fulfillment of the above-mentioned tasks is possible through the establishment of appropriate norms for land allocation for specific non-agricultural purposes.

Issues related to land allocation regulation have been studied by scholars such as I.K. Bystryakov, O.S. Budziak, M.M. Gabrel, T.M. Gapotchenko, D.S. Dobryak, T.O. Yevsyukov, A.G. Martyn, A.M. Miroshnychenko, L.Ya. Novakovskyi, V.V. Nosik, and others. However, land regulation for the transport sector during the transformation of land relations remains insufficiently explored.

A.M. Miroshnychenko notes that, in most cases, land use volume is regulated by establishing specific land allocation norms for particular needs. This means setting absolute regulatory standards, such as land allocation norms for airports, communication facilities, and oil and gas exploration and exploitation wells, which are relatively defined within a lower and upper range [3].

In cases where even a relative determination of land plot size is impossible, regulation is carried out by establishing rules for calculating the specific area using legislatively approved construction norms. This approach is applied in determining land plot sizes for road transport and highway infrastructure [3].

According to L.Ya. Novakovskyi, land plots belonging to specific categories (industry, transport, communications, energy, defense, and other uses) related to road transport and highway infrastructure have diverse purposes and legal regimes. However, in legal doctrine, common features of the legal regime of industrial, transport, communication, energy, and defense land are identified and classified as special-purpose non-agricultural land in specialized literature [4].

The sizes of such plots are generally determined based on norms approved through the legally established process, which are developed in accordance with specific standards. This allows land of special non-agricultural designation to be characterized by land size regulation [4].

T.O. Yevsyukov and A.G. Martyn emphasize that most land use and environmental protection regulations were developed in the 1960s-1980s based on Soviet-era scientific achievements. It is crucial to revise existing regulations and develop new standards while considering international best practices. The current system of land protection norms is fragmented and inconsistent, necessitating the deve-

lopment of a land regulation and standardization concept by the State Geocadastre of Ukraine, which should also account for regional land use specifics [5].

At present, the key safety criteria, according to D.S. Dobryak and O.S. Budziak, include norms, rules, and regulations that limit the impact of hazardous factors on the environment and society. The most dangerous factors are of natural origin, such as adverse climatic conditions, natural disasters, and the functional characteristics of soil, water, and the atmosphere. The most severe technogenic-anthropogenic factors are linked to human economic activities, including environmental pollution by waste, unjustified ecosystem disturbances, and excessive use of natural resources [6].

M.M. Gabrel notes that transitioning to new principles of targeted urban development and regulations requires interaction between spatial characteristics. Harmonious development of humans and nature necessitates clear moral norms in human activities, meaning categorical restrictions that should not be violated under any circumstances [7].

Currently, the majority of regulations in Ukrainian legislation are related to construction. Land use volume is interpreted as the regulation of land plot sizes allocated for specific needs, while the estimated land plot size for road transport and highway infrastructure is determined in accordance with state and industry-specific construction norms of Ukraine, including:

- DBN V.2.3-4:2015. Roads. Part I. Design. Part II. Construction;
- DBN V.2.3-16:2007. Transport Facilities. Land allocation norms for the construction (reconstruction) of highways;
- DBN V.2.3-5:2018. Transport Facilities. Streets and roads of settlements;
- GBN V.2.3-218-007:2012. Environmental requirements for roads. Design.

The parameters of land plots for the construction of new and reconstruction of existing public roads are regulated by DBN V.2.3-4:2015 [8], which covers their design, construction, and reconstruction; requirements for network

and communication intersections, and the placement of service facilities within road reserves. The requirements of this regulatory document do not apply to departmental (technological) roads, streets, and roads in cities, other settlements, or private territories.

According to the Law of Ukraine "On Roads" [9], departmental (technological) roads include internal economic technological roads owned by legal or physical entities.

At the same time, under the Law of Ukraine "On the Expropriation of Land Plots and Other Real Estate Objects Located on Them, Which Are in Private Ownership, for Public Needs or for Reasons of Public Necessity" [10], land plots and other real estate objects on them that are in private ownership may be expropriated for public needs or due to public necessity.

Thus, the question arises: if the expropriation of departmental (technological) roads is necessary for public needs or public necessity, should their construction or reconstruction follow the current DBNs, or should new state construction norms for departmental (technological) roads be developed?

In our opinion, the proposal to include provisions regarding departmental (technological) roads, streets, and roads in cities and other settlements, as well as roads on private territories, in DBN V.2.3-4:2015 should be considered.

Taking into account the requirements of DBN V.2.3-16-2007, norms for land allocation for the construction (reconstruction) of highways establish the size of land plots for interchanges at different and same levels and the width of the road reserve for public roads. These norms are mandatory for application by legal and physical entities engaged in economic activities related to the design and construction of new and reconstruction of existing highways [11].

These construction norms clearly define the methodology for calculating the width of the right-of-way strip for the construction or reconstruction of a highway. Specifically, the minimum width should be determined considering the requirements for the placement of all elements of the highway:

- The earthwork within the limits between the base of embankments or the upper edges of excavation slopes;
- Side drainage ditches (culverts), reserve ditches, and reserves;
- Sub-bank ditches, shoulders, and mountain ditches;
- Safety strips with a width of at least 1,0 m on each side of the road, measured from the base of the embankment or the edge of the excavation, or from the outer edge of the slope of the side, sub-bank, or mountain ditches.

The width of the right-of-way strip is calculated using the following formulas:

a) Embankment height up to 2,0 m:

$$CB = B + 2 (H \times U + h \times y + BK + 1,5 h + 1,0), \quad (2.1)$$

where $U = 4$; $BK = 0.6$ m, $h = 1.0$ m for roads of categories I-III; $U = 3$; $BK = 0.6$ m, $h < 1.0$ m for roads of categories IV-V;

b) Embankment height from 2,0 m to 6.0 m:

$$CB = B + 2 (H \times m + h \times m + BK + 1,5h + 1,0), \quad (2.2)$$

where $m = 1.50$; 1.75 or 2.00; $BK = 0.6$ m, $h < 1.0$ m;

c) Embankment height from 2,0 m to 12,0 m:

$$CB = B + 2 (6,0 \times m + (H - 6,0) \times n + h \times n + BK + 1,5h + 1,0), \quad (2.3)$$

where $m = 1,50$ and 1,75 for embankments up to 6,0 m; $n = 1,75$ and 2,00; $BK = 0,6$ m, $h < 1.0$ m for embankments exceeding 6,0 m;

d) Excavation depth from 0,0 to 1,0 m:

$$CB = B + 2 (U \times H + 1,0), \quad (2.4)$$

where $U = 10$ – excavation slope;

e) Excavation depth from 1,0 to 12,0 m:

$$CB = B + 2 ((H + h) m + h \times U + BK + 1,0), \quad (2.5)$$

where $U = 4$; $m = 1,50$ and 1.75 or 2,0 $h = 1,0$ m, $BK = 0,6$ m and 2,0 m for roads of categories I-III; $U = 3$; $m = 1,50$ and 1,75 or 2,0 $h = 1,0$ m and 0,8 m, $BK = 0,6$ m for roads of categories IV-V; CB – width of the right-of-way strip, m; B – width of the earthwork between the edges, m; H – embankment height or

excavation depth, m; h – side ditch depth, m; BK – side ditch width, m; U – slope; m – embankment or excavation slope steepness; n – lower part embankment slope steepness; BT – shoulder width, m; NK – mountain ditch width, m; $1,0$ – safety strip, m [11].

The design of additional highway elements (acceleration/deceleration lanes, bus stops with pavilions, pedestrian and bicycle paths, local transport roads, decorative and snow protection plantings, reserve ditches, etc.) is also considered. Justification of technical and economic indicators is provided when selecting the optimal route for the projected highway. The dimensions of land plots allocated for the placement of interchanges are also presented, determined based on the placement conditions of all elements and the road interchange scheme (Fig. 2.1).

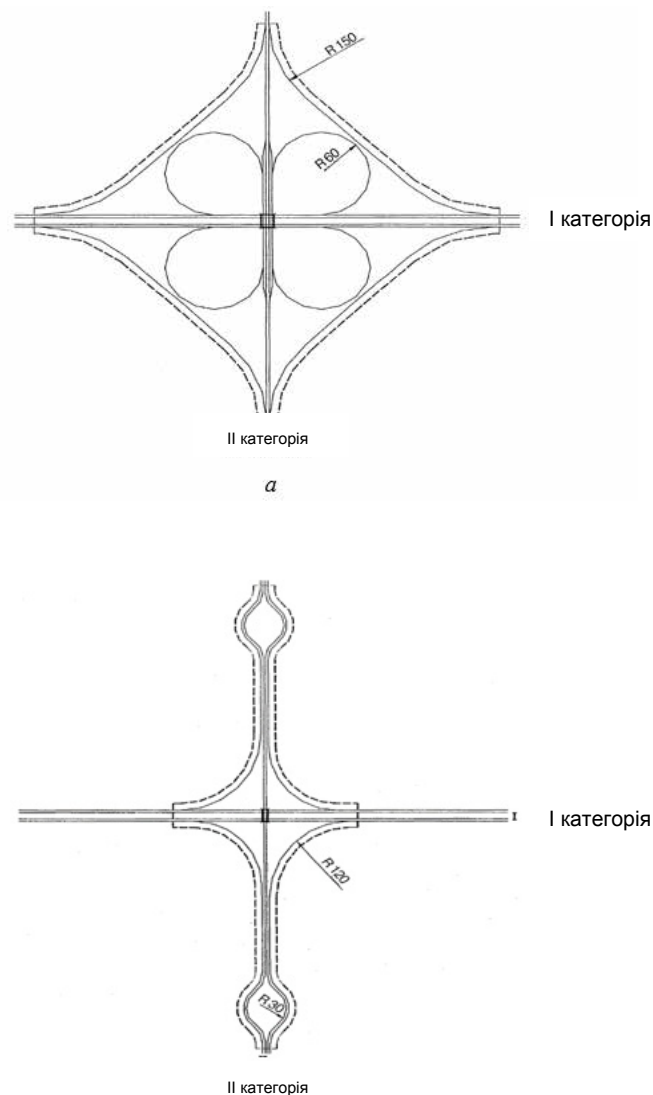


Fig. 2.1. Road Interchange Diagram "Cloverleaf" (a) and with Roundabouts (b):

Traffic lane axis;

Right-of-way boundary;

Although these construction norms reference Ukrainian laws, including the "On Highways" Law, the "On Environmental Protection" Law, and the Land Code of Ukraine, they simultaneously contain certain regulatory and legal discrepancies with them.

According to the State Building Norms, these regulations apply to all legal and physical persons engaged in economic activities during the design and construction of new highways and the reconstruction of existing ones.

The Law of Ukraine "On Concessions for the Construction and Operation of Highways," dated 25.03.2018, defines the peculiarities of constructing and operating state highways under concession terms [12]. It also states that a concession is the provision by the concession grantor (the state represented by an executive authority) under a concession agreement on a paid and temporary basis to the concessionaire (a business entity) the right to construct and operate a highway, provided that the concessionaire assumes obligations for its construction and operation.

Based on the experience of European Union countries, where concessionaires are typically foreign investors, the question arises as to which construction standards a foreign concessionaire will follow when fulfilling their obligations under the Law on Concessions. Considering the current state of our country's roads, it is advisable to draw on the experience of foreign partners in road construction and reconstruction—especially France, which is a leader in using the concession mechanism, as well as Italy, the United Kingdom, Spain, Germany, and others.

Therefore, proposals to regulate this issue by amending the Law of Ukraine "On Concessions for the Construction and Operation of Highways" and DBN V.2.3-16-2007. Transport Structures. Land Allocation Standards for Road Construction (Reconstruction) deserve attention. These amendments should specify whether a foreign concessionaire has the right to apply foreign experience,

norms, and standards or must perform work strictly according to the applicable legislation of Ukraine.

For the design, construction, reconstruction, and major repair of existing streets and roads in urban and rural settlements, DBN V.2.3-5:2018. Transport Structures. Streets and Roads of Settlements, effective since August 1, 2018, is applied [13].

These standards include requirements for designing key elements of streets, roads, and squares, such as:

- ✓ Roadways (central and local (side) lanes), sidewalks, pedestrian and bicycle paths, including pavement structures, public transport stops, and street parking;
- ✓ Street and road junctions, pedestrian crossings at the same and different levels, and artificial structures;
- ✓ Landscaping, lighting, and drainage systems;
- ✓ Traffic management measures and environmental protection measures.

Previously, the lane width on roads ranged from 3,5 to 3,75 meters. However, under the current DBN V.2.3-5:2018. Transport Structures. Streets and Roads of Settlements, the lane width is as follows: 3,0 meters on main streets of citywide and district significance in the largest, large, medium, and small cities (except for roads with uninterrupted traffic), as well as on settlement roads and main streets; 3,5 meters on citywide main streets with uninterrupted traffic in the largest and large cities; 2,75 meters on local residential streets and roads in all settlements. Table 2.1 presents the width of streets and roads, considering their categories and the calculated intensity of vehicle and pedestrian traffic.

In areas with existing development, the width of streets and roads within the red lines may be reduced, provided there is proper urban planning justification, with the minimum possible narrowing of their cross-sectional elements (Table 2.2).

Table 2.1

**Width of streets and roads considering the intensity of vehicle
and pedestrian traffic***

Group of Settlements	Category of Streets and Roads	Design Speed, km/h	Minimum Lane Width, m	Number of Lanes	Maximum Longitudinal Slope, ‰	Minimum Curve Radius in Plan, m	Minimum Pedestrian Zone Width, m
Highways		100	3,75	4–8	40	500	1,0**
Major Streets							
Largest and Large Cities	Citywide Significance (Uninterrupted Traffic)	80	3,5	4–8	50	400	3,0
	Citywide Significance (Regulated Traffic)	60	3,0	4–8	60	250	3,0
	District Significance	60	3,0	2–6	60	250	2,25
Large Cities	Citywide Significance	60	3,0	2–6	60	250	3,0
	District Significance	60	3,0	2–4	60	250	2,25
Medium and Small Cities	Citywide Significance	60	3,0	2–4	60	250	2,25
	District Significance	60	3,0	2–4	60	250	1,5
Local Streets and Roads							
All Settlement Groups	Residential Streets	50	2,75	2	70	125	1,5
	Streets and Roads in Scientific-Industrial, Industrial, and Utility-Warehouse Areas (Districts)	40	3,0	2	60	250	1,5
	Driveways	30	2,75	1–2	80	30	1,0

*Source: based on data [26].

**The maximum lane width should not exceed 3,75 m.

***Technical sidewalk.

Table 2.2

Width of the carriageway of local driveways, m*

Category of Streets and Roads	Design Speed, km/h	Minimum Lane Width, m	Number of Lanes	Minimum Pedestrian Zone Width, m
Settlement Road	60	3,0	4	–
Main Street	40	3,0	2–3	1,5
Residential Street (in a Residential Area)	40	2,75	2	1,0
Driveway	20	2,75	1–2	0–1
Utility Road	30	4,5	1	–
Pedestrian Road	–	0,75	2,4	–

**Source: based on data [13]*

According to L. Partskhaladze, former Deputy Minister of Regional Development, Construction, and Housing and Communal Services, the possibility of reducing the width of streets and roads would contribute to improving road safety and reducing accidents; increasing street capacity and reducing traffic congestion; and promoting the efficient development of cycling and public transport by providing dedicated lanes.

It should be noted that the maximum lane width (except for utility roads) should not exceed 3,75 meters.

These innovations have sparked numerous debates, as demonstrated by the case of the Kyiv-Sviatoshynskyi district, which is currently one of the leaders in the construction of new residential complexes. Every day, approximately 500,000 people commute from the suburbs to Kyiv, primarily from Tarasivka, Boyarka, Petropavlivska and Sofiiivska Borshchahivka, Bilohorodka, Vyshhorod, and Kryukivshchyna. Their main problem is transportation: passengers traveling by road face hour-long traffic jams, as exits from these settlements have only single-lane roads, and according to current regulations, reconstruction or new construction cannot exceed two lanes (Tables 2.1, 2.2).

Given the current situation, it is advisable to reconsider this issue, as Kyiv and Kyiv Oblast lead in vehicle ownership rates, with 353 cars per 1000

residents, and every fifth family owning two cars. Therefore, in our opinion, it is necessary to increase the number of traffic lanes.

According to GBN V.2.3-218-007:2012. Environmental Requirements for Highways. Design, the requirements for designing, constructing, reconstructing, and overhauling public highways and artificial structures concerning environmental protection have been established [13].

These sectoral construction norms aim to develop projects for the construction, reconstruction, and major repairs of public roads, considering the need for environmental protection, sustainable development, and the mitigation of depressed regions.

Their primary goal is to improve the state road network, enhance transportation infrastructure, and ensure proper operational conditions for highways.

The main environmental impacts of highways and artificial structures, along with design solutions for their mitigation, according to GBN V.2.3-218-007:2012 [13]. The regulation of land allocation for the needs of agriculture and road transport is preceded by a significant set of works consisting of legislative, legal, managerial, design and technical procedures. It should be noted that we are not talking about one or two land plots within one administrative-territorial unit (village, township, district), but about tens or hundreds within one or more regions. As practice shows, it is the inconsistency of legal norms and administrative decisions that leads to great difficulties in allocating land plots for the needs of the automotive industry.

An example is the problems that arose during the design and construction of a large ring road around Kyiv, which should pass through the territory of Vyshgorod, Borydianskyi, Makarivskyi, Kyiv-Svyatoshynskyi, Vasylkivskyi, Obukhivskyi, Boryspilskyi and Brovarskyi districts of Kyiv region. The road right-of-way passes through land plots owned by hundreds of state, municipal and private land owners and land users. Each land plot requires the approval of all

owners, land users, executive authorities and local governments, as well as other approving bodies, in order to be withdrawn. Inconsistencies between certain provisions of the Law of Ukraine 'On the Alienation of Privately Owned Land Plots and Other Real Estate Located Thereon for Public Needs or for Reasons of Public Necessity' and the Land Code of Ukraine hinder, and in many cases lead to a 'dead end', the withdrawal of land for the needs of the transport sector [14].

In addition, other problems often arise when registering the right to use land plots under existing roads and road facilities, in particular

- 1) overlapping of the boundaries of land plots transferred into private ownership and provided for use (including lease) to individuals and legal entities on land plots located in the road right-of-way;

- 2) most of the state acts for the right of permanent use of land plots were issued in the late 1990-s and early 2000-s to road construction organisations and enterprises, road administrations, which do not exist today;

- 3) absence of cadastral numbers of land plots, as a result of which the automated database of the State Land Cadastre does not contain data on such land plots of the road state, therefore, in the process of allocating land plots adjacent to the road right-of-way to individuals and legal entities, land management organisations often make mistakes by placing such plots within the road right-of-way or without taking into account their boundaries;

- 4) the difficulty of restoring and establishing in kind (on the ground) the boundaries of land plots under road state facilities on the basis of issued state acts, which is caused by the lack of coordinates in land management documentation [15].

The emergence of these problems is mainly due to the imperfection of land legislation and the lack of professionalism of officials.

One of the ways to solve them is to form a new paradigm of the institutional environment of the transport, energy and communications sectors at the state level, which are dominated by linear objects in their land use.

The regulation of land allocation is a type of rational use of natural resources, preservation of land productivity, and environmental safety, aimed at avoiding unjustified withdrawal of land from agricultural, forestry, and other priority uses. The current legislation uses the term 'regulation' as a means of legal regulation of land relations.

The level of motorisation in the country is extremely high, so the issue of regulating land allocation for roads and road facilities is quite important and relevant. The state construction norms that guide the design and construction of roads, land allocation, and environmental requirements for roads need to be supplemented, improved, and adjusted to meet the needs of society. Achievement of these goals is possible only by amending regulatory acts, in particular: authorising the relevant authorities to develop and approve the norms of use of road transport land, introducing and updating the State Construction Standards in accordance with European standards, developing a clear mechanism for allocating land plots for roads, etc.

In addition to improving the regulation of land use for the transport sector, a new paradigm of the institutional environment for the territorial development of this category of land needs to be formed at the state level. Quality management of road construction or reconstruction does not have a specialised regulatory framework. Regulatory documents require the inclusion of quantitative quality criteria both in individual processes and in the overall assessment of the quality of work in the road sector, further improvement, and the creation of an interconnected system that will ensure the quality of road construction and reconstruction. In particular, this applies to DBN B.2.3-16-2007. Transport Facilities. Norms for allocation of land plots for construction (reconstruction) of highways, the Laws of Ukraine 'On Land Management', 'On the State Land Cadastre', 'On Concessions for Construction and Operation of Highways' and others.

2.2. Features of executing land management works and land inventory for the requirements of automotive transport

Okay, here's the English translation of the provided text, maintaining the original structure:

According to the law "On Land Management," land management works are surveying, exploration, topographic and geodetic, cartographic, design, and design-exploration works performed for the purpose of compiling land management documentation [16].

Land management documentation is text and graphic materials approved in the established procedure, which regulate the use and protection of state, communal, and private land ownership. The main task of such documentation is the formalization of design solutions, the essence of which lies in the development of documents regarding a specific land plot, land use, territorial zone, administrative-territorial unit with the definition of its spatial characteristics, legal regime, and the solution of social, economic, environmental, sanitary and hygienic, and engineering-technical aspects [16].

According to Article 20 of the Law of Ukraine "On Land Management" dated May 22, 2003, land management works are carried out on a mandatory basis on lands of all categories, regardless of the form of ownership, namely: in the case of the development of land management documentation regarding the organization of rational use and protection of land; establishment and changes in the boundaries of land management objects, including the determination and establishment in kind (on the ground) of the state border of Ukraine; granting, withdrawal (redemption), alienation of land plots; establishment in kind (on the ground) of the boundaries of lands restricted in use and ¹ encumbered (burdened) by the rights of other persons [16].

Regarding the subcategory of land for automobile transport and road management, the allocation of land plots for the placement, construction, and

operation of road management facilities is a complex land management and legal procedure, which is divided into the following main types of work:

- selection and coordination of the location of land plots in cases where the location of such facilities is not determined by the relevant urban planning or land management documentation (general plans of settlements, detailed planning projects, other urban planning documentation, feasibility studies for the use and protection of land of administrative-territorial units, land management projects for the organization of territories of settlements, etc.);

- development of a land allocation project, making a decision on its approval, withdrawal and granting of land plots; transfer of the project to the field (on the ground), preparation of documents certifying the right to use land plots, registration of this right.

Current legislation provides for the execution of land management works related to the provision of land for the needs of automobile transport in three stages:

- selection and coordination of the location of land plots;
- development and approval of a land management project for the allocation of land plots;
- transfer of the land management project to the field, certification of the right to use, and registration of title documents. The first stage of land management works includes preparatory work and the coordination procedure.

During the performance of preparatory work, the following is carried out:

- identification of the passage of the right-of-way of highways within administrative-territorial units;
- processing of land cadastre information necessary to determine the legal status of land plots within the right-of-way of a highway;
- drawing up cadastral maps (plans) of land plots that are withdrawn (redeemed), leased for the construction period, encumbered by servitudes, and

used with restrictions on the territory of individual rural (settlement, city) councils and within the districts of regions (Autonomous Republic of Crimea);

- drawing up lists of landowners and land users with the determination of the areas of their land plots that will be used for the construction period on lease terms;

- forming lists of legal entities whose land plots are granted for permanent use, and the areas of land plots to be withdrawn;

- drawing up lists of landowners and the areas of their land plots to be redeemed;

- forming lists of lessees of state-owned land plots and the areas of plots to be withdrawn;

- drawing up lists of owners and users of land plots within which it is planned to establish land servitudes;

- conducting and formalization of calculations of estimated amounts of losses to be compensated to landowners and land users;

- implementation and formalization of calculations of estimated amounts of losses of agricultural and forestry production related to the withdrawal (redemption) of land plots.

The relevant executive authorities make decisions on the coordination of the location of objects and the granting of permission for the development of a land allocation project.

In our opinion, although the executive authorities have the powers to make relevant decisions, one should not forget about the population living in cities, and especially in villages and settlements, on the territories of which the construction of a new or reconstruction of a highway is to take place. Residents of consolidated territorial communities (OTG) should be informed in a timely manner about the possibility of such construction through local mass media, OTG meetings, etc., and have the opportunity to express their opinions or proposals regarding this project at the planning stage. As is known, only the

population living in the area can suggest better options for the route of the highway, and the authorities should take their wishes into account.

For example, the village of Ksaverivka in the Kyiv region is divided into two parts by the Kyiv-Odesa highway. During the reconstruction of the M-05 highway, the ground-level pedestrian crossings, of which there were seven, were demolished. Only two crossings were left: an underground one in the center of the village and a ground-level one on the outskirts, to which people have to go through the entire village, so they are forced to climb over barriers and cross four lanes of traffic every day. As a result, about 40 people have died on this road recently.

Therefore, it is advisable at the stage of coordination and decision-making on the location of objects to legally approve the holding of public hearings, and to approve the granting of a coordination decision with the signatures of local authorities' representatives (village head, land management engineer, activists, and others) to regulate such situations at the planning stage.

The complexity of this stage of land management works lies in the withdrawal of land plots or parts thereof for the construction of a highway. The road service needs to buy them from citizens, and most of them first need to formalize ownership of the land plots and obtain the relevant documents. Today, not everyone has the latter, which is already a problem and delays or even makes the start of construction impossible.

In all road services of the regions, the right of permanent use of land under highways of national importance has been formalized only for 74,53% (61169 hectares out of 83410 hectares of the total area), and under local roads – for 52% (143118 hectares out of 275198 hectares of the total area). The average indicator in this case is 57,25% [17].

Solving and preventing the problem of overlapping boundaries is possible by conducting a full inventory of road management land plots in accordance with the Procedure for Conducting Land Inventory, approved by the Resolution

of the Cabinet of Ministers of Ukraine No. 476 dated June 5 2019 [18], their state registration in the state land cadastre with the assignment of cadastral numbers. An example of detecting overlaps using GIS technologies, which facilitate their detection, is shown (see Fig. 2.2).



Fig. 2.2. Identifying problem areas ²

According to the mentioned resolution, land inventory is a set of measures aimed at verifying and documenting the availability and condition, assessment of land resources, land ownership or land use, or a specific land plot.

The purpose of the inventory is: establishing the location of land management objects, their boundaries, sizes, legal status, identifying unused land, land used irrationally or not for its intended purpose; identifying and conserving degraded agricultural land and contaminated land; establishing quantitative and qualitative characteristics of land necessary for maintaining the State Land Cadastre; exercising state control over the use and protection of land and making appropriate decisions on their basis by executive authorities and local self-government bodies [18].

Inventory is carried out by forming land plots regardless of the form of ownership, determining their land use, and assigning such land plots to certain categories for informational filling of the State Land Cadastre [18].

² <https://zemli.vkursi.pro/kejsy/yak-vyyavyty-faktychni-nedoliky-zemlekorystuvannya-na-terytoriyi-gromady/>

Land inventory under highways is focused on establishing the boundaries of highway sections and rights-of-way; identifying unauthorized occupation of highway rights-of-way; detecting cases of agricultural cultivation in rights-of-way; planning felling and planting in them; identifying all objects within rights-of-way; conducting accurate calculation of the scope of repair work on certain sections; determining investment-attractive plots for the placement of roadside service facilities, etc.

Currently, the sources of funding for land inventory can be funds allocated by the Road Fund, established in January 2018 to ensure transparency and predictability of financing the road sector, as well as funds from local budgets as a result of the decentralization of roads, due to which 120 thousand km of roads are transferred not only for maintenance but also for financing by regional authorities, which will enable local residents to demand proper repair and maintenance of roads from the authorities of consolidated territorial communities.

Studying the foreign experience of highway operation, it can be noted that the road sector in many countries of the world is decentralized.

For example, in Germany, most issues regarding highway maintenance fall under the competence of the road administrations of the federal states, which develop strategic plans for 10 years, tactical plans for 5 years, and operational plans for 1 year for the repair and construction of all highways. The sources of road financing are funds included in the price of fuel, vehicle registration fees, as well as tolls collected from trucks. This is what formed the basis of the German autobahn, which today is a true standard for highways.

In each US state, separate departments of transportation (DOT) are engaged in road repair and maintenance, which set standards, conduct tenders, and resolve other issues related to maintaining the quality of the road surface. For state "highways," 70% of the funds come from taxes, which are mainly included in the price of fuel. Other funds come from vehicle taxes, bond issuance, and other sources. There are also toll roads in the USA, the fare for which ranges

from \$1,5 to several tens of dollars. This approach has its advantages: the country builds highways, the cost of which ranges from several to hundreds of millions of dollars, but the service life reaches 35–40 years without major repairs [19].

In the second stage, the State Agency of Automobile Roads of Ukraine or its territorial subdivisions commission a land management organization to develop a land management project for the allocation of land plots for the construction of a road management facility within each region in accordance with Article 50 of the Law of Ukraine "On Land Management" [16].

The coordination of the land management project is carried out in accordance with Article 186 of the Land Code of Ukraine, which states that land management schemes and feasibility studies for the use and protection of land of administrative-territorial units are coordinated by the territorial body of the central executive body that implements state policy in the field of land relations [20].

The relevant executive authority or local self-government body, within a two-week period from the date of receipt of the land management project for the allocation of land plots, and in case of the need for mandatory state expertise of land management documentation in accordance with the law, after receiving a positive conclusion of such expertise, ¹ makes a decision on granting land plots for use. The process of developing a land management project is quite lengthy due to the lack of cooperation between state authorities and territorial authorities on the ground.

If land plots are granted for use by the Cabinet of Ministers of Ukraine, the coordinated land management project for their allocation is submitted to the Council of Ministers of the Autonomous Republic of Crimea, regional, Kyiv and Sevastopol city state administrations, ² which consider it and, within a month, submit it with their proposals to the Cabinet of Ministers of Ukraine.

If land plots are granted for use by the Verkhovna Rada of the ARC, the coordinated land management project for the allocation of land plots is

submitted to the Council of Ministers of Crimea, which considers it and, within a month, submits it with its proposals to the Verkhovna Rada of the Autonomous Republic of Crimea.

The decision on granting land plots for use according to the land management project for their allocation includes:

a) approval of the land management project for the allocation of land plots;

b) withdrawal of land plots from land users with the approval of the terms of their withdrawal (if necessary);

c) granting land plots to a legal entity for use with the determination of the conditions of its use and approval of the terms of granting, including (if necessary) requirements for compensation for losses of agricultural and forestry production.

As world practice shows, most states do not attach sufficient importance to the integration of uniform control between the government, local communities, and the private sector in this area during the development of a land management project for the construction of highways, especially developing countries. The disjointed activities of state authorities and territorial bodies lead to the emergence of obstacles that could be avoided, the main ones being: the lack of so-called holistic power in state institutions and local self-government bodies; pressure from documentation developers; the need for cooperation between road authorities and local self-government bodies; the lack of coordination mechanisms between state institutions and local self-government bodies; the lack of interest of individual developers in the project [21].

Solving the outlined problems will make it possible to improve integration between the government, local communities, and the private sector in this area, accelerate the planning and implementation of urban and regional infrastructure projects, and expand the range of project financing in all regions in order to achieve practical results in a relatively short time.

The third stage is the procedure for approving the land management project for the allocation of land plots for permanent use for the construction of a road management facility and its transfer to the field (on the ground). The turning points of the boundaries of the land plots granted for use are fixed with boundary markers of the established standard, and the coordinates of the vertices of the angles – the turning points of these boundaries – are determined.

It should be noted that the coordinates of the vertices of the turning points of the boundaries were determined at the design stage of the highway right-of-way. Such works were carried out to determine the exact areas of land plots (up to 1 m²) that were planned for coordination, approval of the land management project, and making a decision on granting land plots for use.

However, during the period of coordination of the location of the land plot, development, and approval of the land management project, the areas of these land plots or their location may change. When using modern geodetic instruments – electronic total stations, geodetic GPS receivers – it is not difficult to restore the coordinated turning points of the lines of land plots on the ground.

Based on the land management documentation regarding the establishment of land plot boundaries in kind (on the ground), documents certifying the right to them are drawn up.

In accordance with the Resolution "On Approval of the Procedure for Maintaining the State Land Cadastre" No. 1051 dated October 17 2012 [22], land management documentation is the basis for entering information (changes to it) into the State Land Cadastre, submitted to the State Cadastral Registrar, who enters such information in paper or electronic form in accordance with the requirements of the Law of Ukraine "On Land Management" [22] and in the form of an electronic document in the context of the requirements of the Law of Ukraine "On the State Land Cadastre" [23].

From January 1, 2013, the right to a land plot is certified by a Certificate of Ownership or Use, which is issued by the justice authority on the basis of state

registration of the land plot by the bodies of the State Agency of Land Resources of Ukraine in accordance with the Law of Ukraine "On State Registration of Real Property Rights and Their Encumbrances." To illustrate the described procedure, the stages of land management works related to the provision of land for the needs of automobile transport and road management have been developed (Fig. 2.3).



Fig. 2.3. Stages of land management works to provide land plots for the needs of road transport and road management

To expedite the procedure for approving the land management project for the allocation of land plots for permanent use for the construction of a road management facility, in our opinion, the proposals regarding the cooperation of personnel of the relevant state authorities (Ministry of Infrastructure, Ukravtodor) with employees of local self-government bodies from the stage of drafting to the stage of project implementation deserve attention to ensure appropriate measures for the use of land for automobile transport and road management; and the creation of advisory committees on planning, design, and approval of road construction or reconstruction projects with the participation of local communities. The mechanism for coordinating the land management project for the allocation of land plots for the placement, construction, and operation of road management facilities is shown (Fig. 2.4)..

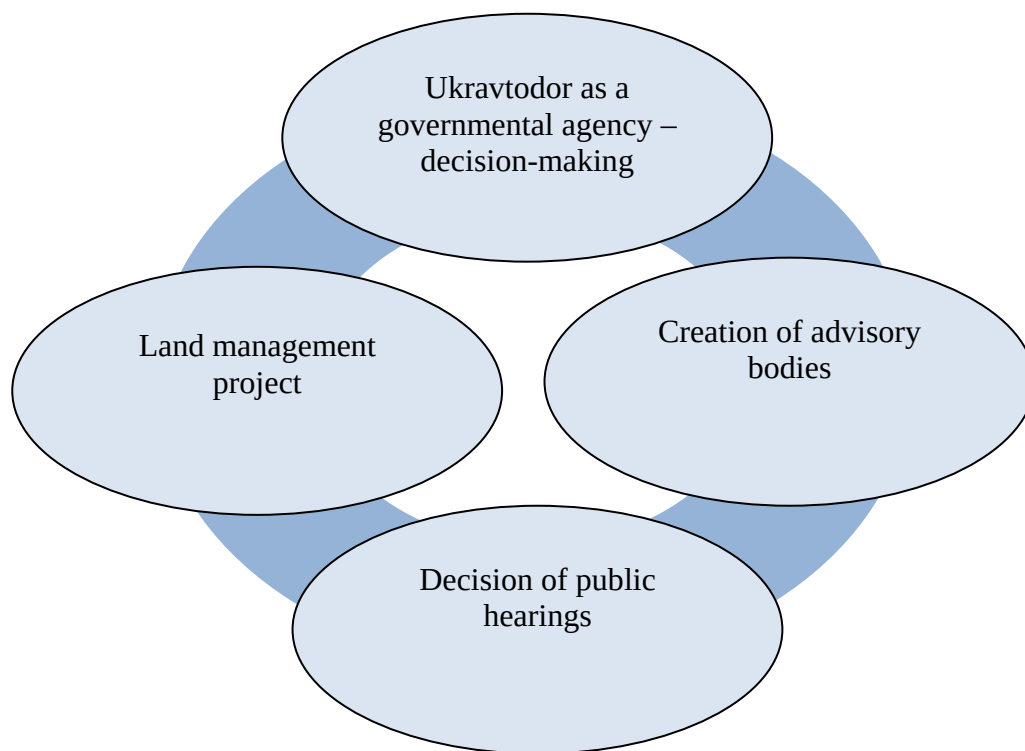


Fig. 2.4. Coordination mechanism of the land management project
(formed by the authors)

The practical application of land legislation by organizations of the State Agency of Automobile Roads of Ukraine in the formalization of the right of

permanent land use has revealed numerous problems and shortcomings, as well as the need to improve certain provisions of the Land Code and other laws.

The legislative framework for land use by automobile transport should aim at the application of accurate and up-to-date information regarding the length of highways, their uninterrupted functioning and control by relevant infrastructure services, constant updating of the condition of the road surface for proper planning and organization of repair works, and the design of new roads and interchanges.

The introduction of these proposals into land legislation will facilitate the allocation and formalization of the right to use land plots for the placement, construction, and operation of road management facilities, which should be taken into account in the preparation of the Laws of Ukraine "On the State Land Cadastre," "On State Registration of Real Property Rights and Their Encumbrances," "On Land Management," "On Concessions for the Construction and Operation of Highways," DBN V.2.3-16-2007. Transport structures. Norms for the allocation of land plots for the construction (reconstruction) of highways, and other legislative acts.

2.3. Redemption and forced alienation of land for public needs, including automobile transport and road management

The development of social, engineering-transport, defense, and energy infrastructure, as well as the formation of roadside areas and environmental protection zones, is impossible under the constraints of land as a spatial resource.

Reforming the road transport sector requires the expansion of highways to ensure a priority place for every individual within the state's infrastructure. Therefore, the issue of expropriating privately owned land plots for public needs is becoming increasingly relevant today.

The procedure for the expropriation of land plots for public needs in the placement and construction of highways and other road infrastructure facilities has been developed in accordance with the Land Code of Ukraine [20], the Civil

Procedure Code of Ukraine [24], the Laws of Ukraine «On Transport» [25], «On Motor Roads» [26], and other legislative acts which have not definitively regulated the issues arising during the expropriation of land plots from private owners. Therefore, with the aim of providing methodological assistance to executive authorities and local self-government bodies, enterprises and organizations in the road sector — customers and business entities in the field of land management and property valuation — performers in the procedure of expropriating privately owned land plots for the construction of highways and road infrastructure facilities, the Law of Ukraine «On the Expropriation of Land Plots, Other Real Estate Located on Them, Which Are in Private Ownership, for Public Needs or for Reasons of Public Necessity» [10] was adopted on November 17, 2009. The law is aimed at regulating the organizational, legal, and economic aspects of relations arising in the process of expropriating land plots and other real estate located on them that are owned by individuals and legal entities for public needs or for reasons of public necessity [27].

The issue of the expropriation or exchange of land plots from owners for public needs has always been problematic and conflict-prone. On the one hand, the Constitution of Ukraine [28] and the Land Code [20] guarantee every citizen the right to own a land plot, while on the other hand, they provide for the possibility of alienation, exchange, and purchase of certain properties, and termination of ownership rights – ensuring owners receive equivalent compensation for their losses, which is not always favorable.

The study of these issues has been the focus of works by Ukrainian scholars such as D.S. Dobryak, A.H. Martyn, A.M. Miroshnychenko, and V.K. Chybiryakov, who consider the technical and legal aspects of land exchange from the standpoint of rational land use.

Despite the long-standing existence of the institution of compulsory land expropriation in EU countries, foreign scholars such as S. Zborek and A.

Thomson also devote considerable attention to the issues of fair compensation and the protection of human rights regarding private property.

According to Article 1 of the Law of Ukraine «On the Expropriation of Land Plots and Other Real Estate Located on Them, Which Are in Private Ownership, for Public Needs or for Reasons of Public Necessity», the acquisition of land plots and other real estate for public needs involves their transfer, with the consent of individuals or legal entities, into state or communal ownership for satisfying public needs through a purchase agreement or another legal transaction in accordance with the procedure established by law [10].

A.H. Martyn notes that the expropriation of land plots for public needs should be regarded as a specific instance of the market turnover of rights to them, which can be carried out compulsorily, including without the consent of the landowner, in cases where further use of private ownership may harm public interests [29].

According to V.K. Chybiryakov, land exchange is a component of the regulation of land use and land ownership, which entails the regrouping of land and improving the methodology of equivalent exchange under modern conditions [30].

A team of leading scientists from the Food and Agriculture Organization of the United Nations (FAO) has developed a manual titled «Compulsory Acquisition of Land and Compensation» [21].

The International Federation of Surveyors (FIG) has organized and conducted conferences and discussions among scholars and leading experts in the field of land management and land law in Europe, where the main principles and procedures of expropriation and compensation for expropriated land plots in various countries around the world have been discussed [31].

For example, the Constitution of Germany enshrines the idea of social justice, which recognizes the necessity of state intervention in social processes, as well as the socialization of land, natural resources, and means of production.

Expropriation of property is permitted only for the public good and must be carried out exclusively in accordance with a law that regulates the nature and amount of compensation, which must be determined with fair consideration for both the society and the individuals affected. It is public, rather than state, interest that forms the basis for land acquisition – urgent public needs that may warrant restrictions on private rights [32].

In studying the issue of compensation for expropriated property in Poland, S. Zborek points out that the main principle is full compensation for the losses incurred by the owner during the acquisition of real estate. However, in many cases, individuals whose private property was expropriated feel upset not so much by the fact of expropriation itself but because the compensation amounts are almost always insufficient to purchase alternative real estate [33].

The issue of property expropriation for public needs in Estonia has been analyzed by O. Thomson, who notes that the valuation of expropriated property is carried out by private appraisers who are not connected to government authorities. In his opinion, there is a disconnect between the market value of the object from the appraiser's perspective and the losses from the owner's standpoint, and the legislation on these issues is imperfect due to the lack of feedback mechanisms [34].

Thus, in the legislation of both foreign countries and Ukraine, the right to private ownership, guaranteed by the Constitution, remains a priority. However, the procedure for the expropriation of land plots for public necessity exists in all countries and is regulated by relevant legal acts and follows a specific implementation algorithm (Fig. 2.5).

Analyzing the Land Expropriation Procedure in the EU and Ukraine, One Can Observe Certain Differences.

First and foremost, the planning phase differs: while the Ukrainian government makes decisions on land acquisition based on master plans of settlements, other urban planning documents, and land management project

materials for land allocation, in EU countries, the planning stage involves consideration of location options, impact assessment of land expropriation, and an evaluation of the project's consequences.

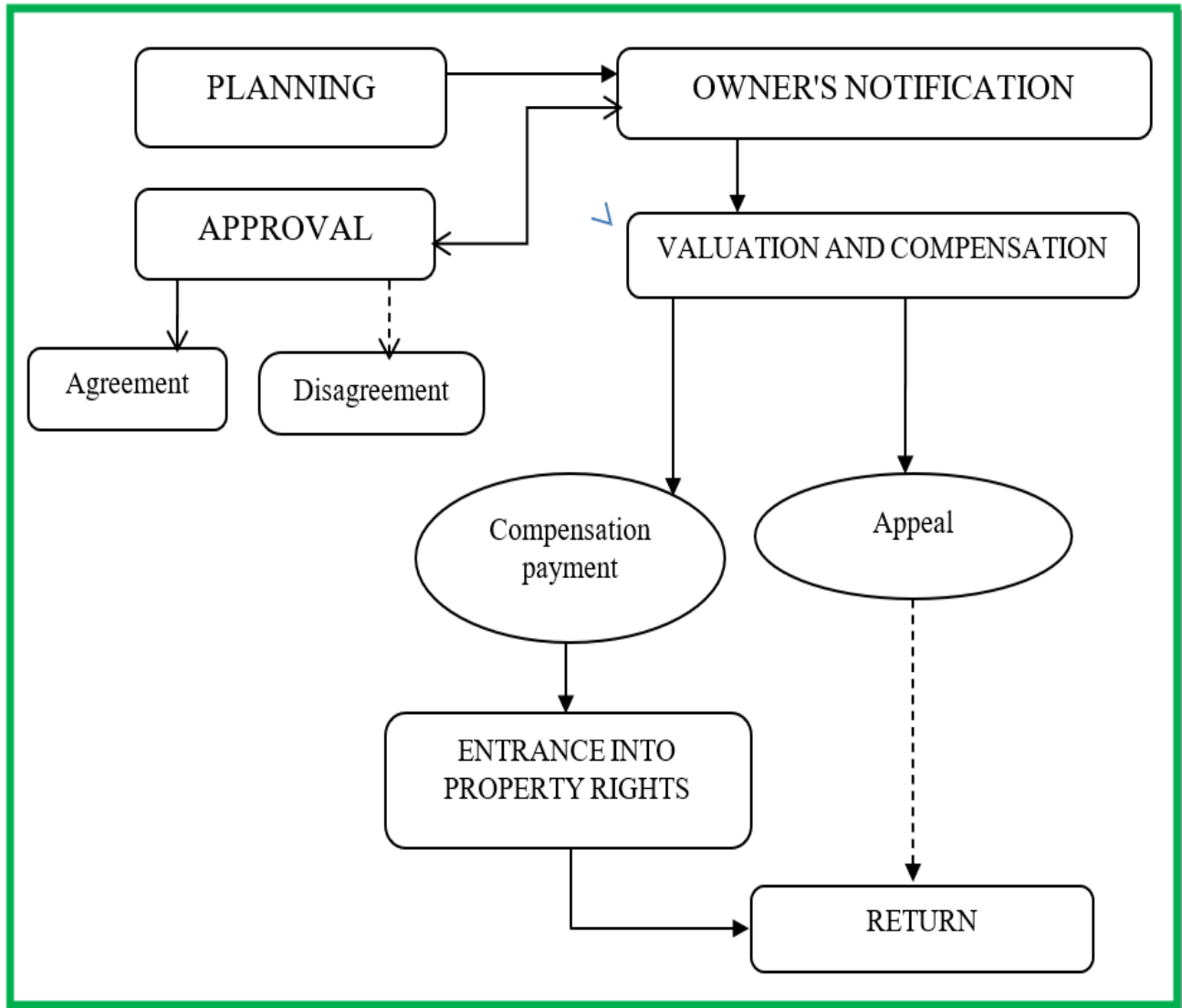


Fig. 2.5. Algorithm of the Land Expropriation Procedure
(compiled by the authors)

At the notification stage, foreign countries typically conduct wide public announcements regarding the potential implementation of land expropriation procedures. These announcements specify the purpose of compulsory acquisition and include important dates. Public meetings and discussions are held, allowing all interested citizens to learn more about the project, express their opinions about it, and discuss the compensation amount.

However, despite these and other differences, governments must strike a clear balance between guaranteeing each citizen's right to private property and ensuring the satisfaction of public needs.

This primarily concerns the definition and implementation of principles and standards that ensure transparency and legitimacy in the land expropriation process, helping to reduce conflicts between landowners and relevant authorities.

Currently, this issue is highly relevant, especially in terms of land allocated for transport infrastructure, construction, reconstruction, and major repairs of highways. Of particular importance is the construction of the large ring road around the city of Kyiv, which, as previously mentioned, is expected to resolve transportation problems in Kyiv, Boryspil, Brovary, Boyarka, Bilohorodka, and relieve the capital from a large volume of transit traffic [3]. The road, which will connect three international and four national transport corridors, will ease the traffic load through Kyiv and contribute to the development of the metropolitan region's infrastructure [36].

According to the approved layout of the general route for the large ring road, nine design sections have been identified. For example, the compensation calculation for landowners of plots subject to acquisition within the Krushynska village council is part of section No. 5 of the ring road. This section crosses lands of the Markhalivska, Krushynska, Ivankovychi, Roslavychi, and Hvozdiv village councils of Vasylkiv district, as well as the Pidgirtsy, Velykodmytrovychi, Starobezradychi village councils, and the Kozyn settlement council of Obukhiv district in Kyiv region, Ukraine [36]. In this area, the Kyiv Region Road Service plans to permanently allocate around 24 hectares of land, including agricultural land, residential and public development, industrial use, transport and communications land, as well as unallocated land plots (see Fig. 2.6).



Fig. 2.6. Diagram of the Great Ring Road around Kyiv ³

According to the adopted general direction scheme of the Great Ring Road, 9 sections of design have been defined. As an example for the calculation of compensation for landowners of land plots to be allocated within the Krushynska rural community, section № 5 of the ring road includes lands from the Marchalivska, Krushynska, Ivankovytska, Roslavytska, Hvozdivska rural councils of Vasylkivskyi district in Kyiv region, as well as the Pidhirtsivska, Velykodmytrivska, Starobezradychivska rural councils and Kozynska settlement council of Obukhivskyi district in Kyiv region, Ukraine [22].

According to this direction, the Kyiv Regional Road Service is expected to allocate approximately 24 hectares of land for permanent use, which include agricultural land, land for residential and public development, land for industry, transport, and communications, as well as land not transferred into ownership or use. The percentage distribution of the land is shown in Fig. 2.7.

³ State Road Agency of Ukraine. URL: <http://ukravtodor.gov.ua>

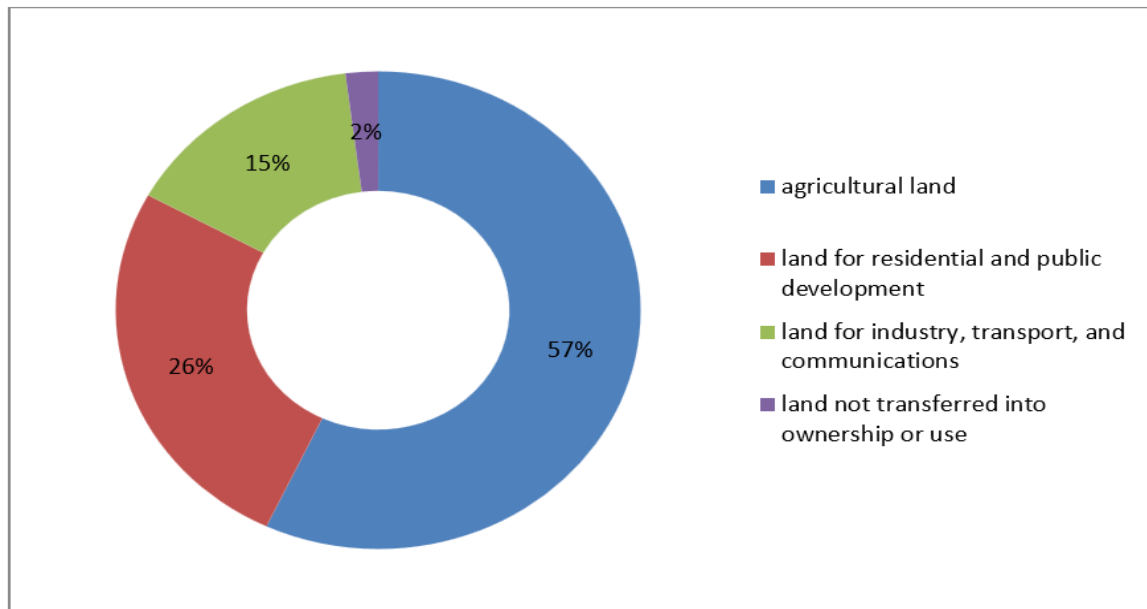


Fig. 2.7. Lands subject to expropriation

**according to the source [22]*

In this case, a significant portion of the land, specifically 57%, is allocated to agricultural land, which according to the classification of land purpose types (KVTSPZ), is intended for commodity agricultural production and subsidiary farming. It should be noted that during the land exchange process, especially for agricultural land, it is important to consider a number of factors [37], as shown in Fig. 2.8.

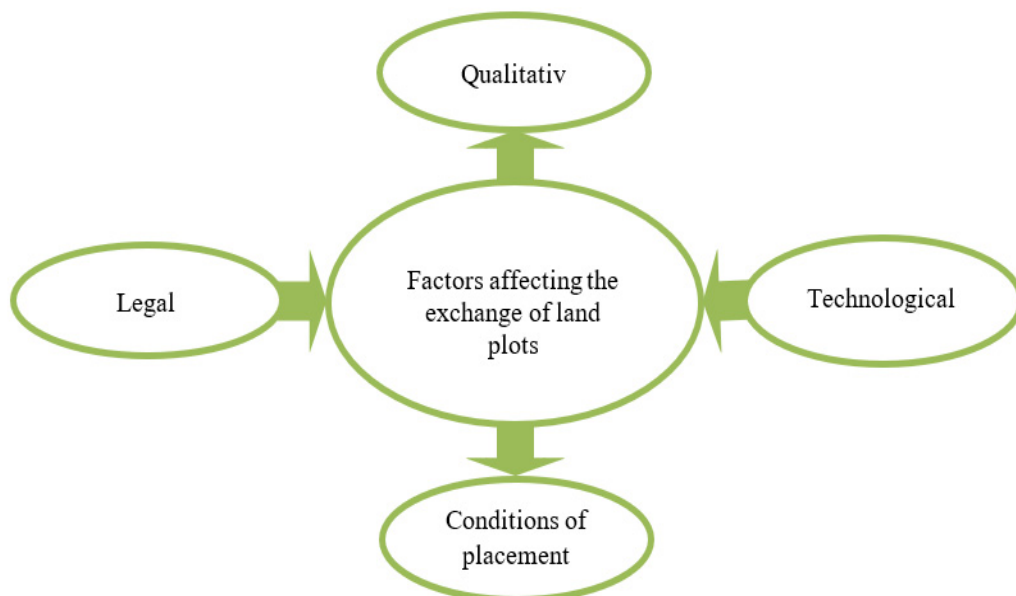


Fig. 2.8. Factors influencing the equivalent exchange of agricultural land plots

The calculation of equivalent land plots in the exchange process is reflected by the dependence of the land plot area P_i on the bonitet score B_i , and is calculated using the formula proposed by V.K. Chibiryakov: [37]

$$P_2 = \frac{P_1 \times B_1}{B_2}, \quad (2.6)$$

where P_1 is the area of the land plot; B_1, B_2 are the bonitet scores.

In this case, an equivalent exchange of specific land plots has been proposed, with the expropriation of approximately 100% of the plots (plots 19, 22, 23). Also, considering that the route for the new road will intersect the plot, creating several fragmented plots, the use of the remaining land plots for their intended purpose after expropriation is impossible (plots 17, 18, 20), as shown in Fig. 2.9.

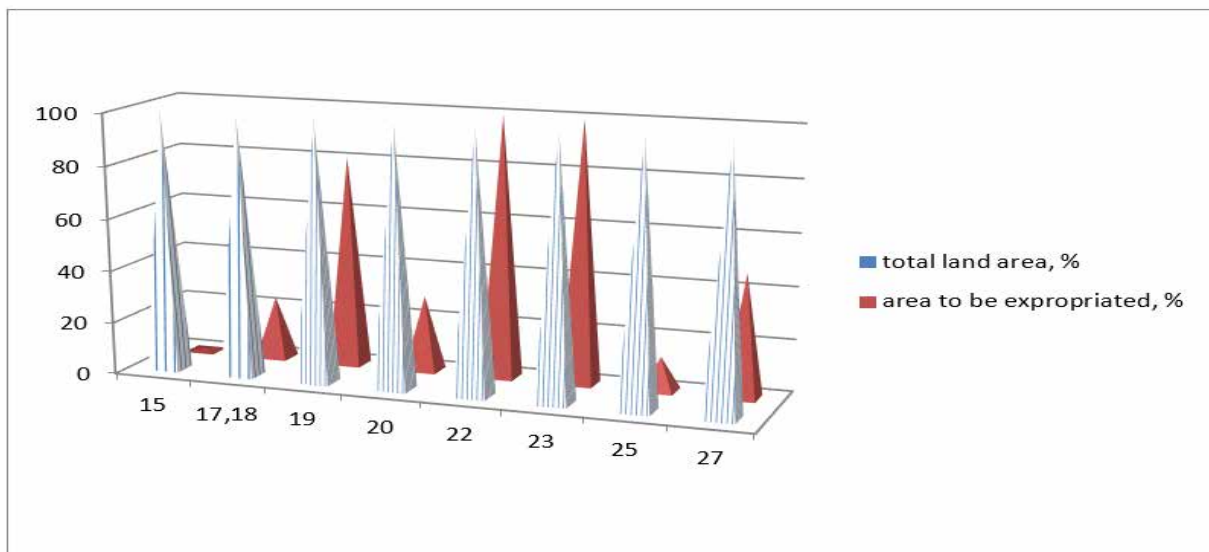


Fig. 2.9. Areas of land plots subject to expropriation, %
(formed by the authors based on the data from [38])

According to the data from the public cadastral map, the land plots proposed for exchange are located within the boundaries of a single administrative-territorial unit, the village of Krushynka. They are designated for commodity agricultural production, as shown in Fig. 2.10

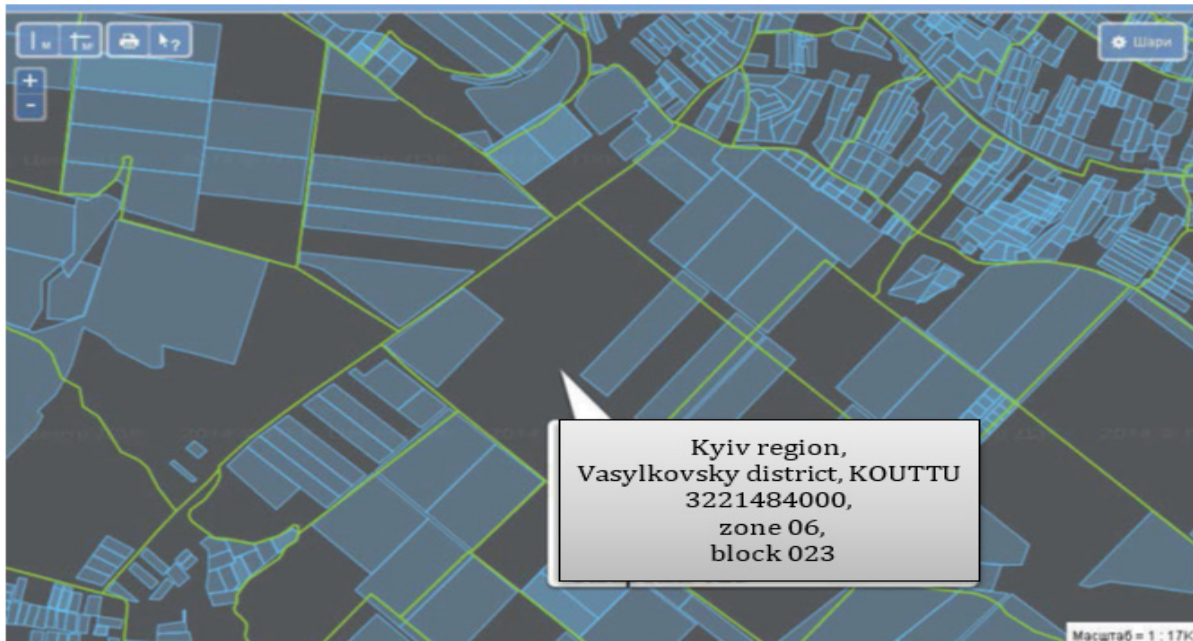


Fig. 2.10. Land plot for exchange ⁴

Using the available soil bonitization materials, we estimate the bonitet of the agro-production soil groups of the land plots (the agro-production group of the soil cover of the expropriated land plot, 121 g – 45 points, which is proposed for exchange, 41 g – 42 points) [6] and calculate the area of the arable land that the landowner will receive in the exchange using the formula:

$$\begin{aligned}
 P_{2(17,18)} &= \frac{5,3460 \times 45}{42} = 5,72 \text{ га} , \\
 P_{2(19)} &= \frac{0,5197 \times 45}{42} = 0,56 \text{ га} , \\
 P_{2(20)} &= \frac{2,6773 \times 45}{42} = 2,87 \text{ га} , \\
 P_{2(22)} &= \frac{2,15969 \times 45}{42} = 2,31 \text{ га} , \\
 P_{2(23)} &= \frac{0,8999 \times 45}{42} = 0,96 \text{ га}
 \end{aligned}
 \tag{2.7}$$

According to the calculations, the total area proposed for exchange is 12,42 hectares and is depicted in the materials of the public cadastral map (See Fig. 2.11).

⁴ <https://ubiz.ua/sale3/auction/LAE001-UA-20241028-08524>



Fig. 2.11. Calculated area of the land plot ⁵

If within the land plot subject to exchange there are soils of different agro-production groups, then the given ratio should be appropriately adjusted to the following form [39]:

$$\sum_{k=1}^n P_k B_k = \sum_{j=1}^m P_j B_j, \quad (2.8)$$

where P is the area of soil of the agro-production group within the land plots subject to exchange;

B is the bonitet score of the corresponding agro-production group;

n,m are the number of production groups within the first and second plots subject to exchange.

To reflect the spatial, legal, and qualitative factors affecting the exchange of land plots, we propose the coefficient K, which will be applied to formula (2.8) and will have the following form [37]:

$$K_1 \sum_{k=1}^n P_k B_k = K_2 \sum_{j=1}^m P_j B_j. \quad (2.9)$$

The value of the coefficient K is calculated as the product of individual coefficients depending on the factors that determine them, according to the formula [160]:

$$K_i = K_{\pi i} \times K_{\gamma i} \times K_{\eta i} \times K_{\kappa i} \times K_{\lambda i} \times K_{\rho i} \times K_{\sigma i} \times K_{\mu i} \times K_{\omega i}, \quad (2.10)$$

⁵ Sydorenko, V. D., et al. (2016). Calculation of compensation for land expropriation for public needs: A case study of the reconstruction of the Kyiv Great Ring Road. Technology Audit and Production Reserves, 4/6(30), 25–34.

where $K_{\kappa i}$ is the coefficient characterizing the deterioration of soil quality due to contamination, erosion, etc.;

$K_{\gamma i}$ is the coefficient characterizing the type of agricultural land;

$K_{\mu i}$ is the coefficient characterizing the presence of land improvements;

$K_{\kappa i}$ is the coefficient characterizing the configuration of the land plot;

$K_{\lambda i}$ is the coefficient characterizing the fragmentation of the land plot boundaries;

$K_{\rho i}$ is the coefficient characterizing the relief;

$K_{\nu i}$ is the coefficient characterizing the hydrographic conditions of the land plot;

$K_{\mu i}$ is the coefficient characterizing the location of the land plot;

$K_{\omega i}$ is the coefficient characterizing the presence of restrictions and encumbrances on the use of the land plot.

Since the exchange of arable land plots takes place within a single land massif, where there are no land improvements, restrictions, or encumbrances on the land use, it is advisable to establish technical indicators that characterize the existing influencing factors (See Fig. 2.8).

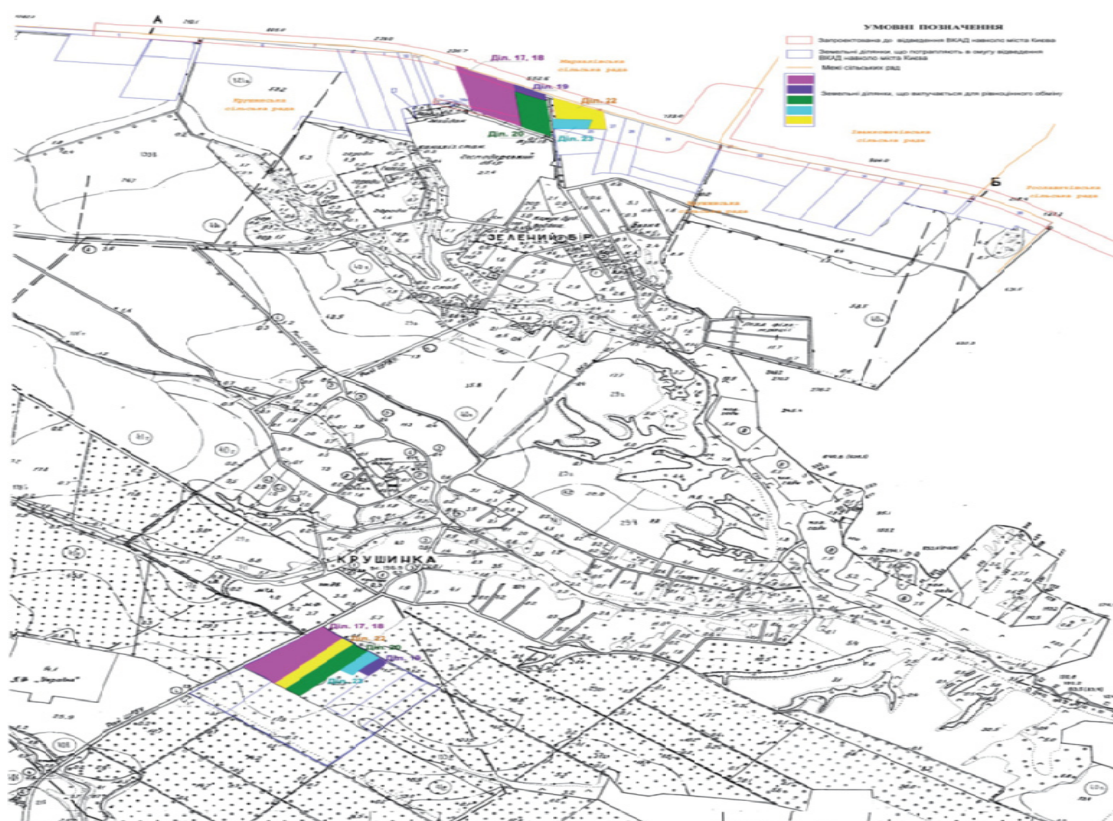


Fig. 2.12. Equivalent exchange land plots in the village of Krushynka⁶

⁶ <https://zml.com.ua/uk/prodazh-zemli-kiievskaya-oblast-vasilkovskiy-rayon-krushinka>

Therefore, the coefficient K_i in this case can be characterized by the combined impact of the configuration, fragmentation of boundaries, relief of the land plot, and calculated according to the formula [37]:

$$K_i = K_{ki} \times K_{fi} \times K_{pi} \quad (2.11)$$

The calculation of land plot sizes (Table 2.3), which may initially seem equivalent, is not always reliable, despite physical characteristics such as size, shape, flat terrain, slope steepness, etc. It is also important to consider that new land plots, as a rule, lack the necessary infrastructure, such as waste disposal sites, drainage systems, etc. This delay in economic development leads to a loss of income from the exchange of land plots and their subsequent use.

Table 2.3

Calculation of equivalent land plots*

Factors	P_1 , ha	B_1	K_1		P_2	B_2	K_2	
Without consideration	$P_1(17,18) = 5,35$ $P_1(19) = 0,52$ $P_1(20) = 2,68$ $P_1(22) = 2,16$ $P_1(23) = 0,90$	45	–		$P_2(17,18) = 5,72$ $P_2(19) = 0,56$ $P_2(20) = 2,87$ $P_2(22) = 2,31$ $P_2(23) = 0,96$	42	–	
With consideration	$P_1(17,18) = 5,35$	45	K_k	0,63	$P_2(17,18) = 5,00$	42	K_k	0,71
			K_n	0,99			K_p	0,98
			K_p	0,98			–	–
			–	0,61			–	0,70
	$P_1(19) = 0,52$	45	K_k	0,71	$P_2(19) = 0,54$	42	K_k	0,71
			K_n	0,99			K_p	0,98
			K_p	0,99			–	–
			–	0,69			–	0,70
	$P_1(20) = 2,68$	45	K_k	0,71	$P_2(20) = 2,83$	42	K_k	0,71
			K_n	0,99			K_p	0,98
			K_p	0,98			–	–
			–	0,69			–	0,70
	$P_1(22) = 2,16$	45	K_k	0,63	$P_2(22) = 2,02$	42	K_k	0,71
			K_n	0,99			K_p	0,98
			K_p	0,98			–	–
			–	0,61			–	0,70
	$P_1(23) = 0,90$	45	K_k	0,63	$P_2(23) = 0,84$	42	K_k	0,71
			K_n	0,99			K_p	0,98
			K_p	0,98			–	–
			–	0,61			–	0,70

*Source: based on data from [37]

The data from the table show that during the process of land exchange, the consideration of influencing factors, in this case, the coefficients characterizing the land plot's configuration, boundary irregularities, and relief, significantly affect the size of land plots.

Therefore, the procedure for expropriating land for public needs in Ukraine is currently a highly relevant issue. A comparative analysis of this process with European Union countries allows us to conclude that the concept of compulsory expropriation in the country meets global standards for regulating relations in the sphere of compulsory land acquisition for public needs. However, it has several drawbacks, primarily the lack of clear methodological guidelines for organizing the negotiation process between the government and landowners, the inability of landowners to appeal the government's decision on land expropriation, as well as the compensation amount.

To address these issues, it is advisable to implement the experience of European countries. First and foremost, changes should be made to the regulatory and legislative framework, with a key focus on determining the feasibility of developing a project for which land plots need to be expropriated. All possible losses and profits from the project should be calculated. Proposals should be made for organizing public meetings and hearings where landowners, and not only they, can get more detailed information about the projects, ask questions they are interested in, and receive answers. The issue of appeal situations for landowners and land users should be regulated, where individuals have the right to appeal against the project's objectives, the procedures used for expropriation, and the amount of compensation offered to them.

CONCLUSIONS TO THE SECTION II

The modern system of regulatory regulation in the field of construction and reconstruction of highways in Ukraine is in a state of transformation, which is due to the need for its harmonization with the current legislative framework. State construction standards, which serve as the basis for the design, construction and operation of infrastructure facilities, require updating taking into account new approaches to quality management, innovations and international experience. The need for a systematic revision of the State Construction Standards is due to the increasing requirements for resource efficiency, environmental safety and transparency of procedures. The introduction of quantitative quality criteria both in the design and construction processes and in the implementation of a comprehensive assessment of the quality of road works should be a key step towards creating an objective and transparent control system. Standardization of these parameters will avoid subjectivity and ensure greater responsibility of contractors for the final result.

Special attention is paid to the need to improve the regulatory framework by amending the current State Code of Ukraine on the design of roads in the territories of settlements, private territories, as well as within departmental infrastructures. Proposals to supplement the law "On Concessions for the Construction and Operation of Motor Roads" are aimed at defining clear rules for the application of international norms, standards and technologies. This will help attract investors and improve the quality of work.

In the process of analyzing the procedures related to the allocation of land for the needs of the road industry, numerous difficulties were identified at the stages of developing project documentation. The complexity of approvals, the uncertainty of the mechanisms of interaction between landowners and authorities complicate the implementation of projects. In this context, a mechanism for coordinating a land management project is proposed, which will

increase the transparency and predictability of processes related to land allocation.

The issue of land acquisition for public needs remains one of the most sensitive in the system of public administration. A study of foreign experience shows the presence of clearer and balanced procedures that take into account the rights of owners and guarantee fair compensation. A comparative analysis demonstrates gaps in Ukrainian legislation that need to be addressed.

The sphere of forced land acquisition has significant regulatory shortcomings. The lack of instructions on organizing negotiations between the state and land owners, the absence of mechanisms for appealing decisions on alienation, as well as opacity in determining the amount of compensation create risks for the rights of landowners and slow down the implementation of infrastructure projects. Solving these problems requires a systematic approach to forming a legal framework and applying the principles of social justice in public administration practice.

Harmonization of regulatory, technical, and procedural components in the field of road construction can not only increase the efficiency of infrastructure project implementation, but also lay the foundation for the development of the transport industry in accordance with the principles of sustainable development, openness, and European standards.

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■ Section 3

ECOLOGICAL-ECONOMIC AND ORGANIZATIONAL-LEGAL MECHANISM FOR IMPROVING LAND USE IN AUTOMOBILE TRANSPORT AND ROAD MANAGEMENT

3.1. Improvement of the organizational and legal mechanism of lands of automobile transport and road management

The significant importance of land in all spheres of society's life determines its separation from all other objects of property at the constitutional level, the approval of the principles of special protection by the state, which consists, in particular, of the legislative restriction of the rights of landowners and land users.

The object of property rights is not land as a physical element of the objective world, but precisely a land plot with its specific location, established boundaries, and defined rights regarding it.

The basis of legal regulation of land relations is the principles that reflect the nature and trends of the development of land law and are implemented by reproducing their basic requirements in land legislation. According to their significance, imperativeness, and reflection of essential provisions of law, principles are divided into constitutional, general legal, and special [1].

Constitutional principles are universal and inherent in all branches of law.

General legal principles are the result of the reflection of constitutional principles in land legislation. According to Article 5 of the Land Code of Ukraine, land legislation in the field of regulation of land relations is based on the following principles:

a) combination of the peculiarities of land use as a territorial basis, natural resource, and the main means of production;

b) ensuring the equality of land ownership rights of citizens, legal entities, territorial communities, and the state;

c) non-interference of the state in the exercise by citizens, legal entities, and territorial communities of their rights regarding possession, use, and disposal of land, except in cases provided by law;

d) ensuring rational use and protection of land;

e) ensuring guarantees of land rights;

f) priority of environmental safety requirements [2].

Special principles form a system based on the structural organization of land law regulation of land relations, which include:

- the principle of targeted and rational land use – clearly established by law the procedure, conditions, and limits of exploitation of land plots to achieve specific goals, taking into account the category of land and its special legal regime [3]. Land legislation clearly interprets the concept of the intended purpose of the category of land, and not the analogous purpose of a specific land plot, perceiving them as identical. The intended purpose is the basic principle of regulating land relations. The intended purpose of a specific land plot should be understood as the limit of its exploitation (use) established by a competent authority in accordance with the approved territorial development plans and land zoning, as well as the legal regime of the corresponding category of land [2];

- the principle of paid land use – follows from the provisions of the law, according to which land use in our state is paid. Payment for land is charged in the form of land tax or rent, the amount of which is determined depending on the monetary valuation of the land;

- the principle of ensuring the protection of the rights of legal entities and citizens to land – is revealed in the norms of land legislation, which provides for such special methods of protection: recognition of rights; restoration of the state of the land plot that existed before the violation of rights, and prevention of actions that violate rights or create ¹ a danger of violation of rights; recognition ² of an agreement and decisions of executive authorities or local self-government

bodies as invalid if they were adopted in violation of rights; compensation for damages, etc.;

- the principle of a special legal regime for categories of land – directly provided for in Part 2 of Article 18 of the Land Code of Ukraine. The concept of regime (Latin: regimen – management) refers to a set of rules, measures, norms necessary to achieve a certain goal. The legal regime is the procedure for using an object established by law, the permissible limits and methods of its disposal. The legal regime of land is a concept that generalizes the legal characteristics of land as an object of land relations and contains an indication of the range of the most important legal relations that arise regarding land. Its application is important for the correct determination of the procedure for the use and protection of a land plot.

The main elements of the legal regime of land are land ownership, other rights to it (restrictions, encumbrances), management of land use and protection, legal protection of land, and measures of liability for violation of land legislation.

The legal regime of land use should be understood as the procedure and conditions for the use of land of all categories and forms of ownership for its intended purpose, established by legal norms, taking into account established restrictions and encumbrances, ensuring and protecting the rights of landowners and land users, exercising state management of land resources, control over the rational use of land and compliance with land legislation, maintaining the state land cadastre, land monitoring, land management, payment for land, and the application of legal liability for violation of land legislation [2].

The practical significance of using this concept lies in the fact that it makes it possible to establish the procedure for the use and protection of a certain category of land, that is, the specifics of the content of property rights in relation to a particular category of land, the possibilities of using the corresponding titles of land rights, and the peculiarities of land management of a particular category.

The mechanism for regulating land relations, namely its legal aspect, includes not only the sources of land law but also land law norms and land legal relations (Fig. 3.1).

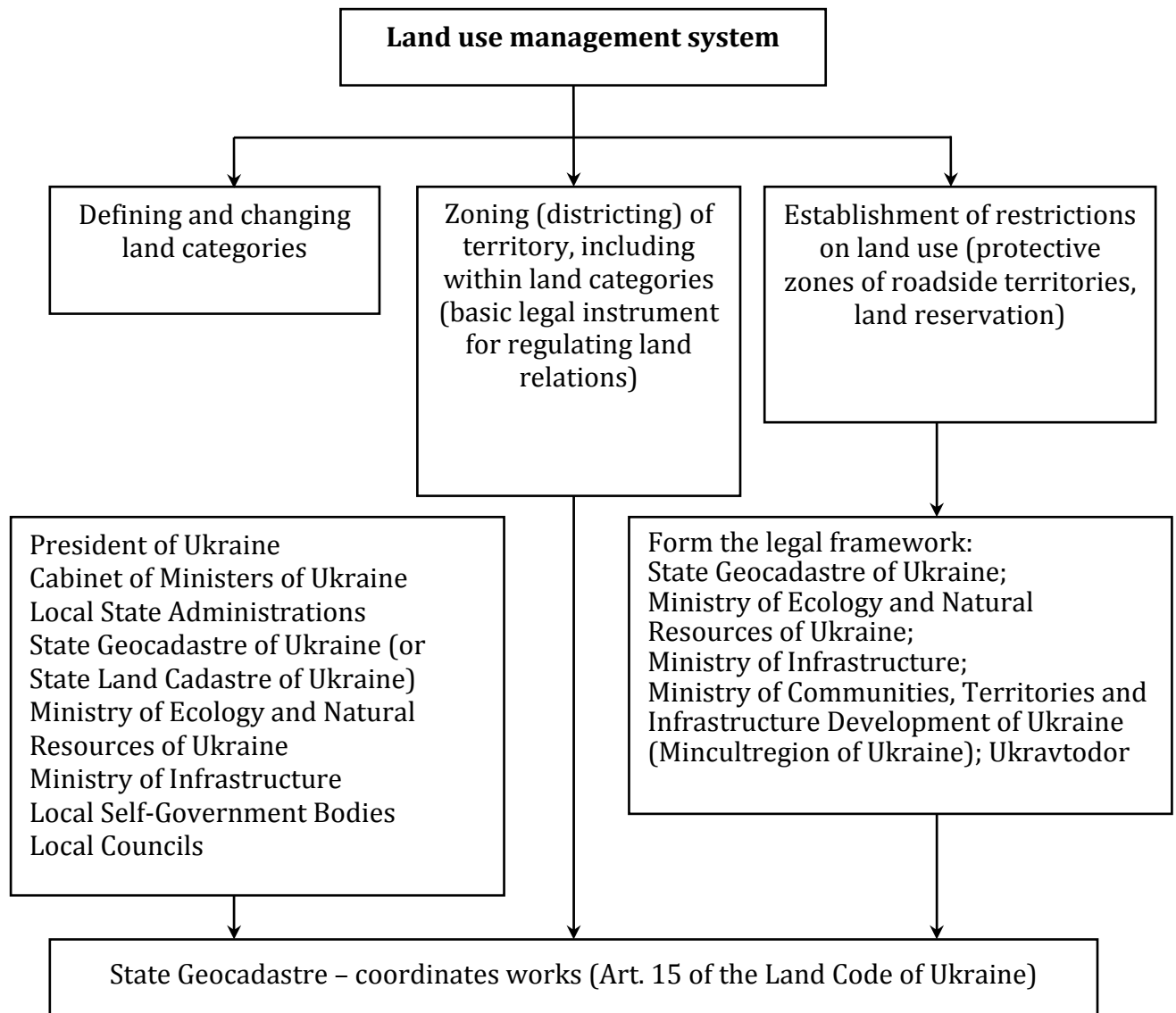


Fig. 3.1. Mechanism for regulating the land use regime of automobile transport and road management*

*(created by the authors)

Previously, in the science of land law, the concept of state land management was defined as the state's activity in organizing the use and protection of land – the most important natural object, which is also an object of state ownership and land use rights. State management was considered as a form and means of exercising the state's right of ownership to land. In modern

conditions, the traditional understanding of state land management is somewhat clarified and specified.

H. Hreshchuk emphasizes that the state's administrative activity is based primarily on its sovereign powers as a political entity, including exclusive state ownership of land [4].

Other authors point out that state management of land resources consists of the administrative activity of authorized state bodies in organizing the rational use and protection of land.

Considering the problems of compliance with the requirements of land legislation, H.I. Baliuk rightly notes that the issues of economic, efficient, and rational land use, protection of the land fund, and restoration of soil fertility have now grown into a problem of national security and require constant attention from state authorities and local self-government bodies [5].

Therefore, an important structural element of the legal regime of land for automobile transport and road management is their management, the land relations of which in this area are governed by a number of provisions and relevant legislative acts.

The above provides grounds to define management in the field of land use and protection of automobile transport and road management as the activity of state executive bodies to ensure the rational use and protection of land by all economic entities within the limits established by the land legislation of Ukraine.

At the current stage of development and formation of land legislation, among the management functions, there is a need to develop relevant areas of activity for authorized bodies in the field of land use and protection of automobile transport and road management: planning, accounting, regulation, and control.

It should be noted that the implementation of such areas as forecasting, planning, organization of rational land use, and land protection at various levels of management, in particular national, regional, local, and economic, is one of the new types of land management works. In accordance with the Law of Ukraine

"On Land Management," forecasting, planning, and organization of rational use and protection of land at the national, regional, local, and economic levels is ensured by land management [6].

Land use and protection planning occupies a special place among the management functions in this area. Under the administrative-command system of state management, the goal of centralized planning was to cover the entire process of production and distribution of material goods. In modern conditions of market relations, planning in

Ukraine focuses primarily on determining the strategic directions of the country's economic and social development. As the main method of exercising the economic-organizational function of the Soviet state, it has not lost its significance now, and in relation to land, it acquires special attention.

The specifics of planning the use and protection of land for automobile transport and road management are not defined in the scientific literature. Current regulatory legal acts do not solve this problem either.

State planning in the studied area is an objective necessity due to a complex of socio-economic factors, primarily the special role of land in the ecological system [7,8].

Based on the analysis of the totality of all current legal prescriptions, it can be concluded that there are a large number of peculiarities in the field of planning the use and protection of land for automobile transport and road management.

Firstly, its basis is territorial planning. The Law of Ukraine "On the Regulation of Urban Development Activity" dated February 17, 2011, states that territorial planning is the process of regulating the use of territories, which consists of the creation and implementation of urban planning documentation, and the adoption and implementation of relevant decisions. It should be emphasized that this law defines territory as a part of the Earth's surface within defined boundaries with its inherent geographical location, natural and human-

created conditions and resources, as well as airspace and the subsoil located beneath it [9].

Environmental protection and the rational use of natural resources are one of the main tasks of territorial planning and development. The role of long-term territorial planning in both international and domestic practice is to maintain long-term sustainable socio-economic development while preventing its harmful impact on the environment. D.S. Dobryak and L.Ya. Novakovskiy draw attention to the fact that the implementation of urban planning documentation ensures the most rational and efficient use, as well as the appropriate protection of land and other natural resources of cities.

Plans for the development of engineering and transport infrastructure are provided for, in particular, in the General Scheme of Territorial Planning. According to the Law of Ukraine "On the General Scheme of Territorial Planning of Ukraine" dated February 7, 2002, such a scheme defines the priorities and conceptual solutions for the planning and use of the country's territory, the improvement of settlement systems and ensuring the sustainable development of settlements, the development of industrial, social, and engineering-transport infrastructure, and the formation of a national ecological network [10].

In order to meet the needs of the population and the economy in passenger and freight transportation, the General Scheme provides for certain measures directly related to engineering and transport infrastructure – a complex of engineering and transport structures and communications, which includes the objects of automobile transport and road management.

The object of planning in this case is not only land but also the placement of industrial, transport, and road management facilities in certain regions of the country. When planning the use and protection of their land, the interests of society and the requirements of environmental safety (from a long-term perspective) should be taken into account, since its basis is public and state interests.

Scientific literature emphasizes the environmental focus of territorial planning. Yu.S. Shemshuchenko, for example, believes that urban planning

documentation should provide the necessary requirements for creating environmentally safe living conditions for the population and maintaining a full-fledged natural environment for human existence in settlements [11].

N. L. Ilyina notes that the planning of land use through the development and approval of urban planning documentation contributes to solving environmental problems at a comprehensive level, including the rational use of natural resources, the protection of the natural environment of settlements, and the guarantee of environmental safety of the population [12].

Automobile transport as a branch of social production also develops according to certain programs. Ways to solve the industry's problems, based on the new tasks facing transport in the context of the revival and recovery of the real sector of the economy, the growing demand for transport services, and the intensification of Ukraine's integration into European and global transport systems, are provided for in the National Transport Strategy for the period up to 2030. The concept contains the fundamental directions of the strategy for the development and sustainable functioning of the transport and road complex of Ukraine until 2030, with the definition of priorities and immediate tasks [13].

Thus, the planning of land use for road management should be carried out with a long-term perspective for the development of highways and other automobile transport facilities based on the mentioned socio-economic programs, land management, urban planning, environmental protection, and other documentation.

Normative legal acts adopted in Ukraine in recent years have universal significance and are applied in various sectors of the economy. They regulate the issues of land use by citizens, legal entities, territorial communities, and the state, including the acquisition of land rights, land use, and protection. Since in many sectors there are no independent normative legal documents on specific issues of land relations regulation, universal acts largely replace the gaps in current legislation.

The fundamental principles of land relations regulation are enshrined in the Constitution of Ukraine, in accordance with which a number of codes and laws have been adopted. A separate link in land legislation is the resolutions of the Cabinet of Ministers of Ukraine. A special place in the system of departmental normative legal acts belongs to regulatory documents – building codes, standards, rules, etc.

For the establishment, functioning, and development of the country's road complex, a significant part of the legal norms of the Land Code is fundamental. Thus, Chapters Two and Three regulate the powers of the Verkhovna Rada of Ukraine, the Verkhovna Rada of the Autonomous Republic of Crimea, local self-government bodies, as well as executive authorities in the field of land relations.

In particular, the Verkhovna Rada of Ukraine, in addition to legislative regulation of land relations and determining the principles of state policy in the field of land use and protection, establishes and changes the boundaries of districts and cities, and agrees on issues related to the withdrawal (redemption) of particularly valuable lands, including for the placement of road complex facilities.

The Verkhovna Rada of the Autonomous Republic of Crimea decides on the granting of land plots for the construction of highways and other road management facilities from land in the joint ownership of territorial communities of villages, settlements, and cities; approves republican programs for the use, improvement of soil fertility, and protection of land; and coordinates the activities of local land resource bodies and the implementation of control over land use and protection.

Local self-government bodies (regional, Kyiv and Sevastopol city, district, rural, settlement, city councils) manage the lands of territorial communities, except for regional and district councils, which manage the lands of joint ownership of territorial communities; organize land management and coordinate the activities of local land resource bodies. Kyiv and Sevastopol city councils, as well as rural, settlement, and city councils, also manage the lands of

the respective territorial communities; transfer communal land plots into the ownership of citizens and legal entities and grant land plots for use; withdraw land plots from communal ownership and redeem them for public needs; and control the use and protection of the lands of territorial communities and compliance with land and environmental legislation.

Thus, the mentioned local self-government bodies resolve the entire complex of issues regarding the acquisition of land rights for road management facilities from communal land.

The powers of executive authorities are mainly focused on the disposal of state-owned land, the implementation of state policy in the field of land use and protection, the development and ensuring the implementation of national and regional programs for land use and protection, the organization of the state land cadastre, the implementation of state control over land use, and the organization of land management.

The Cabinet of Ministers of Ukraine, in particular, carries out the redemption of land plots for public needs, transfers land plots from state ownership to the ownership of legal entities or grants them for use, and agrees on the placement of facilities on particularly valuable lands in accordance with the procedure established by law. Central executive bodies on land resources and environmental and natural resources carry out state expertise of programs and projects on land management, the state land cadastre, land protection, as well as state environmental expertise of land use. They are identified as the main bodies for the implementation of state land and environmental policy.

The Council of Ministers of the Autonomous Republic of Crimea and local state administrations manage state-owned land within the limits defined by the Land Code of Ukraine, carry out the redemption of land plots for public needs; prepare conclusions on the granting or withdrawal (redemption) of land plots, coordinate the implementation of land management and state control over land use and protection, and the activities of state land resource bodies. The sale of

land plots on which objects subject to privatization are located is carried out by state privatization bodies.

Thus, executive authorities are endowed with a wide range of powers regarding the formation and implementation of state land policy and the regulation of land relations, the disposal of state-owned land, and the management of land resources. They directly resolve issues of land use in the road sector, the acquisition of land rights from state-owned land, and environmental protection.

The composition and intended purpose of the lands of Ukraine are regulated by Chapter Four of the Land Code of Ukraine. According to their main intended purpose, lands are divided into nine categories. According to Article 19, the lands of industry, transport, communications, energy, defense, and other purposes are combined into one category. A characteristic feature of the latter is that for the functioning and development of the sectors of the national economy whose lands are included in this category, land is a spatial, territorial basis. However, the formation of this category based solely on this characteristic is not exhaustive. In terms of its legal regime, land as a spatial basis has quite a few differences in economic functioning in various fields of activity. The legal regime of these spheres also differs significantly, which led to the division of the main intended purpose of land by categories into separate internal types, or by functional purpose, as indicated in the Classifier of Intended Land Use, introduced by the State Committee of Ukraine for Land Resources in 1998.

Within the lands of automobile transport and road management, as an integral part of transport land, there is a significant difference in the structure of these two components (Article 71), the regulation and nature of their land use, and the peculiarities of their legal status. Road management land within the specified article is an independent second part. Its legal regime is based on the components of highways, which have independent legal regulation (laws on highways, road traffic, concessions for the construction and operation of highways, and others). Land for road management of public roads is exempt from land tax in accordance with the Tax Code of Ukraine (Article 283). The

regulation of their use and protection as an independent object of land relations is provided for by other normative legal acts.

Certain legal norms regarding the establishment and change of the intended purpose of land also need improvement.

In particular, Chapter 13 contains the definition of lands of industry, transport, communications, energy, defense, and other purposes, the composition of lands by individual types of categories, forms of ownership in which lands can be, and the specifics of granting land plots and establishing protective zones.

It is defined that the procedure for the use of lands of industry, transport, communications, energy, defense, and other purposes is established by law [14.].

The analysis of current legislative acts confirms that the state network of highways has sufficient legal peculiarities, the regulation of which is carried out independently, that is, separately from the lands of automobile transport, with which the lands of road management form a common type within a separate category of land. A structural diagram of the distribution and management of land for automobile transport and road management as separate categories of transport land is shown (Fig. 3.2).

The complexity of regulating land use in the studied area lies in the fact that the composition, status, procedure for granting, withdrawal (redemption) of land plots, transfer of highways for concession, land taxation, and environmental protection are resolved in various legislative acts, some provisions of which have not been codified. Separate issues of establishing easements, reserving land plots, and defining special zones and regimes for their land use have not been developed for road management land at all.

Issues concerning soil protection and the safeguarding of valuable land during the construction (reconstruction) of highways, as well as noise control, are insufficiently regulated.

Contradictions are also observed between a number of subordinate and legislative acts.

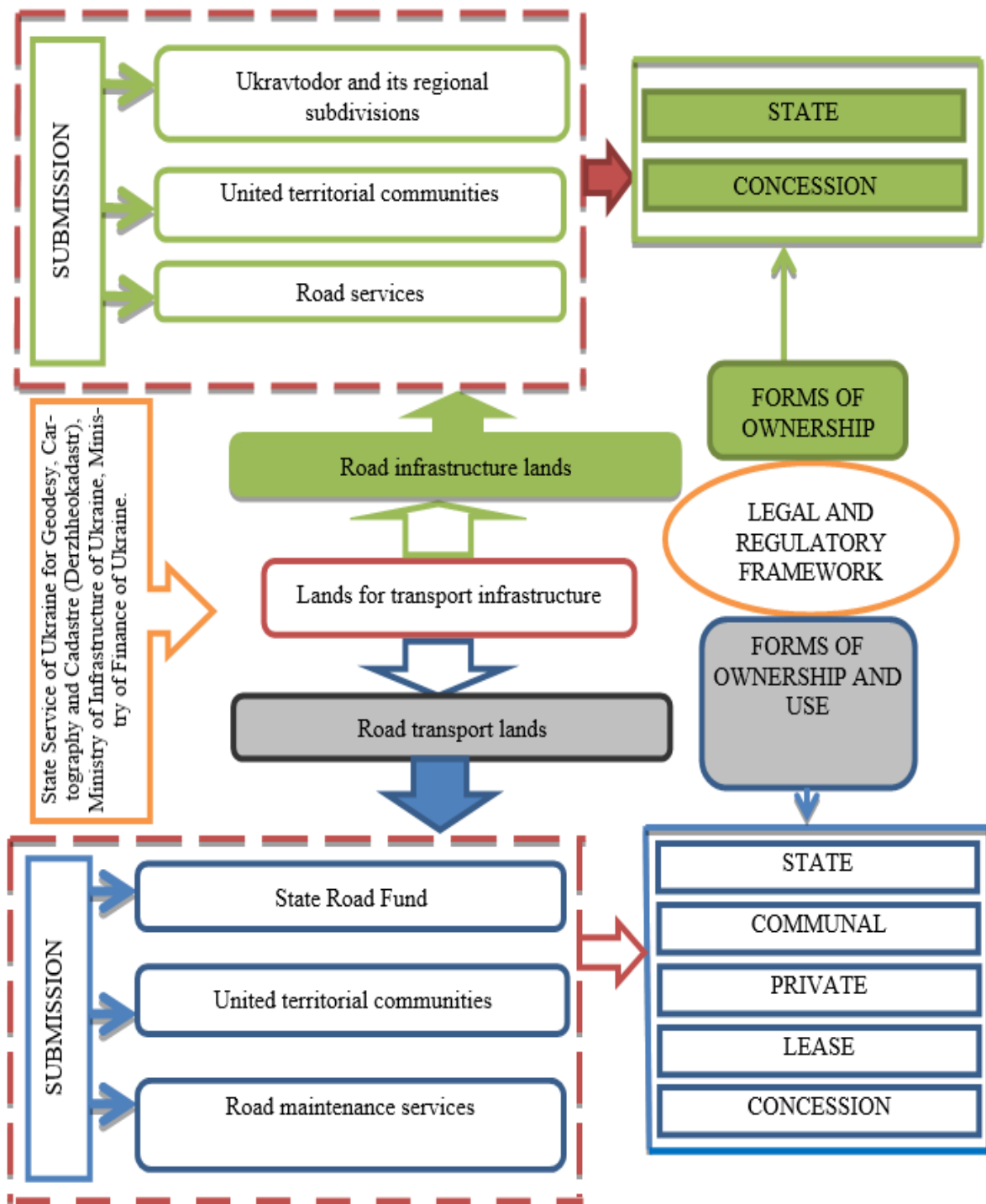


Fig. 3.2. Structural diagram-model of land use for motor transport and road management (developed by the authors)

Therefore, the improvement of the legal regime of road management land, directing it towards the efficient use and protection of land, and simplifying the procedure for acquiring land rights should be carried out in several directions.

First of all, it is necessary to raise the status of road management land within the categories of the country's land fund.

It is known that the basis of the road complex is highways as an integral part of road management land. The composition and specifics of the use of these lands are defined by the Land and Tax Codes of Ukraine, the Laws of Ukraine "On Transport," "On Highways," "On Road Traffic," "On Sources of Financing the Road Sector of Ukraine," and "On Concessions for the Construction and Operation of Highways.

It is justified to amend Article 71 of the Land Code of Ukraine, in particular, to single out road management land into a separate article. It is necessary to codify the definition of the composition of road management land by amending the Land and Tax Codes, the Laws of Ukraine "On Transport," "On Highways," and a number of subordinate acts. Within the additional (new) article of the Land Code, it is advisable to regulate the issues of land plot reservation, the establishment of roadside, protective, and sanitary protection zones along highways and the regimes of their land use, and the establishment of land easements and their types.

It is advisable to amend Article 20 by excluding from it the provisions on the development of land allocation projects in cases where the boundaries of the land plot do not change, to define specific types of land management projects on the basis of which a change in the intended purpose of land can take place, and to establish the types of land use within specific categories that should be criteria for determining the expediency and necessity of resolving issues of changing the intended purpose.

Simultaneously, it is necessary to regulate the issue of prohibiting the privatization of road management land under public highways, clarifying the privatization of communal highways, and contributing the right of permanent use of land plots to the authorized capital of the public joint-stock company "State Joint-Stock Company 'Automobile Roads of Ukraine'".

Taking into account the increased environmental hazard of automobile transport and its negative impact on the environment and humans, the second direction should be the regulation of soil protection issues in roadside zones,

changes in the nature of agricultural production due to the impossibility of growing environmentally friendly agricultural products in roadside strips, and the protection of the population from noise and vibration by establishing sanitary protection zones along public roads with restrictions on economic activity within them.

A separate direction should be the regulation of issues concerning the establishment of protective zones along public highways, roadside territories for transport development (reserve zones), restrictions on the regime of use of these territories, and the prohibition of certain types of construction and economic activity.

Legislation should enshrine norms regarding the planning of road management land use, its accounting at the national and regional levels, the simplification of the procedure for coordinating the location of facilities, the withdrawal (redemption) of land plots, and the introduction of easement land use rights.

Measures requiring legislative regulation also include the construction of structures, roadside service facilities, and gas stations, the placement of advertising structures, and the use of land adjacent to the rights-of-way of highways.

3.2. Ecological and economic substantiation of the use and protection of roadside strips

At the current stage of the country's economic development, the road transport industry is one of the most promising. The quality of road transport connections determines the economic, social, environmental, and cultural indicators of the state's functioning, its future growth, and its place on the world stage. The condition and development of the road network create a close interrelationship between investment, integration, socio-economic, economic-ecological, anti-crisis, and civilizational processes in society.

In Ukraine, vehicles, as an effective factor in business and everyday life, have become a tool for violating legal norms, as well as a constant source of danger for the population and the environment [15].

At a time when developed countries worldwide are increasingly focusing on transport ecology and air purity, demonstrating the effectiveness of stringent environmental standards, our country is struggling with the environmental problems of polluting the natural environment.

The Resolution of the Cabinet of Ministers of Ukraine "On Approval of the Concept for Reducing Emissions of Heavy Metals into the Ambient Air" No. 1291 of August 21, 2000 [16] indicates that heavy metal pollution has led to the exceeding of the maximum permissible levels of lead, mercury, and other pollutants in the soils of areas adjacent to highways. The use of leaded gasoline, in particular, has caused pollution of roadside strip soils and rendered them unsuitable for use. Thus, the pollution of roadside areas of highways has acquired national significance and remains a significant and pressing problem to this day.

Depending on the land use of highways, their impact on the ecological state of the environment can be divided by sources of impact, determining their nature and direction (Table 3.1).

Table 3.1

Sources of impact, nature, and direction of land use for highways*

Source of Impact	Nature of Impact	Results of Impact
Highway as an engineering structure	Not related to vehicles, permanent, has broad coverage, can be direct and indirect	Leads to changes in the geographical landscape
Traffic flow	Depends on intensity, traffic patterns, and composition of traffic flows. Can be constant, with local coverage	Pollution from vehicle emissions; noise and dust pollution; physical danger
construction and reconstruction processes	Temporary, intensive, local, direct	Pollution from emissions of specialized transport, industrial waste, construction materials, construction debris, construction noise, dust pollution, social inconveniences, physical danger
Road maintenance processes	Temporary, non-intensive, local, direct and indirect	Pollution from the use of anti-dust and anti-icing agents. Social inconveniences during repair works

Source: based on data from [17].

Automobile roads impact natural objects through the pollution of atmospheric air with gases and dust, increased noise levels, pollution of surface runoff, groundwater, and water bodies, reduced soil fertility, as well as on the animal and plant world, especially in roadside areas, and the production of agricultural products.

Primarily, a highway affects natural and socio-economic objects (Fig. 3.3).

The socio-economic characteristics of the impact of highways include sanitary and psychological parameters of the population's life activity, their economic interests, provision of jobs, housing, living conditions, recreation areas, summer cottages, and the appearance of the landscape. Accessibility to social facilities, transport interchanges, communication systems, transport landscape, road infrastructure, cultural and service objects are of significant importance.

According to SBN V.2.3-218-007:2012. Environmental requirements for highways. Design [18] , their impact zones are divided into protective and reserve-technological (Table 3.2).

The dimensions of roadside impact zones on highways are determined based on the results of predictive assessments of harmful pollutant emissions and the spread of physical impact [18].

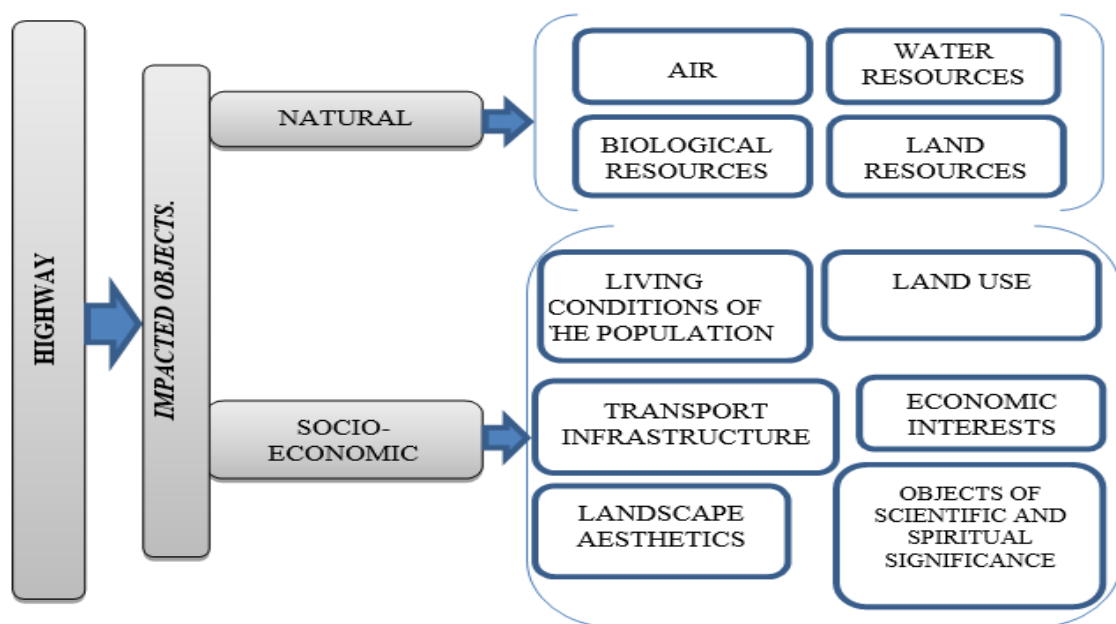


Fig. 3.3. Impact of highways on natural and socio-economic objects (developed by the authors)

Table 3.2

Approximate sizes of impact zone, protective zones, and reserve-technological zones*

Area Adjacent to the Highway	Distance from the Edge of the Carriageway for Roads of Different Environmental Classes, m		
	I	II	III
Under conditions of free impact propagation			
Impact zone	3 000	2 000	600
Protective zone	300	150	60
Reserve-technological zone	30	12	7,5
In the presence of obstacles (terrain, forest, buildings, green spaces)			
Impact zone	1 500	1 000	600
Protective zone	200	90	30
Reserve-technological zone	30	12	7,5

Source: developed by the authors based on data from [18]

Engineering structures on highways – bridges, culverts, drainage ditches, etc. – are the cause of water erosion of soils in roadside areas. Surface runoff, formed as a result of precipitation, snowmelt, and road watering, washes away and carries various soluble and insoluble pollutants to roadside areas. The concentration of these pollutants depends on the frequency of street cleaning, the intensity of traffic, precipitation, and the duration of the preceding dry period.

The roadside strip is characterized not only by the pollution of surface water but also of soils, groundwater, and vegetation on it. Pollution of the land surface by transport and road emissions accumulates gradually, depending on the number of vehicles passing through the route, road, or highway, and persists for a very long time even after the roadbed is eliminated (closure of the road, route, or highway, or complete removal of the path and asphalt pavement). Various chemical elements, especially metals, that accumulate in the soil are absorbed by plants and through them enter the bodies of animals and humans via the food chain. Some of them dissolve and are carried away by groundwater, then enter rivers and water bodies, and can reach the human body through

drinking water. Experience confirms that the concentration of fine particulate matter and toxic components in the soil decreases more rapidly with increasing distance from the carriageway. Analysis of statistical data indicates that residents of houses located 10 m from the road are 4 times more likely to develop cancer than those living 50 m away. The level of toxic substances in the soil is directly proportional to the traffic intensity on the road.

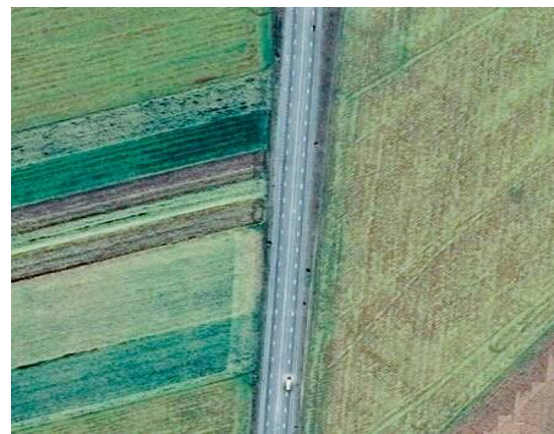
Currently, the situation with the illegal plowing of roadside lands is becoming increasingly relevant. Along highways, lessees and land users illegally plow the land to sow agricultural crops, harvest, and sell them for production.

These are typically the most common crops: sunflower, corn, and wheat.

Such examples of illegal plowing are observed in almost every region of our country (Fig. 3.4).



a



b



c



d

Fig. 3.4. Use of roadside areas (developed by the authors): a – Kyiv region;
b – Odesa region; c, d – Myronivka district

It is clearly visible that the lands along the highways are sown immediately adjacent to the right-of-way of the highways, and there are many such examples. Landowners and land users do not comply with the relevant regulations, which leads to the contamination of agricultural plants with heavy metals that, through chain reactions, enter the human body in the form of everyday food products, including bakery products, oil, butter, eggs, meat, etc. As a result, substandard food causes people to suffer from extremely serious diseases.

Their occurrence and patterns of distribution are determined by natural-ecological and socio-economic factors. The significance of the latter is increasingly important due to the influence of lifestyle, population income, housing conditions, and dietary patterns [19].

Analyzing the dynamics of the most common diseases of the population according to the International Classification of Diseases over three years (Fig. 3.5), it can be concluded that the majority of the population suffers from diseases of the digestive system caused by low-quality food products resulting from the contamination of agricultural crops along highways..

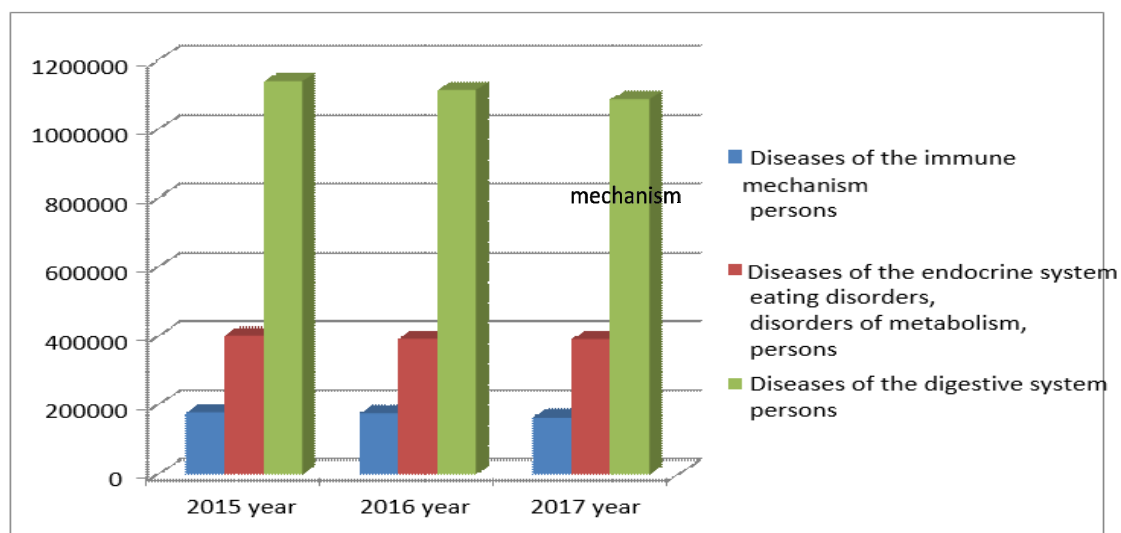


Fig. 3.5. Dynamics of morbidity of the population of Ukraine, thousand people (developed by the authors based on data from [19])

In the context of the above, the issues of land protection and the creation of prerequisites for the formation of sustainable land use in the country are

extremely relevant. It is necessary to implement measures at the legislative level that would help to avoid such land use, namely:

- Introduce a system of strict fines for landowners and land users who illegally plow land;
- Oblige landowners and land users to sow crops along highways, especially those without vegetation that retains harmful emissions, which are used for the production of alternative fuels;
- Increase the size of roadside areas, primarily those where agricultural crops are grown;
- Develop a methodology for determining the amount of damage caused by the unauthorized seizure of land plots;
- Develop industry standards and regulations in the field of land protection and use;
- Create an automated information system to detect violations of land legislation, primarily the misuse of land plots;
- Ensure the introduction of land reservation for the needs of road transport and road management.

According to the Resolution of the Cabinet of Ministers of Ukraine "On Approval of the Unified Rules for the Repair and Maintenance of Highways, Streets, Railway Crossings, Rules for Use and Protection" No. 198 of March 30, 1994 (as amended), roadside zones are defined, in particular:

- For highways (outside settlements) on sections of state-owned roads of categories I, II, and III, built or under construction bypassing cities, towns, and rural settlements – not less than 100 meters;
 - On access roads to regional and large industrial centers – 50 meters;
- On sections of state-owned roads between settlements – 32.5 meters [20].
- Within these specified zones, restrictions on economic activity are established, but they are not legally regulated.

Roadside strips (controlled zones, roadside protection zones, etc.) with a width of 20 to 150 m are established on highways in various countries. For

example, let's compare the roadside strips of Ukraine, Belarus, and the USA (Table 3.3).

Table 3.3

Analysis of regulatory parameters for the placement of highway elements and roadside areas in Ukraine, Belarus, and the USA*

Parameter of Element	Ukraine	Belarus	USA
Vertical clearance (distance from the road surface to the upper line of the clearance outline), m	5	4,5	–
Distance between interchanges, km	10 – for category I; 5 – for categories I-b, II; 2 – for category III.	Not less than 1 km for roads of categories I-v and II; 0.5 – for categories III and IV	3
Minimum distance from the edge of the carriageway to bus shelters, m	2 (remote from road intersections by more than 50 m)	3	Bus stops are recommended to be located at road intersections.
Placement of rest areas from the carriageway, m	10	7,3	3
Distance between short-term rest areas, km	Small ones every 40	Category I – ≤ 10; Categories Ib, Iv, II – ≤ 15 Category III – ≤ 30	Small ones – 50 «Freeway» – 100
	Category 1 roads – 35		
Placement of lighting poles, m	Local streets and roads – 0.75; main streets and roads: regulated traffic – 1.0; continuous traffic – 1.5	2,5	Roads with a speed limit of: 60 km/h – 2; 70 km/h – 2,5; 80 km/h – 3,0; 90 km/h – 3,5; 100 km/h – 4,0; 110 km/h – 4,5; 120 km/h – 5,0; 130 km/h – 5,5

Source: developed by the authors based on data from [21].

Analyzing the presented regulatory requirements for the placement of highway elements and roadside areas in different countries, it was found that the right-of-way of a highway in Belarus, in addition to the structural elements of the road, provides for the placement of service facilities, while in Ukraine, such facilities are located outside this strip. In Belarus, the construction of highways includes the planning of roadside strips, where the placement of any objects is controlled by the road owner. Roadside strips are intended to ensure road safety, proper conditions for reconstruction and major repairs of highways, taking into account development prospects.

The width of Belarusian roadside strips is up to 100 m on both sides of the highway axis, and in settlements – land plots up to the existing building line [22]. The road owner's territory also includes a reserve zone – a land plot reserved for the future construction or reconstruction of the highway [22]. In Ukraine, roadside strips are not provided for [23].

Regarding the parameters for the placement of amenity elements in the USA, interchanges are not very frequent, with a distance of 100 km (or one hour of driving) between them along freeways, while in Ukraine, it is 35 km along category I roads; bus stops are located at road intersections, while in our country, on the contrary, they are located more than 50 m away from road intersections [21].

Thus, summarizing the comparison of domestic regulatory requirements with foreign ones, it should be noted that certain parameters of highway elements in different regulatory acts of Ukraine contradict each other; the distance between service facilities in the USA is regulated more than in our country; in Ukraine, only a strip for the placement of structural elements of the road is allocated during highway design, and the territory for the construction of amenity facilities is not provided for, unlike Belarus; necessary roadside strips and reserve zones are absent.

When establishing roadside strips, it should be emphasized that land plots within their boundaries are not alienated (not purchased), specific restrictions

on the construction of facilities and economic activities should be defined, and the possibility of conservation of agricultural land should be provided for.

To ensure the protection of highways from destruction in areas with landslides and erosion, even the Instruction on the Procedure for the Allocation and Use of Land in the Right-of-Way of Highways in the Ukrainian SSR, approved by the Resolution of the Council of Ministers of the Ukrainian SSR No. 876 of August 4, 1962 (as amended), provided for the establishment of special protection zones without including them in the right-of-way.

Article 112 of the Land Code of Ukraine provides for the creation of protection zones along transport lands for their protection against adverse anthropogenic impacts. In particular, in places where there is a danger of landslides, collapses, washouts, mudflows, snowdrifts, and other dangerous impacts along railway transport lands.

However, the procedure for their establishment, size, and usage regime has not yet been determined by the Cabinet of Ministers of Ukraine.

The protection of highways from the effects of water and wind erosion, waterlogging, landslides, mudslides, avalanches, snowfalls, etc., is no less relevant than the protection of railways. Within the land of the road management system, anti-avalanche and anti-mudflow structures, snow protection structures and plantings, and drainage water treatment facilities already function to protect highways.

It is advisable to establish that the dimensions and configuration of protection zones are determined as part of the design documentation for the construction (reconstruction) of highways, and their boundaries should be established in urban planning documentation, land management documentation, and cadastral plans.

Regarding restrictions on activities in protection zones, they should include a ban on logging, the construction of buildings not related to road protection, and activities that cause the development of erosion processes and waterlogging of soils.

3.3. Organizational and legal mechanism for providing land plots for reservation

The development of the road network in Ukraine, as well as the construction of necessary transport facilities on it, requires the allocation and proper legal registration of land plots necessary for the implementation of projects for both new construction and reconstruction.

Unfortunately, land allocation in Ukraine is a lengthy bureaucratic process that includes both the preparation of project documentation for land allocation and the resolution of legal issues related to ensuring the property rights of the road sector to the necessary land plots [24].

One of the main directions of the land reform, which remains incomplete to this day, is land privatization aimed at ensuring the demonopolization of land ownership. However, in connection with the ongoing reform of land relations in Ukraine, it has become evident that the state cannot adequately respond to the development of privatization processes without optimizing the functions of state land management. That is why, immediately after the start of privatization, the state sought to expand its legal tools for influencing the development of land relations, one of which was land reservation.

According to the current land legislation, enterprises and institutions are provided with land plots for the development needs of road transport through their allocation from state or municipal land ownership or through the expropriation of privately owned land for public needs or for reasons of public necessity, as defined by the Law of Ukraine No. 1559-VI of 17.11.2009. At the same time, legislation provides for the development of forecast land management documentation, specifically the redistribution of land between categories for a 15–20 year perspective.

To improve the procedure for land allocation and the development of forecast documentation, it is advisable, in our opinion, to establish a land reservation mechanism, which is widely used in foreign countries in cases related to road construction and reconstruction. Examining international

experience in the use of transport land, particularly in the United States, it can be stated that an essential aspect of road infrastructure is the organized work within three key directions: comprehensive land use planning for road infrastructure, the development of methods for analyzing land use, and strategies for mitigating the impacts of land use. After implementing these planning and land use directions, executive authorities and local governments can collaborate to achieve economic, environmental, and social goals.

This primarily involves engaging transport agencies in local land use planning, enabling them to develop mechanisms and interact with local land management processes to resolve discrepancies caused by documentation-related divisions and organizations. Such interaction ensures that land planning decisions can be realistically considered and implemented. In fact, the mitigation of impacts often depends on early planning efforts. This collaboration fosters constructive dialogue between the political environment, transport agencies, and the community, ultimately ensuring problem-solving and economic development.

Transport agencies are working to improve forecasting methods for land use, ensuring the minimization of the impacts of transport projects, which contributes to their justification, as well as the identification of problems and benefits.

Ultimately, mitigation strategies are essential for the implementation of planned projects, the visualization of management objectives, and the economic and social growth of the region. Some strategies include land use regulations, emphasizing the importance of close coordination and partnerships with state and executive authorities. By engaging in and supporting land use planning, transport agencies can build partnerships and help form a regional consensus on land management and development.

The outlined directions used in the United States confirm the necessity of successful land use coordination at all stages of decision-making—from planning the system to project implementation. Success lies in identifying the

most effective types of analysis and actions at each stage of road design, construction, and reconstruction [25].

Thus, based on international experience, it should be noted that land reservation is considered one of the functions of land-use planning. Therefore, when allocating land, special attention should be paid to the prospective organization of road transport and road management land in order to determine the socially, environmentally, publicly necessary, and economically feasible form of use of this category of land and adjacent territories.

In studying the theoretical and practical aspects of road construction and reconstruction, we have developed a mechanism for providing land for reservation for their construction and reconstruction (Fig. 3.6).

The first stage of the proposed mechanism is the decision-making process regarding road construction, which is legally based on the approved territorial planning materials of the administrative-territorial unit: the General Territorial Planning Scheme; development programs for specific territorial parts, which define the road's location, as well as the public announcement of this decision.

The stage of collecting and reviewing influencing factors is crucial since it is necessary to gather reliable and up-to-date information about the region where road construction is planned, including its environmental conditions (air pollution levels, water resources, soil quality), socio-economic conditions (population demographics, transport infrastructure, economic indicators, aesthetic landscape). Additionally, it is essential to analyze and identify the strengths and weaknesses of legislative, administrative, financial, and production factors in the region.

At the third stage, the determination of the land plot for road construction involves defining its area, which is necessary for allocation in both new construction and reconstruction projects. In the case of new construction, it is essential to forecast reserve territories, considering future traffic loads and the impact on roadside areas. For reconstruction, the focus should be on assessing

the need to expand existing right-of-way strips and evaluating the projected environmental impact on adjacent lands.

The next stage involves the development of a land management project, a feasibility study, and a land protection program for the given region. Based on the aforementioned documentation and its approval in accordance with current legislation, managerial decisions are made regarding the possibility of reserving land for the construction and reconstruction of roads.

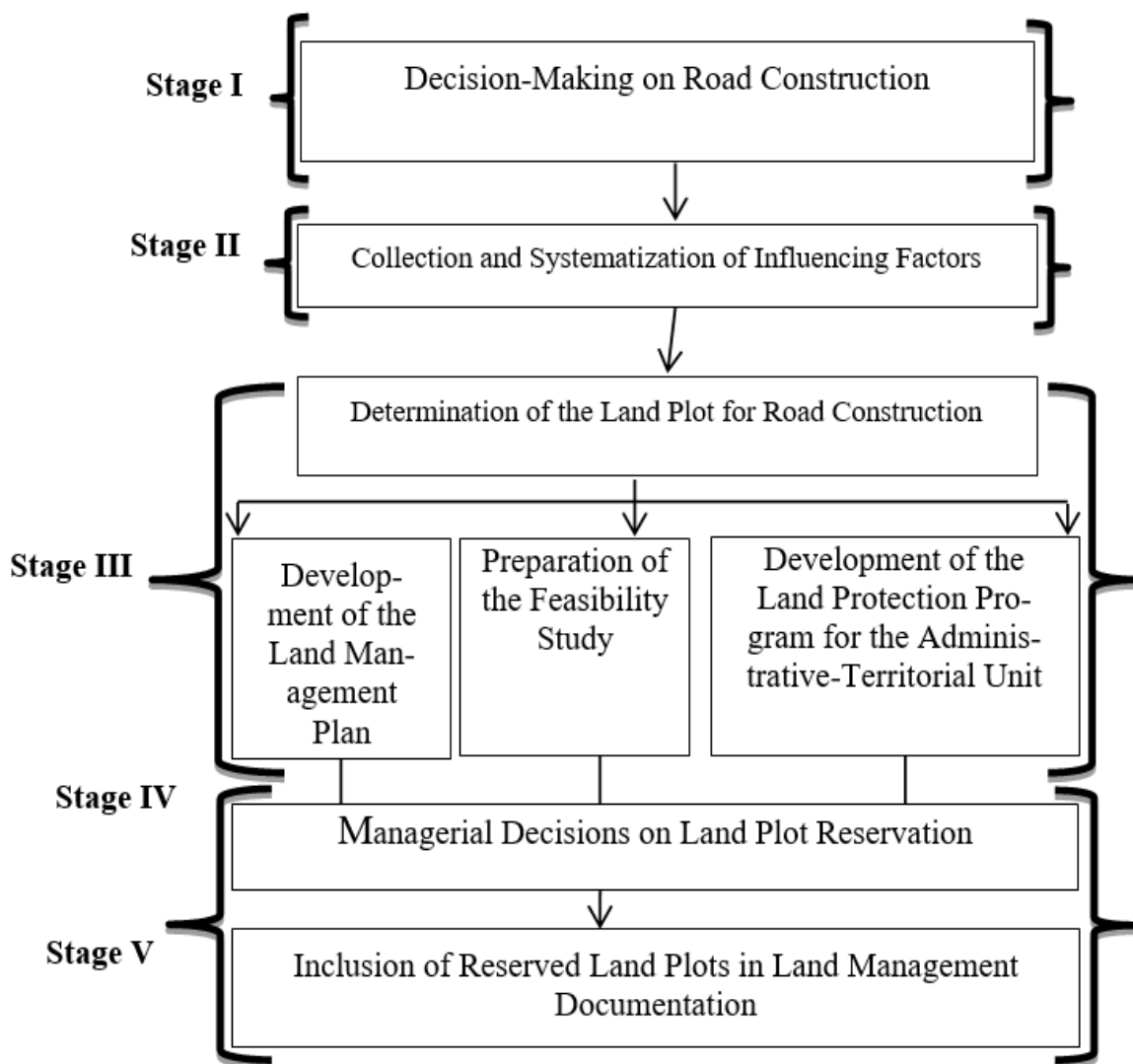


Fig. 3.6. Mechanism for Allocating Land Plots for Reservation
(Developed by the Authors)

One of the most widespread modern approaches to land-use coordination in the United States, Germany, France, and other foreign countries is the use of planned or forecasted land use for road construction planning and investment—

known as the “anticipate and provide” model. This approach allows for the prediction and resolution of land-use optimization consequences and requires monitoring and response from relevant authorities, including land-use planning agencies, throughout the entire implementation of road construction projects.

The key characteristics of this approach include:

- ✓ directing the planning process of road construction projects toward mitigating the impacts of land use;
- ✓ the active involvement of executive authorities in enhancing safety, ensuring mobility, and coordinating efforts among those who plan, design, and implement projects;
- ✓ the implementation of projects as a function of state departments;
- ✓ the consideration of investment projects for road construction by local authorities to achieve consensus on investment priorities for the transport infrastructure of the region.

After reviewing the road construction project, government authorities issue the necessary permits for its implementation, coordinate and execute tasks required for project approval, finalize construction plans and schedules, conduct engineering design, environmental analysis, and coordinate funding requirements, among other activities [25].

In our opinion, the “anticipate and provide” model is highly relevant and effective for regional development. According to the Law of Ukraine “On Voluntary Amalgamation of Territorial Communities” (effective from 01.01.2019) [26], newly formed territorial communities (OTGs) must independently regulate the development of their regions. This includes creating multiple decision-making bodies to ensure their region functions as a unified system, considering social, transport, and environmental perspectives.

Currently, the Ministry of Regional Development, Construction, and Housing and Communal Services of Ukraine, in collaboration with the National Democratic Institute of International Affairs, has signed a “Memorandum of Cooperation” on conducting public consultations and events for the

development of the State Strategy for Regional Development and Regional Development Strategies for the period 2021–2027.

This memorandum emphasizes the need to involve not only local authorities but also businesses and civil society organizations, which often have deeper insights into regional challenges and opportunities. Public consultations on the development of regional strategies for 2021–2027 will take place in Vinnytsia, Zhytomyr, Zaporizhzhia, Zakarpattia, Kirovohrad, Cherkasy, and Kyiv regions.

During such strategic discussions – aimed at planning regional development for at least five years-it is crucial to address road construction and land reservation for transportation infrastructure.

The Land Code of Ukraine (Articles 177, 178) also provides for the development of national and regional programs on land use and protection.

Regarding road construction and reconstruction, two key programs have been developed: The National Transport Strategy of Ukraine until 2030 [85], The State Targeted Economic Program for the Development of Public Roads of National Importance for 2018–2022 [27]

The primary goal of the National Transport Strategy is to create an efficient, globally integrated transportation network in Ukraine. This would meet the needs of the population for passenger and cargo transportation while improving business conditions to enhance the competitiveness and efficiency of the national economy. The strategy outlines effective state governance and strategic development directions for the transport sector up to 2030.

Ensuring the implementation of the transport strategy will facilitate Ukraine's approximation to the EU, as it concerns the implementation of the Association Agreement and the creation of conditions for gradual integration into the EU internal market, improving the quality of transport services, effective implementation of administrative reform, fighting corruption, transparency of decision-making, monitoring of activities, clear division of functions and distribution of powers between authorities and business entities, and ensuring equal conditions for the provision of transport services [13].

The State Targeted Economic Programme is aimed at restoring and developing public roads of national importance to integrate them into the European transport system and improve traffic safety, speed, comfort and efficiency of transportation.

There are several ways to achieve the programme's goal. The first - traditional - involves financing the restoration and development works only at the expense of the State Budget of Ukraine. Such an approach will not ensure a significant improvement in the transport and operational condition of public roads of national importance, since the amount of road works necessary for the sustainable development of the road sector was not carried out in previous years due to significant underfunding. However, the State Road Fund alone is only sufficient for maintenance and rehabilitation, leaving no room for the full development of the road network.

Thus, this implementation option will create the basis for a decline in the competitiveness of the national economy and an increase in social tension in society, which could slow down the country's European integration processes.

The second, optimal variant of the programme's implementation envisages long-term planning and financing of clearly defined tasks and measures to restore and develop the network of public roads and bridges (including those destroyed as a result of military operations in the East of the country) at the expense of not only the State Budget of Ukraine, but also International Financial Institutions (IFIs) and investors (concession).

At the same time, it is planned to finance mainly new construction and reconstruction of roads at the expense of IFIs and investors, while repairs and ex-operational maintenance will be financed from the state budget, IFIs and other sources [28].

The National Transport Strategy, which serves as the primary document for transport development (all other program documents in the transport sector and road management must comply with its provisions), and the State Targeted Economic Program for the Development of Public Roads outline the economic

impact on the national economy resulting from the implementation of all planned tasks and measures. The estimated labor demand for carrying out these tasks is approximately 55,000 jobs in the road sector, construction industry, road engineering, and the service sector of roadside infrastructure facilities.

The projected funding volume for the program amounts to 298,349 million UAH, including funds from the special state budget fund (State Road Fund) – 178,111 million UAH, of which 33,520 million UAH is allocated for loan repayment. Additionally, 6,358 million UAH will come from the general fund, and 113,881 million UAH from other sources, including 67,510 million UAH from international financial organizations and 46,372 million UAH from investors [29].

However, none of the documents mention land reservation for the construction and reconstruction of roads.

In our opinion, it is advisable to include the issue of land reservation in such key documents related to the development of the road network. The expansion of the road network, the construction of new roads, and their reconstruction depend on the size of the land plots allocated for these purposes.

All programs are developed with a common goal – to meet the needs of the population and economic sectors in land resources, ensuring their rational use and protection. An essential forecasting document in this process is the Land Management Scheme and the Feasibility Study for the Use and Protection of Land in Administrative-Territorial Units.

During the development of programs and land management schemes, the demand for land resources by various economic sectors is studied and considered to plan the future placement of buildings and structures. These are determined using calculation methods, specifying the required areas and locations of such objects. The procedure for developing land management schemes and their composition is regulated by Article 45 of the Law of Ukraine "On Land Management" [30].

The programs and land management schemes, once developed, approved, and adopted in accordance with established procedures, serve as the foundation

for justifying and making managerial decisions regarding the allocation of land plots for various purposes and their rational use.

These documents would, to some extent, allow for the reservation of land plots for the development of economic sectors, particularly for the construction and reconstruction of roads. Moreover, they could form the basis for legislative justification of land reservation regulations for different needs, including road transport, since current Ukrainian legislation does not define such a concept.

For instance, Article 25 of the Land Code of Ukraine refers to the reserve land fund, which consists of land in state or municipal ownership designated for future redistribution and targeted use [2].

Thus, the law provides for the formation of a reserve fund during the privatization of land belonging to state and municipal agricultural enterprises, institutions, and organizations, in cases where part of the agricultural land remains in the ownership of the state or territorial communities. However, the legislation only applies the concept of a reserve fund to agricultural land, without including any other land categories.

Therefore, when addressing the legal aspects of land reservation, two main directions should be distinguished: Reservation of land to meet state and public needs, Reservation of land in the process of allocation.

According to P.F. Kulynych, the issue of land reservation could be regulated by adopting a Law of Ukraine "On Land Reservation" [31].

In our opinion, such a Law would enable government authorities to regulate the distribution of Ukraine's land fund more effectively, facilitate faster integration into the European Union, and simplify the procedure for land acquisition for public needs, particularly for privately owned land.

The issue of land reservation for future road construction requires close cooperation between executive authorities and local self-government bodies to identify such land plots and grant them special status. Since the current state road management system was formed after the collapse of the Soviet Union in late 1991, through the reorganization of all state road organizations within

Ukraine, such cooperation at that time was ineffective. Currently, the Ministry of Infrastructure of Ukraine is responsible for managing and developing roads and road infrastructure. State-owned roads fall under the jurisdiction of the State Agency of Motor Roads of Ukraine (Ukravtodor) - a central executive authority whose activities are directed and coordinated by the Ministry of Infrastructure of Ukraine. Meanwhile, local roads have been transferred to the management of regional state administrations. The road network management is structured so that Ukravtodor plans and oversees international and national corridors, while regional road management bodies handle roads within Ukraine's regions. Given that most road networks are already in place, regional road services primarily focus on planning and carrying out repairs, reconstruction, and maintenance, while municipal services are responsible for urban streets.

The Ministry of Economic Development and Trade of Ukraine and the Ministry of Agrarian Policy and Food of Ukraine are closely linked to the development of the transport sector. The former is mainly responsible for strategic planning, economic restructuring, macroeconomic policies, and trade development, while the latter is responsible for developing and implementing national agricultural policy. These two ministries work closely with the Ministry of Infrastructure of Ukraine, and this cooperation should be aimed at developing state roads according to European standards by securing the necessary land reserves for their construction and reconstruction. At present, the allocation of land plots for road construction and reconstruction is associated with a set of complex issues (see Fig. 3.7).

One should not forget that road infrastructure lands are intended to serve public interests, with the primary condition being their predominant state ownership. This is the basis for refusing the transfer of such lands into the ownership of citizens and legal entities.

Thus, land reservation is a mechanism for restricting the property rights of landowners to ensure public needs for territorial development. It enables the planned allocation of land within specified timeframes and simplifies the

subsequent procedure for granting land for the prospective construction and reconstruction of highways.

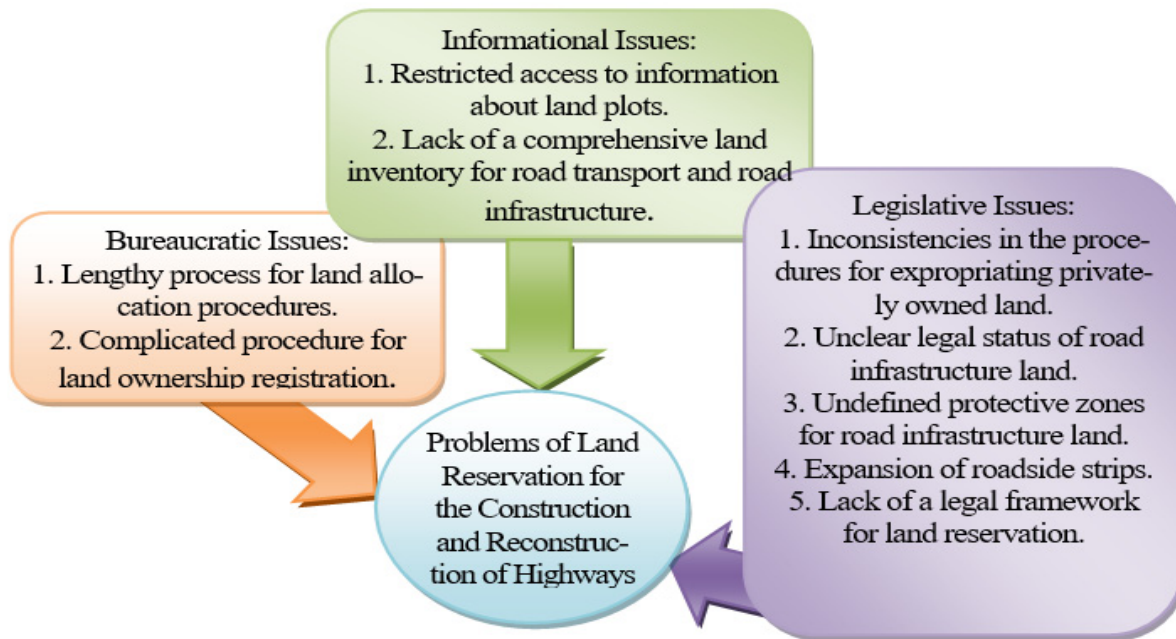


Fig. 3.7. Problems of Land Reservation for the Construction and Reconstruction of Highways (*compiled by the authors*)

The consequences of the lack of a legislatively approved norm for reserving land for highway construction are evident even today. For instance, during the planning of the Large Ring Road around Kyiv, it became necessary to develop proposals for reserving the right-of-way, interchanges, and roadside service facilities. This was initially envisioned in October 2007 by the resolution of the Cabinet of Ministers of Ukraine, "On the Organization of Design and Construction of the Large Ring Road Around Kyiv." Later, the General Route of this road was approved, specifying the vicinity of certain settlements in the Kyiv region. A proposal was justified to prohibit any actions aimed at leasing or alienating land plots and objects within the designated right-of-way for this road's construction. However, since land reservation lacks legislative support, its implementation was impossible. As a result, the land for the Large Ring Road around Kyiv was not allocated, and a national highway that could have alleviated the city's persistent traffic congestion has not yet been built. The land intended

for its construction remains in private ownership, complicating the initiation of works.

Therefore, land reservation is a legal necessity for regulating land relations, ensuring public and economic sector needs for land, its rational use, and protection- particularly for highway construction. It should be carried out in accordance with the following regulatory documents:

- The National Road Development Strategy;
- Prospective plans for highway construction, reconstruction, or expansion;
- Land allocation norms for highway construction (reconstruction) [32], including the definition of reserve zone widths for new highways;
- The General Territorial Planning Scheme of Ukraine, territorial planning schemes of the Autonomous Republic of Crimea, regions, districts, and land management schemes of administrative-territorial units.

Additionally, the expansion and reconstruction of existing highways should be carried out within roadside strips, subject to approval by landowners (users). Land plots for new highway construction should be reserved for up to 10 years. The procedure for land reservation will be determined by the Cabinet of Ministers of Ukraine.

3.4. Ecological and economic mechanism for determining and compensating for losses and damages due to the deterioration of the soil cover which was caused by the functioning of automobile transport and road economy

The feature of land use for automobile transport and road infrastructure is that their objects are located on lands of all categories defined by the current Land Code of Ukraine, which requires certain legal relationships between different forms of ownership. It should be noted that as a result of human activity, the areas of land, especially agricultural land, are shrinking and being

withdrawn from economic use due to the needs of new housing construction, linear transport infrastructure projects, urbanization processes, and the increase in population.

As already mentioned, the functioning of automobile transport and road infrastructure has a negative impact on the environment, particularly on the adjacent territories – agricultural lands (arable lands, perennial plantings, meadows, pasture lands, fallow lands). As a result of pollution by heavy metals, the quality of these lands deteriorates significantly, leading to a decrease in productivity. Therefore, landowners and land users incur losses and damages, which should be compensated, as stipulated by the current land legislation. In accordance with Article 156 of the Land Code of Ukraine, landowners and land users are entitled to compensation for damages caused by:

- a) the withdrawal (purchase) of agricultural lands, forest lands, and shrubs for purposes unrelated to agricultural and forestry production;
- b) temporary use of agricultural lands, forest lands, and shrubs for other purposes;
- c) the establishment of restrictions on the use of land plots;
- d) the deterioration of soil quality and other beneficial properties of agricultural lands, forest lands, and shrubs;
- e) rendering agricultural lands, forest lands, and shrubs unsuitable for use;
- f) the failure to receive income during the period of temporary non-use of the land plot.

Articles 97, 101, 146, 147, 152, 155, and 212 of the aforementioned code establish the obligation to compensate damages, which may be done voluntarily by the individuals who caused them or through legal proceedings. According to Article 156 of the Land Code of Ukraine, such damages are classified and arise from unlawful actions. Part 4 of Article 1166 of the Civil Code of Ukraine states that damages resulting from lawful actions are compensated only in cases provided by law.

The damages caused by the functioning of automobile transport and road infrastructure can be classified as those specified in Article 156 of the Land Code of Ukraine. That is, these damages may be caused both during the construction of roads and road infrastructure objects and during the functioning of automobile transport and road infrastructure. It is important to emphasize that there is a unified state information system, such as the State Land Cadastre, which collects data on the quantity and quality of lands within Ukraine's borders, their intended use, restrictions on their use, as well as their evaluation and allocation among landowners and land users. However, this system is practically not maintained. While the number of lands has been recorded, since 1995, the quality of lands has not been monitored at all.

As a result, the state does not have reliable information about the quality of land resources within its borders. This situation highlights the need for materials that would address the potential solutions, determination, and compensation for damages caused by the construction and functioning of automobile transport and road infrastructure.

The issue of determining the negative impact of automobile transport and road infrastructure on the environment, including agricultural lands (arable lands, perennial plantations, etc.), has been addressed by both domestic and foreign scholars, such as D.I. Bambindra, D.S. Dobryak, O.A. Korchynska, R.M. Kuryltsiv, I.O. Novakivska, O.I. Shaporenko, P. Blaikie, A. Brookfield, and others.

D.I. Bambindra and D.S. Dobryak propose determining the impact through the introduction of land monitoring, particularly for lands adjacent to automobile roads. This monitoring is considered an important mechanism for systematically collecting, accumulating, and preserving information about the ecological crisis state of these lands, assessing and predicting further changes, and creating an informational and normative-reference base for a data bank. The analysis, summarization, and preparation of information are necessary for making decisions and submitting them to government authorities and local self-government bodies (special commissions) for compensating the incurred damages.

The level of pollution by heavy metals in the land areas adjacent to state highways is determined by their content in soil samples taken from the relevant agro-groups of soil cover (table 3.4).

Table 3.4

**Content of heavy metals in soil samples taken in the Zaporizhzhia region
(fragment), mg/kg***

Sampling location	Depth, cm	Copper		Lead		Cadmium	
		total	mobile	total	mobile	total	mobile
Maximum allowable concentrations	–	10,0	3,0	10,0	2,0	0,3	0,02
Typical Chernozem with low humus (winter wheat)	0–20	17,0	7,0	8,0	4,8	0,06	0,04
Typical Chernozem with low humus (winter wheat)	20–30	10,0	5,5	8,0	4,0	0,03	0,03
Southern Chernozem (lucerne on irrigation)	0–20	15,0	5,8	15,0	5,8	0,06	0,06
Typical Chernozem, leached	0–20	8,0	8,0	6,0	2,8	0,03	0,03

**Source: according to [32]*

The analysis of the provided data indicates that the content of total forms of heavy metals does not significantly exceed their maximum allowable concentrations (MAC). Therefore, based on these indicators, the situation can be classified as favorable. However, the content of mobile forms of these metals in all the depicted samples exceeds the MAC level, meaning the situation is critical.

Dr. of Economic Sciences I.O. Novakovska proposed a scientific and methodological approach to determining the damages to landowners and land users, providing examples of how to calculate the damage. This includes damages caused by the failure to carry out land reclamation works; using land for purposes other than its designated use; removal of soil cover (fertile topsoil) without a special permit; contamination of land with fuel oil; and land pollution (moderately hazardous waste). The damage amounts are determined both in monetary terms and by the reduction in the normative monetary valuation of the land. It is also important to emphasize one more detail: the damage amounts are calculated by authorized individuals who conduct state control over

compliance with environmental legislation, based on inspection reports, protocols on administrative offenses, and other materials confirming the fact of land pollution, within six months of the violation being detected. The basis for calculating the damage from land contamination is the normative monetary valuation of the land plot that has been contaminated [33].

It is also necessary to pay attention to another aspect of assessing the natural properties of soils contaminated with toxic substances, namely seasonal or short-term changes, which determine the doses of fertilizers and pesticides used to increase soil productivity in a given year. These are measured by the content and reserves of humus, structural condition, composition of exchangeable cations, alkalinity, acidity, and salt content [34]. To assess the change in soil properties due to environmental pollution, including the soil cover of lands adjacent to highways, a normative standard is used, namely the maximum allowable concentration of technogenic substances (MAC). According to the recommendation of Dr. O.I. Shaporenko [35], the normative and methodological documents that determine the pollution level and assess its impact on soil quality are conditionally divided into three groups:

Soil quality standards (MAC, ODC – approximate permissible concentrations, total pollution indicators, background content), which form the basis for assessment;

Standards regulating soil use and limiting pollution (MPC – maximum permissible discharges, MPE – maximum permissible emissions, permission for waste disposal, permissible norms for mineral fertilizers and pesticides application);

Instructional and methodological documents regulating the survey of contaminated areas, identifying pollutants, and determining the level of contamination [33,34].

For the assessment of technogenically polluted lands, summarized data from the standards (Table 3.5) on soil contamination with heavy metals are of great importance [33].

Table 3.5

**Summary Indicators of Norms for Assessing the Environmental State of
Technologically Polluted Arable Lands***

Ecological situation	Norms for assessment (heavy metals)		
	Total forms		Mobile forms in the soil
	in soil	in plants	
Favorable	at the level	< MPC	< MPC
Satisfactory	< MPC	< MPC	< MPC
Pre-crisis	< MPC	< MPC	< MPC
Crisis	1,1–10 MPC	1,1–1,5 MPC	2–100 MPC
Catastrophic	>10 MPC	>1,5 MPC	>10 MPC

*Source: based on data from [33, 36]

It is important to emphasize that there are many methodological approaches for determining the impact of heavy metals on the quality of various soils. Summarizing them, it can be stated that chernozems have the highest adsorption capacity [35, 37.].

For the most widely adopted practical application, regulations are recommended that take into account the granulometric composition and acidity of the soil cover (Table 3.6).

Table 3.6

**Approximate acceptable concentrations (AAC) of heavy metals and arsenic
in soils (GN 2.17.020-94 Supplement No. 1 to the list of AAC and GPC No.
6229-91)***

Soil Group	Number of Elements, mg/kg of air-dried soil					
	<i>Ni</i>	<i>Cn</i>	<i>Zn</i>	<i>As</i>	<i>Cd</i>	<i>Ph</i>
Sandy and sandy-loam	20,0	33,0	55,0	2,0	0,5	32,0
Acidic (loam and clay), $PH_{kci} < 5,5$	40,0	66,0	110,0	5,0	1,0	65,0
Close to neutral (loam and clay), $PH_{kci} > 5,5$	80,0	132,0	220,0	10,0	2,0	130,0

*Source: based on data from [34,35]

Most researchers agree that the objective assessment of soil contamination can be carried out based on the content of mobile forms of element compounds. This is due to the buffering capacity against the toxic impact of pollutants and their conversion into poorly soluble and less accessible forms for plants. The highest range of chemical forms is found in heavy, organic-rich, carbonate soils with specific granulometric composition [34,35]

Using the provided data, it can be stated that critical (crisis) levels of total heavy metal content vary for different soils. For example, in black soils, grain yields decreased with lead content in the soil of 500 mg/kg, while in podzolic soils, the threshold was 50 mg/kg [35] Thus, when evaluating heavy metal contamination, it is necessary to consider the following fundamental approaches (criteria): different metals have varying toxicity thresholds for plants.

Agricultural crops show different sensitivities to soil contamination with heavy metals and significantly differ in the toxicity threshold, even within the same group of plants [34].

The protection of adjacent land uses, primarily agricultural lands, from highways is carried out using protective forest belts (windbreaks and non-windbreaks), as demonstrated in a case study presented in scientific works [34., p. 139]. In experimental land management developments (the land management project of the Brovary district in the Kyiv region), along the Kyiv–Chernihiv–Moscow highway, soil samples taken by employees of the State Scientific Research and Design Institute of Land Management of the State Committee for Land Resources of Ukraine revealed the presence of heavy metals at a distance of 100 m from the edge of the paved surface (asphalt). The soil contamination density was as follows: up to 50 m – 75%, 50–75 m – 15%, and 75–100 m – 15%, with protection provided by a non-windbreak forest belt along the road surface (asphalt). On the opposite side, there was a protective forest belt of a windbreak design, where the contamination density of agricultural lands was different: 60%, 25%, and 15%, respectively (Fig. 3.8).

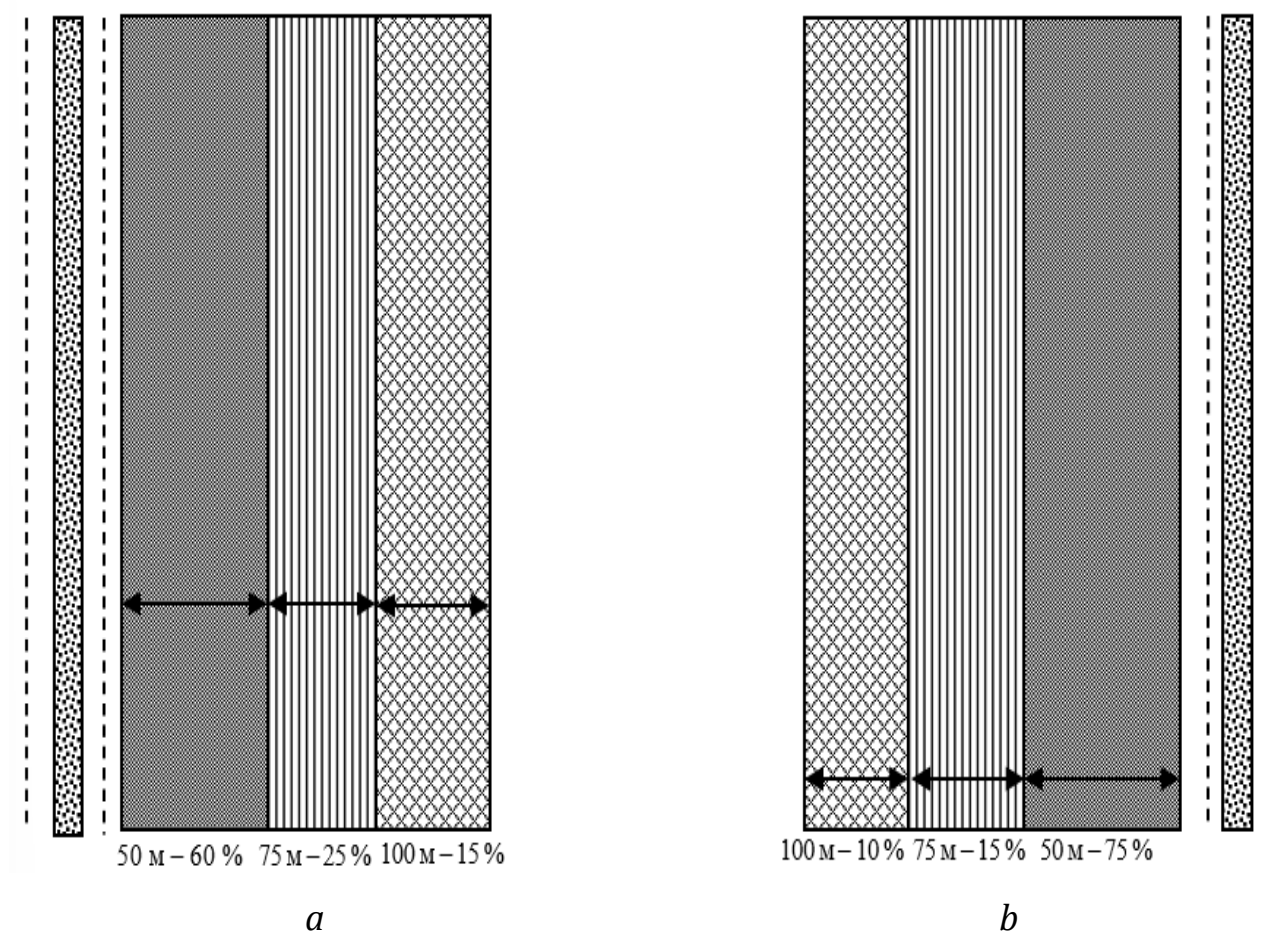


Fig. 3.8. Soil contamination density with heavy metals along the Kyiv–Chernihiv–Moscow highway: a – in the presence of a windbreak forest strip along the highway; b – in the presence of a non-windbreak forest strip along the highway (according to data from source [34.])

An important task in assessing heavy metal contamination of adjacent agricultural land is translating ecological parameters into economic ones, which will form the basis for preparing materials on compensation for damages. It is proposed to use the indicators of the bonitet rating and the normative monetary valuation of contaminated land plots. To illustrate this approach, let's consider an example from Kyiv Oblast, where the bonitet rating of arable land is 41 points, and the normative monetary valuation of arable land (as of January 1, 2018) is 26,194.09 UAH/ha. We can calculate the value of one bonitet rating point using the normative monetary valuation: $26,194.09 : 41 = 638.88$ UAH/point.

According to the survey materials, it was established that the rating decreases, and notably, it drops sharply at a distance of 100 meters from the asphalt with the corresponding contamination density. Therefore, a generalized average decrease in the rating is calculated. If, for example, the rating due to contamination equals 36 points (the average for a land plot of 100 meters in length), the normative monetary valuation will decrease by 3,194.40 UAH/ha. Thus, the amount to be compensated is 3,194.40 UAH/ha. This standard increases depending on the number of hectares that were contaminated. As mentioned earlier, such a calculation is justified by a special methodology.

A comprehensive scientific and methodological approach to assessing the negative impact of the construction of facilities, the functioning of road transport, and road management, as well as compensating for losses and damages caused by this sector, is proposed to be developed in the form of an economic mechanism.

An analysis of scientific research on the concept of the mechanism by different authors shows that there is no single interpretation, as it depends on the conditions of the problem being addressed. Therefore, in the study of the formation of land use by road transport and road management, we use the concept found in the large explanatory dictionary of the Ukrainian language, which defines it as a set of states and processes that make up a certain physical, chemical, and other phenomenon [38].

Thus, in our case, the ecological-economic mechanism for determining and compensating for losses and damages related to the deterioration of soil cover quality, caused by the functioning of road transport and road management, should be viewed as a system of measures aimed at ensuring the optimal formation and development of land use in the studied sector based on sustainable development principles, protecting the population and the natural environment from the negative impact of linear objects of transport infrastructure, by reconciling the economic and social interests of landowners and owners of transport infrastructure linear objects in the relevant territorial units.

At the current stage of land relations reform, a number of laws have been adopted that are directly related to the issues of land use for road transport and road management, in which the economic mechanisms for implementing environmental policy are outlined. These include such normative and legal acts as the Land Code and the Tax Code of Ukraine, the laws "On Land Management," "On Territorial Planning and Development," "On Land Protection," "On Environmental Protection," and others.

The modernization of market transformations in all sectors of the national economy forms a wide range of theoretical and methodological approaches that allow for defining economic directions for stimulating the rational use and protection of land—ranging from relations between landowners (land users) to preventing the harmful impact of economic activity on the ecological-economic balance of territories.

The mechanism that organizes the economic, organizational, legal rules, and norms of land use for road transport and road management forms the basis of the economic mechanism and defines the main direction of their development, ensuring the economically justified use of land (Fig. 3.9).

The development of the economic mechanism for regulating the compensation of losses and damages in land use, caused by the functioning of road transport, also emphasizes the relevance of the issues of assessing restrictions (burdens), especially with the development of private land ownership.

The assessment of restrictions (burdens) and compensation for losses has been addressed in the works of D.I. Bambindra, D.S. Dobryak, I.O. Novakovska, and other scholars. However, a clear mechanism for compensating losses in land use, particularly in agriculture, which is the leading sector in our country, has not yet been developed [39.].

Article 207 of the Land Code of Ukraine outlines the conditions for compensation for losses of agricultural and forestry lands, including the following:

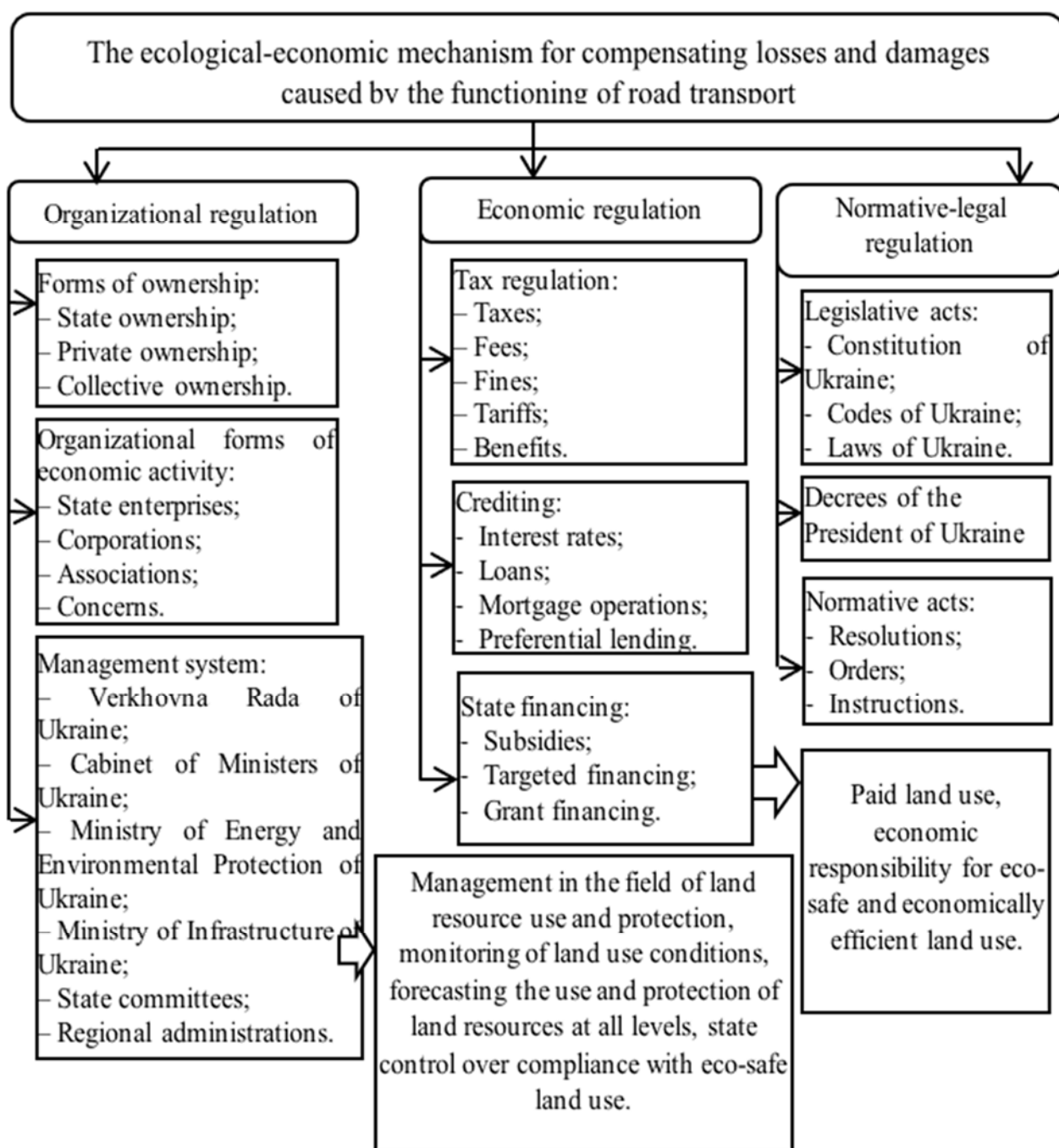


Fig. 3.9. Ecological-economic mechanism for compensating losses and damages caused by the functioning of road transport (developed by the author based on data from [40])

1. Losses in agricultural and forestry production include losses of agricultural land, forested areas, and shrublands, as well as losses caused by restrictions in land use and the deterioration of land quality [2].

2. Compensation applies to losses of agricultural land (arable land, perennial crops, fallow lands, meadows, pastures), forest lands, and shrublands

as the main means of production in agriculture and forestry due to their expropriation (purchase) for non-agricultural or non-forestry purposes, as well as due to their use for construction, placement, and operation of oil and gas extraction facilities and the development of deposits [2].

3. Compensation also applies to losses caused by the restriction of the rights of landowners and land users, including tenants, or the deterioration of land quality due to negative impacts caused by the activities of individuals, legal entities, local government bodies, or the state, as well as in connection with the exclusion of agricultural lands, forested areas, and shrublands from economic circulation due to the establishment of protective, sanitary, and other protective zones [2].

4. Losses in agricultural and forestry production are compensated independently of the compensation for damages to landowners and land users [2].

5. Losses in agricultural and forestry production are determined according to the procedure established by the Cabinet of Ministers of Ukraine [2].

At the same time, Article 208 of the mentioned document states that citizens and legal entities are exempt from compensation for losses in agricultural and forestry production when land plots are used for the construction of schools, preschool institutions, state healthcare, cultural, physical culture and sports, social security facilities, state road construction objects, religious buildings, cemeteries, reclamation systems, anti-erosion, anti-landslide, and anti-debris structures, residential and utility buildings, internal agricultural objects, infrastructure for wholesale agricultural markets, peat extraction, on the condition that the land is returned to a state suitable for its previous use, for objects and areas of the nature reserve fund, construction and operation of energy facilities producing electricity from alternative sources, afforestation of degraded and low-productivity lands based on land management documentation, and for all-Ukrainian public organizations of persons with disabilities of Ukraine, their enterprises (associations), institutions, and organizations financed from the State Budget of Ukraine, in case the land is used for the

construction of rehabilitation facilities, physical culture, sports, and social security objects for adults and children with disabilities [2].

Thus, the main obstacle to the implementation of the economic mechanism for compensating losses and damages related to the deterioration of soil cover quality, caused by the functioning of road transport and road management, is the inconsistency of the legislative framework, specifically Articles 207 and 208 of the Land Code of Ukraine. It should be noted that the construction of state highways and their direct operation cause significant environmental harm, particularly to agricultural lands.

To implement the proposed mechanism for determining and compensating losses and damages caused to landowners and land users by road transport and road management, we believe it would be appropriate to include such data in land management projects for the construction or reconstruction of roads.

Based on the above, it can be concluded that it is advisable to introduce calculations of losses and damages from the functioning of road transport and road management lands at the legislative level, particularly by incorporating them into land management documentation. Funds for the compensation of losses and damages would be directed to the local budgets of the relevant territories.

Therefore, the ecological-economic mechanism for determining and compensating losses and damages related to the deterioration of soil cover quality caused by the functioning of road transport and road management should be approved at the legislative level, specifically through amendments to the Land Code of Ukraine, such as the exclusion of paragraph 1 of Article 208 regarding state road construction facilities. This would allow for the proper calculations, generate funds for local budgets, and strengthen the responsibility of landowners and land users

3.5. Post-war reconstruction of road infrastructure: environmental, economic and legal aspects

The full-scale war in Ukraine has dealt a devastating blow to infrastructure, in particular the road network, which is critical for population mobility, logistics, humanitarian corridors and military operations. Analyzing the combat map in combination with the road map allows for a preliminary assessment of the extent of damage to the road surface, which occurred both as a result of rocket and artillery shelling, and due to the intensive use of heavy military equipment, in particular tanks.

Special attention requires assessing the impact of tanks on road surfaces. According to studies, the T-72 tank, which is actively used by both sides of the conflict, has a destructive effect 2.36 times greater than the standard axle load of civilian transport. (See Fig. 3.10)

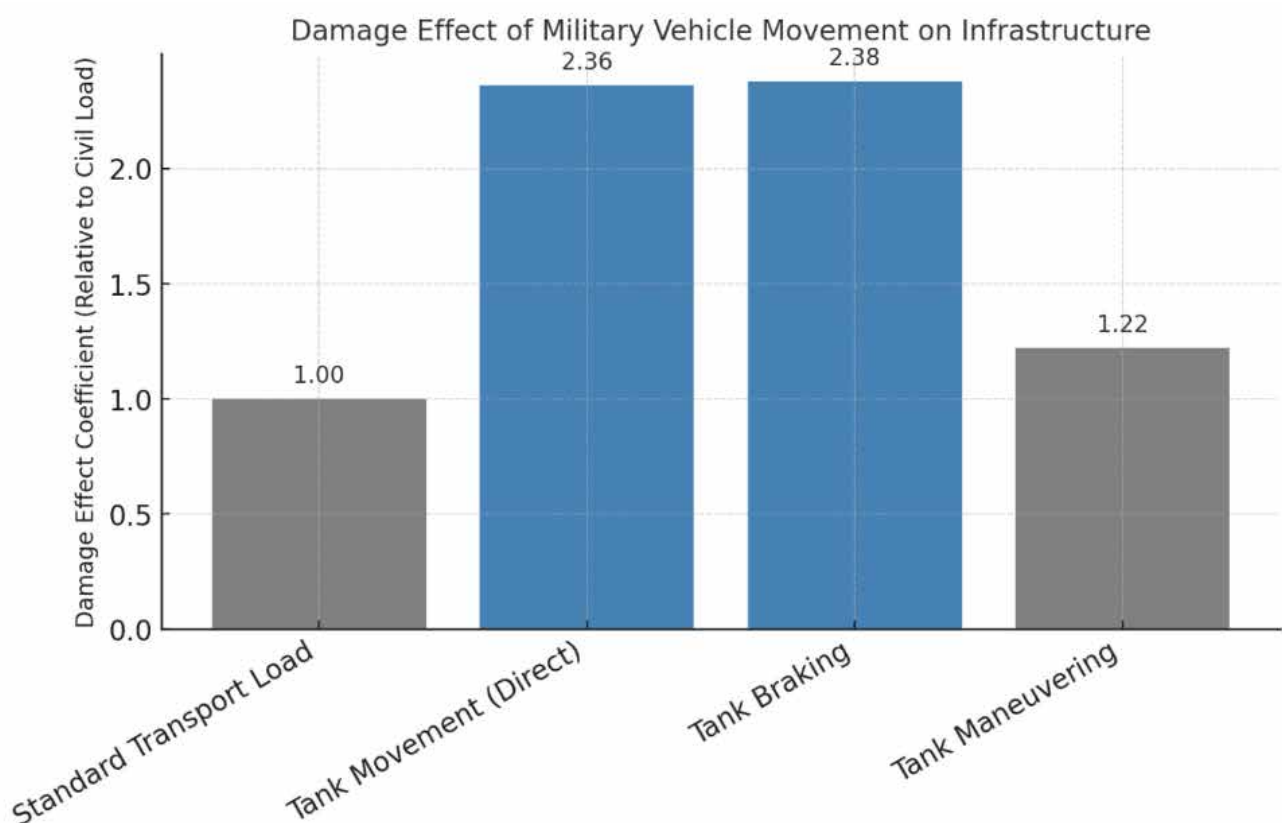


Fig. 3.10. Comparison of the destructive effect of different types of loads on roads

This difference is explained by the metal tracks, the high mass of the machine and the peculiarities of its movement. At the same time, the braking of the tank has an even greater impact on the road surface - 2.38 times more powerful than the mass of the tank itself, while maneuvers (especially turns on the spot or sharp changes in direction of movement) create an additional load that is 1.22 times higher than the static impact. This indicates that even without a combat collision, the simple movement of military equipment causes serious damage to the road infrastructure.

However, the impact is not limited to the road surface. Studies show that the stress from the movement of tanks extends vertically up to three meters deep, damaging not only the asphalt, but also the road base. This significantly complicates restoration work and requires complete reconstruction of the roadbed, and not just patching potholes.

When analyzing satellite imagery and combat maps, it is possible to identify areas with the highest combat load density — for example, eastern Ukraine, the south, and the areas around Kyiv. Comparing these areas with the road network, it can be assumed that approximately tens of thousands of kilometers of roads have suffered some level of damage. (See Fig. 3.11.) Particularly critical are areas connecting large cities, logistics hubs, and borders.

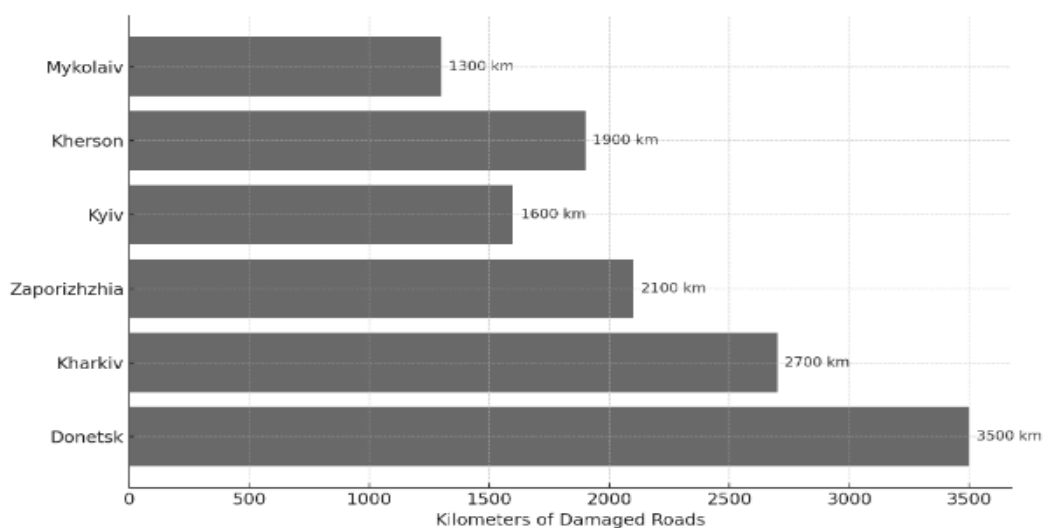


Fig. 3.11. Approximate length of roads in different regions of Ukraine

It is also important to consider the difference in the cost of restoring roads depending on their location. Roads within cities are much more expensive to repair – sometimes by a third or more – because they contain not only asphalt, but also communication networks, lighting, sidewalks, etc. Thus, even minor damage in an urban environment can lead to multimillion-dollar costs, while damage on intercity highways, although larger, sometimes requires fewer resources to eliminate. In general, combining spatial analysis of hostilities with an infrastructure map allows not only to assess the level of destruction, but also to form priorities for future restoration. Taking into account the specifics of the impact of military equipment on roads also allows you to adapt the standards for construction and strengthening the roadbed in the face of potential threats in the future. [41]

The road industry has faced challenges related not only to the restoration of facilities, but also to ensuring logistics for defense needs, humanitarian transportation and population evacuation. In response to these challenges, the Ukrainian government initiated the “Reconstruction of Ukraine” program. This is a large-scale initiative aimed at the post-war reconstruction of the country, taking into account modern standards of sustainable development, security and infrastructure reliability. The specified problem includes the following main areas:

1. Damage assessment and prioritization of critical infrastructure restoration. Based on a regular assessment of damage caused by military actions, priorities for priority restoration are determined. Particular attention is paid to:

- o humanitarian corridors - transport routes that ensure the evacuation of the population, the delivery of humanitarian aid, medicines and products;
- o entrances to medical facilities - to ensure unhindered access to hospitals, mobile medical stations and rehabilitation centers;
- o military infrastructure - including roads to defense and logistics facilities that ensure the mobility of the Armed Forces of Ukraine;
- o logistics hubs - transport and warehouse complexes, train stations, ports that are critically important for the economy.

A priority index is determined for each facility, taking into account the level of damage, strategic importance, socio-economic significance and the cost of restoration.

2. Damage assessment and prioritization of critical infrastructure restoration. Based on a regular assessment of damage caused by military actions, priorities for priority restoration are determined. Particular attention is paid to:

- o humanitarian corridors - transport routes that ensure the evacuation of the population, the delivery of humanitarian aid, medicines and products;
- o entrances to medical facilities - to ensure unhindered access to hospitals, mobile medical stations and rehabilitation centers;
- o military infrastructure - including roads to defense and logistics facilities that ensure the mobility of the Armed Forces of Ukraine;
- o logistics hubs - transport and warehouse complexes, train stations, ports that are critically important for the economy.

A priority index is determined for each facility, taking into account the level of damage, strategic importance, socio-economic significance and the cost of restoration. [42] Ukraine's key needs for 2024 include recovery in the following areas, presented in the fig. 3.12.

housing and utilities	➡	3,1 billion dollars
transport and logistics	➡	2,3 billion dollars
energy	➡	2, 7 billion dollars
social infrastructure	➡	2,4 billion dollars
industry and services	➡	3,6 billion dollars
cross-sectoral priorities	➡	1,2 billion dollars

Fig. 3.12. Needs for the recovery areas of Ukraine[43]

Since the last RDNA2 assessment, the Government of Ukraine, with the support of its partners, has addressed some of the most urgent recovery needs. In particular, regarding the repair and reconstruction of damaged buildings, the removal of debris, and the provision of temporary housing. In the transport sector, emergency recovery work has been carried out on over 2,000 km of motorways, highways, and other national roads, and over 200 km of railway infrastructure has been restored.

The Russian Federation's invasion of Ukraine, which has been ongoing since February 2022, has caused unprecedented destruction on the territory of the country. In response to the challenges associated with the need for rapid, effective, and targeted reconstruction, Ukraine's international partners, together with the Government, have created a powerful analytical platform — the Fourth Rapid Damage and Needs Assessment (RDNA4). This document covers not only the general picture of losses, but also details the priority needs for the restoration of infrastructure facilities that play a key role in ensuring the country's vitality and sustainable development in the long term. [44] The Fourth Rapid Damage and Needs Assessment (RDNA4), jointly conducted by the World Bank Group, the Government of Ukraine, the European Commission, and the United Nations, is a critical tool for systemic planning for the country's reconstruction. Covering the period from February 2022 to December 2024, the document not only quantifies losses but also provides a qualitative picture of how the war has changed the lives of Ukrainians.

RDNA4 builds on three previous rapid assessments (RDNA1, RDNA2, RDNA3), which consistently documented losses and needs at different stages of the war. However, it is the fourth assessment that demonstrates a long-term approach, offering a vision for recovery over a ten-year period. Particular attention is paid not only to physical infrastructure — housing, schools, hospitals, roads, energy systems — but also to humanitarian aspects: access to education, health care, psychosocial support, as well as restoring public trust and social cohesion.

This assessment forms the basis for effective coordination of international assistance, identifying priorities for reconstruction by sector and region. In particular, RDNA4 emphasizes the importance of integrating the principles of sustainable development, transparency and inclusiveness into all stages of reconstruction. The document directly indicates the need to strengthen local self-government, involve communities in decision-making, as well as the use of modern management tools, such as digital platforms for monitoring and evaluating the effectiveness of programs.

RDNA4 also serves as a key source for the development of programs funded by international donors, such as the EU Ukraine Facility, as well as other financial and technical assistance instruments. Programs based on its findings can ensure not only the restoration of the destroyed, but also the modernization of critical sectors of the economy, taking into account the green transition, energy efficiency and digitalization.

In this context, RDNA4 is not just an analytical document - it is a strategic roadmap that orients Ukraine and its partners towards a high-quality, sustainable and people-centered recovery. Its results should become the basis for the formation of new approaches to regional development, spatial planning, land management and the construction of a new architecture of public services in the post-war period.

Thus, RDNA4 is an assessment unprecedented in scale and depth, which gives Ukraine a chance not only to rebuild the destroyed, but also to create a more just, safe and viable society. It should become the basis for all post-war recovery policies aimed at long-term stability, human potential development and Ukraine's integration into the European space.

The European Commission — implements the Ukraine Facility program, which includes long-term financing for the recovery and modernization of the economy; [45]

For example, the goal of the European Union's strategic initiative – Connecting Europe Facility (CEF) - is to connect Ukraine with European countries

through a modern, safe, and sustainable transport infrastructure. [43] The role of CEF becomes particularly important in post-war realities, when a significant part of the infrastructure was destroyed or seriously damaged as a result of military operations. It becomes not only a financial instrument, but also a catalyst for sustainable restoration and development of the transport system at a new level - with the use of innovations, high environmental standards and taking into account safety needs.

Rebuilding destroyed roads, bridges, railway junctions and logistics centers requires enormous investments and coordinated efforts at the national and international levels. This is where CEF Transport demonstrates its effectiveness, directing resources to projects that provide both physical restoration of infrastructure and its modernization in accordance with EU standards. Ukraine, as a country striving for European integration and already part of the Trans-European Transport Network (TEN-T), has a real opportunity to use this instrument to implement large-scale infrastructure initiatives.

In the context of post-war reconstruction, cross-border projects that contribute to Ukraine's economic recovery and its deeper integration into the European market deserve special attention. The restoration and modernization of border crossing points, international railway lines, and highways connecting Ukraine with the EU are critically important for the movement of humanitarian, trade, and defense flows. In this direction, CEF supports projects that not only improve transport connectivity, but also ensure its resilience to possible future challenges. CEF Transport also plays an important role in increasing military mobility, which is especially relevant in times of war and security threats. Improving transport infrastructure so that it is suitable for both civilian and military use allows for a rapid response to crisis situations, evacuations, logistical challenges, and defense needs. For Ukraine, this means the opportunity to receive support in the modernization of dual-use infrastructure facilities, which is an integral part of the state's security strategy.

An integral part of post-war reconstruction is the ecological modernization of transport. In this context, CEF supports the development of infrastructure for alternative fuels - the construction of electric charging stations, hydrogen refueling stations, a network for electric vehicles and innovative transport. This creates the basis for the transition to a "green" economy and sustainable development. For Ukraine, this is a chance not just to restore, but to qualitatively restart the transport system, making it modern, digitalized and energy-efficient.

Another advantage is the support for intelligent transport systems (ITS), digital traffic management and logistics platforms. In post-war Ukraine, such solutions will allow for effective management of transport flows, reduce congestion, ensure cargo control and increase overall road safety.

In summary, the CEF Transport instrument in the post-war period acts as a bridge between reconstruction and development. It not only finances the physical restoration of destroyed infrastructure, but also helps to build a new European transport reality - innovative, sustainable, safe and fully integrated into the common market. For Ukraine, participation in projects financed through the CEF is not only an economic opportunity, but also a political step towards deeper integration into the EU, towards shaping a future in which infrastructure is the foundation of development, security and well-being of society.

Today, when Ukraine is going through a difficult period of transformation and reconstruction, the support of international partners is of particular importance, which not only help to combat the consequences of the war, but also contribute to the creation of effective, transparent and sustainable public administration. One of Ukraine's key partners in this process is the United States Agency for International Development (USAID), whose activities cover a wide range of areas - from supporting digital services and energy stability to rebuilding critical infrastructure and strengthening community capacities. [46]

An important initiative implemented with the support of USAID and the UK aid fund is the Transparency and Accountability in Public Administration and Services (TAPAS) project. [47] This project plays a key role in increasing the

transparency of the functioning of the state, especially in the field of urban development - an industry that has traditionally been accompanied by high corruption risks. TAPAS not only contributes to the digitalization of processes, but also forms a new culture of interaction between citizens, authorities and businesses. The reform supported by TAPAS is based on Law No. 5655 - a comprehensive initiative that lays the foundations for an open, efficient and fair construction process. [48] Its main goal is to create conditions where any construction — from inception to commissioning — takes place under the control of society, with digital traces of decisions and the absence of shadow schemes. As part of this reform, the Unified State Electronic System in the Field of Construction (UESESSB) is actively developing, which already includes 15 electronic services, including notifications of the start of work, issuance of permits, construction passports, certificates, etc.

Digitalization of the construction sector is not only about convenience for citizens and businesses, but above all about trust. Every electronic document, every action in the system is recorded, creating a transparent environment where officials cannot act outside the law. This approach has already yielded real results - only thanks to the implementation of electronic services, over 261 million dollars have been saved.

This initiative was made possible thanks to the joint work of the Ministry of Community Development, Territories and Infrastructure of Ukraine, the Ministry of Digital Transformation, as well as expert and technical support from USAID and UK aid. Such an interagency approach allowed not only to develop a high-quality reform architecture, but also to take into account all the comments from anti-corruption bodies, in particular the National Agency for the Prevention of Corruption.

USAID and its partners are proving that transparency, digital tools, and good governance are not abstract concepts, but real levers of change. Thanks to projects like TAPAS, Ukrainians are receiving better services, having more control over government decisions, and gradually regaining trust in government

institutions. This is the foundation for a strong, democratic, and restored Ukraine.

USAID supports the development of digital services, energy stability, the reconstruction of critical infrastructure, and the strengthening of community capacities. For example, the project, created by the United States Agency for International Development (USAID) and the UK aid fund, funded by the Government of the United Kingdom, "Transparency and Accountability in Public Administration and Services" USAID / UK provides support to the citizens of Ukraine and the Ukrainian government in combating corruption in key public administration functions and services, and also contributes to building the trust of Ukrainians in the government based on transparency, accountability, and improved quality of services. [46]

Other donors and financial institutions — including the EBRD, EIB, G7 governments, the UN, Scandinavian governments, etc. It is important that international support is not only monetary: it includes engineering expertise, technology, personnel training, planning and monitoring support.

3. The principle of "Build Back Better" - rebuilding at a new level. The central approach to the implementation of the Program is the concept of "Build Back Better" - "to rebuild better than it was". It includes:

- o increased quality standards - road surfaces, engineering structures and buildings are designed taking into account the best international practices;
- o safety - in the focus of planning - minimizing vulnerabilities, in particular the arrangement of shelters, emergency systems, safe traffic;
- o environmental friendliness - the use of energy-efficient technologies, secondary materials, the implementation of solutions to reduce emissions and protect the environment.
- o inclusivity - taking into account the needs of low-mobility population groups and socially vulnerable categories;

- o digitalization - creation of digital maps, the use of BIM technologies in design, online monitoring of progress.Міндовкілля: «Build Back Better», «Build Back Greener» – ключові принципи відбудови України. [49]

The principle of “Build Back Better” means that recovery should not be limited to repairing the damaged. It is about creating sustainable, safe, environmentally friendly and modern infrastructure that will meet the needs of communities in the 21st century. The Ukrainian Government has officially begun implementing this philosophy by approving a resolution to launch a pilot project for the comprehensive recovery of six settlements that suffered the most damage: Borodyanka, Moshchun, Trostianets, Posad-Pokrovsky, Tsyrkuniv and Yagidne. [50]

These communities will become an example for the entire country - not a point, but a comprehensive approach: with new spatial planning, modern engineering infrastructure, taking into account environmental and social factors. This is not just restoring roofs - it is a transformation of the way of life and organization of space. It should be noted that the project does not mean ignoring other territories. Restoration is taking place throughout the country, but these six communities are experimental laboratories of new ideas, systematicity, transparency and efficiency. This is a chance to test the best approaches and scale them to the whole of Ukraine.

The Rapid Recovery Plan for 2025 covers hundreds of projects in hundreds of cities and towns. The principle of “rebuilding better” gives Ukrainians not only new homes, but also hope, confidence in tomorrow. In conditions of challenges and instability, it is extremely important: to know that the future is possible, and that it will be better than the past.

Thus, "Build back better" is not just a strategy, but a value that reflects the aspiration of Ukrainian society for a decent life, European standards and sustainable development. This is the path from ruin to revival. And right now we are all witnesses and co-creators of this historical process.

The focus of recovery strategies has also been the introduction of digital technologies in road management - GPS monitoring systems, digital repair projects, and public control over the use of funds through platforms such as "Transparent Infrastructure". [51]

Of particular importance is the development of transport corridors with the EU (in particular, within the framework of the Solidarity Roads initiative), which involves the modernization of western border routes for the integration of Ukraine into the European transport system. [52]

Thus, the initiative to deploy a European track on the railways to Lviv and Chisinau, which has become the subject of a study by the European Commission and the European Investment Bank, has significant potential for improving the integration of Ukraine and Moldova into the European Union transport system. This step is important for the development of economic ties between Ukraine, Poland, Romania and Moldova, which will certainly contribute to greater social cohesion and economic development. The main obstacle to effective rail communication is the different track widths, and therefore the study proposes the construction of a main network of European standard gauges (1435 mm) in Ukraine and Moldova. This will ensure integration with European transport corridors, significantly improving both freight and passenger traffic.

The Solidarity Roads programme, which was initiated after the start of the full-scale Russian invasion, aims to improve transport links between Ukraine and the EU. The development of railway infrastructure will contribute to better logistics of goods, which is extremely important for the Ukrainian economy in wartime conditions, and will also help accelerate the country's integration into the EU single market.

Projects for the construction of the Eurorail have already been identified in such areas as the connection between Poland and Ukraine (Medica/Mostyska - Lviv), as well as between Romania and Moldova. In addition, it is planned to modernise the existing railway network in Ukraine, including the reconstruction of tracks, depots and logistics centres.

At the same time, an important component for successful integration is the harmonisation of legislation, as well as the modernisation of infrastructure, which includes not only the development of new tracks, but also the upgrading of existing ones, in particular after the war.

The implementation of this strategy has the potential to significantly increase transport efficiency, improve the economic capabilities of Ukraine and Moldova and bring them closer to the standards of the European Union, which is important for further integration into the European economy.

Post-war reconstruction is an important stage for every country that has suffered significant destruction. The restoration of road infrastructure is especially important, because it ensures the effective connection of different parts of the country, contributes to the development of the economy and social relations. However, the restoration process requires a comprehensive approach, including environmental, economic and legal aspects. The key tasks of the road industry in the post-war period remain the main directions (See Fig. 3.13.)

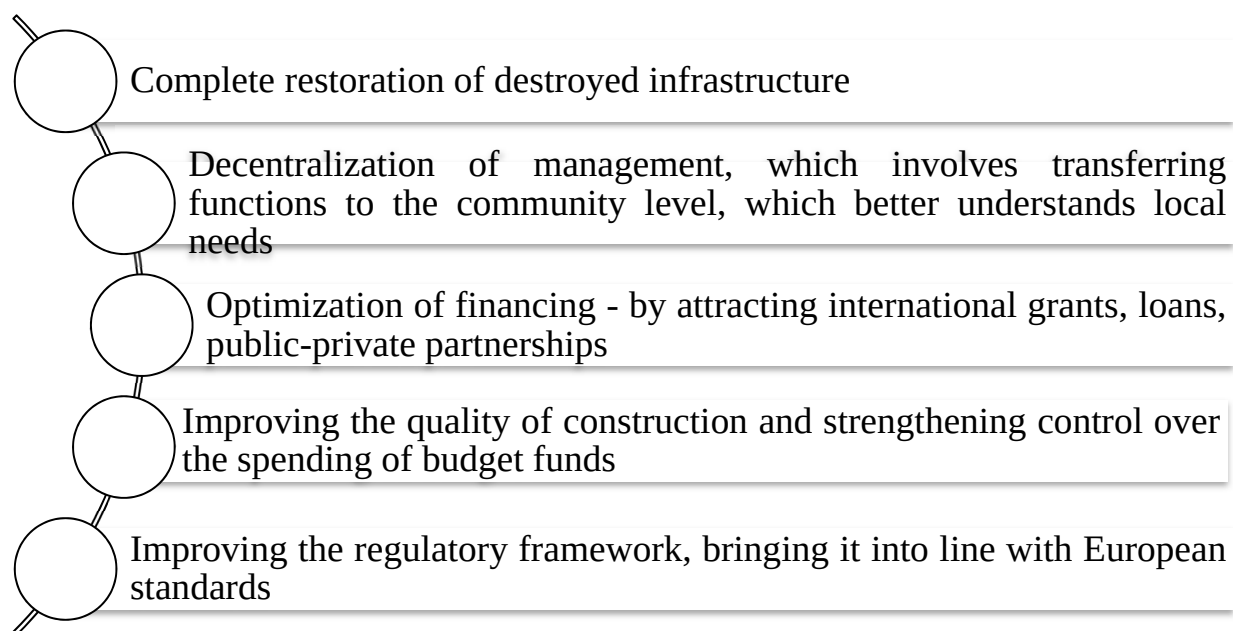


Fig. 3.13. Main directions of post-war restoration of the road industry road industry

Thus, the road sector in Ukraine is at a point of profound transformation. Its restoration is not only a matter of infrastructure, but also a strategic instrument of national development, security, and European integration.

In accordance with paragraph 26 of the Action Plan for the implementation of the recommendations of the European Commission presented in the Progress Report of Ukraine within the framework of the 2023 European Union Enlargement Package, approved by the Order of the Cabinet of Ministers of Ukraine dated February 9, 2024 No. 133-r, and the Work Plan of the Ministry of Culture and Information Policy of Ukraine for 2024, approved by the Order of the Ministry of Culture and Information Policy of Ukraine dated January 16, 2024 No. 13 [53].

The Action Plan to Implement the European Commission Recommendations, approved by the Cabinet of Ministers of Ukraine on February 9, 2024, is a comprehensive document containing over 350 measures. It is aimed at implementing the European Commission recommendations presented in the Progress Report on Ukraine under the 2023 European Union Enlargement Package. The priority areas of restoration according to the Action Plan are presented in Fig. 3.14. [53].



Reconstruction of key national highways (M-03, M-06, M-14, etc.) connecting major cities and borders with the EU
Restoration of bridges – critically important facilities that ensure interregional mobility
Improving border infrastructure – to speed up exports/imports, in the context of trade with the EU
Road safety and standardization – compliance with European technical standards and environmental regulations

Fig.3.14. Priority areas of recovery [53].

It should be noted that the World Bank recently approved a new project “Creating Resilient Infrastructure in Fragile Environments in Ukraine” (DRIVE), within the framework of which \$432 million has been allocated for the

reconstruction of road infrastructure. The restoration of transport infrastructure, according to this project, involves the overhaul of roads and bridges in 19 regions of Ukraine, the reform of national highways, the installation of modular bridges, as well as the provision of technical assistance and project management. The project will be implemented by the State Agency for Infrastructure Rehabilitation and Development of Ukraine [54.] The project is expected to be completed between 2025 and 2028. (See Fig. 3.15.)

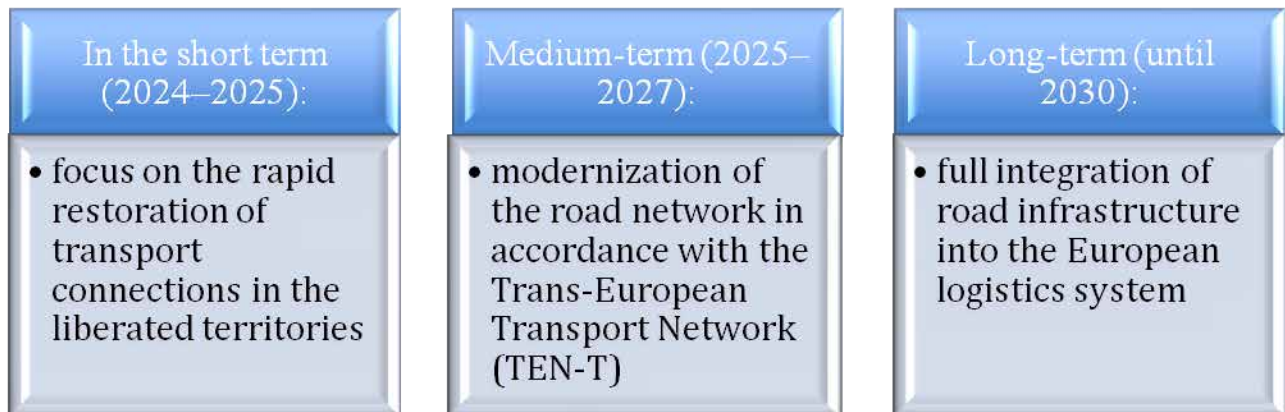


Fig. 3.15. Plans and timelines of the project “Creating Sustainable Infrastructure in Vulnerable Environments in Ukraine” (DRIVE)

The inclusion of Ukrainian logistics routes by the European Commission in the indicative maps of the Trans-European Transport Network (TEN-T) provides for the following changes (See Fig. 3.16.):

- o the North-Baltic corridor is extended through Lviv and Kyiv to Mariupol;
- o the Baltic-Black Sea-Aegean corridor is extended through Lviv, Chernivtsi (Romania and Moldova) to Odessa
- o the Baltic Sea-Adriatic Sea and Rhine-Danube corridors will pass through Lviv.

The specified changes allow:

- o to eliminate existing obstacles in carrying out logistics operations;
- o to attract European investments for the modernization of transport infrastructure;

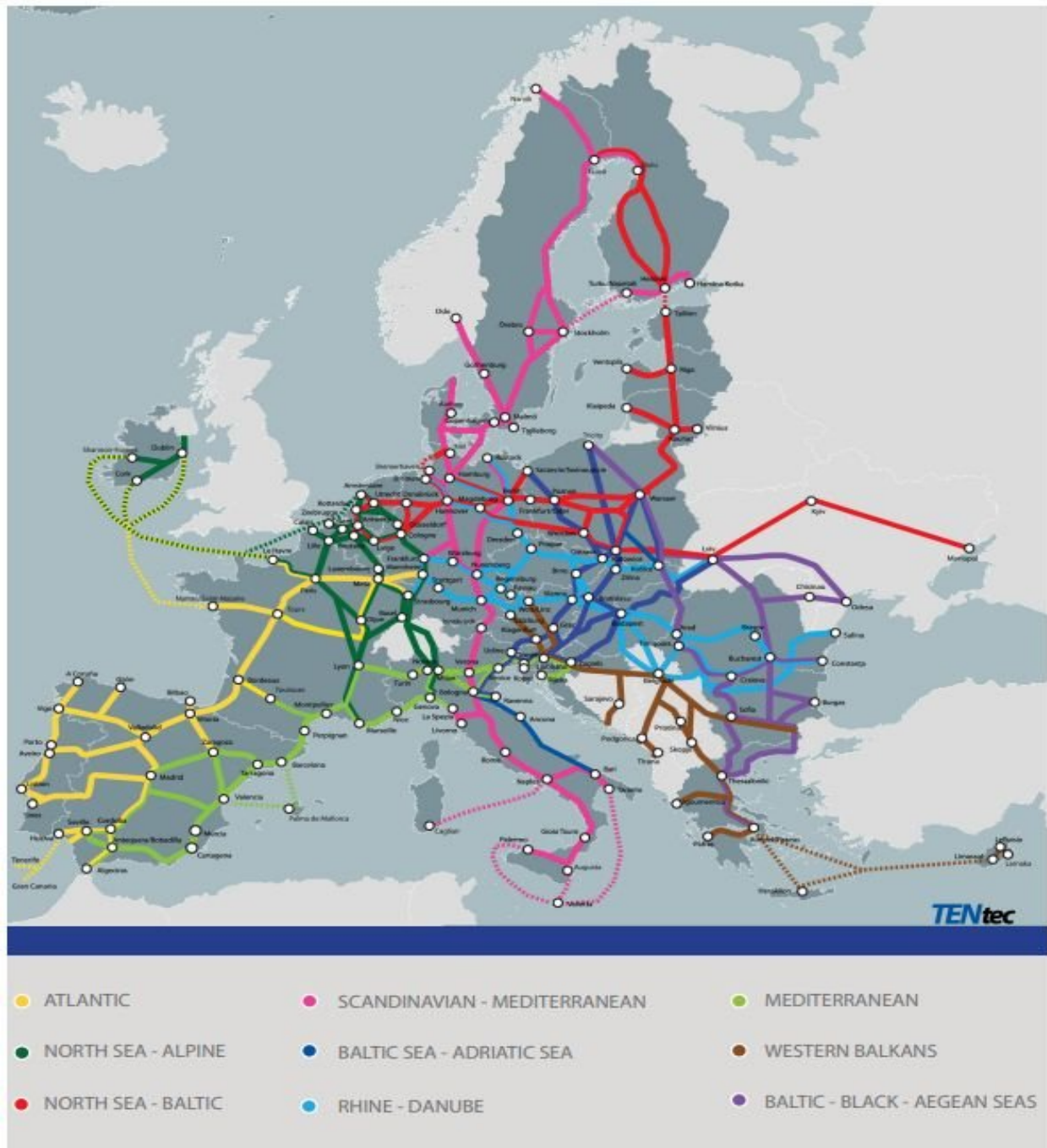


Fig. 3.16. Map of the Trans-European Transport Network (TEN-T) ⁷

- o to gain access to EU assistance instruments in the development of the Ukrainian part of the network;
- o TEN-T;
- o to develop multimodal transportation;

⁷ ЄС включив українські логістичні шляхи до Транс'європейської транспортної мережі, Липень 2022., <https://mtu.gov.ua/news/33618.html>

- o to reduce logistics costs;
- o to improve the quality of services in the transportation of goods.

The Trans-European Transport Network (TEN-T) is being created by the European Union with the aim of connecting Europe from west to east and from north to south with a network of roads, railways, airports and waterways. The development of the transport system will take place in two stages: by 2030 the construction of the “core” network should be completed, and by 2050 – the “general” network. Ukraine joined the TEN-T in 2017. According to the European Commission’s Indicative Investment Plan for the development of the TEN-T corridors, Ukraine plans to implement projects worth a total of €4?45 billion by 2030. This is the largest figure among all EU Eastern Partnership countries. Attracting such investments is critical for the maintenance and repair of infrastructure, as effective logistics play a crucial role in supporting life and security during war.

CONCLUSIONS TO SECTION III

Lands of motor transport and road management in Ukraine constitute a specific legal segment, which simultaneously covers both national and local interests. Despite the fact that they are formally in a common legal field, the features of their regulation require division into independent categories of management. The state network of motor roads, having unique functional characteristics, can be regulated separately from lands of other transport purposes. This opens the way to the formation of a more effective system of management of these lands based on a functional and targeted approach. In this context, an important innovation is the developed structural scheme for the distribution and management of lands of motor transport and road management as two interconnected, but autonomous categories of transport lands. Such an approach allows creating a clear hierarchy of powers between authorities and management entities, which positively affects the efficiency of resource management.

The proposed legal regulation mechanism ensures flexible use of lands in accordance with their category, which reduces the risks of violations of property rights, conflicts between authorities and land users. In addition, it contributes to the preservation of the natural environment through clearer zoning and control over land use within roadside strips.

Of particular importance is the ecological and economic aspect of the functioning of roadside areas. Mass illegal plowing of roadside strips is a threat to the ecological balance, leads to soil degradation and a decrease in the quality of road infrastructure. The introduction of legislative mechanisms for the protection of these lands is an extremely necessary step towards sustainable land use.

It is also important to establish clear parameters of protected areas at the stage of project documentation, with subsequent reflection in urban planning and cadastral documents. This will ensure transparency, predictability and legal certainty for all participants in the process of road construction and operation.

The function of land reservation is defined as a key tool of strategic planning, which allows taking into account social, environmental and economic factors when organizing land use. An effective mechanism for including areas for reservation in land management documentation is proposed, which guarantees the preservation of territories for future transport projects.

Within the framework of the “anticipate and provide” approach, it is proposed to provide the united territorial communities with greater autonomy in planning and developing transport infrastructure. Such a model will contribute to the creation of integrated spatial development, taking into account the specifics of each region, its social, transport and environmental needs. In the context of the post-war reconstruction of Ukraine, the problem of effective use, allocation and reservation of land for road construction is gaining particular relevance. Destroyed infrastructure requires a systemic approach to restoration, where legal regulation, optimal land use, environmental responsibility and strategic planning are interrelated components. The developed proposals can

serve as the basis for the formation of an updated policy for rebuilding the country's transport network, ensuring its long-term sustainability, integration and adaptability to modern challenges. Reservation of land for road reconstruction should become part of the national spatial development strategy, which will create the prerequisites for economic growth, restoration of territories and strengthening national security.

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INTERNATIONAL HIGHWAYS OF UKRAINE

Name of Highway	Index	Length, kilometers
Kyiv–Chernihiv–Novi Yarylovychi (to Gomel)	M-01	223,1
Approaches to: Chernihiv city		13,7
Brovary city		5,0
Total		241,8
Kipti–Hlukhiv–Bachivsk (to Bryansk)	M-02	242,4
Kyiv–Kharkiv–Dovzhanskyi (to Rostov-on-Don)	M-03	856,1
Approaches to: Kharkiv International Airport		14,1
Kharkiv city		1,0
Poltava city		1,6
Total		872,8
Znam'yanka–Luhansk–Izvaryne (to Volgograd via Dnipro, Donetsk)	M-04	607,6
Bypass of Donetsk city		12,3
Approach to Luhansk city		1,8
Total		621,7
Kyiv–Odesa	M-05	496,5
Bypass of Odesa city		41,1
Total		537,6
Kyiv–Chop (to Budapest via Lviv, Mukacheve, Uzhhorod)	M-06	849,2
Approaches to:Zhytomyr city		10,0
Novohrad-Volynskyi city		5,6
Lviv city		5,7
Rivne city		4,1
Total		874,6
Kyiv–Kovel–Yahodyn (to Lublin)	M-07	487,9
Approach to the bus terminal at the Yahodyn checkpoint		1,9
Total		489,8
Bypass of Uzhhorod – Uzhhorod Checkpoint	M-08	14,9
Lviv–Rava-Ruska (to Lublin)	M-09	62,5
Lviv–Krakovets (to Krakow)	M-10	68,1
Western bypass of Lviv		15,2
Total		83,3
Lviv–Shehyni (to Krakow)	M-11	72,1
Stryi–Ternopil–Kropyvnytskyi–Znam'yanka (via Vinnytsia)	M-12	750,4
Approaches to:Vinnytsia city		1,4
Khmelnyskyi city		8,0
Total		759,8

Continuation of Appendix A

Name of Highway	Index	Length, kilometers
Kropyvnytskyi–Platonove (to Chisinau)	M-13	258,1
Odesa–Melitopol–Novoazovsk (to Taganrog)	M-14	634,8
Approaches to:Kherson city		4,1
Mykolaiv city		4,9
Bypass of Melitopol		16,8
Total		660,6
Odesa–Reni (to Bucharest)	M-15	295,2
Odesa–Kuchurhan (to Chisinau)	M-16	58,7
Kherson–Dzhankoi–Feodosiia–Kerch	M-17	430
Kharkiv–Simferopol–Alushta–Yalta	M-18	687,7
Approach to Kharkiv International Airport		8,1
Bypass of Simferopol		12,1
Bypass of Novomoskovsk		23,7
Total		731,6
Domanove (to Brest)–Kovel–Chernivtsi–Terebleche (to Bucharest)	M-19	511,9
Bypass of Chernivtsi		14,0
Approach to Lutsk city		5,2
Total		531,1
Kharkiv–Shcherbakivka (to Belgorod)	M-20	28,4
Zhytomyr–Mohyliv–Podilskyi (via Vinnytsia)	M-21	221,2
Approach to Berdychiv city		7,7
Bypass of Kalynivka city		9,3
Approaches to the "Druzhba" bridge across the Dnister River		0,5
Total		238,7
Poltava–Oleksandriia	M-22	148,1
Beregove–Vynohradiv–Velyka Kopanya	M-23	49,5
Mukacheve–Beregove–"Luzhanka" checkpoint	M-24	37,5
"Solomonovo" checkpoint–Velyka Dobron'–Yanoshi with an approach to the "Kosyny" checkpoint	M-25	59,6
"Vylok" checkpoint – Vylok – Nevetlenfolu – "Diakove" checkpoint	M-26	20,7
Odesa–Illichivsk	M-27	14,0
Odesa–Yuzhne with approaches	M-28	49,0
Kharkiv–Krasnohrad–Pereshchepyne–/M-18/	M-29	157,9
Total length of international highways		8 200

NATIONAL AUTOMOBILE ROADS

Highway Name	Index	Length, kilometers
Kyiv–Znamianka	H-01	272,9
Access road to Obukhiv		8,3
Total		281,2
Lviv–Ternopil	H-02	111,9
Zhytomyr–Chernivtsi	H-03	335,0
Krasnoperekopsk–Simferopol	H-05	115,0
Access road to the International Airport "Simferopol"		1,0
Total		116,0
Simferopol–Bakhchysarai–Sevastopol	H-06	66,4
Access road to Belbek Airport (Sevastopol)		2,9
Total		69,3
Kyiv–Sumy–Yunakivka (to Kursk)	H-07	339,6
Boryspil–Dnipropetrovsk–Zaporizhzhia	H-08	429,6
Access road to the "Dnipropetrovsk" Airport		5,3
Total		434,9
Mukacheve–Rakhiv–Bohorodchany–Ivano- Frankivsk–Rohatyn–Bibrka–Lviv	H-09	435,1
Access road to the "Bukovel" resort area		7,7
Total		442,8
Stryi–Ivano-Frankivsk–Chernivtsi–Mamalyha	H-10	263,5
Access road to Ivano-Frankivsk		4,0
Access road to Tysmenytsia		7,1
Total		274,6
Dnipropetrovsk–Mykolaiv (via Kryvyi Rih)	H-11	239,5
Sumy–Poltava	H-12	151,6
Sumy bypass		18,8
Total		170,4
Lviv–Sambir–Uzhhorod	H-13	232,5
Oleksandrivka–Kirovohrad–Mykolaiv	H-14	214,3
Southern bypass of Kirovohrad		25,6
Total		239,9
Zaporizhzhia–Donetsk	H-15	210,7
Zolotonosha–Cherkasy–Smila–Uman	H-16	199,6

Highway Name	Index	Length, kilometers
Lviv–Radekhiv–Lutsk	H-17	130,5
Ivano-Frankivsk–Buchach–Ternopil	H-18	106,9
Yalta–Sevastopol	H-19	80,7
Sloviansk–Donetsk–Mariupol	H-20	190,4
Starobilsk–Luhansk–Makiivka–Donetsk	H-21	206,6
Ustyluh–Lutsk–Rivne	H-22	155,9
Kirovohrad–Kryvyi Rih–Zaporizhzhia	H-23	251,1
Access road to the "Kryvyi Rih" Airport		2,6
Total		253,7
Total length of national automobile roads		4 811,0

REGIONAL HIGHWAYS

Highway Name	Index	Length, kilometers
Kyiv–Obukhiv	P-01	20,3
Kyiv–Ivankiv–Ovruch	P-02	171,7
Access roads to: Chornobyl NPP (Checkpoint Dytiatky)		27,7
Memorial complex in the village of Novi Petrivtsi		2,0
Special object № 1		1,0
Special object № 2		7,0
Special object № 3		2,4
Total		211,8
North-eastern bypass of Kyiv	P-03	28
Access road to the M-03 highway		5,5
Total		33,5
Kyiv–Fastiv–Bila Tserkva–Tarashcha–Zvenyhorodka	P-04	208,3
Horodyshe–Rivne–Starokostiantyniv	P-05	292,4
Access roads to Rivne		3,4
Access roads to Netishyn		2,4
Total		298,2
Ulianovka–Mykolaiv (via Voznesensk)	P-06	222,3
Access road to the Mykolaiv International Airport		2,2
Total		224,5
Chuhuiv–Milove (via Starobilsk)	P-07	298,3
Nemyriv–Yampil	P-08	118,6
Myronivka–Kaniv–Sofiivka	P-09	58,6
Kaniv–Chyhyryn–Kremenchuk (with access road to the village of Subotiv)	P-10	195,6
Poltava–Krasnohrad	P-11	52,6
Chernihiv–Mena–Sosnytsia–Hremiach	P-12	203,8
Access road to the city of Novhorod-Siverskyi		4,7
Total		208,5
Chernihiv–Horodnia–Senkivka	P-13	72,3
Lutsk–Kivertsi–Manevychi–Liubeshiv–Dolsk	P-14	154,4
Kovel–Volodymyr–Volynskyi–Chervonohrad–Zhovkva	P-15	149,4
Access roads to special objects in the Autonomous Republic of Crimea	P-16	86,0

Highway Name	Index	Length, kilometers
Bila Tserkva–Tetiiv–Lypovets–Humenne–/M-12/	P-17	157,2
Zhytomyr–Popilnia–Skvyra–Volodarka–Stavyshche	P-18	149,4
Fastiv–Mytsnytsia–Obukhiv–Rzhyshchiv–Kaniv	P-19	143,4
Sniatyn–Tiaziv	P-20	107,5
Dolyna–Khust	P-21	128,8
Krasna Talivka Checkpoint–Luhansk	P-22	55,9
Simferopol–Feodosiia	P-23	109,6
Tatariv–Kosiv–Borshchiv–Kamianets-Podilskyi	P-24	246,9
Simferopol–Yevpatoriia	P-25	53,0
Ostroh–Kremenets–Pochaiv–Radyvyliv	P-26	121,2
Sevastopol–Inkerman	P-27	38,5
Vystupovychi (to Mozyr)–Zhytomyr (via Ovruch)	P-28	163,4
Alushta–Sudak–Feodosiia	P-29	121,3
Access road to Irpin	P-30	12,0
Berdychiv–Khmilnyk–Lityn (to the M-12 highway)	P-31	79,4
Kremenets–Bila Tserkva–Rzhyshchiv	P-32	398,8
Access road to Bila Tserkva		3,3
Total		402,1
Vinnytsia–Turbiv–Haisyn–Balta–Velyka Mykhailivka–/M-16/	P-33	366,3
Yalta–Alushta	P-34	77,4
Hrushivka–Sudak	P-35	20,2
Nemyriv–Mohyliv-Podilskyi	P-36	107,1
Enerhodar–Vasylivka–Berdiansk	P-37	200,3
Bohorodchany–Huta	P-38	36,3
Brody–Ternopil	P-39	72,3
Rava-Ruska–Yavoriv–Sudova Vyshnia	P-40	54,8
Bypass of Ternopil	P-41	14,5
Lubny–Myrhorod–Opishnia–/H-12/	P-42	121,9
Ternopil (from the M-12 highway)–Lanivtsi (to the R-32 highway)	P-43	56,2
Sumy–Putyvl–Hlukhiv	P-44	131,0
Sumy–Krasnopillia–Bohodukhiv	P-45	105,1

Continuation of Appendix C

Highway Name	Index	Length, kilometers
Kharkiv–Okhtyrka	P-46	103,7
Kherson–Nova Kakhovka–Henichesk	P-47	199,2
Access road to the "Askania-Nova" reserve		22,3
Access road to Kakhovka city		3,4
Total		224,9
Kamianets-Podilskyi–Sataniv–Viitivtsi–Bilohiria	P-48	159,9
Vaskovychi–Shepetivka	P-49	162,2
Yarmolyntsi–Sataniv	P-50	51,1
Access road to the urban-type settlement of Yarmolyntsi		5,1
Total		56,2
Merefa–Lozova–Pavlohrad	P-51	160,6
Dnipropetrovsk–Tsarychanka–Kobeliaky–Reshetylivka	P-52	147,0
Malyi Bereznyi Checkpoint–Malyi Bereznyi	P-53	3,1
Krasnopilka–Teplyk–Bershad–Savran–Dubynove–/M-05/	P-54	150,6
Odesa–Voznesensk–Novyi Buh	P-55	205,8
Chernihiv–Pakul–Slavutych Checkpoint–Chornobyl (with access road to Slavutych)	P-56	72,3
Tsiurupynsk–Hola Prystan–Skadovsk	P-57	80,9
Sevastopol–"Kamyshova Bukhta" port	P-58	8,2
Access road to special objects in Sevastopol	P-59	2,9
Krolevets–Konotop–Romny–Pyriatyn	P-60	222,7
Baturyn–Konotop–Sumy	P-61	146,2
Access road to the "Hetman's Capital" reserve		1,4
Total		147,6
Verkhovyna–Ust-Putyla–Vyzhnytsia–Storozhynets–Chernivtsi	P-62	111,2
From the H-03 highway (Dankivtsi)–Vartykyvtsi–Sokyryany Checkpoint	P-63	88,7
Access roads to: Rososhany Checkpoint		21,2

Highway Name	Index	Length, kilometers
Larha Checkpoint		1,8
Total		111,7
Kivshuvata–Shushkivka–Lysianka–Moryntsi–Shevchenkove–Tarasivka–/H-16/	P-64	81,3
Mykolaivka Checkpoint–Semenivka–Novhorod-Siverskyi–Hlukhiv–Katerynivka Checkpoint	P-65	107,8
Demyno–Oleksandrivka Checkpoint–Svatove–Lysychansk–Luhansk	P-66	217,3
Chernihiv–Nizhyn–Pryluky–Pyriatyn	P-67	184,2
Access road to Nizhyn		7,6
Total		191,8
Talalaivka–Ichnia–Trostianets–Sokyryntsi–/H-07/	P-68	94,1
Access road to the "Kachanivka" National Historical and Cultural Reserve		5,3
Total		99,4
Kyiv–Vyshhorod–Desna–Chernihiv	P-69	138,0
Odesa–Bilhorod-Dnistrovskyi–Monashi–/M-15/ with access road to the Illichivsk port	P-70	96,9
Odesa–Ivanivka–Ananiv–Pishchana–Khashchuvate–Kolodyste–Ryzhovka–/M-05/	P-71	274,8
Starokozache Checkpoint–Bilhorod-Dnistrovskyi	P-72	32,4
/H-08/–Nikopol	P-73	64,2
Piatykhatky–Kryvyi Rih–Shyrokye	P-74	49,5
Tymkove Checkpoint–Balta–Pervomaisk–Domanivka–Oleksandrivka	P-75	184,3
Prykladnyky Checkpoint–Zarichne–Dubrovytsia	P-76	80,6
Rivne–Tuchyn–Hoscha–/R-05/	P-77	68,3
D=Kharkiv–Zmiiv–Balakliia–Horokhovatka	P-78	127,7
/M-18/–Sakhanovshchyna–Izium–Kupiansk–Pisky Checkpoint	P-79	277,9
Total length of regional automobile roads		7 501

TERRITORIAL MOTOR ROADS

Name of Road	Index	Length, kilometers
Bypass of Simferopol (Myrne–Dubky section)	T-01-01	7,3
Severne–Voikove	T-01-02	26,1
Saky–Orlivka	T-01-04	41,9
Tankove–Oboronnie	T-01-05	11,0
Simferopol–Mykolaivka	T-01-06	35,0
Chornomorske–Voinka	T-01-07	120,6
Chornomorske–Yevpatoriia	T-01-08	67,2
Krasnohvardiiske–Nyzhnohirskiyi	T-01-10	36,2
Rozdolne–Yevpatoriia	T-01-11	67,6
Nyzhnohirskiyi–Bilohirsk	T-01-12	54,1
Kirovske–Pervomaiske	T-01-13	17,8
Lenine–/M-17/	T-01-14	4,1
Novopavlivka–Nauchnyi	T-01-16	14,0
Bakhchysarai–Yalta	T-01-17	69,9
Mohyliv–Podilskiyi–Yampil–Bershad–Uman	T-02-02	216,7
Turbiv–Pohrebyshche–Skvyra	T-02-03	89,9
Southern bypass of Vinnytsia	T-02-04	19,3
Dzhulynka–Haivoron–Ulyanivka–/M-05/	T-02-07	46,1
Verbovets–Naddnistrianske–Bilousivka	T-02-11	29,0
Vinnytsia–Shpykiv–Komarhorod	T-02-12	79,9
M-12–Bilykivtsi	T-02-14	30,8
Yampil–Velyka Kisnytsia	T-02-15	21,4
Vinnytsia–Hnivan–Tyvriv	T-02-16	33,6
Murovani Kurylivtsi–Horai	T-02-17	23,6
Luka Barska–Bilykivtsi–Zhmerynka–Yampil	T-02-18	131,6
Stara Huta–Kalynivka–Turbiv	T-02-19	64,8
Vendychany–Chernivtsi–Tomashpil	T-02-20	60,0
Nemyriv–Illintsi	T-02-21	28,5
Shpykiv–Tulchyn–Trostanets–Bershad	T-02-22	86,4
Plyskiv–Yakymivka	T-02-23	23,6
Trostanets–Teplik	T-02-24	40,1
Border checkpoint "Bolhan"–Pishchanka–Chechelnyk	T-02-25	47,3
Haisyn–Teplik	T-02-26	29,6
Bilopillia–Vivsianyky	T-02-27	54,6
Pariivka–Orativ Station	T-02-28	16,6

Name of Road	Index	Length, kilometers
Orativ–Stupky–Korytnia–Monastyryshche Station– Monastyryshche	T-02-35	33,8
Lypovets–Slavna–Spychyntsi–Pohrebyshche– Zbarzhivka–/R-17/	T-02-36	88,3
Tulchyn–Kleban–Ladyzhyn	T-02-37	31,7
Komsomolske–Ulaniv	T-02-38	47,3
/Nemyriv–Yampil/–ferry crossing	T-02-40	3,3
Bar–Cherniatyn–Zhmerynka	T-02-41	25,4
/M-21/–Braiiiv–Ryzhavka–Tyvriv	T-02-42	35,5
Vilka–Zymne	T-03-01	2,5
Pishcha–Shatsk–Liuboml–Volodymyr–Volynskiy– Pavlivka–Horokhiv–Berestechko–Kozyn–Kremenets– /M-06/	T-03-02	204,1
Lutsk–Radomyshl–Demydivka–Dubno	T-03-03	70,1
Novovolynsk–Ivanychi–Pavlivka–Lokachi	T-03-05	40,8
/T-03-02/–Shatsk–Vilytsia–Prypiat–Liubokhyny–/T- 03-08/	T-03-06	22,3
Border checkpoint "Pulemets"–border checkpoint "Pishcha"	T-03-07	18,9
Liuboml–Dubechne–Zdomyshel–Ratne–Kamin- Kashyrskiy–Liubeshiv–/R-14/	T-03-08	147,0
/T-03-08/–Dubechne–Stara Vyzhivka–/M-07/– Turiisk–Rozhyshche–Kivertsi–Pidubtsi–/H-22/	T-03-09	151,3
Stara Vyzhivka–Butsyn–/M-19/	T-03-10	14,2
/R-14/–Sedlyshche–Kamin–Kashyrskiy–Kovel–/M- 19/–Kolodiazhne–Lokachi–/H-17/	T-03-11	159,1
/R-14/–Zhuravychi–Berestyane–Tsumany–/H-22/– Olyka–Lychany (to Pitushkiv)	T-03-12	53,6
Tsumany–Hremiache–Yakivtsi (to Derazhne)	T-03-13	8,7
/T-03-02/–“Lisova Pisnia” sanatorium	T-03-14	2,0
Zalissia–/T-03-02/	T-03-15	13,7
Dnipro–Vasylivka–Pokrovske–Huliaipole–Polohy– Melitopol	T-04-01	248,8
Ihren–Oleksandrivka–/M-18/	T-04-02	12,8
Maryanske–Beryslav–/R-47/	T-04-03	98,8
Dnipro–Kirovske–/Dnipro–Khutirske/	T-04-04	18,4
Dnipro–Khutirske	T-04-05	33,6
Hryhorivka–Mezhova–Krasnoarmiysk	T-04-06	94,8

Continuation of Appendix D

Name of Road	Index	Length, kilometers
Pavlohrad–Vasylivka–Novomykolaivka–Orikhiv–Tokmak	T-04-08	146,2
Dnipro–Mahdalynivka–Kotovka	T-04-10	72,6
Shyroke–Oleksandrivka–Zaporizhzhia	T-04-11	25,8
Dniprodzerzhynsk–Shulhivka–Mykhailivka–Kotovka– Pereshchepyne–Cherniavshchyna–Zhemchuzhne	T-04-12	197,0
Tsarychanka–Mahdalynivka–Hubynykha	T-04-13	65,2
Dniprodzerzhynsk–Petrykivka–Mahdalynivka	T-04-14	46,4
Verkhnodniprovsk–Vilnohirsk–/M-04/	T-04-15	43,1
Pavlohrad–Synelnykove	T-04-16	25,0
Dniprodzerzhynsk–Mykolaivka–Solone–/H-08/	T-04-17	53,4
Piatykhatky–Apostolove–Zelenodolsk	T-04-19	127,3
Odarivka–Tomakivka–Vyschetarasivka	T-04-20	108,6
Dnipro–Novomykolaivka–/M-04/	T-04-21	24,5
Pavlohrad–Nadezhdivka–Holubivka	T-04-22	56,2
Myshuryn Rih–Vilnohirsk	T-04-23	45,8
Vesele–Oleksandropol–Petrodavlivka–/M-04/	T-04-24	23,1
/M-04/–Pidpilne–Derezuvate–Synelnykove	T-04-25	34,1
/M-04/–Kozachyi Hai	T-04-26	21,6
Dmytrivka–Zelenyi Hai–Havrylivka	T-04-27	51,7
Slovyanka–Mezhova–Dachne	T-04-28	46,2
Verkhnodniprovsk Station–Verkhivtseve–Shchorsk	T-04-29	33,6
Dniprodzerzhynsk–Svitlohirsk	T-04-30	17,6
Pershotravensk–Vasylykivske–Volodymyrivka–Solone	T-04-31	24,9
Shchorsk–Malosofiivka–Nikopol	T-04-32	104,2
Shchorsk–Boltysheva–Malosofiivka	T-04-33	22,2
Ordo–Vasylivka–Serhiivka–Veseli Terny–/H-11/	T-04-34	35,2
/Shchorsk–Malosofiivka–Nikopol/–Novoivanivka– Marhanets–Vyschetarasivka	T-04-35	70,8
/H-23/–Pokrovske–Kapulivka–/H-23/	T-04-36	16,9
Verkhnodniprovsk–/H-08/	T-04-37	2,7
Krynichky–/M-04/	T-04-39	4,2
Dnipro–Tsarychanka–Kobeliaky–Reshetylvka (section: Loboykivka–Petrykivka)	T-04-41	7,6
Nekhvoroshcha–Hupalivka	T-04-42	3,4
/Shyroke–Shestirnia–Zahradivka/–Serhiivka–/H-23/	T-04-43	38,6
Novomykolaivka–Leninske–Sursko–Mykhailivka	T-04-44	13,2
Synelnykove–Slavhorod–Vilniansk	T-04-45	45,6

Continuation of Appendix D

Name of Road	Index	Length, kilometers
Verkhnodniprovsk–Lykhivka	T-04-46	25,9
Shyroke–Shestirnia–Zahradivka	T-04-47	19,3
Krasnoarmiysk–Artemivsk–Mykhailivka	T-05-04	130,8
Avdiivka–Donetsk	T-05-05	7,6
Donetsk–Khartsyzk–Amvrosiivka–checkpoint “Uspenka”	T-05-07	62,5
Donetsk–Novoazovsk–Sedove	T-05-08	111,3
Velyka Novosilka–Amvrosiivka	T-05-09	124,6
Snizhne–Marynivka (to Kuibysheve)	T-05-10	16,7
Yenakiieve–Khartsyzk	T-05-11	26,0
Volnovakha–Telmanove	T-05-12	50,7
Krasnyi Lyman–Artemivsk–Horlivka (Obropillia)	T-05-13	77,3
(unnamed segment)	T-05-14	59,4
Oleksandrivka–Krasnoarmiysk–Kostiantynopil	T-05-15	92,5
Kostiantynivka–Dzerzhynsk	T-05-16	15,2
Yenakiieve–Shakhtarsk–Amvrosiivka	T-05-17	45,5
Bohatyr–Velyka Novosilka–Volodarske	T-05-18	118,8
Amvrosiivka–Telmanove–Mariupol	T-05-19	121,6
/M-04/–Horlivka	T-05-20	8,3
/M-03/–access to the city of Sviatohirsk	T-05-21	9,4
/H-21/–access to Savur-Mohyla	T-05-22	9,1
/H-20/–Kremenivka–Yalta	T-05-23	59,7
Dubrivka–Baranivka–Vysoka Pich	T-06-01	67,8
Korostyshiv–Kosharyshche	T-06-02	13,8
/M-06/–Chervonoarmiisk–Nova Borova	T-06-03	36,3
Korosten–/Kyiv–Ivankiv–Ovruch/ via Narodychi	T-06-04	51,9
Checkpoint "Maidan Kopyshchenskyi" –Olevsk– Chervonoarmiisk–Korostyshiv–Kotliarka	T-06-05	255,3
Berdychiv–Pohrebyshche–Illintsi	T-06-06	130,2
Cherniakhiv–Malyn–Termakhivka	T-06-07	99,9
Ovruch–Malyn–Kocheriv	T-06-08	138,7
/Zhytomyr–Skvyra–Volodarka/–Andrushivka	T-06-09	6,5
Liubar–Khmilnyk–Luka Barska–Nova Ushytsia	T-06-10	138,9
Stavysche–Brusyliv–Popilnia–Vchoraishe	T-06-11	87,7
Novohrad-Volynskyi–Polonne–Starokostiantyniv	T-06-12	100,7
Korosten–/Kyiv–Kovel–Yahodyn/ via Kozhukhivka	T-06-13	9,3
Hlybochysia–Stanyshivka via Kalynivka, Klitynch	T-06-14	9,5

Continuation of Appendix D

Name of Road	Index	Length, kilometers
/Kyiv–Kovel–Yahodyn/–Luhyny	T-06-15	2,7
Chyzhivka–Horodnytsia	T-06-16	28,8
Ovruch–Slovechne	T-06-17	32,6
/M-06/–Romaniv–Romanyvka	T-06-18	46,4
Ovruch Semi-ring	T-06-19	7,5
Velyka Dobron–Mukachevo	T-07-10	24,7
Perechyn–Svaliava–Lypcha	T-07-12	107,3
Shom–Hornohlab–checkpoint "Dzvinkove"	T-07-14	9
Berehove–Kam'yanske	T-07-17	25,3
Nyzhni Vorota–Volovets–Mizhhiria	T-07-18	44,6
Dovhe–Irshava–Vynohradiv	T-07-19	45,5
Mizhhiria–Kolochava–Bushtyno	T-07-20	81,5
Synevyr–Synevyrska Polyana	T-07-24	13,9
Vynohradiv–Tekove–Nevetlenfolu	T-07-35	21,7
Khust–Shayan–Vyshkovo–Bushtyno with access to sanatorium "Shayan"	T-07-37	23,2
Mukachevo Bypass	T-07-39	5,8
/M-06/–Holubyne	T-07-41	1,2
Zaporizhzhia–Mariupol	T-08-03	209,1
Kamianka–Dniprovsk–Velyka Lepetykha–Kakhovka	T-08-04	105,4
Kamianka–Dniprovsk–Velyka Bilozerka–Vesele–/M-14/	T-08-05	116,2
Zaporizhzhia–Bilenke	T-08-06	28,3
Velyka Bilozerka–Mykhailivka–/M-18/	T-08-10	50,2
Vesele–/M-18/	T-08-11	35,6
/M-18/–Luhove–Orikhiv	T-08-12	37,3
Tokmak–Chernihivka	T-08-13	31,1
/Pavlohrad–Tokmak/–Omelnyk–Huliaipole	T-08-14	27
Orikhiv–Polohy–Kinski Rozdory–Andriivka–Novovasylivka–Berdiansk	T-08-15	123,9
Vasylivka–Dnipro-rudne–Vesele	T-08-17	63,1
Vasylivka–Mykhailivka–Matviivka	T-08-18	37,5
Kuibysheve–/M-14/	T-08-19	51
Yakymivka–Kyrylivka	T-08-20	41,6
Polohy–Chernihivka–Prymorsk	T-08-21	95,7
Kalush–Osmoloda	T-09-01	54,4
Krekhovychi–Dzvyniach	T-09-02	46,5
Halych–Horodok	T-09-03	132,1

Continuation of Appendix D

Name of Road	Index	Length, kilometers
Ozeryany–Rozhniv	T-09-04	60,7
Deliatyn–Rakivchyk	T-09-05	30,3
Access to Kolomyia		1,8
Total		32,1
Ivano-Frankivsk–Nadvirna	T-09-06	26,7
Sniatyn–Kosiv–Stari Kut	T-09-09	47,3
Burshtyn–Kalush	T-09-10	32,9
Vorzel–Zabuchchia–/Kyiv–Chop/	T-10-01	12,4
Demydiv–Hostomel	T-10-02	16,9
/M-01/–Rudnia–Hoholiv–Boryspil	T-10-04	44,9
Ivankiv–Radomyshl	T-10-05	60,3
Hlevakha–Pidhirtsi	T-10-06	14,2
Kyiv–Litochky–Kipti	T-10-08	87,4
Ustymivka–Hrebinky–Uzin	T-10-09	32,5
Rokytno–Uzin	T-10-10	15,1
Hostomel–Berestyanka–Myrcha–/M-07/	T-10-11	54,6
Kyiv–Boiarka	T-10-12	10,9
Fastiv–Kozhanka–Fursy–Yablunivka–Volodarka	T-10-13	74,1
Tetiiv–Piatyhory–/M-05/	T-10-14	30,7
Makariv–Komarivka (towards Radomyshl)	T-10-15	28,2
Kyiv–Revne–Rohoziv	T-10-16	37,9
Myronivka–Olshanytsia–Rokytno–Dovhalivske–Ploske	T-10-17	75,4
Boryspil–Berezan–Yahotyn–Zhoravka (to Teplivka)	T-10-18	73,1
Fanevychi–Borodianka–Makariv–Byshiv	T-10-19	65,7
Skvyra–Rude Selo–/Bila Tserkva–Tetiiv–Lypovets–Humenne/	T-10-20	27,2
Teleshivka–Olshanytsia–Tarashcha–Stavyshche	T-10-21	61,4
Myronivka–Bohuslav–/Kyiv–Fastiv–Bila Tserkva–Tarashcha–Zvenyhorodka/	T-10-22	36,1
Vasylkiv–Hlevakha	T-10-23	2,8
Zghurivka–Berezan–/M-03/	T-10-24	33,6
Peremoha–Baryshivka–Pereiaslav–Khmelnitskyi	T-10-25	56,7
Brovary–Trebukhiv–Hora	T-10-26	18,4
Kyiv Semi-Ring	T-10-27	13,3
Fastiv–Didivshchyna–Brusyliv–Kocheriv	T-10-28	49,5
Kaharlyk–Karapyshi–Bohuslav	T-10-29	38,9

Name of Road	Index	Length, kilometers
Rokytne–Stavy	T-10-30	20,5
Pereiaslav-Khmelnytskyi–Dobranichyvka–/M-03/	T-10-31	48,8
Pereiaslav-Khmelnytskyi–Pereiaslavska Station	T-10-32	24,7
Uzin–Vasyliv–Hermanivka–Trypillia	T-10-33	55,0
/M-01/–Krekhaiv village with access to Litky village	T-10-34	28,1
/P-02/–Vilcha Station–Checkpoint “Vilcha–Oleksandrivka”	T-10-35	17,9
Ivankiv–Horodyshche	T-10-37	3,2
Vasylkiv–Kniazhychi–Luka–Horenychi–/M-06/	T-10-38	37,3
Hostomel Highway–Marshal Rokossovsky Avenue	T-10-39	7,3
Kirovohrad–Kanyzh–Novomyrhorod	T-12-01	51,7
/M-12/–"Khutir Nadiia" Nature Reserve–/M-13/	T-12-02	13,5
/M-22/–Pavlysh–Onufriivka–Mlynok–/H-08/	T-12-03	31,6
Dolynska–Novoshevchenkove–/H-23/	T-12-04	19,3
Kirovohrad–Nova Praha–Oleksandriia	T-12-05	59,3
Novoarkhanhelsk–Petroostriv–Novomyrhorod	T-12-06	83,3
/H-01/–Tsybuleve station (district border)–Vysoki Bairaky–/M-12/	T-12-07	38,3
Pushkove–Vilshanka–Dobrovelychkivka	T-12-08	51,6
Novomyrhorod–Oleksandrivka	T-12-09	48,9
Ustynivka–Dolynska–Petrove–Zhovti Vody	T-12-10	109,1
Znamianka–Podorozhnje	T-12-11	51,0
Novomyrhorod–Velyka Vyska	T-12-12	20,7
Novoarkhanhelsk–Dobrovelychkivka–Mykolaivka	T-12-14	81,7
Hlynsk–Oleksandriia–Petrove–regional border	T-12-15	88,6
Shyshkyne–Kompaniivka–Ustynivka	T-12-16	73,1
Oleksandrivka–Buryakove–/P-10/	T-12-17	30,8
Novhorodka–Sharivka station–Nova Praha	T-12-18	34,4
Tyshkivka–Vilshanka–Pervomaisk	T-12-19	47,4
/Znamianka–Podorozhnje/–/M-04/	T-12-20	4,4
Kirovohrad–Rivne	T-12-21	45,0
Novoukrainka–Bratske with access to the "Husarske Urochyshe" Sanatorium	T-12-22	56,2
Ivankhorod–Rozumiivka–Krymky	T-12-23	23,5
Luhansk–Heorhiivka with access to "Luhansk" Airport	T-13-01	16,1

Name of Road	Index	Length, kilometers
Checkpoint "Taniushivka"–Starobilsk–Artemivsk	T-13-02	162,1
Uspenka–Antratsyt	T-13-03	32,8
Sverdlovsk–Biryukove–/M-03/	T-13-05	23,6
Sievierodonetsk–Novoaidar	T-13-06	37,1
Svatove–Novopskov–Milove	T-13-07	164,3
Starobilsk–Markivka	T-13-08	54,3
Shchastia–Shyrokyi	T-13-09	37,4
Lutuhyne–Krasnodon	T-13-10	41,2
Sverdlovsk–Checkpoint "Chervonopartyzansk"	T-13-11	10,8
Krasnodon–Antratsyt	T-13-12	62,3
Troitske–Bilokurakyne–Starobilsk	T-13-13	111,4
Checkpoint "Prosyane"–Bilovodsk–Shyrokyi	T-13-14	93,8
Raihorodka–Slovianoserbsk–Mykhailivka	T-13-15	56,2
Access road to Pervomaisk city	T-13-16	12,7
Access road to Kirovsk city	T-13-17	14,0
Bile–Lutuhyne	T-13-18	18,2
Perevalsk–Ivanivka	T-13-19	27,9
Heorhiivka–Rovenky–/M-03/	T-13-20	48,9
Bilolutsk–Checkpoint "Novobila"	T-13-21	19,0
Checkpoint "Smilnytsia"–Staryi Sambir	T-14-01	30,0
Skhidnytsia–Pisochna	T-14-02	52,5
Hrushiv–Nemyriv	T-14-03	12,4
Chervonohrad–Rava-Ruska	T-14-04	53,2
Uhryniv–Khorobriv	T-14-08	8,0
Brody–Chervonohrad	T-14-10	81,1
Northern bypass of Lviv city	T-14-14	5,0
Mostyska–Sambir–Boryslav	T-14-15	67,2
Lviv–Pustomyty–Medynychi	T-14-16	46,9
Kurovychi–Rohatyn	T-14-17	42,8
Nyzhankovychi–Sambir–Drohobych–Stryi	T-14-18	95,2
Mykolaiv–Zhydachiv–Kalush	T-14-19	64,0
Skole–Slavske	T-14-24	24,0
Mykolaiv–Horodok–Zhovkva–Kamianka-Buzka–Bibrka	T-14-25	173,8
Bypass of Stryi city	T-14-26	4,1
Mykolaiv–Stanislav–Kherson	T-15-01	62,5
Veselynove–Pokrovka–/Mykolaiv–Berizky/	T-15-02	70,1

Name of Road	Index	Length, kilometers
Bypass of Nova Odesa city	T-15-03	13,8
Pervomaisk–Novoukrainka	T-15-04	58,8
Snihurivka–Antonivka–/P-47/	T-15-05	63,0
Mykolaiv–Domanivka–Berizky	T-15-06	174,9
Mykolaiv–Parutyne–Ochakiv	T-15-07	66,6
Kalynivka–Snihurivka–Berezhneuvate	T-15-08	79,2
Bashtanka–Berezhneuvate	T-15-09	42,8
/R-06/–Arbuzynka–Yelanets–Nova Odesa	T-15-10	116,6
Bratske–Voznesensk	T-15-11	36,5
Kazanka–Berezhneuvate	T-15-12	61,2
Nechaiane–Ochakiv	T-15-13	37,1
Access road to Berezhanka urban-type settlement	T-15-14	4,3
Fedorivka–Rybakivka–Luhove recreation base	T-15-15	25,2
Kobleve–Morska recreation base	T-15-16	9,0
Access road to Snihurivka city	T-15-17	3,6
Velyka Korenykha–Kamianka	T-15-18	21,0
Ochakiv–Chornomorka recreation base	T-15-19	6,0
/From Fedorivka to Luhove/–Rybakivka recreation area	T-15-20	1,5
Checkpoint "Vynohradivka"–Bolhrad–/M-15/	T-16-06	48,8
Izmail–Kiliia–Vylkove	T-16-07	68,3
Bolhrad–Chervonoarmiiske–Artsyz–Sarata	T-16-08	99,9
/Odesa–Monashi/–Prymorske–Zhovtyi Yar– Tatarbunary	T-16-10	85,2
Checkpoint "Oleksiivka"–Kodyma–Balta	T-16-11	62,3
Checkpoint "Fedosiivka"–Kotovsk–Ananiv	T-16-12	75,0
Mykolaivka–Striukove–Shabelnyky–/M-05/	T-16-13	56,9
Checkpoint "Yosypivka"–Frunzivka–Shyriaieva–/M-05/	T-16-14	61,5
Checkpoint "Velykoploske"–Novopetrivka–Veselyi Kut– Tsebrykove–/M-05/	T-16-15	51,8
Checkpoint "Hrebenyky"–Chervonoznam'ianka– Berezivka	T-16-16	106,7
/M-05/–Ivanivka–Petrivka–/Odesa–Novyi Buh/	T-16-17	61,0
/Vinnytsia–Turbiv–Haisyn–Balta–Velyka Mykhailivka– /M-16//–Rozdilna–Yeremiyivka–/M-05/	T-16-18	36,8
Biliaivka–Vyhoda Station–Rozdilna	T-16-19	52,0
/M-15/–Dobrooleksandrivka–Velykodolynske–/M-27/	T-16-20	30,5
Savran–Baksha–Zaplazy–Liubashivka–/M-05/	T-16-21	51,5

Name of Road	Index	Length, kilometers
Kodyma–Slobidka–Kotovsk	T-16-22	49,2
Ananiv–Troitske–Berezivka–Viktorivka	T-16-23	106,1
Checkpoint "Stanislavka"–Chorna–/M-13/– Novosamarka	T-16-24	35,1
Checkpoint "Kuchurhan"–Biliaivka–Mayaky– Ovidiopol	T-16-25	74,5
Checkpoint "Serpneve"–Tarutyne–Artsyzy– Tatarbunary	T-16-27	75,4
/M-15/–Spaske–Vylkove	T-16-28	44,7
Checkpoint "Tabaky"–Vynohradivka–Kotlovyna– Nahorne–Orlivka	T-16-29	53,8
Strumok–Shevchenkove–Kiliia	T-16-30	32,4
Bolhrad–/M-15/	T-16-31	33,5
Checkpoint "Novi Troyany"–Chervonoarmiyske– Vasylivka–Kamianka	T-16-32	56,6
Ananiv–Baitaly–Bilyne	T-16-33	32,5
Velyka Mykhailivka–Velykokomarivka–Velykoploske– Hrebennyky	T-16-34	43,4
/Odesa–Novyi Buh/–Kominternivske–/Odesa Bypass/	T-16-35	36,4
Kominternivske–Dmytrivka–Sychavka	T-16-36	25,7
Kotovsk–Dolynske–Maryanivka	T-16-37	52,7
Checkpoint "Stanislavka"–Stanislavka–Murovana	T-16-38	20,2
Chubivka Station–/M-13/–Mardaryvka Station	T-16-39	19,7
Mykolaivka–Andriievo–Ivanivka–Nastasiivka–/M-05/	T-16-40	35,7
Ovidiopol–Dalnyk–Sanzheika–/H-04/	T-16-41	23,6
/M-15/–Checkpoint "Dolynske"	T-16-42	8,6
Moldova Border–Faraonivka–Sarata–Dyviziia	T-16-43	71,7
Checkpoint "Lisne"–Checkpoint "Maloyaroslavets Persnyi"	T-16-44	59,9
Checkpoint "Lisne"–Checkpoint "Maloyaroslavets Persnyi"–Vynohradivka–Novoivanivka–/M-15/	T-16-45	55,4
Frunzivka–Mardaryvka Station–Dolynske–Shymkove	T-16-46	50,4
/T-16-04/–Karolino–Buhaz–Hrybivka	T-16-47	16,8
Hrebinka–Kulazhyntsi–/M-03/	T-17-01	19,6
/Sumy–Poltava/–Krasnokutsk–Bohodukhiv	T-17-02	48,7
/H-08/–Nedoharky–Svitlovodsk	T-17-03	8,2
Lokhvytsia–Hadiach–Okhtyrka–Checkpoint "Velyka Pysarivka"	T-17-05	164,3

Name of Road	Index	Length, kilometers
Hadiach–Opishnia	T-17-06	61,0
Mala Rublivka–Poltava	T-17-07	43,1
Hrebinka–/M-03/	T-17-08	11,2
Orzhytsia–Khorol	T-17-09	43,0
Pyriatyn–Hrebinka	T-17-10	12,5
/M-22/–Sosnivka–Kremenchuk–Komsomolsk	T-17-11	15,8
/M-03/–Mashivka–Karlivka	T-17-12	38,1
Bypass road of Lokhvytsia city	T-17-13	3,9
Chornukhy–Lubny	T-17-14	33,9
Myrhorod–Khorol	T-17-15	29,1
Khorol–Semenivka–Kremenchuk	T-17-16	79,4
Access road to Hlobyne city		3,5
Total		82,9
Mostovyvshchyna–Velyki Krynky–Hlobyne	T-17-17	43,8
Dykanka–Reshetylivka	T-17-18	50,7
Myrhorod–Velyka Bahachka–Bairak–Podil	T-17-19	34,0
/P-42/–Shyshaky–Podil	T-17-20	41,7
Buhaivka–Hlobyne–Frunzivka–Manzheliia– Kozelets–/M-22/	T-17-21	77,4
Hrebinka–Orzhytsia	T-17-22	33,1
Lokhvytsia–Vyrishalne–Lubny	T-17-23	59,8
Vyrishalne–Zalizniaky–Komyshnia	T-17-24	18,7
Hadiach–Myrhorod	T-17-25	59,3
Rashivka–Savyntsi–Velyki Sorochyntsi	T-17-26	30,0
Velyka Bahachka–Velyki Sorochyntsi–Zinkiv	T-17-27	76,1
Zinkiv–/T-17-05/	T-17-28	14,3
Bypass road of Kotelva township	T-17-29	10,7
Velyka Rublivka–Chutove	T-17-30	36,1
/M-03/–Maksymivka–Karlivka	T-17-31	25,8
Runovshchyna–Cherkasivka–/M-03/	T-17-32	16,1
Shyshaky–Baliasne	T-17-33	25,7
Reshetylivka–Novi Sanzhary–Nekhvoroshcha	T-17-34	72,8
Kobeliaky–Nekhvoroshcha–Mashivka	T-17-35	72,0
Frunzivka–Diachenky–Dmytrivka–Komsomolsk	T-17-36	61,3
/M-03/–Bochky–Novyi Bairak–Petrivka	T-17-37	15,2
Rivne–Zdolbuniv–Mizoch–Dubno	T-18-01	47,2

Name of Road	Index	Length, kilometers
/M-07/-Maiunychi-Velyka Osnytsia-Krasnovolia-Kolky-/R-14/-Kopyllia-Rozhyshche-Torchyn-Shklyn-/H-17/	T-18-02	122,8
Korets-Slavuta-Antoniny	T-18-04	108,0
Rivne-Mlyniv-Berestechko-Busk-Peremyshliany	T-18-06	182,8
Zarichne-Borove-Rafalivka Station-Polytsi	T-18-08	81,6
Perebrody-Dubrovitsa-Volodymyrets-Sukhovolia	T-18-09	95,2
Dubrovitsa-Liubkovychi-Sarny	T-18-10	25,1
Klesiv-Mykhailyn-Berezne-/R-05/	T-18-11	59,5
Nemovychi-Berezne-Velyki Mezhyrychi-Fedorivka	T-18-12	89,8
Demidivka-Velyka Horodnytsia-toward Olyka	T-18-13	58,5
Rokytne-/M-07/	T-18-14	3,2
Dubno-Mlyniv-/T-18-13/	T-18-15	29,7
Eastern access to Radiviliv	T-18-16	4,5
Berezhnytsia-Stepan-Derazhne-Klevan-/M-06/	T-18-17	139,3
Budky Kamianski-Rokytne-Klesiv-/M-07/	T-18-18	101,4
Sosnove-Marynyn	T-18-19	8,3
Kunyn-Zelenyi Dub	T-18-20	26,0
Verba-Onyshkivtsi-Khotivka	T-18-21	15,8
Onyshkivtsi-Stara Mykolaivka	T-18-22	13,9
Udrytsk-Zhaden	T-18-23	6,6
Dermanka-Korets-/M-06/	T-18-24	31,1
Dermanka Persha-Dermanka Druha	T-18-25	8,3
Stepan-/R-05/	T-18-26	20,6
Kostopil-Yapolot	T-18-27	22,0
Korchivia-Ivanychi-Berestovets	T-18-28	9,6
Vezhytsia-Rokytne-Borove	T-18-29	97,3
Rivne-Taykury-Ozhenyn	T-18-30	24,7
/M-06/-Buhrin-Ozhenyn-Ostroh	T-18-31	33,7
/H-22/-Khodosy-Kustyn-/R-05/	T-18-32	16,0
Poznan-/T-18-29/	T-18-33	7,8
Sumy-Myropillia-Osoivka-/Sumy-Bohodukhiv/	T-19-01	58,5
Bilopillia-Terny-Lypova Dolyna-Hadiach	T-19-04	101,6
Checkpoint "Ryzhivka"-Bilopillia-Zhovtneve-Lebedyn-Lantrativka	T-19-06	122,1
Shostka-Krolevets	T-19-07	35,1
Shostka-Znob-Novhorodske-Seredyna-Buda	T-19-08	84,0

Name of Road	Index	Length, kilometers
Sumy–Lebedyn	T-19-09	41,1
Konotop–Burin–Chumakove	T-19-10	43,7
Mutyn–Putyvl	T-19-11	31,0
Shostka–Yampil	T-19-12	20,0
Romny–Lypova Dolyna–Trostianets–Mezenivka	T-19-13	149,8
Khmeliv–Chernecha Sloboda–Burin	T-19-14	46,8
Checkpoint "Seredyna-Buda"–Yampil–Bereza with access to the city of Druzhba	T-19-15	69,2
Romny–Bubny (toward Talalaivka)	T-19-16	23,6
/Lochvytsia–Hadiach–Okhtyrka–Checkpoint "Velyka Pysarivka"/–Zinkiv	T-19-17	1,0
Krasnopillia–Checkpoint "Pokrovka"	T-19-18	20,8
Burin–Voskresenka–Sukhoverkhivka–Terny	T-19-19	20,7
Putyvl–Lynove–Nova Sloboda with access to Safroniivskyi Monastery	T-19-20	21,7
Putyvl–Shalyhyne–Zarutske	T-19-21	39,7
Putyvl–Kardashi–Spadshchanskyi Forest	T-19-22	12,0
Trostianets–Nytsakha–Soldatske–/Sumy–Krasnopillia–Bohodukhiv/	T-19-23	32,9
Seredyna-Buda–Stara Huta–Vasylivka with access to the villages Khliborob, Vyntorivka	T-19-24	26,3
Konotop–Sosnivka	T-19-25	4,0
Shtepivka–Katerynivka–Zhovtneve–Mykhailivska Tsilyna–Tymchenky–Kushniry	T-19-26	33,2
Chernechchyna–Zhuravne	T-19-27	12,2
/Sumy–Poltava/–Lutysche–Kuzemyn	T-19-28	10,3
Okhtyrka–Bakyriivka	T-19-29	13,8
/Lochvytsia–Checkpoint "Velyka Pysarivka"/–Dobrianske–Sydorova Yaruga	T-19-30	13,3
Velyka Pysarivka–Oleksandrivka–/Lochvytsia–Checkpoint "Velyka Pysarivka"/	T-19-31	5,9
/Sumy–Poltava/–Zarichne	T-19-32	3,0
Buchach–Chortkiv–Skala-Podilska	T-20-01	73,3
Ternopil–Skalat–Zhvanets	T-20-02	175,1
Berezhany–Pidhaitsi–Monastyriska	T-20-04	47,6
Pidvolochysk–Volochnysk	T-20-05	0,2
Horodyshe–Zarvanytsia–Buchach	T-20-06	55,9

Name of Road	Index	Length, kilometers
Berezhany–Naraiv–Briukhovychi	T-20-07	17,9
Shumsk–Velyki Dederkaly–/R-32/	T-20-08	16,3
Vyshnivets–Lanivtsi	T-20-09	24,6
Zbarazh–Pidvolochysk	T-20-10	40,1
Kopychyntsi–Husiatyn	T-20-11	18,8
Lanivtsi–Lysohirka–Teofipol	T-20-12	26,3
Pochaiv–Zboriv	T-20-13	57,1
Borshchiv–Zalishchyky	T-20-15	36,0
Buchach–Tovste	T-20-16	37,9
Hrymailiv–Yabluniv	T-20-17	24,0
Zboriv–Kozova	T-20-18	26,7
/M-12/ (Kamianka)–Skalat	T-20-19	14,5
/M-19/ (Myshkovychi)–Druzhba	T-20-20	10,8
/M-18/–Merefa–Zmiiv	T-21-01	20,2
Kharkiv–Zolochiv–Checkpoint "Oleksandrivka"	T-21-03	54,0
Kharkiv–Vovchansk–Checkpoint "Chuhunivka"	T-21-04	116,6
/M-03/–Staryi Merchyk–Murafa–Krasnokutsk	T-21-06	55,0
Vovchansk–Checkpoint "Pletenivka"	T-21-08	8,7
Shevchenkove–Balakliia–Pervomaiskyi–Kehychivka	T-21-10	138,1
Chuhuiv–Pechenihiy–Velykyi Burluk	T-21-11	64,4
Peresichne–Berezivske–/M-03/ with access to "Berezivski Mineral Waters" sanatorium	T-21-12	6,9
Zolochiv–Maksymivka	T-21-13	32,0
Prykolotne–Velykyi Burluk–Dvorichna	T-21-14	47,7
Husarivka–Hrushevakha	T-21-15	34,1
/M-03/–Kolomak–Shelestove–Kolontaiv	T-21-16	40,3
Derhachi–Kozacha Lopan–/M-20/	T-21-17	33,6
Kehychivka–Sakhnovshchyna	T-21-18	25,1
Natalyne (Krasnohrad)–Zachepylivka– Pereshchepyne	T-21-19	50,6
Zachepylivka–Andriivka–Kehychivka–Starovirivka– /M-18/	T-21-20	97,5
Lozova–Blyzniuky–Barvinkove–Velyka Kamyshuvakha	T-21-21	82,3
Izium–Barvinkove	T-21-22	29,6
Nova Kakhovka–Armiansk	T-22-02	73,7

Name of Road	Index	Length, kilometers
/T-04-03/-Vysokopillia-Velyka Oleksandrivka-Beryslav	T-22-07	127,2
/T-08-04/-Verkhni Rohachyk-Nyzhni Sirohozy	T-22-08	65,6
Velyka Lepetykha-Ivanivka-Henichesk	T-22-09	136,1
Nova Kakhovka-/M-17/	T-22-10	48,2
/M-17/-Skadovsk	T-22-13	31,5
Access to Kakhovka	T-22-14	3,8
Access to Kherson Airport	T-22-15	3,0
Hola Prystan-Zaliznyi Port	T-22-16	50,8
Bilohirya-/Ostroh-Kremenets-Pochaiv-Radyvyliv/	T-23-01	26,4
Chernelyvka-Horodok-Smotrych	T-23-02	94,1
Dunaiivtsi-Hrushka	T-23-03	32,5
Khmelnyskyi-Vinkivtsi-Yaltushkiv	T-23-05	71,6
Shepetivka-Starokostiantyniv	T-23-06	47,7
Hukiv-Dunaiivtsi-Mohyliv-Podilskyi	T-23-08	162,1
Shepetivka-Chudniv-Berdychiv	T-23-09	111,5
Holoskiv-Derazhniia-Luka Barska	T-23-10	48,7
Khmelnyskyi-Volochysk	T-23-11	59,5
Husiatyn-Horodok	T-23-12	30,8
Kamianka-Shepetivka	T-23-13	46,7
Teofipol-Krasyliv-/Zhytomyr-Chernivtsi/	T-23-14	63,7
Solobkivtsi-Nova Ushytsia	T-23-15	53,9
Manykivtsi-Derazhniia	T-23-16	17,4
Kamianets-Podilskyi-Stara Ushytsia	T-23-17	45,6
Saryi Ostropil-Vovkovyntsi	T-23-18	83,5
Stara Syniava-Medzhybizh-/Stryi-Ternopil-Kirovohrad-Znamianka/	T-23-19	28,9
Access to Volochysk	T-23-20	16,3
Yarmolyntsi-Kamianets-Podilskyi	T-23-21	55,1
Access to Khmelnytskyi Airport	T-23-22	0,9
Starokostiantyniv-Antoniny	T-23-24	24,6
Kamianets-Podilskyi-Ustia	T-23-25	10,4
Starokostiantyniv-Shrubkiv	T-23-26	36,4
Horodyshe-Shpola-Novoukrainka-Bobrynets-Ustynivka	T-24-01	205,2
Subotiv-Medvedivka-Kamianka	T-24-02	43,8

Name of Road	Index	Length, kilometers
Oradivka–Khrystynivka–Zhashkiv–Korsun-Shevchenkivskyi–Moshny	T-24-03	178,1
Kaniv–Lipliave–Prokhorivka–Domantove–/H-08/	T-24-04	44,4
Zhashkiv–Buky–Ozirna	T-24-05	65,0
/M-05/–Mankivka–Ivanky–Buky	T-24-06	27,2
/H-01/–Kamianka	T-24-07	2,3
Shevchenkove–Horodyshe–/H-16/	T-24-08	59,2
/M-03/–Drabiv–Zolotonosha	T-24-09	61,5
/M-03/–Drabiv–Zolotonosha/–Svichkivka–Hrebinka	T-24-10	28,2
Zvenyhorodka–Katerynopil–Talne–Mankivka	T-24-11	59,7
Sofiivka–Drabiv	T-24-12	34,7
Katerynopil–Viknyne–Shpola	T-24-13	31,4
Smila–Tashlyk–Kapytanivka–Novomyrhorod	T-24-14	52,5
Talne–Kamianeche–Nerubaika–Holovanivsk–Ulyanivka	T-24-15	97,2
/M-12/–Sushkivka–Vilshana–Slobidka–Rohova–Perehonivka	T-24-16	29,8
/H-08/–Chornobai–Khrestyteliye–Orzhytsia–Lubny	T-24-17	71,3
/H-16/–Smila–/H-01/	T-24-18	2,1
Zvenyhorodka–Vatutine	T-24-19	8,3
/M-01/–Olyshivka–Kulykivka	T-25-01	37,0
Vilne–Krolevets	T-25-03	25,3
Chernihiv–Liubech–Slavutych	T-25-06	71,8
/M-01/–Dobrianka	T-25-07	13,3
Ripky–Horodnia–Shchors–Koriukivka–Semenivka	T-25-12	147,5
Kozelets–Kozary–Nosivka	T-25-13	38
Nizhyn–Bakhmach–Dmytrivka	T-25-14	100,6
/P-68/–Dmytrivka–Kharkove	T-25-15	53,7
Sosnytsia–Korop–/M-02/	T-25-16	71,0
Korop–Nekhaivka–Shabalyniv	T-25-17	28,0
Checkpoint "Khrinivka"–Shchors–Berezna	T-25-18	61,7
Kholmy–Avdiivka–Obolonna	T-25-19	36,9
Sosnytsia–Shapovalivka–/M-02/	T-25-21	34,7
Borzna–Strilnyky–Bakhmach	T-25-23	26,3
Borzna–Ichnia–Pryluky	T-25-24	69,5
/M-02/–Nosivka	T-25-25	22,7
Nizhyn–Bobrovytsia–Nova Basan	T-25-26	71,9

Name of Road	Index	Length, kilometers
Bobrovytsia–Novyi Bykiv–Ichnia	T-25-27	82,4
Kozelets–Bobrovytsia	T-25-28	33,4
Chernivtsi–Zastavna–/M-19/	T-25-30	75,5
Chernivtsi–Nedoboivtsi–Khotyn	T-25-31	12,4
Chernivtsi–Hertsia–Checkpoint "Diakivtsi" with access to "Aurela" area	T-25-32	35,7
Chernivtsi–Hlyboka	T-25-33	52,9
Novoselytsia–Marshyntsi–Hertsia–Hlyboka	T-25-34	84,5
Kitsman–Storozhynets–Hlyboka–Oprysheny with access to Vadul Siret Station	T-25-35	59,0
Storozhynets–Checkpoint "Krasnoyilsk"	T-25-36	25,6
Vyzhnytsia–Berehomet–Shepit–Checkpoint "Ruska"	T-25-37	32,3
Khotyn–Mamaliga–Checkpoint "Mamaliga" with access to /H-03/	T-25-38	13,3
Novoselytsia–/H-03/ (toward Khotyn)	T-25-39	21,2
Kelmentsi–Putryne–Checkpoint "Zelena"	T-25-40	61,1
Valia Kuzmyna–/M-19/	T-25-41	47,4
Zalishchyky–Zveniachyn–Horodenka with access to Stepaneshty Station	T-25-42	10,4
/M-19/–Repuzhyntsi	T-25-43	2,2
Kelmentsi–Voronovytsia (toward Kamianets-Podilskyi)	T-25-44	14,7
Kitsman–Kyseliv–Stepanivka (toward Horodenka)	T-25-45	14,3
Kitsman–Osykhliby–Nepolokivtsi–Berehomet (toward Sniatyn)	T-25-46	6,5
Brusnytsia–Nyzhni Stanivtsi–/R-62/	T-25-47	8,0
Strointsi (toward Novoselytsia)–Perebykivtsi	T-25-48	22,5
Hlyboka–Cherepkivtsi–Staryi Vovchynets–Bila Krynytsia with access to "Bila Krynytsia" Checkpoint	T-25-49	7,0
/R-63/–Bilousivka–Mykhalkove–Neportove with access to the village of Halytsia	T-25-50	9,0
Petrychanka–Banyliv–Pidhirnyi–Lukavtsi–/R-62/ with access to Hlyboka township and the "Myhove" resort area	T-25-51	6,0
Chernivtsi–Zastavna–/M-19/	T-25-52	25,1
Chernivtsi–Nedoboivtsi–Khotyn	T-25-53	10,9
Chernivtsi–Hertsia–Checkpoint "Diakivtsi" with access to "Aurela" area	T-25-54	8,0

Continuation of Appendix D

Name of Road	Index	Length, kilometers
Chernivtsi–Hlyboka	T-25-55	2,6
Novoselytsia–Marshyntsi–Hertsya–Hlyboka	T-25-56	4,6
Kitsman–Storozhynets–Hlyboka–Oprysheny with access to Vadul Siret Station	T-25-57	67,3
Storozhynets–Checkpoint "Krasnoyilsk"	T-25-58	9,4
Vyzhnytsia–Berehomet–Shepit–Checkpoint "Ruska"	T-25-59	1,2
Khotyn–Mamaliga–Checkpoint "Mamaliga" with access to /H-03/	T-25-60	5,1
Novoselytsia–/H-03/ (toward Khotyn)	T-25-61	35,0
Kelmentsi–Putryne–Checkpoint "Zelena"	T-26-01	110,6
Chernivtsi–Zastavna–/M-19/	T-26-02	26,8
Chernivtsi–Nedoboivtsi–Khotyn	T-26-03	36,6
Chernivtsi–Hertsya–Checkpoint "Diakivtsi" with access to "Aurela" area	T-26-04	34,2
Chernivtsi–Hlyboka	T-26-05	19,6
Novoselytsia–Marshyntsi–Hertsya–Hlyboka	T-26-06	44,3
Kitsman–Storozhynets–Hlyboka–Oprysheny with access to Vadul Siret Station	T-26-07	73,0
Storozhynets–Checkpoint "Krasnoyilsk"	T-26-08	27,6
Vyzhnytsia–Berehomet–Shepit–Checkpoint "Ruska"	T-26-09	44,4
Khotyn–Mamaliga–Checkpoint "Mamaliga" with access to /H-03/	T-26-10	34,3
Novoselytsia–/H-03/ (toward Khotyn)	T-26-12	5,4
Kelmentsi–Putryne–Checkpoint "Zelena"	T-26-13	8,2
Valia Kuzmyna–/M-19/	T-26-14	12,3
Zalishchyky–Zveniachyn–Horodenka with access to Stepaneshty Station	T-26-15	13,3
/M-19/–Repuzhyntsi	T-26-16	8,8
Kelmentsi–Voronovytsia (toward Kamianets-Podilskyi)	T-26-17	18,9
Kitsman–Kyseliv–Stepanivka (toward Horodenka)	T-26-18	23,5
Kitsman–Osykhliby–Nepolokivtsi–Berehomet (toward Sniatyn)	T-26-19	17,5
Brusnytsia–Nyzhni Stanivtsi–/R-62/	T-26-20	20,1
Strointsi (toward Novoselytsia)–Perebykivtsi	T-26-21	44,8
Hlyboka–Cherepkivtsi–Staryi Vovchynets–Bila Krynytsia with access to "Bila Krynytsia" Checkpoint	T-26-22	13,3

Name of Road	Index	Length, kilometers
/R-63/-Bilousivka-Mykhalkove-Neportove with access to the village of Halytsia	T-26-23	16,5
Petrychanka-Banyliv-Pidhirnyi-Lukavtsi-/R-62/ with access to Hlyboka township and the "Myhove" resort area	T-26-24	65,0
Krasnoyilsk-/Storozhynets-KPP "Krasnoyilsk"	T-26-25	4.3
Vyzhnytsia-Vyzhenka	T-26-26	6.0
/H-10/ (Nehrynci)-Shcherbyntsi-Stavchany-/H-03/	T-26-27	29.0
Vikno (toward Zastavna)-Balamutivka-Blyshchad (toward Khotyn)	T-26-28	14.1
Yurkyvtsi (toward Chernivtsi)-Bridok	T-26-29	14.3
/M-19/-Chunkiv-Kulivtsi-Repuzhnytsia	T-26-30	14.1
Kelmentsi-Zelena-Checkpoint "Podvirivka"	T-26-31	9.4
Putyla-Selyatyn-Checkpoint "Shepit"	T-26-32	10.1
/R-63/-Vaskauts Station-Shyshkivtsi-Checkpoint "Vashkivtsi"	T-26-33	10.6
Novodnistrovsk-Ozheve-Rozkopnytsi-Sokyriany	T-26-34	18.2
Orlivka-Bakhchisarai	T-27-01	21.4
/Sevastopol-Port "Kamysheva Bay"/-Cape Fiolent	T-27-02	11
Honcharne-Yalta	T-27-03	44.9
/Sevastopol-Port "Kamysheva Bay"/-Kozacha Bay	T-27-04	6.7
Access to Laspi village	T-27-05	2.1
Lyubymivka-Fruktove	T-27-07	3.9
Shturmove-Khmelnyske	T-27-08	5.5
Access to Kacha village	T-27-09	26.6
Shturmove-Sakharna Holovka	T-27-10	2.8
Orlyne-Rodnykove-Kolkhozne	T-27-11	8.7
Rodnykove-Peredove	T-27-12	6.1
Orlyne-Tylove	T-27-13	4.7
Access to Lyubymivka Station	T-27-14	4.2
Access to Maksymova Dacha Station	T-27-15	1.7
Fifth Kilometer of Balaklava Highway-Cape Fiolent	T-27-16	3.9
Access to Mekenzi Hory Station	T-27-17	7.9
Total length of territorial highways		28280.4
Total length of state highways		51734.1

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