To the problem of renovation of the industrial areas in Khabarovsk. Multifunctional waste processing complex on the site of the former Amurkabel plant

S A Sadredinov, M E Bazilevich
Department of Architecture and Urbanistics, Institute of Architecture and Design, Pacific National University, 136, Tihookeanskaya St., Khabarovsk 680035, Russia
E-mail: semyon933@gmail.com

Abstract. The article is devoted to the problem of renovation of abandoned industrial facilities in Khabarovsk city. On the example of the territory of the former Amurkabel factory located in the southern part of the city, the possibility of reequipping the old factory buildings and the adjacent territory with a new, more technological and relevant industrial production for the city is considered. Based on the former plant, the creation of a modern multifunctional waste recycling complex using advanced environmentally friendly technologies is proposed. The possibility of integration and interaction of the industrial production environment with social and recreational spaces is considered. The results of the pre-project analysis of the designed territory are presented. A set of measures for engineering protection was developed in connection with the location of the facility near the water area.

1. Introduction
Renovation of industrial areas and their transformation into modern public spaces in recent years are very popular both in Russia and abroad. The era of industrialization had a strong influence not only on the ecology and urban planning of our cities, but also on the consciousness of their inhabitants, perceiving industrial enterprises and surrounding areas as a depressing and uncomfortable environment. The development of innovative technologies and the transition to new forms of production lead to the fact that many industrial enterprises are reorganized or completely closed. Buildings collapse over time, territories are overgrown with trees and shrubs. These circumstances create the prerequisites for the modernization and transformation of abandoned industrial areas located within the city limits.

This problem is also relevant for large cities in the Far East of Russia, where in the Soviet period the defense and manufacturing industries were actively developing. Now, most of these enterprises have ceased to exist, leaving behind half-abandoned or abandoned buildings and vast land plots. One of such problematic facilities is the territory of the former Amurkabel plant in Khabarovsk.

2. Literature review
The study was conducted based on a number of scientific and popular scientific works of Russian and foreign researchers, covering various aspects studied by the authors of this article problems.

Issues of renovation of industrial areas dedicated to the work of V. A. Belyanina, S. N. Solonina, E. Collatun, C. Bartsch [1], N. S. Solonina, O. A. Shipitsyna [2], A. O. Yakubova, L. V. Desyatov, A. V. Tsorik [3]. The authors analyze the specificity of the architectural environment of industrial
development of Russian cities and offer a variety of activities for its development. The problem of functional conversion of a number of former industrial enterprises in Khabarovsk was adopted in a number of publications by local researchers [4-6].

The problem of construction waste recycling plants is considered in the works of J. R. Stokes and A. Horvath [7], N. M. Sidorkina [8]. The authors conduct an environmental analysis identifying the harm to the environment when using the traditional method of solid waste management, paying attention to the possibility of using new safer technologies. Development of innovative technologies for processing of municipal solid waste are devoted to the work, H. Luo, H. L. Guo, Y. S. Gao and J. J. Liu [9], Filatov V. V., Rukina I. M. and V. I. Golovanov [10].

The typology of waste processing enterprises and their inclusion into the urban environment are considered publications of D. V. Popov [11, 12]. On the example of Russian and foreign experience, the researcher discusses the General principles for the development of the waste recycling industry.

The development of the coastal areas of the city of Khabarovsk rise in publications O. E. Olshevskaya, I. Yu. Grin [13], Ivanchuk S. A., Luchkova V. I. [14], Ivanchuk S. A., Golovei E. A., Podgornaya T. I. [15], the authors consider the depressed areas of the city, which include the coastal zone, and offer a variety of options for their development.

Note that the problem and the prospects for the creation of a network of recycling and disposal of solid waste in Khabarovsk were previously covered by authors in the scientific press [16, 17]. In particular, taking into account the current master plan of the city [18] developed guidelines for siting of plants of this type in the city and its surroundings.

However, despite the fairly wide range of available work, the issue of the renovation and conversion of former industrial plants on the territory of the city of Khabarovsk remains insufficiently studied and requires deeper analysis and further development.

3. Materials and methods of research
The methodology of work included an interconnected study of scientific literature and Internet resources dedicated to this issue. The authors conducted a comprehensive analysis of the territory of the former Amurkabel plant in the city of Khabarovsk, which made it possible to develop specific proposals and recommendations on the organization of the territory, as well as provide for a number of measures for engineering protection and shoreline strengthening.

4. Results
4.1. Amurkabel plant
This Khabarovsk plant was founded in 1956 as a "Universal cable Khabarovsk Zavod imeni 50-letiya USSR" [19]. The place for construction was chosen undeveloped land in southern part of the city on the banks of the Amur River. The production consisted of nine workshops, groups responsible for the production of cable and wiring types. The plant was one of a kind venture in the Khabarovsk territory and the manufactured products have found demand not only in the far East, but also exported. High quality products speak numerous awards that the company received in the Soviet and modern period: diploma of trade unions and Gosstandart of the USSR, diplomas of the contest "100 best goods of Russia", certificates of quality from the Dutch company KEMA and the prize of the Government of the Russian Federation for introduction of highly effective methods of quality management [19]. Gradually around the plant increased residential quarters and social infrastructure, and in 2009 in front of the enterprise was built a massive sports complex – regional center of hockey "Amur".

In the 2000s, the production declined, and in 2012, the plant of was closed. In 2013, during abnormally severe flooding that occurred in the Delta of river Amur, part of the former plant, located on the lower level of the relief, was partially flooded [20]. This circumstance had a negative impact on some buildings, part of which is now in disrepair. Currently, abandoned area of the plant is in dire need of renovation, especially in view of the fact that in recent years the city authorities are actively exploring the coastal strip in the southern part of the city by building residential areas, community and
sports centres. In addition, the residential area near the former plant of needed recreational areas. In this regard, it seems appropriate to conduct comprehensive research aimed at developing specific proposals to update this site.

4.2. Pre-project analysis

The territory of the plant of is an abandoned industrial area, located in the southern part of the Khabarovsk in borders of Pavla Morozova and Aleutskaya streets. On a plot of 35 hectares located abandoned industrial buildings, oriented predominantly along the direction of the coastline. The area has several points of visual perception: from the waters, from Pavla Morozova st. and from the side of the ash lagoon, located on the North-Eastern side of the site. The plot is mainly flat with no visible compositional centers. The topography of the site has minimal slope. Altitudes range from 41.6 m to 40.04 m. The soils consist of alternating layers of sandstones, siltstones, clayey and siliceous-clayey shales [21]. Gardening presents herbal and shrub plantings. The border of the water protection zone for the enterprises of special purpose, which include this property, is 500 metres from the coastline.

The facility is adjacent to the highway of city value (Pavla Morozova st.) from which the territory of the plant is carried out in road transport. From the South-West side of the site come rail is not for General use in the North-Western part of industrial zone equipped pier for mooring small boats.

According to the zoning maps of the city of Khabarovsk [22-23], this area belongs to the area P2 and is intended for placement of industrial enterprises of III-IV hazard class. This circumstance allows speaking about possibility of establishment on the site of the former factory of new, more technologically advanced and relevant to the city's industrial enterprises.

One of which, according to the authors, can become a multifunctional waste-processing complex. Note that the problem of collection, recycling and processing of municipal solid waste (MSW) to Khabarovsk and the Far East of Russia as a whole, is relevant for several reasons. In the region used outdated methods of waste management, a shortage of specialized enterprises for the collection and disposal of solid waste. So, in the territory of Khabarovsk currently, there is only one waste treatment station "Severnaya", carried out a partial sorting of solid waste for production of secondary raw material, which is then sent to China for further processing [16]. Thus, the introduction of new, technologically advanced production will improve the situation with the problem of disposal and recycling of solid waste and will contribute to the improvement of the ecological situation in the city.

4.3. Project proposal

The analysis and study of Russian and foreign experience in the construction of enterprises for processing and disposal of solid waste allowed to develop project proposals and recommendations for the creation of the territory of the former factory of new garbage processing complex.

The proposed facility is a multifunctional complex that includes several functional blocks to implement sorting, processing and disposal of solid waste. In addition, the complex includes creation of public spaces: objects of public catering, exhibition center, park area. This integration will be possible with modern ecologically safe technologies of waste management.

The main technological chain will consist of several stages. The initial, preparatory phase involves the creation in the city of Khabarovsk primary sorting of waste into four categories: wet, dry, recyclable, and harmful. The next stage envisages the delivery of sorted materials directly to the premises and loading it into the hopper. The third stage involves the transfer of raw material conveyor line sorting, where different types of waste are sent for disposal or recycling. Disposal of solid waste will be produced using the method of plasma gasification, which allows minimizing harmful emissions into the atmosphere. In the process will produce synthetic gas that is cooled in the treatment of cooling Venturi system and the gas cleaning system, and then passes through a series of purification processes and removal of intermediate moisture [23]. At the final stage, purified gas is compressed and fed into a steam turbine to produce electricity. In addition, the combustion of MSW the proposed method will produce an ash that can be used for the production of slag bricks and the development of road
surfaces. Also implied by the presence of the plant in which the sorted waste can be recycled into secondary raw materials.

The presence of water and rail transport communication allows considering the use of the capacity of the complex to service the needs of neighbouring regions and border cities of China, which, undoubtedly, will attract new investments.

The project offers the reconstruction of the factory buildings adjacent to the Pavla Morozova st., to accommodate exhibition facilities, business centres and premises for rent. The area will be equipped with surface; covered parking for cars of employees and visitors. The design of the roof of the parking lot involves the placement of landscaping objects on it and the arrangement of a walking area. The movement of automobile transport will be organized according to the ring scheme, so as not to violate the technology for sorting and transporting solid waste inside the complex. In the northern part of the territory, it is planned to create a walking promenade that goes into the park zone. It implies the installation of viewing and sports grounds, the installation of small architectural forms.

The introduction of public and recreational facilities into the territory of the waste recycling complex will create a comfortable, attractive environment free time forwarding and recreation for residents of nearby areas. On the other hand, such "openness" of industrial production and the presence of exhibition spaces on the territory of the complex will attract the attention of residents and visitors to the problem of waste recycling.

4.4. Design features
The analysis showed that part of the plant is located in the flooded areas, which entails a number of actions to combat ground water. The project does not involve the use of underground space and the creation of basement floors. This fact leads to some technical difficulties with my device-hopper drive, which usually must be buried in the ground one-third of its height to ensure the smooth delivery trucks of primarily recycled materials. The solution to this problem will be the device of the flyover, a space which will be used to host storage and technical rooms.

Space-planning solution of the complex is subject to the peculiarities of the technological process and dimensions of the specialized equipment. The height of the main body is determined by the dimensions of the storage hopper, reactors and purification filters. The building will have a sloping roof with variable height. The vertical emphasis of the spatial composition will be the exhaust pipe that rises to 40 m.

The project envisages a number of measures on engineering protection and strengthening the coastline:

- **Strengthening the shore Boone.** Design is a situated perpendicular to shore the walls are made of stones and piles, taken boards. This decision will limit the movement of coastal sediment and will contribute to the extension of the beach.
- **Strengthen the banks by gabion structures.** Rectangular boxes made in kind of steel mesh filled with rubble stone, laid in a single construction, forming a vertical wall.
- **Rip rap shoreline.** It is constructed from a large solid stone of hard-weather non-weathered rocks with levelling the ranks and filling the voids with a small stone. In order to avoid leaching of soil is done the device a lot-ply reverse gravel filter.
- **Strengthening the banks with concrete slabs.** This design the load in was under way into the soil and binds the concrete beam between them. In order to avoid leaching of soil occurs device multilayer reverse gravel filter.
- **Strengthening the Bank using concrete piles.** Piles of rectangular cross section immersed in the ground, forming a sheet pile range with tongue and groove. Then the whole structure is bound between a reinforced concrete beams. As in the previous case, in order to avoid leaching of soil requires a multi-layered about the inverse of the gravel filter.
- **Strengthening the Bank piles of polyvinylchloride (PVC).** Tongue-and-groove piles of PVC immersed in the ground forming a vertical polymer fence.
- **Strengthening the coast with dams and embankments.** Engineering structures of this type are created by the method of hydraulic washing with the help of dredgers. At the same time, a significant density of sandy soil is ensured, which does not require further compaction.

5. **Conclusion**

The study showed the urgency of the problem of renovating the territory of the former Amurkabel plant in Khabarovsk. One of the possible solutions of which, according to the authors, is to create, on the basis of this enterprise, a modern multifunctional complex for the disposal and recycling of solid household waste. The use of new environmentally friendly technologies will allow integrating a number of public and recreational facilities into the structure of the industrial enterprise, which will create a comfortable environment for residents of nearby areas, as well as attract public attention to the problem of waste recycling in the region.

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