5 ASSESSMENT OF IMPACTS ON SOCIAL ENVIRONMENT

Population of the Danube Region makes up a little more than 250,000. During the last decade it decreased by almost 10,000 and at present the tendency still remains. At the same time the general demographic situation in the region, as compared to Odessa Region as a whole, is relatively better on the whole: birth-rates have stabilized at the level of 7-10‰ (7-10 born infants per each thousand inhabitants during a year), death-rate is 13-17‰; natural loss of population makes up 5-7‰ a year with a real prospect of subsequent reduction.

Migrations of population do not have a noticeable effect on the general demographic situation and the population changes in the region.

The region is distinguished by a high portion of junior age groups of population which is related to traditions of families having many children among Bulgarians, Gagauzes, Moldavians, Greeks and Azerbaijanis. The number of schoolchildren, as compared to 1991, decreased by 3,400 but still remains significant – 37,600 schoolchildren.

Labour force in the areas adjacent to the Danube make up 45-52% of the total population number. The level of provision with labor resources is quite high. The greater part of labor potential of the region is used in labor-intensive branches of agriculture – vegetable-growing, viticulture, horticulture, irrigated agriculture, in particular in rice-growing. In the crisis condition of the last decade, intensive branches of farm production have significantly decreased production output and, correspondingly, the use of labor resources.

The official unemployment rate in the region is about 2%, but hidden unemployment and underemployment affect a significant part of the population and are an acute social problem. The main course to overcome it is priority development of labour-intensive branches of agro-industrial complex, building up in-house processing of agricultural products in agricultural enterprises and at homes. The real prosperity of the population, however, is provided by work of skilled labor force, in particular in river transport, shipbuilding, ship-repairing, in other branches of mechanical engineering and instrumentation.

Three quarters of the population live in big villages with 2,000-2,500 inhabitants. Taking into account the high population density, it is advisable to create new jobs in big villages and small towns in the form of joint ventures, branches and sections aimed at skilled and relatively cheap labour force. Subsequent development of industries using skilled labor force and experts in recreation activity have prospects.

The majority of the population – from 34% (Reni district) to 70% (Izmail district) are employed in agriculture. By expert review, the need of farm production in labour force is about 90% satisfied at present.

Population of the area is traditionally engaged in manufacturing grain, meat and milk products, as well as viniculture, gardening and cultivation of truck and commercial crops [24]. The largest areas for rice cultivation in Odessa Region are located here. More than half of these lands are irrigated. Construction of powerful irrigating rice systems in Kilia region began in 1965. For farms this meant additional areas for rice and other cultures, lessen dependence on weather conditions. Now rice fields are mainly used for cultivating fodder, whereas rice sowing is being reduced.

Navigable sections of the Kilia delta, of Yermakov Island, of Zhebriyanski dunes and the area of Stentsovsko-Zhebriyanskiye Plavni serve as pasture-lands for cattle and horses.

On the strength of quantitative indicators, in particular, of floristic structure and the values of phytomass, four stages of pasture degradation of the DBR herbage have been singled out and the corresponding map was made. As one can see from the map, the vegetation of Zhebriyanski dunes and northern parts of Yermakov island (Fig. 5.1) is the most degraded due to cattle pasturing. The of Kilia delta is less degraded in this respect. Thus, the channel and seaside ridges of the delta, as well as of Yermakov island, appeared to be the territories of excessive pasturing of cattle.

At present the number of cattle at the islands of a lower reaches of Kilia delta of Danube has somewhat decreased particularly in connection with decreasing of the activity of separate

cooperative farmings. However an excessive pasture at Yermakov Island is proceeding. The impact of pasture at the seaside areas of Zhebriyanski dunes remains significant, as well as the territory located near the villages of Liski and Primorskoye, and Vilkovo town.

In the seaside part of Zhebriyanski dunes, apart from pasture, regular burning of herbage at significant parts of the salted-meadow and marsh areas takes place in the second half of a summer. The basic part of channel areas of the Kilia delta and Yermakov Island are covered with natural or artificially planted willow forests the wood of which is mainly used as fuel. A part of near-channel areas (approximately 300 ha) is occupied with gardens and vegetable gardens.

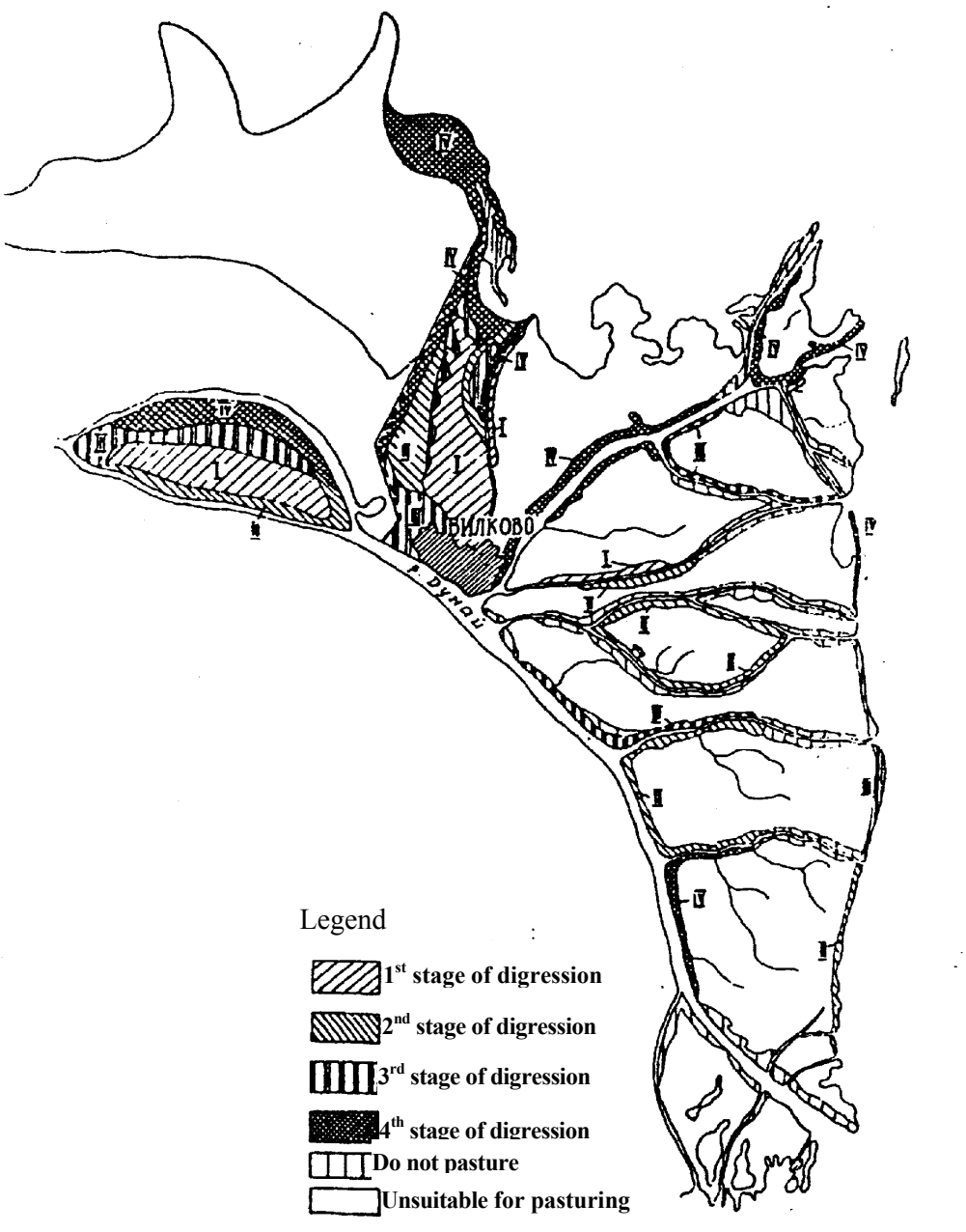

Fig. 5.1 – Map of pasture digression of the DBR vegetation

Woods of Zhebriyanska seaside ridge are excluded from its principal use, scheduled provision of fruits and herbs is made here, local population gather mushrooms and fruits of sea-buckthorn berries.

A common form of nature management at Zhebriyanski dunes is sand recovery.

Provision of reed is also developed in the Kilia delta. Some reed is cut in order to feed domestic animals. Reed gathered in winter is used as local building material.

Both legal and illegal hunting are common in the locality. The hare, the pheasant sometimes the fox, the roedeer are usually hunted after, the muskrat catching also takes place but its number has essentially decreased: if in the 1970s about 18,000 species were bagged, at present up to 2,000 are. The main object of hunting is water birds.

Within the DBR territory bee-farming is developing. This is caused due to climatic conditions of the territory, species abundance of bee plants and a long season of honey yield (from March till November).

The region economy is represented by such inter-sector complexes as: 1) agro-industrial; 2) transport; 3) biospherical-environmental; 4) water industry; 5) fishery; 6) recreational.

Agro-industrial complex consists of the following subcomplexes:

- *viticultural-winemaking,* including Izmail winery and numerous juice- and winemaking workshops;
- *fruit and vegetable canning* – Izmail canning factory, Kilia tomato workshop, workshops for primary processing fruit and vegetables;
- *grain-industrial* – with Bolgrad and Kilia bakery integrated works and grain export via the ports of Reni, Izmail and Ust-Dunaysk;
- *meat-industrial* – with livestock processing at Izmail meat-packing plant and in slaughtering workshops (Reni, Bolgrad, Kilia);
- *dairy-industrial,* lead by Izmail milk plant and Kilia creamery with their numerous separator workshops.

The main problems of harmonious development of the regional agro-industrial complex (AIC) (according to "Seville Strategy of Biospherical Reservations", 1995) is application of modern systems of land cultivation on the agrolandscape basis, switch to organic agriculture with minimum use of chemicals, growing ecologically clean agricultural products, proliferation of new technologies of land cultivation, irrigation, fabrication of agricultural products.

Fish industry of the region, under normal ecological state of the Danube lakes, had the fish catch at the level of 1,000-1,200 t/yr. At the end of the 1950s, after flood-control dams along the Danube had been constructed, the fish catch decreased sharply. Later, during the 1960-1970s, stocking the lakes with carp was practiced, in the 1980s – with silver carp, and the total norms of the fish catch increased to 1,500-2,500 t/yr. At the end of the 1980s terminal fish suffocations took place in lakes and in the 1990s, under conditions of a long economic crisis, stocking the water ponds was suspended and the fish catches decreased to 500-1,000 t/yr, about a third of that amount being caught within the DBR (see Table 4.5.2).

The Danube Port-Industrial Complex with the available port facilities and a well-developed network of motor-roads and railways is potentially a priority sector of the Danube region economy and is capable of handling up to 20 million tons of cargoes a year, though as a result of NATO countries' action in Yugoslavia that blocked ships' movement along the Danube, the ports' volume of work is only 35-40% of their nominal capacity. The transport complex is formed of the Danube Ukrainian Shipping Company and its subsidiary enterprise *Transkruise*. Sea and river transport service Izmail ship-repair plant and Kilia

shipbuilding-ship-repair plant, enterprises that produce machinery and equipment for port facilities and the marine, many related branches.

A very acute pressing problem for the region and for Ukraine as a whole is creation of a new ***navigation route " Danube-Black Sea".*** As using the old navigation route via the Prorva estuary has become impossible since the beginning of the 1990s, Ukrainian vessels use the Sulina Channel (Romania), which costs our state about $ 6 million together with direct and indirect expenses of users of various forms of property [75]. Opening the deep-water navigation route "Danube-Black Sea" will become a significant incentive for socio-economic development of the region. By preliminary estimates it will give at least 4,200 new work places and about UAH 90 million of additional profit a year, of which UAH 12 million will go to the state budget and UAH 1.7 million – to the local one.

Three sea ports – Izmail, Reni and Ust-Dunaysk with marine terminals in Kilia and Vilkovo function within the structure of the Danube port-industrial complex. At present their common freight turnover is a little over 6 million ton, 70% of which make up export cargoes and 23% – transit cargoes. The ports' specialization by main types of cargo is as follows: Izmail port handles coal, ore, grain, ferrous metals, containers; Reni – bulked cargoes (oil, oil products, chemical products), coal, coke, grain, chemical cargoes, package-piece cargoes; Ust-Dunaysk – grain, ore, ferrous metals.

The region's motor transport carries more than 3.7 million tons of cargoes (in 2001) and has the turnover of about 56 million t/km. Railway transport services ports and industrial enterprises of the region. Taking into account active participation in the projects of International Transfer Corridors (MTK), the most pressing problem is technological reconstruction of Reni (Izmail)-Artsiz-Odessa trunk-railway which at present remains single-line and technically weak.

The region plays a significant role in *international transit of oil and gas* which will grow in future. The Danube water way is determined as an important link of oil transport corridor "the Caspian region – Europe". Along its territory passes a gas pipeline (two lines) from Russia to the Balkans and further to Turkey.

The Danube region's share in *external economic turnover* of Odessa Region made up about 11%, and as a result of action of the NATO countries in Yugoslavia and blocking the Danube waterway it decreased to 5%. The region is notable for a high share of external economic services, mainly transport ones, that make up more than 13% of the region's export (in 2001) and almost 9% of its import. The shares of goods export (1.3%) and import (2.3%) remain small.

Water industry is a basic problem of socio-economic development of the region, that permeates all types of economic activity of population and in many respects determines social activity. On the one hand, there are tremendous resources of fresh water, precious for a steppe region, on the other – the water quality is unsatisfactory and is continuously decreasing. In many villages of Bolgrad and Kilia districts shortage of water is felt sharply. Water quality in the Danube, under the impact of pollution mainly from other countries of Europe, decreases significantly, which negatively affects water consumption in the Ukrainian Danube region, the existence of valuable flora and fauna in the DBR. This problem needs special regulation, monitoring and control of water quality on the international level of cooperation. Until now Ukraine does not receive any compensation of damages.

Reni and Izmail districts of Odessa Region have mainly underground water supply, whereas Kilia and Bolrad regions use surface waters and wells. The most critical situation with water supply is in Kilia and Vilkovo, which use exclusively the Danube water, as well as in Bolgrad, which receives water from Lake Yalpug. The quality of drinking water in the

stated towns does not meet sanitary norms. The 1990s saw more than fourfold cutback of water consumption in the area due to the crisis state of irrigated agriculture and the economy as a whole. Izmail, Vilkovo and Reni give the greatest amounts of industrial and residential waste waters, most of which (more than 90%) are discharged untreated.

Environmental activity plays an important role in the economic complex of the Danube region. There are about two dozens objects of natural-reserved stock, including three nature-conservation areas of state significance:

- the Danube Biosphere Reserve (46,400 ha till 2004 and more than 50,000 ha as per the Decree of the President of Ukraine on widening the DBR territory of 02.02.2004);
- a regional landscape park "Izmail Islands" (1,400 ha);
- a zoological reserve "Zmeiny Island" (232 ha).

The region has an exceptionally high ***recreational-tourist potential,*** which at present is used exceptionally insufficiently. The DBR receives 4-6 thousand "green tourists" annually. The flow of unorganised tourists, hunters and fishermen in particular, remains the principal one for the region. In prospect the main directions of tourist activity in the region must be: ecological tourism over the DBR and other objects of natural-reserved stock; hunting tourism; fishing and water sport tourism; ethnographic as well as historical and cultural tourism, which answers the letter of the Seville strategy of biospherical reservations as well as to the Johannesburg declaration.

The general level of quality of life of population of the Ukrainian Danube region is assessed as low, even as compared to our national standards.

The main social problems of the region are:

- drinking water of poor quality (Kilia and Bolgrad districts) and the lack of fresh water (Bolgrad district) which results in a heightened of illness frequency and the danger of epidemics;
- underemployment, an elevated unemployment level that is half as much again as the corresponding indices for the region and for the country as a whole.
- a low salary level, especially in small towns and villages, which has an effect on provision with foodstuffs and medical care;
- insufficient development level of social infrastructure and human services.

The level of medical care for the region population by the main indices is almost twice inferior to the average regional one, especially by the number of higher medical staff and by provision with hospital accommodations, equipment and medications. General increase in illness frequency on the whole over the region is observed. The region is notable for a heightened morbidity with infectious and parasitic diseases (Kilia and Izmail districts), new growths (Kilia, Izmail and Reni districts). Tuberculosis and cardiovascular diseases are considered especially dangerous. During the past years the Danube region is notable for a heightened children's morbidity rate at the age of up to one year, which is half as much again as the average regional one.

A pressing social problem of the region remains a low level of salary and of the well-being of the population. The workers' salary in the region is 1.5-3 times lower than the average regional one. A major part of the population income is formed at the expense of homesteads. A raise of salary has been noted lately, in particular, in the course of 1997-2001 it practically doubled. But the lion's share of salaries remains much lower than the minimum of subsistence.

The region is notable for underdeveloped human services, despite quite developed social infrastructure. By paid services indices per head the Danube districts are 5-10 times inferior to the average regional level, and only in the town of Izmail – 2 times.

The quickest solution of acute social and economic problems in the Ukrainian Danube region is optimally connected to revival of using by Ukraine its own river arms in the Danube delta, the way it is done in the neighbouring Romania.

First of all, improvement in the social sphere will happen due to increase of employment and wages level in the most promising and dynamic sectors of economy. For instance, additional jobs must appear in the fleet of Danube Ukrainian Shipping Company, in ports, in railway and motor transport, in service organizations, industrial shipbuilding and ship repair enterprises, etc. Increase of investment not only in transportation complex, but also in other sectors of economy and the region's infrastructure can be confidently predicted. The conditions of passenger traffic for people from the Danube towns and villages will improve considerably. Good prospects for developing water tourism, including international, appear.

The positive effect for economy and social life of the region from the project realization exceeds many times over the possible negative consequences for a part of population of the town of Vilkovo. For instance, the terms of fishing for fishermen working at "Bystroye" fishery, temporary loss of jobs by people working in the port of Ust-Dunaysk with their consequent employment at the installations, related to the DWNR operation, is also possible.

On the whole, restoration of the Danube navigation route will have not only a great economic and transportation significance, but also political and strategic one, which is absolutely necessary in the present situation for development of both the Danube region and Ukraine as a whole.

The impact on social environment, despite negative attitude to the project from a part of the population, should, by objective criteria, be considered as positive.

6 ASSESSMENT OF IMPACT ON THE TECHNOGENIC ENVIRONMENT

The economic installations that pose a potential ecological threat in connection with realization of the DWNR project are, for the most part, linear installations of man-caused infrastructure, namely: 750 kW and 500 kW power lines, gas pipeline, communication cables that traverse the Danube at Reni – Isakcha segment. Taking into account the fact that navigation in this section of the river is carried out without restrictions at present (the Sulinskiy narrow strait – the Tulceaskiy narrow strait – the Danube) and that the project makes no provisions to carry out dredging and other work here, there will be no deterioration of man-caused situation here and probability of man-caused disasters risk will not increase.

In Vilkovo – Bystre – seashore section man-caused infrastructure is practically nonexistent and no negative impact may be had on it.

Indirect negative impact may be had on installations of the port of Ust-Dunaysk if they lose their economic significance in connection with the DWNR creation. But its technical base is of insignificant material value. At present, berths as hydraulic works are absent in the port and three buoy anchorages are used for mooring the handled ships. Office and residential buildings in the port area are also absent, the administration is located at Vilkovo. All operating mechanisms are mobile and may easily be relocated to another port area.

7 COMPLEX MEASURES TO ENSURE NORMATIVE ENVIRONMENT CONDITION AND ECOLOGICAL SAFETY

7.1 Resource-saving measures

Choosing for temporary bank dumps little used, periodically flooded and swamped lands, overgrown with shrubs and reed, permits to minimize the damage to agriculture.

Reclamation of the lands taken for dumps ensures their return to agricultural use with improved fertility and water regime.

Storing dredged soil to bed dumps reduces the need to occupy land. The choice of sites for bed dumps is well-grounded ecologically and provides ecologically safe burial of bottom sediment with small content of silts and pollutants.

Location of sea disposal dump in accordance with environmental impact statement permits to minimize the damage to bottom biocenoses, to provide a reliable burial of dredged soil and to prevent secondary pollution of coastal waters.

Placement of navigational situation marks in floating version, foreseen in the working draft, permitted to do without allocating for these purposes sections of riverside territories along the Bystre branch.

7.2 Protective measures

Hydraulic engineering measures

The hydraulic engineering measures listed below, whose primary objective is providing navigation along the created navigation route, are also environmental, as they prevent banks erosion and decrease the volume of dredging operations that have a negative impact upon water quality and habitat conditions of water organisms.

Clearing the bed of the Starostambulske branch in the area of T-junction of the Starostambulske and the Bystre branches. Below the source of the Bystre branch, partial clearing of the left-bank meander bar up to the mark minus 7.26 mBS is foreseen, which will ensure turning water and sediment runoff away from the navigation route, preventing banks erosion of the Bystre branch and reducing sediment accumulation in the slot through its sand-bar. The length of cleaning section is 550 m. At present this meander bar works as a natural barrier, directing water and sediment flow to the Bystre branch. The efficiency of the given technical measure is confirmed by conclusions of Institute of Hydromechanics of NASU.

Creation of a turning dike in the Starostambulske branch forward to the source of the Bystre branch is provided for the purpose of regulated distribution of water discharge rates by these branches, prevention of banks erosion of the Bystre branch and sediment accumulation in the slot through its sand-bar. The parameters of the designed installation will be optimised on the basis of the results of hydrological monitoring.

Creation of a protective dam along the sea approach channel 2,830 m long is provided for the purpose of reducing sediment accumulation in the slot through the sand-bar of the Bystre branch at storm roughness. Apart from the main purpose, the dam will prevent bank erosion of the Ptichya spit with storm waves at strong northern winds.

Core pools, created on the territories of bank charts of dredging soils filling and inner dams that lengthen water clarification path, enable to substantially decrease pollution of the Danube water by surface runoff from the places of bottom sediment storage. Estimated path of pulp clarification in the core pools depends on granulometric of stored soils, the pool breadth and depth, and ranges from 40 m to 140 m. The projected length of the pools ensures that the given condition is met.

Bank protecting sections along the banks of the Bystre branch are provided for the purpose of preventing the branch banks erosion, as such a trend appears under natural conditions in

connection with the branch development. The operations will be carried out only if a real danger of disrupting the banks stability becomes apparent.

Bioreinforcement of channel banks along the Bystre branch by means of reforestation with the Danube flora species – common willow, abele, black poplar, high ash-tree; of planting river bank slopes with local wave-absorbing aero-aquatic plants is provided for on the basis of the results of monitoring in case a threat of banks erosion arises according to the DBR staff recommendations.

Technological measures

Termination of all construction and repair-and-renewal operations on the DWNR track during spawning period and downstream migration of fish whitebait is the main measure of decreasing the negative influence on ichthyofauna. While carrying it out, it is necessary to take into account that maximum downstream migration of ordinary fish fry takes place some time after the ban starts. This fry, that hatched upstream of the Danube, reaches the delta sections 10-15 days after the ban starts, sometimes later, for example, in 1984 in the first – second decades of June 96.2% of the total number of Danube shad fry migrated downstream to the sea.

Termination of construction and repair-and-renewal operations in the section of the sea approach channel and in the area of the Bystre branch source during birds' nesting period is the most important measure that ensures minimizing the DWNR impact on the DBR ornithofauna, which at that period is the most sensitive to disturbance factor, related to the work of construction equipment.

Speed reduction of the vessels' passage along the Bystre branch to 7 is a necessary condition for preventing the negative wave impact on channel banks and providing the normative noise levels in the DBR reserve zone.

Dispersal of mechanization means, adjustment of their power, variation of their work simultaneity coefficient is a complex of measures directed at providing the normative quality of atmospheric air (in particular, to lower surface concentration of "priority" ingredient – NO_2) in inhabited localities and reserve territories, adjacent to the work sites. In case of adverse weather conditions complete termination of hydraulic work and engines shutdown is previewed.

The ban to sound vessels' blasts, the ban to transmit music to the deck during the vessels' passage along the DBR territory, restriction, when possible, for the vessels passage along the Bystre branch to day-time is a complex of measures directed at minimization of disturbance factors for the DBR fauna and reduction of damage for fish industry.

7.3 Reconstructive measures

As it was stated in Chapter 2, last century saw gradual runoff redistribution of the Danube by two main branches of the delta – the Kilia and the Tulcea ones – in favor of the latter. This resulted in watering reduction of the Kilia delta during that period, which contributed to deterioration of natural conditions in its northern dying part. A number of scientists believe that one of the reasons of the Danube runoff redistribution that happened is carrying out by Romania hydraulic engineering work to ensure navigation along the Sulina and the St. George branches.

Under these conditions, ***deepening the bed of the Kilia branch***, stipulated by the working draft of the first stage of the DWNR creation, may be regarded as a reconstructive measure that enables to partially reconstruct the water regime of the Kilia delta, disrupted as a result of the man-made impact, made on the Romanian part of the Danube delta. The efficiency of this measure at the second stage of the DWNR construction will be increased by means of further deepening of the bed of the Kilia branch along with restriction of water flow entrance into the Bystre branch by turning dike, that is being created in the Starostambulskiy branch near the source of the Bystre branch, which will permit to preserve, maybe even increase, water discharge rates in branches of the northern part of the Kilia delta.

7.4 Compensation measures

7.4.1 Reimbursement for irreparable damage by taking measures on equivalent improvement of natural environment state

The most essential irreparable damage resulting from the DWNR construction and operation may be inflicted on ichthyo- and ornithofauna.

Damage to ichthyofauna resulting from deterioration of forage reserve, reproductive and migration conditions may be compensated by constructing a fish-farming installation in the given region. Such an installation just on the Danube may become a sturgeon factory on the Ochakivske branch (downstream of the town of Vilkovo), the feasibility study for which was devised by *Odessarybvod* (former ZapCherrybvod).

The damage associated with disturbance factors for birds in the sand-bar area during the period of carrying out construction work and during vessels' passage along the Bystre branch may be compensated by means of implementing measures to increase capacity of the adjoining areas of the reserve for this group of animals by a thought-out hydro- and phyto-melioration of the most degraded grounds.

In the opinion of the DBR staff, taking into account a high mobility of birds and movement of many colonial species within large area, it would be advisable to direct the bulk of compensation funds at ecological reconstruction of the Steptsovsko-Zhebrianovsli Plavni, namely:

- at clearing the existing watercourses and building new ones for the purpose of increasing watering degraded grounds of the SZhP;
- at mosaic withdrawal of excessively accumulated organic mass of reed to improve water cycle conditions and prevent the development of putrefaction processes.

The funds deducted during the DWNR construction and operation for nature-conservative measures in accordance with the calculations of irreparable damages restitution given below, according to the pessimistic prediction of the consequences of the DWNR creation for plant and animal kingdom, may be directed for the designated purpose of carrying out compensation measures.

If natural conditions of the adjacent territories are preserved due to protective measures, it would be advisedly to carry out the above-mentioned compensation measures as reconstructive ones, directed at compensation of the damage inflicted on the environment by the previously executed business activity.

7.4.2 Cast of financial reimbursement of eventual irreparable damage to environment

Calculation of damage to aquatic environment

Assessment of damage to aquatic environment from water quality deterioration during carrying out dredging operations was made only by "suspended substances" index, accepting that by their chemical composition (pollutants) bottom sediment belongs to class II (Annex J). While carrying out the monitoring program, a complex of granulometric and chemical composition research of excavated bottom sediment will be conducted. In case of an increased sediment pollution, an additional compensation of damage for aquatic environment pollution will be made.

Calculations are made by the procedure described in the report on EIA by Odessa Branch of the Institute of Southern Seas Biology of the NASU [1], in accordance with the requirements of the following normative document: "The order of setting the normatives of environment pollution duty and of collecting this duty", approved by Regulation of the Cabinet of Ministers of Ukraine No. 303 of March 1, 1999, and "Instruction on the order of calculation and payment of environment pollution duty" No. 162/379 of July 19, 1999.

The amounts of payment for discharging pollutants into surface waters, territorial and internal sea waters were determined by the formula:

$$P_B = \sum_{I=1}^{N} [(H_{\delta i} \times M_{\lambda i}) + (K_n \times H_{\delta i} \times M_{ni})] \times K_T \times K_{ind} \quad (1)$$

where:

P_B – amount of payment, UAH;

$H_{\delta}i$ – base payment rate for discharge of 1 ton of i-th pollutant within the limit range, UAH/t;

$M_{\lambda i}$ – the mass of yearly discharge of *i*-th pollutant within the limit range. For dredging operations $M_{\lambda i}$ =0.

In this case the formula will acquire the following look:

$$P_B = \sum_{I=1}^{N} K_N \times H_{\delta i} \times M_{ni} \times K_T \times K_{ind} \quad (2)$$

where:

K_N – factor of payment for over-the-limit discharges of pollutants;

K_T – regional factor, that takes into account territorial ecological peculiarities. K_T for the Black Sea and the Sea of Azov basins equals to 2.0; of the Danube – to 2.2;

M_{Ni} – the mass over-the-limit yearly discharge of *i*-th pollutant, t;

K_{ind} - indexing ratio, K_{ind} =1.

Reni – Vilkovo section

Bottom sediments excavation is planned to be done by "Dnieprovsky-5" type suction dredger of 1000 m^3/h productivity. In-process loss may do as high as 2%. In the given section it is necessary to excavate **4,058,620 m^3** of bottom sediments that are characterized by the following average physico-chemical properties: consistency of the soil – 1.9 t/m^3; turbidity-causing fraction – 5.0% (according to Rechtransproekt data).

Calculation of impact on aquatic environment is made by suspended solids.

Bottom sediments excavation will result in discharge of the following quantity of suspended solids to aquatic environment:

M_{susp} = 4,058,620 m^3 x 1.9 t/m^3 x 0.02 x 0.05 = 7711 t

The amount of damage to aquatic environment as a result of suspended solids discharge during bottom sediments excavation, according to the formula (2), will make up:

P_{susp} =7,711 t x 1 UAH/t x 2.2 = **16,965 UAH**.

At Reni–Vilkovo section the planned annual operating excavation makes up 800,000 m^3. In this case, correspondingly, the annual payment amount will make up **3,314 UAH/yr**.

Vilkovo – Bystre section

It is planned to carry out bottom sediment excavation in Vilkovo – Bystre section by "Skadovsk" type hydraulic dredge of 750 m^3/h productivity. In-process loss according to Building Regulations 3.02.01-87 make up 5%. In the given section it is necessary to excavate 595,988 m^3 of soils that are characterized by the following averaged physico-chemical properties: consistency of the soil – 1.9 t/m^3; turbidity-causing fraction – 5% (according to Rechtransproekt data).

Soil excavation will result in discharge of the following quantity of suspended solids to aquatic environment:

M_{sus} = 595,988 m^3 x 1.9 t/m^3 x 0.05 x 0.05 = 2831 t

The amount of damage to aquatic environment as a result of suspended solidss discharge during bottom sediment excavation, according to the formula (2), will make up:

P_{sus} = 2,831 t x 1 UAH/t x 2.2 = **6228 UAH**.

In Vilkovo – Bystre section the planned annual operating excavation makes up 150,000 m^3 which will result in pollution of aquatic environment with suspended matters. In this case, correspondingly, the annual payment amount will make up **1568 UAH**.

The sand-bar part

It is planned to carry out soils excavation on the sand-bar part by "Skadovsk" type chain-bucket hydraulic dredge. In-process loss during the work of a chain-bucket hydraulic dredge make up 5%.

In the littoral section it is necessary to excavate 2,998,720 m^3 of sandy and sludgy bottom sediments, in which the stable suspension-forming fraction makes up, correspondingly, 2.1% and 23.2% (according to Rechtransproekt data). As ratio of the given types of sediments is estimated close to 1:1, we accept in the calculation the average content of suspension-forming fraction of 12.65%. The soil density is 1.9 t/m^3.

Soil excavation will result in discharge of the following quantity of suspended solids to aquatic environment:

M_{susp} = 2,998,700 m^3 x 1.9 t/m^3 x 0.05 x 0.1265 = 36,030 t

The amount of damage to aquatic environment as a result of suspended matters discharge during soils excavation, according to the formula (2) will make up:

P_{susp} = 36,030 t x 1 UAH/t x 2.0 = **72,060 UAH**

In the sand-bar section the planned annual operating excavation makes up 350,000 m^3 which will result in pollution of aquatic environment with suspended matters. In this case, correspondingly, the annual payment amount will make up **8,411 UAH**.

Thus, the amount of pecuniary compensation for polluting water with suspended matters during carrying out dredging is valued at 95,253 UAH, payments for similar pollution during the operating period – at 11,071 UAH.

Calculations of damage from polluting water during dumping to sea disposal dump and to bed dumps were performed by *NOOSFERA Research Center* during developing the corresponding EIA [50, 74].

Assessment of damage to plant and animal kingdom

Assessment of damage was made in accordance with the technical approach used in the report [1].

Preliminary amount of pecuniary compensation of the possible damage to plant communities is calculated at the existing rates for natural-reserve fund of Ukraine (Regulation of the Cabinet of Ministers of Ukraine No. 521 of April 21, 1998 "On adoption of rates for calculating the amount of compensating damage, inflicted by violating environmental legislation within the borders of territories and objects of natural-reserve fund of Ukraine"). Taking into account the uniqueness of estuary wetland forest and its unrecoverability in future, the damage for exterminating wood-and-brush vegetation must be calculated for each tree, bush or subshrub. In a section with the area of 0.1 ha the average of 5-6 trees grow with trunk diameter from 60 to 120 cm, 90 cm on average (19,800 UAH) and 12-15 trees with trunk diameter from 25 to 50 cm, 37.5 cm on average (11,840 UAH) and up to 20 bushes (900 UAH).

In case estuary forest in such section dries as a result of its partial damaging by wave breakage from vessels' passage, calculations must be made by the above-stated rates on the basis of 30,000 UAH for 1 ha of the damaged area. For mouth part of the Bystre branch (1/3 is occupied by estuary forest) it may makeup **810,000 UAH**.

Damage for disturbing grass cover, related to the change of hydrological regime, as well as with other actions, resulting in land erosion, is calculated on the basis of 20,000 UAH for 1 ha of the damaged area.

If, under impact of wave effect, in mouth of the Bystre branch herbaceous plants species, unsteady to long-term underflooding, fall out on 2/3 of the territory, the damage to reserve ecosystems may make up **1,133,000 UAH.**

Thus, in case of degrading of plant communities of the Bystre branch banks, the damage in the long term may be estimated at 1,943,000 UAH. But, to calculate actual damage, annual ecological monitoring of probable degrading of communities along the Bystre branch is necessary.

The main damage to ornithofauna of the reserve is possible in the sand-bar part. Direct damage may be inflicted in case of washing away a part of the Ptichya spit – the place of waterbirds mass nesting, which may result in the following species losing habitual places of nesting (in couples):

- Sandwich tern – 2,600;
- Common tern – 1,850;
- Herring gull – 65;
- Avocet – 12;
- Oyster catcher (RBU) – 1;
- Snowy plover (RBU) – 1.

If impossibility of the given species' nesting is accepted as equivalent to destruction of their nests, according to the current legislation the amount of pecuniary compensation of the damage will make up (in UAH):

- Sandwich tern – 2,600 x (48 x 2) = 249,600
- Common tern – 1,850 x (48 x 2) = 177,600
- Herring gull – 65 x (48 x 2) = 6,240
- Avocet – 12 x (95 x 2) = 2,280
- Oyster catcher (RBU) – 1 x (90 x 2) = 180
- Snowy plover (RBU) – 1 x (90 x 2) = 180
- **TOTAL** **= 436,080**

The rates of compensating damage to birds species, not entered into the Red Book of Ukraine, are calculated on the basis of Regulation of the Cabinet of Ministers of Ukraine No. 521 of April 21, 1998 "On adoption of rates for calculating the amount of compensating damage, inflicted by violating environmental legislation within the borders of territories and objects of natural-reserve fund of Ukraine".

The rates of damage to birds species, entered into the RBU, are calculated on the basis of Regulation of the Cabinet of Ministers of Ukraine No. 398 of March 16, 1999 "On introducing alterations to Regulation of the Cabinet of Ministers of Ukraine of June 1, 1999 No. 399".

Besides that, the following species (in specimens) can lose places of rest, feeding and wintering:

- Dalmatian pelican (ERL, RBU) – 5;
- White pelican (RBU) – 45;
- Spoon-bill (RBU) – 5;
- Big curlew (RBU) – 4;
- Wild duck – 230;
- Herring gull – 120;
- Common teal – 60;
- Pintail – 45;
- Black-headed gull – 45;
- Widgeon – 35;
- Gadwall – 15;
- Little gull – 15;
- Black tern – 10;

The procedure of calculating damage to birds resulting from loss of places of rest, feeding and wintering is not regulated by current environmental legislation. However, the damage undoubtedly exists. Expertly, in report [1] the amount of damage from loss of places of rest, feeding and wintering by the given species was assumed as equal to half that from their death. Then, by current legislation, the amount of pecuniary compensation of the damage will make up (in UAH):

- Dalmatin pelican (EKK, RBU) – 5 x (1,000 x 0,5)	= 2,500
- White pelican (RBU) – 45 x (1,000 x 0,5)	= 22,500
- Spoon-bill (RBU) – 5 x (500 x 0,5)	= 1,250
- Big curlew (RBU) – 4 (100 x0,5)	= 200
- Wild duck – 230 x (90 x 0,5)	= 10,350
- Herring gull – 120 x (48 x 0,5)	= 2,880
- Common teal – 60 x (90 x 0,5)	= 2,700
- Pintail – 45 x (90 x 0,5)	= 2,025
- Black-headed gull – 45 x (48 x 0,5)	= 1,080
- Widgeon – 35 x (90 x 0,5)	= 1,575
- Gadwall – 15 x (90 x 0,5)	= 675
- Little gull – 15 x (48 x 0,5)	= 360
- Black tern – 10 x (48 x 0,5)	= 240
TOTAL:	**= 48,335**

Altogether, according to the given preliminary calculations, **in case of partial washing away of the Ptichya spit, the direct damage to ornithofauna from the navigation route construction and operation may be evaluated at 523,805 UAH.**

To assess the actual damage to ornithofauna, as well as to animals of other groups for whom even a preliminary predicted damage assessment is difficult, special long-term research (monitoring) of the DWNR impact on birds and other animals of the given area of delta and of the reserve as a whole, are necessary.

The damage to ichthyofauna from carrying out dredging was calculated by "Ukrrybproekt" [49], and the damage from dumping to sea disposal dump and to bed dumps – by *NOOSFERA* Research Center [50, 74].

Compensation of damage to land-utilization from temporary taking lands for banking dumps will be carried out in the amounts determined in accordance with the procedure specified by Regulation of the Cabinet of Ministers of Ukraine No. 3284 dated April 19, 1993.

Preliminary calculation of the maximum possible damage for 5 years as per the data of the Department of the State land cadastre in Odessa Region is given in supplement 9.

A summary of pecuniary compensation of possible irreparable damages to natural environment is given below (Table 7.1).

Table 7.1 – Preliminary evaluations of pecuniary compensation amount of a possible irreparable damage to natural environment

Natural environment component, kind of damage	Amount of compensation payments		Note
	construction period, UAH	operation (preliminary), UAH	
1 Aquatic environment, water pollution	**524,860**	**22,574 (annally)**	During dumping and dredging
1.1 Deepening the riverbed	95,253	13,293	
1.2 Dumping to bed dumps	258,931	–	Calculation of *NOOSFERA* RC
1.3 Dumping to sea disposal dump	170,676	9,281	Calculation of *NOOSFERA* RC (with correction)
2 Ichthyofauna, damage to fish reserves	**2,255,345**	**289,262 (annually)**	During dumping and dredging
2.1 Deepening the riverbed	1,253,080	171,438	Calculation of "Ukrrybproekt"
2.2 Dumping to bed dumps	210,075	–	Calculation of *NOOSFERA* RC
2.3 Dumping to sea disposal dump	792,190	117,824	Calculation of *NOOSFERA* RC (with correction)
3 Vegetation, disappearance of valuable communities	–	***1,943,000***	In case of degrading of channel banks communities as a result of navigation. **Actual damage is assessed by monitoring**
4 Orhithofauna, disappearance of places of reproduction and wintering	–	***523,805***	In case of washing away of the Ptichya spit as a result of navigation. **Actual damage is assessed by monitoring**
5 Air pollution	**12,343**	**1,324 (annually)**	During the work of equipment
5.1 Deepening the riverbed and hydrotechnical construction	8,807	837	
5.2 Dumping to bed dumps	-	0	Included in it. 5.1
5.3 Dumping to sea disposal dump	2,143	298	Calculation of *NOOSFERA* RC
5.4 Banking dumps layout	1,393	189	
6 Soils, temporary taking lands for banking dumps, damage to land-utilization	**693736 (for 6 years)**		As per preliminary data of the Department of the State land cadastre in Odessa Region
TOTAL:	**3486284**	**313160 (annually)**	

7.5 Protective measures

7.5.1 Organizational measures

On the grounds of the Decree of the President of Ukraine No. 502/2003 of June 10, 2003, for the purpose of preventing negative ecological consequences as well as obtaining funds, necessary for the project realization, the first stage of DWNR designing and construction, singled out in the investments feasibility study, is stipulated in the given working draft as experimental. Such status of the object permitted to carry out integrated surveillance (monitoring) during the construction and operating period already and to continue them during the DWNR experimental operation for the purpose of preventing negative ecological consequences. This is especially important in the present conditions, as the navigation route passes through the territory of the Danube Biosphere Reserve.

By the Decree of the President of Ukraine No. 117/2004 of February 02, 2004, for the purpose of improving preservation of the unique natural complexes in the Danube delta in its natural state, protecting wetlands of international importance, other valuable natural complexes of the Ukrainian Danube region, carrying out zonation of the Danube Biosphere Reserve territory and optimizing control of them, taking into account the interests of the region development, transportation and other state requirements, as well as stirring up international cooperation and environment monitoring; along with expansion of the DBR territory the scheme of temporary zonation of its territory is approved (Annex A). According to that scheme, for the purpose of renewal navigation in the Ukrainian part of the Danube delta, the lands of the littoral protective strip of its channels – the Bystre and the Ochakivske branches – and the adjacent part of the Black Sea water area within the DBR territory are allotted to the man-made landscapes zone (Annex B).

Thus, the Decree incorporates creation of the DWNR in the Ukrainian part of the Danube delta according to the variant of the route, passing along the Bystre Branch into the legal sphere of Ukraine and eliminates the principal legal obstacles to implement the design decisions of the first stage of its construction and to develop the working draft for the DWNR full development.

7.5.2 Monitoring natural environment of the DWNR zones of impact

From the moment the operations of the first stage of the DWNR creation started, the program of integrated environment monitoring in the DWNR zone of impact designed for the period of carrying out construction work of the first stage and the DWNR experimental operation started as well.

The main purposes of organizing and carrying out the integrated monitoring are:

- acquisition of objective information, necessary to further design of the DWNR;
- effective control of the natural environment state by key indices;
- determining the actual changes of the natural environment related to the DWNR construction and operation;
- detecting the tendencies of natural and man-caused changes of environment conditions and characteristics and futures analysis of these changes at experimental operation and at full DWNR development;
- developing, on the basis of the monitoring results, recommendations to minimize the negative impacts of the DWNR construction and operation on the natural environment and to improve its state.

Implementation of the monitoring program during the first stage of the DWNR construction and operation will result in accumulation and integration of information that will be used to accomplish the following tasks:

- to support decisions at completing the DWNR creation and passing to its permanent operation;
- to substantiate the measures to prevent potentially possible negative consequences of the DWNR operation;
- to report to controlling authorities and information for the interested organizations and the public;
- to work out the program of a permanent environment monitoring in the zone of the DWNR impact as a component of the system of supporting steady operation of the navigation route itself and, at the same time, as one of the measures to preserve the integrity and uniqueness of the delta natural environment.

The elements of the monitoring program, aimed at improving the DWNR steady operation, are incorporated by the notion “engineering monitoring”, though the greater part of the monitoring results has both engineering and environmental significance.

The natural environment components that experience a substantial impact during the DWNR construction and operation and, in their term, affect the conditions of the DWNR operation, namely:

geological environment, air environment, surface waters, soil, plant and animal kingdom, are subject to the monitoring within the program limits.

In accordance with this list, the following monitoring directions in the DWNR zone of impact are determined:

- geo- and hydromorphodynamics;
- hydrodynamic conditions, hydrological regime (incl. sediment regime);
- weather conditions and atmospheric pollution;
- ecological and sanitary state of water bodies;
- the state of soils;
- the state of ichthyofauna;
- the state of plant and animal populations of the shore zone and wetlands, the dynamics of biogeocenoses' composition.

The monitoring system, that meets the above-stated goals and objectives, includes:

1. Carrying out regular observations under standard programs at the network of operating meteorological stations, hydrological posts and sites, as well as at the points of controlling natural environment pollution.

2. Organizing additional sites of standard observations of hydrometeorological, hydrochemical, and sanitary and hygienic regime elements.

3. Organizing and carrying out more detailed observations and special research, including field research, to study natural and antropogenic variability of hydrometeorological, morphological, hydrodynamic, hydrochemical and biological processes and phenomena.

All hydrometeorological and hydrochemical observations, carried out in the Ukrainian part of the Danube delta, may be divided into standard ones and special ones.

Regular routine observations are carried out at the network of meteorological stations and hydrological posts, as well as at cross sections of the Danube delta and in the pollution control points. Standard observations and processing of the data received are carried out according to the uniform procedures of Hydremeteorological service.

Observations of the complete complex of meteoelements are carried out at Izmail, Vilkovo and Ust-Dunaysk meteorological stations.

The work program of Reni, Izmail, Kislitsa, Kilia, Liski, Vilkove, Prorva, Ust-Dunaysk and Primorskoye hydrological sites includes observations of water level and temperature, as well as roughness and ice phenomena. Besides, at Reni, Izmail, Vilkovo, and Prorva posts, observations of water turbidity are carried out.

Measuring water discharge rates and suspended sediment discharge rates are carried out in 24 hydraulic sections, eight of which are boundary. Measurements, carried out in different phases of water regime, embrace the main river-bed of the Danube and all branches in the Ukrainian part of the delta.

Regular hydrochemical observations are organized along the entire length of the Ukrainian part of the Danube, in the estuaries of the Kilia delta branches and in the estuary coastal waters.

The standard observations results are the basis for studying the most important characteristics of natural environment, such as:

- the delta climate and its perennial changes;
- the level, the thermal and the ice regime;
- the delta water balance;
- perennial and seasonable water and sediment runoff variation in the delta top;
- distribution and redistribution of water and sediment runoff by the delta branches;
- hydraulic and morphometric parameters of runoff and river-bed;
- the total runoff of water, heat, solid and dissolved substances to the sea and their distribution over the coastal waters;
- the chemical composition, the pollution state of the Danube waters and their perennial and seasonable variations.

In connection with the DWNR creation, provisions are made to resume observations at hydrological sites that used to exist in the source of the Bystre branch and in the estuary of the Starostambulske branch, as well as to open a specialized hydrometeorological station.

No less important is studying responses of the biotic constituent of the delta ecosystem to changes of conditions of its existence. The Danube delta is distinguished by its unique biodiversity and richness of nature. That is why protection of natural complexes of the Danube region is one of the priorities in reserve business of Ukraine. This priority is secured by creation of the DBR in the lower course of the Ukrainian part of the delta.

Preserving plant and animal kingdom of the Danube lower course goes beyond the scope of natural interests, as unique wetland grounds of the second-largest delta in Europe is of acknowledged international significance.

The DBR scientists, with the participation of profile institutes of NASU, have accumulated extensive data of species diversity, availability and size of populations of rare and valuable representatives of fauna and vegetable groupings, research data of the delta territory, maps of animal and plant kingdom. The DBR has contacts with similar foreign establishments of natural-reserve fund that have experience in navigation in reserve area.

In the monograph [24], written by a group of researchers on various directions (botany, zoology, hydrobiology, parasitology), the results of already conducted research of animal and vegetable kingdom are given, it also contains data on organizing hydroecological monitoring at the modern stage of the DBR development.

All this attests the possibility to carry out the biota monitoring in the DBR zone of impact at a high scientific level.

Special observations are organized to accomplish specific research and practical tasks and are carried out according to separate programs.

One of the main lines of these observations and research is obtaining quantitative assessment of experimental-operational slot and the river-bed part of the DWNR on natural **abiotic** processes that take place in the delta.

The most important here are considered the observations of dynamics of:

- estuary sand-bar where the navigation route path will pass;
- sea boundary of the delta;
- hydrographic network of the Danube delta as a whole;
- distribution of water and sediment runoff by the delta branches;
- suspended and drawn sediment transport;
- alongshore sediment transport;
- penetration of sea waters into the artificially deepened branch.

In respect of studying the DWNR impact on the ***biotic*** constituent of the delta ecosystem, the most important are the research of:

- reaction of hydrobionts communities of the DWNR river-bed part and the sand-bar area of the Bystre branch to carrying out construction work, navigation, as well as the possible changes of water chemical composition and trophicity;
- changing of fish migration routes in connection with creation of hydraulic structures;
- changing of terrestrial animals' population size and floristic complexes' composition on channel banks, littoral sections of *plavni* and the territory of the Ptichya spit in connection with creation a slit through the sand-bar and wave load from passing ships;
- succession of biotic groupings of the delta in case the DWNR creation results in redistribution of river discharge along the delta branches and in changing of the wetlands water regime.

To accomplish the listed tasks, subdivisions and individual experts of the below-listed institutions and organizations are recruited to organizing and carrying out of the monitoring:

- the DHMO (Izmail Town, Odessa Region);
- Odessa YUGNIRO Center of the Ministry of Agropolicy of Ukraine;
- UkrNIIMF (Ukrainian Marine Scientific Research Institute) of the Ministry of Transportation of Ukraine;

- UkrNTSEM (Ukrainian Scientific Center of Ecological Monitoring) of the Ministry of Ecological Resources of Ukraine;
- ChernomorNIIproject;
- Odessarybvod Central Directorate;
- Odessa branch of Institute of the Southern Seas Biology of the NAS of Ukraine;
- Odessa State Ecological Institute;
- The Danube Biosphere Reserve of the NAS of Ukraine;

To give scientific and normative-legal advice, experts from State Inspection of the Black Sea Protection and USRIEP (Ukrainian Scientific and Research Institute of Ecological Projects) of the Ministry of Environment Protectionof Ukraine are recruited.

Hydrographical work concerning the navigation route, including drawing up pilot charts, river-bed survey of complicated sections (sand-bars and rifts), building bottom grade lines along the axis of the ship's motion (bottom and water level) must be done by the organization that operates the DWNR. In this case, it is state enterprise "Delta-Pilot».

Control of sanitary and hygienic regime of water bodies in the DWNR zone of influence is prerogative of sanitary bodies of Ministry of Health of Ukraine. Epidemiological monitoring and control, related to passing of foreign ships, must be placed upon customs service and its lower organizations.

The DWNR zone of impact is the zone of a special monitoring, at the same time the main attention is paid to the DBR territories adjacent to the navigation route.

The main objects of a special monitoring are:

- the Danube branches, along which the DWNR passes, including channel dumps, coastal dumps and the territories adjacent to them;
- the coastal waters section in the area of the approach channel, including the area of the sea dump and the area of the Bystre branch with the DSE [delta sea edge] sections and the Ptichya spit, adjacent to it;
- sections of *plavni* on the DBR territory, that have hydraulic connection with the Bystre branch and its sand-bar area.

The volume of special research and observation on each direction is restricted by those key indices and the number of control points that permit to reliably attest the presence or absence of significant changes in natural environment state with regard to initial one at the moment of the construction beginning. Besides that, within the bounds of the monitoring, analysis and integration of the data from the existing network of standard hydrometeorological, hydrologic and hydrochemical observations in the Ukrainian part of the Danube delta that must be preserved and modernized. It is also suggested that observations at hydrologic sites, that used to exist in the estuary of the Bystre branch and in the estuary of the Starostambulske branch, be resumed and that a specialized gaging station be opened.

It is advisably to effect coordination of research and observations, carried out within the framework of monitoring of the DWNR zone of impact, with the planned scientific work, executed by institutes of NASU and the DBR authorities on the reserve territory, with the subsequent exchange of the obtained results.

The order and periodicity of control, methods of estimation of natural environment state indices and of data processing are determined in accordance with the demands and recommendations of the current normative base.

The intended composition of research on the main monitoring directions is given in Table 7.2.

Table 7.2 – The composition of research intended within the framework of natural environment monitoring

No.	Environment elements and controlled parameter	Sites
1	GEO- AND HYDROMORPHODYNAMICS	
1.1	Morphometric parameters of flow and estuary	Along the entire DWNR track
1.2	Morphometric parameters of estuary sand-bar of the Bystre branch and the Ptichya spit	The sand-bar area of the Bystre branch
1.3	Position of boundaries of sea boundary of the delta	Within the bounds of the Kubanski and the Stambulski islands
1.4	The state of channel banks	Along the Bystre branch
2	**Hydrodynamic conditions, hydraulic regime and sediment regime**	
2.1	Ice conditions	Along the entire DWNR track and in the adjacent sections of the adjoining branches
2.2	Water level	The same
2.3	Water discharge	The same
2.4	River stream velocity	The same
2.5	Water runoff	The same
2.6	Sediment runoff	The same
2.7	Parameters of wind-induced waves, onset waves and waves from passing ships	In the area of sand-bar and estuary of the Bystre Branch
2.8	Speed of sea currents	In the area of sand-bar of the Bystre Branch and in the sea waste dump area
3	**Meteorological condition and atmospheric pollution**	
3.1	Air temperature	At the points of constant meteorological observations and in the places of carrying out dredging operations
3.2	Precipitation	The same
3.3	Wind direction	The same
3.4	Wind speed	The same
3.5	CO	The same
3.6	Ammonia content	The same
3.7	NO_2	The same
3.8	SO_2	The same
3.9	Inorganic dust	The same
3.10	Soot (C)	The same
4	**Hydroecological and sanitary and hygienic state of water bodies**	
4.1	**River and sea waters**	
4.1.1	***Hydrophysical and organoleptic indices***	
4.1.1.1	The presence of floating admixtures and oil slicks on the water surface (visual observations)	Along the entire track length
4.1.1.2	Temperature	The same
4.1.1.3	Smell	The same
4.1.1.4	Transparency (by print and by Secchi disc)	The same
4.1.1.5	Colour	The same
4.1.1.6	pH	The same
4.1.1.7	Suspended solids	The same
4.1.2	***Macro-components***	
4.1.2.1	Total mineralization (the sum of ions)	Along the length of the Bystre Branch, in the sand-bar area and in communicating sections of plavni

No.	Environment elements and controlled parameter	Sites
4.1.2.2	Cl^-	The same
4.1.2.3	SO_4^-	The same
4.1.2.4	H_4SiO_4	The same
4.1.2.5	HCO_3^-	The same
4.1.2.6	CO_3^{2-}	The same
4.1.2.7	Ca^{2+}	The same
4.1.2.8	Mg^{2+}	The same
4.1.3	***Thropo-saprobiological indices***	
4.1.3.1	$N\text{-}NH_4+$	All objects of monitoring
4.1.3.2	$N\text{-}NO_2^-$	The same
4.1.3.3	$N\text{-}NO_3^-$	The same
4.1.3.4	$P\text{-}PO_4^-$	The same
4.1.3.5	Fe total	The same
4.1.3.6	Dissolved oxygen	The same
4.1.3.7	$–BOD_5$	The same
4.1.3.8	COD-Cr	The same
4.1.4	***Toxic substances***	
4.1.4.1	Mn	All objects of monitoring
4.1.4.2	Co	The same
4.1.4.3	Cu	The same
4.1.4.4	Zn	The same
4.1.4.5	Cd	The same
4.1.4.6	Hg	The same
4.1.4.7	Pb	The same
4.1.4.8	Cr	The same
4.1.4.9	Oil products	The same
4.1.4.10	Pesticides (DDT and its derivatives, G-HCH (α- and γ-isomers)	The same
4.1.4.11	General phenols	The same
4.1.4.12	Synthetic surface-active materials	The same
4.1.5	***Microbiological and parasitological indices***	
4.1.5.1	Number of coli-phages	Along the entire track length
4.1.5.2	Number of colon bacillus group bacteria (coli. index)	The same
4.1.5.3	Number of bacterial plankton	The same
4.1.5.4	Number of saprophytic bacteria	The same
4.1.5.5	Presence of elementary pathogenic intestinal protozoa – lamblia, cryptosporidia, eggs and larvae of helminthes	The same
4.2	**Bottom sediment**	
4.2.1	Granulometric composition	In places of dredging operations and in dumps
4.2.2	Organic matters (total content)	The same
4.2.3	Mn	The same
4.2.4	Co	The same
4.2.5	Cu	The same
4.2.6	Zn	The same
4.2.7	Cd	The same
4.2.8	Hg	The same
4.2.9	Pb	The same
4.2.10	Cr	The same
4.2.11	Oil products	The same
4.2.12	Pesticides (DDT and its derivatives, hexachlorocyclohexane – (α- and γ-isomers)	The same

No.	Environment elements and controlled parameter	Sites
	Synthetic surface-active materials	The same
4.3	**Hydro-biological indices**	
4.3.1	Composition and biomass of phytoplankton	Along the entire track length
4.3.2	Composition and biomass of zooplankton	The same
4.3.3	Saprobity indices by Pantle-Buck	The same
4.3.4	Water toxicity for test objects	The same
4.3.5	Species and biomass of water macrophytes	The same
4.3.6	Species and biomass of zoobenthos	The same
4.3.7	Toxicity bottom sediment for test objects	The same
5	**State of soils**	
5.1	**Toxic substance content in surface layer of soils**	
5.1.1	Mn	In the places of bottom sediment storage
5.1.2	Co	The same
5.1.3	Cu	The same
5.1.4	Zn	The same
5.1.5	Cd	The same
5.1.6	Hg	The same
5.1.7	Pb	The same
5.1.8	Cr	The same
5.1.9	Pesticides (DDT and its derivatives, hexachlorocyclohexane – (α- and γ-isomers)	The same
5.2	**Indices of soil value**	The same
6	**State of ichthyofauna**	
6.1	Species of fish with separation of rare and endangered species	In the Bystre branch, in the area of sand-bar and in the sea dump area
6.2	Number and productive properties of fish populations	The same
6.3	Growth and development of fish and their whitebait	The same
6.4	Distribution and migrations of fish and their whitebait	The same
7	**The state of plant and animal populations of the shore zone and *plavni*, the dynamics of biogeocenoses' composition**	
7.1	Rarity spicies	On reserve territories adjacent to the DWNR track
7.2	Natural floristic complexes	The same
7.3	Adventive plants	The same
7.4	Synanthropic floristic complexes	The same
7.5	Species of animals of land ecosystems	The same
7.6	Species, entered into the RBU. Occurrence and size of the populations.	The same
7.7	Insects. Occurrence and size of the populations, development conditions.	The same
7.8	Amphibian. Species composition, occurrence and size of the populations, spawning places and tadpole development conditions.	The same
7.9	Reptiles. Occurrence and size of the populations, development conditions.	The same
7.10	Wetland birds. Species composition, occurrence and size of the populations, reproduction conditions, the size of wintering species.	The same
7.11	Mammals. Occurrence and size of the populations.	The same

7.6 Complex environment impact assessment of the project activities

7.6.1 Assessment of residual effects of planned activity at the period of construction and normal operating conditions

Results of integrated assessment of the effect of the DWNR in the Bystre branch on the natural environment at the period of construction **and normal operation conditions** subject to the measures to secure normal conditions of natural environment and ecological safety are presented in Tables 7.3 and 7.4.

According to Table 7.3 the impact on natural environment at the period of construction the DWNR is admissible subject to the restrictions on carrying out the works provided in the project for the periods of mean water, spawning and nesting.

According to Table 7.4 the impact on natural environment is admissible at the period of the DWNR operation subject to the variety of resource-saving, protective, restoration, compensating, organizational measures and integrated ecological monitoring of the processes with man-caused impact on natural environment, which will provide timely detection and prevention of possible negative ecological consequences of creation and operation of the DWNR.

7.6.2 Estimate of risk and consequences of ship accidents

The accidents of the ships passing through the DWNR may cause severe negative impacts on natural environment. At that, a severe fire or explosion onboard the vessel transporting Dangerous Chemical Agents (DCA) may cause the most significant influence on biota of the delta. In the high seas such serious accident usually results in the loss of a ship.

In 1963 the world fleet tonnage (the ships over 1000 register gross tons) made 198 Mt including 88 Mt of dry cargo vessels, 44 Mt of oil tankers, 24 Mt of bulk carriers, 42 Mt of reefer and passenger vessels [81]. In other words there were about $1.98 \cdot 10^5$ vessels in terms of 1000 register gross tons. At that time there were 426 fires a year at average (Table 7.5) [82]. **Probability of fire on board a ship was about $2.1 \bullet 10^{-3}$**.

Table 7.3 – Complex evaluation of the impact of the DWNR during its creation

Kind of works	Impact factor	Quantitative characteristics of the factor	Characteristics of processes of impact	Evaluation of the consequences of the impact, considering the measures on their limitation
1. **Dredging** of bottom sediment from Reni to Vilkovo in the quantity **5,785, 000 m³** with the dumping at the bank dumps of 3,325,000 m^3 and at the bed dumps of 734,000 m^3 and removing the remaining ground to the sea dump.	Damage of the bottom during the excavation and dumping in the bed dumps	3.457 km²	Destruction of the benthos biocenoses during the construction period on the area of 4.3% of the bottom of the channel considered plot, the area of losses of spawning places is 3 ha.	A slight temporary drop of the self-purification capability of the river ecosystem on the considered reaches. Reversibility of the process is ensured by non-simultaneous impact along the reach and benthos organism move by bedload sediments. **The impact on the aquatic ecosystem is permissible taking into account compensations for damage to ichthyofauna and ban on building during the spawning, provided by the project.**
	Suspended matter losses during the excavation (2 %) and dumping into the bed dumps (5.3%)	126,300 m³	Downstream diffusion of a fine SS with adsorbed pollutants, increase of the water content of nutrients, heavy metals, persistent organic pollutants, both in dissolved and suspended phases (Tables 4.3.10 - 4.3.12), radioactive nuclides (in case of their heightened content in the bottom sediments).	During the low-water flows, in the cross-section of complete mixing, which is situated downstream the site of the simultaneous operation of two hydraulic dredges, the 95% of the water content of SS will increase on 0.5 mg/l. Thus the gross content of SS in water would briefly increase: nitrogen - on 0.12% from the background concentrations, P - by 16.2%, Mn - by 11.5 %, Zn - by 28.6 %, Cu - by 2.1 %, Cd - by 1.0 %, Pb - by 2.7 %, Cr - by 1.6 %, BOD5 - by 5.7 %, oil products - by 9 %, surface-active materials – by 2.2 %, pesticides – by less than 1 %. The growth of concentrations of these substances at chronic contamination during the construction period is estimated as 10-20 times less. The increase of the content of the SS, water body trophisity and deterioration of the dissolved oxygen content on the considered reach of the channel and downstream are **estimated as permissible with reference to existing regulations under the condition of limitation of the number of operating pump-dredges, as it was stipulated by the project for the period of extremely low-water flows.** The toxic impact on aquatic organisms would be shown incidentally, on local plots and will not change essentially the usual toxicological situation in the Danube delta. **Taking into account the compensation of the damage to water fauna and the ban on operation during the spawning period, stipulated by the project, the impact would be allowable.**
	Land occupation for temporary dumps	125 ha	An inwash of a ground layer of 2-3 m on the sites between the channel banking dams and near dam channels of polder system by a suction-tube dredger.	The lands, assigned under the sites, are unused and man-caused infringed. Their considerable part was already used for dumps earlier. The ground from dumps will be used for repair and reconstruction of the defective plots of dams. In accordance with reduction of amounts of works on excavation these assigned lands will be reclamated. **The impact on the land resources is allowable taking into account compensatory damages.**

Kind of works	Impact factor	Quantitative characteristics of the factor	Characteristics of processes of impact	Evaluation of the consequences of the impact, considering the measures on their limitation
	Drainage waters from the dumps	ΣQ_i <1.0 m³/s	The intake of pollutants by the channel, having the same nature as ones, appeared during dredging. These pollutants come with storm and filtration waters, formed on the sites.	Suspended matters with adsorbed metals, organic substances, radioactive nuclides are detained in core pools. Thus the receipt of the dissolved harmful impurities averages over time. In view of slight flow of return waters and diluting in near dam channels, **the impacts on the quality of the river water are allowable.**
	Noise of operating engines and mechanisms	The noise level on a coast is 55 dB(A)	The calculations of the noise nuisance are presented in the data for EIA, given by "Rechtransproyekt"	According to the calculations, **the noise nuisance is permissible in reference to existing regulations.**
	Pollutant emissions into atmosphere made by operating equipment	see Table. 4.2.3	The calculations of the air emission of hazardous substances and their concentrations in the affected zone after dispersion are presented in the data given by "Rechtransproyekt".	According to the calculations, taking into consideration the temporary character of the works, the impact on the air is allowable with reference to existing regulations.
2. Excavation operations on the area from Vilkovo to the delta sea edge in the quantity of **596 thou m³** with the removal to the sea dump and creation of the hydraulic structure with the enrockment and break-stone filling in the quantity of **205,217 m³ .**	A damage of a bottom during the excavation and detritus filling	0.501 km², in particular under filling 0.125 km²	Destruction of benthos biocenoses over a period of the construction on the 6 % of the bottom and the appearance of firm substrates on the 1.5% of the bottom of the section concerned navigable cannel outside the reserve areas of the DBR.	Insignificant and temporary reduction of the self-purification capacity of river ecosystem, later on increase of species diversity and benthos biomass due to the development of biofouling biocenoses, which occupy about 1,5 % of the territory. **The impact is admissible.**
	Sediments losses during the excavation (5%)	29,800 m³	The same pollutants would come in the channels of the Starostambul and the Bystry branches as on the plot of Reni - Vilkovo.	The increase of the content of the SS, water body trophisity and deterioration of the oxygen content are estimated as insignificant. The toxic impact on aquatic organisms would be brief and will not change essentially the usual toxicological situation. **Taking into account the compensation and the ban on operation during the certain periods, stipulated by the project, the impact would be allowable.**
	Noise of operating engines	The noise level on a coast is 55dB(A)	The calculations of the noise nuisance are presented in the data for EIA, given by "Rechtransproyekt".	According to the calculations **the noise nuisance is permissible in reference to existing regulations. The deterrent impact on the fauna is shown out of the reserve zone and has a local character.**

Kind of works	Impact factor	Quantitative characteristics of the factor	Characteristics of processes of impact	Evaluation of the consequences of the impact, considering the measures on their limitation
	Pollutant emissions into atmosphere made by operating engines	see Table 4.2.3	The calculations of the atmospheric gross emission of hazardous substances and their concentrations in the affected zone after dispersion are presented in the data given by "Rechtransproyekt".	The emission takes part outside the reserve zone. According to the calculations, taking into consideration the temporary character of the works, the **impact on air is allowable with reference to existing regulations. It is fauna disturbing, but of a local character**.
3. Works in the sea part of the DWNR: Excavation of ground of 2,998.7 thou m³; dumping of the ground to the sea dump; creation of a dam on the bar part with the **2830 m** length with the enrockment and break-stone filling in the quantity of **195,358 m³**	Damage to the bottom during the excavation and dam construction.	1.40 km²	Destruction of the benthos biocenoses on bottom plots at the area of the sand bar of the Bystre branch.	The effaceable biocenoses are valuable ones. The drop of self-purification activity would have little impact on the quality of water due to sufficient water exchange. **The impact on biota is significant. Taking into consideration the compensation of the damage to the fish food reserves, provided in the project, it is permissible.**
	Ground losses during the excavation (5%)	149,936 m³	Discharge of the pollutants to the coastal waters.	The water quality worsening because of the pollutants coming in from the sediments. **The impact is significant, but has a local character. Taking into account the compensation of the damage to the water fauna, which is provided in the project.**
	Noise of operating engines	The noise level on a coast is 32dB(A)	The calculations of the noise nuisance are presented in the data for EIA, given by "Rechtransproyekt".	According to the calculations **the noise nuisance is permissible** in reference to existing regulations. In view of the sufficient distance from the shore the **impact on a fauna will be negligible**. Out of the zone of 50m from the riverside the exceeding of the noise level permissible for reserves is not predicted.
	Pollutant emissions in atmosphere made by operating engines	see Table 4.2.3	The calculations of the emission of hazardous substances and their concentrations in the affected zone after dispersion are presented in the data given by "Rechtransproyekt".	According to the calculations the **impact on air is allowable** with reference to existing regulations. In view of the sufficient distance from the shores **the impact on the fauna is insignificant.**
	Contact **5,319 thou m³** of the ground with water mass and bottom in the dumping site.	The bottom damage on the territory of **3,000 thou m²**, the input of fine suspension to the water in the quantity of 18,953.6 m³	Destruction of benthos organisms on the dumping area. Periodical input of suspended contaminating matters and contaminating dissolved substances and nutrients, which are similar for their compound to incoming with the ground losses during the construction of the sea approach channel.	**Dumping is held per segment to the specially assigned part of the seabed at 8 km from the seaboard, the situation of which ensures minimization of negative ecological implications. The impact is strong in the dumping place. The impact is admissible taking into account provided compensations for damage to ichthyofauna.**

Table 7.4 – Complex evaluation of the impact of the Deep-Sea Navigation Route during its operation

Kind of works	**Impact factor**	**Quantitative characteristics of the factor**	**Characteristics of processes of impact**	**Evaluation of the consequences of the impact, taking into account the measures on their limitation**
1. Repair dredging operations on the riverbed plots of the DWNR. Excavation of **900 thou m³** a year (under condition of mean annual sediment load).	A damage of a bottom during the excavation	**1.2 km²**	Destruction of the benthos biocenoses during 1 year on the area of 1.4% of the bottom of the riverbed.	A slight temporary drop of the self-purification capability of the river ecosystem on the considered plot. Convertibility of the process is ensured by non-simultaneous impact along the plot and benthos organism move by bedload sediments. Taking into consideration the provided compensation of the damage to the fish food reserves, it is **permissible.**
	Ground losses during the excavation (2 %)	**18,000** m³/yr	Downstream diffusion of a fine dispersed suspension (5% from the value of losses) with adsorbed pollutants, increase of the water content of nutrients, heavy metals, harmful organic substances, both in dissolved and in solid state.	The increase of the content of the SS, water body trophisity and deterioration of the oxygen content on the considered part of the riverbed and downstream are estimated as **insignificant**. The toxic impact on aquatic organisms would appear occasionally, on the local plots and **will not change essentially** the usual toxicological situation in the Danube delta. Taking into account the provided compensation of the damage to water fauna, the impact is **allowable**.
	Land occupation for temporary dumps	< 125 ha, considered in Table 7.3	The use of the lands which were allocated for dumps previously is assumed.	The lands, assigned under the dumps during the period of construction, are used. The liberated sites are rehabilitated. The Impact on the land resources is **allowable**.
	Runoff of drainage waters from the dumps	$\Sigma Qi < 1.0$ m³/s	Suspended matters with adsorbed metals, organic substances and radioactive nuclides are detained in core pools.	Suspended matters with adsorbed metals, organic substances and radioactive nuclides are detained in core pools. Thus the intake of the dissolved harmful impurities averages over time. In view of slight flows of drainage waters and their dilution in near dam channels, the impact on the river water quality is **insignificant**.
	Noise of operating engines	The noise level on a coast is 55 dB(A)	The calculations of the noise nuisance are presented in the data for EIA, given by "Rechtransproyekt".	According to the calculations the noise nuisance is **permissible** in reference to existing regulations.
	Pollutant emissions into ambient air by engines	18.8 t/yr	The calculations of the emission of hazardous substances and their concentrations in the affected zone due to dispersion are presented in the data given by "Rechtransprojekt".	According to the calculations, taking into consideration the temporary character of the works, the impact on air is **allowable** with reference to existing regulations.
2. Repair dredging operations on	A damage of a bottom during the excavation	0.3 km²	Destruction of the benthos organisms on the plots of the bottom on the area of the sand bar of the Bystre branch .	Annihilable secondary bottom biocenoses are not valuable. In view of sufficient water exchange the drop of the self-purification activity will have a **little impact** on the quality of the water. The impact is **permissible**.

Kind of works	Impact factor	Quantitative characteristics of the factor	Characteristics of processes of impact	Evaluation of the consequences of the impact, taking into account the measures on their limitation
the bar plot. An excavation of **250 thou** m^3/yr year (under condition of mean annual sediment load) and up to 1,200 thou m^3 in years of maximal river sediment load.	Ground losses during the excavation (5%)	17,500 m^3 /yr	The intake of pollutants in the coastal waters.	The deterioration of the water quality due to inflow of the contaminants from the ground. The impact is **detectible , but local one**. Taking into account the provided compensation of the damage to water fauna it is **allowable**.
	Noise of operating engines	The noise level on a coast is 32 dB(A)	The calculations of the noise nuisance are presented in the source data for EIA, given by "Rechtransproyekt".	According to the calculations the noise nuisance is **permissible** in reference to existing regulations. In view of the sufficient distance from the shore the impact on a fauna will be **negligible**.
	Pollutant emissions into ambient air made by operating engines	5.3 t/yr	The calculations of the emission of hazardous substances and their concentrations in the affected zone due to dispersion are presented in the source data, given by "Rechtransproyekt".	According to the calculations, the impact on air is **allowable** with reference to existing regulations. In view of the sufficient distance from the shore the impact on a fauna will be **negligible**.
3. Dumping the ground to the sea dump **1,150 thou m^3**/yr (under condition of mean annual sediment load)	Contact of dumped sediments with water mass in the place of the sea dump.	Bottom damages on the area of **650 thou m^2**, the input of SS to the water in the quantity of 6,070.4 m^3	Destruction of benthos organisms on the dumping area. Periodical input of suspended contaminating matters, nutrients, etc., which are similar for their compound to incoming with the ground losses during the construction of the sea approach channel.	Dumping is admissible only on the earlier specially assigned and being used part for that of the coastal waters. The impact is strong in the dumping place. The impact is **admissible** taking into account provided compensations for damage to ichthyofauna.
4. **Operation of the complex construction of navigation route**	Presence of the slot and protective dam in the region of the sand bar.	2.83 km	The change of the natural character of the processes of the extention of the delta marine edge in the area of the sand bar and of the development of the Ptichya spit.	Possibility of the loss of places of safe nesting of protected species of birds, breaking of alongshore fishes' migration routes and their foraging areas. The impact on the fauna is the subject of monitoring. **The realization of regulating protective hydraulic engineering measures and money compensation of unavoidable damage is stipulated on necessity.**
	Changed parameters of channels and sand bar area	Complex of factors	Enlarged salt sea waters intake in the riverbed of the Bystre branch.	The degradation possibility of the existing benthos organisms' complex and formation of a new one. Rare and endemic fishes' species can leave this areas. Impact on a fish fauna is the subject of monitoring. Money compensation of **unavoidable damage is stipulated on necessity.**

Kind of works	Impact factor	Quantitative characteristics of the factor	Characteristics of processes of impact	Evaluation of the consequences of the impact, taking into account the measures on their limitation
			The probability of redistribution of the water flows between the branches of the Kilia delta. Intensification of wind-caused rise-fall phenomena in the Bystre branch and its riverside.	Some intensification of the water exchange and water level fluctuations at the riverside of the Bystre branch will not produce an essential impact on coastal biocenoses. The redistribution of the river flow in the delta due to first-stage works is predicted as **slight**; on the second stage of construction the engineering regulation of the water flows on the entrance in the Bystry branch is provided for prevention of the negative changes of water regime in the delta. The impact is the **subject of monitoring**. Taking into consideration of the provided regulating hydraulic engineering measures, it is **allowable**.
5. Traffic of ships	Landward waves during the passage of ships	The waves height is up to 0.7 m		According to the estimation, at ships speed limitations, assumed in the project, the parameters of man-caused hydrodynamic loads on the banking near the riverbed of the Bystre branch and on the Ptichya spit do not fall outside the limits of the natural values amplitude and **will not produce significant distortion** in these biocenoses. The impact is the subject of monitoring. Taking into consideration the provided restrictive and protective hydraulic engineering measures, including the compensations and bank consolidation, it is **allowable**.
	Pollutants intake into the water	On the length of the navigation route, **172.2 km**	A water drain of engines' cooling systems, the exhausts in water of boats engines. Drains which are not authorized or emergency ones.	Contamination is insignificant in conditions of normal operation. At failures ecological impacts **can be very serious**, irrespective of the allocation of the initial pollution focus. The probability of failures in the accepted variant is **the least** in view of a smaller channel length and the best navigating conditions.
	Noise of operating engines and other factors, disturbing the fauna of the DBR	The noise level on a coast is 54.75 dB(A) in the conservation area – 25 dB(A)	Impact of passing by ships on animals' senses in the riverside of the branch Bystre. Calculations of noise nuisance are given in Table 4.2.4.	Difficulties for migration of land animals through the water area of the Bystre branch, decrease of their number in the riverside of the Bystre branch are possible. The level of a noise nuisance from engines of cargo and passenger vessels and of motor-boats is in permissible limits after the regulations for reserves, which are situated outside the riverside. The impact is the subject of monitoring. Taking into consideration the provided restrictions of the ships speed and sound signal injections, it is **permissible**.
	Pollutant emissions into ambient air made by engines	Depend on the quantity of ship passages.	Calculations of emissions dissipation are given in Table 4.2.2.	The impact is **allowable** with reference to existing regulations.
	Bringing of new representatives of flora and fauna.	Probable	During the transit of ships through the Bystre branch and upstream with possible following spread in all the delta	The undesirable change of water biocenoses is possible. The displacement of protected and valuable species, the deterioration parasitologic state. The impact is the **subject of monitoring** and control from the specialized agencies.

Note: mean annual sediment load has been determined during the period from 1985 to 2002

Table 7.5 – Fire statistics at sea-going craft for 1958-1961

Site of fire	Number of fires on vessels			
	1958	**1959**	**1960**	**1961**
In high seas	109	106	109	168
During ship repair	36	63	48	51
During anchorage at ports	234	259	262	261
Total	**379**	**428**	**419**	**480**

Taking into account that about 5% of ships wrecked in the fires [82]**, P_F, that is a probability of a shipwreck due to a fire may be taken $1{,}05 \cdot 10^{-4}$**. According to classification accepted in Ukraine (Table 7.6) [79, 80] a level of man-caused risk of such event is estimated as «acceptable».

Table 7.6 – Classification of risk levels

Category	Estimate of the levels	Risk
1	Safe	$< 10^{-4}$
2	Acceptable	10^{-4}
3	Dangerous	10^{-3}
4	Extremely dangerous	$> 10^{-3}$

P_A - probability of a ship severe accident caused by fire or explosion in a part of the DWNR crossing the territory of the DBR under conditions of the factors that bring to the accidents in the happenings irrespective of location of a ship is determined by the formula

$$P_A = P_F \cdot P_L,$$

where P_L is a probability of the ship location on site.

The length of a part of DWNR route from the approach sea channel to western extremity of Ermakov Island is 33 km; speed of motion is taken restricted by maximum of 7 knots (13 km/hr). At that, a ship passing through the length takes 2.54 hours. Considering that the expected number of ship passes is 569...1700 per year or 2...5 units per 24 hours the time for a ship being in the length will make (2...5) ·2.54 = **5.08...12.7** hours or 0.21...0.53 of 24 hours. In other words P_L = 0.21...0.53. **Under these conditions a probability of a severe accident P_A at the length where it would have caused the biggest damage to the reserve makes $(2.2...5.6) \cdot 10^{-5}$ and conforms to the safe level of risk.**

Probability of a fire or explosion to happen on the vessel with toxic chemical agents (TCA) on board shall be even lower. With reliable statistics of such accidents being not available one may accept with enough degree of confidence a probability of accident on the ship carrying TCA in this part of DWNR is **$<1 \cdot 10^{-5}$, that conforms to the safe level of risk both in Ukraine and abroad.** This value may be made more accurate upon receiving information relative to composition and volumes of cargoes on the ships passing through DWNR.

When deciding scenario of the estimated accident of a ship and methods of estimation of its consequences for delta it is necessary to take into account that the basic factors of its impact on natural environment are severe discharge of pollutants into water and atmosphere. Discharge of the liquid chemical agents effects first to the conditions of water ecosystem. In the present context of the DWNR part, the channel is separate from the adjacent territory of overflow land with the barriers of near-channel banking, the polluted water volume first shall be carried to the coastal waters and then from there a part of pollutants may get to the overflow land. At that, the more high upstream is the accident site the more dimensioned its negative consequences are, as the number of delta arms by which the spreading of pollution increases.

Therefore, considering possible consequences of hypothetic chemical accident with epicenter within the DBR the top-priority attention should be paid to the pollution of atmosphere air spreading to vast territories.

As a rule, the main components of emission in a ship fire are carbon dioxide and carbon monoxide influencing considerably less on biota than SO_x and NO_x. Period of combustion products influence on biota when a ship is on fire is short enough**. At that the overnormative effect may happen only on territory immediately adjacent to the epicenter.**

In the context of the DWNR the most severe consequences for biota is ***emission of the Toxic Chemical Agents (TCA) to ambient air as a result of outflow and evaporation at high temperature destruction of structures or at detonation***.

To analyze the consequences of such event the methods [83] may be applied for predicting the scope of pollution in the accidents with TCA at industrial objects, highway, river, railway and pipeline transport as well as sea transport, in case when, when TCA cloud reaches coastal zone.

The methods are applied only for TCA, which are stored in gaseous or liquid state and at the time of spilling or emission they turn to gaseous phase and create primary or/and second cloud of TCA.

Primary cloud of TCA is formed by vapourish part of TCA, which is in any container over the surface of liquid TCA and goes to the atmosphere immediately on destruction of a container without evaporation from underlying surface.

Second cloud of TCA appears during certain time as a result of evaporation of liquid TCA from underlying surface (for volatile matters the time of creation of the second cloud after the end of primary one is absent, for other matters it depends on the property of TCA, state of banking and air temperature).

According to the methods [83], a zone is determined for possible chemical pollution (PCPZ) that is the territory where permutation of TCA cloud of dangerous concentration may occur because of wind direction change. Within PCPZ the parameters are computed for predictable zone of chemical pollution (PZCP). Parameters of PZCP are the extension of predictable zone chemical pollution $\mathbf{E_{PZCP}}$ and the area of this zone $\mathbf{S_{PZCP}}$.

The time of the TCA cloud approach to the given object and duration of the pollution source is also computed

When estimating influence of TCA on biota of the DBR one should take into account of that although the list of substances, which negatively influence on biota, checks largely with the list of hazardous substances for population however the priorities are different in principle. Most negative influence for vegetation is chlorine and compounds of sulfur and nitrogen.

Chlorine (Cl_2) effects vegetation in various forms: gaseous chlorine, gaseous hydrogen chloride, halates, etc.. Compounds of chlorine cause deep structural and functional disorders in living organisms, they are toxic for human being [84]. Depositions of chlorides cause irreversible damage to the forests ranging from leaves necrosis to complete die-off of a plant.

Sulfur oxides are most toxic among harmful compounds of sulfur to which SO_2 and CO_2 belong. Time of ambient air self-cleaning from SO_2 exceeds 10 hours [85].

Dioxide sulfur (SO_2), being the main gaseous compound of sulfur in combustion products, in dry clean air it remains intact during 2...4 days or more. Destruction of SO_2 in atmosphere takes place under the influence of ultraviolet radiation (290...400 nm) with forming of sulfuric anhydride SO_3. In high humidity and with solid matters present, which catalyze oxidation, the half-period of reactions are 10...20 min. During this time a half of SO_2 turns to SO_3. However according to kinetics of this reaction the full oxidation of the second half may take from a few hours to a few days and nights.

Mechanism of intoxication of plants by SO_2 is very complicated. The pollutant enters into trees through leaves pores as well as through buds, bark and other parts. Absorbed gas accumulates in edges of leaves and thorns. A redundant amount of oxidized forms of sulfur and their imbalance with the restored forms are considered to have influence on vitally important ferments [85]. At that, the mineral composition of green mass changes i.e. calcium, magnesium and iron and chlorophyll decomposes [86].

Nitrogen oxides – NO_x. NO, which quickly finally oxidizes in air to NO_2, is formed immediately during combustion of fuel. When calculating emissions the compounds of nitrogen NO_x reduces to NO_2. During gaseous-phase reactions, the nitrogen oxides turn to nitric acid in about 10 hours. Ammonia neutralizes a part of it.

Nitrogen oxides being absorbed by leaves disturb metabolism and worsen feed properties of plants [84]. Rather small concentrations of nitrogen oxides in air can destroy green mass.

It is recommended to use twice more lower MAC for plant than for the population [87]. A list of recommended MAC of hazardous matters in air by criteria of harmful influence on biota is presented in Table 7.7.

Table 7.7 – A list of recommended MAC of pollutants in air by criteria of harmful influence on biota [59, 60, and 88].

Matter*	Maximum one-time (MAC_{ot}) and average daily (MAC_{ad}), mg/m^3					
	biosphere		vegetation		trees	
	MAC_{ot}	MAC_{ad}	MAC_{ot}	MAC_{ad}	MAC_{ot}	MAC_{ad}
F	0.020	0.003	-	-	0.020	0.003
HCHO	0.020	0.003	0.020	-	0.020	0.003
Cl_2	0.025	0.015	0.025	-	0.025	0.015
SO_2	0.020	0.015	0.020	-	0.300	0.015
NO_2	0.040	0.020	-	0.02	0.040	0.040
H_2SO_4	0.100	0.030	0.100	-	0.100	0.030
NH_3	0.050	0.040	0.050	-	0.100	0.040
C_6H_6	0.100	0.050	0.100	-	0.100	0.050
O_3	0.100	-	0.100	-	-	-
Dust	0.200	0.050	0.200	0.05	0.200	0.050
CO	1.000	1.000	3.000	-	3.000	1.000
H_2S	0.080	0.080	0.080	-	0.080	0.080
CH_4O	0.200	0.100	0.200	-	0.200	0.100
C_6H_{12}	0.200	0.200	0.200	-	0.200	0.200

* F fluorides (by fluorine); HCHO – formaldehyde; Cl_2 – Chlorine molecular NO_2 – nitrogen dioxide; CO – carbon dioxide; SO_2 – sulfur dioxide; C_6H_6 – benzol; H_2S – sulphuretted hydrogen; NH_3 – ammonia; dust – suspended non-differential matters in air; CH_4O – methanol; C_6H_{12} – cyclohexane. H_2SO_4 – sulphuric acid; O_3 – ozone

Input data to make prediction

According to the methods [83], a prediction is made for a **designed accident,** when there is no natural or man-caused disaster in peaceful time**.**

In such accident, the one-time mass TCA ($MTCA_{ot}$) equals 70 % of TCA mass **in one-time maximum technological capacity.** Volume of a capacity is taken as 60 t, hence $MTCA_{ot}$= 42 t.

Taking spilling of TCA «to pallet» or «loose» – subject to conditions (in spilling mode «**to pallet»** TCA spills on the surface within banking with the layer $\mathbf{h_{spill} = (H_{bank} - 0.2)}$ **m**, where $\mathbf{H_{bank}}$ is a height of banking (Table 7.8).

Table 7.8 – K_{bank} factors of reduction of extension of the cloud of TCA when spilling «loose» and «in pallet»

Height of banking H_{bank}, m	≤ 0.05	1.0	2.0	3.0
TCA:	**K_{bank}**			
Cl_2	1.0	0.48	0.42	0.40
NH_3	1.0	0.50	0.45	0.43
HCHO	1.0	0.48	0.43	0.40
SO_3	1.0	0.40	0.33	0.32
H_2S	1.0	0.63	-	-
HCl	1.0	0.22	0.14	0.10
$CC_{l3}NO_2$	1.0	0.19	0.11	0.09

The following **meteorological parameters** are taken:

$U_в$ = 1 m/s - wind speed in surface layer;

T = + 20 °C -air temperature;

CBCB – degree of vertical stability of air – inversion is accepted, wind direction is not taken into account, spreading of polluted air cloud is taken in a circle [83].

Under conditions of vertical obstacles, the extension of polluted air cloud for each 1 km of these zones decreases by respective factors (Table 7.9).

Table 7.9 – Factor of reduction in spreading of polluted air cloud K_{ter} and factor subject to the extent of vertical stability of air K_{CBCB}

State of surface layer of air		K_{CBCB}	K_{ter} (to be deducted)		
			biota	village	town
inversion	$T_{soil} < T_{serf.2}$	0.081	1.8	3.0	3.5
isothermality	$T_{soil} = T_{serf.2}$	0.133	1.7	2.5	3.0
convection	$T_{soil} > T_{serf.2}$	0.235	1.5	2.0	3.0

Note: T_{soil}– soil surface temperature; $T_{serf.2}$ – air temperature at the height of 2 m over the surface.

All calculations are made within 4 hours. After determination of estimated spreading of a chemical pollution zone $\mathbf{E_{est}}$ subject to all factors, the value received is compared to the maximum value of air mass transfer during 4 hours:

$$\mathbf{E_{max} = 4\ V_f}$$

Where $\mathbf{E_{max}}$ - maximum extension of zone;

$\mathbf{V_f}$ [km/h] – speed of the front of polluted air transfer subject to wind speed $\mathbf{V_w}$ [m/s] [83]..

Responses $\mathbf{V_f\ (V_w)}$ according to Table 2 Methods [83]:

Inversion $\mathbf{V_f} = 5.3\ \mathbf{V_w} - 0.3$

Isothermality $\mathbf{V_f} = 5.9\ \mathbf{V_w} - 0.1$

Convection $\mathbf{V_f} = 7.0\ \mathbf{V_w}$

For accepted normative conditions the wind speed in surface air layer $\mathbf{V_w}$ = 1 m/s with inversion in the background

$\mathbf{V_f} = 5.3 * \mathbf{V_w} - 0.3 = 5.3 * 1.0 - 0.3 = 5.0$ km/h.

$\mathbf{E_{max}} = 4.0 * \mathbf{V_f} = 4.0 * 5.0 = 20.0$ km.

$\mathbf{E_{est}}$ and $\mathbf{E_{max}}$ are compared and the least of the two values is accepted:

$$\mathbf{E_{CBCB} = min\{E_{max}, E_{est}\}}$$

For calculations of $\mathbf{E_{est}}$ of various TCA the value of extension of TCA cloud spreading that meets the input data (wind speed, CBCB, air temperature, quantity of TCA) is multiplied by factor for the given TCA [83].

Results of estimation

Subject to spillage mode «to a pallet» with banking height $\mathbf{H_{src}}$ = 1...3 m we take the banking factors $\mathbf{K_{bank}}$ by Table 7.8. Reduction of the extension of polluted air cloud $\mathbf{K_{ter}}$ (Table 7.9) with forest strips available of total width of 3 km makes **E** = 3 [km] · 1.8 = – 5.4 [km];

Extension of pollution zone $\mathbf{E_{est}}$ dangerous for biota due to the compounds of chlorine, sulfur and nitrogen [83] with spillage of 42 t of the respective matter is predicted for 0.9...17.0 km (Table 7.10).

Table 7.10 – Estimated extension zone of pollution E_{est} with the initial data: $MTCA_{mot}$ = 42 t; wind speed V_w = 1 m/s; T = + 20 °C

TCA	**E**	$\mathbf{K_{bank}}$	$\mathbf{E_{est}}$	№ Table, Methods [83]
	km	-	km	
Cl_2	47.1	0.48	17.2	Table 8
SO_3	23.6	0.40	4.0	Table 11
HCl	19.1	0.22	0.6	Table 14
NO_x	13.2	0.48	0.9	Table 8; table 20
H_2S	6.2	0.63	0.3	Table 11
CS_2	2.9	0.63	0.1	Table 14

In accordance with the methods the area of predictable zone of chemical pollution (PZCP) of biota by the compounds of chlorine, sulfur and nitrogen makes

S_{PZCP}= 0.11 $(E_{est})^2$ = 0.09...32.5 km^2.

This area makes less than 6.5% of the area of the DBR. Such scope of accident impact one may consider as acceptable subject to very low degree of risk.

7.7 Conclusions to Chapter 7

According to the received estimations for the separate factors of impacts and for a complex of impacts the realization of the planned economic activities is admissible taking into account that:

- realization of engineering decisions is provided in the project to prevent negative effects on the processes of further forming of delta and on the territory and the water bodies which represents the ecological value and adjacent to the DWNR;
- the implementation of requirements for ecological safety and introduction of a number of permanent and seasonal restrictions which are directed to prevent or mitigate possible negative ecological consequences of the activities;
- the program has been worked up and financial supporting have been provided for integrated monitoring of the environment for early warning of the tendencies of possible negative consequences of the activity;
- full pecuniary damages in total of 3,486 thou UAH is provided for irremovable negative consequences for fish resources, air, water and land resources as a result of construction and in total of 313 thou UAH per year as a result of dredging during operation;
- additional pecuniary compensation is provided in total of 2,467 thou UAH in case of damage to the flora and fauna of DBR at the period of construction and operation despite protective and safety measures to prevent it;
- estimated area of DBR biota affected makes less than 6.5% of the area of the DBR in case of the most severe ship accident having a probability P<1E-5, that agrees with the safe level of risk accepted both in Ukraine and abroad.

CONCLUSION

1. The absence of the DWNR in the Ukrainian part of the Danube delta causes Ukraine a serious economical, strategic and social damage thus attesting the objective necessity of its creation.

2. Natural conditions of the Danube delta enable Ukraine to have a DWNR that meets the requirements to the highest international class of waterways. This possibility is provided by the existence of the Kilia branch of the Danube, the most affluent and deep enough, with branching delta.

3. The DWNR track, providing an exit from the Kilia branch to the Black Sea along the Starostambulske and the Bystre branches was chosen on the grounds of comparing more than ten variants worked over the Feasibility Study and the design suggestion levels. The range of variants covered virtually all possible ways of providing navigation in the Ukrainian part of the Danube delta using both the existing branches and man-made navigation canals.

4. A detailed comparative impact assessment of the impact on natural environment of the track variant along the Bystre branch and the suggested alternative variant of the DWNR passing along the Solomoniv branch – Zhebriyanska bay lock canal, carried out at the stage of investments feasibility study [FS], showed that by the complex of ecological criteria the track variant along the Bystre branch makes a less impact on the DBR territory, its biota. The advantage of the DWNR variant track along the Bystre branch was also confirmed by the Conclusion of the Integrated State FS Epertise, on the strength of which the variant along the Bystre branch was approved on the government level for further designing, marking out two construction phases.

The impact assessment on the environment, carried out when working out the development project of the Phase I of the DWNR construction, showed that the impacts of this construction stage and further operation of the DWNR are acceptable, taking into account the scheme of DBR territory temporary zoning approved by Decree of the President of Ukraine No. 117/2004 of February 2, 2004. Having successfully passed the integrated investment expertise this draft was approved by the Order of the Cabinet of Ministers of Ukraine No. 283 of May 12, 2004 and by now it has been mainly implemented.

5. The work stipulated by the DWNR project for full development permit to increase the designed draught of the vessels passing along the track from 5.85 m (according to the project of the Phase I) to 7.2 m and to provide a steady operation of the navigation route by way of protective hydraulic constructions.

6. According to all variants, within the territory of Ukraine more than 90% of the DWNR track are made up of the Kilia branch channel, the breadth and prevailing depth of which meet the demands to waterway of the highest international class. At the same time, the existing rifts need to carry out dredging work there. In the present design the amount of the sediment excavated at Reni – Vilkovo section is 5,785,000 m^3 in the course of the DWNR creation (1,727,000 m^3 at the first stage of construction) and 800,000 m^3 a year during the operating period. When carrying out dredging at this section 3,457,000 m^3 of the bottom area will be changed during the construction period and 1,020,000 m^3 during the operating period which will make up 4.3 % and 1.3 % of all bottom area of this branch section respectively.

7. Of all branches, along which the DWNR may be built at the delta extension section, the Bystre branch is the most acceptable by a complex of technical and economic criteria as well as ecological one. Its breadth, slight sinuosity of its river-bed and, the most important, great depth enabled to open the DWNR without dredging operations in the branch. At the phase of the DWNR full development the amount of the soil excavated in the Bystre branch is insignificant - up to 76,000 m^3.

Besides, the project stipulates a limited amount of dredging in the Starostambulske branch in the area of the Bystre branch derivation with excavation of about 520,000 m^3 of sediments (154,000 m^3 – at the Phase I).

The coastal strip 50 m wide along the Starostambulske and the Bystre branches is attributed to the DBR zone of anthropogenic landscapes, which enables to carry out construction and operation of the DWNR under this variant in accordance with the current environmental legislation.

8. The sea approach channel (SAC) is an integral part of any deep-water navigation route. In the approved variant the vessels' passage through the sand-bar area of the Bystre branch is provided by the SAC 3.1 km long with a protective dam 2,830 m long (under the Phase I – 1,040 m). The amount of the sediment excavated at the sea section is 2,997,000 m^3 during the DWNR creation (1,774,000 m^3 at the first stage) and 250,000 m^3/yr at the operating stage.

9. The approved variant of the DWNR enables to count on a long-term successful operation of the DWNR due to the following natural factors that distinguish the Bystre Branch from other branches of the Kilia delta:

– the slowest extension of the delta sea edge in the branch mouth area;

– a constantly increasing portion of the Kilia delta runoff passing along the Bystre branch;

– carrying-out of the bulk of sediment load from the branch beyond the bounds of coastal waters;

– a comparatively rapid increase of sea depths outside the sand-bar area.

10. Water flow control at the upstream reaches of the Danube that resulted in consecutive decrease of the solid sediments runoff during last several decades without decrease of the average annual water flow may be regarded as a positive factor for the DWNR creation. This phenomenon results in slowing down of the processes of the branches silting and the sand-bars lengthening. Nevertheless great long-term and within-year variability of the sediment load stipulate the corresponding fluctuations of the repair dredging amounts and the possibility of *force majeure* conditions arising during the DWNR operation remain.

11. The factors of dredging impact *on the delta formation and the flow redistribution* are regulated and may be minimized due to the hydraulic facilities foreseen at the stage of the DWNR full development. Besides the SAC protective dam, which is being finished, they include bank stabilization sections of the upstream sections of the Bystre branch and the turning dam at the place of the Bystre and the Starostambulske branches radiation.

According to the predictions done, flow redistribution along the Danube delta as a result of the DWNR creation will not affect the system of the Ochakivske branch. The increase of discharges in the Kilia and the Bystre branches could make 1-2 %. This should be considered acceptable, especially in view of the fact that the hydraulic engineering construction carried out by Romania to provide navigation along the Tulcea and the Sulina branches results in gradual decrease of discharges of the Kilia branch.

12. The main impacts *on water quality and the delta branches biocenose*s during the DWNR construction and operation are dredging operations that result in increase of suspended and dissolved pollutant content and in worsening of fish reproduction conditions.

According to obtained results for the terms of minimal annual runoff of 95 % provision and the simultaneous work of two dredge hoppers on the rift, the SS concentration in the water of the Kilia branch at the distance of more than 1 km downstream the work site may increase on average by 0.4 mg/l in the cross-section, and on the axis of the increased turbidity tail – by 2.7 mg/l. Exceeding of background concentrations of priority pollutants in the branches water at the assumed design conditions are estimated less than 7 % except total phosphorus (exceeding of background by 21.3 %), Mn (exceeding by 16.5 %) and oil products (exceeding by 13.4 % and 71.8 % by different calculation methods). Such an impact on the water quality may be considered acceptable taking into

account the limited impact period of pollution factors and maintenance of restrictions on carrying out dredging in the low water period.

In total, during the whole construction period about 4 % of the Kilia branch bottom biocenoses will be damaged, which cannot affect the ecosystem significantly.

13. The main impact factors *on water quality and the biocenoses conditions in the estuary section and in the Bystre branch area* are sediment losses while dredging during the construction of the SAC, dumping into the sea dump and penetration of salt water wedge upstream into the Bystre branch.

The source of water pollution in the sand-bar section will exist only during the dredge hoppers operation, then it will be dispersed by the water flow of the Bystre branch and by sea currents. According to the modelling results, dispersion of the increased turbidity tail carried by along-shore current towards Romania takes place mainly at the distance of 1 km away from the dredge hopper. Near Romanian border water turbidity does not exceed background values.

Certain damage from carrying out work in the Bystre branch bar area may be inflicted on benthos organisms at the expense of bottom damage. But benthos in this area is adapted for existence in the conditions of active processes of bottom reformation, of constant pollutants and sediments carry-over, owing to which it is capable of restoring after cessation of impact of the man-made factors, which in this case are similar to the impact of natural factors.

In the area of dumping a short-time local pollution of water and a long-term pollution of sea bottom within the bounds of sea dump are predicted. Localizing the pollution source and prevention of its spreading to coastal biocenoses are achieved by placing the dump at the distance of 8 km away from the shore at the depth of more than 20 m, owing to which the possibility of bedload sediments spread by sea currents is minimized. Natural burial of the dumped soil and restoration of bottom biocenoses are achieved by the fact that during the flood period the dump area is in the zone of avalanche settling of sediments carried by the Bystre branch.

Intensification of the periodical process of penetration of sea water wedge into the Bystre Branch to the distance of 2-5 km from the estuary will result in displacement of transitional zone between the fresh-water and salt-water benthos biocenoses into the branch and in prevalence of euryhaline bottom organisms within this zone.

Changing of hydromorphologival parameters in the Bystre branch sand-bar area may cause partial redistribution of migratory fish flows by the delta branches.

Local impacts of the work in the sand-bar area on the water environment will not result in significant disturbance of biocenoses of the Kilia delta branches and coastal waters on the whole and will not worsen the conditions of fish stock reproduction in this region.

14. Of biotic groups of the DWNR track area water and marsh birds, whose populations make the main treasure of the DBR, are represented by the largest number of protected species. Certain damage may be caused to these populations if the Ptichya spit is transformed and the channel banks are destroyed, which, as well as the delta sea edge, are ecotones on the border of aquatic environment and wetlands. Being one of the most vulnerable elements of the natural environment, ecotones are characterized by the greatest species diversity of animal and plant kingdoms; they serve as habitat of its many rare and endangered species. Transformation of ecotones may result not only in direct losses for flora and fauna but also in disturbance of water exchange on the adjoining territories of *plavni*.

At the DWNR creation a series of measures to decrease the amount of dredging work and ecotones preservation are foreseen:

- constructing a protective dam in the SAC area that will decrease its silting and limit the area of waves distribution;

- constructing a turning dam in the fork area of the Bystre and the Starostambulske branches, as well as deepening the bed of the Starostambulske branch downstream of the fork for the purpose of deviating bedload sediments from the DWNR track and preventing uncontrolled activating of the Bystre branch;

- speed limitation for vessels' passage along the SAC and of the Bystre branch for the purpose of reducing the wave impact on the Ptichya spit and the branch banks;

- bank protection and artificial reforestation of the channel banks sections exposed to river erosion;

- storing the excavated sediments along the Kilia branch only on the territories that had been exposed to man-caused disturbance while artificially dammed or swamped with the further use of soil for dams repaid, recultivation of shore dumps.

The final work amounts and the design parameters will be determined on the basis of physical modelling and monitoring results.

15. An important factor of impact on the vertebrates' fauna is the disturbance given to them while carrying out construction and dredging work as well as during vessels' passage.

To decrease the disturbance factors' impact, imposing a ban on carrying out work in the area of the Bystre branch sand-bar for the period of birds nesting is foreseen. During vessels' passage along the Bystre branch, the rules of navigation will foresee a ban to sound vessels' blasts and to broadcast music to the deck.

16. As fishery protection measures the project foresees dispersing dredge hoppers along the length of the navigation route track and cessation of the work during the spawning period. The choice of place for the sea dump is made taking into account minimizing the damage to hydrobionts, inflicted during dumping.

17. If the nature protection measures specified by the project are maintained, construction and operation of the navigation route will not result in changes in size and species composition of the DBR biota. Biotic groupings of the Bystre branch area, including rare species and associations, are not unique for the DBR; they are widely spread within the boundaries of its territory. That is why certain local successions of vegetative aggregations and partial migration of animals from the branch itself and its riverside, possible in connection with the DWNR creation, do not pose a threat to preservation of the reserve biodiversity, to the existence of rare and especially valuable species of plant and animal kingdoms on its territory, in particular.

18. Taking into account the measures, specified by the project to ensure the normative state of the environment and ecological safety, residual effects on the DBR territory and their consequences are permissible according to the current environmental legislation as they are either confined in to the territories directly adjacent to the track, which are attributed to the zone of anthropogenic landscapes, or are insignificant in volume.

19. The project provides a pecuniary compensation for the damage to fish industry in the places of carrying out construction work and dumping in the amount of 2,255,000 UAH.. During the operating period, the annual amount of compensation for the damage caused by repair dredging work is evaluated in the amount of 289,000 UAH. These funds must be directed first and foremost for measures aimed at improving the conditions of fish stocks reproduction in the area of the Danube delta.

20. The possibility of compensating the damage from decrease of water quality due to increase of turbidity in the places where dredging and dumping are carried out is foreseen separately in the amount of 524,860 UAH during the construction period and 22,574 UAH per year during the operating period.

21. Certain damage resulting from temporary allotment for shore dumps will be caused to farming industry. A pecuniary compensation for that damage is stipulated by way of entitlement payments to the land plots owners in accordance with the current legislation. By preliminary

conservative estimates the amount of these payments will make up 693,736 UAH for five years of take. After recultivation the lands will be returned to the owners with improved fertility rate.

22. The project stipulates a considerable pecuniary compensation for the possible damage to land flora and fauna in the amount of 2,467,000 UAH in case carrying out protective measures cannot prevent this damage. The allocated funds will be directed to supporting the reserved regime and scientific research of the DBR on new territories allotted to it upon expansion, as well as to restoration of the degraded sections of wetlands in the northern part of the DBR.

It should be specially pointed out that assessments of damage to natural environment, taken as the basis for calculating compensation payments, are to a great extent hypothetical and correspond to pessimistic forecasts of negative ecological consequences of the DWNR creation. The stipulated protective measures will enable to prevent real damage or decrease its possible amount many times over.

23. The DWNR creation should be regarded as a restoration measure with respect to technogenic environment. The increase of vessels' turnover in the ports of Izmail and Kilia will contribute to restoration of work both of the ports themselves and of the infrastructure, which will result in revival of all economical activity in the region.

24. The DWNR creation will be a restoration measure with respect to social environment as well. Aside from direct creation of new work places for the staff operating the DWNR, the increase of employment of the local residents will also be stipulated by restoring the infrastructure of the region as a whole. Hence, the impact on social environment should be judged as positive by objective criteria.

25. Construction of the navigation route at full development will be carried out in conditions and taking to account the experience of operating the experimental navigation route (Phase I). To specify the work sequence, its amount and structures' parameters the following results will be used:

– of an integrated ecological monitoring of the natural environment carried out since the beginning of the DWNR construction;

– of physical modeling of the most unstable sections of the DWNR track carried out by the Institute of Hydromechanics of the NASU;

– of forecasts of the Danube delta development developed using mathematical models of hydrological processes in the NASU Institute of mathematical machines and systems problems and at the Department of Geography of the Moscow State University;

26. The integrated assessment of residual effects of the DWNR creation on natural environment, given in section 7 of the EIA, allows considering them admissible, taking into account attributing the Bystre branch water area, its sand-bar area and riversides to the zone to anthropogenic landscapes of the DBR.

27. According to the results of assessing accident risk while vessels pass through the Bystre branch, the probability of a severe accident on the vessel resulting in ingress of a significant amount of pollutants into the environment is less than 1E-5. It corresponds to the safe risk level approved in Ukraine and abroad.

28. The analysis of the possible impacts of the DWNR construction and operation on the adjoining territories of Romania and on bilateral Ukrainian-Romanian biosphere reserve in the Danube delta demonstrated that the DWNR implementation in accordance with the development project for the full development will not make a significant transboundary impact on the natural environment and nature resources of Romania and will not result in negative ecological consequences for the reserve biota.

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APPENDICES