Report

PlanMER
Program Integral Rivermanagement

Definitive

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Royal HaskoningDHV
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Summary of the Plan EIA of the IRM

S.1 Background

The national government works together with provinces, water boards, and local authorities on ensuring a safe, navigable water system with sufficient nature, good water quality, and spatial development. These river functions cannot be assessed or resolved separately from each other. This is a very urgent task; it is already difficult to facilitate all river functions, and climate change is complicating matters even further. The update of the KNMI climate scenarios released in 2023 confirm this urgency. For this reason, the river zone is being looked at as a whole, and challenges tackled together in a coordinated manner. That is the underlying idea of Integrated River Management. The Integrated River Management Programme (IRM) focuses on the tasks and opportunities in the river zone (consisting of the Meuse and Rhine tributaries, see Figure S-1) in the period up to 2050, while taking the period to 2100 into account.

The central task is to achieve a future-proof river area by making choices about the system characteristics that will ultimately change the design of the river.

The aim is to adopt the Integrated River Management Programme in 2023. The Programme seeks connections with other programmes in the river zone.
Linked to the IRM Programme, this Environmental Impact Assessment (Plan EIA) was drawn up to review the impacts of policy choices in the programme. Given that significant negative impacts on the conservation goals of Natura 2000 sites cannot be ruled out in advance, an appropriate assessment was also drawn up. Finally, a cost-benefit analysis (CBA) [1] of the key figures was conducted.

Figure S.1 IRM Programme planning zone

S.2 Ambition and goals

The ambition of the IRM Programme is to create a future-proof river zone that functions well as a system, and is available for multiple purposes.

There are 5 goals in the IRM Programme:

1. In terms of **river discharge when water levels are high.** the goal is to ensure water can be discharged and stored safely.

[1] *This is a form of a Social CBA in which all impacts are considered, but in this case the impacts were estimated/valued quickly and roughly.*

2. In terms of **freshwater availability and drinking water supply**, the goal is robust availability of freshwater in periods of drought and low discharges through a main water system that can withstand a drought expected to occur on average once every 20 years in 2050 in the STEAM Scenario.
3. In terms of **nature and ecological water quality**, the goal is a dynamic river system with robust river nature, which guarantees that the goals attained or yet to be attained are maintained in connection with WFD and N2000.
4. In terms of **navigability**, the goal is to maintain navigability for current shipping classes and to maintain and develop accessible ports (also for overnight berths) and locks.
5. In terms of **regional economic development and spatial quality**, the aim is to create space for regional developments in line with the characteristics and identity of the zine, and stimulate these developments.

S.3 Assessment of options

To attain the goals listed above, choices are made in the IRM Programme about the planned discharge and storage capacity, riverbed level, sediment management, and nature development. These choices are intended to reverse the various negative trends that have arisen in the areas of safe discharge of water when levels are high, river dynamics with robust nature, freshwater availability, shipping, and spatial quality. Realizing the policy choices can directly or indirectly lead to the IRM goals being attained to a greater or lesser extent, but may have an impact on other environmental aspects.

The policy choices can be realized through various measures, such as expanding the winter channel, changing the main channel, depositing sediment as fill, or a combination of these. The exact measures which will be taken are not yet known. To provide insight into both the extent to which goals will be achieved and potential environmental and other impacts, indicative packages of measures have been used. Three alternative options with various combinations of policy choices have been compiled:

- Option 1: emphasis on resolving issues when water levels are low
- Option 2: emphasis on resolving issues when water levels are high
- Option 3: emphasis on resolving issues when water levels are high or low

The options are distinctive, as can be seen in Figure S.2, in the ‘trade-off’ between riverbed height and sediment management, and discharge and storage capacity. The riverbed position is variable (expressed in centimetres of riverbed elevation or reduction) as is the discharge capacity (expressed in centimetres of water level reduction or increase with an indicative increase in peak discharge from 16,000 m3/s to 17,000 m3/s at Lobith), with differentiation according to the stretch of river. The PAGW task[2] is part of all the options.

Each option was assessed on the extent to which it contributes positively or negatively to the five IRM goals, compared to the positive or negative trends visible in the reference situation.

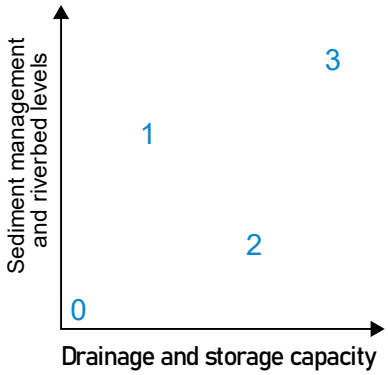

Figure S.2 Positioning of options 1, 2 and 3 (0 represents the reference situation)

[2] *PAGW stands for ‘Programmatische Aanpak Grote Wateren’ (Programmatic Approach to Large Water Bodies). Its goal is to improve water quality (morpho-ecological quality) and boost nature in large water bodies. The PAGW task for the river zone is described in the ecological system task ‘PAGW-Rivieren’ (PAGW Rivers). It involves, among other things, changing the ecotype of 28,300 hectares.*

The results of the assessment of goal attainment can be seen in Tables S.1 and S2. Here, the three tributaries of the Rhine and the Meuse have been assessed independently. The environmental impacts of the options were also assessed, with the results shown in tables S3 and S4.

Both assessments relied on expert judgment, which involved consulting the available information and various studies, such as the calculation of the baseline option [Asselman et al., 2022], IRM System Review and sectoral studies (such as Climate-proof Networks - Navigability), the Freshwater Delta Programme, and the Programmatic Approach to Large Water Bodies (PAGW). The assessment used a seven-point scale with pluses and minuses.

Table S.1 Summary of impact assessment of goal attainment in the Rhine tributaries (incl. PAGW)

IRM goals	**Aspect**	**Option 1** ***Emphasis on riverbed level and sediment management***			**Option 2** ***Emphasis on discharge and storage capacity***			**Option 3** ***Maximum ambition for both policy choices***			**Indicative Preferred Option**		
		Upper Rhine, Waal, and Upper Merwede	Lower Rhine and Lek	IJssel, Pannerdensch Kanaal, Vecht, and Zwarte Water	Upper Rhine, Waal, and Upper Merwede	Lower Rhine and Lek	IJssel, Pannerdensch Kanaal, Vecht, and Zwarte Water	Upper Rhine, Waal, Upper Merwede	Lower Rhine and Lek	IJssel, Pannerdensch Kanaal, Vecht, and Zwarte Water	Upper Rhine, Waal, and Upper Merwede	Lower Rhine and Lek	IJssel, Pannerdensch Kanaal, Vecht, and Zwarte Water
Safe discharge and storage when water level is high	High water levels	0	0	0	+	0	+	++	0	++	++	0	++
	Water storage capacity	0	0	0	0/+	0	0/+	0/+	0	+	0/+	0	0/+
Dynamic river system with robust river nature	Hydrodynamics	++	+	++	++	+	++	++	+	++	++	0/+	++
	Morphodynamics	++	+	++	++	+	++	++	+	++	++	+	++
	Space for nature development	++	+	++	++	++	++	++	++	++	++	++	++
Robust freshwater availability	Freshwater supply	0/-	0	+	0	0	0/+	-	0/+	++	0/-	0	+
	Low-water flow	+	0	+	0/+	0	0/+	++	0/+	++	+	0	+
Smooth and safe transport over water	Navigability when water levels are low	0/+	+	+	0/+	0/+	0/+	0/-	+	+	0	+	+
Regional economic development with reinforcement of spatial quality	Regional economic developments	0/+	0	0/+	+	0/+	+	++	+	++	++	0	++
	Spatial quality	+	0	+	0/+	0/+	0/+	+	0/+	+	+	0/+	+

Table S.2 Summary of impact assessment on attainment of goals in the Meuse (incl. PAGW)

IRM goals	Aspect	Option 1 *Emphasis on riverbed level and sediment management*	Option 2 *Emphasis on discharge and storage capacity*	Option 3 *Maximum ambition for both policy choices*	Indicative Preferred Option
Safe discharge and storage when water level is high	High water levels	0	+	++	++
	Water storage capacity	0	+	++	++
Robust freshwater availability	Freshwater supply	0	0	0	0
	Low-water flow	0/+	0/+	+	0/+
Dynamic river system with robust river nature	Hydrodynamics	+	+	+	+
	Morphodynamics	+	+	++	++
	Space for nature development	++	++	++	++
Smooth and safe transport over water	Navigability of the main waterway network and connecting waterways	0	0	0	0
Regional economic development with reinforcement of spatial quality	Regional economic developments	0/+	+	+ +	++
	Spatial quality	0	0/+	+	+

S.3 Summary of impact assessment on environmental impacts in the Rhine (incl. PAGW)

Aspect		Option 1 *Emphasis on riverbed level and sediment management*	Option 2 *Emphasis on discharge and storage capacity*	Option 3 *Maximum ambition for both policy choices*	Indicative Preferred Option
Nature	Natura 2000 sites	0/+	++	++	++
	Nature Network Netherlands	++	++	++	++
	Water Framework Directive	+	+	++	++
	Protected species	++	++	++	++
Landscape and cultural history	Effect on landscape values	+	+	++	++
	Effect on cultural-historical values	0/-	-	- -	-
	Effect on archaeological values	0/-	-	- -	- -
Soil and salt penetration	Soil quality	0	0	0	0
	Salt penetration	0/-	0	-	0/-
Shipping	Nautical safety	0	0/-	-	0/-
	Effect on shipping when water levels are high	0	0	0/+	0/+
Usage functions	Living and working	0/-	-	- -	-
	Recreation	0/+	+	++	++
	Agriculture	0/+	-	0	-
	Availability of drinking water and water for industry	+	0/+	++	+
	Stability of banks and structures	+	0/+	++	0/+
	Extraction of mineral resources	0/+	+	++	++
	Cables and pipes	+	0/+	++	+
Sustainability	Adaptivity and climate change	0/+	+	++	+
	Energy and raw material consumption	0/-	-	- -	- -

S.4. Summary of impact assessment on environmental impacts in the Meuse (incl. PAGW)

Aspect		Option 1 *Emphasis on riverbed level and sediment management*	Option 2 *Emphasis on discharge and storage capacity*	Option 3 *Maximum ambition for both policy choices*	Indicative Preferred Option
Nature	Natura 2000 sites	++	++	++	++
	Nature Network Netherlands	0/+	+	++	++
	Water Framework Directive	+	+	++	++
	Protected species	++	++	++	++
Landscape, cultural history, and archaeology	Effect on landscape values	+	+	++	++
	Effect on cultural-historical values	0/-	-	- -	-
	Effect on archaeological values	0/-	-	- -	- -
Soil and salt penetration	Soil quality	0	0	0	0
	Salt penetration	0/-	0	-	0/-
Shipping	Nautical safety	0	0	0/-	0/-
	Effect on shipping when water levels are high	0	0	0/+	0/+
Usage functions	Living and working	0/-	-	- -	-
	Recreation	0/+	+	++	+
	Agriculture	0/-	-	- -	- -
	Availability of drinking water and water for industry	0	0	0/+	0
	Stability of banks and structures	0/+	0/+	++	0/+
	Extraction of mineral resources	0/+	+	++	++
	Cables and pipes	0/+	0/+	++	0/+
Sustainability	Adaptivity and climate change	0/+	+	++	+
	Energy and raw material consumption	0/-	-	- -	- -

S.4 The Indicative Preferred Option

An indicative Preferred Option was selected on the basis of the initial results of the EIA (the assessment of the options), and the CBA of the key figures. The indicative Preferred Option consists of a combination of the three options.

The indicative Preferred Option for ‘Riverbed level and sediment management' consists of a combination of options 1 and 2. In terms of 'disposal and storage capacity', the indicative Preferred Option is between options 2 and 3.

The ultimate decision in the context of the IRM Programme fits within the limits of what has been investigated in this Plan EIA. However, the level of detail in the decision is less specific than the indicative Preferred Option. The Preferred Option in this Plan EIA prevails in the further elaboration of the IRM Programme. If follow-up decisions fall outside the framework of the Preferred Option, additional environmental effect assessments will be required.

In the indicative Preferred Option, the riverbed may not erode beyond the level it was at in 2020. Efforts are also being made to raise the riverbed level even higher in certain sections, restoring it to the 2000 level. To this end, excavations in the main channel are being terminated and measures taken such as depositing fill, groyne lowering, construction of longitudinal dams, and river-widening, all intended to remove the flow’s erosive force and prevent further erosion. In addition, the indicative Preferred Option ensures sufficient discharge and storage capacity to accommodate the higher discharges expected in the course of this century (before and after 2050), and to facilitate spatial developments, such as nature, riverbed height and other tasks. This is achieved through river-widening measures, such as the construction of secondary channels, as well as new reservations on the landward sides of dykes based on the General Spatial Planning Regulations Decree (Barro). These measures reduce water levels by between 0 and 80 cm compared to the current situation[3]. Finally, the indicative Preferred Option focuses on preserving and strengthening Natura 2000 sites, WFD sites, and NNN sites, and realizing approximately 28,300 hectares of ecotope change in the river zone (approximately 21,000 hectares of which will change function; see the PAGW system task).

The indicative Preferred Option is visualized in figures S.2, S.3 and S.4. These shows the number of centimetres riverbed levels will rise in each section (figure S.2), the degree of river widening required to meet the various tasks such as the climate task (figure S.3), and the area required (figure S .4).

S.5 Assessment of Indicative Preferred Option

S.5.1 Overall conclusions

The indicative Preferred Option primarily contributes to the five goals to a greater or lesser extent (see S.1 and S2). However, given the uncertainties surrounding the required water level reduction and possible measures in the indicative Preferred Option, the actual impacts are still very uncertain. A lot depends on subsequent choices, such as those made when elaborating specific measures per area in response to urgent tasks. For this reason, it is important to keep a 'finger on the pulse' when further detailing the policy (e.g. through a Decision EIA), and to thoroughly embed points of attention and recommendations for the follow-up (see section S.8) in this process.

The indicative Preferred Option offers many opportunities to meet the goals, but does require a lot of space, especially on a number of river stretches along the Waal, IJssel, and Meuse. This concerns the space required for large-scale river widening, including multiple interventions landside of the dykes (see Figure S.5). More detailed research is required to determine whether sufficient space is available here. Further elaboration is also required to determine whether the nature task can be addressed entirely on the water sides of the dykes at the PAGW hotspots (Biesbosch, IJssel-Vechtdelta, and Common Meuse). Where this is not the case, space on the landward side of the dyke will be required or the task will have to be realized

[3] *Since this option also responds to various tasks, such as raising the level of the riverbed and executing the nature task, part of this water level reduction is cancelled out.*

differently or elsewhere. In the Gelderse Poort hotspot, it is already clear that there is not enough space available, and that the interventions must also be carried out partly on the landward side of the dyke.

Landward space is often outside the Natura 2000 sites, but does indirectly contribute to a robust system.

In principle, the indicative Preferred Option is technically feasible. After all, we can draw on a set of previously implemented measures (such as those in the Room for the River, Maaswerken, WFD, N2000, HWBP and PAGW programmes). However, interventionist major riverbed management is something new, as it has never been done on such a big scale before. It requires knowledge and innovation, not least in terms of feasibility and workability. Rijkswaterstaat is carrying out feasibility tests on the riverbed policy on behalf of the Ministry of Infrastructure and Water Management. This includes an analysis of sediment supply and its possible availability from the river system, from management and maintenance activities, from the implementation of new river projects, and from third parties. Limited substantiation has also been drawn up of the achievability and feasibility of a decision to stop riverbed erosion in the Waal, restore the discharge distribution over the Rhine tributaries at low-water flow, and raise the riverbed of the Waal [Deltares, 2023]. The conclusion of the study is that possible measures to realize these choices cannot be elaborated separately. Measures in the field of sediment management can be implemented more quickly than measures aimed at redesigning a zone (such as creating a multiple channel system). It is estimated that implementing measures on redesigning the system will take 10 to 20 years in total, so it is recommended to first acquire the required learning experience with both types of measures; launch and monitor projects in the short term. This can provide insight into achievability, affordability, manageability, workability, and feasibility, and enable a knowledge and experience bank to be built to later decide on the specific target riverbed height. The IRM Programme proposes an adaptive approach, in which necessary studies and reviews are carried out in national and regional implementation strategies, measures are elaborated, and experience is gained through pilots and projects that can be used to recalibrate policy choices as necessary.

In addition, these interventions have negative environmental impacts on existing values and usage functions (for example on culturally and historically valuable landscapes, agricultural areas or residential functions). The indicative Preferred Option generates between 4.4 and 13.3 billion in costs. It is possible to prioritize tasks on routes where space is too limited for them, and/or to accommodate part of the climate task by raising the dyke.

The Plan EIA and the Appropriate Assessment show that the result of the assessment on the attainment of goals, the environmental impacts, and the effects on Natura 2000 goals do not put the feasibility of the programme in jeopardy. The conclusions on which this is based are explained below.

Figure S.3 The riverbed level task compared to the current situation (section 8.3.2 also includes a map showing the change compared to the reference situation)

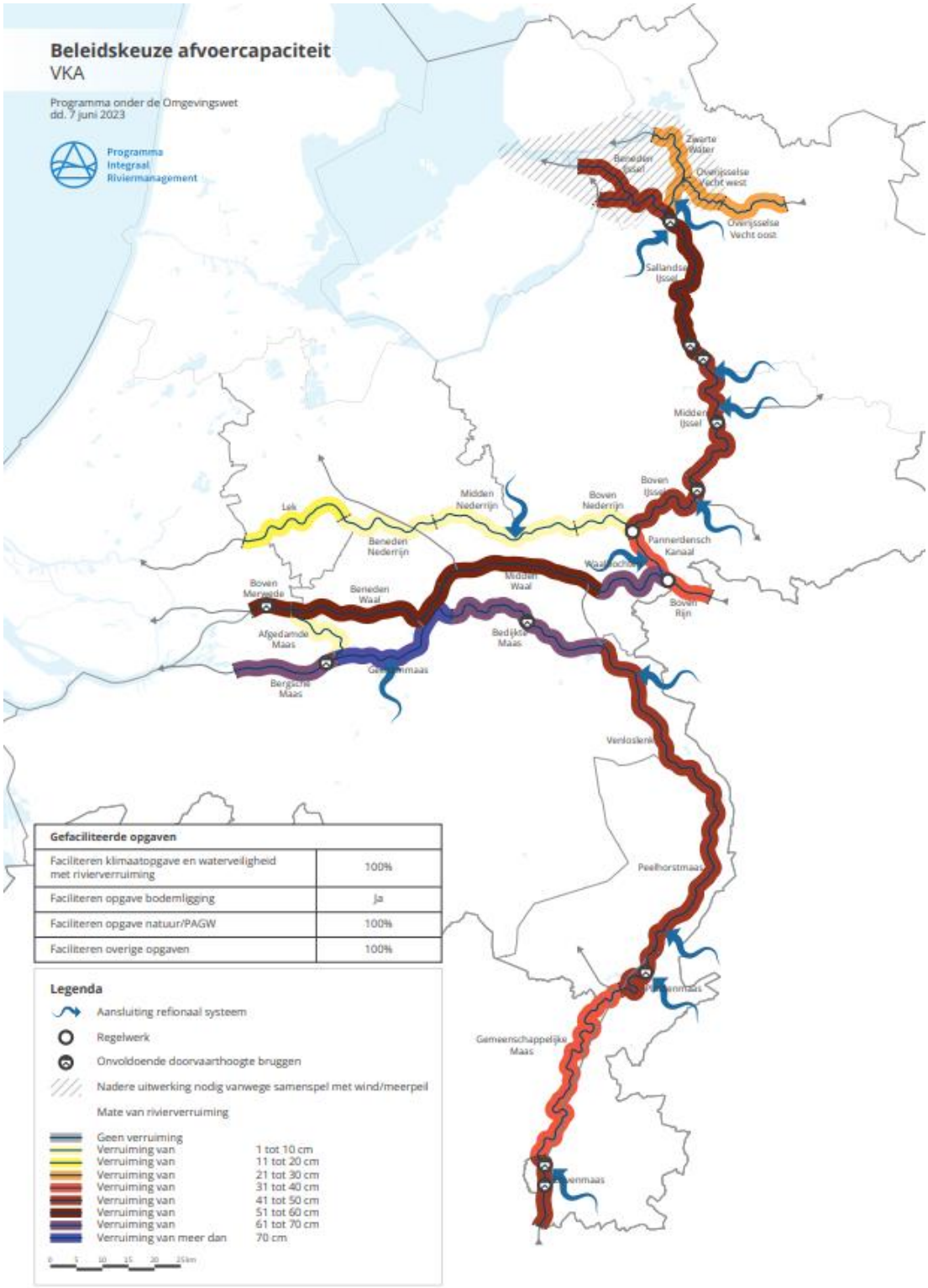

Figure S.4 Degree of river widening in the indicative Preferred Option

Figure S5. Indicative spatial task 2050

S.5.2 Degree of goal attainment

The assessment shows that the indicative Preferred Option of the policy choices contributes predominantly positively to the IRM Programme's goals for both the Rhine tributaries and the Meuse (see tables S.1 and S.2). None of the policy choices in the indicative Preferred Option have an adverse effect on the target attainment. The following considerations illustrate this conclusion:

- The indicative Preferred Option helps high water levels to be safely discharged and stored by increasing the discharge and storage capacity of the rivers, and distributing the high water discharge over the Rhine tributaries in accordance with the agreed distribution through river widening. This reduces the high water level by up to 40 centimetres compared to the reference situation[4]. These reductions potentially reduce the dyke reinforcements required where dyke heights have to be raised until 2050, and extend the lifespan of other dykes.
- The indicative Preferred Option contributes to robust freshwater availability and sufficient ground and surface water in periods of drought and low discharges. This is achieved by maintaining the riverbed height (and in parts of the Rhine tributaries raising it), and consequently the low water levels, which means fewer restrictions arise at entry points. Raising the riverbed level also improves the discharge distribution across the Rhine tributaries: at low-water flow, slightly more discharge flows towards the IJssel (national freshwater buffer). On the other hand, the reduced discharge to the Waal will slightly decrease the freshwater supply in the supply area of the Waal. Because the Waal is several times larger than the IJssel, the reduced discharge has a smaller impact. The degree of salinization remains practically the same, and is independent of the riverbed level (Asselman et al., 2022b). The indicative Preferred Option has little effect on the freshwater supply of the Meuse, because it is largely dammed and more affected by the rain and the discharges that enter the Netherlands upstream.
- The indicative Preferred Option contributes to a dynamic river system with robust river nature by realizing natural hydrodynamics and morphodynamics, good ecological water quality, and ensuring sufficient space for nature. This is mainly the result of the implementation of the PAGW task. To realize and sustainably maintain the wetland ecotopes, hydrodynamic conditions have to be improved and groundwater levels raised, especially in the river forelands in the hotspot areas of Gelderse Poort and the Common Meuse. By implementing the tasks under the PAGW with the policy choices, it is expected that the indicative Preferred Option will make a significant contribution to the attainment of the ecology and water quality goals.
- By maintaining the riverbed, the indicative Preferred Option helps keep waterways navigable and maintain and develop accessible ports (also for overnight berths) and locks. Raising the eroding riverbeds of the Rhine tributaries lowers the height of existing ridges in the river, resulting in more constant water depths. This reduces the number of days that the standard is not met (water depth at the 'OLA' - agreed low river discharge) and improves the accessibility of ports and locks compared to the reference situation. Due to the uneven elevation of the riverbed around the Pannerden branching point, the indicative Preferred Option will result in less discharge to the Waal and more to the IJssel when water levels are low. The indicative Preferred Option improves navigability along the IJssel and the Nederrijn-Lek. The decrease in discharge to the Waal slightly reduces the available water depths when water levels are low Depending on the effect of the measures taken, the net result for the Waal could be positive or slightly negative. Large-scale works may cause temporary or permanent disruption to shipping. The indicative Preferred Option relies on dams and parallel channels, so it has limited influence on the Meuse.
- The indicative Preferred Option helps create space for stimulating regional economic developments, in line with the core qualities of the area. This is the result of the planned river widening measures and nature development that offer opportunities for new and smart combinations of functions in

[4] This concerns the part that is used to compensate for the climate task, not to compensate for other tasks (implementation of raising the riverbed level without affecting the water level, PAGW, etc.).

areas such as river-related activities, nature-inclusive agriculture, and recreation, which can also increase the area's value in terms of quality, usage, and future.

S.5.3 Environmental impacts of the Preferred Option

The key conclusions per theme:

Nature: The indicative Preferred Option, which includes 100% realization of the 28,300-hectare nature task, results in a climate-proof river ecosystem in which a place is reserved for all important habitats and characteristic species. River widening measures on the water sides of the dykes offer opportunities to create robust units for Natura 2000 values that are currently too fragmented, such as riparian woodland and riverine grasslands. Rising the riverbed promotes riverbed dynamics, sediment exchange, and the duration that river forelands are inundated. This favours dry habitat types that benefit from sand deposition, such as riverine grasslands, and wetland habitat types that are sensitive to desiccation, such as softwood riparian woodland. The indicative Preferred Option also offers opportunities for the Netherlands Nature Network (NNN) by improving connectivity in the river area and making it more resilient to climate change. Through measures such as additional spawning grounds for fish, habitat for macrofauna, and growing areas for aquatic vegetation, it contributes to the attainment of WFD goals. The indicative Preferred Option creates sufficient space for sustainable populations of species, some protected, that are native to the river area, such as the pond bat, otter, beaver, yellow-legged dragonfly, houting, and sturgeon. The indicative Preferred Option makes a positive contribution (++) to Natura 2000 areas, the NNN, protected species, and the WFD.

Landscape and cultural history; The indicative Preferred Option preserves existing landscape and cultural-historical values by combating desiccation. The river widening measures (on both the water sides and landward sides of dykes) also offer opportunities for improving the landscape. This does require that the identities of the river landscape are taken into account in the new design. Cultural-historical values and structures, such as side channels, can also be accentuated or reduced. On the other hand, river widening measures or nature development may put existing cultural-historical values of the river area in jeopardy, such as allotments, paths, and green structures. Another point of attention is the lowering of the summer dykes. This has a negative effect on the landscape and cultural-historical values, because it affects the routing and the appearance. Large parts of the river area will be excavated for the indicative Preferred Option, which can have a negative effect on the archaeological values in the subsurface. In terms of the effect on the landscape and cultural-historical values, the indicative Preferred Option scores very positive (++) and slightly negative (-), respectively. In terms of effect on the archaeological value, the indicative Preferred Option scores (- -).

Soil and salt penetration: The indicative Preferred Option scores neutral on soil quality, because according to the regulations it may not deteriorate as a result of interventions. According to these regulations, the quality of the soil must remain the same or improve (for example following remediation). The indicative Preferred Option has a slight negative effect on the degree of salt penetration. Because this option involves a reduction in discharge to the Waal, a deterioration in the degree of salt penetration is also expected in the Rhine-Meuse estuary. On the other hand, salt penetration does decrease slightly at the IJsselmeer (due to an increase in discharge to the IJssel), although to a lesser extent.

Other shipping: The higher riverbed in the indicative Preferred Option reduces the risk of incidents (collision with the riverbed), especially where solid layers are present and at connections with ports: there is less tendency to form ridges, and the water is higher above them (e.g. at the Nijmegen solid layer where incidents are common). The higher levels even when rivers are low can also reduce congestion at locks to some extent, because they can operate more often and for longer. Shipping can also sail with a greater load factor, and the shipping intensity decreases slightly compared to the reference situation. This benefits nautical safety. On the other hand, the implementation and maintenance required for the riverbed requires a lot of

marine machinery in the waterway. The river widening may also create problematic cross-currents to arise at more places. The indicative Preferred Option will slightly increase the vertical clearance at bridges by creating additional discharge capacity and therefore lower water levels. In certain situations, this may allow ships to carry extra cargo (an extra layer of containers).

Usage functions: In terms of usage functions, risks for agriculture and living and working are foreseen in the indicative Preferred Option. This is due to the large-scale river widening measures on both the water sides and landward sides of dykes, and the realization of the PAGW, all of which require considerable space. In some places, more space is required for lowering the water level than the area available on the water sides of the dykes. Reservations on the landward sides of dykes based on the General Spatial Planning Regulations Decree (Barro) are expected to be necessary for the poldered Meuse, Middel Waal, Waalbochten, Upper Merwede, Lower Waal and Middel IJssel. In the Bergse Maas, Getijdenmaas (Tidal Meuse), Sallandse IJssel, Beneden IJssel (Lower IJssel) and Overijsselse Vecht, the task is so great that in addition to space on the water side of the dyke and Barro reservations, additional space on the landward side of dykes may also be required. On the other hand, the indicative Preferred Option offers many opportunities for a number of usage functions, such as keeping riverbanks and embankments stable, securing cables and pipelines, and extracting mineral resources. In addition, there is an increased likelihood that drinking water and water for industry will be widely available in the Rhine tributaries, and the indicative Preferred Option offers opportunities to promote recreation.

Sustainability: The degree of adaptivity depends on whether hard or soft design measures are deployed. River widening measures and raising the riverbed level can generally be considered soft design measures, and therefore highly adaptive. River widening measures will have lasting positive impacts until 2100, and are also adaptable during this period (by this time dyke reinforcement will still be an option, but unnecessary before then). Interventions in the river forelands, on the other hand, are often irreversible, rendering this option less adaptive. Because the indicative Preferred Option will be implemented gradually, there are sufficient opportunities to adapt the option during this process. In terms of energy and raw material consumption, the indicative Preferred Option scores negatively, because it requires major interventions in the river zone to achieve the desired situation.

S.5.4 Appropriate assessment

In summary, it can be concluded that measures concerning riverbed deepness and sediment management are positive in terms of Natura 2000 objectives, and in the final phase there is no risk of significant negative effects on Natura 2000 sites. Erosion in the main channel, the deepening riverbed and the associated lower groundwater levels in the river forelands and beyond lead to desiccation of river forelands. Raising the level of the main channel is therefore an important measure to combat the issue of desiccation in river forelands. It helps disturbed river dynamics recover, and increases the potential for the realization of wetland river nature. This is necessary to ultimately solve the issue of small areas and fragmented habitats in Natura 2000 sites through more spatial measures in the river forelands.
In addition, discharge and storage capacity measures are necessary to realize the Natura 2000 task, also taking into account the future when the impact of climate impacts on the nature task will become more drastic. Restoring natural dynamics depends on important conditions such as preventing further riverbed erosion, raising the level of the riverbed, and lowering river forelands and summer dykes, in line with the DNA of the river.

River widening interventions that may be part of the development of the IRM programme are important to limit riverbed erosion and address the related issues in the Natura 2000 tasks, such as disturbed river dynamics, desiccation, fragmentation, and areas that are too small. As a result, the policy choices in the IRM Programme can be implemented under the Nature Conservation Act.

S.5.5 Costs and Benefits

To support the policy choices in the IRM Programme, a CBA of the key figures was drawn up in addition to the Plan EIA. The CBA of the key figures is intended to give a global estimate of the costs and benefits of the three policy options developed in the context of the IRM Programme, and the indicative Preferred Option. The term 'key figures' indicates that both costs and benefits are largely determined according to available, global key figures. It has been concluded that the costs of the indicative Preferred Option are approximately €4.9 billion for the Meuse, and approximately €8.4 billion for the Rhine. The benefits are estimated at approximately €1.6 billion for the Rhine and €1.7 billion for the Meuse.

S.6 Cumulative impacts

In this Plan EIA, the policy choices on riverbed height, sediment management, discharge capacity, storage capacity, and nature development have been considered and assessed in an integrated manner. In addition, the impacts of holding back water due to nature measures, raising the waterbed level, and realizing other spatial tasks within the options have already been compensated (see table below). As a result, the individual measures that are part of the IRM Programme no longer need to be considered cumulatively.

Table S.5 Discharge capacity in the options

	Facilitating climate change and water safety	Facilitating tasks waterbed level	Facilitating tasks nature/PAGW	Facilitating other tasks
Reference situation	No	n/a	No	No
Option 1	No	Yes	100%	No
Option 2	50%	n/a	100%	50%
Option 3	100%	Yes	100%	100%
The Indicative Preferred Option	100%	Yes	100%	100%

In the further elaboration of the policy, for example when tackling specific tasks, cumulative impacts may arise at measure level if the integrated IRM measures coincide with sectoral interventions. These sectoral interventions are not yet known, but could ultimately have an effect if they take place at the same location and time. For example, cumulative disturbance may arise if implementation is carried out at too many locations simultaneously. Regional policy will therefore have to take into account any cumulative impacts in these areas at the level of measures.

S.7 International impacts

The choices regarding riverbed height, sediment management, discharge capacity, storage capacity, and nature development in the Netherlands are not expected to result in any cross-border environmental impacts in Belgium or Germany that would hinder the feasibility of the draft IRM Programme. This is because there are no large-scale negative environmental impacts, and all the interventions will have at most a neutral effect on water levels. No impacts on water levels are therefore expected in Belgium or Germany as a result of the planned interventions. However, work in the Common Meuse may have a positive effect on groundwater levels in Belgium. Another point of attention concerns nitrogen in the implementation phase, which will have to be taken into account when further elaborating the policy.

S.8 Points of attention for the follow-up

The key points requiring further attention are explained below. These recommendations are based on the results of this Plan EIA for the next steps, implementation of the policy, optimization and mitigation, uncertainties and knowledge gaps, and monitoring and evaluation. An explanation follows below.

Opportunities for optimization and mitigation
The process of further elaboration of policy choices and the preparation of measures in the region involves opportunities for optimization and mitigation. It will only be from this point on that the exact measures will be known, and any possible impacts to be determined. The identified environmental opportunities can then be seized, and, where necessary, measures determined to mitigate any risks. When developing policy choices, it is recommended that the goals should be area-specific. The key possibilities in terms of optimization and risks to be mitigated are explained below.

Opportunities for optimizing goal attainment
In the coming years, the implementation of the national and regional urgent tasks will become clear, after which clarity will emerge about any effects they have on goal attainment. The most obvious optimization opportunities are as follows:

- In the Rhine tributaries, the discharge distribution when water levels are high plays a key role in determining these levels. If the “Lek relief” policy is continued for a discharge at Lobith of 17,000 m3/s, the high water levels along the Nederrijn-Lek will remain unchanged if the indicative Preferred Option is implemented. For this policy to be feasible, it is important that the control range of the control structures at the branching points is sufficient. Since the indicative Preferred Option includes measures to compensate for the higher riverbed level, the discharge distribution does not change compared to the reference situation, and the control range of the control structures remains adequate. During the realization phase, it is important that attention is paid to the policy-based discharge distribution.
- There are also opportunities for measures at a more sectoral level, such as creating additional supply and control options for the freshwater supply to national freshwater buffers and the IJsselmeer in particular.
- It is important for the waterway function that at least the internationally agreed waterway dimensions are maintained at the agreed low river level (OLR - *Overeengekomen Lage Rivierstand)*. Local optimizations can be implemented by removing frequent and critical bottlenecks.
- There are also opportunities for optimizing the goal attainment when policy choices are elaborated into measures. For example, increasing the discharge capacity and a higher riverbed can be at least partly achieved through the longitudinal dams or multi-channel concept. This provides opportunities for navigability at low-water flow, lower high water levels, and the creation of space for natural hydrodynamics and morphodynamics in the riparian zone.

Opportunities for optimization and mitigation of environmental risks
During the elaboration of urgent national and regional tasks, various optimization opportunities to benefit the environment will arise. The following opportunities for optimization and any risks to be mitigated will have to be explicitly considered in subsequent decisions:

Nature:
Points of attention for follow-up decisions The policy in the IRM Programme has not yet been developed to such a specific extent that the impacts can be fully visualized. This appropriate assessment has revealed points that should be considered in follow-up decisions. These points of attention do not lead to conflicting goals that would require amendments to the policy in the IRM Programme, but do have to be taken onboard in the follow-up phase.

- Redevelopment of the river zone will be at the expense of agricultural land, which will result in a change in the carrying capacity for grass-eating water birds, especially in the Rhine tributaries. Attention must be paid to this aspect in the further elaboration of this policy in integrated area developments, which must also include areas on the water sides of dykes outside the Natura 2000 sites. After all, grass-eating water birds need nutrient-rich grasslands, but such foraging areas are also present outside the river zone.
- Redesigning the system will also allow the river to have more impact on the river forelands, which will increase river dynamics. The objective expressed in the PAGW is to maintain and further reinforce hotspots with more static environments, which are important for interconnectedness. The focus should, therefore, primarily be on the smaller static areas located between dynamic zones, where species such as great crested newts and weatherfish are found. In the further elaboration of the river widening plans, attention must be paid to ensure there are enough static environments that are both interconnected and linked to areas on the landward side of dykes.

The negative effect of measures promoting an ecologically robust river system on certain Natura 2000 objectives is also recognized in the context of the PAGW, and attention is paid to this in the Nature Profit Plan and the further elaboration of this policy.

Points of attention for the construction phase: Risks are also anticipated for the construction phase, particularly in situations where large-scale interventions are implemented simultaneously. In practice, this is unlikely to arise because the consequences are temporary and the elaboration of the policy and its final implementation will take place in phases.

- Possible measures to realize the policy choice for riverbed level and sediment management include depositing fill in the main flow of the rivers. This is the habitat of species protected under the Habitats Directive such as sea lamprey, river lamprey, shad, and salmon. When depositing fill, it is important to prevent excessive disturbance or other forms of damage to this habitat.
- Disturbances such as noise, light, and human presence will arise during the execution of the work, which can affect sensitive species such as birds. The extent of such negative impacts depends entirely on the method and period of implementation. Various interventions in the river zone at the same time can also play a role, especially if there are not enough alternative habitats available and if species do not have space to temporarily flee their habitat.
- River widening measures that could be included in the elaboration of the IRM programme will also use agricultural land. Ending agricultural use leads to a permanent decrease in nitrogen deposition. This permanent decrease is expected to be more than sufficient to offset the consequences of temporary and limited increases due to the use of machinery.

Landscape and cultural history

- Depending on the exact locations chosen and method of design and implementation of specific measures such as river widening or depositing sand as fills, archaeological values in the soil may be put in jeopardy. The Monuments Act (*Monumentenwet*) which plays a role the Spatial Planning Act (*Wet ruimtelijke ordening*) and the Environmental Management Act (*Wet milieubeheer*) states that the planning drawn up must indicate how archaeological values and other expected values are dealt with. This is based on the principle that archaeological values are preserved or measures taken to preserve archaeological values, possibly in situ. For this reason, preliminary archaeological research is prescribed on the basis of the Archaeological Monuments Care Act (*Wet op de archeologische monumentenzorg*) for specific planning and project decisions. This must be taken into account in all specific follow-up decisions.
- It is important that cultural history, archaeology and landscape are included as early as possible in the design process. This limits the risks of negative impacts or even allows positive impacts on these values to be created.

Nautical safety: River widening can have substantial negative impacts on the waterway function due to silting up of the navigation channel and/or excessively high cross-current speeds. This must be taken into account when elaborating specific measures.

Stability of banks and structures: If river-widening measures have to be taken, the minimum protection zone used by water boards must be respected. The resistance present in the foreland is required for water safety (piping). Digging in this zone is not permitted in principle, because it can aggravate the water safety tasks. River widening in the form of channels can also improve water discharge in the areas on the landward sides of dykes, so it is not recommended unless taken into account in the design.

Living and working: When further developing river widening measures inside and outside the dykes and the realization of the PAGW, it is important that the space for living and working is taken into account. In addition to the occupation of space, indirect impacts such as groundwater levels and visual impact are also relevant.

Agriculture: The river widening measures and the realization of the PAGW task may have to be at the expense of agricultural areas. To limit this impact, more nature-inclusive forms of agriculture can be sought, accompanied by positive opportunities for nature and the landscape.

Energy and raw material consumption Given the major task and the required maintenance, much energy and raw material will be consumed. The Ministry of Infrastructure and Water Management has expressed an ambition to be completely climate neutral and work circularly by 2030. This means a complete elimination of net CO_2 emissions, high-quality reuse of materials, and halving the use of primary raw materials. This must be respected wherever possible to limit energy and raw material consumption.

S.9 Uncertainties, knowledge gaps, and points to consider during monitoring and evaluation

The draft IRM Programme is notable for the fact that it sets the agenda, and incorporates high levels of scale and abstraction. This environmental impact assessment follows the same pattern. An impact assessment of this nature which also considers long-term impacts, is by definition surrounded by uncertainties and knowledge gaps. Two types of knowledge gaps can be identified in this environmental impact report. Firstly, there is uncertainty about the actual impact of the proposed choices, as the measures to be taken are not yet known and their concrete implementation depends on the follow-up steps that have not yet been taken. Secondly, in many cases there is a lack of knowledge and information about the situation in the future, which makes it difficult to interpret the impacts at the current time The actual implementation of the IRM Programme therefore requires more specific knowledge, which is important to prevent environmental effects as a result of its further elaboration.

A programmatic approach offers the opportunity to set long-term goals and gradually work towards achieving them through projects and other efforts. National and regional partners are collaborating and monitoring progress together. Including both target attainment and progress on system choices in a dashboard enables adaptive adjustments to be made on both aspects.