Prepared for:

Ministry of the Environment of the Czech Republic

"Increasing channel capacity of the River Opava in Krnov and incorporation of the river into the urban structure of the town"

Review of Report

Report

July, 2006

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"Increasing channel capacity of the River Opava in Krnov and incorporation of the river into the urban structure of the town"

Review of Report

Ir. H.J.M. Ogink

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Contents

1 Introduction

On request of the Ministry of the Environment of the Czech Republic (Contract for work Section 536 et seq. of Act No 513/1991) a review is made of the study entitled "Increase in the Capacity of the Channel of the Opava River in Krnov and Integration of the Water Course in the City Structure" by Ing Václav Čermák and Ing. Helena Králová CSc for the client Nadace Partnerství in 2005.

The assessment includes:

1. The initial state of affairs-description of the current situation;
2. Analysis of the individual scenarios of flood protection of the City of Krnov on the basis of the documents and results provided by the aforementioned study (evaluation of the water-surface regime of flood flow rates in relation to river processes, the manner and scope of the necessary modifications-built-up/non-built-up areas);
3. Evaluation of the results of the study and recommendations for further procedure.

The assessment is elaborated in the following Chapters.

2 Documents received

The review presented in this report is based on the following documents:

1. Original report "Zkapacitnění koryta řeky Opavy v Krnově a začlenění toku do struktury města" Vypracovali: Ing. Václav Čermák and Ing. Helena Králová CSc. Průvodní zpráva. Zadavatel: Nadace Partnerství , Brno, duben 2005, consisting of 8 chapters covering 30 pages with photo's and sketches attached.
2. English translation of the text of the above captioned report.
3. Dutch translation of the text of the report captioned under 1.
4. Výkresové přílohy:
   a) B1-B3 Varianta V1
   b) C1-C5 Varianta V2, V0, V21, V22, V23.
   c) D1-D2
   d) E

Annex A: Schematický podélný profil …etc mentioned in the annex-list **has not been received.** This is rather unfortunate as from the text it is revealed that it provides a comparison of the water level profiles for the various alternatives. Furthermore, no translations were provided for the text in the Annexes.

3 Current situation

Re Chapter 1 Introduction

In the Introduction of the Report the flood control measure including the implementation of the Nové Heřminovy dam and reservoir is mentioned as well as the negative social and environmental impacts for the inhabitants of the village and surroundings. Furthermore, it is stated that the construction and maintenance costs of the dam and reservoir are high. It is stated that the reservoir would provide sufficient flood peak reduction and delay up to the mouth of the Opavice in Krnov, but that further downstream the effect is much less due to the contribution of the Opavice and that at the level of Opava town the effect is almost gone.

Also, reference is made to a study ordered by the Ministry of Agriculture on widening and raising of the river banks of the Opava in Krnov to enhance the flood control capacity. The study indicated that such an activity would lead to substantial demolition and high costs and lead the Odra Water Board conclude to recommend the construction of the Nové Heřminovy dam and reservoir, which was taken over by the Moravian-Silesian Town Council.

Re Chapter 2. Aims of the study

The reviewed study aims at increasing the discharge capacity in Krnov town by means of measures that would be more sensitive to the environment of Krnov, restore river functions and near-to-natural condition of the river, establish a bio-corridor and cycle track. It also includes flood control measures for the stretch upstream of Krnov up to the proposed dam location for provision of social, environmental and economic indices to be compared with other solutions.

Re Chapter 3. Investigation and background information

Chapter 3 starts with a denial of the Ministry of Agriculture and Odra Water Board to supply the investigators with reports (e.g. Aquatis, November 2001) and data pertinent to the river and flood conditions between the proposed dam site and Krnov. Investigators therefore carried out a re-levelling of the whole water course of the Opava in Krnov at intervals up to at maximum 250 m. No mentioning is made of the km reach, but from the drawings it is deduced that the reach km 68.3 to km 72.3 has been surveyed.

The reported 100-year flood and 1997 flood data for Opava at Krnov upstream of Opavice mouth are consistent with other publications. Those mentioned for Opava downstream of the Opavice mouth (337 m^3/s and 583 m^3/s) are higher then mentioned elsewhere (< 300 m^3/s and < 530 m^3/s in DHI, Aquatis and Odra Water Board, December 2000).

According to the flood maps the discharge capacity of river and flood plain of Opava at Krnov downstream of the Opavice confluence is indeed of about a 20-year flood. It is stated that upstream of the Opavice confluence the discharge capacity of Opvava river in Krnov is of about a 50-year flood. Flood maps indicate that this statement is incorrect; large parts of the city are within the present 50-year flood contour line (see DHI et al, 2000).

The Opava river appears to be heavily polluted with fecal and coliform bacteria and contains high concentrations of nitrate.

A regional bio-corridor is located along the river.

The Development Plan does not include any major riverbed modifications in view of awaited approvals for construction of the dam and reservoir.

Comments

The description of the current conditions of the Opava river in Krnov in the Report is **insufficient**. This is probably mainly due to non-availability of detailed documents. Furthermore, the assessment of the present discharge capacity of the Opava river in Krnov upstream of the Opavice confluence is inconsistent with flood extent maps presented elsewhere. The capacity is rated too high, which may have consequences for the assessment of required additional improvements to reach the needed protection level.

With amazement it is noted that information on flood conditions in Krnov available with the authorities could not be made available for this study, which hampered a proper assessment of the flood conditions in Krnov town.

It is required that the baseline conditions, (social, environmental, ecologic, structural and hydraulic) are properly described for reasons of comparison with the alternatives, to give the decision maker a clear view on the pro's and con's of the alternatives.

4 Analysis of flood control measures

Re 4.1 Proposed flood control measures

The basis of the flood control measures were apparently not known to the investigators. They have applied a 100-year protection level and for parts also a protection levels against the 1997 flood discharges.

Comment: there is indeed not a clear cut flood protection norm in the Czech Republic. In the "Conceptual Document for Water Management Planning on the territory of the Moravian and Silezian Region in the transient until 2010" by the Odra Water Board, 2003, it is mentioned that:

- for historical centres of towns and historical urban development the design flood should be ≥ 100-year flood;
- for continuous urban development, industrial premises, important line constructions and buildings the design flood should be ≥ 50-year flood;
- for scattered housing and industrial development and continuous development of cottages the design flood should be ≥ 20-year flood.

These norms indicate that the design flood for Krnov should be the 100-year flood and for the villages between the proposed dam-site and Krnov the design should be based on the 20-year flood. Note that the 1997 flood on Opava at Krnov had a return period of about 500 years. It follows that designing a protection for Krnov and particularly for the villages upstream of Krnov up the level of the 1997 flood discharge (500 year flood) **is not realistic**.

Re 4.2 General approach to the river modifications in Krnov, KMs 68.374-72.330

In the analysis the river reach is divided into the following 7 sub-sections, see Table 4-1 below. The following main alternatives are considered to increase the river discharge capacity:

- V0: it implies **no** river widening but **raising** of the banks only onto the 100-year flood protection level and no enlargement of the capacity at the bridges;
- V1: it implies conveyance of Q_{1997} flood discharge by **widening** the river, but only for those sections where no architecturally valuable or large buildings exists, and further by **enlargement** of the discharge capacity at bridges;
- V21, V22, V23: mixture of V0 and V1 for a Q_{100} design discharge, see Table 4-1;
- V3: modification of Alternative V1 that incorporates a more natural solution into the town's structure.

Table 4-1 River sections and definition of variants

Section	Variant	V0	V1	V21	V22	V23	V3
	Design flow	Q_{100}	Q_{1997}	Q_{100}	Q_{100}	Q_{100}	Q_{1997}
	Km						
1	68.374-69.427	V0	V1	V0	V0	V1	V3
2	69.427-70.235	V0	V1	V0	V0	V0	V3
3	70.235-70.616	V0	V1	V1	V1	V1	V3
4	70.616-70.894	V0	V1	V0	V0	V0	V3
5	70.894-71.459	V0	V1	V0	V1	V1	V3
6	71.459-72.001	V0	V1	V0	V0	V0	V3
7	72.001-72.330	V0	V1	V0	V0	V1	V3

River banks are either flood protection walls or levees with gentle slopes ranging from 1:4 to 1:10 dependent on the space available. Free boards of respectively 0.3 m for Q_{100} and 0.6 m for Q_{1997} have apparently been applied in the designs. Wave run up calculations and settling conditions are required to assess the suitability of this choice.

For the incorporation of the river into the urban structure of the towns the following aspects have been considered: the ecosystem of the flood plain and the social structure of Krnov. Particularly, the natural values will be reinstated in the flood plain and a cycle track is proposed.

Important aspects of improving the natural value of the river and riverine area are the creation of a bypass of the barrier created by the fixed weir near Mir cinema and establishment of longitudinal continuity by allowing conditions for deposition of gravel beds and creation of riffles and pools. Flood plain continuity is also considered necessary to ensure a bio-corridor.

Comment: a quality comparison of the alternatives is missing in the Report.

Re 4.3 The concept of functionally-interconnected space for the town of Krnov

Discussed in the report are solutions for the following river sections:

- Natural area (Section 1);
- Border areas (Sections 2, 6 and 7);
- Urban park (part of Section 6);
- Recreational function (Section 5);
- River bank (Section 4).

Note that a solution for Section 3 is apparently missing.

It is stated that two bridges in the reach are not suitable to pass the Q_{100} or Q_{1997} design discharges: the Sokolovská street bridge (km 70.353) with a too low roadway and the Svatováclavská street (km 70.782) with a central support blocking passage of debris in case of floods. Modifications to U Jatek bridge (km 69.612) and Vrchlického bridge (km 72.017) are proposed. The rest of the bridges are said to be capable to pass a Q_{100} flood discharge (with 0.5 m free board underneath) and with minor modifications also a Q_{1997} discharge.

Comment: drawing B3 indicates that beside above bridges also the bridges at km 70.136 and km 71.459 need considerable modification.

Re 4.4 Example of the modifications of the River Isar in Munich

Example is given of the Isar in Munich of implementation of the ideas the authors propose for Krnov.

Re 4.5 Evaluation of water levels of Opava in Krnov

In this section it is indicated what hydraulic roughness values have been applied for river and flood plain. Reference is made to an Annex A, where a apparently a comparison of flood profiles is given. This Annex was not included in the sent materials, and can therefore not be judged. As a result, the Consultant derived the water levels for Q_{100} conditions from the Annexes B2 and C2-C5.

Comment: The description of the results of the hydraulic calculations is **insufficient** to judge the accuracy of the calculated water levels. There is no mentioning of any type of calibration being done before applying the hydraulic model for the design alternatives. The roughness values applied for the river bed may be acceptable.

For the flood plain the roughness values seem to be too optimistic as summer conditions have to be considered for the resistance of the vegetation. No details are provided as to the energy losses applied at the bridge sites. The Report gives the impression that the calculations were done in a very approximate manner, with loose statements on water levels of alternative V3 and V1 being similar because of compensations between a wider profile and roughness. It is the Consultants opinion that **this chapter should be completely modified and extended** with all details of cross-sections, division between river and flood plain, hydraulic roughness for each river and flood plain section based on due consideration of type and extent of vegetation in the section, longitudinal and cross-sectional profiles of hydraulic sections of the bridges with details of approaches to bridge constrictions and assumed loss coefficients, and proof of the applicability of the hydraulic model by calibration and verification on historic floods. Flow velocities in the river and in the flood plain should be made visible.

Furthermore:

- From the English translation it seems that unsteady flow calculations have been carried out ("time-course" of the water levels). From the Dutch translation it looks as if only non-uniform steady flow (backwater) calculations have been carried out;
- Vegetated flood plains can create large resistance to flow when not properly maintained. The hydraulic roughness of the flood plain in the natural variants seems to be underestimated;
- Apparently, the flow velocity in longitudinal direction varies considerably due to the continuous widening and narrowing of the river cross-section. This is not favourable for discharge of ice and may lead to back up of the water table by ice-dams in early spring floods;
- It is understood that the river-bed level is not changed in the alternatives, so little effect on groundwater levels are expected;
- There is no mentioning of any type of investigation into river morphological aspects during extreme floods and possible consequences for the water levels.

The 100-year flood water levels as calculated are presented in Table 4-2. In Figures 4-1 and 4-2 a comparison is made between the extreme alternatives V0 and V1. The effect of widening of the river cross-sections (V1) compared to raising of the banks (V0) on the design water levels is visible from the graphs. In all sections but Section 5 the reduction in design water level appears to be considerable. From the water table calculations it is observed that at some bridge locations, due to constriction, the velocity head effect may be large causing the water level to fall locally in upstream direction. Cross-sectional details are missing to assess this in detail.

The alternatives V21, V22 and V23 are mixtures of V0 and V1. The water level differences of each of the variants with V0 are presented in the Figures 4-3 to 4-5. From the modifications presented in Table 4-1 for alternative V21 in Section 3 a lowering of the design flood level may be expected, for alternative V22 in the Sections 3 and 5 and for alternative V23 in the Sections 1, 3, 5 and 7. From the Figures it is observed that at least qualitatively these alternatives have correctly been calculated. A hick-up is observed for km 70.2 which needs further attention in the calculations. Furthermore, the results of alternative V22 and V23 in comparison with V0 requires further attention as to the modelling of the weir at km 71.0, see Figures 4-4 and 4-5.

Table 4-2 Q_{100} water levels for the investigated alternatives

Section	Km	mtrs	Cross-section	V0	V1	V21	V22	V23
1	68	360	1	310.67	310.67	310.67	310.67	310.67
1		640	2	311.60	311.17	311.60	311.60	311.11
1		820	3	312.11	311.31	312.11	312.11	311.41
1	69	050	4	312.54	311.70	312.54	312.54	311.91
1		120	5	312.53	311.81	312.53	312.53	311.98
1		300	6	312.91	311.95	312.91	312.91	312.10
1		390	7A	313.07	312.24	313.07	313.07	312.33
2		470	7B	313.30	312.59	313.30	313.30	312.75
2		612	8	313.53	313.14	313.53	313.53	313.06
2		700	9	314.03	313.38	314.03	314.03	313.62
2		800	10	314.17	313.49	314.17	314.17	313.84
2		960	11	314.34	313.72	314.34	314.34	314.09
2	70	070	12	314.38	313.87	314.38	314.38	314.17
2		100	13	314.60	313.71	314.60	314.60	314.44
2		170	14	314.92	314.29	314.92	314.92	314.66
2		200	15	314.67	314.17	315.14	315.14	314.91
3		273	16	315.74	314.68	315.33	315.33	315.15
3		321	17	316.03	315.00	315.53	315.53	315.37
3		400	18	316.48	315.14	315.61	315.61	315.47
3		530	19A	316.56	315.34	315.71	315.72	315.59
3		580	19	316.66	315.54	315.78	315.79	315.69
3		616	20	316.68	315.87	315.89	315.89	315.82
4		670	21	316.76	315.95	316.07	316.08	316.02
4		773	22A	317.10	316.50	316.67	316.68	316.65
4		800	22B	317.35	316.52	316.91	316.91	316.89
4		874	24	317.63	316.61	317.26	317.27	317.24
5		910	25	317.70	317.14	317.55	317.55	317.62
5	71	000	26	317.50	317.27	317.50	317.71	317.73
5		300	27	319.28	319.10	319.28	318.76	318.67
5		427	29	320.00	319.11	320.00	319.10	319.09
6		480	30	320.47	319.36	320.47	319.91	319.91
6		583	31	320.65	319.77	320.65	320.24	320.25
6		650	32	320.79	319.82	320.79	320.62	320.62
6		780	33	321.08	320.28	321.08	320.96	320.96
6		970	34	321.62	320.88	321.62	321.57	321.58
7	72	017	35	321.89	321.05	321.89	321.82	321.92
7		276	36	322.61	322.10	322.61	322.59	322.35
7		324	37	322.86	322.26	322.86	322.84	322.46

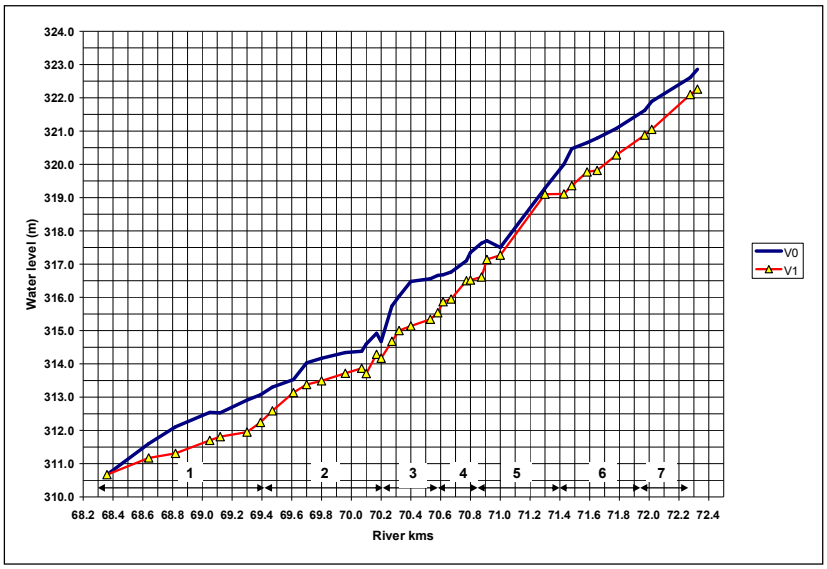

Figure 4-1 Q_{100} water level profile in Opava at Krnov for alternatives V0 and V1

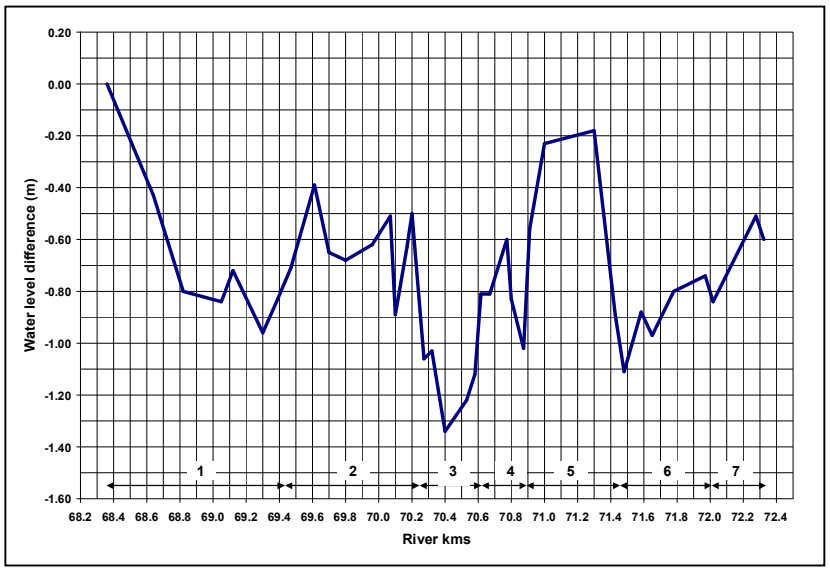

Figure 4-2 Difference between Q_{100} water level profiles of alternatives V1 and V0

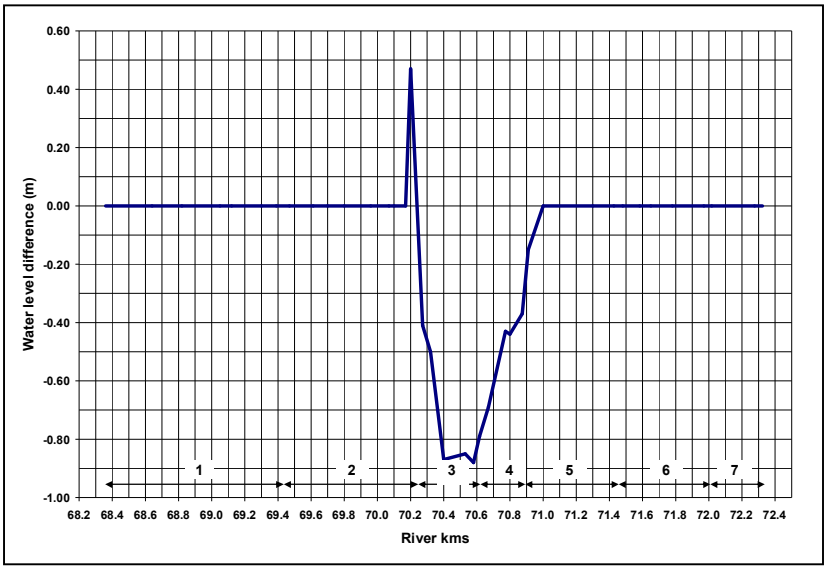

Figure 4-3 Difference between Q_{100} water level profile of alternatives V21 and V0

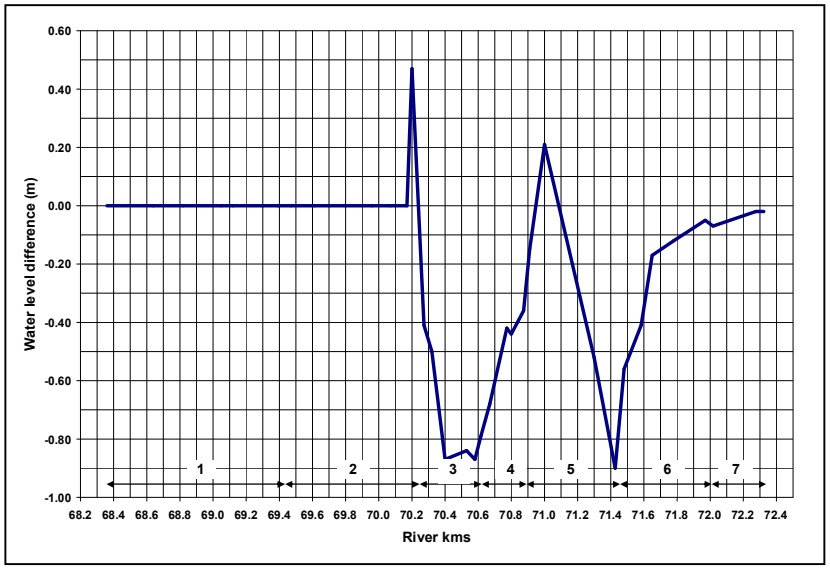

Figure 4-4 Difference between Q100 water level profile of alternatives V22 and V0

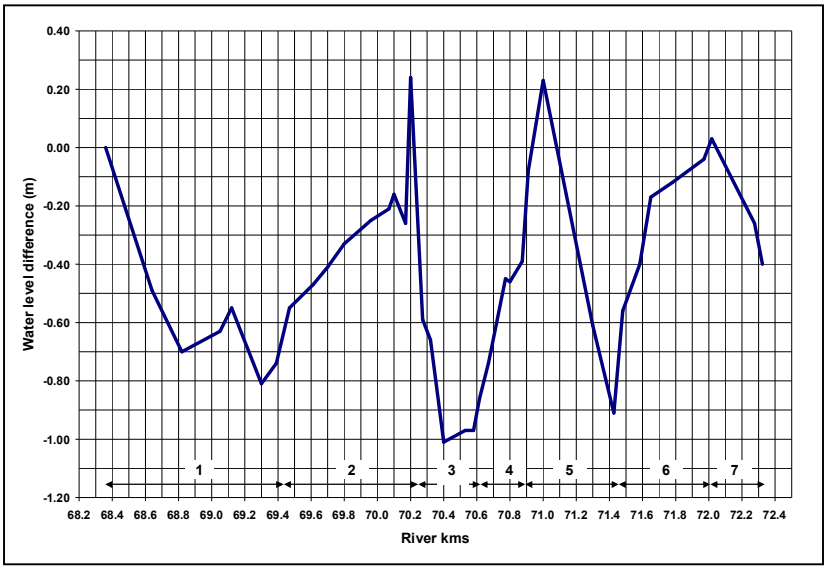

Figure 4-5 Difference between Q100 water level profile of alternatives V23 and V0

Re 4.6 Description of technical realisation of modifications in Krnov

In this part for each river section per variant the river modifications are described in more detail. Graphics of the modifications, except cross-sections for some bridges, are missing. From the descriptions it is concluded that the main modifications necessary in each of the alternatives have been taken into consideration.

It is advised to bring alternative V1 back to the Q_{100} flood protection level. It would be helpful in judging the alternatives to summarise the modification per element in a section in an overview table, supported by graphics.

In the description no mentioning is made whether the modifications are designed on grounds owned by the City of Krnov or may involve expropriation of grounds.

Re 4.7 Flood protection of villages Kostelec, Brantice and Zátor

No details are given as to how the hydraulic calculations have been carried out and the cross-sectional information used. As stated before, design of a flood protection based on the 1997 flood conditions is not realistic for these areas; protection against a Q_{20}-flood is more appropriate. Modifications have been dealt with in a very preliminary manner and are only very approximate.

Re 5. Costs of the proposed alternatives

In Chapter 5 an overview is given of the costs of the alternatives, starting with an overview of the unit prices of construction work. The indicated unit prices have a strong local component, as to the availability of materials and labour costs.

The unit prices are low compared to those in use in Western-Europe. It is requested that a costing expert of a local contractor reviews those estimates.

An overview of the estimated costs is presented in Table 4-3. No maintenance costs have been included. It is also noticed that purchase of ground is not considered in the costing.

Table 4-3 Overview of estimated construction and overall costs of implementation of the alternatives

Alternative	Construction costs Million CZK	Overall costs Million CZK
V1	806.8	1,089.2
V21	287.3	387.9
V22	309.2	417.5
V23	358.9	484.5
V3	883.8	1,193.1

From the table it is observed that the alternatives V21, V22 and V23 from a costing point of view do not differ much and their implementation cost is less than half the cost required for V1 or V3. In this respect it is noted that the latter alternatives are based on protection against the 1997 flood, which has a return period of about 500 years. These alternatives should also be elaborated for the Q_{100} flood conditions.

The costs of the protection in the villages upstream of Krnov against the 1997 flood are estimated at 454 Million CZK, i.e. costs similar to the alternatives V21-V23 in Krnov.

Re 6 Proposal of realization phasing

In this chapter the authors state that Krnov should have at least a Q_{100} flood protection level. They propose an implementation in phases to increase the channel capacity, using an alternative which allows for simple future increase of the capacity. Their preference is towards alternative V23, but mention that alternative V3 would be ecologically more attractive. In the first phase modifications to the left bank of Sections 6 and 7 are recommended. They also mention that a higher protection level along the left bank is possible without worsening the conditions for the right bank. In the Report the consequences of this statement are nowhere found.

Comment: Before any decision is taken or preferences expressed it is requested that first a **score card analysis** (or a multi-criteria analysis) is made of the social, environmental and economic impacts of the alternatives. The aspects to be considered in such an analysis are to be prepared together with the decision makers.

Re 7. Summary and conclusions

In the conclusions it is stated that the channel capacity of the Opava in Krnov can be upgraded to the conveyance of 1997 flood discharge without major interference to the built-up area of Krnov, in an ecologically and economically attractive way.

The proposed alternatives are stated to provide a cheaper solution for flood protection than the dam and reservoir option.

Comment: Support of the conclusions first need the hydraulic calculations proofed to be sound and the costings shown to be realistic.

5 Evaluation and recommendations

The following conclusions are drawn:

1. Interesting and ecologically attractive solutions have been provided by the flood protection alternatives presented in the Report.
2. The presentation of the baseline conditions is insufficient and need to be upgraded.
3. The description of the hydraulic calculations of the baseline and the alternatives is insufficient to be able to judge the results quantitatively. Apart from some hick-ups the results are qualitatively correct. An analysis of the river morphology under extreme flood conditions is missing.
4. The alternatives are more vulnerable to the creation of ice dams due to the longitudinal variation of the flow velocity.
5. A score card analysis is missing for a fair comparison of the pro's and con's of the alternatives.
6. A realistic flood protection level for Krnov according to the guidelines is protection against a 100-year flood. Comparison of different alternatives to different protection levels as done in the Report is highly confusing.
7. A realistic flood protection level for the villages upstream of Krnov according to the guidelines is protection against a 20-year flood. Investigations to protection against a 500-year flood for these stretches are not realistic.

The following recommendations are made:

1. The required flood protection level for Krnov should first be agreed upon, or be derived based on social, environmental and economic indices.
2. The description of the **baseline conditions** of the Opava in Krnov should be upgraded and extended.
3. Chapter 4.5 on the hydraulic calculations should be **fully modified and extended** according to the guidelines set forth in the discussion of this chapter.
4. Attention should be given to the river morphological aspects.
5. Attention should be given to discharge of ice in the various alternatives.
6. The costing of the alternatives should be reviewed by specialists.
7. A **score card analysis** should be made based on aspects selected in co-ordination with the decision makers.