DRAFT MASTERPLAN

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Abbreviations

AC	Asbestos Cement pipe
AS	Activated Sludge
asl	Above sea level
AtP	Affordability to Pay
BAT	Best Available Technology
BOD	Biochemical Oxygen Demand
BOO	Build, Own and Operate
BREF	Best (Available Techniques) REFerence (Document)
C	Concrete pipe
CCTV	Closed Circuit TV
CE	Communal Enterprise
CETI	Ecotoxicological Institute (Podgorica)
CL	Clayware (ceramic) pipe
Cl	Chlorine
COD	Chemical Oxygen Demand
DI	Ductile Iron pipe
DUP	Detailed Urban Plan
Dwg	Drawing
EAR	European Agency for Reconstruction
EC	European Community
EEC	European Economic Community
EIA	Environmental Impact Assessment
ELV	Emission Limit Values
EPA	Environment Protection Agency
EU	European Union
FC	Faecal coliform
FRY	Federal Republic of Yugoslavia
FST	Final Sedimentation Tank
GIS	Geographical Information System
GUP	General Urban Plan
HAZOP	Hazard and Operability Study
IFI	International Financial Institution
IPPC	Integrated Pollution Prevention and Control
LDC	Long-run Discounted Cost
LG	Cast Aluminium pipe
MAC	Maximum Allowable Concentration
MoEUP	Ministry of the Environment and Urban Planning
MIS	Major Industries Survey
MP	Masterplan
MSW	Municipal Solid Waste
NTU	Nephelometric Turbidity Units
O&M	Operation and Maintenance
PDGM	Planning and Design Guidelines Manual
PDV	Value Added Tax in Montenegro (currently 17%)
PE	Population Equivalent
PE	Polyethylene pipe
PIP	Project Implementation Plan
PST	Primary Sedimentation Tank
PTE	Potentially Toxic Elements
PVC	Polyvinyl chloride
RBC	Rotating Biological Contactor
SCADA	Supervisory Control and Data Acquisition
SBR	Sequencing Batch Reactor

Abbreviations (continued)

SH	Sodium Hypochlorite
SS	Suspended Solids
SST	Secondary Sedimentation Tank
SWOT	Strengths, Weaknesses, Opportunities, Threats (analysis)
TEA	Trade Effluent Agreement
ToR	Terms of Reference
TM	Technical Memorandum (a component report of this project)
TN	Total Nitrogen
TP	Total Phosphorous
Total N	Total Nitrogen
Total P	Total Phosphorous
TSS	Total Suspended Solids
UNECE	United Nations Economic Commission for Europe
USA	United States of America
UV	Ultra Violet
ViK	Vodovod i Kanalizacija (Water and Sewerage Company) or relevant department of the Communal Enterprise
Ww	Wastewaters
WwTP	Wastewater Treatment Plant

1. INTRODUCTION

1.1 General

This Masterplan is the final document of the project “The Preparation of a Sewerage and Wastewater Strategic Masterplan (Central and Northern Region) Montenegro (Serbia and Montenegro)”. The project is funded by the European Union and managed by the European Agency for Reconstruction.

A number of tasks were defined in the Terms of Reference (ToR) for the project, and each task has been the subject of an individual report termed a “Technical Memorandum”. These Technical Memoranda (TM) have been published as they have been completed and as the job progressed, and are as follows:

Technical Memoranda Table 1.1

TM No	Title	Tasks in the proposal	Clauses of ToR
1	Household Survey	3	4.1.3
2	Industrial Effluents	5	4.1.5
3	Impact of On-site Sanitation	6	4.1.6 & 4.2.5
4	Environmental Impact	4	4.1.4 & 4.2.3
5	Asset Inventory	2	4.1.2 & 4.2.2
6	Land-use, Population Estimates and Water Demand	1	4.1.1 & 4.2.1
7	Design Criteria	12	4.2.4
8	Future Wastewater and Sanitation Requirements	7	4.1.7 & 4.2.6
9	Implementation Schedule, Costs, Financing Plan and Tariffs	9 & 11	4.1.9, 4.1.11, 4.2.9, & 4.2.10
10	Prioritisation and Ranking of the Programme	8	4.1.8
11	Institutional Aspects	10	4.1.10 & 4.2.12
12	Public Consultation	13	4.4

These Technical Memoranda are the normal components of a masterplan, and, as they describe an area of 11,000 km^2, and a population of 400,000 in 14 main towns or conurbations, are relatively bulky. They have been produced as “stand-alone” documents.

This Draft Masterplan is therefore a summary document which integrates the main findings of these TMs and provides the reader with a series of references to the data and findings.

In terms of a conventional masterplan, the Draft Masterplan may therefore be seen as an Executive Summary and the TMs as the chapters of the main report. For that reason, this Draft Masterplan does not contain an Executive Summary. Chapter 9 however does provide a summary of the main assumptions and recommendations.

1.2 Report structure

The introduction in this chapter is followed by a description of the objectives stated in the Terms of Reference and a description of the modifications to those objectives necessary to better fit the financial capacity of Montenegro in Chapter 2.

Chapter 3 describes the existing situation.

Chapter 4 describes the design basis

Chapter 5 describes the resulting proposals and their prioritization.

Chapter 6 describes the financial aspects of the project and the proposed implementation.

Chapter 7 describes the institutional set-up and makes proposals for changes

Chapter 8 describes the Public Consultation Process employed for this project.

Chapter 9 summarizes key proposals, recommendations and assumptions, as a checklist.

Each chapter, except the last, is a summary of the Technical Memoranda which have been issued during the elaboration of the project. These documents provide more detail on each subject should this be required.

1.3 Project deliverables and their distribution

The deliverables of this project comprised the following:

Inception Report	(November 2003)
Interim Report	(March 2004)
Technical Memoranda	(As Table 1.1 above)
Draft Masterplan	(This document)
Final Masterplan	(To follow)
GIS	(Delivered on individual CDs to every municipality and ViK/CE at a seminar on 27th September)
Drawings (A0 scale)	Existing Land-use Future Land-Use Existing Sewer System Future Sewer System

The documents were prepared in English, and from them a summary document in Serbian was prepared. This Serbian summary contained three elements: (a) A translation of the Table of Contents of the English version in full with the translated parts highlighted, (b) the Executive Summary translated in full, and (c) in most cases, translations of the critical parts of the main text. This was a means of keeping the local beneficiaries fully informed of what had been produced and facilitating their access to the full reports (in English) should further detail be required.

The set of four drawings described above were produced for all of the areas proposed for wastewater infrastructure development with the exception of Podgorica. They were derived from the GIS.

The distribution of these items is as follows:

EAR :

3 copies of the English version of all reports

1 set of 14 CDs describing the GIS in each municipality

1 full set of A0 drawings

All reports in electronic format on CD

MoEUP :

1 copy of the English version of all reports

3 copies of the Serbian summary of all reports

1 set of 14 CDs describing the GIS in each municipality

1 full set of A0 drawings

All reports in electronic format on CD

Municipalities & ViKs/CEs

1 copy of the Serbian summary of all reports except the Inception and Interim Reports, “personalized” to each Municipality and ViK/CE where appropriate.

2 copies of the GIS CD for that municipality

2 sets of A0 drawings for that municipality

All reports in electronic format on CD

2. OBJECTIVES

2.1 Project synopsis

A synopsis of the project is presented in Table 2.1

Project synopsis **Table 2.1**

Project Title:	Preparation of a Sewerage and Wastewater Strategic Master Plan (Central and Northern Region) Montenegro (Serbia and Montenegro)
Project Number:	EAR/03/MTG01/04/001
Country:	Serbia and Montenegro
Project overall objectives	To contribute to economic growth in Montenegro by improving environmental conditions, a particular aspect being to facilitate the growth of the tourist industry, which has considerable economic potential.
Project purpose	1. To establish a medium-term investment programme for sewerage and wastewater treatment facilities in the central and northern regions of Montenegro. 2. To propose a rational and effective institutional structure relating to wastewater management, legislation, regulation and service provision. 3. To enhance the capacity of the Government to attract IFI investment in sewerage and wastewater at a Republic level.
Planned results	1. Acquisition and development of data for the planning basis for wastewater infrastructure and development of this data into a GIS and Asset Inventory. 2. Determination of environmental and public health impacts of the current situation and expected benefits of any improvements. 3. Preparation of a prioritised Programme of Projects for the development of sewerage infrastructure in three phases over the next 25 years, complete with a staged Implementation Schedule and Financing Plan. 4. Proposals for institutional and management restructuring, and appropriate tariffs.
Project activities	1. Develop land use zoning and associate population, water consumption and wastewater production, all in digital format. 2. Compile an Asset Inventory of all existing sewerage infrastructure. 3. Review, assess and suggest modifications to relevant National legislation. 4. Review and assess the Planning and Design Manual for Wastewater and Sanitation. 5. Identify and evaluate the impact on Public Health of the current wastewater disposal practices. 6. Predict future needs for wastewater and sanitation facilities in the main population centres. 7. Estimate volumes of sludge production and co-ordinate the results with the Solid Waste Masterplan. 8. Recommend appropriate wastewater disposal measures for all settlement centres and prioritise them. 9. Prepare a Programme of Projects for implementation in three phases. 10. Prepare a staged Implementation Schedule and Financing Plan for the 25 year planning period. 11. Develop a Rural Sanitation Programme for all settlements where on-site sanitation is proposed. 12. Propose appropriate institutional and management organisations to implement, operate and maintain the proposed works.
Project starting date:	July 17th 2003 (contract signing date)
Start date of activities	September 2nd 2003 (actual start of project activities)
Project duration	9 months from the starting date of activities

2.2 Modifications to the Planned Results

Whilst the overall objective remains the same, modifications to the Planned Results were necessary. Item 3 of the Planned Results in the table above and Appendix B of the Terms of Reference (Annex 1 of this report), between them, suggest that sewerage and wastewater treatment should be developed fully, wherever practical in the Project Area, within the 25 year design horizon, ie by 2029.

Preliminary cost estimates made for the Inception Workshop in January 2004 put the cost of providing full sewerage and wastewater treatment plants for just the conurbations at about 220 M Euro, with domestic tariffs of about 1.25 Euro/m^3 (about 10% of the average household income, which, according to UNDP, was already below the poverty line).

Clearly, the rates of progress towards full sanitation suggested by the ToR were impossible to meet, and an alternative strategy was sought for the subsequent development of the Masterplan.

This was as follows:

Rural communities

As the EU Directive UWWTD 271 only requires sewerage systems for communities with a population equivalent (PE) of greater than 2000, and there was no substantial evidence that on-site sanitation was causing any significant pollution of groundwater, it was proposed not to provide sewerage and wastewater treatment to any villages in the Project Area, except those forming part of a conurbation (ie those in close proximity to an urban area).

As noted above, there are four communities with populations greater than 2000 according to the 2003 Census. Two of them, Reznik and Ibarac are parts of conurbations (Rozaje and Bijelo Polje respectively), and two of them, Golubovci and Tuzi, are isolated. With respect to Golubovci and Tuzi, the Census populations are spread over administrative districts of 1663 ha and 1189 ha respectively and there are village clusters within them with populations below 2000. An investigation into the operation of on-site sanitation facilities in Golubovci and Tuzi was made (Section 5.1.6 of TM 6 refers). The conclusion was that it was not necessary or feasible to provide sewerage infrastructure in these communities.

Further, it was considered impossible to condemn existing on-site sanitation facilities, which are in fact almost all infiltration pits, on the available evidence of groundwater pollution (see Technical Memorandum No 3). What evidence there was of micro-bacteriological pollution of groundwater suggests that it probably originates from animals and not humans. However, using the precautionary principle, it was proposed that any new house construction be obliged to build conventional septic tanks where no sewerage systems were to be proposed.

On-site sanitation facilities are invariably in private ownership and are not normally provided with public money.

Very late in the development of the project, Plav Municipality asked that the village of Gusinje be also considered for inclusion in the Masterplan. Although it has a population of 1600 or so, and was initially excluded from the proposals, in summer the population is reported to increase to 3000. Gusinje has been the leading settlement of the area at various times in the past and has a more “urban” character than many villages as a result. It also has a sewerage network which serves 40% of the population and discharges sewerage into a river system which ultimately outfalls to Plav Lake. Consequently, the village of Gusinje has been included in the Masterplan and is the one exception – all the other proposed schemes are for the town or conurbation which is the capital of the municipality.

Urban communities

Effectively, the problem is reduced to the urban areas by the above strategy.

But even here, the costs of providing sewerage and wastewater treatment are currently beyond the means of most people. Nevertheless it was proposed to keep full sewerage and wastewater treatment as the long term goal (2029) and to seek low cost/high impact interventions for the short and medium terms.

Every town or conurbation has a sewerage system with varying degrees of coverage, but typically 50%. These systems are generally arranged to discharge directly to a river (the exceptions being a lake in Pluzine, a sinkhole in Zabljak, and a WwTP in Podgorica) and raw sewage is conveyed quickly to these receptors by this means.

Sewers without treatment plants cause more pollution than even the worst performing infiltration pit, and the collection and treatment of the wastewater collected by these existing systems therefore offers the highest benefit/cost, and is the obvious “Phase 1” scheme. Effectively this means the provision of an interceptor sewer connected to all existing sewers leading to a WwTP where the sewage can be treated.

The concept of the Terms of Reference was to provide full sewerage and wastewater treatment to all main settlements in Phase 1, which is a 5 year period from 2004 to 2009. Whilst this is not feasible (the cost would be about 280 M Euro), the implied urgency of development has been retained in the revised phasing, and “reduced-scale” schemes have been proposed for this timeframe (the “Phase 1” schemes), rather than “full sewerage and wastewater treatment”.

2.3 Modifications to the proposed phasing

The two concepts are thus the two extremes of sewerage development in urban areas, viz;

- Phase 1 : The immediate low cost/high impact scheme (interceptor sewer and treatment plant capable of fully treating the collected sewage, and
- Phases 2/3 : the schemes leading to full sewerage and full treatment for the whole of the urban area (town or conurbation)

The definition of the complete wastewater infrastructure needs of all the main settlements will thus be defined, and from this system can be selected those parts necessary to make a high impact at minimum cost in the short term. Specifically, the collector sewers leading to the treatment plant will be sized to be adequate to transfer all the wastewater arising from the fully sewered conurbation in 2029, and the treatment plant will be constructed to allow for expansion in future to treat that flow.

However, the urgency of scheme development implied in the ToR was retained by retaining the period 2004 to 2009 for Phase 1, and Phases 2/3 thus cover the remaining period from 2009 until the design horizon (25 years) of 2029.

The modified phasing has been developed for every urban area in the Project Area, but no attempt has been made to divide Phases 2/3 into two distinct phases. The construction of the Phase 1 schemes to be operational in 2009 and the Phase 2/3 schemes to be operational in 2019 has been termed the "Base Case" and has been used as the starting point in the financial analysis.

The reason for this is that sewers and treatment plants must be developed in parallel – it is pointless to build a treatment plant in advance of sewers because the investment will have been made without having any flow to treat, and if sewers are developed first, then sewage will be discharged to rivers untreated, which is similarly pointless. Sewers have effectively an unlimited service life if well designed. Treatment plants are usually designed to have a service life of 10 to 15 years. With the relatively short design horizon of 25 years, or rather the 20 years between 2009 and 2029, it is practical to have two stages of development of the treatment plants, the first one having a service life of 10 years, and the two together being sufficient for the design horizon in 2029. As the sewer development is inextricably linked to the treatment plant development, it is appropriate for the sewers to be developed in two phases also.

The Phase 1 treatment plant has been designed to be operational in 2009, and with a 10 year service life, has been designed to accommodate the expected flows up until the year 2019. In view of the precarious economic feasibility of the schemes, and with the exception of Podgorica and a few towns where it was desirable to increase the loads on treatment plants to suit the proposed modularisation, no secondary sewer development was planned to be brought into service until 2019 (construction will be made in 2018 and 2019). There will be an increase in flow to treatment between 2009 and 2019, but this will be due to densification of residential development, and increases in volumes of industrial effluents from industries connected to the existing sewers.

The Phase 2/3 treatment plant will be an extension of the Phase 1 plant, and together will provide full treatment to the whole town at the design horizon. In order to give it a 10 year service life, it is envisaged to be operational in 2019, and built in 2018 to 2019. Sewers to provide this load are planned to be built in the same years, and, as for the Phase 1 scheme, there will be an increase in flows and loads between 2019 and 2029 (and for the same reasons).

This programme provides a common timing of construction for all sewerage infrastructure in all urban areas. It minimizes cost in early years, and defers the cost of sewer development until later years, when improvements in the economy will hopefully make the tariffs necessary to support the construction more affordable. It is considered that deferment of secondary sewer development is reasonable because those houses not connected to sewers do have on-site sanitation and this does seem to be working reasonably well.

This approach does determine all works (and their costs) necessary to achieve the long term goal, and in addition offers a "cheap and effective" first scheme. It is however a "starting position" for the economic modeling, and has been termed the "Base Case" in that work. If the planned schemes for a particular urban area proved unfeasible on the first run of the model, the schemes were deferred and the model re-run until such time as it did become feasible. This means that, for some settlements, the development of the projects will have to be deferred, and the construction periods noted above will not be possible. Technical Memorandum No 9 gives details.

2.4 The ultimate development plan

Whilst the approach described above does define (i) the ultimate infrastructure needs and (ii) what can be done in the short term to radically reduce pollution of the environment by wastewater in the Project Area, the development of a firm implementation schedule is not entirely practical because:

- Central Government has not yet established an investment policy for wastewater infrastructure. To some extent this is a "chicken and egg" situation; it is necessary to know the scale of the necessary investment before deciding what can be afforded, and this Masterplan provides the first estimates of that in the Project Area, and

- The policy of decentralisation and empowerment of Local Government means that, ultimately, the Municipalities will be able to develop these projects at their own speed, albeit with some input from Central Government.

- It is not known with any certainty what grants will be made available by IFIs for these projects. The availability of grants or loans will be the key to the commencement of these schemes.

Whilst decentralisation does mean a degree of individuality of approach for each Municipality, this Masterplan has standardised as much of the applied technology as possible. For example, most pumping stations are of one design, and treatment plants have been modularized so that many of them are identical or very similar in design. To fully realize the advantages of this approach (standard designs, simple interchangeability of operating staff, reduced stockholding of spare parts etc) needs some kind of "regional" or even "national" control. An institutional reorganization has been proposed which should facilitate this approach.

3. THE PROJECT AREA

3.1 Introduction

The Project Area comprises 14 municipalities of the Northern and Central Regions which together have a population of about 450,000, and occupy an area of about 1.1 M ha or 11,000 km^2. For the most part, the Project Area is sparsely populated and is in mountainous terrain. The area contains Montenegro's first and second cities; Podgorica, the capital, and Niksic, the dominant industrial town. The urban areas range in size from 600 in Savnik to 140,000 in Podgorica.

The geology and hydrogeology of the Project Area is described in Section 3.7.2.

The scope of this project is essentially, together with the sister EAR project – the Coastal Cities Masterplan, to define the wastewater infrastructure needs of the whole of Montenegro over the next 25 years.

Fig 3.1 shows the Project Area and the main settlements and rivers.

Although wastewater infrastructure is relatively undeveloped (there are no fully functional treatment plants) the Project Area still has an unspoilt feel to it, and, as such, has a great potential for tourism. Indeed, the potential for international tourism is arguably greater than for the Coastal Region as the latter is already relatively saturated with local tourists in the summer. The two biggest brakes on tourism development in the Project Area are probably the relatively high cost of travelling to Montenegro, and the under-developed hotel sector. Privatisation of hotels is however gaining pace and it is to be hoped that some means can be found to reduce the cost of air-travel.

Besides the development of tourism, the Government's development strategy for the Project Area is to develop agriculture.

In former times, industry was widely dispersed throughout Montenegro, however this was a planned economy which was very badly affected by the political turmoil of the early 90's. Whether industry can be fully regenerated is difficult to say, and even if it is, privatisation (the likely engine for recovery) will probably result in the employment of less people in the long term.

The Project Area is comprehensively described in the Technical Memoranda. The following abstracts represent the key findings which have determined the final outcome of the Masterplan.

3.2 Land-use, population estimates and water demand (TM 6)

3.2.1 Population

The population of the Project Area is growing at about 0.17% per annum, having increased from about 445,000 in 1991 to 454,000 in 2003. There is a marked trend of rural depopulation; the urban areas have gained population at an average rate of 0.75% per annum (a gain of 24,000), and the rural areas having lost population at 0.69% per annum (a loss of 15,000), over the same period.

But the urban areas are not all growing, and 21,500 of the 24,000 increase in urban population in the Project Area occurred in Podgorica (an average growth of 1.4% per annum over the last 12 years).

The average population density overall is 0.4 capita per hectare and in rural areas is 0.15 capita per hectare.

The villages number 881, of which 65% have populations less than 150. Actually the term “villages” in Table 3.2.2 means the census district centred on that village, and so the actual size of the village is smaller than that suggested by the table.

Hence the Project Area contains two major settlements, Podgorica and Niksic of which Podgorica is expanding rapidly. The other towns are generally not larger than 20,000, and sometimes much less, and the villages are small and widely dispersed.

Fig 3.1 : The Project Area, main settlements and rivers

Population of the Project Area, per municipality and settlement type (2003 Census) **Table 3.2.1**

Municipality	Municipality area (ha)	Population of Municipality (capita)	Population by settlement type		
			Urban (capita)	Suburban (capita)	Rural areas (villages) (capita)
Andrijevica	28,300	5,697	1,061	392	4,244
Berane	71,036	34,912	11,734	6,644	16,534
Bijelo Polje	92,400	49,967	15,875	5,009	29,083
Danilovgrad	50,100	16,376	5,093	364	10,919
Kolasin	89,700	9,934	3,033	917	5,984
Mojkovac	36,700	10,015	4,114	2,162	3,739
Niksic	206,500	75,274	58,358	0	16,916
Plav	48,600	13,725	3,589	952	9,184
Pljevlja	134,600	35,751	21,353	0	14,398
Pluzine	85,400	4,270	1,494	0	2,776
Podgorica	144,100	168,812	136,351	0	32,461
Rozaje	43,200	22,559	9,108	2,893	10,558
Savnik	53,300	2,938	568	0	2,370
Zabljak	44,500	4,181	1,940	0	2,226
TOTAL	**1,128,436**	**454,436**	**273,671**	**19,333**	**161,432**

Notes :
1. This table corrects minor errors in the equivalent table in TM 6 (Table 2.1)
2. The Census data classifies Spuz in Danilovgrad, Gradac in Pljevlja, Tuzi in Podgorica and Gusinje in Plav as "urban" however they have been classified as "rural" in the table above.
3. Conurbations in this report mean the Urban and Suburban areas combined. The villages making up the suburban areas are defined in Table 2.4 of TM 6.

Demographics of villages, per municipality (2003 Census) **Table 3.2.2**

Municipality	Number of villages by size						
	0-50	50-150	150-250	250-500	500-1000	1000-2000	>2000
Andrijevica	1	11	5	4	1	0	0
Berane	8	23	9	10	8	1	0
Bijelo Polje	5	23	20	34	11	2	0
Danilovgrad	35	19	11	9	2	1	0
Kolasin	27	33	6	1	1	0	0
Mojkovac	1	1	3	6	1	0	0
Niksic	36	42	14	10	4	2	0
Plav	0	3	4	8	5	1	0
Pljevlja	63	64	23	6	2	0	0
Pluzine	18	21	2	1	0	0	0
Podgorica	53	44	12	18	9	4	**2**
Rozaje	0	1	4	11	8	0	0
Savnik	6	16	3	1	0	0	0
Zabljak	10	13	4	0	0	0	0
Total	**263**	**314**	**120**	**119**	**52**	**11**	**2**

Note : This table refers only to non-urban settlements (ie the suburban and rural populations of Table 3.2.1 above)

Recent trends in population, by municipality Table 3.2.3

Municipality	Settlement type	Population 1991	Population 2003	Annual growth (%)
Andrijevica	Municipality total	6552	5697	-1.16
	Urban	923	1061	**1.17**
	Other	5629	4636	-1.60
Berane	Municipality total	37473	34912	-0.59
	Urban	11908	11734	-0.12
	Other	25565	23178	-0.81
Bijelo Polje	Municipality total	54437	49967	-0.71
	Urban	16423	15875	-0.28
	Other	38014	34092	-0.90
Danilovgrad	Municipality total	14573	16376	**0.98**
	Urban	5689	6623	**1.27**
	Other	8884	9753	**0.78**
Kolasin	Municipality total	11044	9934	-0.88
	Urban	2531	3033	**1.52**
	Other	8513	6901	-1.73
Mojkovac	Municipality total	10725	10015	-0.57
	Urban	5801	4114	-2.82
	Other	4924	5901	**1.52**
Niksic	Municipality total	73878	75274	**0.16**
	Urban	55649	58358	**0.40**
	Other	18229	16916	-0.62
Plav	Municipality total	15684	13725	-1.11
	Urban	6051	5228	-1.21
	Other	9633	8497	-1.04
Pljevlja	Municipality total	39188	35751	-0.76
	Urban	20458	21717	**0.50**
	Other	18730	14034	-2.38
Pluzine	Municipality total	5219	4270	-1.66
	Urban	1453	1494	**0.23**
	Other	3766	2776	-2.51
Podgorica	Municipality total	145696	168812	**1.23**
	Urban	118478	139988	**1.40**
	Other	27218	28824	**0.48**
Rozaje	Municipality total	22330	22559	**0.09**
	Urban	8775	9108	**0.31**
	Other	13555	13451	-0.06
Savnik	Municipality total	3680	2938	-1.86
	Urban	821	568	-3.02
	Other	2859	2370	-1.55
Zabljak	Municipality total	4900	4206	-1.26
	Urban	1848	1940	**0.41**
	Other	3052	2266	-2.45
Total		**445379**	**454436**	**0.17**
Total urban		256808	280841	**0.75**
Total other		188571	173595	-0.69

Notes:
1. The Census definitions of Spuz, Gusinje, Tuzi and Gradac as “urban” have been used in this table.

The main settlements in the Project Area are the main towns together with any adjacent villages which form a conurbation. Of the total population of 454,000 in the Project Area, 292,000, or 64% live in the main settlements.

Future population growth rates were extrapolated from growth trends recorded in the Census data from 1971, 1981, 1991 and 2002, with the following results:

Population projections by municipality and settlement type Table 3.2.4a

Municipality and settlement type	Population (2003 Census)	MAGR	Projected population		
			2009	2019	2029
ANDRIJEVICA municipality	**5,697**		**5,597**	**5,468**	**5,422**
Town of Andrijevica	1,061	1.50%	1,161	1,347	1,563
Slatina	392	1.50%	429	498	578
Conurbation of Andrijevica	**1,453**		**1,590**	**1,845**	**2,141**
Villages	**4,244**	-1.00%	**4,007**	**3,623**	**3,281**
BERANE municipality	**34,912**		**34,075**	**33,200**	**32,487**
Town of Berane	11,734	0.20%	11,876	12,116	12,360
Buce	950	0.50%	979	1,029	1,082
Luzac	834	0.50%	860	904	950
Dolac	1,292	0.50%	1,332	1,400	1,471
Pesca	1,722	0.50%	1,775	1,866	1,961
Donje Luge	1,846	0.50%	1,903	2,000	2,102
Conurbation of Berane	**18,378**		**18,725**	**19,315**	**19,926**
Villages	**16,274**	-1.00%	**15,350**	**13,885**	**12,561**
BIJELO POLJE municipality	**49,773**		**48,946**	**47,432**	**46,227**
Town of Bijelo Polje	15,875	0.50%	16,358	17,194	18,074
Nedakusi	2,288	0.50%	2,358	2,479	2,605
Resnik	2,721	0.50%	2,804	2,948	3,098
Conurbation of Bijelo Polje	**20,884**		**21,520**	**22,621**	**23,777**
Villages	**29,083**	-1.00%	**27,426**	**24,811**	**22,450**
DANILOVGRAD municipality	**16,376**		**16,968**	**18,119**	**19,365**
Town of Danilovgrad	5,093	1.00%	5,407	5,972	6,597
Gorica	142	0.50%	147	154	162
Zagreda	222	0.50%	229	241	253
Conurbation of Danilovgrad	**5,457**		**5,783**	**6,367**	**7,012**
Villages	**10,819**	0.50%	**11,185**	**11,752**	**12,353**
KOLASIN municipality	**9,934**		**9,861**	**9,761**	**9,758**
Town of Kolasin	3,033	1.00%	3,220	3,557	3,929
Smailagica Polje	917	1.00%	974	1,076	1,188
Conurbation of Kolasin	**3,950**		**4,194**	**4,633**	**5,117**
Villages	**5,984**	-1.00%	**5,667**	**5,128**	**4,641**
MOJKOVAC municipality	**10,015**		**10,102**	**10,256**	**10,435**
Town of Mojkovac	4,114	0.50%	**4,239**	**4,456**	**4,684**
Gornja Polja	1,498	0.50%	**1,544**	**1,623**	**1,706**
Podbisce	664	0.50%	685	720	756
Conurbation of Mojkovac	**6,276**		**6,468**	**6,799**	**7,146**
Villages	**3,739**	-0.50%	**3,634**	**3,457**	**3,289**
NIKSIC municipality	**75,274**		**76,068**	**77,375**	**78,813**
Town of Niksic	**58,358**	**0.35%**	**59,595**	**61,114**	**63,908**
Villages	**16,916**	-0.50%	**16,473**	**15,661**	**14,905**

Population projections by municipality and settlement type Table 3.2.4b

Municipality and settlement type	Population (2003 Census)	MAGR	Projected population		
			2009	2019	2029
PLAV municipality	**13,725**		**13,744**	**13,812**	**13,955**
Town of Plav	3,589	1.00%	3,810	4,209	4,649
Brezojevica	952	1.00%	1,011	1,117	1,234
Conurbation of Plav	**4,541**		**4,821**	**5,326**	**5,883**
Villages	**9,184**	-0.50%	**8,923**	**8,486**	**8,072**
PLJEVLJA municipality	**35,751**		**35,031**	**34,345**	**33,963**
Town of Pljevlja	**21,353**	**0.50%**	**22,002**	**23,127**	**24,310**
Villages	**14,398**	-1.50%	**13,029**	**11,218**	**9,653**
PLUZINE municipality	**4,270**		**4,098**	**3,818**	**3,595**
Town of Pluzine	**1,494**	**0.50%**	**1,540**	**1,619**	**1,701**
Villages	**2,776**	-1.50%	**2,558**	**2,199**	**1,894**
PODGORICA municipality	**168,812**		**182,780**	**208,873**	**238,991**
Town of Podgorica	**139,998**	**1.50%**	**153,080**	**177,665**	**206,176**
Villages	**28,824**	0.50%	**29,700**	**31,218**	**32,815**
ROZAJE municipality	**22,559**		**22,622**	**22,755**	**22,945**
Town of Rozaje	9,108	0.50%	9,385	9,865	10,370
Ibarac	2,893	0.50%	2,981	3,134	3,294
Conurbation of Rozaje	**12,001**		**12,366**	**12,999**	**13,664**
Villages	**10,558**	-0.50%	**10,256**	**9,756**	**9,281**
SAVNIK municipality	**2,938**		**2,752**	**2,460**	**2,213**
Town of Savnik	**568**	**0.20%**	**575**	**587**	**599**
Villages	**2,370**	-1.50%	**2,177**	**1,873**	**1,614**
ZABLJAK municipality	**4,206**		**4,167**	**4,140**	**4,188**
Town of Zabljak	**1,940**	**1.20%**	**2,084**	**2,348**	**2,646**
Villages	**2,266**	-1.50%	**2,083**	**1,792**	**1,542**
TOTALS					
Municipalities			**466,811**	**491,814**	**522,357**
Conurbations			314,343	346,365	384,006
Villages			152,468	145,449	138,351

The trend towards migration from villages to urban areas means that about 74% of the population is expected to live in the conurbations by 2029.

3.2.2 Land Use

Land Use plans for 2004 and 2029 were developed for all the urban areas and are presented in TM 6.

Although General Urban Plans exist for all urban areas and have been the basis for all development in Montenegro, most are now considerably out of date and do not reflect the actual development which has taken place over the last 15 years. Most were developed after the earthquake in 1979 and had a validity of 20 years. In many towns it was clear that development had, and was, taking place which was not in accordance with the GUPs, in two ways in particular:

- Often the GUPs showed development in towns comprising of large blocks of communal housing, ie high density development, of a type which was previously developed by the Government, but which appears to be unlikely to be developed now. The road network to service these buildings has also not been built, so constructing sewers in appropriate locations would be difficult.
- In the absence of much building activity by the Government, people are developing individual buildings for themselves. This low density housing does not feature in the GUPs at all. Most of this development is illegal (as it does not follow the GUP), but is so extensive that it will be impossible to demolish it all, and the Government will probably find a way to legalize it, possibly by payment of a special tax.

The land-use plans have been developed in some detail and have been incorporated into a GIS. They show the distribution of residential population, industry and institutional/commercial activity, parks etc and can be used for the detailed design of the new infrastructure.

Three principal types of land uses were determined:

- Residential (with various different population densities)
- Industrial
- Institutional (schools, government or municipal facilities, hotels and other facilities which tend to produce substantial quantities of wastewater)

Existing Land-Use

For the principal land use types, the following data was recorded:

<u>Residential</u> : Number of households per structure, typical household size (number of persons per household) and hence population per structure and thus a first estimate of population density. No socio-economic distinctions were made and all residential land-use is thus of one class.

<u>Industrial</u> : The name of the factory, type of product (and hence classification of “wet” or “dry” production), and scale of production. This data was made available to the Industrial Expert who conducted an in-depth study of the largest industries. For smaller industries, area factors for wastewater generation were used (water supply records being too unreliable).

<u>Institutional/commercial:</u>

Schools :	Name, number of pupils
Libraries, Municipality Buildings etc :	Name, number of staff
Governmental buildings such as Police stations, Post offices etc.	Name, number of staff
Hotels :	Name, number of beds
Stadia :	Name, spectator capacity
Military camps :	Name, number of occupants
Prisons :	Name, number of prisoners

In addition, other land-use zones were recorded, such as Parks (names), Bus Stations (names) etc.

In this way a mosaic of the whole of the town or conurbation was built up.

Future Land Use

Although the project is to be elaborated in three phases, the low population growth rates made development of intermediate land-use plans unnecessary – the extent of development in any of the phases could be estimated with sufficient accuracy from the Existing and 2029 (Future) land use plans.

Projections of the municipal areas to be covered by residential zones, commercial zones, industrial and rural zones have been developed. These trends were reconciled against the projections estimated by the municipalities and the 2003 Census to ensure that no deviations occurred. For the cases where the GUPs and DUPs were recent, this data was incorporated into the projections.

<u>Residential</u>

Future residential land-use was determined with recommendations from the urban planners in the municipalities and the ViKs. The methodology was to include areas that:

- Have been identified to have an increased population growth, which is expected to continue in the future
- Are not included in the existing land use but expansion of the town is seen towards that area

As for the existing residential land-use, reconciliation was made between the product of the area of the residential zones and population densities on one hand, and the projected population totals for the conurbation on the other.

A small amount of densification of existing residential zones was made where appropriate, but generally most of the expansion of the town or conurbation was assumed to be in new zones.

Once the 2029 population densities had been determined, an estimation of the saturation population densities was made. Sewers have an almost indefinite service life if properly maintained, and at least 50 years. The concept of using saturation population densities for sewer design is to ensure that any sewer once constructed will not become hydraulically overloaded during its service life, regardless of the design horizon (in this case 25 years). The concept also allows some factor of safety to allow for development taking place in a way not anticipated in the planning. In order to keep costs to a minimum, saturation densities were generally kept very close to the densities predicted for 2029 for this project.

<u>Industrial</u>

The flows and loads predicted to be produced by all industries both now and in the future is reported in Technical Memorandum No 2 : Industrial Effluents. In terms of land-use therefore, it was only necessary to locate these industries on the land-use plans.

<u>Institutional/Commercial</u>

Identified institutional/commercial land use has been assumed to remain constant over the planning period. The basic assumption supporting this approach was that these institutional and commercial facilities were adequate for the current populations, and that they would be able to accommodate the relatively low levels of population growth in the next 25 years.

An allowance of 30 l/c.d in the residential water consumption for unidentified institutional/commercial flows was also made.

Where no data was available (recorded as N/A in the tables), an estimation of the probable wastewater flows and loads arising was still made and these estimates are described in TM No 8.

Tourism

Tourism is not likely to be significant in the Project area in comparison with the Coastal Region. Tourist infrastructure is largely confined to Zabljak, Kolasin and Podgorica. Tourism development has been accounted for in terms of hotel development.

3.2.3 Water demand

Water consumption was considered in three categories:

- Domestic
- Institutional and commercial
- Industrial

Existing water consumption

Domestic water consumption

Three data sources were used in order to estimate current domestic water consumption:

- "Projekcija Dugorocnog Snabdijevanja Vodom Crne Gore, Decembar 1998" (Projection of long-term water supply in Montenegro – (Annex 2)
- Technical Memorandum No 1 "Household Survey" (Safege–Tebodin–LDK, 2004)
- ViK and Communal Enterprise estimates

Comparison of domestic water consumption estimates **Table 3.2.5**

Municipality	Estimated domestic water consumption from: Household Survey (l/c.d)	"Projekcija Dugorocnog Snabdijevanja Vodom Crne Gore" (l/c.d)	ViK or CE estimates (l/c.d)	Indicative value (l/c.d)
Podgorica	233	267	280	**280**
Niksic	171	97	200	**170**
Bijelo Polje	273	114	250-400	**280**
Berane	319	200	250	**280**
Plav	380	165	100-170	**280**
Pljevlja	188	191	300	**190**
Rozaje	136	93	235	**140**
Mojkovac	351	111	170-200	**280**
Kolasin	400	300	200	**350**
Danilovgrad	201	237	170-200	**280**
Zabljak	222	225	300	**225**
Pluzine	476	327	200	**400**
Savnik	116	274	300	**200**
Andrijevica	446	238	170	**350**

From the above estimates a current typical urban water consumption of **280 l/c.d** has been assumed for planning purposes.

For villages not supplied with piped water, a value of **80 l/c.d** has been assumed as a current consumption, which will be increased to **100l/c.d** in the future.

Industrial water consumption

Industrial water consumption and wastewater generation data and the approach adopted for the estimation of the rates is presented in Technical Memorandum No 2 "Industrial Effluents", in Chapters 4, 5 and 6.

It is only necessary to know what industrial water consumption actually is for the purpose of determining a tariff – the tariff for wastewater being based on the amount of water consumed. For this purpose it was assumed that the return-to-sewer percentage would be 80% on average, and therefore that the industrial water consumption would be 1.25 times the current industrial wastewater production estimated in Technical Memorandum No 2.

Institutional/commercial water consumption

As for industrial water consumers, data concerning the consumption of institutional and commercial establishments was very poor.

Consequently, water consumption rates have been determined in the same way as for industries, that is, by applying an assumed return-to-sewer percentage to estimated wastewater productions. Normative wastewater production values are presented in Section 2.2.4 of TM No 6 "Planning and Design Guidelines Manual", and again the assumption that **80%** of the water used will ultimately become wastewater was adopted.

Data in terms of employees, pupils, hotel beds etc have been determined during the site visits and the development of the Land Use plans and these data are presented in Sections 3.3.1 to 3.3.14 of TM 6 per municipality.

Where data were not available, assumptions were made on the basis of the area of the site and the type of establishment.

Projected water consumption

Projections for domestic water supply

The cost of sewerage is solely dependant on the volume of sewage to be conveyed and the cost of sewage treatment is highly dependant thereon (the strength of sewage – the load – also plays a part).

Some 80 to 90% of water consumption will be returned to the sewer as wastewater. It is essential therefore to use an appropriate value of per-capita water consumption if the sewerage infrastructure is to be provided economically.

The Project Area has reasonably well developed water supply systems, and relatively less well developed sewerage systems. Water is not intensively treated before being distributed as it is the rest of Europe, and consequently is relatively cheap. As there is only one wastewater treatment plant in operation in the Project Area, the operating cost of providing water and collecting and treating wastewater is very low. The tariffs are consequently low.

However, whereas the cost of providing water may continue to be relatively low in future, the cost of operating full developed sewerage systems and wastewater treatment plants will be relatively significant, and will erode some of the benefit of the low levels of treatment given to potable water.

Current domestic water consumption in Montenegro is very high, and comparable with the highest consumptions in the world (USA average is about 270 l/c.d), and almost double the Western European average of 150 l/c.d.

Although population growth in Montenegro is not excessive, this level of consumption and the increasing losses from the water supply networks means that "less pure" water sources have to be exploited to augment the supplies from upland springs which have provided water to most settlements in the past. The water from these sources may need a higher degree of treatment before being put into supply, and the cost of water could also rise relatively in future. Obviously, if there were less losses in the water distribution systems, and/or water demand was reduced, then the existing sources would be able to satisfy a greater proportion of demand.

There is an acknowledgement that water consumption will have to be reduced in future.

The values adopted for domestic water consumption in recent studies are as follows:

- "Projekcija Dugorocnog Snabdijevanja Vodom Crne Gore, Decembar 1998":

  200 l/c.d everywhere except Podgorica where 280 l/c.d was recommended, however the development of wastewater infrastructure (and the consequent increased need to reduce consumption) was not then considered
- Coastal Region Wastewater Masterplan 2004:

  120 l/c.d plus 60 l/c.d for unidentified demand
- Podgorica WwTP Feasibility Study 2004:

  150 l/c.d

For this study it was considered that the latter two estimates were reasonable and consequently the following was proposed in Section 2.2.2 of the Design Criteria (Technical Memorandum No 7):

Niksic and Podgorica :	150 l/c.d plus 30 l/c.d for unidentified institutional and commercial flows (180 l/c.d in total), and
Other towns/conurbations :	120 l/c.d plus 30 l/c.d for unidentified institutional and commercial flows (150 l/c.d in total)
Villages :	100 l/c.d

As the first projects are planned to be operational in 2009, it was assumed that reductions in consumptions to the above levels would be attained by then. It is expected that this will be achieved to some extent by the increased tariffs and bill collection necessary to support any new wastewater infrastructure development, but also by a Public Awareness Campaign. Such a campaign is being planned by the EAR.

Projections for industrial water supply

The projections for industrial water supply are derived from the wastewater projections detailed in Chapter 6 of Technical Memorandum No 2 using an assumed return-to-sewer rate of 80%, as for the current water consumptions discussed above.

Consequently, the total Industrial water demand per conurbation for the target years 2009, 2019 and 2029 is presented in the following table.

Projections of industrial water consumption Table 3.2.6

Conurbation / Town	Water supply (m^3/d)		
	2009	2019	2029
Andrijevica	53.8	107.5	160.0
Bijelo Polje	1721.3	3158.8	4597.5
Berane	1002.5	1855.0	2710.0
Danilovgrad	70.0	147.5	225.0
Kolasin	118.8	230.0	340.0
Mojkovac	238.8	325.0	411.3
Niksic	5466.3	7061.3	7366.3
Plav	23.8	38.8	53.8
Pljevlja	235.0	317.5	432.5
Pluzine	2.5	3.8	5.0
Podgorica (1)	12,048.0	12,856.0	14,839.0
Rozaje	140.0	296.3	452.5
Savnik	11.3	21.3	30.0
Zabljak	28.8	85.0	141.3

(1): The values for Podgorica adopted from "Feasibility study for Podgorica Wastewater Treatment Project" Final Report, January 2004 by SOGREAH. They referred to the years 2011, 2020 and 2031 respectively.

Projections for institutional water supply

As previously noted, the term "Institutional" has been used to cover institutional flows (from schools, libraries etc), commercial flows (from restaurants, offices etc) and flows arising from tourism (mainly from hotels).

Institutional/Commercial land uses have been assumed to remain constant over the planning period. Thus, the water supply rates remain the same over the planning period. However, for the prediction of future flows, an amount of the domestic daily water demand has been reserved for unaccounted institutional/commercial flows.

In the following table the total institutional water demand per conurbation centre for the target years 2009, 2019 and 2029 is presented.

Projections of institutional water consumption Table 3.2.7

Conurbation Centre	Water supply (m^3/d)		
	2009	**2019**	**2029**
Andrijevica	88.1	88.1	88.1
Bijelo Polje	618.0	618.0	618.0
Berane	677.0	677.0	677.0
Danilovgrad	275.0	275.0	275.0
Kolasin	239.0	239.0	239.0
Mojkovac	188.0	188.0	188.0
Niksic	1,127.0	1,127.0	1,127.0
Plav	205.0	205.0	205.0
Pljevlja	718.0	718.0	718.0
Pluzine	90.0	90.0	90.0
Podgorica (1)	N/A	N/A	N/A
Rozaje	260.0	260.0	260.0
Savnik	48.0	48.0	48.0
Zabljak	206.0	244.0	281.0

(1): These values for Podgorica were not identified in the "Feasibility study for Podgorica Wastewater Treatment Project" Final Report, January 2004 by SOGREAH.

3.3 Asset Inventory (TM 5)

3.3.1 Existing sewer networks and on-site sanitation facilities

The existing sewer network coverage varies significantly among the towns of the Project area. Sewer networks are generally confined to the main town of each municipality (which gives its name to the municipality), and the other settlements, mainly small villages, have no sewerage. There, houses generally have individual infiltration pits for wastewater disposal, or occasionally discharge to a watercourse or ditch.

In the main town, sewer networks generally cover the central part, which is most densely populated. The remaining parts of the town have on-site sanitation in the form of infiltration pits.

The most extensive networks in terms of spatial coverage, after Podgorica, are in Niksic, Berane and Pljevlja. Table 3.3.1 presents the coverage of sewers in each of the municipality towns (not the conurbation as the associated villages have no sewers), the total population of that municipality, and hence the number of people reliant on on-site sanitation.

The methodology used to compile the inventory and details of the existing sewers is presented in TM 5. A GIS of the existing systems has also been compiled, and from this GIS schematic drawings showing the existing sewers have been produced and are also included In TM 5.

Existing sewer network coverage in main towns, by municipality in 2003 **Table 3.3.1**

Municipality	Population of main town [(1)] (capita)	Population served by sewers (capita)	Population without sewers (capita)	Area served by sewers (ha)	Total sewer length (km)
Andrijevica	890	605	285	12.4	2.4
Berane	10,805	8,887	1,918	140.8	16.0
Bijelo Polje	15,794	3,383	12,411	79.2	7.7
Danilovgrad	5,188	2,073	3,115	36.3	2.5
Kolasin	3,461	1,642	1,819	39.9	3.4
Mojkovac	3,995	2,990	1,005	33.4	4.3
Niksic	59,133	27,000	32,133	351.4	39
Plav	5,196	2,289	2,907	62.5	8.1
Pljevlja	21,118	19,006	2,112	314.1	24.2
Pluzine	2,524	917	1,607	30.3	1.9
Podgorica [(2)]	136,351	81,811	54,540	1001.0	88.4
Rozaje	7,690	5,126	2,564	99.0	12.0
Savnik	576	419	157	6.1	1.1
Zabljak	1,938	948	990	27.9	4.3

(1) Populations for 2003 based on Land Use densities
(2) Population for Podgorica based on 2003 census data

Consequently the number of people reliant on on-site sanitation in each municipality of the Project Area is presented in Table 3.3.2

Sewerage availability in the whole Project Area, by municipality Table 3.3.2

Municipality	Population of the municipality [1] (capita)	Population served by sewers (capita)	Population <u>without</u> sewers (capita)	Percentage of population <u>without</u> sewers (capita)
Andrijevica	5,697	605	5,092	89%
Berane	34,912	8,887	26,025	75%
Bijelo Polje	49,773	3,383	46,390	93%
Danilovgrad	16,376	2,073	14,303	87%
Kolasin	9,934	1,642	8,292	83%
Mojkovac	10,015	2,990	7,025	70%
Niksic	75,274	27,000	48,274	64%
Plav	13,725	2,289	11,436	83%
Pljevlja	35,751	19,006	16,745	47%
Pluzine	4,270	917	3,353	79%
Podgorica	168,812	81,811	87,001	52%
Rozaje	22,559	6,724	17,433	77%
Savnik	2,938	419	2,519	86%
Zabljak	4,181	948	3,233	77%

(1) Populations for 2003 based on Census data

3.3.2 Summary of existing wastewater infrastructure and its condition

Sewers

Most of the sewers in the Project Area have been constructed in the last 35 years. In the 1970’s when many of the sewer building programs began, Asbestos Cement pipes were frequently used. PVC pipes became more readily available in the 1990’s, and became the most commonly used material for sewers.

The sewer systems were designed as separate systems, that is, stormwater and foul sewage were kept separate. Some connections of surface water gullies to the foul sewers have been made over the years, however these incidents are not extensive but are limited to certain areas of some towns. These gullies drain storm water from yards and roofs but also any rainwater that drains off the road surface. This practice does affect the performance of the foul sewers since a lot of the sediments are transferred together with storm water, and the networks have been originally designed only for foul sewage and the stormwater flows may overload some parts of the network. It has been assumed that these connections will be eliminated by the time that the first WwTPs are operational.

Prior to 1990, the sewers were mainly constructed by the Yugoslavian State Contractors and are believed to have been constructed to a reasonable standard. No CCTV inspections of the sewers have ever been made and inspecting manholes was the only way of making assessments for this project. These inspections however support this general observation. The ViKs reported very few instances of sewer collapse. The main problem seems to be blockages, but this is due to lack of cleaning and the disposal of solid waste into manholes rather than inadequate design. Sewers have generally been well dimensioned.

Since 1990, little new sewer construction has taken place. Our assumption has been therefore, in the absence of any other data, that the sewers are structurally sound and adequate for service for at least the next 25 years. In some cases, replacement may be necessary because of the proposed additional flows and loads arising from the development of the system upstream.

All connections to the system are made to the manholes (rather than on the sewer pipes), and pipes terminate at the inner face of the manhole and wastewater is allowed to cascade to the bottom. Many manholes have no benching, and the inlet and outlet are set above the invert of the manhole so that a 'grit–trap' is formed. This, together with the other conditions mentioned above means that the manholes are unpleasant and unsafe places in which to work.

A variety of manhole designs have been employed. The majority are square cast in-situ concrete manholes typically 1 m x 1 m, with Savnik the only exception (0.8 m x 0.8 m) in plan. Circular manholes were also used of the pre-cast concrete ring type typically 1 m diameter. The manhole depth varies from 1.2 to 5m deep. The manhole covers are typically cast-iron and circular. Manholes are fitted with step-irons; however, these are often constructed with bent steel reinforcement, which is inadequate.

Although the manholes have not been constructed in an ideal manner, it is not proposed to replace them.

Montenegrin legislation stipulates a minimum sewer diameter of 200 mm, as pipes of small diameters frequently block. It is proposed that the 150 mm diameter sewers are replaced in Phase 2 (2009 – 2019), but that all existing sewers with a diameter smaller than this are replaced in Phase 1.

The operation and maintenance tasks carried out on the sewerage system are only those of emergency repairs and/or unblocking, and no preventative maintenance is carried out. Where blockages and flooding problems are reported, it does not necessarily mean that the sewers need to be replaced. It is possible that additional preventative maintenance is necessary but this would be preferable to abandoning the sewer. And it is possible that many blockage problems will disappear once people are persuaded not to dispose of solid waste to the sewers. Sewer cleaning is compromised at present by the fact that manholes are not designed for man-entry, and by the lack of proper cleaning equipment.

It is essential that a major sewer cleaning programme be instigated to clear the accumulated debris from the sewers before the treatment plants are commissioned.

Some sewers were reported to have inadequate hydraulic capacity .Where hydraulic calculations confirmed this, it is proposed to replace these sewers. Where hydraulic calculations did not confirm this, then it is proposed to retain these sewers.

No incidences of structural deficiencies were reported, and the sewers are believed to be in fair condition, and consequently capable of being retained indefinitely.

Table 3.3.3 summarizes the extent of the existing sewer networks and that part which will have to be abandoned or replaced in the next 25 years.

Summary of existing sewers and their condition, by municipality Table 3.3.3a

Municipality	Existing sewers			Length proposed to:			Reported/Observed Problems
	Diameter (Ø mm)	Material	Total Length (m)	Abandon (m)	Replace in Phase 1 (m)	Replace at the end of Phase 2 (m)	
Andrijevica	100	PVC	260	260	0	0	*Blockages of sewers – attributed to solid waste disposal, siltation of sewers and small diameters*
	200	PVC	1,570	94	0	0	
	200	AC	535	0	0	0	
Berane	100	AC	418	0	418	0	*Blockages of sewers – attributed to solid waste disposal, sanitation of sewers and small diameters* *Sewage flooding from manholes (as a result of blockages)*
	150	AC	916	0	0	916	
	200	AC	1,377	0	0	437	
	250	AC	9,797	0	0	0	
	300	AC	1,401	17	0	0	
	500	AC	962	45	0	0	
	300	PVC	55	0	0	0	
	500	PVC	1,108	0	0	0	
	1000	C	270	96	0	0	
Bijelo Polje	60	AC	287	0	287	0	*Blockages of sewers – attributed to solid waste disposal, siltation of sewers, and small diameters.* *Sewage flooding from manholes (as a result of blockages)*
	80	AC	315	163	152	0	
	100	AC	317	177	140	0	
	125	AC	705	178	527	0	
	150	AC	1,738	162	0	1,576	
	200	AC	1,556	95	0	0	
	250	AC	432	86	0	0	
	300	AC	1,017	174	0	0	
	200	C	766	0	0	0	
	300	C	260	32	0	0	
	700	C	140	0	0	140	
	150	PVC	118	0	0	0	
Danilovgrad	150	AC	530	175	0	355	*Blockages of sewers – attributed to solid waste disposal, and siltation of sewers.* *Sewage flooding from manholes (as a result of "hydraulic throttle" phenomenon and blockages)*
	200	AC	460	0	294	0	
	300	AC	608	189	0	0	
	200	PVC	186	0	0	0	
	250	PVC	458	0	0	0	
	300	PVC	117	0	0	0	
	400	AC	183	167	0	0	
Kolasin	400	C	523	0	0	0	*Oversized pipes.* *Kolasin has a new system, however it is not well maintained*
	500	C	988	108	0	0	
	250	PVC	1,706	0	0	0	
	400	PVC	20	0	0	0	
	500	PVC	173	0	0	0	

Summary of existing sewers and their condition, by municipality Table 3.3.3b

Municipality	Existing sewers			Length proposed to:			Reported/Observed Problems
	Diameter (Ø mm)	Material	Total Length (m)	Abandon (m)	Replace in Phase 1 (m)	Replace at the end of Phase 2 (m)	
Mojkovac	150	C	742	0	0	742	*Blockages of sewers – attributed to solid waste disposal, and siltation of sewers* *Sewage flooding from manholes (as a result of blockages and high sedimentation)*
	200	C	669	0	0	0	
	300	C	568	17	242	0	
	400	C	1062	0	0	0	
	600	C	131	59	0	0	
	1000	C	437	0	0	0	
	200	PVC	305	22	32	0	
	300	PVC	226	0	0	0	
	1000	PVC	129	0	0	0	
Niksic	100		1,648	0	1,648	0	*Blockages of sewers – attributed to solid waste disposal*
	110		73	0	73	0	
	125		850	0	850	0	
	150		6,844	0	0	6,844	
	200		2,164	0	0	2,551	
	250		2,964	0	0	132	
	300		3,276	0	0	541	
	350		302	0	0	280	
	400		191	0	0	0	
	500		157	0	0	0	
	600		452	0	0	352	
	600x600		38	0	0	38	
Plav	700	C	318	0	0		*Blockages of sewers – attributed to solid waste disposal and siltation of sewers.*
	200	PVC	2,814	0	0		
	250	PVC	4,930	0	1,678		
	700	PVC	40	0	0		
Pljevlja	200	AC	4,371	0	0	0	*Blockages of sewers – attributed to solid waste disposal and siltation of sewers.*
	250	AC	2,950	0	0	0	
	200	CI	1,411	0	0	0	
	200	C	1,071	0	0	0	
	200	PVC	1,122	0	685	0	
	250	PVC	1,070	0	190	0	
	300	PVC	1,728	0	0	0	
	400	PVC	218	0	0	0	
	500	PVC	215	0	0	0	
Pluzine	200	AC	1,059	0	0	0	*Blockages of sewers – attributed to solid waste disposal and siltation of sewers.* *Sewage flooding from manholes (as result of blockages)*
	200	C	108	97	0	0	
	200	CI	526	0	526	0	
	300	PVC	103	0	0	0	
	150	AC	115	115	0	0	
Rozaje	150	AC	77	0	0	77	*Blockages of sewers – attributed to solid waste disposal and siltation of sewers* *Sewage flooding from manholes (as result of blockages)*
	200	AC	6,379	213	0	403	
	300	AC	2,496	0	385	0	
	400	AC	445	0	0	0	
	500	C	398	88	0	0	
	200	PVC	2,102	0	0	0	
	300	PVC	163	0	0	0	

Summary of existing sewers and their condition, by municipality Table 3.3.4c

Municipality	Existing sewers			Length proposed to:			Reported/Observed Problems
	Diameter (Ø mm)	Material	Total Length (m)	Abandon (m)	Replace in Phase 1 (m)	Replace at the end of Phase 2 (m)	
Savnik	200	PVC	636	10	0	0	*Blockages of sewers – attributed to solid waste disposal and siltation of sewers.*
	300	PVC	496	0	0	0	
Zabljak	200	AC	4,094	0	0	1,993	*Blockages of sewers – attributed to solid waste disposal and siltation of sewers. Sewage flooding from manholes (as result of blockages)*
	200	PVC	155	0	0	0	

Pumping stations

There are no pumping stations in any of the existing networks in the Project Area.

Wastewater treatment plants

There are two formal WwTPs in the Project area, at Podgorica and at Niksic. Others were planned but never built (existing sewers have therefore been directed towards a planned site).

The treatment plant at **Niksic** has been abandoned and all the Mechanical and Electrical equipment has been removed. It was built in the 1970's and ceased to function in about 1990. It was an Oxidation Ditch plant, which comprised :

- Inlet pumping station
- Primary treatment (screens, sand/grit removal). The civil works are in bad condition and cannot be reused
- Biological treatment (oxidation ditch and secondary settlement). Only civil works are in place although poorly maintained. The electrical-mechanical equipment is missing.
- Disinfection (chlorination basin) - only the civil works are in place.
- Sludge treatment (thickening and drying beds). Only civil works are in place.

The capacity of the old plant is about 28.000 PE.

The old treatment plant in **Podgorica** is still being operated, although it is severely overloaded, having been built for a population of 55,000, and is now receiving flow from about 80,000 population. The rehabilitation of the old plant in the short term, and the construction of a new plant in the medium term are planned.

In **Kolasin** there are two lagoons, which serve as a treatment facility. They function as percolation basins with some retention capacity, and wastewater is ultimately discharged to the adjacent River Tara.

The following "informal" arrangements exist:

- **Andrijevica**: a septic tank is being used, which discharges to the River Lim
- **Mojkovac**: two of the total outfalls are being used, discharging to the artificial lake "Jaloviste"
- **Savnik**: a septic tank is in place, which discharges to the River Piva
- **Zabljak**: the existing network discharges into a sinkhole, but due to blockages the effluent is flooding freely to the land.

There are some small plants which serve military camps (as in Danilovgrad) and industries, as described in Technical Memorandum No 2 "Industrial Effluent" (Safege Tebodin, LDK, 2004) or other facilities, but these are not in the public domain, therefore have not been included in the Inventory.

3.3.3 Summary of existing on-site sanitation facilities

The population without access to sewers, by municipality is shown in Table 3.3.2 above.

Generally, where sewers are not available, "septic tanks" are used for wastewater disposal. These septic tanks are actually infiltration pits with percolating floors and walls, and have been described in TM 1. In brief they are typically a 9 – 20 m^3 buried chamber with permeable stone walls (without mortar joints) and covered with a concrete slab buried under soil and grass. The septic tank is usually built at a distance of 10 to 25 meters downhill and or at the backside of the house. An underground pipe connects the house to the septic tank. An overflow pipe is sometimes incorporated but more often it is not.

Septic tanks are usually designed with just one compartment but in areas where ground permeability is low (such as Golubovci) a second compartment is constructed.

However, septic tanks are not always used and in some cases wastewater is discharged directly to watercourses or field drains or onto open land.

The ViKs and Communal Enterprises reported the following methods of disposal for areas without sewers in their areas:

- In Berane, 90% of the population without network coverage is served by on-site sanitation and 10% is discharging to the river
- In Bijelo Polje, 40% of the population without network coverage is served by on-site sanitation and 60% is discharging to the river
- In Plav, 80% of the population without network coverage is served by on-site sanitation and 20% is discharging to the river
- In Pljevlja, 98% of the population without network coverage is served by on-site sanitation and 2% is discharging to the river
- In Rozaje, 40% of the population without network coverage is served by on-site sanitation and 60% is discharging to the river

The remaining municipalities reported that septic tanks are used everywhere where sewers are not available.

3.3.4 Geographical Information System

The ToR require that all the data acquired for the Asset Inventory for the sewerage systems of the main settlements be entered into a GIS system.

The structure of the GIS has three main divisions, as follows:

- Base mapping
- Existing sewer network (details of the existing sewers and their condition)
- Masterplanning layers (details of land use, population, proposed future sewerage infrastructure, and current operation and maintenance)

The Podgorica ViK GIS system was adopted for this project, and their generosity in making this system available is gratefully acknowledged.

Dealing with each of the three main divisions of the GIS in turn:

Base mapping

The base mapping for the GIS comprised two parts:

- Plan data (x and y coordinates) which was developed from the existing digital cadastre drawings, which were integrated on a town by town basis, so that for any of the 14 towns, there was a continuous digital map base, and
- Elevation data (z coordinates) which was developed from scanned contour overlay drawings which were geo-referenced to the digital plans. This elevation data was not produced by this project for Podgorica, where the GIS is already complete.

Existing sewerage network layers

The limitations of the existing sewerage data are described in TM 5. However, all the data presented in this report has been entered into the GIS, and the GIS has been constructed so that, when and if additional data is acquired (particularly level data), it can be accommodated.

The sewerage networks were digitized directly onto the base map. There were no existing wastewater treatment plants or pumping stations to digitize.

Data recorded in the GIS

Sewer pipes: Material (AC, PVC, B…)
Diameter
Calculated Length in meters
Real length in meters
Slope in %
Date of construction
Date of cleaning

Manholes: Name (for example EN-1)

Depth in meters
Ground level in meters asl
Invert level in meters asl

Outfalls: Name

Water level in meters asl
Ground level in meters asl
Flow in m^3/s

Masterplanning layers

The masterplanning layers were those layers necessary for just the development of the masterplan, and included land-use, operation and maintenance (existing problems), overall sewer condition assessment, and sewer condition), and the proposed new infrastructure development, as follows:

(a) *Land use layers*

Two layers of Land Uses were defined separately:

- That existing in 2004
- That projected for 2029

Data recorded in the GIS

Land Use: Number of the zone (an index number)
Type of land use (residential, industrial, park etc)
Population (for residential)
Calculated area
Calculated population density
Calculated saturation population density (for 2029 land use only)

(b) *Operation and maintenance layers*

Data recorded in the GIS:

Condition of sewers: Hydraulic – Sewer Sedimentation (High/Medium/Low)
Hydraulic – Sewer Blockages (High/Medium/Low)
Hydraulic – Sewer Insufficient Discharge Capacity (H/M/L)
Structural – Sewer condition (Good/Fair/Bad)
Environmental – Overflowing sewers (Yes/No)
Environmental – Stormwater entering sewers (Yes/No)
Environmental – Illegal outfalls (Yes/No)

Condition of manholes: State of the manhole (Good/Bad)

(c) Final sewer assessment

Data recorded in the GIS:

The final sewer assessment is the result of the combination of the hydraulic, structural and environmental assessments of the sewers noted above. Sewers to be replaced are classified into two categories; replaced in the short or medium term. Each sewer length was therefore classified as:

- Retained sewers
- Abandoned in Phase 1
- Abandoned in Phase 2 or 3

This attribute is shown on a thematic map, created for each town, which gives the global analysis of the state of the network (Figures 4.1 etc refer).

(d) ***Proposed future sewerage infrastructure layers***

The description of the proposed future sewerage infrastructure (ie the planned sewers, pumping stations, pumping mains and wastewater treatment plants) has been incorporated into the GIS.

<u>Data recorded in the GIS</u>:

The structure used for the future sewers and manholes was very similar to that used to describe the existing sewers. In addition, the following were recorded:

Pumping stations :
- Name (PS + number)
- Phase of construction (1 or 2/3)
- Number of pumps (duty)
- Number of pumps (standby)
- Head in meters
- Wet well capacity in litres
- Total flow in m3/h

Wastewater treatment plants:
- Name
- Equivalent inhabitants (PE)
- Type of treatment (biological, etc…)
- Capacity

3.4 Household Survey (TM 1)

3.4.1 Methodology

A sampling plan was developed to ensure that the survey was representative of every municipality. A total of 2576 interviews were held with respondents representing their households. The survey was carried out in the period between of 1st October and 1st December 2003. The household representatives were interviewed about their experiences, preferences, opinions, perceptions, financial situation and payment behaviour particularly with respect to water consumption and wastewater disposal.

A household was defined in this survey as the smallest production unit of domestic wastewater.

3.4.2 Results of the survey

The key findings of the household survey are summarized below:

Housing

On average the number of persons per household in the Project Area is 4.4. This is higher (more than one person more) than the average number of persons per household according to the 2003 census.

The dominant type of housing in urban areas is the apartment which accounts for about 60% of households. In suburban areas individual houses are most popular followed by apartments. Rural areas are dominated by individual houses.

Most households also own their housing even when they live in an apartment block. In Podgorica the percentage of rented houses is about 10% higher than the average in the Project Area.

Public water and wastewater services

Some 71% of the households in the Project Area are connected to the public water supply system. In urban areas the public water supply system has an almost universal coverage. This figure falls to 35% in the rural areas, where communal or private small-scale water supply solutions are often found.

Approximately half of the households connected to the water supply are also connected to the public sewerage system. This means that 38% of the population in the Project Area is connected to sewers.

Of the total number of 135,547 households in the survey area, approximately 102,668 are connected to the public water supply system and of those, 51,664 are connected to the public sewerage system. No public sewerage systems exist in places without public water supply systems.

In general the billing for water and/or sewerage services is based on measured consumption (80% of households) and bills are issued monthly. Sewerage charges are made according to the water consumed, and the rates are normally 50% of the water rates. Charges vary depending on the ViK/CE and sometimes on the distance to the Municipal centre. In the municipality of Savnik a flat rate is charged for water and sewerage.

In apartment blocks one water meter usually exists, which measures the consumption of the whole block. Bills are consequently the result of an apportionment of this volume. However 30% of the households could not answer this question.

The awareness of the amount of water consumed is low; two thirds of respondents did not know how much water they consumed per neither month nor the costs per cubic meter. Some 72% did not answer the question.

Only the households that received a bill for water and wastewater and knew what they had to pay, were included in the calculation of the average monthly water bill. This average is €8.48 per month. There are differences in the monthly averages per Municipality in the range of €4.70 to €12.00. On average this implies a water consumption of 34.3 m^3 per household per month or 260 litres per capita per day.

Satisfaction with the wastewater services provided by the ViKs/CEs is in general good. This includes not only the sewer services but also the service for emptying the septic tanks. (70% of the septic tanks emptied were done by the ViK). Households in urban areas (urban and suburban areas) are the most satisfied. In the Municipalities of Pluzine, Danilovgrad, Mojkovac, Berane and Kolasin a significant number of households were unsatisfied or even very unsatisfied. These are indicators for problems and/or malfunctioning of the sewer systems in some of the Municipalities. Some 80% of households did not experience problems with sewage in the past 6 months, which probably accounts for the high level of public satisfaction with the wastewater services.

Significant sewage problems like flooding or blockages occur in some of the municipalities. Public dissatisfaction is correlated to a delayed response as well. The most serious sewage problems are reported in Berane and Kolasin and to a lesser extent in Mojkovac, Danilovgrad and Pluzine.

Water and wastewater outside ViK/CE service areas

When no sewer systems exist, wastewater disposal is effected by individual “on-site sanitation” methods. Approximately 29% of the population (39,417 households) are outside ViK/CE service areas, and 33% (44,568 households) of the population within the ViK/CE service areas are not connected to sewers. Together they represent 62% of the population in the Project Area, an estimated 83,985 households, who rely on on-site sanitation.

Water supply outside the public ViK/CE service areas are: Bunar or open or deep well (4%), spring water often combined with a communal gravity fed pipe network (17%); Bistijerna or rainwater harvesting (5%); and surface water from rivers (2%). The available water sources depend on the local geographic conditions.

The septic tank is the dominant technique used for the disposal of wastewater when there is no sewer. Some 65% of the household use a septic tank with permeable masonry walls and covered with a concrete slab.

Most of the septic tanks work properly and are never emptied (74%). About 20% of the households have the septic tank emptied once a year. Problems related to septic tanks are bad smells, spills and or blockages. Cultural hygiene factors can be a reason for having the septic tank emptied once a year. When the household lives in an area where there is public water supply it is usually the ViK/CE that empties the septic tank and attends problems.

Public opinions and preferences

As far as the importance of public services to the public is concerned, water supply and road infrastructure are considered most important followed by sewerage.

Almost all respondents see sewerage as the preferred option over septic tanks. Sewerage is also considered healthier and cheaper. Only in the rural areas of some municipalities are septic tanks more favoured.

Concerns over the negative impact of disposal of untreated wastewater to the environmental is shared by the great majority of people, who absolutely disagree with the practice of discharging wastewater to rivers or into groundwater. However with the exception of part of Podgorica, the whole of the wastewater arising in the project area is disposed untreated in one of these ways.

Financial aspects

Assessment of the household income was a very difficult issue. Respondents tended to be very pessimistic about their income situation as over 60% saw their personal financial situation as weak, bad or even very bad while virtually none admitted they had a good position. In rural areas there are more households in a very bad position.

The average household monetary income according to this survey is in the range of €210 - €250 per month. This average is below the poverty line definition in the Poverty Reduction Strategy Paper issued by the Government of Montenegro in November 2003, which is €116.20 per person per month in the household. According to these figures almost 8 out of 10 households in our survey would be below the poverty line. Comparison with income figures in other recent surveys strengthened the opinion that the incomes quoted by respondents were incomplete and did not fully represent the overall household income. Supplementary income in the informal economy, domestic agriculture revenues, family support, pensions etc. were not explicitly asked for and are therefore most likely not considered by the respondents in their answer.

Regional differences in income were found with the Northern Region having the lowest.

Some 74% of the households receive a ViK/CE bill for water and/or sewerage every month. Approximately 6% of the households do not pay their bills because they are of the opinion that they are not obliged to pay or are illegally connected. Another 6.5% never receive a bill and will therefore never pay. People that do not pay their bills are usually not disconnected.

Around 35 % of the bills are paid at the ViK/CE office. The majority waits until the collection officer rings and will then pay several bills at once. The latter is most convenient to the customers but not very cost effective.

Half of the population has difficulty to pay their bills regularly, even in the urban areas where the incomes are usually higher. About half of them did not have the money at hand when they were asked to pay several bills at once. About 38% consider the ViK/CE services too expensive, and 34% think they are appropriate.

Willingness to pay extra for improvement of the sewers is low with 56.3% not willing to pay anything extra at all. In the Municipalities where there are problems with sewers, the households not willing to pay anything is much lower. There is slightly more support to pay some extra for treatment of wastewater before disposal to the environment.

Although 73% of the households would prefer to be connected to the sewer, if they had a choice, only 29% is willing to pay for the services and the connection.

3.5 Environmental Impact (TM 4)

3.5.1 Environmental baseline - general

Most of Montenegro is covered by high and extensive mountain massifs intersected by river gorges and deep valleys. Larger lowland areas are to be found in the south, near the coastline. The average altitude of the land area of Montenegro is around 1,050 m asl, and around 70 % of the total surface is between 500 m and 1,500 m.

The **climate** in the Central and Northern Region of Montenegro is considered to be continental. Podgorica has the highest average maximal monthly temperature (20.5 C), while Zabljak and Rozaje show the lowest average minimal monthly temperature (0 C). Kolasin is the settlement with the bigger number of days with high precipitation, while Niksic and Podgorica are also areas with high precipitation. Heavy snowfall is common in many areas of the Project Area, such as Zabljak, Pljevlja, Rozaje, Kolasin and Niksic.

The **geology** of Montenegro is complex and is dominated by karst terrains and is thus characterized by numerous surface and underground forms of karst relief. The major part of Montenegro belongs to the High Karst Zone, which is very complex, and mainly consists of Mesozoic (Triassic, Jurassic and Cretaceous) limestone and dolomite of several kilometres of thickness. Reverse faulting and overthrusting, and thus repeating of carbonate series, has contributed to this great thickness.

In their **hydro-geological characteristics**, karst terrains generally differ greatly from other types of aquifers. The vast differences in water-yielding capacity of the constant and periodic karst springs point to the strong karstification of High Karst Zone limestone and dolomites. The most numerous and biggest accumulations of groundwater are formed in areas of karst limestone formations. This water appears on the surface through numerous constant and periodic karst springs. It is estimated that minimal quantity that flows out from these accumulations is 15 m^3/s. Some 3.36 m^3/s of this water represents the main source for public water supply in Montenegro. Karst springs exist in all carbonate rocks from the Adriatic coast to the northeast border of Republic. Levels of underground waters are mostly a few hundred meters below ground level, except in areas of the narrow coastal zone, the depression of Skadar Lake, the Bjelopavlici plain and river valleys (canyons on the north of Montenegro). The main springs for water supply are located in the central part of Montenegro. Karst aquifers are exploited in morphologically lower parts of the terrain, starting from Niksic field, including Zeta and Moraca valleys to the basin of Skadar Lake. These springs greatly contribute to the increase of the quantity of the springs in Cemensko field and Zeta valley. These valleys get water from surface and underground springs and the rivers of Moraca and Cijevna. The number of underground spring can be also only approximately determined. Most of them are located in Zeta valley. The exploited quantity of these underground waters is 10 m^3/s.

Within the Project Area, there are three areas protected under international status and one nominated to be included in the UNESCO List of World Natural Heritage:

- The **Skadar Lake**, on the List of Wetlands of International Importance (Ramsar List) at the end of December 1995;
- The **Durmitor National Park** and part of the Tara Canyon, 20,000 ha, registered on the UNESCO List of World Natural Heritage;
- The **Tara River basin** with a surface of 182,000 ha, registered in the “List of World Biosphere Reserves – the UNESCO” under the “Man and Biosphere” programme;

- The **Biogradska Gora National Park**, nominated for the UNESCO List of World Natural Heritage.

Regarding **industrial activity** within the Project Area, data were retrieved from the Technical Memorandum on "Industrial Effluents" and from the parallel project of the "Feasibility Study for Podgorica Wastewater Treatment Plant". In total, 89 industries were identified in the Project Area (focusing on the urban areas), of which 22 industries were included in the Major Industries Survey (conducted in the course of this Project). The main types of industrial activity within the Project Area are as follows:

- Food industry (including alcohol and beverage products) – 16 industries
- Wood industry – 14 industries
- Machinery, metal processing and metal products – 9 industries
- Textiles and wool processing – 7 industries
- Slaughterhouses and breeding units – 6 industries
- Tanneries and Leather products – 6 industries

Although the majority of the registered industries currently operate with reduced capacity, the current status of the industrial sector was considered to be transitional and it was presumed for the estimates necessary for this project, that industry would be rebuilt in the future to some extent. The main settlements with industrial activity were Podgorica, Niksic, Pljevlja, Bijelo Polje, Berane and Rozaje.

Agriculture is not a well - developed sector in Montenegro and many food products are said to be imported from other countries. The low capacity of the food-processing industry is considered to hold back the development of agriculture. Environmental pressure from agricultural production is limited at present, but it is likely to increase with intensified production, once this starts to apply. Currently the use of fertilizers and pesticides is limited and results in low run-off of polluted waters to the aquatic receptors. Based on recent data on livestock population, the density and thus possible environmental impact is significantly higher in certain areas such as the municipality of Savnik, Zabljak, Pluzine and Pljevlja. Existence of only one large pig farm is reported in Spuz, anticipated to contribute in the degradation of waters of River Zeta.

Irrigation works are rather limited in Montenegro, although according to the Hydro Economy of Montenegro Republic, several irrigation systems will be developed by 2021 to cover the Coastal, Central and North-East region of the country. According to this report one of the sources to be used is "reused water", including treated wastewaters from municipal WwTPs. In total, 22.17 Mm^3/y of reused water is foreseen to irrigate an area of 4,525 ha in the "Zeta - Podgorica" area, 6.8 Mm^3/y of reused water is foreseen to irrigate an area of 2,000 ha in the "Niksic" area.

Public water supply needs are almost exclusively covered by underground water resources or highland springs, with the exception of Pljevlja where a surface water reservoir is also utilised. In urban areas public water supply systems, operated by ViKs or Communal Enterprises (CEs), serve 99% of the residents, while in suburban areas and villages the corresponding percentage is 97% and 35% respectively.

Industrial water needs are covered to a large extent by the ViKs or CEs, while surface and groundwater are also used by water intensive industries, such as KAP in Podgorica or the Iron and Steel factory in Niksic. Water is also a significant energy source in Montenegro, as currently 76% of the installed generating capacity is from

Hydropower Plants, the biggest ones being the HPP Perucica (Zeta River) and HPP Piva.

A description of the current situation in terms of existing infrastructure and practices with regard to **wastewater disposal**, as well as derived impacts are presented in more detail in Chapter 6 of TM 4, and Sections 3.5.4 and 3.7.4 below.

The Tourism Masterplan for Montenegro (May 2001) targets five main regions for **tourism development**, among which the Skadar Lake and the inland mountain region, including the Tara River and the area of Zabljak with the Black Lake. Although tourism development has only recently started, preserving the water's quality, as part of the broader environmental protection of these areas, is among the priorities of the Government, which maintains strong interest in the development of Montenegro as an Ecological State.

Issues related mainly, to poor practices in Solid Waste Management and to the mining activity in the Project Area are also outlined in TM 4, as they are well-known for causing degradation of the quality of the environment in the Project Area.

In a parallel project, the Solid Waste Strategic Masterplan, being elaborated by GOPA, it has been estimated that a total area of 85 ha is covered by the dumping sites, which are usually located in naturally formed depressions, abandoned mining areas (such as in Pljevlja) or even at the river banks (such as in Bijelo Polje, Mojkovac and Rozaje). The waste dumping site in Niksic is also reported to impose a serious threat to the environment and public health. Significant is also the impact from inappropriate disposal of industrial waste, hazardous or not. The KAP factory in Podgorica, the Iron and Steel factory in Niksic and the TE Plant in Pljevlja are the ones identified as causing the most significant environmental impact in the Project Area. Two tailing ponds (jaloviste) in Mojkovac (Tara River Basin) and in Gradac (Pljevlja region, Cehotina River basin) are also known to pose threat to the environment.

The quality of surface waters and groundwater are discussed in separate sections below as they are affected most by disposal of wastewater.

3.5.2 Environmental baseline - surface waters

Required classes of surface waters in the Project Area Table 3.5.1

River reach or Lake	Drinking Water (A1, A2, A3)	Fish farming (S, Š or C)	Bathing waters (I, II)
Moraca			
Upstream Duklja	A1	S	I
From Duklja to the confluence of Moraca with the Skadar lake	A2	C	II
Zeta			
Upstream Brezovik	A1	S	I
From Brezovik to the confluence of the River Zeta with the River Moraca	A2	C	II
Piva downstream Pivsko lake	A2	C	II
Komarnica	A1	S	I
Tara	A1	S	I
Cehotina			
Upstream Pljevlja	A1	S	I
Downstream Pljevlja	A2	C	II
Lim			
Upstream Berane	A1	S	I
From Berane to the border with the Republic of Serbia	A2	C	II
Ibar			
Upstream Rozaje	A1	S	I
Downstream Rozaje	A2	C	II
Skadar lake	A2	C	II
Sasko lake	A2	C	II
Artificial lakes (Liverovici, Krupac, Slano, Vrtac, Grahovo, Pivsko lake, Gradac	A2	C	II

Note: Classification of waters is defined in Regulation 19/96, 15/97. Quality of drinking waters, i.e. waters abstracted for drinking purposes, is defined as A1, A2 and A3, corresponding to waters that can be used for drinking purposes: directly or after disinfection (A1), after physicochemical treatment and chlorination (A2), after intensive physicochemical and/or biological treatment and chlorination (A3). The classification for "fish farming" corresponds to waters that can be used for farming of high quality fishes (e.g. salmonids) (S), for shell breeding (Š), for farming of lower quality fishes (e.g. cyprinids). Classification of bathing waters corresponds to waters of very good quality (I) and waters of good quality (II)

The following definition of ecological status qualification was applied to assess the quality of surface waters.

Qualification of water quality applied for this study Table 3.5.2

Class	Qualification	Environmental Categories		
		Drinking water	Fish farming	Bathing water
1.	High	A1	Š	I
2.	Good	A1 and A2	Š and S	I
3.	Moderate	A2	C	II
4.	Poor	A3	>C	>II
5.	Bad	>A3	>C	>II

Out of a total of 18 parameters monitored, a set of selected parameters, considered to be the most relevant for the identification of impact from municipal wastewater discharges to surface waters, were assessed in this report, specifically:

- BOD_5
- COD
- Nitrogen forms, i.e. NH_4, NO_2 and NO_3
- PO_4 (and detergents)
- Total coliforms and faecal coliforms
- Saprobiotic Index (Liebmann – U)

Monitoring results from 34 stations on 11 rivers were assessed in order to identify waters of degraded quality, in terms of these parameters. This was the first step in the process of identification of the waters within the Project Area that are affected by municipal wastewater discharges.

Regarding the quality of the rivers the following conclusions were drawn:

The most polluted rivers are: **Cehotina downstream Pljevlja, Vezisnica, Moraca downstream Podgorica and Ibar downstream Rozaje.**

Regarding **Cehotina and Vezisnica rivers**, pollutants related with municipal wastewaters (such as BOD_5, NO_2, NH_3, PO_4 and total and faecal coliforms and well as the Saprobiotic index) were found to fall in the range of “poor” to “bad” quality.

The **River Ibar** is also polluted. Downstream of Rozaje, near Bac, water quality fails to meet the standards of third class for many of the parameters monitored, such as ammonium, nitrites, phosphates, total and faecal coliforms.

A favourable hydrological regime is reported to have positively affected the quality of water of the **River Moraca**, which appears, in general, to be of improved quality, when compared with monitoring data from previous years. However high values were monitored for ammonium and total coliforms, downstream of Podgorica.

The water quality of **River Lim** appears to be “good” for most of the parameters assessed. However, its micro-bacteriological condition can be characterised as “poor” to “bad”, due to its elevated faecal and total coliform concentration, found downstream of Berane and Bijelo Polje.

The **Zeta river** appears to be of “poor” quality only in terms of total coliforms at the stations Duklov Most (upstream of the main wastewater outfall in Niksic) and at Danilovgrad. The higher values are recorded at the station of Duklov Most, although it should be noted that the remaining parameters indicate “high” to “moderate” quality of waters. It should be emphasized that the location of the monitoring stations along the river Zeta do not allow for the impact from Niksic discharges to Zeta River to be assessed fully.

The **Rivers Tara and Piva** were assessed to be of good quality, with the exception of Mojkovac where ammoniac and total coliforms fail to meet class A3.
Regarding **saprobiological index**, all rivers fall in first to second class with the exception of Cehotina, which downstream Pljevlja is of third class.

Skadar Lake is monitored at nine monitoring stations, while a number of studies have also been conducted to assess its quality status. Overall the quality of the Lake could be characterised as “good” to “moderate”, for the parameters under review, with some deviations for certain parameters or locations. Specifically, in terms of NH_4 and total coliforms the quality is “moderate” to “poor”. According to CETI, high coliforms are attributed to the settlements of Cetinje and Podgorica. In general, the northern part of Skadar Lake seems to have lower quality, when compared to the southern part of the lake. Apart from the discharge of the Moraca River, the northern part of the lake also receives groundwater polluted with industrial effluent from the Podgorica area and the run-off from the adjacent plain which supports significant agricultural activity.

Regarding the trophic status of the Lake, based on a study conducted by the University of Montenegro, it was concluded that *Skadar Lake is mesotrophic* (not-eutrophic), as low concentrations of chlorophyll, low numerical production of phytoplankton and small values of saprobic indices were observed, due to low levels of nutrients in the lake.

Plavsko Lake and the Black Lake are also monitored. Both lakes are of “high” to “good” quality, for all the parameters assessed, with the exception of NH_4 and total coliforms for which the measured values are of “poor” quality.

3.5.3 Environmental baseline - groundwater

Groundwater was studied to determine the impact of on-site sanitation and was reported in TM 3. A summary is provided in Section 3.7 below.

3.5.4 The impact of current wastewater disposal methods on surface water

In order to assess the impact of current municipal wastewater discharges to surface waters, data retrieved and processed during other Technical Memoranda of this project were used, including:

- current and future population;
- percentage of population connected with sewerage network;
- presentation of the current outfalls, per settlement;
- hydraulic and organic pollution loads (current and future);
- wastewater production per type of source, i.e. domestic, industrial (major or non-major industries) and institutional.

Projections on population reveal a trend of increase for the urban areas and decrease for the rural areas. Rural areas have no sewerage networks, while in urban areas the coverage varies significantly among the 14 settlements. For the settlement of Pljevlja this is as high as 90% while for Bijelo Polje is limited to 15%.

All 14 settlements discharge to surface water receptors, with the exception of Zabljak, which discharges to the ground and Mojkovac which discharges mainly to the Jaloviste, and then to the River Tara.

In assessing the current impact to surface waters of municipal wastewaters, a point source is assumed per settlement, equivalent to the load from the population connected to the sewerage network.

A review of the types of wastewaters production per settlement revealed that in some settlements such as Niksic and Bijelo Polje industrial wastewaters account for significant percentage of the total, while in other settlements such as Zabljak and Andrijevica institutional/commercial wastewaters were significant part of the total wastewater production.

A two-fold approach was adopted to assess the impact of wastewater discharges to the surface waters, as follows:

- A qualitative approach, in which results from the water quality monitoring programme were correlated to the pollution loads known to be discharged to the river, in order to identify waters affected by municipal discharges;
- A quantitative approach, in which contribution of organic pollution load discharged by the settlements to the river was "approximated" and presented as percentage of BOD_5 actually measured.

The qualitative assessment

The following table summarises the "hot spot" areas identified during the review of the water quality monitoring results, i.e. the settlements for which the water quality as indicated by the near-by station was found to be of "poor" to "bad" quality.

Table 3.5.3 Summary of the parameters found to be of "poor" or "bad" quality at monitoring stations close to the settlements of the Project Area

Settlement	Receptor	"Poor" quality	"Bad" quality
Berane	River Lim		Total coliforms & faecal coliforms
Bijelo Polje	River Lim		Total coliforms & faecal coliforms
Danilovgrad	River Zeta	Total coliforms & faecal coliforms, (NH_4)	
Mojkovac	River Tara	NH_4, Total coliforms	
Niksic (upstream the discharge of wastewater)	River Zeta	Total coliforms & faecal coliforms	
Pljevlja	River Cehotina	BOD_5, NO_2, (NH_3, PO_4)	Total coliforms & faecal coliforms, Saprobiotic Index
Podgorica	River Moraca	NH_4	Total coliforms
Rozaje	River Ibar	NH_4, PO_4, NO_2	Total coliforms & faecal coliforms

The **River Zeta** flows through the cities of Niksic and Danilovgrad. A significant percentage of the population of Niksic (52.5%, corresponding to a population of 27,000) is connected to the sewerage network, which currently discharges ultimately to the river Zeta, as the WwTP is out of operation. The current pollution load in Niksic originates mainly from the industrial activity of the area, which is estimated to discharge approximately 76,000 PE, 90% of which comes from the Trebjesa Brewery in Niksic.

The results obtained from the monitoring station located upstream of the discharges of the settlement, reflect mainly the microbiological pollution from Brezovik Hospital. Flow rates of the River Zeta in Niksic are extremely low in the summer period, so even small discharges can significantly affect the quality of the river.

It is reported that the pollution load from the Niksic plain, mainly coming from industry, has caused degradation of quality of the groundwater of the area, which are then discharged to waters of the Zeta (Lower Zeta), and subsequently to the River Moraca and finally to Skadar Lake.

However, the current location of the monitoring stations along the river and especially the lack of a monitoring station immediately downstream the town of Niksic, do not allow for this impact to be verified.

The flow of River Zeta and its quality is monitored at Danilovgrad, where the small load discharged by the settlement (approx. 4,000 PE) does not seem to affect the quality of the river due to significant dilution. Intensive farming activities at Danilovgrad and a major pig-breeding unit further downstream at Spuz, are known to affect the quality of the river more significantly than the domestic discharges.

A percentage of 60% of the population of Podgorica is connected to a sewerage network. Together with the industrial, institutional and commercial flows, a total PE of 120,750 is estimated to be discharged directly to the **River Moraca**. The high flow rate of the river allows for significant dilution to take place and thus there is evidence of some self-purification occurring further downstream. The river is of bad quality or at critical condition (as reported in the recently released report by the Hydro Meteorological Institute) at the discharge point of the old WwTP but shows improvement further downstream.

The **River Ibar** is significantly affected by municipal wastewater discharges. A big percentage of the population of Rozaje (65.7%, corresponding population 6,700 or total PE 8,300) is connected to a sewerage network and discharges directly to the River Ibar. The flow rate of the river is very small, which hinders the self-purification capacity of the river. In the summer period, wastewater discharges form stagnant ponds, creating conditions dangerous for the Public Health.

The **River Lim** used to be among the most polluted rivers of Montenegro when the paper pulp unit of the industry “Beranka” was in operation. The reduced industrial activity together with the relatively constant and significant flow of the river, seem to be the explanations for the satisfactory quality levels of the river’s waters. The only exception is the microbiological load, which seems to originate from the untreated municipal wastewaters being discharged by the municipalities along the river and especially from the settlements of Berane and Bijelo Polje. These two settlements have similar population (Bijelo Polje 20,300 and Berane 16,500) but the domestic load discharged directly to the river from Bijelo Polje is almost three times lower than that from Berane (4,500 PE vs. 11,700 PE), as the percentage of population connected to the sewerage network in Bijelo Polje is very low (16.6%). However, the existence of significant industrial activity in Bijelo Polje, brings the total PE currently discharged to the river to similar levels to Berane (15,900 PE versus 20,700).

The settlements of Kolasin (total PE 2,870), Mojkovac (total PE 4,800) and Zabljak (total PE 2,000) are located within the catchment area of the **River Tara**. Municipal wastewaters that reach the river directly are from the settlement of Kolasin, following percolation from the lagoon adjacent to the river and only a part of the municipal wastewater discharge from Mojkovac, which is discharged to a small tributary of the **River Tara**. The majority of municipal wastewaters from Mojkovac are discharged to the Jaloviste, which is known not to drain into the River Tara. A very low impact on the River Tara is verified from the analyses results, at the station close to Mojkovac.

The **River Cehotina** runs through the city of Pljevlja. The river does not have a high flow rate and appears to be, together with its tributary Vezisnica, significantly polluted and affected by municipal wastewater discharges, as the parameters related with these discharges fall into the "poor" to "bad" quality Class. Concentrations measured further downstream indicate that the self–purification capacity of the river is insufficient.

The poor water quality of River Cehotina could be attributed to the fact that approximately 90% of the population of Pljevlja (approximately 19,000) are connected to a sewerage network which discharges directly to the River Cehotina without treatment. Pollution also appears to be carried over from the industrial pollution sources along Vezisnica, before its confluence with Cehotina.

The **Rivers Cehotina and Vezicnica** were also recently reported, by the Hydro Meteorological Institute, to be the rivers with the lowest quality among all the rivers monitored in Montenegro. The Thermoelectric Plant and the coalmines, together with other industries operating in Pljevlja valley, certainly contribute to the "poor" quality of these rivers. It seems though, that the impact from the municipal discharges is also significant and cannot be neglected.

The **River Piva** is known to be of good quality. The only station along the river is located downstream the reservoir Pivsko and the analyses results do not provide evidence of pollution. The pollution load in Piva's catchment area from point sources is very limited.

The quantitative assessment

In order to approximate and assess the impact on surface waters from the current discharges, the net increase of BOD_5 concentration in the river from these discharges was estimated, based on average and minimum (95% probability) flow data. For the average flow rate, this was compared with the measured values of BOD_5, in the relevant monitoring stations for the year 2002. The raw wastewater discharged to the river was considered to arise from (a) the flows in the existing sewers, and (b) all industries. It was assumed that all other forms of wastewater disposal (mainly septic tanks) caused no pollution of surface water. This analysis is therefore conservative as individual houses sometimes have a private outfall into the river (see Section 3.3.3).

The results are presented in Table 3.5.4.

This table provides a basis for comparison among the impact to surface waters from different settlements. This approach takes into consideration, the total pollution loads discharged to the rivers and the flow rate of the river; thus the self-purification capacity of the river is taken into account, at least in terms of dilution of the received load.

However, there are certain limitations in the aforementioned approach, such as the proximity of the monitoring station to the discharge point of the relevant settlement.

The settlements **Kolasin, Pljevlja, Rozaje and Podgorica** seem to contribute significantly to the organic load of the river, as this was measured in the relevant monitoring stations. The net increase in BOD_5 concentration, from the discharges of these four settlements, and especially from Pljevlja and Rozaje and during the dry season (minimum river flow) are significant and exceed the limit set for A3 rivers (i.e. 7mg/l), corresponding to waters of "bad" quality.

It should be highlighted though that the above are the settlements with significant impact among the ten for which the data available allowed for this approximation to be made, and that the following four settlements which may have a significant impact but were not included in this approach: Niksic, Pluzine, Savnik and Zabljak.

Impact of current wastewater discharges on river quality Table 3.5.4

Settlement	River (Station code)	Average river flow			Minimum river flow (95%)
		Net increase in BOD_5 of river due to discharges from sewers (mg/l)	BOD_5 measured in the river (in 2002) (mg/l)	Percentage attributable to settlements sewerage	Net increase in BOD_5 of river due to discharges from sewers (mg/l)
Andrijevica	River Lim (L2)	0.02	3.0	1 %	0.16
Berane	River Lim (L3)	0.31	3.4	9 %	2.30
Bijelo Polje	River Lim (L5)	0.17	3.0	6 %	1.13
Danilovgrad	River Zeta (Z3)	0.03	2.1	2 %	0.45
Kolasin	River Tara (T2)	0.67	1.8	37 %	6.64
Mojkovac	River Tara (T4)	0.10	1.8	5 %	1.12
Niksic	River Zeta (Z2)	4.05	2.6	-	396.00
Plav	River Lim (L1)	0.12	2.9	4 %	0.80
Pljevlja	River Cehotina (C2)	2.36	5.2	45 %	26.48
Podgorica	River Moraca (M3, M5)	0.52	1.5 (M3) 3.4 (M5)	35 % (M3) 15 % (M5)	7.88
Rozaje	River Ibar (I1)	2.33	6.2	38 %	26.08

The lack of monitoring station downstream Niksic has been discussed before and it is considered of great importance, to allow for assessment of impact of the town of Niksic to Zeta River. Station Z3, which is the first station downstream Niksic is not only at a great distance from Niksic (more than 30 km), but also after Zeta has passed through the canal and then through the pipes system entering the Perucica HPP before it reappears upstream Danilovgrad.

Although contribution to the measured values cannot be assessed, the existence of hydraulic data at the Station Z2 (Duklov Most) allowed for the estimated concentration of BOD_5 in Zeta river, due to wastewaters discharged from Niksic, which is 4.05 mg/l for the average flow and as high as 396 mg/l for the minimum flow of the river (95%), assuming a point source discharging load equal to the load produced in the whole settlement (domestic, institutional and industrial untreated).

At this point, it should be noted that, for the dry season the minimum flow rate (probability 95%) of the River Zeta in Niksic has an extremely low value. Thus, the flow rate of the wastewater discharge, assuming a point source discharge, is double than that of the river (i.e. 0.20 m^3/s versus 0.11 m^3/s). Consequently, there is very limited dilution of the discharged effluent. Thus, discharge of the treated effluent to either of the two adjacent irrigation reservoirs (Krupac or Slano) is recommended, especially for the dry season. This suggestion is also in line with the anticipated "water reuse" foreseen by the "Hydro Economy of Montenegro Republic" for the Niksic area.

Wastewater discharges from Niksic are reported to be responsible for the contaminated springs in Bijelopavlici valley, where River Zeta reappears after the Perucica HPP flowing in the surface. This used to be the most fertile valley of Montenegro and it is reported that due to the degradation of the water's quality, the life in the valley has been significantly affected. Pollution from Zeta is transferred via the River Moraca to the Skadar Lake.

Summary

Based on the qualitative approach, the settlements for which there was evidence of impact from municipal wastewater discharges to the river, and thus were suggested to be considered with higher priority, were:

- **Pljevlja** and **Rozaje**, for which there was strong evidence;
- **Podgorica, Berane, Bijelo Polje**, **Danilovgrad** and **Mojkovac**, for which there is an indication of impact.

Regarding Niksic, the lack of a monitoring station downstream from the wastewater discharge point did not allow for impact justification, through this approach.

Based on the quantitative approach, the settlements that were estimated to contribute significantly to the pollution load of the river were, with order of significance, as follows: **Niksic, Rozaje, Pljevlja and Kolasin**.

3.5.5 The impact of current wastewater disposal methods on groundwater

This was the subject of TM 3 and is discussed in Section 3.7.4 below.

3.5.6 Comparison of National and European legislation

The National "Environmental" standards for wastewater discharge to public sewers and natural recipients (Regulation 10/97), and for surface water quality standards (Regulations 14/96, 19/96 and 15/97) were compared to EU Directive 91/271/EEC.

The following conclusion was drawn: the national limits for COD, P_{tot} and SS should be considered to be amended to those of EU standards, unless there is evidence due to the characteristics of the receiving waters that they should be maintained as they are. Regarding N_{tot}, a limit should be introduced and the relevant limits for NO_3 and NO_2 should be lessened accordingly.

The following table allows for a rapid comparison of the national and EU standards.

Comparison of national standards with corresponding EU standards for discharges to surface waters **Table 3.5.5**

Parameter	National regulation (10/97)	EU directive (91/271/EEC)
BOD_5 (mg/l)	30	25
COD (mg/l)	45	125
SS (mg/l)	20	60 (2,000 <PE<10,000)
		35 (PE>10,000)
Total Phosphorous (mg/l)	1	2 (if sensitive receptor **and** 10,000 <PE<100,000)
		1 (if sensitive receptor **and** PE>100,000)
Total Nitrogen (mg/l)	(Equivalent N_{tot}<10 mg/l)	15 (if sensitive receptor **and** 10,000 <PE<100,000)
		10 (if sensitive receptor **and** PE>100,000)
NO_3	40	
NO_2	0.5	

The conclusions of the review were as follows:

- The national effluent standards for **BOD is slightly less stringent** than the EU one, i.e. 25 mg/l vs. 30 mg/l.
- The difference between the **COD values is great with the national standard being much more stringent than the EU requirement, i.e. 45 mg/l vs. 125 mg/l.** The national standard is too stringent and should be amended to be in line with the EU standard.
- **TSS national standard is also quite stringent compared to the EU ones**, (20mg/l vs. 35 mg/l for >10,000 PE and 60mg/l for <10,000 PE). This standard should also be amended to be in line with the EU standard. The TSS value in effluents is normally higher than the corresponding BOD value.
- **P_{tot} national standard is also too stringent (1 mg/l) as it is equal to the EU standard for discharge of large agglomerations (PE>100,000) to sensitive waters.** The EU standard for settlements with 10,000<PE<100,000, discharging to sensitive waters is 2.0 mg/l. The EU standard only applies for discharges to sensitive waters and in addition minimum 80% reduction in

phosphorus as an alternative to the standard is permitted. **The national standard is too stringent for discharge to normal (non-sensitive waters). Designation of sensitive receptors has not been carried out in Montenegro. A preliminary assessment carried out by this project, is presented in Section 5.16 of TM 4, and is summarized below.**

- **The result when comparing the National with EU standards for N_{tot} is similar.** Specifically, although there isn't a national standard for N_{tot}, the standards for NO_3 and NO_2 of 40mg/l and 0.5 mg/l respectively, correspond to less than 10 mg/l of N_{tot}. This is again equal to EU standard for large agglomerations (PE>100,000) discharging to sensitive waters, while for smaller agglomerations (10,000 < PE < 100,000) the relevant limit is less stringent, i.e. 15 mg/l.

The EU Directive requires that an assessment of the receptor be made to determine whether it is sensitive in which case, limits for the discharge of nutrients (i.e. nitrogen and phosphorous) apply.

Sensitive areas have not been designated in Montenegro. However the national limits for discharge to surface waters, regardless their sensitivity, are more stringent than the ones suggested by the EU directive for sensitive areas. Consequently, for the time being and if the National Standards are to remain the same, this would mean that the whole territory of Montenegro is identified as a sensitive area and that there is no need for designation of certain receptors as "sensitive areas". This strategy has been adopted by certain EU Member States and is an option to be considered.

On the other hand, this option would impose additional costs for the removal of nutrients from the WwTPs outflows, before discharging to the river, in order to be in compliance with the national standards. Thus, designation of particular receptors as sensitive, only if there is enough evidence for such designation to be given, would be a more appropriate approach.

Specifically it is proposed the national limits for COD, P_{tot} and SS should be amended according to EU standards. Regarding $N_{tot,}$ a limit should be introduced and the relevant limits for NO_3 and NO_2 should be lessened accordingly.

It has been assumed that EU legislation will be adopted in Montenegro for the purposes of the Masterplan.

Consequently, it was necessary to make a preliminary assessment of potentially sensitive receptors so that nutrient removal facilities could be proposed for WwTPs discharging to them.

The candidate agglomerations, with PE>10,000, for which designation of the corresponding receptor as sensitive would impose the requirement for additional treatment (i.e. nutrients removal) of their wastewaters are: Berane, Bijelo Polje, Niksic, Pljevlja, Podgorica and Rozaje.

The criteria applied were based on the EU Directive's requirements and on the "guidance limits" for eutrophication assessment issued by the Joint Research Centre of European Commission in 2001. The following table summarises the criteria and the results.

Identification of sensitive receptors–criteria and results Table 3.5.6

Receptor		Criteria	Sampling points exceeding the criteria limits
Rivers	Moraca	**PO_4> 0.4 mg/l** (all but station M6, where PO_4 > 0.2 mg/l) and **TN_{inorg} > 1.6 mg/l**	**M4** – Grandski collector, discharge of Podgorica, PO_4 = 0.46 mg/l
	Zeta		None
	Lim		None
	Ibar		**I2** – Bac (downstream Rozaje), PO_4 = 0.71 mg/l
	Cehotina		**C2**–Pljevlja, PO_4 = 0.44 mg/l **C3**–Upstream the confluence with Vezisnica, PO_4 = 0.42 mg/l
Lakes	Skadar	**PO_4 > 0.1 mg/l**	None
	Plav		**PL1**- in the middle of the lake, PO_4 = 0.10 mg/l
	Black		None

Consequently, the receptors for which there is evidence for possible designation as “sensitive areas”, based on the eutrophication criteria of the directive 91/271/EEC are the **Rivers Cehotina and Ibar**. Since designation of sensitive areas concerns only settlements with PE > 10,000, the settlements for which "provision" for nutrients removal should be made are **Pljevlja and Rozaje*.*** For these two settlements, the type of WwTP foreseen is “Oxidation Ditch” which will provide nitrogen removal. Phosphorous removal, which is the nutrient of importance in these cases, will be easily provided in the future, if the receptors are finally designated as sensitive.

For the **River Moraca**, which is claimed to be the only eutrophic river in the region, there is no supporting evidence according to the criteria applied, as the only station found to exceed the limit is at the outflow of the main wastewater collector of Podgorica. In any case, since the new Podgorica WwTP has been designed to meet the criteria for discharge to sensitive receptors (i.e. national limits equal to the EU ones for discharge to sensitive receptors), a safe approach is to be implemented in terms of protection of Moraca from eutrophication.

For **Lake Plav**, the measured value is just at the limit, so only weak evidence is provided.

For **Skadar Lake**, as described in Section 5.13 of TM 4, the measured values do not provide evidence of eutrophication.

For **Niksic**, there is no evidence to prove eutrophication of River Zeta due to the lack of a quality station close to Niksic. The stations located further downstream do not provide evidence for designation of River Zeta as “sensitive area”. However, it is expected that potential for eutrophication development in Zeta River close to Niksic could be justified if data were available. Apart from the significant pollution loads discharged untreated into the River Zeta from Niksic, the river is also known to have low flow rate, especially during the summer when conditions for development of eutrophication are favourable.

Regardless of the above, it should be noted that provision for nutrients removal can be made by simple modifications of the WwTPs for all towns with a PE > 10,000 can be made in the future, if necessary.

3.5.7 Mitigation of impact to surface waters from industrial effluents

For the scope of this report, the impact on surface waters from industrial wastewater discharges was assumed to result from direct wastewater discharges, through the existing sewerage network or direct outfalls to the river from the industries of the area. As sewerage network currently serves only urban areas, the impact of urban industries was assessed based on data referring to the urban areas and thus the mitigation measures also refer to the ones foreseen by the Masterplan for the urban areas.

Mitigation of impact through measures, targeting reduction of pollution from industrial effluents was presented in TM 2. As in some towns (eg Niksic) the current (referring to 2002 production data) pollution load discharged into the river is mainly derived from the industrial sector, the significance of controlling these wastewaters for the environment is apparent. Settlements falling in this category are mainly **Niksic and Bijelo Polje,** followed by Berane. It is indicative that in Niksic, compliance of industrial discharges with even the limit for discharge to sewers (BOD_5 – 500 mg/l) would result in 30% reduction of the current pollution load currently discharged to the River Zeta from the city.

Measures presented in detail in TM3 aimed at mitigating the impact of industrial effluents included:

- Introduction of the Trade Effluent Agreement as a new control mechanism for industrial wastewater discharges, posing terms and measures for discharges to network as well as setting a tariff based on the hydraulic load and possibly on the strength of the effluent.
- Introduction of a Wastewater Management Strategy at a national level and a synoptic Action Plan for its implementation, focusing on the strengthening of the country’s Institutional Capacity
- Encouraging industries to develop and implement an internal Industrial Wastewater Management Scheme, in order to minimise their wastewater discharges in terms of both hydraulic and organic pollution load. This would benefit not only the aquatic environment, as final receptor, but also themselves through the cost savings that could be achieved, once the TEA is implemented.

3.5.8 Mitigation of impact to surface waters from municipal wastewaters

The quantitative approach used to assess the current impact from municipal wastewaters to the aquatic environment, was also applied in order to assess the positive impact of the proposed works of this study.

Details of the proposals are presented in the Technical Memorandum “Future Wastewater and Sanitation Requirements”. In the present report only the main concept for the development of the Masterplan is presented.

According to the approach adopted in the Masterplan, during **Phase I** (which lasts till 2009), all the existing sewerage networks will be connected to a WwTP and sewage will thus be treated prior to discharge to surface waters. Additionally, it was assumed that connected industrial wastewater discharges would be in conformity with the national limits for discharge. Assuming that the aforementioned conditions are fulfilled, the net increase of BOD_5 concentration in the river due to municipal wastewater *during the dry season,* for the settlements identified to mainly affect the rivers quality will be as follows.

Comparison of BOD_5 concentrations in the rivers, with and without Phase 1 works for minimum river flows **Table 3.5.7**

Settlement	Receptor (Station code)	Net increase in BOD_5 of the river due to discharges from sewers (in mg/l)	
		Current	Completion of Phase I works
Kolasin	River Tara (T2)	6.64	0.49
Niksic	River Zeta (Z2)	396.00	13.56
Pljevlja	River Cehotina (C2)	26.48	1.59
Podgorica	River Moraca (M3, M5)	7.88	0.39
Rozaje	River Ibar (I1)	26.08	1.56

Consequently, the positive impact to surface waters will be significant, as the anticipated concentration from municipal wastewater discharges will be very low with **the exception of Niksic**, for which it will exceed the concentration of waters of "bad" quality in terms of BOD_5, (ie a concentration > 7 mg/l), but this is because of the low flow rate in the river. This positive impact is of particular importance, especially for settlements identified as currently affecting the quality of the receiving waters, i.e. Pljevlja and Rozaje.

Assessment of the positive impact from the implementation of **all the three phases of the Masterplan in 2029,** was also made. In terms of impact to the rivers, and with regard to the settlements for which the existence of monitoring stations close to their location allow for this estimate to be made, the following table is indicative of the anticipated impact. For purposes of comparison, "untreated" wastewaters for 2029, assuming discharge of the entire projected load to the river, i.e. the whole settlement served by sewerage network discharging directly to the river, was assessed.

The results presented in the table under the column "With WwTP", were based on the assumption that the whole settlement is served by sewerage network, connected with a WwTP, from where final discharge to the river will have a BOD_5 concentration of 20 mg/l. In other words, this referred to the situation after the works foreseen by the Masterplan would have been completed and would be fully operational.

Impact of wastewater discharges on river quality, with or without the implementation of the Masterplan, in 2029 **Table 3.5.8**

Settlement	River (Station code)	Average river flow		Minimum river flow (95%)	
		Net increase in BOD_5 of the river due to discharges from sewers (in mg/l)		Net increase in BOD_5 of the river due to discharges from sewers (in mg/l)	
		Untreated	With WwTP	Untreated	With WwTP
Andrijevica	River Lim (L2)	0.09	0.00	0.77	0.04
Berane	River Lim (L3)	0.59	0.03	4.33	0.20
Bijelo Polje	River Lim (L5)	0.61	0.03	4.08	0.18
Danilovgrad	River Zeta (Z3)	0.08	0.00	1.18	0.06
Kolasin	River Tara (T2)	2.21	0.10	22.15	1.04
Mojkovac	River Tara (T4)	0.22	0.01	2.58	0.12
Niksic	River Zeta (Z2)	4.10	0.20	242.11	12.31
Plav	River Lim (L1)	0.31	0.01	2.13	0.11
Pljevlja	River Cehotina (C2)	3.16	0.15	35.49	1.68
Podgorica	River Moraca (M3, M5)	0.76	0.04	11.60	0.53
Rozaje	River Ibar (I1)	4.58	0.21	51.16	2. 35

From the above table it is apparent how critical is the provision of biological treatment for the wastewater discharges of certain settlements, and for the time horizon considered (2029). The most critical settlements were:

- Niksic
- Rozaje
- Pljevlja
- Kolasin and
- Podgorica

The anticipated concentration of BOD_5 in River Zeta, during the dry season, from the discharge of Niksic treated effluent raises concern, as it was unacceptably high (estimated as 12 mg/l). This was due to the low flow rate of the river, which is insufficient in providing dilution of the discharged effluent. Thus, discharge of the treated effluent into either of the two adjacent irrigation reservoirs (Krupac or Slano) was recommended, especially for the dry season. This suggestion would also be in line with the anticipated “water reuse” foreseen by the “Hydro Economy of Montenegro Republic” for the Niksic area.

However, it should be emphasized that this approach does not allow for conclusions to be drawn for the settlements of Savnik, Zabljak and Pluzine.

With regard to Savnik and Pluzine, as the anticipated pollution loads are not significant and since there are no indications of them posing any environmental stress, it could be concluded that any positive impact will not be significant.

As far as Zabljak is concerned, the current outfall of the municipal wastewaters is a sinkhole in the limestone, from where raw sewage percolates into the karst. According to a study, said to have been carried out by the Geological institute, contaminated waters finally reach river Tara (NE direction, about 15 Km away), thus affecting its quality. However, due to the very low wastewater flow in the existing sewers of Zabljak, and the great distance, it seems unlikely that Zabljak could be causing any significant pollution of the River Tara.

3.5.9 Proposals for mitigation of impact from on-site sanitation on groundwater

These proposals were made in TM 3 and are reported in Section 3.7.5 below,

3.6 Industrial Effluents (TM 2)

3.6.1 Introduction

For the scope of this study, a Major Industries Survey was conducted, including site visits to 22 industries and one Hospital in Niksic known to pollute the River Zeta. During the survey, industrial wastewater management practices were observed and necessary data for estimation of pollution loads were collected.

Apart from the major industries visited, assessment of pollution loads from the remaining (non-major) industries located in the urban areas of the Project Area was also made.

Recommendations for the implementation of a sound industrial wastewater management strategy were put forward.

The Trade Effluent Agreement Model prepared by the parallel project concerning the preparation of the Masterplan for the Coastal Region of Montenegro, was reviewed and recommendations were put forward.

Finally, suggestions on pollution prevention and abatement were elaborated, on a sector basis, to cover all the water-intensive industries which are currently active in the Project Area.

The results of this work were used to design the proposed wastewater infrastructure, where it was necessary to accommodate also industrial effluents, and to assist in the prioritisation of the works for the three phases of the MP.

3.6.2 Methodology of industrial pollution loads estimate

One of the specific objectives of this task was to provide quantitative data of loads for the development of the Masterplan in Northern and Central Montenegro.

Extensive research and evaluation of information sources took place to identify Major Polluters and assess qualitative and quantitative data of industrial pollution loads; these sources were principally as follows:

- *Municipalities' responses* to the questionnaires sent for general information collection;
- *ViKs and communal enterprises;* data on water consumption;
- *Ministry of Agriculture*, through its Water Management Inspectorate, was consulted in the identification of major polluters in the Central and Northern region area of Montenegro;
- *Ministry of Industry*, provided a list of all industries in Montenegro as well as a document containing all companies included in the list for privatisation;
- *Ministry of Environment* and its project carried out by Finnconsult, assessing the Transposition of Environmental *Acquis* in Serbia and Montenegro who provided a preliminary list of the industries falling in Annex I of the IPPC Directive (96/61/EC)
- *Ecotoxicological Institute (CETI),* which provided useful information regarding major polluters of the area as well as some wastewater quality analysis results for some of the sites of interest.

Ad loc investigation during the visits to towns with industrial activity, as well as feedback from the team of experts that carried out the "Land Use Development" contributed also to the identification of industrial polluters within the project area.

Estimates of flows and loads for the major industries (see table below) were based on specific data collected during the Major Industries Survey (MIS).

Estimates of flows and loads for the non-major industries, located in urban areas of the Project Area, were made based on area factors, varying for low and high water consumptive industries (8 m^3/ha day and 30 m^3/ha day, respectively).

List of Major Industries (& Brezovik hospital) Table 3.6.1

Location	Factory or site	Activity	Final Receptor
Niksic	TREBJESA	Brewery	River Zeta
	ZELJEZARA NIKSIC	Iron and Steel	
	BREZOVIK	Hospital	
	GORANOVIC (two sites)	Meat processing and slaughterhouse (ex- Mesopromet)	
	AGROPRODUCT	Dairy factory	
	NEKSAN	Alcohol drink production	
	METALAC	Machinery, metallic tools production	
	MLIN MUSHREM ASOVIC	Grain mill products (corn)	
Pljevlja	TE PLJEVLJA	Thermoelectric plant	River Cehotina
	RUDNIK UGLJA	Coal mine	
	VELIMIR JAKIC	Wood processing, wood products	
Bijelo Polje	SPIRO DACIC	Wood processing, wood products	River Lim
	ECOMESO	Slaughterhouse and meat processing	
	VUNKO	Wool processing	
	ECOFLORA (formerly BUDIMKA)	Fruits processing and canning	
Berane	POLIMKA	Leather factory	River Lim
	A.D. BERANE	Wood processing, wood products	
	BEPANKA	Paper factory	
	ZORA	Dairy factory	
Rozaje	GORNI IBAR (wood processing)	Wood processing, wood products	River Ibar
	A.D. DEKOR	Printing and publishing	
Mojkovac	ELOKSIRANA BRAVARIJA	Aluminium frames	River Tara

For the **industries included in the MIS** the following data were collected, based on the questionnaires prepared for this purpose:

Quantitative data collected or assessed included:

- Area of the site
- Number of employees (currently and at full capacity)
- Production capacity and recent production
- Water consumption
- Wastewater quantity
- Wastewater qualitative characteristics (usually assessed, based on sector norms, as data availability was very rare)

Qualitative data:

- Type of activity and products
- Current operational status (e.g. working at reduced capacity or being in privatisation process etc)

- Means of wastewater pre-treatment on site (prior to discharge)
- Discharge point of wastewaters
- Final receptor of wastewaters (sanitary and industrial wastewaters)
- Plans for future modification of the production or the production capacity with consequences for the quantity or the quality of the wastewaters.

For the validation of the above collected data, a table was prepared where flow rates based on different estimates were presented. Comparison of the different estimates, allowed for a better approximation of the final flow rates used for the preliminary design of the wastewater infrastructure.

Estimates of wastewater flow rates in the table were made with three techniques:

- Data provided during the site–visit,
- Estimated flow rate based on area factor
- Use of normative rates for the industries, applying World Health Organisation norms,

In most cases, the "**worst case scenario**" principle was adopted for the flow rate estimates, i.e. the higher flow rate was recommended for design.

Peak flow rates were used for the design of wastewater infrastructure, and applied to the average daily flow rates presented in this text.

As flow rates had to be estimated for all the three time intervals of the Masterplan (i.e. for 2009, 2019 and 2029) **future projections** had to be made. Bearing in mind the current situation of industrial production, with much of it being either ceased or reduced, making future projections was a difficult task. It was presumed however that, the current situation is not sustainable and that industrial base will be rebuilt.

A site–specific approach was adopted, with the following points being the basis of the overall approach:

a. **Short term projections (2009**) - depending on the case:

   - projection was made based on information provided by the site for near–future plans for expansion of their capacity.
   - it was assumed that production level will return back to the "reference year", which is the last year for which the site was said to have some significant production
   - projection was made based on the current production, assuming an industrial growth rate of 2% or 2,8% (for industries with low or high growth potential, respectively) to be applied on the current wastewater flow rate 2004 or

b. **Long term projections (2029**) - depending on the case:

   projection was made based on information provided by the site for future plans for expansion of their capacity.

   the maximum of the four estimated flow rates (based on (i) production capacity or (ii) on questionnaire data or (iii) on area factor or (iv) on future projection applying the selected growth rate) was assumed.

   one of the aforementioned flow rates was selected, if the maximum flow rate was considered highly unlikely factor of 70% of the projected flow rate was assumed in many cases, due to improved water management practices that are anticipated to occur after 25 years and due to the fact that water consumption per unit of product in general decreases with the increase of production.

c. **<u>Mid term projections (2019</u>**) – was assumed to be the mean value of the two extremes, i.e. the short-term and the long-term projection, 2009 and 2029, respectively.

As **qualitative data on wastewater** was not available in most of the sites visited, due to limited monitoring of wastewaters, assumptions based on sector norms were made to estimate the quality of industrial wastewaters, whenever necessary. Estimated pollution loads were accordingly adjusted to the "actual" flow rates of each industry.

For **the industrial sites, not included in the MIS,** the following data was collected during the "Land Use Development" task and from several other sources:

<u>Quantitative data</u> collected or assessed included:

- Area
- Number of employees
- Water consumption data from the ViK (usually referring to flat rates)

<u>Qualitative data:</u>

- Type of activity

The following table summarises the assumptions made in estimating the hydraulic and the pollution loads, both current and projected in the future, for the non-major industries.

Summary of assumptions for industrial pollution loads Table 3.6.2
of non–major industries

Type of activity	Dry area factor Wet area factor	8 30	m^3/ha/day m^3/ha/day
For industry which **is** currently in operation	2029 2019 2009	100% 75% 50%	of wastewater estimate, based on area factor, depending on the type of activity
For industry which **<u>is not</u>** currently in operation	2029 2019 2009	100% 60% 20%	
BOD_5	Food industry or other sectors with high BOD_5 load Other sectors	500 300	mg/l mg/l
Sanitary wastewaters	Number of employees	40	l/employee day

3.6.3 General findings of Major Industries Survey

Data collected from the Major Industries Survey were processed in order to obtain, apart from quantitative data for the preliminary design of wastewater infrastructure, **qualitative findings with regard to industrial wastewater management**, in order to allow for recommendations on improvement.

General findings of the MIS conducted can be summarised as follows:

- **Working and Ownership status** - It is indicative that out of 22 sites visited only 12 were working and for half of them the production rate was less than 50% of their capacity. With regard to the ownership status, 10 out of 21 (TE Plant in Pljevlja excluded) were privately owned.
- **Water Usage – sources and consumption** - The majority of the sites visited, use only water provided by the ViK to cover their water needs, i.e. 15 sites out of 23 visited (22 industrial facilities and Brezovik Hospital in Niksic). Only 5 of the visited sites abstract surface water (from either the nearby river or from a reservoir constructed for this purpose). Regarding the quantity of water used, approximately 15 of the visited sites, were either not aware of it or they provided very approximate figures which were out of proportion with their production. Complaints for high charges by the ViK were received in Bijelo Polje and in Pljevlja.
- **Industrial Wastewaters – quantity, quality, pre-treatment and discharge** Regarding the quantities of wastewater produced, only approximate estimates could be given by the interviewees; self-monitoring of wastewater quality is very rare, as only 3 of the visited sites were said to monitor, or used to monitor, their wastewaters on a regular basis. Sampling and wastewater analysis, by a competent authority (Ministry of Agriculture or CETI), was reported to have been carried out at least once in the past in 9 of the visited sites and none of them reported having been fined for exceeding the relevant limits for discharge to either sewers or surface waters. Pre-treatment on site of the industrial wastewaters is applied in only 6 of the 23 sites visited and only in one case industrial wastewater was said to be fully pre-treated on site prior to discharge to surface waters. It is doubtful whether the type of pre-treatment applied in the other five cases, is adequate in order to meet discharge criteria to surface waters (which is the direct receptor in four of the five cases) or to the sewers. The types of pre-treatment reportedly used are: pH adjustment, screening and sedimentation. Regarding the discharge method reported to apply by the visited sites for the industrial wastewaters these are discharged to surface waters, mainly directly or after some pre-treatment in Berane, Bijelo Polje and Pljevlja while the situation is different in Niksic, where industrial wastewaters are discharged mainly to the town's sewerage network. This however is ultimately discharged without treatment to the River Zeta.

3.6.4 Industrial wastewaters – summary of the estimated pollution loads

The following table summarises the estimated quantity of industrial wastewater, as a percentage of the total amount of wastewater, per settlement.

In the total amount of wastewater, a percentage of approximately 10% of domestic wastewater is attributed to infiltration. The remaining is wastewater arising from domestic, industrial and institutional consumers. Total amount of wastewater refers to the central settlement of each municipality, including adjacent to it smaller settlements that are to be included in the Masterplan

Industrial wastewater as percentage of the total, per municipality Table 3.6.3

Municipality	Current Wastewater Production for 2003		Projected Wastewater Production for 2009		Projected Wastewater Production for 2019		Projected Wastewater Production for 2029	
	% Industrial	Total (m^3/day)	% Industrial	Total (m^3/day)	% Industrial	Total (m^3/day)	% Industrial	Total (m^3/day)
ANDRIJEVICA	5	372	14	316	22	390	27	468
BERANE	1	4255	21	3766	32	4577	40	5393
BIJELO POLJE	20	5426	31	4457	43	5837	51	7219
DANILOVGRAD	3	1454	5	1048	10	1196	13	1350
KOLASIN	4	1041	11	840	19	989	24	1142
MOJKOVAC	7	1459	17	1136	22	1253	25	1371
NIKSIC	21	18510	35	15331	36	15761	37	16056
PLAV	1	1369	2	983	3	1074	4	1172
PLJEVLJA	2	5469	5	3870	6	4090	8	4345
PLUZINE	0	643	0	443	1	462	1	480
PODGORICA*	19	41386	26	45706	38	34387	36	41126
ROZAJE	1	2510	6	1803	12	2021	17	2241
SAVNIK	2	165	7	123	13	134	17	143
ZABLJAK	0	645	4	527	11	612	16	701

Note – For Podgorica figures were retrieved from the "Podgorica WwTP feasibility study); the time horizons are as follows: 2001 (in 2003 column), 2011 (in 2009 column), 2021 (in 2019 column), and 2031 (in 2029 column)

It should be noted that the percentage of industrial wastewaters increases in most cases for the future projections. One of the reasons is the reduced water consumption assumed for the domestic and institutional users for the future. Specifically, current domestic wastewater production is typically 196 l/c.d, while for future projections this was assumed to be 120 l/c.d (with the exception of Niksic and Podgorica, where it was assumed to be 144 l/c.d). In addition, future projections for industries assumed that they will be gradually return to full operation, while currently many of them were either not in operation or they are working at very low production rates of their full capacity.

3.6.5 Industrial wastewater per settlement

In TM 2, data on industries included in the MIS and estimates for the non-major industries are presented and discussed, based on the completed questionnaires presented in Annex 2 of TM 2.

Cases of special concern were highlighted per settlement. In summary, these are:

- **Leather factory "Beranka" in Berane**, estimated to contribute with 7,000 PE (Population Equivalent, as BOD) out of 8,800 PE which is the total load originating from all the Berane industries included in the MIS
- **Wool factory "Vunko" in Bijelo Polje** (at the time of the site visit, operating only at reduced capacity), as well as the slaughterhouse Ecomeso and the Fruit Processing and Canning industry Ecoflora (currently not operating but expected to start operation in the near future) are/will be the major industries, estimated to generate 15,000 PE in 2009 and 46,000 PE in 2029, assuming

operation close to their design capacity. Of these loads, 7,000 (for 2009) and 36,000 (for 2029) are estimated to originate from “Vunko”.

- **Wood Impregnation industry “Sik Tara” in Kolasin** is known to be among the industries causing pollution to river Tara with phenols, creosote and mineral oils. The site was not included in the MIS as access was not granted.
- **The Jaloviste in Mojkovac**, where flotation mud from a currently abandoned mine was disposed, is still a special case of concern, in terms of environmental impact originating from industrial activities. A tender procedure from the MoEUP was known to be in progress, for the allocation of a project concerning the remediation of this Jaloviste in order to tackle the problem.
- The military owned facility of **“4th Novembar” in Mojkovac** caused recently significant pollution to river Tara due to an **accidental release of wastewaters.** The Ecotoxicological Institute (CETI) was called upon to investigate the incident and found out that high concentrations of cyanides, cadmium and magnesium were measured in the tributary of river Tara, Rudnica.
- The **Trebjesa Brewery in Niksic** estimated to generate currently a pollution load of 69,500 PE and 108,500 PE in the 2029, out of a current total industrial pollution load of 78,000 PE and a future projected of 127,500 PE. Apart from its significant contribution, approximately 90% of the total industrial load at Niksic, the Brewery is of major importance for the development of the Masterplan for Niksic, as it discharges untreated wastewaters to the town’s sewerage network, connected to the abandoned WwTP of the town, which would be overloaded if it was to be back in operation. The capacity of this plant, if rehabilitated, is estimated to be about 28,000 PE. However, a pre-treatment plant is planned for the brewery for construction in 2007 to 2008. This will be designed so that the effluent conforms to the current requirements for discharge to sewers in Montenegro, and the BOD concentration will be limited to a maximum of 500 mg/l. In this case the PE (organic) of the brewery will fall to about 37,000 PE).
- The **Brezovik Hospital in Niksic,** is known to pollute river Zeta with its wastewaters contaminated with pathogens. Currently, wastewater is discharged to a series of old septic tanks, most of them operating as infiltrations pits, while overflow during the rainy season is also quite common.
- The **Thermoelectric plant and the coal mines in Pljevlja** are of concern in terms of the environmental impact they cause to the broader environment of the Pljevlja valley.
- **KAP Aluminium Plant in Podgorica**, is also a well-known case of significant environmental impact. This factory, together with all other factories located in Podgorica was assessed by the parallel project, “Feasibility study for Podgorica WwTP”.

3.6.6 Trade effluent standards and Trade Effluent Agreement

One of the objectives of this project was to **review the Model Trade Effluent Agreement (TEA) suggested by the Wastewater Feasibility Study for the Coastal Region** of Montenegro, prepared by DHV. Following this review, comments and suggestions were forwarded to the Coastal Region project. The agreed Model Trade Effluent Agreement is presented in this chapter in order to produce a stand-alone document, for Central and Northern Region of Montenegro.

Most of the suggestions made during the review of the TEA were incorporated in the final document prepared for the Coastal Region. The ones not included are presented in TM 2.

Limits for discharge to sewers (i.e. **Trade Effluent Standards**) are part of a Trade Effluent Agreement. In order to define them, the current MAC (maximum allowable concentrations) in Montenegro, as defined in Regulation 10/97, were compared to both EU Directive standards and to commonly applied standards in other countries and found to be stringent for a number of parameters.

However, maintaining the existing standards was finally proposed, as it was considered to be a 'safe approach', for the situation as it is now and as it will be for at least a few more years (i.e. in the short term), whereby industrial wastewaters are practically discharged to natural recipients, without receiving any pre-treatment, as the sewers are not connected to WwTPs.

Amendment of some of the MACs should be considered in the future, in line with EU standards. The parameters for which amendment of the MACs were suggested are:

- Suspended solids
- COD (suggested to be an additional parameter)
- Lead
- Cadmium
- Total Chromium
- Hexavalent Chromium
- Iron
- Copper
- Nickel
- Mercury
- Tin
- Active chlorine
- Ammonium
- Cyanide
- Fluorides
- Sulphides
- Phenols

During the review it was also suggested **to consider allowing variation from individual MAC standards, provided that the total mass load of a pollutant is below a "case specific" limit.** This would be determined on a case-by-case basis, depending on the capacity of the WwTP and the type of industry, and would apply in cases whereby the industry would prove that it would not be economically feasible to meet the set standard.

The **Model Trade Effluent Agreement** together with **Guidance Notes** for its completion is presented in Appendix 3 of TM 2.

The Agreement is intended for use by the Operator of the Wastewater System in preparing a Trade Effluent Agreement with an Industry or a large user, such as an Institution or a hotel. The Guidance Notes on the Model Agreement are intended for the use of the Operator of the Wastewater System in the preparation of Agreements.

The Agreement is intended for industries which:

- Discharge more than 5m^3/d on average, based upon flows during the maximum week of discharge;
- Discharge trade effluent, which has the potential to cause problems with the operation and maintenance of wastewater treatment plants. This should be

based upon the list in Directive 96/61/EC (on Integrated Pollution Prevention and Control);

For industries that do not meet the above criteria then a more simple agreement (and a more simple tariff structure) is considered to be appropriate.

The Model Agreement includes the following sections:

Clause 1: **Introduction,** which includes the parties to and duration of the Agreement

Clause 2: **Definitions,** which apply in the Agreement, such as “prohibited waste”. More definitions could be introduced by the two parties as appropriate.

Clause 3: **Allowable waste to be discharged,** where location of discharge, maximum daily and hourly flow rates of discharge, time of discharges and quality requirements that should be met (MAC) are described and agreed herein.

Clause 4: **Prohibited Waste**, where types of wastewater that could endanger the efficient and safe operation of the WwTP or that could cause adverse damage to any of the assets are described and their discharge prohibited.

Clause 5: **Facilities to be provided by the Industry**, referring to necessary facilities to be provided by the Industry in order to ensure that the conditions agreed are observed. These include provision for manholes to allow for easy sampling of the discharged wastewaters, metering installation to verify the quantity of wastewater discharged and regular monitoring of the quality of wastewaters. Records of monitoring should be kept on site. Also provision for adequate pre-treatment facilities in order to meet the requirements of Clause 3 are defined.

Clause 6: **Records to be maintained by the Industry,** are described in this Clause. Templates of the forms to be completed are annexed to the TEA. These forms are the same as the ones required by the Regulation 10/97, so that involved parties are already familiar with them. There are five template forms:

- General Form (A) of the wastewater discharge,
- Form B-1 or B-2 for continual or batchwise discharge and
- Form C-1 or C-2 for analysis results of composite or individual daily samples.

The TEA will specify which of these forms the industry will have to complete and file. Frequency of monitoring could also be specified in the TEA. The dilution coefficient, as specified in the Regulation 10/97 could be the basis for determining the required frequency.

Clause 7: **Charges**, specifying basis on which charges will be made, and penalties in case of delayed payment. "Mogden formula” is suggested as basis for charges, taking into account the volume and the strength of effluent.

Clause 8: **Offences and Penalties**, to be applied in case of failure to meet the requirements foreseen in the TEA and particularly in Clauses 3 and 6.

Clause 9: **Appeals,** specifying that the Industry may appeal to the Operator within 21 days and in writing.

Clause 10: **Variations to the Consent**, specifying that the Operator may give a direction to vary the conditions of the TEA, but not earlier than 2 years from the date of the Agreement. Cases whereby exceptions can be made are specified in this Clause.

With respect to Clause 6, the Mogden formula is commonly used as basis for charges application. This formula, links charges for discharging trade effluent to the public sewer with the volume and strength of trade effluent discharged.

3.6.7 Proposed strategy for regulating industrial effluent discharge to public sewers

Following Strengths, Weaknesses, Opportunities and Threats (SWOT) Analysis to define strengths and weaknesses of the existing situation in regulating industrial effluent discharges, an Action Plan was put forward to implement a strategy for regulating industrial discharges, including among others the following:

- Completion of an industrial database, by extending with additional information the register that is currently under development
- Enforcement of existing legislation regarding sampling and monitoring, including ensuring that adequate pre-treatment of trade effluents is carried out
- Introduction of legislation (or other requirements) relating to Trade Effluent Agreements
- Determination of a method of calculating tariffs for industrial discharges
- Strengthening of the Competent Authorities with additional Human and Financial resources to enable them to implement a Wastewater Management Strategy

3.6.8 Industrial wastewater – recommendations on pollution prevention and abatement

The introduction of the TEA as a new control mechanism, would require additional expenditure, on behalf of industry, in order to comply with the imposed requirements.

Apart from "charges" that the industry will have to pay for discharging its wastewaters to sewers, based on volume and also possibly on strength of effluent, capital investment will be required in providing facilities to observe the requirements set by the TEA. These facilities would mainly be related to provision for "pre-treatment" on site and to monitoring of the discharged wastewaters.

In minimising these expenditures, an internal, Industrial Wastewater Management Scheme could be developed, which would investigate options to:

- **Minimise water consumption**, and consequently amount of generated wastewater. This would result in cost savings from imposed charges through the TEA, as well as reduced capital investment for pre-treatment facilities.
- **Minimise the strength of effluent**; this would result in less charges through the TEA and less expensive on –site treatment to comply with the MACs (regardless of the chosen discharge method, i.e. to the sewerage network or to surface waters).

Suggestions to achieve these two objectives are outlined in the TM 4. General options for reduction of industrial pollution loads are introduced first, followed by suggestions on pollution prevention and abatement, on sectoral basis, to cover all the industries which are currently active in the Project Area.

3.7 Impact of On-site Sanitation (TM 3)

3.7.1 Introduction

Details of groundwater pollution incidents and of the geology – hydrogeology of the Project Area were collected, especially parameters that could be used for the determination of the source of the groundwater contamination.

Such data was however limited due to the absence of a regular national programme of groundwater quality monitoring.

Micro-bacteriological contamination of groundwater can have either human or animal origins, hence comparisons were made with estimates of on-site sanitation facilities and average livestock densities, in an attempt to determine the prevailing source of groundwater pollution.

For the assessment of the potential impact of on-site sanitation facilities, the following criteria were considered:

- Population using on-site sanitation;
- Geological substratum and prevailing hydrogeology;
- Proximity to water supply sources, proven to be contaminated.

These criteria were applied to the main urban areas, and to rural areas with the additional criterion of average livestock densities.

To determine the potential for incidents of groundwater pollution an assessment of the geology and hydrogeology of the Project area was made, which was then correlated with the presence of on-site sanitation facilities.

For the quantification of the problem in terms of spatial distribution and severity, the evidence of contamination was compared with the hydro-geological conditions in the Project Area (depth of groundwater development, groundwater flow direction, hydro-geological connections between different areas etc), as retrieved from bibliographic references.

Proposals for the protection of groundwater from human sources in the areas where settlements exist, and where actual or potential groundwater contamination has been identified, are also described.

Remedial actions are suggested and described, based on the extent of contamination, the status of the on-site sanitation facilities and the existing geology – hydrogeology.

3.7.2 Geology and hydrogeology of the Project Area

The geology of Montenegro is complex and is dominated by karst terrains and is thus characterized by numerous surface and underground forms of karst relief.

The major part of Montenegro belongs to the High Karst Zone, which is very complex, and mainly consists of Mesozoic (Triassic, Jurassic and Cretaceous) limestone and dolomite of several kilometers of thickness. Reverse faulting and overthrusting, and thus repeating of carbonate series, has contributed to this great thickness.

In their hydro-geological characteristics, karst terrains generally differ greatly from other types of aquifers. The vast differences in water-yielding capacity of the constant and periodic karst springs point to the strong karstification of High Karst Zone limestone and dolomites.

The most numerous and biggest accumulations of groundwater are formed in areas of karst limestone formations. This water appears on the surface through numerous constant and periodic karst springs. It is estimated that minimal quantity that flows out from these accumulations is 15 m^3/s. A certain quantity of this water (3.36 m^3/s) represents the main source for public water supply in Montenegro.

Karst springs exist in all carbonate rocks from the Adriatic coast to the northeast border of Republic. Levels of underground waters are mostly a few hundred meters below ground level, except in areas of the narrow coastal zone, the depression of Skadar Lake, the Bjelopavlici plain and river valleys (canyons on the north of Montenegro).

The main springs for water supply are located in the central part of Montenegro. Karst aquifers are exploited in morphologically lower parts of the terrain, starting from Niksic field, including Zeta and Moraca valleys to the basin of Skadar Lake. These springs greatly contribute to the increase of the quantity of the springs in Cemensko field and Zeta valley. These valleys get water from surface and underground springs and the rivers of Moraca and Cijevna.

The number of underground spring can be also only approximately determined. Most of them are located in Zeta valley. The exploited quantity of these underground waters is 10 m^3/s.

3.7.3 Potential sources of groundwater pollution

General

The potential sources for contamination of groundwater in general, may be classified into the following groups:

- Concentrated sources of water pollution:
  - From population, tourism and some industries, where the wastewater produced is not treated;
  - From industries, mines, agricultural and similar surfaces, where the wastewater produced is not treated.
- Diffuse sources of water pollution:
  - As a result of runoff from urban, agricultural, livestock and other surfaces, as well as contamination from runoff of surfaces used for solid waste landfill.

The quality of the karst groundwater could also be influenced by the quality of the surface waters due to transfer of flow from one to the other.

Moreover, karst limestone's lack of natural purification results in the immediate transmission of pollutants to the groundwater bodies. Therefore, any pollution that takes place on or below the ground may result in the pollution of the groundwater table.

The main potential sources for <u>micro-bacteriological</u> contamination of karst groundwater in Montenegro are:

- Wastewater of human origin, including existing on-site sanitation facilities and leakages of the existing sewerage network of towns, located on karst formations,
- Wastewater from other pollution sources, mainly agriculture (intensive and free-range animal production)

Human sources of micro-bacteriological pollution of groundwater

The main source of human micro-bacteriological contamination of groundwater is probably on-site sanitation, although the interconnection between the surface water and underground waters means that the untreated wastewater from sewers which is generally discharged to rivers, could also contribute. This may be significant in the area to the south of Podgorica.

The distribution of population in the Project Area is described in Tables 3.2.1 and 3.2.2 above.

The average population density in the Project Area is 0.4 capita per hectare.

The villages tend to be rather small and they are widely dispersed.

On-site sanitation facilities in the Project Area

On-site sanitation facilities in the Project Area are exclusively individual "Septic Tanks". This term is used in Montenegro to describe "Infiltration Pits", typically with a volume of $9m^3$, with both walls and floor capable of percolation. Some retention of solids will occur with time, as solids reduce the percolation capacity, particularly as 75% of the pits are never emptied. Hence some of the functionality of a conventional (watertight) septic tank is attained.

A critical aspect in the successful operation of a conventional septic tank is the "treatment" afforded to the tank effluent by the adjacent soil. This treatment is due to filtration and to micro-organism activity in the soil and take-up of "effluent" by roots of plants. Some studies have measured BOD, TSS and COD removal rates of 75 to 90% in a depth of 1.5m of soil. The exact rate depends on the type of soil, and the absence of a water table in the soil. Clearly, the best position for the outlet from a septic tank is near ground level, to maximize the depth of soil unaffected by the water table. This is provided by a "conventional" (watertight) septic tank, which has an outlet approximately 0.5 m to 1.0 m below ground level. Infiltration pits transfer effluent to soil at the depth of the pit, typically 3 m to 4 m.

Utilization of on-site sanitation facilities in the Project Area

Sewerage systems are generally confined to the central areas (urban and suburban areas) of the main settlements so that parts of these areas, and all of the rural areas are all reliant on on-site sanitation. The use of on-site sanitation is described in Section 3.3.3 above. Overall, about 70% of the population without access to sewers has infiltration pits with the balance discharging wastewater directly to surface water or land.

Animal sources of micro-bacteriological pollution of groundwater

The only other sources of the micro-bacteriological contamination of groundwater, (besides humans), are animals.

There are no data concerning wild animals, but details of the numbers of farm animals are recorded in the 2003 Census and are presented in Table 3.7.1.

Coliforms (micro-bacteriological contamination) are roughly proportional to the BOD production of various species. Applying typical BOD production rates to the species above, and comparing these values to norms for humans results in Table 3.7.2.

Numbers of farm animals per municipality (2003 Census) Table 3.7.1

Municipality	Horses	Cows	Sheep	Pigs	Total
Andrijevica	452	2,112	3,377	910	6,851
Berane	953	7,167	13,196	2,817	24,133
Bijelo Polje	1,213	13,121	22,082	2,291	38,707
Danilovgrad	197	2,782	5,086	3,937	12,002
Kolasin	449	3,069	5,566	363	9,447
Mojkovac	396	2,883	3,350	368	6,997
Niksic	802	10,754	20,661	9,469	41,686
Plav	640	4,152	10,448	531	15,771
Pljevlja	565	12,537	21,150	804	35,056
Pluzine	310	3,213	9,775	240	13,538
Podgorica	448	7,408	9,874	9,695	27,425
Rozaje	76	5,886	6,509	131	12,602
Savnik	284	2,954	11,346	110	14,694
Zabljak	141	2,553	4,432	36	7,162
TOTAL	**6,926**	**80,591**	**146,852**	**31,702**	**266,071**

Ratio of animal BOD to human BOD per municipality (2003 Census) Table 3.7.2

Municipality	Total Animals	Population in rural areas without sewers (capita)	Ratio - Animals to Human (without sewers)	BOD ratio - Animals to Human (without sewers)	Approximate Rural Area (ha)
Andrijevica	6,851	4,244	1.6	7.1	28,208
Berane	24,133	16,534	1.5	6.1	59,504
Bijelo Polje	38,707	28,889	1.3	6.0	91,841
Danilovgrad	12,002	10,919	1.1	3.9	49,716
Kolasin	9,447	6,901	1.4	6.1	89,354
Mojkovac	6,997	3,739	1.9	9.6	36,449
Niksic	41,686	16,916	2.5	9.2	202,419
Plav	15,771	9,184	1.7	6.8	48,396
Pljevlja	35056	14,398	2.4	11.0	134,129
Pluzine	13,538	2,776	4.9	17.9	85,348
Podgorica	27,425	32,461	0.8	3.2	139,800
Rozaje	12,602	10,558	1.2	6.3	42,902
Savnik	14,694	2,370	6.2	21.1	53,279
Zabljak	7,162	2,241	3.2	14.5	44,401
TOTAL	**266,071**	**162,130**	**1.6**	**6.8**	**1,105,746**

Animal sources of micro-bacteriological contamination are thus a much more significant potential threat to groundwater than human sources.

3.7.4 Review of known cases of groundwater pollution

Very little hard evidence of groundwater pollution in the Project Area exists. The main sources were as follows:

- “Projection of long-term water supply in Montenegro” report;
- “Environmental Performance Review of Serbia and Montenegro” report, UNECE, 2002;
- “Water Quality Monitoring Results of Montenegrin Waters in 2002 ” report, Centre of Ecotoxicological Research in Montenegro (CETI);
- “Institution of Public Health”;
- An investigation into the operation of on-site sanitation in Golubovci and Tuzi;
- Miscellaneous sources.

The **“Projection of long-term water supply in Montenegro”** report cited the on-site sanitation facilities of some 40 villages as being the suspected cause of micro-bacteriological pollution in the water used for piped supply in the Project Area. However the origin of that pollution (animal or human) was not determined. On balance is seems to be unlikely to be of human origin because:

- The population of the suspected villages is generally small in comparison to the relatively large numbers of animals in the catchments
- Some springs exhibit continuous micro-bacteriological pollution, and others only do so intermittently. If the origin of this pollution was mainly from on-site

sanitation facilities, then it might be expected that this pollution would be more regular, although varying in concentration due to the changes in flow regime from the springs.

- Of the 20 springs identified as suffering from “increased micro-bacteriological contamination”, 5 of them (25%) have no villages in their catchments at all, and their pollution is definitely not of human origin.
- Given the Government policy, and social trend, towards increased agricultural production, it seems more likely that this pollution was caused by animals.

It seems therefore unreasonable to attribute increased micro-bacteriological contamination of groundwater to on-site sanitation.

The **“Environmental Performance Review of Serbia and Montenegro” report (UNECE, 2002)** stated that the quality of drinking water in Montenegro deteriorated between 1997 and 2000 with 25% of samples in 2000 below bacteriological standards. The report cites a survey conducted by the Montenegrin Institute of Public Health in 2001, which showed that, out of 194 private wells analysed in rural areas, 120 (62%) did not comply with bacteriological standards. The Institute were unfortunately unable to supply any details of this work. However, CETI offered the opinion that the pollution was minor and probably of animal origin. This report refers to <u>increased levels of micro-bacteriological pollution</u> (the worsening situation), and if this was due to on-site sanitation, then some increasing trend in their use would be expected. However, village populations are generally decreasing, and there have been no improvements in water supply or changes to on-site sanitation. Given the Government policy towards increasing agricultural production, it is more likely that the increased pollution is of animal origin.

The **“Water Quality Monitoring Results of Montenegrin Waters in 2002 ” Report** was conducted by the Centre of Eco-Toxicological Research in Montenegro, one of the foremost environmental laboratories in the Balkans. The report includes a section on groundwater quality of the Zeta valley. This area contains the major urban and industrial conglomeration of Podgorica, with a population of 140,000. Approximately 70,000 of this total are served by infiltration pits. This population being in excess of the full population of all the other towns in the Project Area, it would be reasonable to expect that any problems arising from on-site sanitation facilities would be more evident here than anywhere else, ignoring any other considerations. However, the groundwater in the Zeta valley was found to be in general of “high” to “good” quality and satisfy the required class of A2 for all the key parameters apart from NO_3 and total coliforms. Only one well, at Gostilj, of the nine examined exhibited Total Coliforms, beyond class for water supply. Such pollution could be attributed either to animals or to humans.

The **Institute of Public Health (IPH) data** comprised the following statement:

(1) The most polluted groundwater lies in the areas of Podgorica, Kolasin, Mojkovac and Andrijevica.

(2) Only two epidemiological episodes are attributed to pollution of groundwater as follows:

- In 1993, in Danilovgrad, there was an epidemical episode of bacillary dysentery, with over 1,000 of infected, due to the contamination of spring Oraska Jama.
- In 1994, in Pljevlja, about 100 people were infected by enterocolitis bacteria from the contaminated spring of Tvrdas water. Water from

this spring is only used when the water supply springs are unsuitable due to turbidity.

No qualitative data were provided by the IPH. Hence only two epidemiological episodes were attributed to pollution of groundwater since 1993, and, whilst they have been attributed to pollution of the source water, both incidents occurred “at the tap” and pollution could have occurred anywhere in the distribution system. Given the very high rates of leakage in the systems (generally 50% plus) then it may have been the case that other pollutant sources could have caused the contamination. This is of course conjecture. However, if on-site sanitation was causing significant pollution of water supply sources, it could be expected that more than 2 incidents in 11 years would have been recorded, especially as disinfection of potable water is not always carried out.

An **investigation into the performance of the on-site sanitation facilities in Golubovci and Tuzi** was undertaken, as these villages are the only two in the Project Area which apparently exceed the 2000 population threshold for sewerage suggested by the Urban Wastewater Treatment Directive (91/271/EEC), and are not part of a conurbation. Both villages are in Podgorica Municipality and lie in the flat plain between Skadar Lake and Podgorica. Although there are some small “more dense” communities in both of these areas, their average population densities are 1.73 and 3.06 capita per hectare respectively. Golubovci, unlike Tuzi, has no piped water supply system, and residents have individual wells on their land usually within 30 m of the septic tank (ie infiltration pit) for the house. Due to the proximity of Lake Skadar, groundwater levels in winter rise to about 2 to 3 m below ground level, and fall to about 6 m below ground level or lower in the summer. There were no problems with the operation of any septic tanks, and there were no reported incidents of cross-contamination of the wells by the septic tanks. People were worried by the industrial pollution from KAP and the pesticides attributed to Plantaze. For those reasons their priority was for a piped water supply system. In Tuzi, where the groundwater level is much deeper (of the order of 30 m) there were no reported problems with septic tanks or health. Tuzi does have a piped water supply system, and that supply is reported to be heavily chlorinated. Regardless of the lack of any health problems in Golubovci, the proximity of wells to septic tanks is a risk. But the best and cheapest way to eliminate that risk would be to construct a water supply system and not a sewerage system, and to leave the septic tanks in place.

Information from miscellaneous sources included the advice that wastewater pollution originating in Zabljak has been detected in the River Tara some 15 km away, which seems unlikely. Also mentioned were Podgorica ViK’s concerns that three sources for their supply system, which are surrounded by suburban areas of Podgorica which use on-site facilities, are at risk. And finally that the on-site facilities of the village of Dolac may be affecting one of the springs used for water supply in Berane. No qualitative data was available to support any of these propositions.

Summary

There is no doubt that there is micro-bacteriological pollution of groundwater, but this appears to be relatively minor, and, although this has been attributed to on-site sanitation in some cases, this is by no means certain.

Where increased levels of micro-bacteriological pollution have been reported (UNECE Report), it is unlikely that this is due to on-site sanitation as there have been no changes in the numbers of, or method of use of, those facilities, and therefore no reason for them to cause increased pollution. There is another, more probable, cause, and that is increased animal stocking densities.

The plain around Lake Skadar is where the greatest impact of on-site sanitation might be expected to occur, due to the proximity of Podgorica which has a concentration of people (of the order of 70,000) using on-site sanitation facilities. However, the quality of groundwater even here is reasonable from the perspective of pollution from on-site sanitation, with some exceptions. The evidence from Tuzi and Golubovci is that the on-site sanitation facilities work better than could reasonably be expected.

The very low population density of the Project Area means that pollution from human sources will be minimal. Given that pollution from animals is likely to be more significant, it is not worth considering replacing village on-site sanitation with sewerage systems. This would be very expensive, and at least 1300 Euro per capita.

Public health in villages can best be protected by provision of piped water supply systems, which is, in any case, what villagers want. This will be cheaper than installing sewers and will counter pollution from animals and the wider environment as well.

Water for potable supply for main settlements is generally sourced from upland springs and the risk of contamination of such sources from concentrations of population using on-site sanitation facilities does not arise. The main danger is where potable water is sourced from boreholes within main settlements, such as Podgorica. In such cases however it is planned to provide sewers, this being the objective for all main settlements. These main settlements are themselves widely dispersed, and it is not expected that any human micro-bacteriological pollution from one town would in any case affect the water supply of another town, regardless of respective elevations.

With regard to the development of new water supply sources for main settlements, it seems to be becoming necessary to abstract water from wells relatively near or even in the towns themselves, for example Podgorica and Niksic, to meet demand. This does increase the potential for on-site sanitation contamination to become more significant. However, is the development of additional supply capacity really necessary? The losses from all water supply networks are excessive, and a better strategy would probably be to repair the leaks and to use productively more of the water which is already captured, which tends to be from upland sources. In addition, it is expected that the demand for water will decrease once realistic tariffs (and a public awareness campaign) are introduced, and this will also decrease the need to develop “risky” water resources.

In fact, Montenegro is blessed with water of a quality which demands little or no treatment (although chlorination should always be applied). This situation is by no means the norm in the EU, where water treatment plants are practically universal.

These conclusions are however drawn on little hard evidence. Even were this evidence to suggest that there is a significant problem with pollution from on-site sanitation, it would still not be prudent to suggest providing sewers and treatment in villages; such a major investment would demand better justification.

Such justification can only come from a frequent and regular groundwater quality monitoring programme, and it is important to put such a programme in place soon, before the expected impacts from intensified agriculture (the increased use of pesticides and fertilizers etc) are felt.

It may be that careful analysis of the collected data from this future programme will reveal some isolated cases where development of sewerage systems in villages is necessary, although this is considered to be unlikely. A reactive, rather than proactive, programme of interventions to solve problems arising from on-site sanitation facilities is justified. In other words, it would be reasonable to only apply corrective measures to “defective” on-site sanitation facilities at such time that a substantial problem arises and can properly be attributed to on-site sanitation with hard evidence. TM 3 proposes a solution, the “conventional” septic tank described in Annex 3 of that report, which can be adopted, if the need arises.

3.7.5 Proposals

Urban and suburban areas

The main settlements contain the greatest concentration of on-site facilities, and thus pose the greatest potential risk to groundwater pollution.

The masterplan proposes that these areas be fully sewered by the year 2029, and all of these on-site facilities will then become disused.

The evidence to support interim measures to improve the on-site facilities in the short-term does not exist, and it is proposed that existing infiltration pits be retained.

The performance of on-site sanitation facilities would be improved by the construction of conventional septic tanks rather than infiltration pits. It is proposed therefore that any new houses built should be obliged to construct a conventional septic tank if no sewer is available. A design for such a septic tank is presented in Annex 3.

Rural areas

The Urban Wastewater Treatment Directive (91/271/EEC) does not require that settlements with populations of less than 2000 are sewered, and it is proposed that this strategy be adopted also for Montenegro other than for those settlements forming part of a natural conurbation around a main settlement.

The cost of providing sewerage systems in villages would be at least 1300 E/capita, which is neither economic, nor on the available evidence, necessary.

The overwhelming need of most villages is for the development of a reliable drinking water supply system, and scarce National resources would be much better employed in achieving this objective.

Whilst there is little construction of new houses in villages, it is recommended that conventional septic tanks be constructed.

Sanitary protection measures for the springs

Sanitary protection measures for the springs in the territory of Montenegro are not carried out in conformity with the requirements of Law (Regulation on the methodology for identification and preservation of the sanitary zones for the water intakes protection, and restrictions regarding these zones: Official Gazette of the Republic of Montenegro, No. 8/97).

According to the report “Hydro Economy of Montenegro Republic, 2001”, sanitary protection measures are regulated by municipalities and carried out properly in only 2 out of 25 local water supply systems. In 4 water supply systems, only some springs are protected, while in the remaining 19 there are no protection measures at all.

Karst characteristics of terrains have a bad influence on protection conditions, because massive, fissured rock has a low auto-purification ability and polluted water can easily pass through it. Incomplete protection measures are established on the 2/3 of springs used for Water Supply and on only 24 springs are those measures regularly carried out (fence around the entrances, clean terrain etc). Incomplete protection means that a spring has inappropriate fence or has only part of it, unclean terrain, small protection zone etc.

The levels of micro-bacteriological contamination that have been recorded are only of any consequence to groundwater in so far as it is used as a source of drinking water. Simple chlorination of the supplied water would be enough to eliminate the contamination and this would both have other benefits, and be a cheaper solution than remediating on-site sanitation facilities.

Therefore it is proposed to establish sanitary zones for all the water supply sources (springs) within the Montenegro territory, and to apply disinfection (by means of chlorination) to all water used for water supply.

Groundwater quality monitoring programme

Currently, there is a lack of a comprehensive quality groundwater monitoring programme in Montenegro. It is important to put such a programme in place soon, before the expected impacts from intensified agriculture (increased use of pesticides, fertilizers etc) are felt.

Therefore it is suggested to establish and implement a thorough, detailed and regular quality monitoring programme of water used for water supply.

Groundwater remediation

The main remedial works for a contaminated karst aquifer is the removal of the pollution source; the low retention capacity of the system means that any pollution already present is rapidly flushed out.

Therefore, taking into consideration the current situation of the on-site facilities in Montenegro and the assessment of potential impacts of the on-site sanitation facilities, no further remedial works are suggested.

4. DESIGN CRITERIA (TM 7)

4.1 Background

The main design and planning criteria used in the development of the Masterplan are set out in TM 7, the "Planning and Design Guidelines Manual".

The ToR for this project required that the equivalent manual produced for the sister project "Wastewater Feasibility Study – Coastal Region" be considered in the production of this document. As the two projects together describe the wastewater infrastructure requirements of the whole of Montenegro for the next 25 years, it was desirable that the manuals be identical as far as possible. Consequently there was a collaboration with consultants responsible for the sister project – DHV Water and Fidelco FG – in the early stages of this project, and the Coastal Region version of the manual was subsequently published in February 2004.

This manual is the Northern and Central version of that work, and has been tailored to the Project Area by the following modifications:

Chapter 2	Population data relating to the Northern and Central Regions have been substituted for those of the Coastal Region
	Ditto water consumption data
	Ditto specific industrial wastewater production data
	Peak flow factors described in more detail
Chapter 5	Design criteria for a septic tank have been added
Chapter 6	Effluent standards of European Directive 91/271 (Urban Wastewater Treatment Directive), proposed for adoption for Montenegro are presented
	A preliminary classification of sensitive receptors in the Project Area has been added.
	Different wastewater treatment processes have been proposed, and criteria for these processes have been added
	The proposed treatment options for the Northern and Central Regions have been described in tables and as schematic drawings.

The Chapter on Marine Outfalls has been omitted, and some changes in the way the data is presented have been made.

The contribution of the Coastal Region Project to this work is nevertheless appreciable, and the assistance of DHV Water/Fidelco FG is gratefully acknowledged.

4.2 The purpose and structure of the Planning and Design Guidelines Manual (TM 7)

The Manual is intended as a tool for "Planning and Projects Units" in the Wastewater Utilities and is to assist such Units in overall planning of wastewater development and in managing third parties (Consultants and Contractors) that carry out study, design or construction contracts.

The Manual intends to provide a broad overview of technical aspects of planning and design of wastewater infrastructure, without pretending to be a design manual for any specific component of such infrastructure. Where appropriate, reference to other reports and documentation prepared as part of the Study, and to existing guidelines, standards and legislation is made. And when relevant, comments on existing design standards are given.

The Planning and Design Guidelines Manual covers all aspects of sewerage and wastewater and sludge treatment, together with disposal, reuse of sludge and effluent and is structured in six sections (Sections 2 to 7) plus one annex as follows:

Section 2	Sewage Flows
Section 3	Sewers
Section 4	Sewage Pumping Stations
Section 5	On-site Sanitation
Section 6	Wastewater and Sludge Treatment
Section 7	Sludge Utilisation and Disposal and Effluent Reuse
Annex 1	Wastewater and sludge treatment planning and design guidelines by discipline.

The Manual presents:

- Design parameters, guidelines and standards (for example for wastewater treatment). The guidelines are presented in the form of issues to consider in the design (as discussed below);
- Design options (for example different methods of wastewater treatment);
- Proposed treatment variants for the Northern and Central Regions
- Issues to consider in the design and operation and maintenance (including health and safety) of the various infrastructure.

In compiling the Manual four main references were used:

- The PDGM as developed by the sister EAR Project for the Coastal Region of Montenegro
- Planning parameters that are typical for the Project Region and that have been developed and used in the Wastewater Feasibility Study for the Coastal Region, and in the Preparation of a Sewerage and Wastewater Strategic Masterplan for North and Central Region. This concerns primarily criteria that determine sewage flows.
- Existing National regulations regarding wastewater management.
- International documentation such as textbooks, reference guides, project references and the consultants' own experience with regard to planning and design of wastewater infrastructure.

Details of the application of these criteria are set out in TM 8, and in the following section, Section 3.9.

5. THE PROPOSED PROJECTS AND THEIR PRIORITIZATION (TM 8 AND 10)

5.1 Background

The future wastewater and sanitation requirements for the main population centres are described in TM 8, and their prioritization in TM 10, and both are summarized in this section.

The methodology used to determine the wastewater infrastructure uses data from several other Technical Memoranda, particularly TM 2, TM 5 and TM 6, and summaries of key data are included in TM 8, especially flows and loads.

5.2 Objectives of the Future Wastewater and Sanitation Requirements Task

The general objective of this task was to predict the future needs for Wastewater and Sanitation facilities in the main population centres i.e. Andrijevica, Berane, Bijelo Polje, Danilovgrad, Kolasin, Mojkovac, Niksic, Plav, Pljevlja, Pluzine, Podgorica, Rozaje, Savnik, Zabljak over the planning period 2004 to 2029.

The primary objective of this task was defined by Section 4.2.6 of the ToR, as follows:

- Predict the future needs for wastewater and sanitation facilities in the region's **main population centres** over the planning period (2004 to 2029).

Section 4.2.8 of the ToR requires that:

- Waterborne sewers and wastewater treatment facilities or where waterborne sanitation is not found feasible, as an alternative, appropriate on-site sanitation systems shall be recommended, for **all settlement centres** within the Study Area.

Thus, these two clauses mean that all settlements in the Project Area are included in the study, and Appendix B of the ToR (which forms Annex 1 of this report) makes recommendations on the phasing of a very ambitious programme of works to achieve the objective of appropriate sanitation for the whole of the Project Area by the year 2029. This programme was to be elaborated in three phases:

- Phase 1: 2004 to 2009 – full sewerage and treatment plants for all urban centres and major villages, plus 50% of villages, plus 30% of smaller settlements (on-site sanitation to be used where waterborne sewers are unfeasible)

- Phase 2: 2009 to 2019 – full sewerage and treatment plants (or on-site sanitation) to 50% of villages, plus 40% of smaller settlements

- Phase 3: 2019 to 2029 – full sewerage and treatment plants (or on-site sanitation) to the balance (30%) of smaller settlements.

The order in which these projects are to be undertaken was to be determined separately in a prioritisation task.

A clear understanding of the demographics of the Project Area (TM No 6 refers), and a study of the available evidence of the performance of existing On-Site Sanitation

(TM No 3) has allowed these objectives to be modified to accord more closely with a reasonable level of expenditure for the country as a whole.

Chapter 2 of this Masterplan describes the modifications made to these objectives and the strategic approach finally adopted.

5.3 Design data

5.3.1 Maps

The mapping used in the design of the sewerage system was as follows:

- Topographic maps
- Land-Use maps
- Contours and spot levels
- Existing sewers maps

5.3.2 Population Data

Population data for sewerage design

In order to ensure that the proposed sewerage design will remain adequate for the entire service life of the sewers, and will be able to cope with envisaged densification of urban areas, saturation population densities were estimated.

Population and Land Use are described in detail in Technical Memorandum 6 "Land Use, Population Estimates and Water Demand". Saturation densities for every town/conurbation per municipality can be obtained from Figures 3.1 – 3.27 of this TM.

Population data for WwTP design

Whereas the spatial distribution of population is important for network design, only the total population of the catchment is necessary for treatment plant design.

The population data for the two target years of 2019 and 2029 are based on the current (2004) land use population data projected for the relevant periods i.e. 15 and 25 years.

5.3.3 Existing Sewerage infrastructure

General observation for sewers O&M regime

A full description of the current O&M regime of the existing sewer networks is included in TM 5.

Retained, Replaced and Abandoned Sewers

The assessment of the existing sewerage system condition, was based on the recorded data for the sewers and the O&M regime, the hydraulic capacity, sewer inspections (manhole inspections) and the experience of the local operations and maintenance staff.

The existing sewers have been divided into three categories; (a) to be replaced, (b) to be abandoned and (c) to be retained, according to their current condition, characteristics and utilisation in the proposed sewerage network.

Existing WwTPs

There are two formal WwTPs in the Project area, at Podgorica and at Niksic. Others were planned but never built (existing sewers have therefore been directed towards a planned site).

The treatment plant at Niksic has been abandoned and all the Mechanical and Electrical equipment has been removed. We understand that it was built in the 1970's and ceased to function in about 1990.

The old treatment plant in Podgorica is still being operated, although it is severely overloaded, having been built for a population of 55,000, and now receiving flow from about 80,000 population. The rehabilitation of the old plant in the short term, and the construction of a new plant in the medium term are planned.

Existing on-site sanitation facilities

On site sanitation facilities i.e. septic tanks are a common means of wastewater disposal in the Project Area. Septic tanks are widely used in the rural areas and are also used in parts of the main towns.

The performance of the septic tanks has been investigated under Technical Memoranda No 1 “Household Survey” and No 3 “On-Site Sanitation”. No major incidents of septic tank flooding have been reported.

5.3.4 The Planning and Design Guidelines Manual

The manual is intended as a tool for “Planning and Projects Units” in the Wastewater Utilities and it provides a broad overview of technical aspects of planning and design of wastewater infrastructure. The Planning and Design Guidelines Manual, which forms Technical Memorandum No 7 and has been described in Chapter 4 of this report, covers all aspects of sewerage and wastewater and sludge treatment, together with disposal, reuse of sludge and effluent.

5.4 Sewer design methodology

5.4.1 Design criteria main aspects

All sewers have been designed to receive only foul wastewater together with any associated extraneous flows.

The retention of existing sewers in the future systems was a design objective, and this resulted in a relatively low construction cost for the initial phase of the Project.

The most economic routes among the available alternatives were sought by aiming for short sewer lengths and fewer pumping stations.

The proposed sewer layouts were discussed with the local ViKs/CEs in each municipality during the Public Consultation Process, and any suggestions were taken into account in the design.

5.4.2 Construction details

Sewers

The basic principles for the construction of the proposed sewer networks are presented in this section.

The minimum pipe diameter for all new foul sewers is 200 mm. It was therefore proposed that all sewers with diameters less than 150 mm will be replaced in the Phase 1 scheme, and all 150 mm diameter sewers, except for cases where the discharge capacity is not adequate for Phase 1 flows (which will mean replacement in Phase 1), will be replaced in the Phase2/3 schemes.

The proposed materials for sewers are PVC (according to DIN 19534, ISO DIS 4435) for sewer diameter up to 500 mm and concrete for diameters greater than 500 mm.

The minimum cover for sewers will be 1.2 m, while the maximum depth to invert will be 6.0 m.

A typical detail of the sewer trench is presented in Drawing TD 01.

Manholes

A typical manhole detail is presented in drawing TD 02. Two different designs have been adopted - one for depths to soffit less than 3.0 m and one for depths up to 6.0 m.

5.4.3 Sewer design procedure

Existing sewerage networks

The existing sewerage layouts for each conurbation were mapped (TM No 5 refers) and catchment areas for segments were determined with the aid of the contour drawings. The various catchment areas consist of different land uses thus producing different amount of wastewater. The catchment area of the existing sewer networks is presented in Figures 5.1.1 to 5.1.13 for every municipality.

Domestic wastewater flows were determined by assessing the saturation population densities of the residential areas in the catchments, and multiplying the resultant population by the water consumption and return-to-sewer ratios. Peak flows were determined by multiplying by calculating the total population connected upstream of the segment and calculating the peaking factor.

Institutional/commercial and industrial land uses were considered as point sources of wastewater discharging in the relevant nodes of the network and were thus added to the rest of the wastewater flows (for both average and peak flow cases).

Infiltration and inflow has been accounted on every sewer as a percentage of the average flow as described in TM 7 (Section 2).

The adequacy of the existing sewer network was then checked. As noted in TM No 5, longitudinal profiles of the existing sewers do not exist. Consequently an approximate assessment of sewer capacity was made by assuming that the gradient would always be sufficient for a normal minimum flow velocity to be attained under pipe-full conditions, in this case 0.75 m/s.

Where sewers were found inadequate to convey the corresponding flows they have been planned to be replaced with sewers of an appropriate diameter. Also sewers that fall into the “Replaced sewers” category for Phase 1 were also proposed for replacement.

Future sewer networks

The procedure for determining the flows into the future sewer networks is the same as described above for existing sewers.

However, only primary sewers were determined in this way, and secondary sewers were determined on an areal basis (using a sewer density in the range of 100 to 200 m per hectare).

Contour and spot elevation data were used to plan the sewers with the objective of making as much as possible of the system flow by gravity. However some pumping stations proved necessary. All proposed sewers fulfill the maximum and minimum velocity criteria set out in the Planning and Design Guidelines Manual.

5.5 Pumping station design methodology

5.5.1 General

A typical PS design concept is presented on Drawing TD 03 of TM 8.

There are approximately 40 wastewater pumping stations envisaged for the Project Area by the year 2029 (the inlet pumping stations at WwTPs are excluded from this number).

All of them except for two have a duty capacity of less than 166 m^3/hr (46 l/s), the majority of these being less than 50 m^3/hr, and submersible pumping stations are planned for all of these applications, with one duty and one standby pump.

The two largest stations have duties of 224 m^3/hr (62 l/s) and 1089 m^3/hr (303 l/s). The former is planned to be a submersible pumping station with 2 duty and 1 standby pumps, and the latter a wet well/dry well station with 3 duty and 2 standby pumps.

5.5.2 Submersible pumping stations

For all pumping stations with two installed pumps, the wet well has been assumed to be circular and 3m in diameter. This diameter is dictated by the required separation between the pumps to stop cavitation/vortices, and could be reduced marginally for the smallest pumping stations. However it is desirable to be able to standardise the designs as much as possible. Where three installed pumps have been planned, a diameter of 4.5 m has been assumed.

5.5.3 Conventional wet-well/dry-well pumping stations

The option of using submersible pumps mounted in a dry well has been adopted for these pumping stations.

The station and thus the wet well are rectangular. The dimensions of the wet well are dictated by the required separation between the pumps to stop cavitation/vortices, and the need to provide an active sump volume sufficient to limit the number of starts per hour of each pump (in this case 10 starts per hour). This has resulted in a wet well 7.5 m x 3.5 m in plan, with an active sump depth of 1.0 m.

5.6 WwTP design methodology

5.6.1 Process Selection

The following parameters have been taken into account for the proposed processes to be used for the WwTPs for the Northern and Central Regions:

- Construction cost
- Operational cost
- Upgrade of the treatment processes

- Local climatic conditions
- Industrial flows and pollution loads
- Sludge processing
- Environmental impact: The treatment method selected needs to be friendly to the surrounding environment, minimizing the nuisance that can cause (odor, noise, visible pollution etc);
- Standardization of the treatment plants throughout the project area.

Furthermore, in Section 6 of TM 7 the main planning considerations and design parameters for WwTPs are presented and have been used for the selection below.

5.6.2 Preliminary Treatment

The selection of the pre-treatment process for the various plants was based on the plant capacity.

For treatment plants with a Hydraulic PE <6,000, the following pre-treatment regime was selected:

- Mechanical Screens (One screen for each flow stream)
- By – pass channel with manual screen
- Horizontal grit channel
- Flow measurement – Parshall Flume

For treatment plants with a Hydraulic PE > 6,000, the following pre-treatment regime was followed:

- Mechanical Screens (One screen for each flow stream)
- By – pass channel with manual screen
- Double Aerated Grit / Grease removal
- Flow measurement – Parshall Flume

5.6.3 Primary Treatment

For the Rotating Biological Contactor (RBC) plants, the Imhoff tank system was selected for primary treatment.

For plants using secondary treatment process with Conventional Activated Sludge, conventional primary settlement tanks were proposed – very large Imhoff Tanks would have been required and these plants are large enough to justify appropriate separate sludge treatment.

5.6.4 Secondary - Biological Treatment

The selection of the secondary treatment process was as follows:

- For small installations with < 6,000 Hydraulic PE, the **RBC** units were chosen for both the technical and economic advantages over the other possible processes.

- For installations that serve populations >6,000 Hydraulic PE and <60,000 Hydraulic PE the applicable processes were the Extended Aeration, SBR, Oxidation Ditch and Trickling Filter. The SBR system and the Trickling filter were rejected. Hence for plants <20,000 Hydraulic PE, **Extended Aeration** is proposed and for >10,000 Hydraulic PE, the **Oxidation Ditch**.

- Finally, for the largest treatment plants (hydraulic PE >50,000), **Conventional Activated Sludge** systems have been proposed, which are reliable in their operation and viable for the size of the installation

5.6.5 Tertiary Treatment:

TM No 4 determined that the receptors of Niksic, Pljevlja and Rozaje should be considered as sensitive. Apart from organic matter removal and nitrification of ammonia, nutrient removal (nitrates and phosphates) is also provided at the plants proposed for those conurbations.

Also chlorination tank as disinfection is provided for all the treatment plants.

5.6.6 Sludge Treatment:

To treat secondary sludge, which is stabilized, or primary sludge from septic tanks, the sludge treatment process is:

- Gravity thickener
- Storage tank
- Mechanical Dewatering

When primary sludge is not stabilized, then digestion is required. The sludge treatment process is the following:

- Gravity thickener for primary sludge
- Anaerobic digester
- Mixed – gravity thickener for primary and secondary sludge
- Mechanical Dewatering

The following table summarises the proposed biological treatment options for WwTPs.

Proposed biological treatment options for WwTPs Table 5.1

Option	Typical range of flow
RBC	1,000 to 6,000 PE (150 m^3/d to 900 m^3/d)
Extended Aeration	6,000 to 20,000 PE (900 m^3/d to 3000 m^3/d)
Oxidation Ditch	10,000 to 60,000 PE (1500 m^3/d to 9000 m^3/d)
Conventional A.S.	50,000 PE and above (7500 m^3/d and above)

5.6.7 Modularization of WwTPs

Wastewater treatment plants are usually designed with a number of parallel modules or streams so that parts of the treatment plant can be shut down for maintenance and so that additional modules can be added to accommodate increases in flow to treatment as the sewer networks are expanded.

The concept of modularisation is usually applied to primary treatment and biological treatment (including final settlement).

For all but the smallest treatment plants, two modules in parallel are normally provided as a minimum, and this has been applied in the planning of the plants in the Project Area, where only Savnik has been designed as a single module.

On the other hand, too many parallel streams are also to be avoided, and a maximum of three have been used in the planning as in Niksic.

Therefore it is planned to develop a modular approach to the sizing of the treatment plants in line with the regional nature of the masterplan. Hence the streaming (parallel flow paths of divided flow through the plant) and capacities of those streams have been selected to try to achieve common dimensions and common mechanical and electrical equipment across the Project Area. This has many advantages, in particular the simplicity of servicing the equipment, reduced stockholding of spares, interchangeability of staff in emergencies, reduced design costs, economy of construction and so on.

5.6.8 Development of flows for treatment

Two stream WwTPs

For WwTP plants where two streams are proposed for the full plant, the design target year for each stream is generally 2019 and 2029 respectively, ie only one stream per plant is to be constructed in Phase 1. However, for Pljevlja both streams are to be constructed in Phase 1. The capacity each stream is identical. Phase 1 of the plant is adequate to treat the flows arising from the existing sewers up to 2019 without being underloaded or overloaded to the extent that the efficiency of the plant is affected adversely (additional secondary sewers have been planned for Phase 1 where necessary to prevent underloading).

Three stream WwTPs

In Bijelo Polje, in Niksic and in Zabljak WwTPs with three streams have been proposed and construction of two out of the three streams has been proposed for Phase 1 with the construction of the remaining one in Phases 2/3.

One stream WwTPs

In Savnik only one stream is proposed capable of treating the flows up to 2029.

The following table presents the proposals for the treatment plants for each town/conurbation. The proposals are based on the development of flows, on the modularisation concept for the plants, and the process selection.

Type of WwTP and number of modules for each municipality **Table 5.2**

Municipality	Pre-treatment	Primary Treatment	Secondary Treatment	Tertiary Treatment	Sludge Treatment	Number of modules at full development
ANDRIJEVICA	Mechanical Screens, grit removal (simple), flow- meter	Imhoff Tank	RBC	Disinfection	Gravity Thickening - Mechanical Dewatering	2 x 2.150 Hyd. PE
BERANE	Mechanical Screens, grit - grease removal (aerated), flow-meter	-	Oxidation Ditch	Disinfection + N Removal	Gravity Thickening - Mechanical Dewatering	2 x 20.000 Hyd. PE
BIJELO POLJE	Mechanical Screens, grit - grease removal (aerated), flow-meter	-	Oxidation Ditch	Disinfection + N Removal	Gravity Thickening - Mechanical Dewatering	3 x 20.000 Hyd. PE
DANILOVGRAD	Mechanical Screens, grit - grease removal (aerated), flow-meter	-	Extended Aeration	Disinfection + Nutrient Removal	Gravity Thickening - Mechanical Dewatering	2 x 6.000 Hyd. PE
KOLASIN	Mechanical Screens, grit - grease removal (aerated), flow-meter	-	Extended Aeration	Disinfection	Gravity Thickening - Mechanical Dewatering	2 x 6.000 Hyd. PE
MOJKOVAC	Mechanical Screens, grit - grease removal (aerated), flow-meter	-	Extended Aeration	Disinfection	Gravity Thickening - Mechanical Dewatering	2 x 6.000 Hyd. PE
NIKSIC WwTP 1 (North Region)	Mechanical Screens, grit - grease removal (aerated), flow-meter	Primary Settlement Tank	Conventional Activated Sludge.	Disinfection + Nutrient Removal	Anaerobic Digester - Gravity Thickening - Mechanical Dewatering	2 x 37.000 Hyd PE + 1 x 22.000 Hyd PE
NIKSIC WwTP 2 (South Region)	Mechanical Screens, grit - grease removal (aerated), flow-meter	-	Extended Aeration	Disinfection + Nutrient Removal	Gravity Thickening - Mechanical Dewatering	2 x 8.000 Hyd. PE
PLAV	Mechanical Screens, grit - grease removal (aerated), flow-meter	-	Extended Aeration	Disinfection	Gravity Thickening - Mechanical Dewatering	2 x 6.000 Hyd. PE
PLJEVLJA	Mechanical Screens, grit - grease removal (aerated), flow-meter	-	Oxidation Ditch	Disinfection + N Removal	Gravity Thickening - Mechanical Dewatering	2 x 20.000 Hyd. PE
PLUZINE	Mechanical Screens, grit removal (simple), flow-meter	Imhoff Tank	RBC	Disinfection	Gravity Thickening - Mechanical Dewatering	2 x 2.150 Hyd. PE
ROZAJE	Mechanical Screens, grit - grease removal (aerated), flow-meter	-	Oxidation Ditch	Disinfection + N Removal	Gravity Thickening - Mechanical Dewatering	2 x 10.500 Hyd. PE
SAVNIK	Mechanical Screens, grit removal (simple), flow-meter	Imhoff Tank	RBC	Disinfection	Gravity Thickening - Mechanical Dewatering	1 x 1.300 Hyd. PE
ZABLJAK	Mechanical Screens, grit removal (simple), flow-meter	Imhoff Tank	RBC	Disinfection	Gravity Thickening - Mechanical Dewatering	3 x 2.150 Hyd. PE

Notes

1. The town of Gusinje in Plav Municipality was a late addition to the proposed projects and does not appear in the above table. The WwTP is however identical to that of Andrijevica.

5.7 Summary of the proposed projects

The proposed projects for each town or conurbation were developed in accordance with the above principles and overall strategy and are described in detail in TM 8, and the GIS. These works are the "Base Case", that is the necessary works ignoring affordability and priority.

A summary of the proposed works per town/conurbation and per phase is presented in the following table.

Summary of the proposed works per phase Table 5.3

Town/ conurbation	Phase 1				Phase 2/3			
	Primary sewers (m)	Secondary sewers (m)	PSs (No)	WwTPs Streams x PE	Primary sewers (m)	Secondary sewers (m)	PSs (No)	WwTPs (PE)
Andrijevica	589	140	1	1 x 2,150	3,803	9,780	2	1 x 2,150
Berane	1,733	3,000	2	1 x 20,000	12,159	59,058	1	1 x 20,000
Bijelo Polje	4,803	1,624	3	2 x 20,000	9,094	63,581	5	1 x 20,000
Danilovgrad	2,321	315	2	1 x 6,000	5,070	53,790	4	1 x 6,000
Kolasin	1,857	5,595	1	1 x 6,000	5,270	8,430	4	1 x 6,000
Mojkovac	845	1,624	-	1 x 6,000	7,374	34,096	3	1 x 6,000
Niksic								
North	1,192	2,571	-	2 x 37,000	9,881	71,849	3	1 x 22,000
South	-	-	-	-	10,694	107,070	-	2 x 8,000
Plav	3,173	500	-	1 x 6,000	8,544	15,596	3	1 x 6,000
Plav - Gusinje	50	-	-	1 x 2,150	461	4,276		
Pljevlja	6,354	500	-	2 x 20,000	4,381	8,830	4	-
Pluzine	678	250	-	1 x 2,150	1,206	1,780	1	1 x 2,150
Podgorica	6,400	-	-	2 x 2,700 m^3/h	41,500[1]	415,090	6 [2]	1 x 2,700 m^3/h
Rozaje	3,624	2,360	1	1 x 10,500	3,612	21,240	2	1 x 10,500
Savnik	20	-	2	1 x 1,300	980	2,505	1	-
Zabljak	576	470	-	2 x 2,150	8,712	3,040	1	1 x 2,150
Totals	**34,215**	**18,949**	**12**		**506,242**	**880,011**	**34**	

Notes

1. The rehabilitation of the existing treatment plant at Podgorica is not shown in the above table, but is to be included in the proposed projects.

2. The cost of the primary sewers in Podgorica was estimated as a percentage of the secondary sewers cost (19.2%). In terms of length, they are assumed to be about 10%.

3. All Podgorica PSs are assumed to be developed in Phase 2. The cost of these stations was estimated as a percentage of the secondary sewers cost (4% equivalent to 560,000 Euro) but the number of stations was not established accurately. They are not required on the main conveyors however, and will therefore be relatively small submersibles. On this basis, 560,000 Euro is the equivalent of about 6 PSs.

4. The town of Gusinje in Plav Municipality was a late addition to the proposed projects and has been included in the above table, which therefore differs slightly from the equivalent table (Table 0.3) in TM 8.

5.8 Prioritisation and Ranking of the Programme (TM 10)

5.8.1 Introduction

The **aim** of TM 10 was to prioritise the works proposed in the Masterplan, to assist decision makers in the event that available funds are inadequate to complete all the works as planned.

The **specific objectives** to accomplish the aforementioned aim of this task were:

- To develop a prioritisation methodology which would be as objective as possible;
- To determine appropriate criteria to assess the proposed projects;
- To determine a weighted scoring system to assess the projects in the national context;
- To apply the system and suggest a pragmatic prioritisation of projects.

5.8.2 Methodology

For the scope of the report, a methodology to facilitate prioritisation of the "Base Case" projects among the 14 settlements (conurbation areas of the main settlements of the 14 municipalities of the project area) was developed. Subsequent to the issue of TM 10, Gusinje in Plav Municipality was included in the Masterplan, and was subjected to the same process, the outcomes of which are described below.

This methodology was based on the application of "Multi-Criteria Analysis" (MCA) technique, in order to facilitate handling of the quite complex and significant amount of information for all the 15 settlements in a more consistent and "objective" way.

5.8.3 Development of the MCA Evaluation Matrix

The selected criteria for the development of the MCA Matrix were divided into four groups. Each group reflects the anticipated key issues on which the decision on the realisation of the Masterplan is to be made by the decision makers. These groups were:

- Group A: National Priorities and Obligations;
- Group B: Environmental Impact;
- Group C: Social aspects;
- Group D: Efficiency or Benefit to Cost ratio of the MP.

The groups of the aforementioned criteria were given weighting factors.

Then, each criterion presented in the following table, was given a weighting factor within its group. Thus, the following matrix was produced for the prioritisation and ranking of the proposed projects.

The Prioritisation Evaluation Matrix Table 5.4

	Group	Group Weighting factor		Criterion	Criterion Weighting factor	
					Within the group	Overall
A.	National Priorities and Obligations	10 %	A1	National priorities	50%	5%
			A2	Obligations derived from International Conventions	50%	5%
				Total	***100%***	
B.	Environmental impact	35 %	B1	Impact of wastewater discharges on surface waters	30%	10.5%
			B2	Sensitive receptor (in line with 91/271/EEC)	40%	14%
			B3	Receptor of poor quality	30%	10.5%
				Total	***100%***	
C.	Social aspects	20%	C1	Population to be served	10%	2%
			C2	Willingness to pay (as indicator of Public Interest)	30%	6%
			C3	Public Health	60%	12%
				Total	***100%***	
D	Efficiency or Benefit to Cost ratio	35 %	D1	Benefit (in terms of BOD_5 removal) /cost	50%	17.5%
			D2	Environmental benefit (in terms of reduction of BOD_5 in the river)/Cost ratio	50%	17.5%
	Total	***100%***		***Total***	***100%***	

5.8.4 Scoring, prioritisation and ranking

For the prioritisation and ranking of the Masterplan works for the 14 conurbations plus Gusinje, the “options” (i.e. construction of Masterplan works for settlement “X”) were rated against the criteria presented above in the Evaluation Matrix.

For the **scoring,** the selected scale was 1 to 5. For “options” that could not be rated against one criterion, no rating was given. The final results were derived following summation of the weighted scores that each “option” had achieved against each criterion.

The rating given to each settlement (“option”) against each criterion is presented in Tables 4.6 and 4.7 of TM 10, and in Section A4.8 of Annex 4 of TM 8.

As “benefit to cost” ratios were assessed for completion of Phase 1 and for completion of the Full Schemes, each matrix presented the relevant results for each case.

The final results obtained by applying the MCA technique are presented in the following table.

Summary of MCA Analysis **Table 5.5**

Completion of Phase 1 of the Masterplan		Completion of the Full Schemes (all Phases) of the Masterplan	
Settlement	***Total Score***	***Settlement***	***Total Score***
Higher Priority			
Niksic	4.11	Niksic	3.76
Rozaje	3.67	Rozaje	3.49
Pljevlja	3.10	Pljevlja	3.28
Podgorica	2.79	Podgorica	2.62
Medium Priority			
Kolasin	1.69	Kolasin	1.87
Bijelo Polje	1.52	Berane	1.71
Mojkovac	1.44	Bijelo Polje	1.70
Berane	1.36	Mojkovac	1.44
Danilovgrad	1.19	Danilovgrad	1.02
Zabljak	0.94	Pluzine	0.96
		Zabljak	0.94
Lower Priority			
Pluzine	0.79	Plav	0.80
Andrijevica	0.73	Gusinje	0.79
Plav	0.63	Andrijevica	0.73
Savnik	0.49	Savnik	0.49
Gusinje	0.48		

A review of the total score gained by each conurbation suggests that these could be grouped in three groups, namely:

- **Higher priority –** Niksic, Rozaje, Pljevlja and Podgorica.
- **Medium priority –** Kolasin, Bijelo Polje, Mojkovac, Berane, Danilovgrad and Zabljak.
- **Lower priority –** Andrijevica, Plav, Savnik and Gusinje (and Pluzine for the construction of Phase 1)

Regarding the groups, and their relevant ranking, the following should be noted:

- The **same four conurbations,** with the same order, appear for the construction of Phase 1 works or for the Full Scheme (All Phases). The sensitivity of the rating has been tested for this group of conurbations and it was found that the same conurbations fall in the high priority group for different weighting factors.
- **Niksic** is the first conurbation in the prioritisation list in both cases (Phase 1 and the Full Scheme). In all cases Niksic is rated higher than **Podgorica** against almost all the criteria with the exception of Criterion A2 due to Podgorica's proximity to Skadar Lake (protected under the Ramsar Convention) and Criterion C1 referring to the population to be served. What is really critical for Niksic, affecting its relevant priority against even

Podgorica, is the "receptor" of the wastewaters and its "assimilative" capacity. From the data available for both water quality and hydrological characteristics, it seems that the River Moraca is less sensitive than the River Zeta at the discharge point of Podgorica and Niksic respectively. The River Zeta is reported to have extremely low flow during summer and is thus unable to provide practically any dilution to the discharged wastewaters. This fact gives also a much higher rating to Niksic (5/5) as compared to that of Podgorica (1/5) for the Environmental Benefit to Cost ratio, as this ratio is affected by the flow rates of the receptors. Another criterion which gives higher priority to Niksic compared to Podgorica is the "Willingness to Pay" as it seems that in Niksic, the interest of the public in provision of wastewater infrastructure is greater than that in Podgorica.

- The rating in the "Environmental Criteria" was what mainly affected the ranking of the remaining conurbations in the high priority group. Thus, ***Rozaje and Pljevlja*** appear in higher positions than ***Podgorica*** in the prioritisation list as the poor quality of the receptors Ibar and Cehotina, their suggested designation as sensitive areas as well as the high environmental benefit to cost ratio offsets the higher scoring given to Podgorica for a number of other criteria related with "social aspects" or benefit to cost ratio (in terms of BOD removal upon completion of Masterplan works). It is significant that if the Criterion D2 was to be ignored (environmental benefit to cost ratio in terms of BOD_5 reduction in the river upon completion of works), then Podgorica would have been in a higher position than Pljevlja in the prioritisation list and with a very similar rating to Rozaje.

Regarding the ***medium priority group,*** the following comments apply:

- Critical for the ranking of this group is their rating against the criteria of Group C "Social Aspects" and Group D "Efficiency or Benefit to Cost ratio".
- The rating of conurbations in criteria of Group A and more specifically Criterion A1 (referring to National Priorities for tourism development) gave significant proportion of the total score achieved by Zabljak
- The rating given to almost all of these conurbations to the Criterion C2 "Willingness to Pay" was also significant, reflecting a strong Public Interest in the provision of adequate wastewater facilities.
- The "Benefit to Cost ratio" in terms of BOD removal by the Masterplan works was also rated highly in almost all cases for Phase 1 works. However, this was not the case for the completion of the Full Scheme (all phases) where Zabljak, Danilovgrad and Mojkovac were rated lowly.

Finally for the ***lower priority group,*** it should be noted that:

- All the conurbations falling in this group have low populations, close to or even below 2,000, which is the threshold limit set by the EU directive 91/271/EEC below which provision of sewer networks and wastewater treatment is not obligatory;
- None of these conurbations get any rating against the criteria of Group A and Group B, as they don't fall in "National Priorities and Obligations" or there is no indication of them causing significant "Environmental Impact"
- The ranking among them derives from their rating against Criterion C2 "Willingness to Pay" and Criterion D1 "Benefit to Cost ratio" in terms of BOD removal that can be achieved upon completion of either Phase 1 or the Full Scheme. The high rating of Pluzine against the "Willingness to Pay" criterion ranks this conurbation higher than the remaining ones of this group.

The implementation of Phase 1 and All Phases of the Masterplan result in similar, but not identical, rankings.

The higher priority group remains the same and also remains in the same order in the ranking list.

The list of conurbations falling in the medium and lower priority group is the same for the implementation of "Phase 1" and "All Phases", with the exception of Pluzine, which falls in the Medium priority group for the implementation of the Full Scheme and in the Lower priority group for the implementation of Phase 1.

Whereas these rankings reflect the priorities of the country as a whole, the recent moves towards decentralization will mean that Municipalities will become fully responsible for the development of infrastructure in their jurisdiction, and they may well choose to develop these projects regardless of any "national" perspective.

These rankings are therefore only of any relevance to Central Government.

The following table presents the accumulated cost for the Phase 1 works in order of priority

Accumulated cost of the Phase 1 works in order of priority Table 5.6

Rank	Conurbation	Cost (M Euro)	Accumulated Cost (M Euro)
Higher priority			
1	**Niksic**	13.070	**13.070**
2	**Rozaje**	4.050	**17.120**
3	**Pljevlja**	7.345	**24.465**
4	**Podgorica**	29.696	**54.161**
Medium priority			
5	**Bijelo Polje**	7.380	**61.541**
6	**Kolasin**	3.013	**64.554**
7	**Berane**	4.993	**69.547**
8	**Mojkovac**	2.129	**71.676**
9	**Danilovgrad**	2.463	**74.139**
10	**Zabljak**	1.522	**75.661**
Lower priority			
11	**Pluzine**	0.889	**76.550**
12	**Andrijevica**	1.059	**77.609**
13	**Plav**	2.859	**80.468**
14	**Savnik**	0.774	**81.242**
15	**Gusinje**	0.780	**82.022**

Note : Costs are capital costs and include contingencies (15%) and engineering (12%) but exclude PDV (17%)

5.8.5 Conclusions

The conclusion that can be drawn from this prioritisation and ranking exercise is that the four conurbations of Niksic, Rozaje, Pljevlja and Podgorica are higher priorities for the realisation of Masterplan works foreseen either for Phase 1 or the Full Schemes, based on environmental, social, national priorities and cost/benefit ratio criteria.

However, it should be noted that realisation of Phase 1 works for these four conurbations accounts for 2/3rds of the total cost estimated for all the 14 conurbations, i.e. 54.2 M Euro out of a total 82 M Euro, still a substantial sum.

Any prioritisation refers to the national context, and may be used to guide investment by the Government. However, decentralisation means that individual conurbations can pursue these schemes on an individual basis, and this prioritisation does not therefore rule out any of the schemes.

6. FINANCIAL ANALYSES AND IMPLEMENTION SCHEDULES

6.1 Data acquisition for the Financial Models

6.1.1 Profit and loss account and balance sheet data for ViKs and Communal Enterprises

A survey to collect information on the current financial operation of the ViKs and CEs was conducted and the results are presented in Annex 2 TM 9.

The information was needed as baseline information to prepare estimates of future operating costs for the proposed infrastructure in the Masterplan. It should be noted that the financial models require estimates of operating costs of all of municipal water and wastewater infrastructure, both for the existing facilities and the new construction (note that water infrastructure operating costs are included in the calculations).

6.1.2 Valuation of existing water and wastewater infrastructure

The financial reporting noted above does not include the value of the existing water or sewerage networks, and it was thus necessary to make an assessment of this for the financial models.

The existing water supply networks are well described in the report "Projection of Long-Term Water Supply in Montenegro" an English translation of which forms Annex 2 of TM No 6. Unit costs for water distribution mains were developed specifically to determine the replacement costs of these networks and are included in Annex 5 of TM 9. A proportion of the replacement cost was taken as the "current value" of the assets, and this proportion was estimated from leakage rates and the age of the systems. The estimated values are necessarily approximate, but nevertheless give an indication of worth.

Similarly the existing sewer networks have been inventoried in TM 5 of this study. Replacement costs were determined using the unit costs in Annex 5 of TM 9, and a proportion of the replacement cost was taken as the "current value" dependent on the age of the sewers.

The results of this work are presented in Annex 3 of TM 9.

6.1.3 Household survey data

The Household Survey assessed the existing level of facilities and services in the project area, and the public's opinion of the adequacy of those services, including their affordability and the willingness to pay for any improvements.

The specific objective of the household survey was the collection of quantitative data (for statistical interpretation) and qualitative data (for non-quantitative interpretation).

<u>Quantitative data</u> included:

- type of wastewater facility in use in the household
- number of persons in the household
- consumption of potable water in litres per month
- use of other water resources
- wastewater discharges

- number of incidents and failures of the services
- current and expected future costs for the wastewater services per household
- the average household income
- the price paid for the wastewater services provided, and
- affordability and willingness to pay

Qualitative data comprised:

- the perceptions of the consumers concerning the preferred type of on-site sanitation facilities,
- The demands concerning quality and reliability of services.

The data abstracted from this report and used in the financial analyses has been reproduced in Annex 2 of TM 9.

6.1.4 Capital cost estimates

Capital cost estimates have been developed for the Phase 1 scheme, which is the “minimum” intervention which will result in the full treatment of the flow from all existing sewers, and the Phase 2/3 scheme, which together make up full sewerage and wastewater treatment facilities for the conurbations. This is the “Base Case”.

Quantities of the proposed infrastructure were developed to a high level of detail for a masterplan in TM 8.

Unit costs were developed and are presented in Annex 5 of TM 9. These unit costs were estimated using a wide range of references, many originating from neighbouring countries. This approach was taken due to the relatively low volume of engineering construction in Montenegro, particularly for wastewater treatment plants and pumping stations, and to some extent the lack of strong competition between contractors at present, which is however expected to increase.

The capital cost estimates are the product of the quantities and the unit costs and are set out in detail in Annex 4 of TM 9. The cost base is 2004, and the costs are summarized in Table 6.1.

These costs were elaborated for the “Base Case” for all communities, ignoring affordability considerations.

6.1.5 Operation and Maintenance costs

Operation and maintenance costs for wastewater infrastructure have been taken as 0.5% of the accumulated cost of civil works, 2.0% of the accumulated cost of M&E works, and the energy costs (based on a tariff of 0.10 Euro/kWh) for the development of flows for the WwTPs and the PSs arising from the “Base Case”, as set out in Annex 4 of TM 9.

Investment according to the Base Case **Table 6.1**

Conurbation / Town	Phase 1	Phase 2/3	Total
Andrijevica	1,059,572	2,656,708	**3,716,280**
Berane	4,992,933	12,694,221	**17,687,154**
Bijelo Polje	7,380,286	15,174,066	**22,554,352**
Danilovgrad	2,463,422	10,226,081	**12,689,503**
Kolasin	3,014,121	3,521,179	**6,535,300**
Mojkovac	2,128,964	7,730,092	**9,859,055**
Niksic	13,069,792	36,240,254	**49,310,046**
Plav	2,859,377	4,822,514	**7,681,892**
Pljevlja	7,345,030	2,489,368	**9,834,398**
Pluzine	888,775	922,779	**1,811,554**
Podgorica	29,695,516	92,845,983	**122,541,499**
Rozaje	4,049,128	5,245,684	**9,294,812**
Savnik	775,123	621,748	**1,396,871**
Zabljak	1,520,989	2,299,191	**3,820,180**
Total	**81,243,028**	**197,489,867**	**278,732,896**

Note : The above costs **include** contingencies (15%), design and site supervision (12%) but exclude PDV and land. The financial analysis has been made with contingencies and site supervision included.

6.2 Financing structure

A mix of loan, grant and "own" ViK financing was assumed. To fill the financing gap a large proportion of grant financing is assumed in the first Phase, which subsequently reduces. Loan conditions used in the calculations are of the "soft-loan" type, and average EBRD and IBRD conditions.

Assumed loan, grant and own financing of the Plan **Table 6.2**

Source	Phase 1 2005-2009	Phase 2 2010-2019	Phase 3 2020-2029
Internal means (Own ViK budget)	5%	10%	30%
Grants	45%	20%	10%
Loans	50%	70%	60%

6.3 Financial model

A financial model was developed to calculate the financial feasibility of the proposed works and was applied individually to each of the 14 municipal ViKs/CEs in the project area.

The model was designed in the Microsoft Excel program, and a separate worksheet was assigned for each ViK/CE.

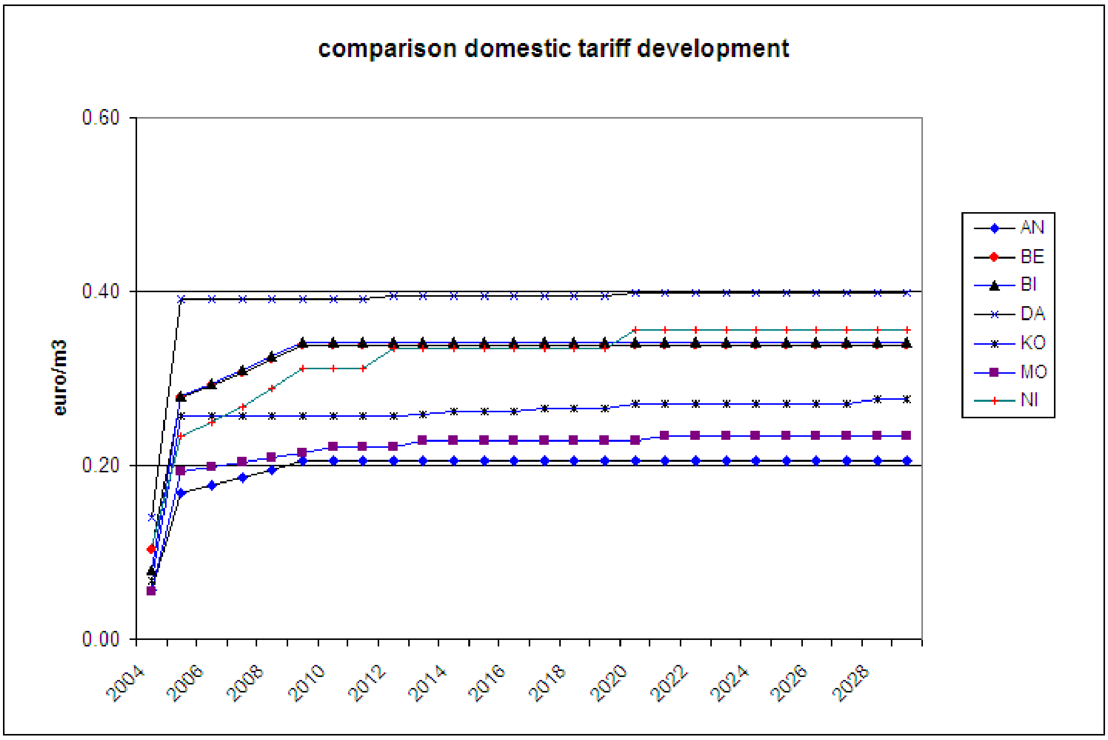
The modelling approach is described in detail in Chapter 7 of TM 9.

The model was used to test the feasibility of the "Base Case", and, where projects were not initially deemed feasible, they were delayed in time and modelled again to establish the sensitivity of the timing of construction. The results are discussed below.

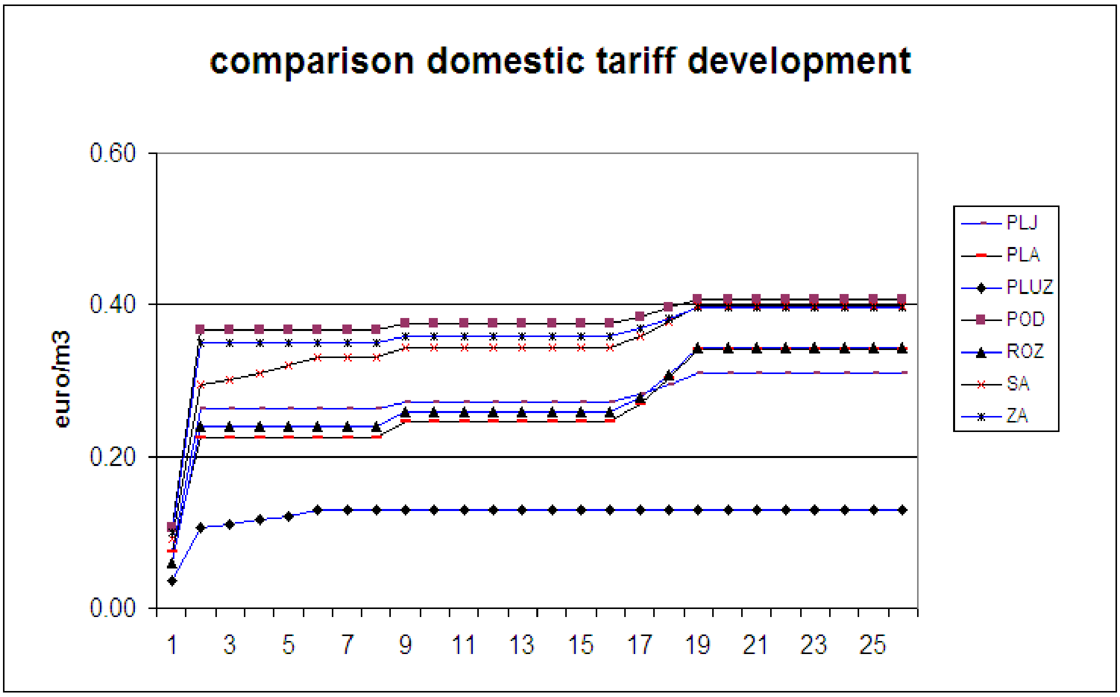
6.4 Tariffs

A minimum tariff development schedule has been prepared that shows the minimum annual increases in the wastewater tariff required allowing for an accumulated flow-of-funds (FoF) that remains positive throughout the entire projection period. The assumption has been made that the ratio of the domestic and non-domestic tariff remains the same. Table 6.3 shows the proposed tariff for the years 2009, 2014, 2019 and 2029. Figure 6.1 shows a comparison of minimum tariff development between the municipalities.

Comparison of minimum average tariff development **Figure 6.1a**



Comparison of minimum average tariff development **Figure 6.1b**



Future tariff development **Table 6.3**

Conurbation / Town	Domestic tariff development (euro/m3)					Non-domestic tariff development (euro/m3)				
	2004	2005	2009	2019	2029	2004	2005	2009	2019	2029
Andrijevica	0.06	0.17	0.21	0.21	0.21	0.11	0.27	0.31	0.31	0.31
Berane	0.10	0.28	0.34	0.34	0.34	0.26	0.35	0.37	0.37	0.37
Bijelo Polje	0.08	0.28	0.34	0.34	0.34	0.16	0.45	0.52	0.52	0.52
Danilovgrad	0.14	0.39	0.39	0.40	0.40	0.21	0.59	0.59	0.59	0.60
Kolasin	0.07	0.26	0.26	0.27	0.28	0.17	0.41	0.41	0.41	0.42
Mojkovac	0.06	0.19	0.21	0.23	0.23	0.14	0.31	0.33	0.34	0.34
Niksic	0.11	0.23	0.31	0.33	0.36	0.21	0.40	0.49	0.51	0.54
Plav	0.08	0.23	0.23	0.25	0.34	0.19	0.40	0.40	0.42	0.51
Pljevlja	0.08	0.26	0.26	0.27	0.31	0.19	0.43	0.43	0.43	0.46
Pluzine	0.04	0.11	0.13	0.13	0.13	0.09	0.18	0.19	0.19	0.19
Podgorica	0.11	0.37	0.37	0.37	0.41	0.16	0.55	0.55	0.56	0.61
Rozaje	0.06	0.24	0.24	0.26	0.34	0.12	0.39	0.39	0.41	0.51
Savnik	0.09	0.29	0.33	0.34	0.40	0.14	0.44	0.49	0.51	0.60
Zabljak	0.10	0.35	0.35	0.36	0.40	0.15	0.53	0.53	0.54	0.59

In addition to the Base Case an analysis of the tariffs has been made for the case where only the Phase 1 schemes are built, while at the same time the feasibility of all ViKs/CEs is aimed at. In this case the cost of investment is reduced from 280 M (Base Case) to 80 M, to be implemented by 2009. This analysis showed the following:

- Tariffs allowing for an accumulated flow-of-funds (FoF) that remains positive throughout the entire projection period (as for the Base Case) are (up to 2009) comparable to the tariffs calculated for the Base Case. The explanation is that the FoF up to 2009 is entirely dominated by the investments made during that period.

- Tariffs allowing full coverage of the costs (for the case where only the Phase 1 schemes are built) are up to 30% higher than the tariffs stated above. This can be explained since these tariffs include the replacement value of the facilities at the end of the project period.

Early analysis showed that the affordability is very low, especially in the short term future. Therefore all further analyses have been made based on the Base Case with the tariffs as started above. This should be considered as the minimum scenario.

6.5 Affordability

For the affordability analysis the following assumptions apply:

- Average household income is taken as that established in the household survey carried out in 2003.
- Households are considered as being able to afford up to 5% of their income on water supply and wastewater services. At this moment an average household pays 2.4%.
- Household income is projected to have a steady 3% real growth per annum.
- The present ratio of water supply/wastewater in the ViK bill to its customer is assumed to remain constant over the 25 years. Current water and sewerage tariffs are listed in Table 6.1 of TM 9.
- The present ratio between non-domestic and domestic tariffs will also be maintained, resulting in a similar cross-subsidy from non-domestic to domestic consumers.

At present the average monthly water and wastewater bill for households stays below the 5% level. Only in Andrijevica the bill is higher than the 5% level.

The analysis indicates that tariff requirements to achieve full coverage of costs are above present 5% levels for all ViKs.

Household incomes and water & wastewater bills **Table 6.4**

Conurbation / Town	Weighted Average Monthly Income	Weighted Average Monthly Water and	Bill/ Income

		Sewerage Bill	
Andrijevica	138	8.60	6.2%
Berane	185	8.50	4.6%
Bijelo Polje	189	8.40	4.5%
Danilovgrad	287	8.50	3.0%
Kolasin	291	6.10	2.1%
Mojkovac	245	7.10	2.9%
Niksic	284	6.70	2.4%
Plav	175	8.70	5.0%
Pljevlja	203	7.10	3.5%
Pluzine	188	5.30	2.8%
Podgorica	268	9.10	3.4%
Rozaje	180	7.20	4.0%
Savnik	230	4.70	2.0%
Zabljak	200	7.10	3.6%
Weighted Average	**219**	**7.36**	**3.4%**

Source: Household Survey, October-December 2003

6.6 Feasibility

The result of calculations reveals that 7 out of the 14 ViK/CE cases are financially feasible. 7 ViK/CEs are not financially feasible, out of which 3 cases are doubtful and 4 are not feasible at all.

Sensitivity analyses have been conducted by delaying the investment of Phase 1 by 5 years, 10 years and 15 years, and without Phase 2/3. The outcome of the sensitivity cases indicated that the three doubtful cases i.e. Bijelo Polje, Mojkovac and Pluzine, could be financially feasible. Bijelo Polje is feasible if the investment of Phase 1 is delayed for 5 years, while Mojkovac and Pluzine could be feasible if the investment of Phase 1 is delayed for 10 years. The four cases of Andrijevica, Plav, Rozaje and Zabljak would not be feasible notwithstanding any delay in the investment of Phase 1.

The results of the modelling and the sensitivity analysis reveal that 10 out of the 14 ViKs are financially feasible, as shown in Table 6.5.

Even with 100% grant financing the four cases of Andrijevica, Plav, Rozaje and Savnik would not be feasible. Not even the general and operational cost can be covered. For these cases government subsidies will be required.

Gusinje was not subjected to financial modelling, but as it is similar in character to the Municipality capital, Plav, which is not feasible, then it is also probably not feasible.

Results of calculations for the Base Case and results of the sensitivity analysis **Table 6.5**

Conurbation / Town	Financially	Doubtful	Not feasible	Result of the sensitivity analysis

	Feasible	Case		
Andrijevica			X	Not feasible
Berane	X			
Bijelo Polje		X		Feasible-Phase1 delayed 10 yrs
Danilovgrad	X			
Kolasin	X			
Mojkovac		X		Feasible-Phase1 delayed 5 years
Niksic	X			
Plav			X	Not feasible
Pljevlja	X			
Pluzine		X		Feasible-Phase1 delayed 5 years
Podgorica	X			
Rozaje			X	Not feasible
Savnik			X	Not feasible
Zabljak	X			
Total	**7**	**3**	**4**	

6.7 Implementation schedule and proposed tariffs

The proposed tariffs have been estimated based on the affordability to pay, the willingness to pay and the projected income growth of households in each ViK. Table 6.6 shows the proposed tariff for the years 2009, 2014, 2019 and 2029.

Tariff development Table 6.6

Conurbation / Town	Tariff development (Euro/m3)									
	Domestic					Non-domestic				
	2004	2005	2009	2019	2029	2004	2005	2009	2019	2029
Andrijevica	0.06	0.17	0.21	0.21	0.21	0.11	0.27	0.31	0.31	0.31
Berane	0.10	0.28	0.34	0.34	0.34	0.26	0.35	0.37	0.37	0.37
Bijelo Polje	0.08	0.28	0.34	0.34	0.34	0.16	0.45	0.52	0.52	0.52
Danilovgrad	0.14	0.39	0.39	0.40	0.40	0.21	0.59	0.59	0.59	0.60
Kolasin	0.07	0.26	0.26	0.27	0.28	0.17	0.41	0.41	0.41	0.42
Mojkovac	0.06	0.19	0.21	0.23	0.23	0.14	0.31	0.33	0.34	0.34
Niksic	0.11	0.23	0.31	0.33	0.36	0.21	0.40	0.49	0.51	0.54
Plav	0.08	0.23	0.23	0.25	0.34	0.19	0.40	0.40	0.42	0.51
Pljevlja	0.08	0.26	0.26	0.27	0.31	0.19	0.43	0.43	0.43	0.46
Pluzine	0.04	0.11	0.13	0.13	0.13	0.09	0.18	0.19	0.19	0.19
Podgorica	0.11	0.37	0.37	0.37	0.41	0.16	0.55	0.55	0.56	0.61
Rozaje	0.06	0.24	0.24	0.26	0.34	0.12	0.39	0.39	0.41	0.51
Savnik	0.09	0.29	0.33	0.34	0.40	0.14	0.44	0.49	0.51	0.60
Zabljak	0.10	0.35	0.35	0.36	0.40	0.15	0.53	0.53	0.54	0.59

Table 6.1 above presents the total cost of the Base Case prior to economic and financial evaluation.

The proposed implementation schedule including those schemes which are financially feasible for all their investment (Phase 1 and 2/3), those only feasible after delaying investment of Phase 1 and without Phase 2/3, and excluding those unfeasible schemes are presented in Table 6.7.

Implementation schedule for financially feasible schemes Table 6.7

Conurbation / Town	Phase 1 (years)	Phase 2/3 (years)			Total
	2005-2009	2010	2015	2017-2019	
Berane	4,992,933			12,694,221	17,687,154
Bijelo Polje			7,380,286		7,380,286
Danilovgrad	2,463,422			10,226,081	12,689,503
Kolasin	3,014,121			3,521,179	6,535,300
Mojkovac		2,128,964			2,128,964
Niksic	13,069,792			36,240,254	49,310,046
Pljevlja	7,345,030			2,489,368	9,834,398
Pluzine		888,775			888,775
Podgorica	29,695,516			92,845,983	122,541,499
Zabljak	1,520,989			2,299,191	3,820,180
Total	**62,101,803**	**3,017,739**	**7,380,286**	**160,316,277**	**232,816,105**

From the figures presented in Table 6.1, the total investment cost is estimated at Euro 278.7 million. The final investment cost presented in Table 6.7, after excluding the non-feasible schemes, is estimated at Euro 232.8 million or 84% of the originally estimated cost.

The proposed financing structure of the final Plan is presented in Tables 6.8 to 6.11 below. In summary, the proposed financing structure is distributed as follows: 8% internal ViK means, 28% grants and 64% loans.

Total estimated internal means Table 6.8

Conurbation / Town	2005-2009	2010-2019	Total internal means
Berane	249,647	1,269,422	1,519,069
Bijelo Polje	369,014	0	369,014
Danilovgrad	123,171	1,022,608	1,145,779
Kolasin	150,706	352,118	502,824
Mojkovac	106,448	0	106,448
Niksic	653,490	3,624,025	4,277,515
Pljevlja	367,251	248,937	616,188
Pluzine	44,439	0	44,439
Podgorica	1,484,776	9,284,598	10,769,374
Zabljak	76,049	229,919	305,969
Total internal means	**3,624,991**	**16,031,628**	**19,656,619**

Total estimated grants Table 6.9

Conurbation / Town	2005-2009	2010-2019	Total grants
Berane	2,246,820	2,538,844	4,785,664
Bijelo Polje	3,321,129	0	3,321,129
Danilovgrad	1,108,540	2,045,216	3,153,756
Kolasin	1,356,354	704,236	2,060,590
Mojkovac	958,034	0	958,034
Niksic	5,881,406	7,248,051	13,129,457
Pljevlja	3,305,263	497,874	3,803,137
Pluzine	399,949	0	399,949
Podgorica	13,362,982	18,569,197	31,932,179
Zabljak	684,445	459,838	1,144,283
Total grants	**32,624,923**	**32,063,255**	**64,688,178**

Total estimated loans Table 6.10

Conurbation / Town	2005-2009	2010-2019	Total grants
Berane	2,496,467	8,885,954	11,382,421
Bijelo Polje	3,690,143	0	3,690,143
Danilovgrad	1,231,711	7,158,257	8,389,968
Kolasin	1,507,060	2,464,826	3,971,886
Mojkovac	1,064,482	0	1,064,482
Niksic	6,534,896	25,368,178	31,903,074
Pljevlja	3,672,515	1,742,557	5,415,072
Pluzine	444,388	0	444,388
Podgorica	14,847,758	64,992,188	79,839,946
Zabljak	760,495	1,609,434	2,369,928
Total loans	**36,249,914**	**112,221,394**	**148,471,308**

Proposed financing structure – summary Table 6.11

Source	2005-2009	2010-2019	Total	% distribution
Internal means ViK	3,624,991	16,031,628	19,656,619	8
Grants	32,624,923	32,063,255	64,688,178	28
Loans	36,249,914	112,221,394	148,471,308	64
Total	**72,499,828**	**160,316,277**	**232,816,105**	**100**

6.8 Prioritised implementation schedule

If the financially viable schemes of Table 6.7 are ranked according to the environmental prioritisation" determined in Section 5.9, it is possible to determine the prioritised implementation schedule shown in Table 6.12.

Implementation schedule for financially feasible schemes Table 6.12

Conurbation / Town	Phase 1 (years)	Phase 2/3 (years)			Total
	2005-2009	2010	2015	2017-2019	
Higher priority					
Niksic	13,069,792			36,240,254	49,310,046
Pljevlja	7,345,030			2,489,368	9,834,398
Podgorica	29,695,516			92,845,983	122,541,499
Sub-total	***50,110,338***			***131,575,605***	***181,685,943***
Medium priority					
Bijelo Polje			7,380,286		7,380,286
Kolasin	3,014,121			3,521,179	6,535,300
Berane	4,992,933			12,694,221	17,687,154
Mojkovac		2,128,964			2,128,964
Danilovgrad	2,463,422			10,226,081	12,689,503
Zabljak	1,520,989			2,299,191	3,820,180
Sub-total	***11,991,465***	***2,128,964***	***7,380,286***	***28,740,672***	***50,241,387***
Lower priority					
Pluzine		888,775			888,775
Sub-total		***888,775***			***888,775***
Grand Total	**62,101,803**	**3,017,739**	**7,380,286**	**160,316,277**	**232,816,105**

Notes :

1. All schemes follow the implementation schedule of the "Base Case" with the following exceptions:
   (a) Bijelo Polje scheme comprises only the Phase 1 scheme and this is delayed by 10 years to begin operation in 2019
   (b) Mojkovac scheme comprises only the Phase 1 scheme and this is delayed by 5 years to begin operation in 2019
   (c) Pluzine scheme comprises only the Phase 1 scheme and this is delayed by 10 years to begin operation in 2019

It will be noted however that the above schedule does not include **Rozaje,** which is a higher priority project from environmental considerations, but is not financially viable under the assumed funding conditions. The total investment for the Phase 1 scheme in Rozaje is 4 M Euro. It is recommended that consideration be given to special funding arrangements perhaps in the form of a National Grant in order to bridge the gap between what is affordable and the cost of the Phase 1 works.

7. INSTITUTIONAL (TM 11)

7.1 Baseline institutional situation

Under the Law on Municipal Activities (Official Gazette of the Republic of Montenegro 7/4/1995), municipalities have been entrusted with the delivery of fifteen or so communal (non-administrative) services, of which the most important to citizens are water supply, wastewater treatment and disposal, solid waste management, roads and lighting. Central government performs only the overall management of the sector, and the legislation which outlines where the central government can intervene is in place.

Of the 14 organizations in the Project Area with responsibility for water and wastewater services, 5 are Vodovod i Kanalizacija companies (ViKs) which are charged only with water distribution and wastewater management, and 9 are Communal Enterprises, with additional responsibilities including maintenance and cleanliness of cities, public green areas and parks, streets, lighting, buildings, local roads, bridges, riverbeds, cemeteries and solid waste disposal etc.

The Law of Local Self Government of the Republic of Montenegro (published on 9th of July 2003) has vested the public utility companies to develop their own individual organisation, and consequently each of them differs slightly. However, in general, the ViK/CE is managed by a Board of Directors (BoD) which is elected by the Municipal Assembly. Usually the BoD comprises members from ViKs/CEs, the municipality, other sectors and social groups.

Although ViKs and CEs are legally independent entities on paper, generally, they have little autonomy and no control over crucial aspects of their business, such as tariffs, staff hiring and firing, and investments. The ViKs and CEs are controlled by (in ranking order): 1) the BoD, 2) the corresponding department of the municipality, 3) the Deputy Mayor and 4) the Tax Department of the Ministry of Finance (normal annual financial control). Further to that, even though ViKs and CEs are responsible for the implementation of investments, it should be noted that the BoD together with the Municipal Assembly plan the investment projects of the ViK/CE and the Municipality finally approves and provides to the ViK/CE the necessary funding for its investment.

The staffing of the ViKs and CEs varies widely, from 328 staff members in Podgorica ViK to 7 in Savnik CE.

Generally ViKs and CEs have relatively small sewerage sections, which, in contrast with the other sections, are understaffed. Only the ViK in Podgorica is well staffed and has the most technologically advanced sewerage section, including staff who operate the only WwTP currently functional in Montenegro. Staff in ViKs and CEs tends to be employed for life, and the majority has been in their positions for 10 years or more and has acquired a long standing working experience.

Very few of the employed staff are degree-qualified or have a higher education. The majority of the workforce consists of personnel with primary education (drivers of sewer cleaning vehicles, sewer cleaners, etc).

Regarding vocational training, a very low percentage of the staff in most ViKs and CEs has attended a course during the last 3 years. Also, the various international organizations who are involved in institutional strengthening programmes generally provide only short term training courses with a general content. Training is therefore provided only occasionally to the personnel of ViKs and CEs and that training tends to be general and not specific. An annual vocational training plan for ViK/CE personnel does not exist.

Overall this results in a ViK/CE establishment which has a limited capacity to implement any Masterplan proposals. The exception is Podgorica ViK, which designs and procures sewerage projects and acts as a “design center” for other ViKs and CEs.

The poor financial state of these organizations means that new investments of any note are not being made, and there are no current construction works of considerable size, which are supervised or implemented by ViKs/CEs in the Project Area. There is a general lack of technical and managerial capacity for undertaking large scale projects. In particular, the procurement of WwTPs, which are complex engineering projects with an insignificant history of construction in Montenegro, could not be undertaken by any ViK/CEs without some technical and managerial experience (with the possible exception of Podgorica ViK).

Usually the Municipality, through its subsidies to a ViK/CE, supports (approves and finances) any infrastructure projects. The Municipality takes charge of tendering procedures, whilst ViKs/CEs can undertake some of the construction. In general, there is no annual investment action plan. The ViKs/CEs plan their schedule on a daily basis according to their needs. All damage to infrastructure is registered and an only elementary, and reactive, maintenance is carried out. Generally there is no preventative maintenance.

Finally, the introduction of modern Information Technology (IT) equipment has been slow in nearly all the ViKs and CEs, although the USAID institutional strengthening programmes are beginning to rectify the situation. Staff has however become used to working without computers and continues to rely on paper systems as a result. Where computers are present, generally they are old and are mainly installed in Accounting Departments, where they are used for billing. There is little or no use of computers for engineering tasks with the exception of Podgorica, where a very high standard GIS dedicated to the water supply and wastewater networks has been developed, and Niksic, which has adopted the Podgorica GIS system and is busy acquiring the data for it.

ViKs and CEs do not gather funds in a regular way. The revenues of ViKs and CEs mainly come from (central and local) government subsidies and fees (see Tables 4.11, 4.12 and 4.13 of TM 11). However, as central government has passed the responsibility of water supply and sewerage management to the Municipalities, it has drastically reduced the amount provided in subsidies (TM 11, Table 4.11).

Tariffs are determined by the BoD and the Mayor, who also takes into account the opinion of the relevant Municipal Department.

As far as revenues from bills are concerned, about 60% of the bills are paid and 40% are not. Regarding revenues from wastewater, the rate paid by industry is related to the quantity but not to the quality of waste, and often the quantity is an estimate and is not measured. Currently there are no Trade Effluent Agreements for the disposal of industrial wastewater.

The revenues (from bills) can barely cover the salary payments and some elementary maintenance. Consequently, relatively little priority is given to sewerage development. Furthermore, the long term neglect of maintenance due to lack of funds and political interference in budget allocations have seriously compromised the technical management of existing systems and also has resulted in inadequate planning and investment to accommodate the growth in demand for these services.

If the ViKs and CEs need extra money (mainly to cover salaries) they ask for short term loans. In order to get a bigger loan from a third party, the Municipality must provide a guarantee, as the ViK/CE cannot itself provide the necessary guarantees.

Usually investments are funded from the municipal tax (2% of the revenue of each company). Finally, 3% of each bill collected by ViKs/CEs is paid to central government (which goes mainly to the Ministry of Agriculture), which re-invests this money for small scale environmental protection projects, usually for small Municipalities/Communities. The criteria under which this money is invested are not clear or standard.

Another major weak point is the huge amount of water consumption per capita, which ranges from 100 to 400 liters per day per capita, and averages 260 l/c.d in the Project Area, about double EU average. For that reason a public awareness campaign to reduce the water consumption to reasonable levels will be necessary.

Also, improved metering of consumption, as well as strengthening of a unit responsible for sending the bills to customers (Accounting Unit) will be necessary to improve bill collection and revenues to improve the financial viability of the ViKs and CEs.

Although the cooperation between ViKs and CEs is good (exchange of information, equipment, spares) official partnerships between them are not yet possible due to the fact that relevant legislation does not exist.

As noted above, international organizations are beginning to assist in institutional development, notably USAID, KfW and EBRD. The USAID interventions concerning the Institutions of the north and central regions of Montenegro, (run by the general development office of USAID) involve mainly three projects in two areas:

- Support for the Municipalities,
- Public participation (associated with infrastructure)

Another significant donor for institutional strengthening is the European Bank for Reconstruction and Development (EBRD) with its Turn Around Management (TAM) Programme. The EBRD and the United Nations Development Programme together with the support of the European Union Phare Programme and other governmental donors, developed the “TAM Programme” to bring specifically selected, experienced, independent, successful business leaders from market-driven economies to act as Senior Industrial Advisors to managing directors of enterprises in central and eastern Europe and the former Soviet Union (the “Bank’s Countries of Operations”).

The cities in the Coastal Region of Montenegro (and Cetinje) operate a regional water authority (PEW), whilst KfW (and their contractor MACS) has proposed the establishment of a joint service and coordination company ‘VODACOM Doo’.

PEW is a public company owned by the state and controlled by the MoEUP. It is so far the only regional authority in Montenegro and was established in 1976.

Today, in addition to the Regional Water Supply project, PEW is also the implementing agency for the following undertakings:

- The feasibility study, the tendering procedure and the supervision of construction of two landfill sites for the disposal of solid waste in the Coastal

Region on behalf of the Government and the involved Municipalities (World Bank funding)

- To assist the ViKs in project formulation for emergency programme for water supply improvements
- To act as a Project Implementation Unit (PIU) for the Coastal Region for projects financed by international donors.

The organizational structure of PEW comprises two departments:

- The Technical Department, which is involved in implementing the water and sewerage projects
- The Financial Department, involved in financial administration of the projects.

The revenues of PEW come from: 1) the central government, and 2) PEW gets 1% of value of any proposed infrastructure in the area, This revenue will be increased in the future when PEW sells water to the Municipalities (PEW intends to install water meters to the connected coastal Municipalities and then sell the water to these Municipalities). The selling price of water is 0.7 €/m^3 for households and 1.4 €/m^3 for industrial use.

Based on the discussions held in several Steering Committee sessions and following the recommendations of two institutional and legal workshops with participants from the Government of Montenegro, the municipalities and ViKs/CEs in the Coastal Region (and Cetinje), MACS has proposed the creation of the joint service and coordination company VODACOM, Doo. in order to institutionalize the ongoing rehabilitation process of the municipal water supply and wastewater services.

VODACOM will carry out a series of general coordination functions such as the planning and optimization of the future development of the water supply and wastewater services, and the monitoring of the billing process and the debt management of the existing ViKs. In addition, VODACOM will offer special services that, due to lack of capacity, are currently are either not performed or outsourced at high cost.

The founders of VODACOM are the Municipalities of Hercog Novi, Kotor, Tivat, Kotor, Budva, Cetinje, Bar, Ulcin and the Government of Montenegro, which contribute equal shares of EUR 50,000 each to the total foundation capital of EUR 400,000. Contributions to the foundation capital could be made as “in kind” contributions or alternatively in cash. All founders send two representatives to the shareholders assembly. All of them have the same voting rights. Major decisions require a unanimous decision, other decisions with a two- thirds majority.

The mayors of the mentioned municipalities and the competent Minister of the Government form the Board of Directors of VODACOM, which after public announcement of the position selects the executive director on the basis of professional criteria. Directors of existing ViKs participate in the Coordination Council.

7.2 Development of institutional aspects

From the analysis of existing situation it appears that a key aspect of a Strategic Plan for the successful implementation of the Masterplan, is to create and/or strengthen the appropriate institutional and organisational framework for operation of the ViKs and CEs, and to develop their human resources in such a way as to enable them to manage the water supply and wastewater sectors (in particular the WwTPs) in an effective way.

From the analysis it is clear that in the Project Area only Podgorica ViK effectively operates in the wastewater sector. Therefore, in order to meet the needs arising from the implementation of Masterplan, the activities/services to be developed elsewhere in the Project Area can be classed into four groups:

- 1st group: **Organisation and planning of the implementation of the Masterplan**
- 2nd group: **Preparation – Production of projects**
- 3rd group: **Development of human resources**
- 4th group: **Operation and Maintenance**

For an optimum solution to cover future needs, it will be necessary for the existing 14 entities to operate jointly with new entities to be established in order to cover each of the 4 groups of services. We propose that the following specific criteria be set (according to PEST analysis and 7 forces model):

- **Economic Criteria:** Given the financial state of the sector, the purpose of these criteria is to place restraints on additional increased administration costs or in any event to create the lowest possible cost, irrespective of who will be burdened with this cost
- **Managerial Criteria:** These criteria aim to promote solutions that will have comparative administrative and managerial advantages against the other alternative proposals (e.g. promptness and flexibility in decision-making, speed up of procedures, elimination of bureaucratic procedures etc.).
- **Subsidiarity Criteria:** These criteria aim to promote a solution that will be closer to those who benefit from it (local level) and to create the lowest possible cost, irrespective of who will be burdened with this cost.

It is important to consider that:

- the Masterplan is in itself a single technical plan which includes projects for the entire project area,
- the sewerage sector should be regarded cohesively on a central planning level since pollution cannot be restrained by geographic boundaries,
- the organisation which will be established will perform better as a single entity because it can uniformly deal with basic issues such as seeking new funding sources, procurement and tendering procedures, supervision of works etc.,
- a single organisation is able to save resources as a result of the economies of scale it creates.

Based on the above, three alternative proposals are considered:

Proposal (A) : An agency established through state action

Proposal (B) : An agency established through inter-municipal action

Proposal (C) : An agency established through the action of the organisations managing water resources (ViKs and CEs)

By assessing the positive and negative points derived from the criteria mentioned above, the proposal which concentrates the most positive points is proposal B. It is therefore proposed **the establishment of an organisation through inter-municipal action** that will cover the organisation, specialisation and planning of the implementation of the Masterplan, as well as the preparation and procurement of projects.

The proposed new organisation has all the characteristics of a Project Implementation Unit (**PIU**). The majority of its responsibilities are not exercised by any other organization at present and there will therefore be no complications or overlapping of responsibilities. However, for reasons related to sustainability, the improvement of the quality of the specific services and the long-term nature of the Masterplan (which has an implementation period 25 years), additional responsibilities may be assigned to the new organisation, either by the founding members or other entities, without however affecting its prevalent role, that of a PIU.

The responsibilities of the new organisation, which also reflect the extent of its activities, may be broken down as follows:

- Preparation of a balanced annual action plan
- Specialisation of the Masterplan
- Maturity of the projects included in the Masterplan
- Preparation of feasibility studies
- Preparation of terms of reference and tender documents for design studies
- Selection of tenderers for design service contracts
- Monitoring/supervision of the preparation of the studies
- Preparation of designs, specifications and tender documents for works projects
- Selection of tenderers for works contracts
- Monitoring/supervision of the execution of works
- Acceptance of studies / works
- Seeking sources to finance the Masterplan
- Preparation of feasibility studies
- Revision of the Masterplan
- Provision of Technical Assistance to ViKs / CEs
- Drafting of standard regulations, guidelines and manuals (procurement manual, project manual, manual for the quality management of services, industrial wastewater management guidelines, manual for managing environmental crises etc.)
- Organisation and support of policies and initiatives (sustainability policies, reduction of water over-consumption, improvement of consumer behaviour etc.)
- Any other responsibility assigned by the partners

The greatest part of these responsibilities is developed for the benefit of all the beneficiaries.

In order to put in place the appropriate institutional and organisational framework of operation and to develop human resources in such a way that will enable them to manage the sector of water supply, sewerage and wastewater treatment plants and to produce results corresponding to those expected by Directive 2000/60/EC, it is proposed to divide the project area into three regional river basin areas, that is one corresponding to the Adriatic Sea, one to the NW Black Sea and the last one to the NE Black Sea.

Therefore, the establishment of regional offices under the auspices of the PIU is considered necessary, as the regional offices, in essence, will facilitate and support the transfer of knowledge to the ViKs/CEs of the area they cover. On the other hand, being closer to the implementation of the Masterplan, they deal in a more direct way with the issues arising and convey the regional concerns centrally.

The proposed structure of the PIU services is as follows: It is composed of the Central Office (with headquarters in Podgorica), where the first regional office will be established. It is proposed that the other two regional offices be established in Berane or Bijelo Polje and in Plevlja. The Central Office supervises the other two regional offices and its 3 Divisions, namely the Administration Office, the Financial Department and the Technical Department. The Technical Department, which contains the greatest number of staff, supervises the Project Department and the corresponding ViKs/CEs which belong to the specific river basin area. In every regional office an employee is designated to act as the head coordinator.

It should be made clear that the two regional offices are not granted any administrative or financial independence, but they are merely the regional offices of a single organisation. The responsibilities of the regional offices will be exercised by assignment from the Central office based on whether they meet the regional organisation criterion and whether they are able to deal promptly with local issues associated with the technical solution proposed. The supervision of each regional office may, moreover, be assigned to a member of the BoD coming from the Municipality where the office has its headquarters or from the zone it covers.

The PIU will be established in accordance with the provisions of the Law on the Local Self Government of Montenegro, with the initiative of the Government.

It is proposed that the complete Charter will be submitted to the Municipal Assemblies of all the Municipalities in the project area, and a specific limited period will be set within which it must be submitted for discussion and voting. From the moment it is submitted to the Municipal Assemblies, it may not be amended. The Charter is either voted affirmatively as it is, or it is not accepted.

It is obvious that during the period preceding the submission, the group that has undertaken the initiative or the informal Steering Committee must brief in detail the Municipal Assemblies on the benefits resulting from the establishment of the PIU and that participation in this Organisation is an essential requirement for each member if it wishes to solve successfully the problem of wastewater management.

The tenure of office of all the members of the management bodies follows the same pattern of the Municipal authorities. There are two management bodies proposed; the Board of Directors (BoD) and the Assembly of Representatives (AoR).

The Management of the PIU is exercised by a 7-member Board of Directors, which is elected by the Assembly of Representatives of the partners by secret ballot. The members of the BoD should have the support of the Municipal Assembly of the Municipality that has proposed them. The members of the AoR are appointed by the Municipalities and represent the corporate shares. The main criterion for the distribution of the corporate shares is the size of population of each Municipality and the principle that all the Municipalities must be represented at the Assembly, irrespective of their size.

In order to meet these criteria, three separate balanced clauses are proposed:

- the Municipality with the smallest population size must appoint at least 1 representative to the Assembly (the size of population serves also as a benchmark to determine the other corporate shares),

- the Municipality with the largest size population must not exceed 40% of the representatives at the Assembly or 3 members in the BoD,
- at least one representative from every zone should participate, at all events, in the Board of Directors. Based on this rationale, the representation of the Municipalities at the Assembly could be as follows:

Corporate shares of the Assembly of Representatives of the PIU, per partner **Table 7.1**

Municipality	Total population 2003	Number of Corporate shares	Percentage of participation
Andrijevica	5,697	2	1.25
Berane	34,912	12	7.90
Bijelo Polje	49,773	17	10.96
Danilovgrad	16,376	6	3.61
Kolasin	9,934	3	2.19
Mojkovac	10,015	3	2.20
Niksic	75,274	26	16.57
Plav	13,725	5	3.02
Pljevlja	35,751	12	7.87
Pluzine	4,270	1	0.94
Podgorica	168,812	57	37.17
Rozaje	22,559	8	4.97
Savnik	2,938	1	0.65
Zabljak	41,81	1	0.92
Total	**454,217**	**155**	**100.00**

The AoR has exclusive powers such as the election, retention or dismissal of the members of the BoD. It may also retain the management of key issues, such as the review of the Masterplan or the approval of the annual action plan. The meetings of the AoR may be open to the public.

The BoD exercises the management of the PIU, and sees to the proper and effective exercise of its duties. It elects the Chairman and Vice Chairman by secret ballot. Their powers are defined precisely by decision of the BoD.

The Chairman represents the PIU before any authority. He is accountable and answers to the BoD. He directs the works of the BoD and fosters a climate of understanding and consent within it. He is deputised by the Vice Chairman. The BoD may assign specific responsibilities to its members with the ultimate aim of exercising onsite supervision of the organisation's regional offices.

The central government is not involved in any way in the management of the PIU. However, it does supervise its operation, as with all Local Authorities. The central government may impose specific conditions for the operation of the organisation in order to provide credit guarantees. However, under no circumstances, may the self-governance of the authority be overruled.

The effective operation of the PIU depends on its offered services. The number of its employees depends on the extent of its activities and mainly on the progress of the implementation of the Masterplan. Partly, the number of its personnel may be covered through the provision of qualified employees from the Municipalities/ViKs/CEs. Also, part of its activities may be outsourced.

The services of the PIU are to be organised according to modern management standards which include the establishment of targets, employee effectiveness and efficiency measurement systems, client satisfaction measurement systems, administration etc. A General Manager is to be appointed as the head of all the services.

The Legal Advisor(s) might not be permanent staff. They might be external legal experts and act as subcontractors depending on the problem.

The Masterplan is divided in 3 phases. During its first phase (2004-2009), it is proposed the construction of some sewerage networks and the 1st module of some wastewater treatment plants for certain settlements. More specifically, it is proposed to start the design phase of works during the years 2006-2007 and the construction phase to last during the period 2008-2009. It is expected that everything will be in operation by the end of the year 2009.

Based on the above schedule, it is proposed to start a step-by-step staffing procedure of the PIU. The PIU will be staffed gradually as its needs and the offered services proceed smoothly and according to the MP. Progressively, the total staff number of the PIU will amount to the total number of 24 staff members. This number of staff members represents the operation of the PIU in **full deployment**, which is the estimated number of employees to be reached by the **year 2008** provided the implementation of the Masterplan is progressing smoothly. Given that the period 2008-2009 will be the phase with the most heavy construction activity (tendering procedures in place so as to start the construction of WwTPs and networks)it will be also the year of the PIU's full deployment.

The specialisations of the staff that will be employed are in their overwhelming majority technical (it is proposed that 17 employees including the general Manager should hold a technical degree). In addition there will be Secretarial Support. Some of the specialised personnel, as already mentioned, might be provided by the ViKs and CEs which already operate in the project area.

The operational sustainability of the PIU will be ensured only by its own resources. These resources may come from its share capital, the nominal contributions of its members, donations, grants, subsidies or funds from other organisations. The organisation will have a credit standing guaranteed by its partners-members and the state.

The share capital will be paid according to the corporate shares. It is proposed that each corporate share should represent the amount of 3,000€ and be paid in two annual equal instalments. From the payment of the share capital only, it is expected that the organisation will accumulate a substantial capital, useful as operating capital (155 shares x 3,000€ = 465.000€). The contribution to the share capital could be partly covered through the contribution in kind of fixed assets to the organisation, such as offices and equipment.

The purpose of this annual contribution is to cover the operational cost of the organisation's activities as stated in the annual action plan. Because the Masterplan, which is the main reason for the establishment of the organisation, is developed in 3 phases of which the first includes mainly maintenance projects and organisation, it is proposed that a progressive annual contribution amounting to 1% be set for the first 4 years (2005-2008) and that it be increased to 2% from 2009 onwards.

Based on the gross revenues of the water supply and sewerage sector of the 14 ViKs/CEs in 2002, it is expected that the revenues from the annual 1% contribution amount to approximately 115,000€, whilst from the annual 2% contribution to 230,224€.

These amounts are expected to be higher if the ability to collect any unpaid bills is improved, from 60% where it stands today to 90%, which may be set as a target for the following 5-year period. The PIU may support this effort of the 14 ViKs and CEs (improvement of capability to collect unpaid bills) through the preparation of relevant manuals and guidelines.

The PIU will establish an internal audit system, and its operating results and its balance statement will be audited by independent auditors. These audits are entirely different from any audits carried out by the central government.

Finally, without distracting the organisation from its designated activities, but aiming only at improving its sustainability, the organisation with its in-house know-how could undertake and carry out other tasks on behalf of its partners-members or others, such as specialised studies, technical studies etc**.**

Estimated revenues of PIU Table 7.2

Municipality	Water supply – waste water disposal sector revenues for 2002	Contribution 1%	Contribution 2%
Andrijevica	31,392	313	628
Berane	328,266	3,282	6,565
Bijelo Polje	400,626	4,006	8,013
Danilovgrad	565,845	5,658	11,317
Kolasin	117,306	1,173	2,346
Mojkovac	315,427	3,154	6,309
Niksic	257,4574	25,745	5,1491
Plav	168,843	1,688	3,377
Pljevlja	886,911	8,869	17,738
Pluzine	31,297	312	626
Podgorica	5,878,155	58,781	117,563
Rozaje	111,460	1,114	2,229
Savnik		0	0
Zabljak	10,101	1,011	2,022
Total	11,511,203	115,112	230,224

Source: TM 9 (Annex 4)

7.3 Future needs and existing organisations – operation and maintenance

It is obvious that the proposed PIU to be established does not divest a priori any responsibilities from the 14 ViKs/CEs active in the field of water and sewerage management. On the other hand, the implementation of the Masterplan will create new conditions in the future. The success of this undertaking will greatly depend on the understanding on the part of the employees and the local enterprises as well as Municipalities that this change does not entail any sacrifices or any additional burden to the households, but is an overall improvement of the services which will benefit both the employees and the consumers. Therefore, emphasis should be placed on the adaptation of the existing organisations to future needs acknowledging the significant role they will continue to play.

Such adaptation is necessary since the existing organisations will be called on to cover the increased needs of the **operation and maintenance** group of services due to the implementation of the Masterplan. To cover this group of services under the future conditions, three alternative proposals were considered.

a) To convert the CEs to ViKs

b) To maintain the current status

c) To assign the whole or part of the activities to third parties

Again the same set of criteria (Financial, Managerial and Subsidiarity) was used in order to select the best possible proposal.

No safe conclusion arises by listing the positive and negative criteria for the organisational evolution of the existing organisations. The proposal for the conversion of Communal Enterprise to ViKs, may indicate a trend, but it cannot be considered a proposed solution in any case.

In fact, in certain cases, such as the Municipalities with few inhabitants, it is not considered at all, because it would create an additional operating cost. Indeed it is noted that the population in 5 out of the 14 Municipalities is less than 10,000 inhabitants (and one Municipality only marginally exceeds this number). It is also noted that the Municipalities have been entrusted with a vast number of responsibilities that could in fact be retained by the CE even after the establishment of a ViK. On the other hand, intensive training and specialisation may improve the effectiveness of the employees of the CE as a whole.

Therefore, the best possible proposal may be **to maintain the current status and encourage only the voluntary conversion of the CEs to ViKs.** It remains to carry out the internal restructuring of these organisations in order to enable them to respond to their future duties.

Based on the needs of the operation and maintenance group of services, the detailed O&M responsibilities may include:

- Drafting of budget and forecast balance statement
- Drafting of the annual and short-term action plan
- Creation and maintenance of client records
- Procedures for confirming and collecting debts (regular metering, issuance of bills, forwarding, informing the technical department of breakdowns /interruptions in water supply, informing the legal department on matters of judicial protection)
- Monitoring the consumer bills. Maintenance of statistical data.
- Payment procedures
- Listing of accredited suppliers
- Drawing up of annual procurement plan
- Drawing up of annual technical plan
- Forwarding procedures for the drafting of project studies (as required)
- Management of warehouse (with records, in cards or electronic format)
- Establishment and maintenance of a call center receiving complaints on breakdowns and establishment of a mechanism for the assessment and the immediate restoration of breakdowns

- Establishment and coordination of work groups and monitoring of water supply and sewerage networks
- Execution of works for the extension of the networks, installation or replacement of water meters
- Maintenance of a calendar with incidents, wastewater treatment measurements
- Maintenance of machinery maintenance records and evaluation of their operation according to guidelines (manuals)
- Monitoring the levels of pollution loads in large and small industrial units within the framework of the Trade Effluent Agreement and the directions of the PIU
- Supervision of procurement and execution of studies and works by third parties

One of the PIU's responsibilities will be to provide technical assistance to the ViKs and CEs in the Project Area in order to implement successfully the Masterplan. More specifically this means that the PIU may provide to the ViKs and CEs of the project area:

- Specialised personnel for the operation and maintenance of WwTPs, who may be involved in specific duties, such as for the operation/provision of services for the cleaning equipment based on robotic application, for matters of regulating and modeling of WwTP in accordance with the input load, for confronting abnormal events as for example sludge bulking
- Know how for various specialised issues, such as Trade Effluent Agreements
- Coverage of specific needs of ViKs and CEs such as studies of plant efficiencies, etc.
- Provision of specialised and expensive equipment for the maintenance of WwTPs and networks, such as underground automated cleaning equipment based on robotic application. The PIU may procure the equipment, or rent their use, or provide the required services.

Regarding the chemical analysis of samples taken at WwTPs, this will take place at chemical laboratories already existing in the area. However, these laboratories should aim at obtaining an accreditation as soon as possible.

In the case of voluntary conversion of any CE to a ViK, the new ViK will have jurisdiction for the same area covered by the Municipality in which the ViK or CE belongs.

It is not proposed to change the financial management and resources of ViKs and CEs, but changes will be necessary to achieve:

a) the improvement of the rate of bill collection

b) the establishment of collection mechanisms, which will be independent of policy, and

c) the rationalisation of the tariffs based on the sustainability of the sector

The establishment of new tariffs adjusted on one hand to the financial status of the consumers and on the other hand to the cost of sound operations of the single water and wastewater sector, will be necessary to finance the works proposed in the Masterplan. Higher tariffs will assist in reducing water consumption to more reasonable levels.

7.4 Human resources development and training needs

This section addresses the formulation of a strategy for the development of human resources and the creation of a model Training Centre to cover the overall needs of those working in the water supply and wastewater sector and to bring them into contact with new technologies. The overall training needs include all ViKs/CEs and the PIU staff.

Three alternative proposals for creating a Training Centre were developed based on the analysis of the existing external conditions and specifically:

a) the training capabilities at University level

b) the academic community and particularly that possessing technical skills,

c) the availability of agencies involved in training,

d) the training needs of the people to be trained and

e) the intentions of all International Organisations active in Montenegro:

The three alternative solutions considered were:

a) An Organisation established by a University entity

b) An Organisation established by International Organisation(s)

c) An Organisation established by ViKs/CEs

By taking into consideration that: a) the capacity of the Technical University in Montenegro in managing and conducting specific training needs is limited and b) all the International Organisations active in Montenegro in training activities offer specific short-term training programmes, the selected proposal would be to establish an organisation that will not only manage training needs on a permanent basis but will also contribute to the formulation of a training strategy. This leads to the choice of a **Training Centre established by the ViKs/CEs and specifically by the largest and most advanced of them, which is Podgorica ViK**.

It is proposed that the Training Centre should cover training needs on every level (primary, re-training, specialisation) and should become the point of interconnection with new technologies, whether these are new technologies associated with the implementation of the Masterplan (e.g. technology to be used in the new WwTPs) or the development of technology in the fields of management and maintenance (e.g. Information Technology- IT tools).

The planning of training should follow two basic directions:

a. Strategy formulation, which aims to identify and prioritise the targets of the integrated training programme.

Initially the identification of training needs is performed, during which:

- The weaknesses and gaps in training or specialisation of the existing human resources are identified
- The fields in which the human resources need further training are identified
- The possibility of creating new specialisations or directing any surplus personnel of a specific specialty to other fields based on the broader planning is examined

- The incorporation of innovative approaches in the basic fields of management and maintenance is investigated

Finally, an established cooperation between the Training Centre and the PIU will exist for the formulation of the strategy so as to ensure the parallel progress of the development of the Masterplan with the training plan.

b. Implementation planning, concerning the identification of the steps that will lead to the achievement of the targets through training and that will ensure all the conditions - social, economic, organizational – required for the success of the plan, and more specifically:

- The training framework is being planned according to topics and groups (thematic units, relation and proportionality of theory and practice, training manuals etc.)
- Selection of specific training methods depending on the nature of each programme
- Determination of duration and structure of the training process
- Selection of the appropriate scientific team
- Planning the interconnection with the requirements of the Masterplan to ensure the necessary coordination with its activities, in terms of time and operation.

The implementation of the plan will guarantee that all the prerequisites – social, economic, organisational – are in place for the success of the training programme.

The identification of the training needs and then the setting of priorities are carried out on an annual periodic basis, including the following actions:

- Circulate and analyse a specially designed questionnaire on training needs
- Rationalize the recorded identified needs
- Connect training to each organisation's development plan, according to the Masterplan
- Develop the contents of training programme
- Examine feasibility of the implementation of the training programmes (cost, parallel operation of organisations, etc.)

Questionnaires will provide the overall picture of the training needs so as to develop training activities on the regional level. Then, the requests are unified and formed into a plan, after consideration of the feasibility of participation in the training programmes by employees without disruption of smooth productive operations.

The annual training plan is organised based on these requests. Two dossiers are created for each programme, the training dossier and the financial dossier. The training dossier includes:

- A detailed timetable
- The CVs of the trainers
- A list of names of the trainees
- The necessary supporting documents

The financial dossier includes the costing of the programme and the cost of participation of each trainee, which is charged to the organisation to which they belong.

The overall dossier is forwarded to the 14 ViKs/CE for updating and planning.

The analysis of the dossier structure may reveal whether it is possible to conduct programmes in other areas as well, provided the specific requirements in material and technical infrastructure allow it.

The Training Centre will produce both training programmes and trainers. The monitoring procedure will be based on human resources indices per region, per personnel category, per subject and per trainee.

From the questionnaires distributed to all the ViKs/CEs for the assessment of the current training situation prevailing in the ViKs/CEs, and the training needs to meet the requirements of the Masterplan expressed by them during interviews, the Training Plan described in Table 7.3 has been determined.

The establishment of the Training Centre is part of the implementation of the Masterplan. During the analysis carried out previously, the investigation of alternative solutions included also the availability of each interviewee, the availability of each structure and technical infrastructure and the relevant experience.

These prerequisites co-exist in the selected proposal. As a matter of fact, the Podgorica ViK expressed its availability and satisfies all the other conditions under the present circumstances. In order to avoid the establishment of new structures that would increase costs and possibly bureaucracy, it is proposed that the Training Centre should be a Division of the ViK and not another independent entity.

The establishment and objectives of the Training Centre and its relations with the PIU could form a separate component of the basic agreement of the establishment of the PIU.

The permanent staff of the Training Centre will include:

- The Administrative – Financial Head (Manager) of the Centre, who is overall responsible for the work.
- The Head of Training , who is responsible for the training process, and
- The Secretarial Support Staff.

The first two positions fall under the scientific staff of the Training Centre. At least one Scientific Coordinator and an Evaluator should be assigned to each training Activity. The Scientific Coordinator has overall responsibility for the preparation of the modules of the Activity, and for the implementation of the Training Programme for that Activity, including the selection of the trainers.

Training plan **Table 7.3**

PROGRAM	Target groups								Nr.	Duration (hrs)
	ViK/CE Managers	PIU Technical Managers	ViK/CE Engineers	ViK/CE Technical Staff	ViK/CE Accountants	Qualified workers	Unqualified workers	Layers		
Water Sector management	x	x							20	15
Management of Water Company	x	x							40	40
EU Environmental Legislation	x	x	x					x	60	40
WwTP Design		x	x						20	120
Design of Sewerage		x	x	x					40	120
Project Management	x	x	x						45	40
Construction Management		x	x						20	80
Networks Maintenance				x		x	x		60	40
GIS systems			x						20	40
Safety Management		x	x						30	40
Safety Procedures						x	x		60	40
Contract Management	x	x	x					x	50	40
Public Works Legislation	x	x	x					x	50	
WwTP Operation		x	x	x					45	120
WwTP Operation/ Maintenance						x	x		30	80
Sewage net. Operation		x	x	x					60	40
Automation		x	x						40	40
Accounting Management					x				20	40
Computer skills		x	x	x	x	x			100	80
Public Relations	x	x			x	x		x	80	10

During the programme's implementation phase, the permanent staff is supported by selected trainers and the evaluator. The trainers may be selected through calls for expression of interest to cover the needs of the annual training programme. Each trainer must have a strong CV, be educated and experienced and have knowledge of the subject of the module that he will teach. The evaluator is responsible for evaluating the training programme and is appointed internally by the Head of

Training. Based on this evaluation a record of accredited trainers may be established which the Centre may use again, as well as to invite them for further training (training of the trainers).

A basic source of income is the tuition fees paid by the beneficiaries for the training services provided to them. In addition, the Training Centre may solicit funds or be in close collaboration with sponsors and International Organisations.

Regarding the minimum operating cost of the Training Centre, the salaries of the 3 officers may be covered by the provision of annual subsidies from the PIU. This clause could be mentioned in the basic decision for the establishment of the PIU.

The salaries of the offices and external associates of the Training Centre are estimated as follows:

Training Centre minimum permanent staff requirements Table 7.4

Position	Method of payment
Administrative – Financial Head (Manager) of the Training Centre	Fixed …monthly salary….
Training Centre Head of Training	Fixed …monthly salary….
Secretarial support	Fixed …monthly salary….
Affiliated Scientific Staff :	
Training Programme Scientific Coordinator (Training Centre external associate)	The Scientific Co-ordinator of each separate training programme provides services according to the training assignment: *number of hours spent x hourly fee*.
Training Programme Evaluator (Training Centre external associate)	The Evaluator of each separate training programme provides services according to the training assignment: *number of hours spent x hourly fee*.

The financial management of the Training Centre involves a) the fixed operating costs (permanent staff salaries, depreciation of fixed assets, lease of permanent facilities and general administrative expenses) and b) the uniform management of separate training programmes based on the financial dossier of each programme.

The total sum of the above costs equals the operating cost of all the work produced by the Training Centre, which is distributed to the users according to the mechanisms described above.

The headquarters of the Centre will be located in the capital Podgorica and specifically in the headquarters of the ViK, where most of the training programmes will take place. As mentioned above, training sessions may also take place in other areas as well, provided these locations have the necessary material and technical infrastructure. Such local training offers the advantage of proximity to the trainees.

8. PUBLIC CONSULTATION (TM12)

8.2 Introduction

The Public Consultation Process designed and implemented within this project facilitated the involvement of the stakeholders potentially affected. It provided stakeholder participants with the information they needed in order to participate in a meaningful way and offered them the opportunity to give useful input in developing the sewerage and wastewater treatment design.

The approach adopted was to obtain as wide response as possible from the involved stakeholders given the minimum resources available. PCP involved sharing information, obtaining feedback, and providing forums of dialogue based on a common understanding of objectives. The consultation programme design, the participants, and the consultation extent and timing, were tailored to the needs of the specific project.

TM 12 describes all stages of the consultation process and includes a summary of opinions and outputs resulting from its implementation, and finally makes a rough evaluation of the process, trying to identify what was eventually achieved and what went wrong.

8.2 Objectives

The purpose of the Public Consultation Process was to inform the stakeholders about the project and seek views on the Masterplan proposals.

The specific objectives of the PCP are the following:

- To inform key stakeholders about the project
- To consult them at the early stages of the project
- To identify all critical issues and concerns
- To obtain stakeholders' response useful for the Masterplan
- To incorporate stakeholders opinion into the Masterplan and thus improve its quality
- To gain Stakeholders' support and public acceptance of the project
- To raise environmental awareness, especially in wastewater management

8.3 Consultation activities

The consultation activities undertaken during the implementation period January to September 2004 were:

- 2 Workshops (Inception and Final)
- 3 Round Table Discussions
- Informal Communications (meetings)
- Production and distribution of brochures
- Production and distribution of presentation handouts
- Supporting activities: press and local radio
- Production of Public Consultation Report

8.4 PCP Results

The key findings of the consultation process are consolidated into the following:

- The stakeholders contributed to the finalisation of the plans by providing technical input
- Environmental sensitization and awareness was achieved
- There was general project acceptance by the stakeholders which actively participated in the PCP. However, concerns were expressed on its future financial sustainability
- The level of participation was rather low, since some stakeholders' groups did not participate actively, resulting in low representation
- There was limited interest in the project by the majority of stakeholders
- Priority is given to economic and financial aspects

In general the process was considered to have achieved the majority of its targets. The most noteworthy result of the process was that it brought together stakeholders from different sectors and initiated them into a common wastewater management framework. The PCP achieved its purpose of public information and facilitated the finalization of the Masterplan.

8.5 Recommendations

The main recommendations arising from the PCP are as follows:

- Organization of awareness campaigns (dissemination of printed materials, using existing media, public meetings, public hearings, conferences) towards understanding of the benefits from the new sewerage networks & WwTPs and from efforts to reduce water consumption and prevent the discharge of solid waste into sewers.
- Support should be given to environmental NGOs in Montenegro, in order that they may become more active and organize Training Workshops and Conferences on environmental awareness and "capacity building" issues. For these campaigns NGOs should be supported with adequate funds by the Government.
- Generation of the environmental conscience of young people in schools and universities, through introduction of environmental subjects and lectures on environmental topics, organization of seminars with environmental topics, dissemination of leaflets and brochures of environmental content.
- Creation of a Web-site presenting the results of the project and the consultation process. This would contribute to project publicity and attract potential financing institutions to invest in the tourism sector.
- Enhancement of the public participation in the environmental impact assessment procedures, concerning the refurbishment of the sewerage network and the construction of the WwTPs.

9. SUMMARY OF KEY ASSUMPTIONS AND RECOMMENDATIONS

9.1 Introduction

This Masterplan describes in some detail the development of **wastewater infrastructure** in the Project Area and has made recommendations for what should be built and when. The exact timing of this work will, of course, be dependent on many factors, not least the availability of grants from Donors, which cannot be planned with any certainty. It is hoped however that this document will provide all the necessary information for IFIs to be able to assess the feasibility of all the schemes.

It is important to state again that the **Phase 1 schemes** will make a very significant contribution to the reduction in pollution of the environment by wastewater, will provide a sound basis for the expansion of the systems in future to “full sewerage services” in all main settlements, and will provide a starting point for the development of the personnel and skills necessary to operate treatment plants. These schemes have been designed to be as low-cost as possible, and an investment of about 80 M Euros in total will be necessary for all the main settlements (ignoring the issue of affordability by consumers). The full schemes will cost about 280 M Euro, a much more significant sum, and possibly beyond the financial means of the country as a whole.

Therefore it is recommended that development of the Phase 1 schemes be considered the top priority, and that all efforts be directed towards that end, without being overly concerned about the development of the Phase 2/3 schemes at the present time.

Proposals have been put forward for the institutional development necessary to support this programme, however it is recognized that this will probably be a “contribution to the debate” of how to tackle the problem of (a) getting the projects built and (b) how to operate them successfully. It is however necessary that such a debate begins as soon as possible.

It is recommended that the MoEUP organize a forum between themselves, Municipalities and ViKs/CEs to seek either a consensus to what has been proposed with regard to institutional strengthening/reorganization in TM 11, or to develop an alternative to it.

Throughout this document, other proposals and assumptions have been made which are tangential to the development of sewers and treatment plants, but are nevertheless important, and in some cases critical. For convenience, these are summarized in the following paragraphs, in no particular order.

9.2 Improvements to water supply in the Project Area (ViKs/CEs, Government, and Donors)

The whole Masterplan is predicated on the assumption that water consumption, which currently averages around 280 l/c.d, will be reduced to more reasonable levels by 2009, specifically 120 l/c.d for all towns except Niksic and Podgorica, where an allowance of 150 l/c.d has been made. The average in Western Europe is about 150 l/c.d and is falling.

This will have two effects:

- The production of wastewater will be reduced (the cost of the wastewater infrastructure proposed in this Masterplan would have been significantly higher had the designs accommodated the wastewater arising from current water consumption)

The need to develop new water supply sources will be reduced

Most water used for supply currently is sourced from upland springs at some distance from the centres of demand and is generally supplied by gravity (without pumping). There is very little treatment of water other than for disinfection with chlorine, and often this is not done either.

This Masterplan has made the recommendation that no wastewater infrastructure development is undertaken in villages in the next 25 years. The basis for this was that there is no hard evidence that the current wastewater disposal methods are causing significant pollution of either surface water or groundwater. Besides this, the preference of most people living in villages is for the development of water supply where this does not already exist.

Whilst there is a lack of evidence of pollution of groundwater, obviously the risk of such pollution increases with the number of people in one location who use septic tanks for wastewater disposal, and the relatively low availability of sewerage in main settlements means that this is quite common.

As the most readily available water sources from upland areas, where there is no possibility of pollution from human sources, have already been used, new sources of water are often from boreholes much closer to the main settlements. As noted above, there is an increased, but unquantified, risk of pollution of these sources from human pollution.

Reduction in water consumption will make the development of these new resources less necessary, and this risk can therefore be avoided.

Over and above this, the physical losses from the water supply systems appear to be very significant at present. According to ""Projekcija Dugorocnog Snabdijevanja Vodom Crne Gore, Decembar 1998", which describes the water supply in the Project Area (see Annex 2 of TM 6), in 1991, the unaccounted-for water was as presented in Table 9.1

The provision of adequate water volumes can probably be accomplished by eliminating these losses rather than by developing new, and possibly more contaminated, supplies.

Besides these large losses, the other main deficiencies in the water supply systems are as follows:

<u>Urban areas</u>

- Inadequate water metering (bulk and individual consumers)
- Inadequate reservoir capacity
- Inadequate protection of the catchment areas of the springs

<u>Rural areas</u>

- Very low coverage by the public water supply system
- Inadequate treatment of the water from private water supply systems.

Percentage of water unaccounted for in public water supply systems, by municipality **Table 9.1**

Public water supply system	Unaccounted-for water (%)
Andrejivica	77
Berane	48
Bijelo Polje	57
Danilovgrad	59
Kolasin	57
Mojkovac	40
Niksic	38
Plav	44
Plevjve	26
Pluzine	39
Podgorica	40
Rozaje	77
Savnik	40
Zabljak	28

It is therefore recommended that a Masterplan for water supply in the Project Area be undertaken, with the aims of :

- providing adequate volumes of water,
- eliminating physical water losses where economic to do so,
- protecting existing water supply systems - although there is provision in legislation (*Regulation on the methodology for identification and preservation of the sanitary zones for the water intakes protection, and restrictions regarding these zones: Official Gazette of the Republic of Montenegro, No. 8/97*) for this protection, in many cases, water supplies are compromised through inadequate application of measures, such as protecting catch-basins from animals by fencing and so on,
- improving metering and billing,
- improving bill collection rates,
- introduction of realistic tariffs and improved services
- expanding water supply systems where economic

Various practices such as using baths full of water to cool bottles of drink in the summer have been reported during the course of this Masterplan. Such practices account in part for the very high water consumptions in the Project Area. Hence another approach to reducing water consumption would be to instigate a **Public Awareness Campaign** to inform and educate people with regard to socially responsible use of water.

It will be necessary to raise tariffs in order to pay for the proposed projects, and, provided bill collection is improved, this will have some effect in reducing water consumption. But this will require that the metering of water supplies is improved so that consumption is directly linked to cost.

9.3 Water quality monitoring (Government)

TM 3 notes that there is very little data available to establish the quality of groundwater in the Project Area. Whilst the quality of surface water is monitored in more detail, this too is not fully adequate at present.

It is therefore recommended that the whole of the water quality monitoring process be reviewed with a view to establishing a comprehensive water quality monitoring programme for both surface water and groundwater. Guidelines issued by the EUROWATERNET could be the basis for the upgrading of the existing network, provided financial means are safeguarded to actually operate it.

9.4 Public awareness campaigns (Government/Donors)

Besides the public awareness campaign proposed in Section 9.1 above, another problem also needs to be brought to the attention of the public, and that is the problem of solid waste disposal in sewers.

This practice was observed in many towns, and is the main source of blockages in sewers.

A public awareness campaign to eliminate the disposal of solid waste into sewers is therefore proposed. This situation may improve when the solid waste disposal facilities proposed in the recent Solid Waste Masterplan are implemented, however there will still be a need for this campaign in the short term until such time as these measures are enacted.

9.5 Development of the GIS (ViKs and CEs)

The GIS developed for this project has been distributed to all Municipalities and ViKs/CEs.

All available data describing sewers were entered into the GIS. The structure of the associated database was set-up to accommodate many attributes such as levels of sewers and manhole covers, and the exact position of the manholes, etc. However, a vast amount of data was not available. Whilst this did not impede the development of the Masterplan, it will be necessary to have all this data available prior to executing the detailed design of the proposed projects.

To acquire this data is a very significant task. Podgorica ViK has spent more than 50 man-years in developing their GIS (which was the model for the Project GIS) to a very high standard, and Niksic ViK is applying the same techniques to the development of their system.

Whilst the detail incorporated in these two GISs is more than required for the detailed design noted above, at least the data describing the exact position of manholes, manhole cover and invert levels and pipe sizes should be acquired as soon as possible.

9.6 Sewer cleaning programme (ViKs and CEs)

The general assumption of this Masterplan is that existing sewers are generally serviceable and can be retained as part of the complete system. Some replacement of sewers has been considered necessary, but generally not more than about 20% of the existing systems.

In inspecting the sewers it was apparent that most are never cleaned, and that cleaning only takes place when blockages occur.

Consequently sewers generally have a large amount of accumulated material in them and this impedes flow and reduces the capacity of the sewers.

The equipment available to clean sewers is inadequate everywhere and this is the main reason for the problem.

A sewer cleaning programme is therefore required, and this could be established either at ViK/CE or on a regional or national level.

Acquisition of sewer cleaning equipment – particularly jetting machines and the associated vacuum tankers – should go ahead now, before the Masterplan proposals are implemented. This will facilitate the acquisition of data discussed in Section 9.5 above.

9.7 CCTV inspection of sewers (ViKs and CEs)

Sewers are normally inspected now with closed-circuit television cameras (CCTV) which record images of the inside of the sewers as they travel through them, and permit the structural condition of the sewers to be determined with great accuracy. Defects can be located easily, reducing the cost of repairs.

The assessments of the structural condition of the sewers for this Masterplan were made from manhole inspections coupled with knowledge of when and how the sewers were constructed, with the aid of the knowledge of local O&M staff. This is the best that could be achieved. However, it would be desirable to know whether these assessments are accurate, and whether the strategy of "planning to retain existing sewers unless there is strong evidence to the contrary" has been over-optimistic or not. That is, whether more sewers have to be replaced than were planned to be in this Masterplan.

The only way of finding out is to carry out a CCTV inspection of all the existing sewers, starting with the primary sewers. This could be arranged on a national level or on an individual ViK/CE level.

9.8 Elimination of stormwater connections to the foul sewers (ViKs and CEs)

The Masterplan has made an allowance for extraneous flows to the sewers system, but this allowance does not cover the formal connection of stormwater drains, which has been reported to a limited extent in some towns.

The assumption of the Masterplan has been that all these connections will be severed before the proposed projects are implemented.

The ViKs and CEs should begin this work, which in some cases will involve the construction of lengths of stormwater sewers, as soon as possible.

9.9 On-site sanitation facilities (Municipalities)

The Masterplan has proposed that existing septic tanks (infiltration pits) be retained for the foreseeable future, but that, when new houses are built, then formal septic tanks with infiltration trenches after them be constructed, the design parameters for which were set out in Chapter 5 of TM 7.

Besides this, some houses do dispose of wastewater directly to surface water or land without the use of a septic tank. This is not permitted under Montenegrin legislation.

It is therefore recommended that Municipalities take the steps necessary to ensure that all properties are served by sewers or on-site sanitation facilities, and that all new septic tanks be constructed in accordance with convention design as set out in the above mentioned reference.

9.10 Adoption of EU legislation (Government)

The National "Environmental" standards for wastewater discharge to public sewers and natural recipients (Regulation 10/97), and for surface water quality standards (Regulations 14/96, 19/96 and 15/97) were compared to EU Directive 91/271/EEC, which is to be absorbed into the Water Framework Directive (2000/60/EC).

It was recommended that the National Legislation be amended to conform to EU legislation, and the proposed projects were designed on this basis. If National Legislation is not changed, the main consequence will be that WwTPs will have to be designed to remove nutrients everywhere, (and not only for discharges of large settlements to sensitive receptors, as required by the EU Directive), which was considered to be an unnecessary expense.

If this recommendation is adopted, it will carry a number of obligations, including the need to determine which receptors are deemed "sensitive". This was done in a preliminary way for the Masterplan, but would need to be done more rigorously.

9.11 Establishment of control over industrial discharges (Government and Municipalities)

TM 2 made a number of recommendations concerning the regulation of industrial discharges. Failure to gain control over these discharges will put the proposed projects at risk, as design of the treatment plants was made on the assumption that the industries do comply with the limits for discharge to sewers, in other words they do not discharge "strong" untreated wastewaters directly to the sewers

The adoption of a Trade Effluent Agreement (Section 3.6.6 above), and measures to regulate industrial discharges to sewers (Section 3.6.7 above) are the most urgent.