DEVELOPMENT OF REMEDIATION PLANS WITH FINANCIAL REQUIREMENTS FOR ELIMINATION OF INDUSTRIAL HOTSPOTS

(EUROPEAID/123674/D/SER/MK)

FEASIBILITY STUDY – Volume II – MHK Zletovo - Veles

Development of Remediation Plans with Financial Requirements for Elimination of Industrial Hotspots
An EU-funded project managed by the European Agency for Reconstruction

FEASIBILITY STUDY – Volume II – MHK Zletovo – "Topilnica" - Veles

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LIST OF ABBREVIATIONS

AP	Action Plan
BAT	Best Available Techniques
BATNEEC	Best Available Techniques Not Entailing Excessive Costs
CARDS	Community Assistance, Reconstruction, Development and Stabilisation
CE	Central-East
CHIP	Chemicals Hazard Information & Packaging
COSHH	Control of Substances Hazardous to Health
DALY	Disability Adjusted Life Years
DS	Dangerous Substances
EAR	European Agency for Reconstruction
EIA	Environmental Impact Assessment
EBRD	European Bank for Reconstruction and Development
EC	European Commission
ESC	Environmental Steering Committee
€	Euro
EIONET	European Environmental Information and Observation Network
EU	European Union
GIS	Geographic Information System
GLPs	Good Laboratory Practices
GoM	Government of Macedonia
GPS	Global Positioning System
GTZ	Gesellschaft fuer Technische Zusammenarbeit
HWL	Hazardous Waste List
HZW	Hazardous Waste
HZWM	Hazardous Waste Management
IFI	International Financial Institution
ISC	Inter-ministerial Steering Committee
ISPA	Instrument for Structural Policies for Pre-accession
IPH	Institute for Health Protection
IPPC	Integrated Pollution Prevention and Control
ISIC	International Standard of Industrial Classification Rev. 2 1968 (UNIDO)
KfW	Kreditanstalt für Wiederaufbau (German Bank for Reconstruction)
LOAEL	Lowest-Observed-Adverse- Effect Level
LoW	List of Wastes
LSG	Local Self Government

LWM	Law on Waste Management
MoEPP	Ministry of Environment and Physical Planning
MoH	Ministry of Health
MoF	Ministry of Finance
MoE	Ministry of Economy
MoTC	Ministry of Transport and Communication
NACE	The EC statistical office (Eurostat) classification scheme of economic activities. ('Nomenclature générale des Activités économiques dans les Communautés Européennes' [General Industrial Classification of Economic Activities within the European Communities])
NE	North-East
NEAP	National Environmental Action Plan
NOAEL	No-Observed-Adverse-Effect Level
NWMP	National Waste Management Plan
REC	Regional Environmental Centre for Central and Eastern Europe
REReP	Regional Environmental Reconstruction Programme
RfD	Reference Dose
POPs	Persistent Organic Pollutants
REReP	Regional Environmental Reconstruction Program for South Eastern Europe
PPP	Public Private Partnership
RIHP	Republic Institute for Health Protection
SAA	Stabilisation and Association Agreement
SC	Steering Committee
SMEs	Small and Medium Size Enterprises
SoEs	Social owned entities
SW	Solid Waste
SWM	Solid Waste Management
TA	Technical Assistance
TCLP	Toxicity Characteristic Leaching Procedure
TNA	Training Needs Analysis
ToR	Terms of Reference
UNDP	United Nation Development Programme
UNEP	United Nation Environmental Programme
WHO	World Health Organization
WG	Working Group
WWT	Waste Water Treatment
YYL	Years of life lost

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Disclaimer

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Volume 00_B	Process Assessment
Volume 00_C	Environmental Impact Assessment
Volume 00_D	Public Information Assessment and Action Plan
Volume 00_E	Geotechnical Assessment
Volume 00_F	Geo referencing and Mapping
Volume 00_G	Samples and Analyses
Volume 00_H	Economical and Financial Evaluation

Извршно резиме

Главната цел на проектот е да помогне во елиминација на индустриските жешки точки во земјата, преку развој на санациони планови, со финансиски барања за 4 индустриски жешки точки. Проектот е финансиран од ЕУ и спроведуван_од страна на шпанската компанија Eptisa, со Министерството за животна средина и просторно планирање како главен корисник.

Во моментот, поранешната Југословенска Република Македонија нема системски пристап или политика за ремедијација на овие жешки точки. Нивното влијание не е целосно познатао, трошоците за расчистување не се систематски проценети; финансирањето за најголем дел е недостапно; институциите за имплементација не се поставени, дури и сопственоста на овие еколошки товари во пост приватизациска поставеност е нејасна. Што се однесува до контролата на индустриско загадување и управување со ризикот, МЖСПП има собрано список од инсталациите кои ќе бидат подложни на интегрирани еколошки дозволи, но интегрираното спречување и контрола од загадување треба да стане оперативно. Некои елементи од ЕУ легислативата во областа на контрола на хаварии, кои вклучуваат опасни супстанции се транспонирани во националното законодавство, но сепак целосна транспозиција сеуште не е остварена. Капацитетот на МЖСПП и на други заинтересирани страни треба да се зајакне (локална самоуправа, претпријатија итн.), за имплементирање на мерки за контрола на индустриско загадување и управување со ризикот. Во 2003 година, земјата започна со хармонизација на националното законодавство од областа на животната средина, со законодавството на ЕУ. Беа подготвени пет основни закони (Закон за животна средина, Закон за управување со отпад, Закон за води, Закон за природа и Закон за квалитет на амбиентниот воздух) и неколку подзаконски акти (ИСКЗ Уредба за определување на активностите на инсталациите за кои се издава интегрирана еколошка дозвола, односно дозвола за усогласување со оперативен план и временски распоред за поднесување на барање за дозвола со усогласување со оперативен план; ИСКЗ Уредба за постапката за издавање на интегрирана А еколошка дозвола; Правилник за постапката за издавање дозвола за усогласување со оперативен план**;** Правилник за формата и содржината на дневникот за евиденција за постапување со отпад, формата и содржината на формуларите за идентификација и транспорт на отпадот и формата и одржината на обрасците за годишен извештај за постапување со отпад ; Листа на видови отпад. Сите горе споменати закони и подзаконски акти се однесуваат целосно или во некоја мера на отпад и управување со опасен отпад, но ниеден од нив директно не ги споменува или регулира „индустриските жешки точки".

Методологијата е базирана на :

Проценка за ризикот по здравјето,

Геотехнички истражувања,

Проценка на јавната свест и информирање,

Проценка на процесот и квалитативна и квантитативна идентификација на токовите на отпадот, проценка на влијанието врз =ивотната средина,

Идентификација на опции за третман,

Еколошко рангирање на идентификуваните опции за третман, Идентификација на економски индикатори,

Финансиска евалуација на разни опции за ремедијација и економска евалуација на истите.

Во сите случаи се земени во предвид најдобрите можни пракси за поранешната Југословенска Република Македонија. Методологијата се состои наизменично од процедура на проверка и рангирање. Специфичната ситуација на двата загадувачи во ОХИС ја наметнува потребата за соединување на две „feasibility“ студии во еден документ, додека двете места се проецнуваат наизменично.

Главни загадувачи на локацијата се олово и цинк од поранешните депонирања на троска, од поранешното работење на топилницата (МХК – Злетово – Велес). Производствената линија е затворена во 2003. Депонирани се остатоци од кокс, на локација близу до топилницата, што не е дел од програмата и припаѓа на повторното отворање и/или затварање на фабриката. Оцената на процесот укажува на депонирани 1,8 Mio Mg на троска која содржи олово и цинк. Локацијата е само делумно покриена и затоа очигледни се тековните емисии, но не се големи и имаат секундарно значење. Не може да се претпостави дека реката Вардар е под директно влијание од постоечката депонија на троска.

Како резултат на поранешниот процес на производство, во почвата наменета за земјоделски активности и јавните места на општината, акумулирани се олово, цинк и кадмиум како резултат на загадување на воздухот. Претходно извршените истражувања покажуваат дека не само почвата, туку и храната произведена на земјоделските површини, покажува зголемено ниво на тешки метали. Извршените истражувања на подземната вода ја потврдија претпоставката дека како резултат на слабата мобилност на тешки метали, повеќето загдувачи се останати во почвата и не се пренесени во подземната вода.

Процената на ризикот од влијание врз здравјето, во 2006 идентификуваше тековно загадување на воздухот од кадмиум, што може да се случи само поради несоодветното повторно отворање на производната единица.

Очигледно е дека активностите треба да се насочат на 4 главни области, оние за деконтаминирање на почвата на јавните „зелени“ области и земјоделското земјиште, оние за повторното отворање и/или затварање на постоечките објекти и санација на постоечката депонија на троска.

Квалитативната процена на ризик по здравјето **(Volume 00_A)** го рангираше влијанието врз здравјето како високо. Главно влијание врз здравјето на луѓето е предизвикано од поранешните производствени активности. Идентификувани како главни опасни материи, се оловото и кадмиумот. Во моментот, извори на тековно загадување се постоечката депонија на троска и прашина акумулирана во фабриката. Миграционите патишта вклучуваат ерозија на фини честички преку ветер, почва и водните текови. Ризикот по здравјето на луѓето, како резултат на соединенија на олово и кадмиум, е рангирано како многу високо. Ризикот од влијание врз здравјето е означен како умерен до висок. Затворањето на топилницата и третман на троската или санација на депонијата, значително ќе го намали ризикот по човековото здравје. Во продолжение, треба да се превземат мерки за санација на големите земјоделски површини и јавно земјиоште со цел да се пресечат секундарните миграциони патишта.

Локација	**Опасности**	**Можни ефекти по здравјето**	**Потенцијаел број на луѓе под влијание**
Поранешна топилница- Велес + Фабрика за ѓубриво	Загадување со олово, никел и кадмиум поранешните активности на фабриката	Олово: токсични и карценогени ефекти кај бремениу жени и деца; оштетувања во ЦНС	47.000 жители

Сумарно рангирање

Жариште	**Загадувач**	**Опасност**	**Ризик**	**Ранк**
Велес	Pb, Cd (Zn)	Голема	Висок	1

Од еколошка гледна точка, влијанието на постоечката депонија на троска врз почвата, може да се смета за толерантно или поврзано со долгиот период на напуштеност на производството, како НИСКО. Резултатите покажаа постоење на олово, цинк, кадмиум и арсен во подземната вода. Некои од резултатите ја надминуваат максимално дозволената концентрација, според холандските стандарди.

Контаминацијата од олово е лоцирана во блиската околина на топилницата, цинкот, кадмиумот и арсенот имаат поширока област на влијание, додека, бакарот и живата не покажуваат никакво ниво на загадување. Не се појави очекуваното влијание во село Башино. Влијанието е скоро пропорционално со растојанието на топилницата, во главната насока на ветрот. Влијанието во близина на топилницата може да се смета за умерено, додека во поголемо растојание, како ниско до умерено, но очигледно. При развојот на целите, ќе се земе во предвид поширокиот опсег на истражување на почвата во јавните зелени зони и земјоделски зони.

Влијанието на отпадните води настанати со лужење на депонијата, врз подземните води, може да се смета за (многу) мало. Троската од депонијата во Велес не е опасна и може да се управува како инертна депонија.

ЛОКАЦИЈА	**Средина**	**ЗАГАДУВАЧ и КОЛИЧЕСТВО**	**ВЛИЈАНИЕ и РИЗИК**	**ВРЕМЕТРАЕЊЕ И ДИМЕНЗИИ**
Троска-Депонија: Куп, троска од топилница-Велес **Депонија на троска** Површина на депонија: 33.000 m^2 Делумно покриена со почва	**Цинк, олово, кадмиум, тешки метали-** 1.800.000 t **Zn**: ≈ 70.000 mg/kg (7%) **Pb:** ≈ 10.000 mg/kg (1%) **Тешки метали :** 2-4000 mg/kg (Mn, Ni, As, Cu)	Влијание: врз здравје и животна средина: Ниско Ризик: Низок Ризик од стабилност на депонијата:Висок	Нема Доколку има-локално	**Троска-Депонија** Куп, троска од топилница **Депонија на троска** Површина на депонија: 33.000 m^2 Делумно покриена со почва

Според хемиските карактеристики на елементите присутни во троската, карактеристиките на почвата каде се лоцирани депониите и растојанието на депониите од населените места, мора да се земат во предвид влијанијата. Почвата околу фабриката и депонијата е контаминирана како резултат на мобилноста на елементите и нивното долготрајно влијание (долгиот животен век) како и растворливоста во вода која предизвикува контаминација на подземната вода и во исто време контаминација на водата за пиење. Во бунарите за вода за пиење, овие елементи се забележани во голема концентрација. Исто така и воздухот околу депонијата и во околната област е загаден од прашината од депониите. Нивото на олово близу топилницата, може да претставува опасност по здравјето, особено за деца, ако се вдише во одредени количини. Индивидуалци може да се излжени на олово преку дишење на контаминираната прашина, преку голтање на контаминираната почва, преку јадење на недоволно измиена храна, која е одгледувана на контаминираната почва. НЕАП извести дека нивоата на кадмиумот, оловото и цинкот се 10- 15 пати повисоки во зеленчукот одгледуван во Велес, во споредба со контролираните области. Во спанаќ и зелка е пронајдено 4-10 пати повеќе од дозволеното ниво на олово и кадмиум што е резултат на контаминација на почвата.

Ризикот од сегашната депонија е низок до умерен; ризикот од зафатената почва, подземната вода, површинската вода и од ланецот на храна е Умерен до Висок.

Според законот за градба, сите градби треба да се конструирани како отпорни на земјотрес со ранг од 7 - 8 според Меркалиевата скала. Сеизмичкиот ризик може да се смета за умерен до висок.

Дозволениот товар е 6,2 пати повисок. Земајќи го во предвид нагибот на теренот, постои висок ризик од лизгање во насока на речното подрачје. Депонијата на троска мора да се премести или израмни на површина со максимум висина од 5 m, за што би била потребна област од 20 ha (17 ha во дополнение)

Земени се во предвид санациските опции in situ, ex situ, на локација, надвор од локација. Тие алтернативи се поделени на биоремедијација, хемиски, физички, термални и други санациски процеси.

За депонијата земени се во предвид 5 опции, како што се: непревземање активности, мерки за намалување на влијание-покривање, третман на испарување на локација и надвор од локација, и надоместување на останатите соединенија на олово и цинк и нивно депонирање надвор од локација. Проценета и повторната употреба на резидуите по процесот на испарување.

За санација на депонијата на троска (контаминирана локација со тешки метали) рангирани се следните опции од процената на животната средина, како најпогодни за понатамошна финансиска и економска евалуација:

Ископување и третман надвор од локација и третман на резидуи	– 1
Ископување и третман надвор од локација и депонирање	– 2
На локација мерки за ублажување на влијание-покривање	– 3
Не превземање на активности	[– 4]

За санација на јавните зони (зелени зони), рангирани се следните опции од процената на животната средина, како најпогодни за понатамошна финансиска и економска евалуација:

Фиторемедијација без производство на храна	– 1
Ископување и депонирање надвор од локација и замена на почва	– 1
Не превземање на активности	[– 2]

За санација на земјоделските површини, рангирани се следните опции од процената на животната средина, како најпогодни за понатамошна финансиска и економска евалуација:

Фиторемедијација без производство на храна	– 1
Ископување и депонирање надвор од локација и замена на почва	– 1
Не превземање на активности	[– 2]

Сите мерки треба да се имплементираат паралелно- превземање на само една активност нема да доведе до потребните и посакуваните резултати.

Економски најпогодната опција, според позитивното влијание на различни индикатори е да се наметне отстранување на троската и повторно да се употреби за производство на олово и цинк, без повторна употреба на внатрешниот материјалl, туку да се употреби за изградба на улици, фабрики за цемент, материјал за полнење на комунални депонии или како покривен материјал за депонијата на гипс. Реактивацијата на земјиштето употребувано за земјоделство ќе генерира приход од една страна, како резултат на неутрални активности на CO_2 , пошумување, вклучувајќи стабилизација на почвата и нагибот и продажба на земјоделски производи и дрво за греење.

Финансиската евалуација истражи разни опции за третман на локација и надвор од локација, мерки за ублажување на влијание (insitu) и депонирање надвор од локација, додека следните резултати го покажуваат рангирањето според финансиската активност во Euro/Mg.

Ископување + Третман на локација + Реупотреба на резидуи + Санација на долен слој на почва	131
Ископување + Третман надвор од локација + Санација на долен слој на почва	113
Ископување + Третман на локација + Санација на долен слој на почва	70
Прамнување на област и покривање	-6,64
Ископување + депонирање надвор од локација	-18

Јавните зелени зони имаат површина од 228.237$м^2$, додека опширното истражување (длабинско истражување) ќе биде превземено. Материјалот ќе биде покриен и депониран надвор од локација (во најлош случај 70 km до Лојане). Пресметани се 500 примероци. Вкупните оперативни трошоци ќе достигнат **2,4 Mio Euro**, што доведува до трошоци за специфичен третман во висина од 21, 38 Euro / m^3 ископана и сменета почва.

Земјоделската област ќе биде фиторемедирана, додека потребни се 250.000 Euro за инвестирање за растенија. Се претпоставува дека 20% од вкупната површина е зафатена над Холандските стандарди, што претставува површина од 80,6 ha. Оперативниот приод се смета дека ќе биде 5 години. За ова време, земени се во предвид такса за компензација од 0,194 Euro/ $м^2$ и една година. Ова ги рефлектира загубите во производствот за овој период. Ќе бидат земени 1500 примероци во период од 5 години, за да се покаже дали концентрацијата на тешките метали во почвата се намалува. Идентификувани се и пресметани се специфични трошоци од 2,09 Euro. Вкупни трошоци од 1,7 Mio Euro резултираат од тие трошоци.

Од потребните инвестиции од 2,4 Mio Euro за санација на јавните области и 1,7 Mio Euro за рехабилитација на земјоделското земјиште (вкупно 4,1 Mio Euro) **порамнувачка концесиска такса од 9,11 Euro / Mg** троска ќе биде договорена како минимум, со цел да се постигне имплементационен период од минимум 5 години.

Најдобра економска корист ќе се постигне со комбинирање на ископување на локација и повторна употреба на резидуите, во фабрика за цемент. Компниите за ископување, персоналот од производствените единици и покривање на финалната долна почва. Специфичниот обрт е 131 Euro / Mg од троска. Земена е во предвид пресметката во најлош случај, со ефикасност на повторна употреба од 6%, што може лесно да се постигне. Индиректната корист во овој случај е најголема, со одприлика 500.000 Euro годишно и оперативен период од 20 години. <u>Враќањето на инвестициите е пократко од 4 години.</u> Фиторемедијацијата ќе биде извршена на зафатените земјоделски површини, кои покажуваат постоење на тешки метали над дозволента концентрација според Холандските стандарди, додека почвата во област на општината ќе биде заменета со јавни зелени површини. Времето за извршување замена на почва е помалку од една година, за фиторемедијација на зафатените земјоделски површини е најмалку 5 години. Ќе треба да се извршат дополнителни длабински истражувања на почвата и ше бидат објаснети во целите на проектот (TOR).

Втора изводлива опција е чисто рекламирање (концесија) на материјалот, поради не постоење на трошоци за депонирање. 113 Euro / Mg троска може да се постигне, вклучувајќи го транспортот и санациските трошоци. Ситуацијата со индиректните трошоци е далеку понеизводлива одколку претходно опишаната опција и покажува помалку од 250.000 Euro годишно за период од 10 години. Фиторемедијацијата и замената на почва ќе бидат извршени како што е споменато во преферираната опција.

Предложената методологија ќе има позитивен ефект врз еколошката ситуација, особено на влијанието врз здравјето, ќе го одбие директното влијание на загдувачите, ќе го опфати економскиот пристап на позитивен начин, ќе ја зголеми геотехничката стабилност, ќе покаже позитивен ефект во намалување на прекуграничното и ќе ја одрази вкупната и специфичната цел на проектот финансиран од ЕУ.

Executive Summary

The main purpose of this project is it to assist in the elimination of industrial hotspots in the country through the development of remediation plans for 4 hotspots with financial requirements. The project is financed by EU and executed by the Spanish Company Eptisa with the Ministry of Environment and Physical Planning as main beneficiary.

Currently, the former Yugoslav Republic of Macedonia has no systematic approach or policy for addressing and remediation of these environmental hotspots. Their impact is not fully known, clean up costs are not systematically estimated; funding for the most part is unavailable; implementing institutions not set up and even “ownership” of these environmental burdens in a post- privatised setting is not clear. Regarding industrial pollution control and risk management, the MOEPP has compiled an inventory of installations to be subject to integrated environmental permits, but integrated pollution prevention and control system has yet to become fully operational. Some elements of EU legislation on the control of major accident hazards involving dangerous substances appear to have been transposed into national law, but full transposition still has to be completed. The capacity of the MOEPP and other concerned parties (local governments, enterprises, etc.) to implement industrial pollution control and risk management measures needs to be strengthened. In 2003, the country started the harmonisation of the national environmental legislation with the legislation of EU. Five basic laws (Law on the Environment, Law on Waste Management, Law on Waters, Law on Nature and Law on Ambient Air Quality) and several sub-laws (IPPC Decree for determining the Installations for which an Integrated permit is required and time schedule for submission of the adjustment plans, IPPC Ordinance regulating the procedure for A integrated environmental permit, Regulation on Transportation, Recording and Reporting on Wastes, List of Wastes,) were prepared. All abovementioned laws and sub-legislation refer completely or to some extent to waste and hazardous waste management, but none of them directly mentions or regulates “industrial hotspots”.

The methodology is based on

The assessments of health risk impact,

Geotechnical investigation,

Public awareness and information assessment,

Process assessment and the identification of qualitative and quantitative waste streams, the environmental impact assessment,

The identification of treatment options,

The environmental ranking of identified treatment options,

The identification of economical indicators,

The financial evaluation of various remediation options and the economical evaluation of those.

In all cases have been taken best practise possibilities for former Yugoslav Republic of Macedonia into consideration. The methodology consists of a alternating procedure of screening and ranking. The site-specific situation of two pollutants at Ohis site makes two feasibility studies in one document necessary, while both spots are always alternating evaluated.

Main pollutants on the site are Lead and Zinc from former slag disposal activities of the Topilica smelter facility (MHK – Zletovo – Veles). The production line is closed since 2003. Coke residues have been disposed on a site close to the smelter facility and is not part of the program and belongs to the re- and/or decommissioning process of the facility. The process evaluation indicates a disposal of 1,8 Mio Mg of Lead and Zinc containing slag. The site is only partly covered and therefore are emissions evident, which are ongoing, but not major and have secondary priority. It cannot be assumed, that the Vardar River is direct impacted from the current existing slag dumpsite.

Due to the former production process have Lead, Zinc and Cadmium been accumulated in the soil of agriculture and public areas of the municipality due to air pollution. Former conducted investigations have shown, that not only soil, but also food, produced on the agriculture or horticulture areas, showing increased levels of heavy metals. The current conducted groundwater investigation has underlined the assumption, that due to the low mobility of the heavy metals, that most of the pollutants have remained in the soil and have not been transmitted into the groundwater.

The health risk impact has identified in 2006 an ongoing air pollution by Cadmium, which can only be occurred due to an improper recommissioned production facility.

It occurs obvious that the activities have to focus on 4 main areas, those to decontaminate the soil of public “green” areas and of agriculture land, the re- and/or decommissioning of the existing facility and the remediation of the existing slag dumpsite.

The qualitative health risk assessment **(Volume 00_A)** ranked the impact on health still as high. Main impacts on the human health have been caused by former production activities. Main hazardous material identified, are Lead and Cadmium. Current sources of ongoing pollution are the existing slag dumpsite and dust accumulated on the plant construction. Migration paths include the wind erosion of fine particles, soil and watercourses. The risk on human health due to lead and cadmium compounds are in principle ranked as very high. The current health impact risk is marked as moderate to high. Decommissioning of the smelter and treatment of the slag or remediation of the dumpsite will significant reduce the risk on human health. In addition measures have to be undertaken to remediate large areas of agriculture and public land in order to cut secondary migration paths.

Hazardous site	**Hazards**	**Possible health effects**	**Potential number of excised people**
Former Smelter Company - Veles + Fertilizer company	Lead, nickel and cadmium contamination during past years of smelter company activities	Lead: toxic and carcinogenic effects in pregnant women and children; CNS damages	47.000 inhabitants

Ranking Summary

Spot	**Pollutants**	**Hazard**	**Risk**	**Rank**
Veles	Pb, Cd (Zn)	High	High	1

The environmental impact of the existing slag dumpsite on soil could be from the environmental view of point treated as tolerant or related to the long period of the abandoning of the production as **LOW**. Results showed the existence of Lead, Zinc, Cadmium and Arsenic in ground water. Some of results are exceed maximal permit concentration by Dutch standards.

The lead contamination is located in the close surrounding area of the smelter, Zinc, Cadmium and Arsenic have a wider impacting area, while Cupper and Mercury does not show any contamination level. The expected impact in the village Bosino Selo does not occur. The impact is almost proportional to the distance of the smelter plant in the main wind direction. The impact nearby the smelter can be attested as moderate, while in a more distance as **low till moderate**, but evident. A wider range of extended investigation of soils of the public green areas and agriculture area will be taken into consideration within the development of the Terms of References.

Impact of leaching waters from the existing landfill on ground waters could be estimated as (very) low. The slag from the Veles dumpsite isn't hazardous one and could be practically managed and disposed as inert one.

LOCATION	MEDIA	CONTAMINANT and QUANTITY	IMPACT and RISK	DURATION and DIMENSION
Slag – Dumpsite: Pile, Slug from smelter plant **Slag Dumpsite** Surface of dumpsite: 33.000 m^2 Partially covered with soil	**Zinc, lead, Cadmium, heavy metals -** 1.800.000 t **Zn**: ≈ 70.000 mg/kg (7%) **Pb:** ≈ 10.000 mg/kg (1%) **Heavy metals :** 2-4000 mg/kg (Mn, Ni, As, Cu)	Impact: on health and environment Low Risk: Low Risk of dump stability - high	Non If any – local	**Slag – Dumpsite:** Pile, Slug from smelter plant **Slag Dumpsite** Surface of dumpsite: 33.000 m^2 Partially covered with soil

According to the chemical characteristic of the elements present in the slag and characteristics of the soil where are located dumpsites and distance of the dumpsites of the inhabited places the impacts must be taken into consideration. The soil around the factory and dumpsites is contaminated as a result of mobility of the elements and its long terms impacts (long life) also its solubility in water they provoked contamination of ground water and at the same time contamination of drinking water. In the wells for drinking water are determined these element in high concentration. Also the air around the dumpsite and its surrounding is polluted of speeded dust from the dumpsites. Lead levels near the smelter may pose a health hazard, particularly to children, if ingested or inhaled in sufficient quantities. Individuals can be exposed to lead by breathing contaminated dust, by swallowing contaminated soil, and by eating food not thoroughly washed that has been grown in contaminated soil. The NEAP reported that cadmium, lead and zinc levels were 10- 15 times higher in vegetables grown in Veles relative to control regions. As much as 4 to 10 times the acceptable levels for lead and cadmium were found in spinach and lettuce due to soil contamination.

The risk exposed from the current dumpsite is low to moderate; the risk exposed from impacted soil, groundwater, and surface water and through the food chain is **Moderate to High.**

The pollution dilution investigation referred to geoelectrical (resistivity) measures and identified mainly surface pollution in the eastern area of the slag dump, into Vardar river direction. 4 anomaly zones have been detected with a depth of 0-15m. In addition have been top soil samples conducted, which underlined the present geoelectrical result. Main pollution in the surrounding area of the facility sites are caused by former production and not from the current existing site. The surface pollution is mainly located in the watershed of the slope downhill and increases the depth in proportion to the distance and in relation with the water flow. Maps and dilution profiles have been produced and recommendations for a total of 7 piezometers with depths of 15m including coordinates have been stated.

According to the building code have all buildings to be constructed to resist an earthquake rank 7 - 8 on the Mercali Ranks. The seismic risk can be evaluated as moderate till high.

The permitted load is 6,2 times exceeded. In addition to the circumstance of a slope situation can the risk for hang sliding along the watershed been ranked as high. The slag dump has to be removed or flattened up to a maximum height of 5 m, which would require and area of 20 ha (17 ha in addition).

The remediation options have taken in situ, ex situ, on site and off site alternatives into consideration. Those alternatives have certainly been divided into bioremediation, chemical physical, thermal and other remediation processes.

For the dumpsite have been taken 5 possibilities into account, such as no activities, onsite mitigation measures - capping, onsite and offsite fuming treatment and recovery of remaining Lead and Zinc compounds and off site disposal. The reuse of residues after the fuming process has been evaluated.

For the remediation of the slag dumpsite (heavy metal contaminated site) have following options been ranked from the environmental assessment as most appropriate for further financial and economical evaluation:

Excavation and off site treatment and residues treatment	– 1
Excavation and off site treatment and back disposal	– 2
On site mitigation measures – Capping	– 3
No activities	[– 4]

For the remediation of public area (green areas) have following options been ranked from the environmental assessment as most appropriate for further financial and economical evaluation:

Phytoremediation with non-food production plants	– 1
Excavation, off site disposal and soil exchange	– 1
No activities	[– 2]

For the remediation of the agriculture areas have following options been ranked from the environmental assessment as most appropriate for further financial and economical evaluation:

Phytoremediation with non-food production plants	– 1
Excavation, off site disposal and soil exchange	– 1
No activities	[– 2]

All measures have to be implemented in parallel steps – a single stated activity will not lead to the required and objected results.

The most economic feasible option according to positive influence to different indicators is to force the removal of the slag and to reuse it for Lead and Zinc production without redisposal of the inter material, but to reuse it in street construction, cement factories, as infill material for municipal dumpsites or as cover material for the existing gypsum dumpsite.

The reactivation of agriculture used land will generate income, on the one hand due to CO_2 neutral activities, reforestation including soil and slope stabilisation and selling of agriculture products and fire wood.

Financial evaluation investigated various options of onsite, offsite treatment, the mitigation measures (insitu) and off site disposal, while following results show the ranking according the financial attractivity in Euro/Mg.

Excavation + Onsite Treatment + Reuse of Residues + remediation of bottom soil	131
Excavation + offsite Treatment + remediation of bottom soil	113
Excavation + onsite Treatment + remediation of bottom soil	70
Flattening of area and capping	-6,64
Excavation + off site disposal	-18

The public green areas have a surface of 228..237sqm, while extensive investigation (depth investigation) shall be undertaken. The material shall be covered and off site disposed (worst case 70 km to Lojane). 500 samples have been calculated. The total operation costs will reach **2,4 Mio Euro**, which results in specific treatment costs of 21, 38 Euro / m^3 excavated and exchanged soil.

The Agriculture area will be phyto-remediated, while 250.000 Euro are required as investment for plants. 20% of the total surface are assumed to be impacted above the Dutch standards, which is a surface of 80,6 ha. The operation period is assumed with 5 years. During this time a compensation fee of 0,194 Euro/sqm and year has been taken into consideration. This reflects the losses of productivity during this period. 1500 Samples shall been taken within a period of 5 years in order to analyse the heavy metal declining in the soil. A specific cost of 2,09 Euro has been calculative identified. Overall costs of 1,7 Mio Euro are resulting out of that costs.

Out of required investments 2,4 Mio Euro for the public area remediation and 1,7 Mio Euro for the rehabilitation of agriculture land (a total of 4,1 Mio Euro) a **break even concession fee of 9,11 Euro / Mg** slag shall be minimum contracted (bottom line) in order to reach a minimum 5 years implementation period.

The most economical benefit can be achieved by the combination of excavation, “on site” treatment and the reuse of the residues in the cement factory. Excavation companies, production facility staff and capping of final bottom soil. The specific turnover is 131 Euro / Mg of Slag. The worst-case calculation has been taken into

consideration with a reuse efficiency of 6%, which can be easily achieved. The cross benefit and indirect benefit in this manner the highest with approximate 500.000 Euro per year during an operation period of 20 years.

<u>The ROI is less than 4 years.</u>

Phytoremediation shall be conducted on agriculture impacted areas, which evidence heavy metal values above the permitted concentrations of the Dutch standards, while within the municipal area soil shall be replaced from public green areas. The time period for the soil exchange is less than one year, for the phytoremediation activities onto impacted agriculture areas at least 5 years. Additional depth soil investigation have to be conducted and will be described within the Term of References (TOR).

Second feasible possibility is the purely marketing (concession) of the material, due to the fact, that no disposal costs are occurring. 113 Euro / Mg slag can be achieved, excluding the transport and remediation costs. The cross benefit and indirect benefit situation is far not that feasible than previous described option and shows less than 250.000 Euro per year within a period of 10 years. Phytoremediation and Soil exchange shall be conducted as in the preferred option described.

The proposed methodology will have positive benefit in the environmental situation, especially in the health impact situation, will decline the direct impact of pollutants, tackles economical approaches in a positive way, increases the geotechnical stability, shows positive effect in a reduced cross boarder pollution and reflects the overall and specific objectives of the EU funded project.

1 Introduction

The Stabilisation and Association Agreement (SAA) signed with the EU (in 2001and enforced since 2004) places new obligations on the administration in the vital task of combating environmental degradation. The Ministry of Environment and Physical Planning (MOEPP) has the responsibility to define environmental tasks, responsibilities and mandates and to arrange sufficient staffing to meet its obligations.

The former Yugoslav Republic of Macedonia faces similar problems in the environmental sector to those of many other former command economies in Central and Eastern Europe. In particular, inadequate solid waste management and numerous industrial hotspots (including historical industrial pollution sites) have in some cases led to threatened public health and environmental implications.

In the last two years, the MOEPP has worked on the development of five environmental laws, including the Law on Environment as a framework law in the area of environment, which transposes the *Acquis Communautaire* into the national legislation. The Law on Environment was adopted by Parliament in July 2005, and incorporates the basic principles of environmental protection, on the basis of which the relevant environmental management procedures are regulated.

Environmental management in the former Yugoslav Republic of Macedonia is guided by the second National Environmental Action Plan adopted by the Government in March 2005.

1.1 Current state of affairs in Industrial Hotspots Management

The lack of suitable infrastructure hampers adequate waste disposal in general and disposal of hazardous waste in particular. There is only one licensed (though not acquis-compliant) landfill in the country compared to around a thousand illegal dump sites, there are no incineration (except for medical waste), no composting and few recycling facilities. Hazardous waste is exported in accordance with the Basel Convention[1]. A register and maps for pollutants and polluting substances for solid and hazardous waste and wastewaters were completed in September 2005.

Regarding industrial pollution control and risk management, the MOEPP has compiled an inventory of installations to be subject to integrated environmental permits, but integrated pollution prevention and control system has yet to become fully operational. Some elements of EU legislation on the control of major accident hazards involving dangerous substances appear to have been transposed into national law, but full transposition still has to be completed. The capacity of the MOEPP and other concerned parties (local governments, enterprises, etc.) to implement industrial pollution control and risk management measures needs to be strengthened.

Environmental burdens left behind by state-controlled industry have now been transferred over to new owners, in most cases without clear specification of environmental liability. Old environmental contaminated industrial sites represent a serious risk for humans who live in or near the contaminated areas, because of either their direct negative impact on the human health or, indirectly, through pollutants in the food chain production. Currently, the former Yugoslav Republic of Macedonia has no systematic approach or policy for addressing and remediation of these environmental hotspots. Their impact is not fully known, clean up costs are not systematically estimated; funding for the most part is

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[1] Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal

unavailable; and even “ownership” of these environmental burdens in a post- privatised setting is not clear.

Decades of industrialization and extensive exploitation of natural resources have left certain number of areas in the country heavily polluted. Since independence no significant concrete investments in this regard have taken place for the protection of the environment. As a result many uncontrolled municipal, as well as industrial landfills and wild dumps proliferated.

In the frame of CARDS 2001 project for development of National Waste Management Plan with Feasibility Studies 16 Industrial Contaminated Sites - “hotspots” were identified and ranked according environmental indicators. In the frame of Cards 2006, the project took additional indicators into consideration, such as:

- Environmental Indication from the Cards 2001
- Exclusion Criteria
    - Ongoing Donor Activities; avoiding of overlaps and replication; overwhelming factors
- Public Health
- Public Sensitivity
- Seismic and geotectonic Risk
- Climate impacting factors
- Cross Border pollution prevention in accordance with Cards 2003
- Economical Benefit and Impacts

Taken those indicators into consideration the project proposed to focuses on 4 prioritised “hotspots”:

- **OHIS A.D (organic chemical industry) - Skopje**
- **MHK Zletovo (lead and zinc smelter) - Veles**
- **Silmak Ferro-silicon plant (former HEK Jugochrome) – Jegunovce / Tetovo**
- **Makstil (iron & steel plant) – Skopje**

2 Objectives / Results / Scope

"The overall objective of the project is to support the remediation of industrial hotspots on a environmentally and financially sustainable manner by promoting donor funding to the sector"

2.1 Specific objectives

The purpose of this contract is to assist in the elimination of industrial hotspots in the country through the development of remediation plans for 4 hotspots with financial requirements

2.1.1 Results to be achieved by the Consultant

- Baseline conditions at 4 Industrial Hotspots identified with project data room and Industrial Hotspot database established
- Qualitative human health and environmental risk assessment related to historical contamination at 4 Industrial Hotspots performed
- Remediation feasibility studies for 4 Industrial hotspots performed
- Pilot site selected based on applying additional prioritisation criteria
- Technical design/ technical specification documents, financial / economical appraisals of remediation alternatives and EIA (if needed) and ToR for remediation of selected pilot site prepared
- ToR for supervision services for remediation works on selected pilot site prepared

2.1.2 Scope of the work

2.1.2.1 Project description

The project will:

- Identify baseline conditions at 4 Industrial Hotspots through collection and analysis of existing data and performing additional site investigation
- Put a strong emphasis on training and capacity building of local stakeholders in the field of contaminated site assessment and remediation
- Estimate possible impacts to human health and environment through performance of risk assessment
- Include relevant stakeholders in the process of prioritising the sequence and identifying the extent of remedial action at individual hotspots
- Provide a prioritised and cost schedule of remedial actions needed to be performed at 4 Industrial Hotspots to mitigate human health and environmental risks
- For all the sites, evaluate the immediate need for implementation of heavy-cost site remediation investments as recommended in NWMP, identifying to whom those costs would accrue (whether public bodies or private sector companies) the current status of possibly ongoing remedial investment and the need for further investment as well as the likely sources of investment funding.

- Adopt clearly defined processes of internal quality assurance and external approval for all outputs.

The overall approach to implementing the project would involve:

- Preparation of Background Site Assessment Reports for 4 priority sites presenting the available data and findings of site visits and results of qualitative human health and environmental risk assessment
- Preparation of feasibility studies for remediation of 4 industrial hotspots, to include detailed evaluation of remedial alternatives and cost schedule for performing the additionally needed site investigation and undertaking the remedial action.
- Prioritising the sequence of remedial action for 4 Industrial Hotspots and selection of pilot site

2.1.3 Target groups

The ultimate target group is the population of the country, which will benefit from a clean environment developed by hot spots remediation activities. In particular, the status of population, of the area distressed by targeted industrial sites, as well as the industrial waste management entities whose capacities to manage waste management in the project area will be significantly enhanced.

2.2 Phases of the Project

The project is facing two phases:

- Inception Phase (Phase I)
- **Assessment and Feasibility Phase (Phase II)**
- Development of Terms for one selected site (Phase III)
- [Implementation Phase – not foreseen by this Project – Phase IV]

Within the implementation phase there are several stages, where decision-making process through the steering committee (SC) is required. The project is currently in phase II.

2.3 Contents of the Study

This Study is Volume II of various volumes and contains the Baselining including Qualitative Public Health Risk Assessment, Reevaluation of the former process and quantitative and qualitative assessment of the contaminants which can be expected, geophysical investigation, qualitative EIA of the current situation, Public Sensitivity assessment and institutional public information scheme, technical objectives of reuse and treatment potentials, EIA of various treatment options and financial/economical evaluation of various steps. The study comprises assessments, evaluations and conclusions. The legal and institutional part (funding mechanism and implementation body) is only short mentioned and can be referred to Volume V[2] and Volume VI[3]. This feasibility study is prepared in accordance with Fidic Guidelines for Reporting (2001).

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[2] Feasibility Study – Volume V - Legal Gap Analyses for the Remediation Issues of polluted and contaminated sites

3 Generally description of the Veles smelter plant

Established in 1973, MHK Zletovo was a lead and zinc smelter employing 1,100 workers. Each year it uses lead and zinc concentrates to produce 30,000 Mg of lead, 60,000 Mg of zinc and 250 Mg of cadmium, as well as smaller quantities of silver, gold and copper dross, and bismuth alloy. The main production line of the Complex of Metallurgy comprises the sinter and sulphuric acid plants and the lead and zinc shaft furnace. Zinc and lead refineries have been located in parallel. Apart from the furnace Complex of Metallurgy comprises other new plants such as: production of Lead Pipes and Balancing Weights, Electrolysis of silver, Zinc dust, Zinc oxide, Lead alloys, Metal cans, production of Silver Jewellery and Bullion cadmium. MHK Zletovo did stop its operation 4 years ago. Tender is opened for investors that will continue its operation on an environmentally allowed manner. Data were collected on the former production and existing hot spots (dump sites for metallurgical slag, raw materials, etc.). Importance of the plant's operation on the economic state of the whole town stressed. Independent of the future of the plant for the time being there are 4 main factors, with serious impact on the environment that should be taken into consideration.

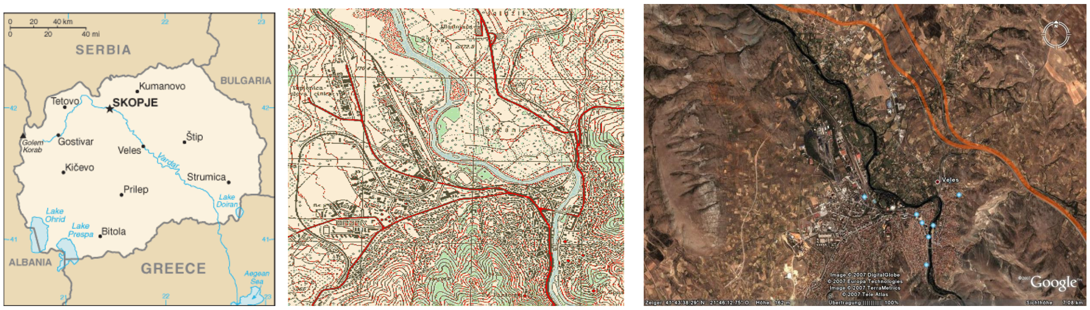
3.1 Geographical description of the area

The Municipality of Veles is situated between the village Basino selo on North, hill localities called Prcorek (altitude 365 m) and Sveti Ilija (565 m) on East, hills Vrsnik (441 m), resp. Golik (560 m) on South and hill Groot on West.

The State Highway Skopje – Gevgelija – Greece is on the left bank of Vardar River, up in the hill. The railroad Skopje – Gevgelija – Greece, as well as the local road Skopje – Veles – Prilep is located on the right bank of Vardar River, between the MHK Zletovo Plant and Vardar River.

The MHK Zletovo factory and dumpsites are located on the central part of Macedonia on the right bank of River Vardar 50 kilometers downstream from Skopje. The terrain altitude is 182 m.

Figure 1_Geographical situation of Veles municipality, production and disposal site



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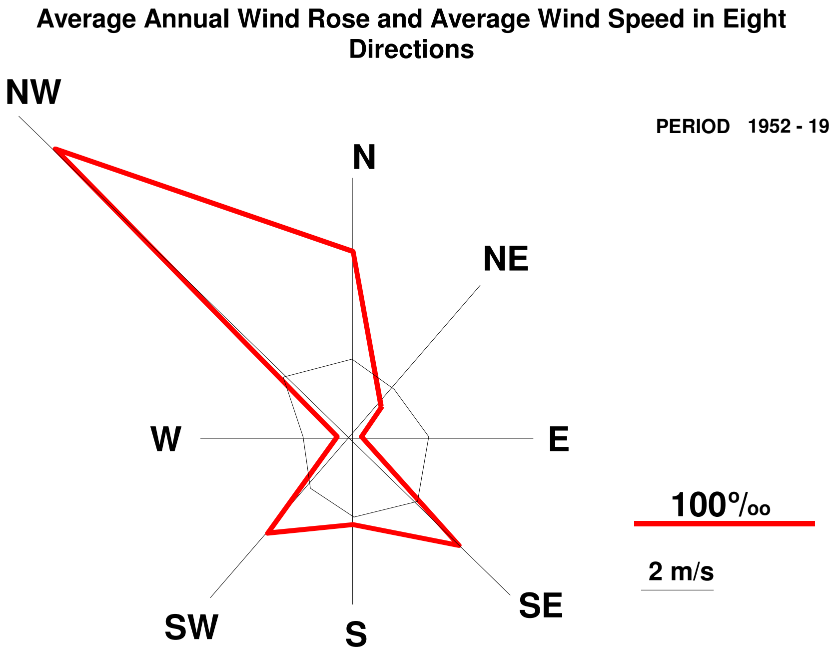
[3] Feasibility Study – Volume VI – Funding Mechanism and institutional set up for the Remediation of contaminated and polluted sites

3.1.1 Climate Characteristics

During the winter months, temperatures typically range from 12-15 C (54 -59 F) and the annual relative humidity is 70%. On average, there is an estimated 12 days of snow per year. These are typically caused by low pressure systems that move down from the north. Low pressure systems from the north also bring winds. The annual rain fall for the Municipality is estimated at 447mm, which is experienced mostly from October through December. August is the driest month of the year and relative humidity is lowest in the summer at 55%.

Due to the terrain configuration i.e. the terrain is open and near the river Vardar, the prevailing wind direction is northwest-southeast. Average wind velocities are abt 2 m/s, however calm periods (w < 0.5 m/s) can not be neglected also - these for the last thirty years being 427 ‰[4].

Figure 2_average annual wind direction distribution in Veles



3.2 Topographical Description of the area

The lead and zinc smelter MHK Zletovo is situated in the North-Western part of Veles, on the right bank of Vardar River.

The position of the slag dump site is [UTM 34T; X = 0563255; Y = 4538757; Z=228]

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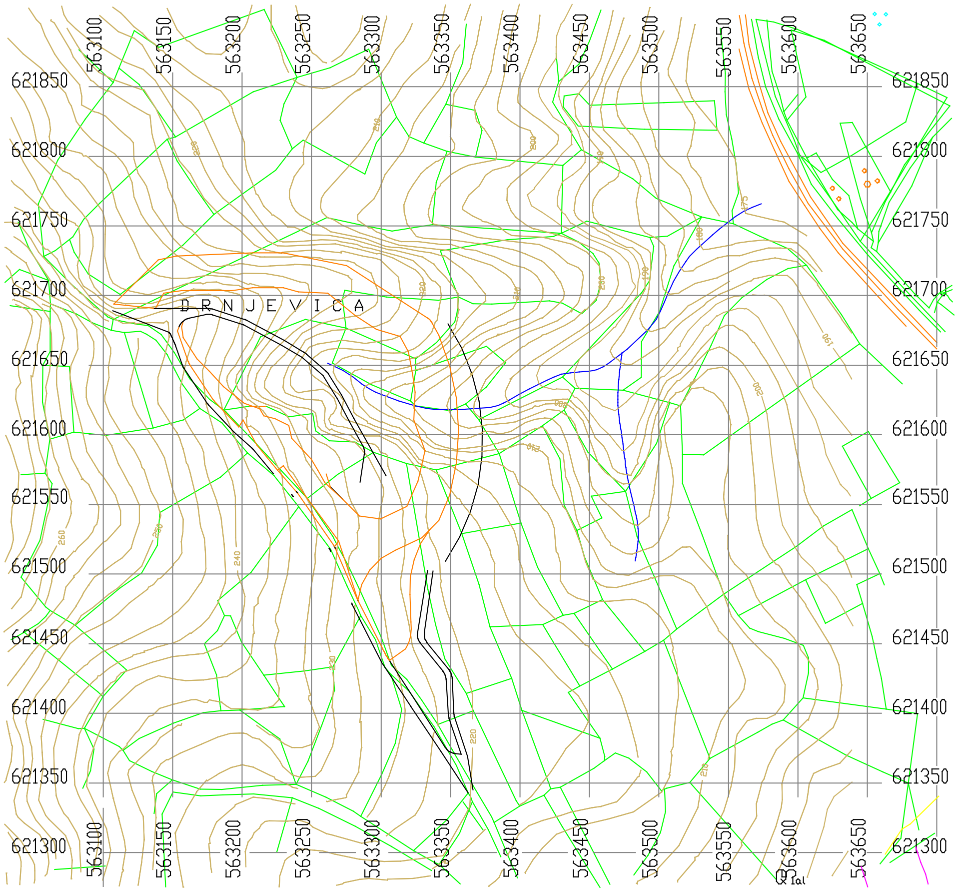
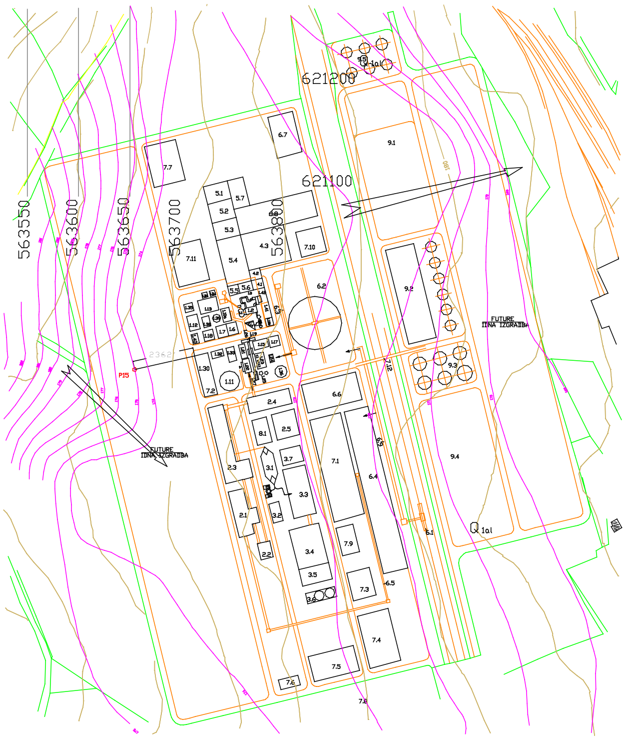
[4] Average annual wind frequencies and velocities in the period 1952 - 1980, as given by the Hydro meteorological Institute of Macedonia.



The position of the production facility (entrance) is N 41°43’46’’ and E 21^{0}45’95’: [UTM 34T; X = 563866 Y = 620614; Z= 182,5]



3.3 Geological Description of the area

The surface terrain of the location is formed from Pliocene sediments that are composed mainly of sand, clay, dust and gravel, and they can be seen on certain places of the open profile-cuttings. These sediments are laying on the limestone and schist, which are from Triassic period. Veles geology is characterized by rather complex composition of elements.

The oldest rocks are of Paleozoic age and contain quartzites, quartz-sericite-chlorite, quartz-graphite and other shales, limestones, marble rocks, granites, ultrabazites (dunites, harzburgites, lerzolites, serpentinized limestones and marbles).

Next are magma, diabazis and melafires. The youngest formation is of alluvial-deluvial sediments.

The existing varieties of soil were produced from the above listed components by means of million of years long action of egzogenic processes. As a result, the soils in the lower part of Veles valley contain a mixture of mainly quartz, ilite, feldspate and some chlorites and carbonates. Up in the hills, the composition of resulting decay products depends on the geological and petrographical composition of every micro-location. So, in the hill of Sveti Ilija mixed silicate-carbonate soils were produced, while in the lower part – near the Vardar and Babuna river banks, arid (infertile) soils, without any content of potassium were accumulated. Consequently, the region is rather desertified and is without any plants. In the typical carbonate regions, soils reach in carbonates (calite) were generated.

A1 – Automorphic soils that were produced by the egzogenezis of shales.

A2 – Automorphic soils that were produced by the egzogenezis of limestones and marbles,

A3 – Automorphic soils of so called reduced type that origin of ultrabazites and bazites.

A common characteristics of all these types is that they were generated by a purely natural process, particularly without any anthropogenic interference.

B - Alluvial – delluvial and soils that experienced anthropogenic/technogenic influence

These types of soils are present in the lower part of Veles valley and are characterized mainly by the anthropogenic and/or technogenic influence. This one varies from low, as along the watershed of Vardar River, up to high, as in the agriculture used soil. Usage of natural and artificial fertilizers, as well as the influence of the industrial activity (e.g. lead and zinc smelting) caused the top soil (30-40 cm) to loose some of its characteristics of primary alluvial-delluvial soil.

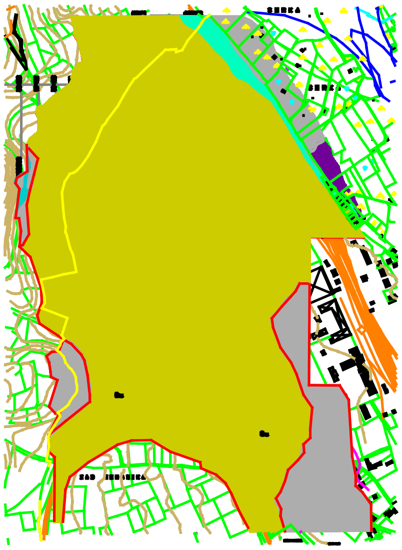
On the object location, from a hydrological aspect there is ground water of inter- granular porosity. There is no data for depth of the ground water, but according to the geological and geomorphologic characteristics, they should be expected deeper in the area around the disposal place, in comparison with the eastern parts of the terrain where they are on lower level. According to the previous investigation works, which has been done on the area around the Smelting plant and north over the plant, the ground water are flowing in direction W-E, in other words from the disposal area toward the Vardar.

According the chemical structure the ground water is of hydro-carbonate origin and has been polluted from the disposal place, which is formed by lead and zinc slag, one of the by-products from the Smelting plant.

By geomorphologic conditions, the terrain from west falls toward east - from the disposal point in a direction of Vardar. The terrain is characterized with clear altitude differences in the relief from 220 ÷ 180 aSL. The most significant appearing from the geo-morphological point of view is two deep ravines that are appearing on the place south from the disposal area, and one depression that leads in direction west east, from the north side of the disposal area up to the railway Skopje - Gevgelija.

The surrounding area shows density values from 10^{-0} till 10^{-4} m/sec. The permitted load can be assumed with 1,2 – 1,3 kg/cm² [equal to 12-13 N/cm²].

Figure 3_Geological boundaries



3.4 Hydro-geological Description of the area

The surface terrain of the location is formed from Pliocene sediments that are composed mainly of sand, clay, dust and gravel, and they can be seen on certain places of the open profiles-cuttings. These sediments are laying on the limestone and schist which are from Triassic period.

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4 Legal Perspective

The purpose of this chapter is to present the summary of the legal analysis regarding Industrial Hotspots. The legislation which has been taken into consideration for the purpose of this analysis is the following and has been detailed described within the **Volume V** "Legal Gap Analyses for the Remediation Issues of polluted and contaminated sites".

- Law on Waste Management (Off. Gazette no. 6/2004); and amendments (Off. Gazette no. 68/2004; 71/07; 107/07)
- Law on Environment (Off. Gazette no. 53/05 and 81/05);
- Law on Privatisation (Off. Gazette no. 37/96; 25/99; 81/99; 49/2000; 6/2002; 74/05);
- The draft Law on Hazardous Waste (which is being produced in the CARDS 2004 Programme, and was provided by them).
- Law on Budgets (Official Gazette of the Republic of Macedonia no. 79/93; 3/94; 71/96; 46/2000;11/2001, 93/2001; 46/2002; 24/2003; 85/2003 and 96/2004 and Decision of the Constitutional Court no. 180/98 (Official Gazette of the Republic of Macedonia no. 15/99)

The following subsequent Legislation was also reviewed:

- Decree on the criteria and manner for B IPPC permit (Off. Gazette no. 04/2006); Decree on the level of charges for A IPPC permit (Off. Gazette no. 04/2006);
- IPPC Ordinance - A permits (Off. Gazette no. 4/06);
- IPPC Ordinance - Adjustment permits (Off. Gazette no. 04/2006);
- IPPC Ordinance - B permits (Off. Gazette no. 4/06);
- Rulebook on the form and content of the application form, and the content of the permit for collecting and transporting urban and other types of non-hazardous waste as well as on the minimum technical requirements for performing the economic activity of collecting and transporting urban and other types of non-hazardous waste (Off. Gazette no. 23/2007);
- Rulebook on the format and the content of the Journal for records keeping on the waste handling, the format and the content of the forms for the annual report on waste handling by legal entities and natural persons and the format and the content of the annual report on waste handling by the mayor (Off. Gazette no. 7/2006);
- Rulebook on the functioning methods and conditions of the integrated waste disposal network (Off. Gazette no. 29/2007);
- List of Waste Types (Off. Gazette no. 100/05);
- The Law on the ratification of the Basel Convention (Off. Gazette no.49/97); Rulebook on the form and contents of the forms for transboundary movement of hazardous waste (Off. Gazette no. 37/03 and 38/03).
- Law on Mineral Resources (Off. Gazette no. 24/2007); the content comprises the subject of regulation of the Law on mineral resources. The analysis of this law discovered that the subject of regulation of the law is general, and there is no relevance to remediation purposes of hotspots;

It has also been taken into account several Tables of Concordance (TOC), produced by the Ministry of Environment and Physical Planning, and the CARDS 2005 Programme. Those are the TOC's for the Waste Framework Directive; the Landfill Directive; the Directive for PCB's and PCT's, Hazardous Waste Directive; IPPC Directive. (It should be noted that I've tried to get the TOC on Mineral Resources, and was promised to get it, however this was not delivered from the Ministry). References were also taken from the National Waste Management Plan (NWMP), as well as the National Environmental Action Plan (NEAP) and the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their disposal, adopted by the Conference of the Plenipotentiaries on 22 March 1989. There is a lack of regulatory provisions both in the privatisation law and in environmental law, as well as lack of the institutional framework and funding mechanism.

As a result of this legal gap analysis the following conclusions and recommendations are made:

- A lot of interpretation is required to identify direct links to the terminology of industrial hotspots. The terminology of hotspots is not clear. Definitions for industrial hotspots and hotspots closely related issues are missing. Terminology regarding "hotspots' can be found only in the Waste Management Plan, but without any legal meaning. It is recommended to include these definitions in the existing Law on Environment, Law on Waste Management, Draft Law on Hazardous Waste. Another recommendation is adoption of a framework Law on soil contamination, which has not been adopted so far. Such a law will give a legal base for subsequent legislation, which could be in the form of technical guideline for remediation of contaminated sites. Such a rulebook could contain the terminology regarding "hotspots", remediation plans, and the question of environmental liability and funding.

- Subsequent legislation on protection from pollution from priority substances is missing, however the Draft Law on Waters provides a legal base for such a rulebook (Article 107, paragraph 2).

- The question of responsibility for environmental liability should be clearly stated and solved. So far this issue was open for negotiations, which cannot remain the case. A cut off date after which any pollution arising is the liability of the installation, is also missing. Amendment of the law on Environment (in the chapter for environmental damage) is recommended to state whether the Government will be responsible or the potential buyer, as well as the time frame of clean up responsibility, or as mentioned, a new rulebook should be issued, for remediation of the contaminated sites, where the environmental liability will also be tackled.

- The monitoring and reporting system regarding the industrial hotspots is relatively poor. This can be understood, because the legal system of the country tackles very little of the hotspots issue. A standard for monitoring and elf-monitoring and reporting procedures is needed (sub-laws, forms, guidebooks).

- There is a lack of an appropriate funding mechanism. No earmarked or dedicates fee or charges to be made to industries are presently being considered or have been considered in the past. Appropriate funding mechanism needs to be established. That is why it is proposed to create a separate law on trust funds, which will enable the establishment of an earmarked fund, under the MOF, independent from the MOEPP.

- So far Law on Soil Protection hasn't been adopted. Such a law could be a legal base for subsequent legislation for remediation of hotspots, which could include technical guidelines for remediation of "hotspots", terminology regarding "hotspots", also the question of environmental liability.

4.1 Gap analyse

The legal framework of the country does not give a clear picture and solutions for remediation of these industrial hotspots, and the purpose of this analysis is to identify the gaps and give some recommendations concerning the legal aspect of this matter.

4.1.1 Gap identification

1. Crucial gaps have been identified within the legal framework related to industrial contaminated sites such as: missing definitions (example: definition of “hotspots”; “dumpsite”; “secure landfill” “sanitary landfill”, “contamination”). These definitions can only be found in the NWMP- Annex 9, Special Study E, and nowhere in the environmental legislation. Clear distinction between the terms “polluted” and “contaminated” is not made, very often a mistake is made with identification of both terms having the same meaning.

2. Another gap, within the terminology, is the incompliance of the existing definitions with the EU Directives

3. The issue of pollution from priority substances is not yet solved, however in the Draft Law on Waters there is a legal base for adoption of subsequent legislation for regulating this matter.

4. The monitoring system should be further developed. There are monitoring provisions found in the Law on Environment, Law on Waste Management, Draft Law on Waters, Law on Ambient Air Quality, IPPC Ordinances, however standards for monitoring and self-monitoring and reporting procedures is needed (sub-laws, forms, guidebooks). Inadequate secondary legislation (existing secondary legislation is not following the requirements of European directives, absence of emission limit values, outdated standards and limits Also there are overlaps in the institutional responsibilities and activities regarding some environmental media

5. The main gap is the clear statement regarding environmental liability, which might be handed over from the Government to a potential buyer of industrial sites within the privatisation activities. None of these articles (listed above) tackles directly the question of historical industrial contamination, or states clearly who is responsible for the clean up of the contaminated sites. A cut off date after which any pollution arising is the liability of the new owner of an installation, is also missing

5. In case of funding the costs for remediation of contaminated industrial sites, the possibilities are to be considered limited, since no earmarked or dedicates fee or charges to be made to industries are presently being considered or have been considered in the past. A new law for a trust (remediation) fund is missing

6. There is no Law on soil protection; No legislation on Remediation of “hotspots”

7. There is no time frame in the NWMP, till when the “hotspots” should be remediated

4.1.2 Gap summary

1. **Unclear, and missing terminology**
2. **Lack of regulation for protection from pollution of priority substances**
3. **Lack of monitoring and reporting regulations**
4. **Missing environmental liability**
5. **Lack of fund establishment and procedure regulations**
6. **Missing legislation on soil contamination**
7. **Missing time frame for remediation of "hotspots"**

4.2 Terms of References

- Terms of References, staff-, time and budget schedule is developed in accordance with the required input to minimize the legal gaps. The ToRs, Time schedule and budget calculation can be seen in Annex 11.1.1. The expertise and timeframe shall be as following
- Foreign Institutional Expert- 4 months within 9
- Local Legal Expert- 6 months within 9
- Local Institutional Expert- 3 months within 9
- Local Technical Expert- 3 months within 9

4.3 Ammendments on the law of waste management

- There have not been significant changes in respect of remediation and rehabilitation of contaminated sites, therefore are the terms of references, developed also for the purpose of Veles Topilica valid.

5 Institutional Perspective

5.1 Funding Mechanism and set up of an implementation agency

The overall objective of this chapter is to propose an approach to building an effective financing and institutional system for remediation of industrial hotspots and is described in detail in the **Volume VI "Funding Mechanism and institutional set up for the Remediation of contaminated and polluted sites"**.

It is to achieve the greatest hand in hand environmental and economy benefits given the available resources and institutional capacity. It is apparent that the approach to building an effective financing system for remediation of contaminated sites is inextricably linked with the legal provision for environmental liability, with the privatisation process (since the value of property assets is directly linked to environmental conditions and obligations) and with the institutional framework for pollution control. On-going problems in environmental protection are encountered in connection with unclear ownership relations to properties, especially old environmental burdens and the limited capacity to date to evaluate environmental damage and environmental benefits of cleanup. It is proposed that environmental liabilities for historical pollution are clearly defined in legislation. Pros and cons of various approaches to environmental liabilities for past pollution are presented. It is acknowledged that application of the polluter pays principle is a precondition for an effective and fair remediation system. It is proposed that regarding the privatised sites that require cleanup, the state is liable for remediation and that a system of pollution taxes should be introduced to raise revenue for cleanup works. In case of sites that are subject to privatisation, it is proposed that the new owners introduce measures to contain contamination (if necessary) and the state assumes environmental liabilities for a limited period of time (10 years) during which time cleanup should be completed by the state. After remediation, all liabilities should be transferred to new owner. Privatisation receipts should cover the costs of cleanup. Priority sites of limited commercial value, and hence not subject to privatisation, should be remediated using state funds (pollution taxes and budgetary sources).

Various funding mechanisms are presented and discussed including their pros and cons for the specific Macedonian context. Remediation Fund is proposed as the most viable option for financing of cleanup works in Macedonia. The sources of financing and institutional aspects of the Remediation Fund are proposed. Estimation of the potential level of funding available from national sources is presented. It is estimated that some 3,5 M Euros can be raised from landfill tax for solid and for hazardous waste. In addition, part of the privatisation revenue and the donor funds are expected to contribute to financial basis of the Fund. Funding from the latter two sources is expected to vary substantially from year to year.

The Remediation Fund should have clearly defined and transparent financing strategies, expenditure priorities, operating procedures. Operation of the Fund should be supervised by the Supervisory Body (chaired by the MoEPP). The MoEPP should have a decisive role in establishing strategic directions of the Fund. Yet, the Fund should be independent and free of political influences that affect project selection procedures. The Fund's operation should be based on a long-term investment strategy and annual operating plans. Donor funding can be channelled to the Fund as individual trust funds or as direct contribution to the Fund's budget. This report is concluded with a simplified SWOT of the

The Cards 2001 project has addressed in their Annex 9 of the Waste Management Plan the need of a legal clarification, set up of institutional system for a sufficient implementation and establishment of funding mechanism.

Similar needs and requirements have been identified by the Cards 2006 program, which finances a project "Development of Remediation Plans with Financial Requirements for Elimination of Industrial Hotspots". Investigations during the inception phase discovered the need of 4 pillars

- Legal Framework (Legal) – PILLAR I
- Funding Mechanism (Financial / Economical) – PILLAR II
- Implementation Body (institutional) – PILLAR III
- Technical set up (technical) – PILLAR IV

While the program is working on the Pillar IV, all other pillars have been identified as gaps. Funding mechanism and a strong implementing body, which can be an agency, a working group, departments or the funds integrated working unit have to be set up. Base for all the efforts is Pillar I (legal part), which is described in Volume V of the programme.

Taking a required investment volume of 200 – 250 Mio Euro for the rehabilitation of contaminated and/or polluted sites into consideration is an investment (funding) mechanism (Pillar II) required, which shall on the one hand guarantee a national (local) source of income for remediation purposes and on the other hand to attract donor and investment agencies and institutions to contribute within this framework.

Pillar III shall form the work- and implementation force, which shall develop remediation programs, request sufficient budget out of the funding pool, tender, contract, supervise and monitor all remediation related works.

Volume VI demonstrates models, case studies and propose the most appropriate one for the current situation of MK taken the technical most feasible and economical most affordable structure into consideration with the final output of an action plan for the stepwise implementation approach.

5.1.1 Recommendation for the Most Appropriate Financing Model for former Yugoslav Republic of Macedonia

5.1.1.1 Selection criteria and principles

Several alternative approaches can be applied to establishing an effective financing system for remediation of contaminated sites in Macedonia. Selection of the most appropriate financing system should be made taking into account international experience and the national conditions:

- The legal framework for environmental liabilities for past pollution.
- The stage of the privatisation process.
- The existing system of environmental financing.
- Experience with the operation of the Environmental Fund.
- Potential sources of revenue from pollution taxes and environmental fees.
- Potential sources of revenue from privatisation of state owned companies.
- Potential sources of funding from bilateral donors, international organisation and the EU.
- The existing human capacity for preparation and cleanup of contaminated sites.

The key principles that can be applied to develop an effective financing system include:

- **The polluter pays principles** - should be applied where feasible. Consequently, regarding the liability for past pollution the state should be liable for cleanup
- **The principle of earmarking** - Environmental revenues from various pollution and environmental taxes, user fees etc should be spent on environment (including cleanup of contaminated sites)
- **The principle of concentration of funding sources** - Ideally, all earmarked environmental funds and donor assistance funding should be concentrated in one Fund that will disperse the funds in an efficient way and at relatively low operating costs

5.2 Institutional Framework for the Remediation Fund

The main objective of this chapter is to put the recommendations from chapter 2 (legal framework and environmental liabilities) and chapter 3 (financing system) in a sound and coherent institutional framework.

5.2.1 Overview of existing institutional situation in Macedonia regarding remediation

The existing institutional arrangements for remediation of industrial hot spots in Macedonia have been influenced by constitutional changes, new legislation, and changes of ownership (privatisation). As a result, a number of overlaps, gaps and inefficiencies have been created that are hindering the process of remediation. This section provides an overall review of the institutional context. Table 5 presents summary of the key institutional weaknesses of the present system.

Table 1_Summary of key institutional weaknesses regarding remediation

Areas	Problems
Policy and legislative	Not clear remediation policy and environmental liabilities Incomplete legislation Lack of monitoring and enforcement
Institutional aspects	Lack of government implementation body Unclear roles and responsibilities of stakeholders Weak institutional implementation capacity within the government Insufficient communication between the national and local level Inappropriate conditions for Private Sector Participation No arrangements for financial / economic instruments in place
Economic/financial Issues	Lack of funds for industrial Hotspots remediation Sustainable financing instruments have not been introduced
Public Information	Lack of communication at all stakeholder levels

5.2.2 Selection of institutional set up for the Macedonian Remediation Fund

5.2.2.1 Selection principles

The institutional set up for the Remediation Fund has to accommodate the recommended financing system, and the proposed environmental liability arrangements. The following principles were applied to select the most appropriate institutional set up for the Remediation Fund:

- The MoEPP takes strategic decisions regarding the Remediation Fund
- Operational independence from MoEPP
- Clearly defined operation strategy
- Adequate level of funding
- Closer working with ministries & other funding agencies
- Clearly defined management structures
- Appropriate and adequately trained staff
- Open and transparent project selection procedures
- Regular monitoring & reporting on projects & programmes
- Formal and independently audited annual reports.

5.2.2.2 Management of the Remediation Fund

The Remediation Fund should be established as an independent institution with clear formal institutional links to the government, and cooperating closely with donors. The mission of the Remediation Fund should be efficient disbursement of funds for remediation of contaminated sites.

Remediation Fund will be a specialised environmental financing institution that determines and follows criteria for funding in accordance with the state environmental policy. The Fund's independence should be ensured through clear operating and decision-making procedures. The government (the MoEPP) should have an important role in strategic decisions of the Fund but not in daily operations. The Fund will play a key role in the hot spot remediation through development of a pipeline of projects and implementing them. It is also expected to attract funding sources additional to those provided by environmental taxes and the privatisation revenue (in particular donor funding).

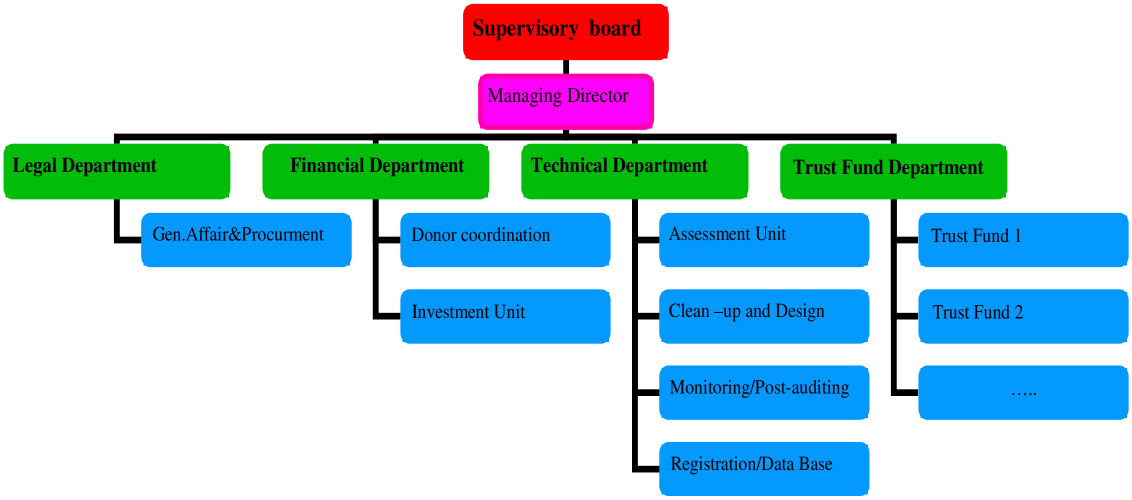
The priority remediation projects for the Fund should be established on the basis of risk assessment. Initially, the 2nd National Environmental Action Plan (NEAP) can be used for reference regarding the funding priorities. Investment strategy and priorities should be prepared by the Fund, approved by the Management Board of the Fund, made widely available, and regularly reviewed.

The Remediation Fund should be supervised by the Management Board, represented by the following institutions (see figure 2)

- Ministry of Environment and Physical Planning (chairperson)
- Ministry of Finance
- Ministry of Economy
- Ministry of Local Self Government

- Ministry of Health
- Ministry of Agriculture Forestry and Water Economy
- International donors

Figure 4_Recommended organizational Chart of the Remediation Fund



Establishing of the Remediation Fund can be divided into 3 operational phases:

- Phase 1 (12 months), with the key objective of establishing a framework (legal basis, funding, director, staff, procedures, priorities) that will ensure that the Fund is capable of operating effectively as an independent agency;
- Phase 2 (30 months), of demonstrating the credibility and effectiveness as an independent agency, and its impact on the (environmental investment) market;
- Phase 3 (3 years), develop the links between the Fund and other funding agencies in order to provide a wider range of financing options that will increase its impact in the market.

5.2.3 Operational procedures of the Remediation Fund

The project cycle operating procedure should become the main operating manual of the Fund. The simplified procedural steps (based on international experience) are presented below:

- **Site identification**
    - Sites, which have been previously identified and investigated, are included in the database
    - Other sites will require environmental audit to evaluate environmental damage
    - The site owner in case of the privatized companies covers the costs of environmental audit. The Fund will cover audit expenses for the state owned sites
    - The MoEPP evaluates the audit results. When approved, the site is included in the database. The Remediation Fund covers all subsequent costs
- **Ranking and registration of sites**
    - Risk assessment study is prepared by the Fund. The results are included in the database of past environmental damages
    - Sites in the database are ranked according to a prioritization methodology (based on risk assessment) prepared by the Fund and approved by the Supervisory Board
- **Design of remediation strategy**
    - The Fund proposes priority sites for remediation in the Annual Operation Plan (the list of priorities should much the funding available)
    - The MoEPP approves by the Supervisory Board and the Annual Operating Plan. The Plan should include cleanup target criteria, time schedule and remediation method
    - ToR for remediation project is prepared and approved (field investigation may be required) by the MoEPP (the Inspectorate of Environment)
    - Tendering of remediation works is initiated by the Fund
    - Selection of supervisory body by the Fund (approval by the Supervisory Board)
- **Post-auditing and site deletion procedures**
    - Remediation works are conducted and supervised by the Fund
    - Verification of remediation works by the Fund. The verification report to be approved by the Supervisory Board and the MoEPP
    - Post-remediation monitoring and supervision conducted by the Fund
    - Completion of remediation process and deletion of the site from the register (approval by the Supervisory Board and the MoEPP)

5.3 Public Awareness and Information

Besides a thorough diagnosis of pollution, and remediation needs, the important tool to ensure the successful implementation of the proposed measures is public consultation and participation. This chapter is required in order to achieve understanding of the key issues of concern to stakeholders/actors in the remediation process. While the technical aspects are of great importance, it is recognized that public involvement and participation is of equal importance. This public awareness programme has been produced following discussions within the Ministry of Environment and Physical Planning, representatives of the municipality of Veles and relevant local NGOs.

5.4 Objectives

Overall objective of this Chapter is to facilitate the attempts of the Project to develop public awareness campaign in order to raise public awareness and inform and educate citizens about mitigation measures and possible solutions related to impacting areas in Veles.

5.4.1 Specific objectives are formulated as follows

- To increase knowledge/awareness of the different target groups concerning impacting areas in Veles
- To develop and initialize a Public Awareness Campaign (PAC) at local level

5.5 Approach

In general, the measures to increase public awareness and participation that are proposed should both support Macedonian’s progress through the process of economic transition, and support the process of alignment with the EU environmental acquis. Member states (and the accession countries) have had the latitude to inform and involve public in decision-making and to enhance public participation in the planning.

The approach has been followed here is in favor of stepwise, incremental changes that build on existing resources and capacity.

5.5.1 Core Issues related to public awareness

The general level of environmental awareness within former Yugoslav Republic of Macedonia is low, and there is an insufficient understanding of environmental issues. This is largely caused by

a) Gaps in formal environmental education in schools, etc; and

b) Limited informal education or dissemination of environmental information.

c) Insufficient capacity within the Ministry of Environment and Physical Planning (MOEPP) to promote and facilitate better environmental education and awareness related to environmental issues

d) Insufficient and improper information transfer through or by media

e) Lack of understanding of the local authority in enforcement of public information (Aarhus perspectives) systems

5.5.2 The core issues related to PA can be summarized as follows

- Low public information and awareness in general and poor public participation

- People are not aware of the industrial pollution problems and the effect on their environment and health
- Lack of understanding of importance to pay for ”cleaner environment”. For example, high percentage of population not paying the fees for waste collection (in Skopje – 30 per cent of population, outside of Skopje – this figure might be 70 – 90 per cent).
- Companies responsible for pollution do not pay enough attention to public awareness
- Lack of information and access to public information
- Public acceptance of illegal dumping of waste, including hazardous waste.
- Current negative perceptions based on bad local experience
- Many isolated, not coordinated PA activities financed by different donors
- Insufficient institutional capacity to cope with and to promote of the public awareness and environmental education.
- Misuse of environmental topics for political issues

5.6 Experiences of past Public Awareness activities in the Veles region

Previous activities aimed on strengthening of public awareness on environment protection issues in the region, mainly are performed as a side activities within the bigger international projects. Usually target groups were general public, civil sector, pupils, etc.

The most frequent used communication tools are as follows:

1. Publication of brochures and leaflets,
2. Lectures and workshops,
3. Media coverage,
4. Articles in newspapers

The effects of the activities focused on general public are not really measured until now (indicators missing). The citizens are familiar with topics for environment protection, but those topics are still under foreign responsibility (shifting of responsibilities).

The general impression is that the protection of the environment is not important issue for older population. This behavior has impact to the behavior of young population. The PA campaigns focused to children can be treating as a complementation of formal education for protection of the environment.

Measurable progress is achieved in capacity building on smaller groups, such as agriculture unions, collectors of raw materials etc. Those activities were depending on investor’s program and not all direct reflect the really necessity and needs of local population. This is one of the reasons for non-continuation of activities after finishing of the projects (missing sustainability)

Economical Ecology vs. Ecological Economy – no environment protection without economical solid base.

5.7 Target Groups, Information Needs, Communication Techniques

5.7.1 General public

People need to see that their government, neighbors and community leaders will join the pro-environmentally sound activities.

- **Information needs:** This target group demands regular information about environmental issues, problems, success stories and proposals how individuals can contribute to preservation of environment. Electronic and printed media could play the important role for public environmental awareness raising, mainly through presentation of collected and processed relevant information in this respect.
- **Communication techniques:** Since it is hard to reach the general public directly, useful communication technique could be combination of media campaign that will ask citizens to initiate proactive action at personal level. For the maximum benefit of the environmental public awareness campaign it is extremely important to provide new possibilities that will offer to people how to change their current behavior into more environmentally friendly. In the media campaign that should follow after these possibilities are provided, simple explanations for the environmental, health and financial benefits should be addressed.
- Local communities of the villages are good tool for individual proactive action. All citizens in an interactive action show their commitment for cooperation in every project they see important for their life.

5.7.2 Schools

School children are very important target group as they represent the future population; therefore the local, national and international efforts for conservation of this area have to ensure building of the future human resources in appropriate way.

- **Information needs**: This target group has need for permanent education about environmental issues and problems at local, national and global level. Different ages of pupils need different types of information.
- **Communication techniques**: Pupils need to learn through well-designed and interactive approach using outdoor experiments. These practical exercises should be combined with messages that adults are personally responsible for growing and development of their society, whereas their pro-environmentally behavior largely contributes to the community. Establishment of local education / visitor centers can be a useful tool for generating interest among young people and demonstrating environmental activities. Specific training and education can be organized for the teachers and their cooperation with local or specialized NGOs can be facilitated.

5.7.3 National (Central) Government

Governmental Ministries (Ministry of Economy, Ministry of Transport and Communication, Ministry of Agriculture and water management, Ministry of Education and Science) Agencies and relevant bodies and local authorities are specific target group that needs to recognize that environmental problems should be posted on their priority agenda.

Information needs: This target group needs explanatory information which will help it to understand why is it necessary to consider that environment should be put in the list of top priorities. It is important to simply explain the environmental policy at local and global level where environment is given same level of priority as to political, economic and social issues. Environmental problems need to be linked with the impact to the economic development, social and health issues. Finally, specific information should be provided how decision-makers could think in environmental friendly manner when making their decisions and how they can benefit from it.

- **Communication techniques:** The first step will be to get the attention of these institutions to environmental issues. This can be achieved indirectly through the awareness raising of the general public, success stories on specific projects, initiative of NGOs or through their involvement in the activities of the Ministry of Environment and Physical Planning. Especially the local authorities will need serious capacity building efforts to be able to perform all their environmental duties foreseen in the new legislation on local self-government. MOEPP can lead by example and produce practical manuals and guides for implementation of national environmental policies as a useful tool for achieving the environmental objectives.

5.7.4 Media

It is evident that media are playing the key role for distribution of environmental information to the public and for raising of its awareness, it is necessary to recognize that this is a target group of special importance and specific information needs and requirements.

- **Information needs:** Media need to have broad access to the results of the different Project activities, Local and national Authorities - including the goals, work, strategies, pilot-projects, achievements and failures. In this way they will consider these structures as trustworthy sources of information in the long term. Second type of very important information for media is the state of environment in the country and globally.
- **Communication tools:** Media should be treated as partners, not as negative observers and criticizers. Press conferences should become part of the regular agenda of Local Authorities. Special attention should be given to the editors in relation to their recognition for importance on environmental coverage in the media.

5.7.5 NGOs

The NGOs are among the best-organized environmental stakeholders in the country and they have collected a significant track record in awareness raising activities. They can serve as important partners of the Local Authorities and PPP in future activities, but they still need capacity building for designing and implementing well defined, targeted and topical campaigns with careful, detailed analysis of the problem and adequate responses for its solving. They also need more stable and long term funding sources to be able to focus on longer-term priorities rather than on short-term access to donor-funded projects. The capacity of NGOs can be improved by their involvement as partners in the planning and implementation of awareness raising activities of the PPP, Local authorities and other stakeholders. The activities and commitment of local NGOs in Veles is rather high. Soil remedition programs have been performed in the past. Those experienced NGOs might be partner in the implementation program due to the close contact with the local authority and community.

- **Information needs:** The NGOs most urgently need free access to environmental information according to the Aarhus Convention. They also need regular information about the activities of other actors in the country in order to be able to coordinate activities and set their own priorities.

- **Communication tools:** The NGOs can be informed through specialized environmental magazines, news services or electronic networks such as EKONET in Macedonia. There should be regular events that provide opportunity for informal communication with the NGOs. To facilitate formal communication i.e. public participation in environmental decision-making, the Strategic Environmental Assessment of plans programs and policies should be introduced.

(See Annex [11.2.4] - List of active NGO's in Veles)

5.7.6 Business sector

Currently there is insufficient environmental communication with the business sector in the country, apart from occasional inspection visits and the permitting process. The experience shows on the other hand, that the business sector can be a very effective partner in solving environmental problems and raising environmental awareness. Situation regarding business sector in Veles is even more complex due to the fact that the biggest industrial capacity in the municipality – former smelter, is not working and all business relations are delegated to the bankruptcy manager.

General instructions related to information needs and communications with the business sector are following:

- **Information needs:** The business sector needs information about the legal requirements and procedures, about the state of environment, environmental technologies and in particular market opportunities in the field of environment. In drafting new laws and regulations, it is important that the business sector is informed about the new requirements early enough, so that they can adapt to these requirements within their regular investment cycle.
- **Communication tools:** The environmental experts /managers in the companies can be invited to join the communication networks with the local authorities and NGOs, or to create their own network. Regular business conferences, trade fairs and similar events can provide an important opportunity for informal communication.

5.7.7 Local Authorities

The Municipality of Veles already has experience with environmental awareness raising activities, but still needs serious capacity building efforts to be able to perform all their environmental duties foreseen in the new legislation on local self-government. The Municipality should be better staffed with specialists for environmental awareness activities, such as trainers, environmental experts and PR experts. This should enable it to continuously plan and implement awareness raising activities and community engagement actions. More specific capacity building needs of the Municipality of Veles are listed below:

- Systematization and on-line acces to information from all environmental projects implemented on the territory of Veles
- Enhancement of the communication with production facilities located at the territory of Veles
- Continuation and enhancement of the procedures within the Municipality enabling transparency

The Municipality of Veles is also primarily responsible for securing free access to environmental information about main polluting facilities on its territory, including information for all facilities of the former smelter.

5.7.8 Ministry of Environment and Physical Planning (MOEPP)

As a support for the thematic areas under the responsibility of MOEPP, it is recommended to continue the operation of the Eco-Caravan (a Road Show including Public Relations office). It would be a very practical and useful tool for supporting awareness raising activities in different parts of the municipality and in relation to a variety of topics.

- There is a need for more strategic and planned approach for designing and printing MOEPP promotion materials and for improvement of their quality in terms of text (slogan, messages, information) and design.
- The web site of the MOEPP should be regularly up-dated with permanent and fresh information about the status of environment. One way how this communication tool can help citizens to raise their awareness is that in every section of the website information, a special attention can be given to advise citizens what they personally can do and how they can contribute to the particular effort of the MOEPP.
- The Public Relation Office currently manages the media relations and other public relations of the Ministry. Ministry should dedicate sufficient resources to such a programme that could include: regular press conferences; regular press releases; media service to respond to specific requests of the journalists; and information about specific activities in the regular newsletter of the Ministry.
- MOEPP should give technical input in preparation of curriculum for environmental education
- With such a service the Ministry can improve its image in the eyes of the journalists, become a trustworthy source of information and gradually establish more close cooperation with media in the field of awareness raising.
- The Ministry should invest in internal formal and informal communication regarding the messages it would like convey to the public and other stakeholders. Only if all the staff share the vision and positions of the Ministry as an organization, they will be able to present them to the public, defend them if necessary and actively implement them in their work.

5.7.9 Donor

Several donors are providing technical assistance in the Republic of Macedonia in terms of Hot Spots remediation or mitigation measures for industrial contamination.

The most active donors in this field are:

- EAR - One of the Projects managed by EAR within the Programme CARDS 2006 is current one: “Development of Remediation Plans with Financial Requirements for Elimination of Industrial Hotspots”
- the Dutch Embassy driving force with a SEE regional programming for the remediation of industrial hotspots. Implementing agency is UNDP. Feasibility studies for two locations, Lojane and Bucim, are planned to be conducted.
- The Austrian Development Agency (ADA) supports a regional program (Envsec) for the remediation of abandoned mining areas. Implementing Agency for this program is UNEP Grid. Sasa and Toranica mines are focal areas.
- JICA (Japan International Cooperation Agency) in cooperation with the Ministry of Agriculture, Forestry and Water Economy (MAFWE) is presently working in phase two of the study on “Capacity Development for Soil Contamination

Management related to Mining in the Republic of Macedonia" with focus on Zletovo mining area.

- SECO, the Swiss Donor Agency is mainly involved in the construction and operation of waste water treatment plants.
- IFC (International Finance Cooperation) is in cooperation with ADA involved in strengthening the recycling market due to direct disbursement and micro crediting. The WB has signalised an interest in future financing strategies.

At the moment, there are no donors expressing interest to invest in remediation of impacting areas in Veles. Attracting donors should be one of the priorities and should be treated as common activities of the Government (Ministry of Environment and Physical Planning) and Local Self Government in Veles.

5.8 Key aspects of Public awareness rising

The mechanisms of public awareness rising and communication are important tools for better understanding of the problem, its acceptance and involvement of the citizens in the solution making. Thus, the way of implementation of public awareness rising campaign is crucial.

There are two principles in the campaign conducting:

- Awareness rising and participation increasing and
- Triggering behavioral change public

The messages that should be pointed out to the target groups are not only for how to protect the environment, but as well why it should be protected. The campaign must transfer information and stress the public motives to do that.

- The message should be simple, understandable for general public and accompanied by a slogans

5.8.1 Communication techniques in small groups

In case of small target group, the following communication techniques are proposed:

Interviews - Meetings between the stakeholders organized in order to get information of the public opinion, public participation perspectives and building of consensus programs. The interview provides an opportunity for getting direct information for public interest and gives possibility of asking questions. Enable to learn the best communication practice with the public and can be used for city committee members' assessment. Disadvantage is that interviews demand time. The invitation for the interview have to be encouraging, in opposite we are facing the risk of potential participants to refuse the interview. When possible the interviews should be taken head to head.

Small meetings with previously defined target groups or meetings related to other happenings. When organizing such meetings there is an opportunity to get an agenda and to plan the discussion in advance. Small meetings, if they are well organized, provide replacement of extensive informing such as a lecture to wider audience. The disadvantage of small meetings is that they can be too selective and important target groups can be left out. For such meetings it is important to know the audience previously. Small meetings give an opportunity for direct contact before or after the formal part of the meeting.

Visits and personal checking are organized to provide the available data. The checking is made by previously standardized questionnaires or methodology. The approach is "head to head" or to closely focused target groups. The advantage is that this approach provides a representative sample of examinees, but this is the expensive way. In this respect, we should have in mind that, sometimes, these focused groups could have a promotive approach. That's why we have to be sure in the purpose of the results before the data collecting technique is determined.

Coffee-chat: Small meetings between the neighbors usually in domestic atmosphere. The advantage of this type of communication is the relaxed surrounding, suitable for effective dialogue. Maximum communication from both sides is obtained. But, these activities demand too much effort if we want to approach many people.

5.8.2 Techniques for large groups participation

In communication with large groups the following techniques are proposed:

Public meetings: Formal meetings with presentations give an opportunity to speak in front of the public without denial. Public convocations satisfy the legal requirements but by them the dialog is not upgrading and there is little chance for discussion. In this form of communication, if the agenda is not precisely defined, there is a possibility of long, undesirable speeches. Detailed minutes that exactly reflect the meeting are usually made.

Leaflets/Survey leaves/Poster/Announcement/Billboard: Leaflets often include facts and other information of public interest. By this technique participation of the citizens that does not want to attend meetings is enabled. The existence of the mechanism that will provide regular up dating and extension of the address book for sending the leaflets is an important pre-condition for this form of communication. If feedback leaflet is required for certain information from the citizens, we should have in mind that there is a possibility of mistakes and results sophistication. The probability that leaflets will be sent back is bigger if the post tax is paid in advance.

Telephone contact: Random choice telephone contacts are useful for getting specific information for statistical analysis. This technique provides participation of individuals who do not want to attend meetings and individuals who are not in the address book of the organization that makes the survey and/or informing. Telephone calls provide bigger response compared to survey leaves sent by mail, but this is more expensive and it is harder to process them. The telephone surveys give opportunity for prejudice if the questions are not carefully formulated. Before investing in this kind of communication, it should be clear that statistically valid data are needed. The questionnaire used in telephone surveys has to be professionally made, to avoid possible prejudices. This way is recommendable for assessment of general attitudes.

5.9 Public awareness rising program

Activities for realization of PA Campaign:

1. Defining of general slogan for public awareness campaign;

Defining of sub-slogan for each of the topics in the public awareness campaign

When forming the slogan we should always think about:

- · what is the target group?
- · What should the message mean?
- · What will the public opinion to that message?
- · What actions will the public undertake from that message?

It is proposed the UNDP office in Resen to announce public call for the best slogan (sub-slogans). The best slogans should be awarded.

2. Preparation of Leaflet: To contain information for the Remediation Project and its significance for the region; The leaflet should in simple and understandable way explain the term "hazardous waste" to the young population, where and when it is generated; to point out the advantages of separation and its treatment. A number of 1000 copies are proposed.
3. Designing and broadcasting of radio clips: Local Radio Stations have experience in designing and broadcasting of radio clips, but the implementer of this activity should have the rights to provide broadcasting of the radio clips to other national and local radio stations by which the number of listeners will increase.

During the realization of these activities the following tasks should be fulfilled:

- at least eight texts for radio clips to be prepared (two for each of the campaign’s themes). The clips should last between 20 and 30 seconds.
- Recording the radio clips.
- Broadcasting according to the agreed media plan with the implementer

4. Realization of debate programs on National TV Station with the possibility to involve listeners in live programme.

At least two debate programs are proposed to be hold for all topics of the public awareness rising campaign for remediation activities at OHIS factory. The following activities are proposed:

- Making of program scenario
- To determine the guests in the studio for each of the debates
- Making on time announcements for the debate programs in main terms

5. Survey on satisfaction of the population from the activities undertaken. The outcomes of the survey can serve for measuring of the effects from PA campaign and to direct the additional activities.

The survey can be enforced in two ways:

- By telephone calls and
- Questionnaires

6. Billboards making: Billboards as a way of communication have advantages compared to other methods because through them it’s easy to reach the general public. It is very important billboards to be made by a professional organization and/or experienced individuals. It is a custom to make a simple message on the billboard that will affect the local population. Often those are messages that appeal on protection of natural heritage and/or messages that provoke sustainable development. The billboards should be placed on frequent places in the city of Skopje (3 billboards), village Dracevo and on a road from Skopje to OHIS
7. Round tables: To improve the campaign significance it is recommended to organize round tables to as higher as possible level. It is good if the Mayor has a conversation with the stakeholders of the public awareness rising activities. In that way mutual confidence will be achieved and the stakeholders will be motivated to continue with the activities in progress. It is proposed four meetings to be realized during the year

8. NGOs meetings: Regular meetings (at least once a month) where the PA activities of local NGOs will be briefly presented. It is useful the representatives of village communities and Municipality to attend these meetings
9. Activities in educational institutions - art exhibitions, show
10. Detailed plan and the separate activities in which the pupils will be included will be defined by the local NGOs as they are directly included in the realization. It is proposed to organize art exhibitions with awards in all elementary schools in the Municipality, and the chosen ones to participate in the group exhibition in the tracts of Municipality Kisela Voda. Awards for the best works, should be provided

5.10 Near future planned activities

Veles has been chosen as focal “pilot” site, while Terms of References will have to be developed. A two step session will be initiated within the project – an introductory session and a stakehoder conference, hosted by the municipality of Veles and organised by the project. The inception phase has shown a crucial need on stakeholder participation and public information. In order to support the set up of this institutional requirement, the project asks for the approval of following required budget. Some mandates of the organisation (especially the stakeholder analyse and contacting) are indented to be outsourced due to support of local experts:

5.10.1 General objective of the Public Information Campaign

Besides a thorough diagnosis of MHK Zletovo- Veles pollution and remediation needs, the important tool to ensure the successful implementation of the proposed measures is public consultation and participation. That is required in order to achieve understanding of the key issues of concern to stakeholders/actors in the remediation process. It intends to facilitate the attempts of the Beneficiary to deliver information to relevant stakeholders and support a public awareness campaign to the new regulatory structure and proposed measure for remediation.

5.10.2 Specific objective

- To present to the relevant stakeholders general Project findings about MHK Zletovo in Veles
- To present possible mitigation measures and/or final solutions for currently polluted soil in the region of Veles
- To provoke discussion about de-commitment of Zletovo smelter Plant in Veles (pro and contra arguments)

5.10.3 Details

Proposed date/Duration/Place: Initiation of PA Campaign is proposed for the period October 2007- December 2007

Locatiohn: Municipality of Veles

Language: The language of the meetings, presentations and discussions will be Macedonian. Interpretation to/from English will be provided by the project members for the first meeting, while professional translation for the second roundtable discussion shall be conducted.

5.10.4 Proposed activities

#	Activity	Participants / Stakeholders	Venue	Time frame
1	Preparatory meeting	- Local Self Government, - MOEPP, - EAR - Local NGOs, - Representatives of MHK Zletovo - Union of agricultures	Municipality of Veles	End of October
2	Roundtable discussion and final presentation	- Local Self Government, - MOEPP, - EAR - Local NGOs, - Representatives of MHK Zletovo - Union of agricultures - Donors	Municipality of Veles	End of November
4.	Printing of Flyer[5]	n/a	n/a	Mid of November

5.10.5 Financing, breakdown of costs

Pos A – Supportive Expert in the set up and stakeholder contacting for a total period of 10 days within two months: 10 days x 65 Euro 650 Euro

Pos B – Development of Flyer (printout of results) under the term visibility

2000 pcs x 1,0 Euro 2.000 Euro

Pos C – Renting of Facility for conducting the meetings:

1st meeting in the Municipality - 0 Euro

2nd meeting in Hotel premises (rent) 250 Euro

Pos D – Transport of participants from Skopje to Veles and retour (in order to tackle green house gas reduction measures it is indented to hire a bus for the participants from Skopje) - 1 Bus transfer for 2nd Event (feasibility demonstration) 350 Euro

Pos E – Invitation, Lunch, Drinks 40 person x 12 Euro = 420 Euro

Pos F – Interpretation for the presentation and roundtable discussions (simultaneous)

1 day x 600 Euro = 600 Euro

Pos G – Set up Material (conference material) under the term of visibility (notebooks, folders, pencils, copies, maps, printouts) 60 pcs x 30 Euro = 1.800 Euro

SUM **6.070 Euro**

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[5] Prior to issuing, Project will submit draft version of the Flyer to EAR for its approval according to EAR Visibility Guidance

Figure 5_Proposed mid term Public Awareness Rising Activities for the Remediation Activities in Veles

Activity	**Implementation**	**Stakeholders**	**Time frame (in months)**	**Predicted budget (in Euros)**
Defining of general slogan and sub-slogans	Municipality; Local NGOs in cooperation with professional companies	Local self-government; Business community; Local population	0-2	250
Preparation and distribution of leaflets	Local NGOs in cooperation with professional companies	Local self-government; Business community; Local population	2 - 4	2000
Designing and broadcasting of eight radio clips	Experts; Local and national radio stations	Local self-government; Business community; Local population; The schools; OHIS	2 - 12	800
Debate programs on National TV	Experts and Local radio	NGOs; Local self-government; Business community; Local population;	4-8	800
Billboards designing	Municipality, experts and professional companies	Local self-government; Business community; Local population; The schools	2-12	3000
Organizing of round tables	Municipality; experts	NGOs; Local self-government; Business community; Local population	3-12	100 (expenses for meetings organization)
Local NGOs meetings	Experts; Local NGOs	NGOs; Local self-government	0 - 12	250 (expert costs)
Afforesting actions	NGOs; Local population; Schools; Municipality	Local self-government; Business community; Local population; The schools	4-8	250 (expert costs)
Organizing of the shows and art exhibitions in school	NGOs; Schools	Local self-government; Business community; Local population; The schools	6-12	550 (awards for the best works)
Defining of general slogan and sub-slogans	Municipality; Local NGOs in cooperation with professional companies	Local self-government; Business community; Local population	0-2	250

A budget of approximate **10.000 Euro** is required to perform a sufficient public awareness and information campaign supported by various experts and in cooperation with the central and local authorities and involved companies. A timeframe of **one till two years** seems sufficient to involve the public in remediation activities.

6 Technical Perspective - Assessments

6.1 Qualitative Health Impact Assessment

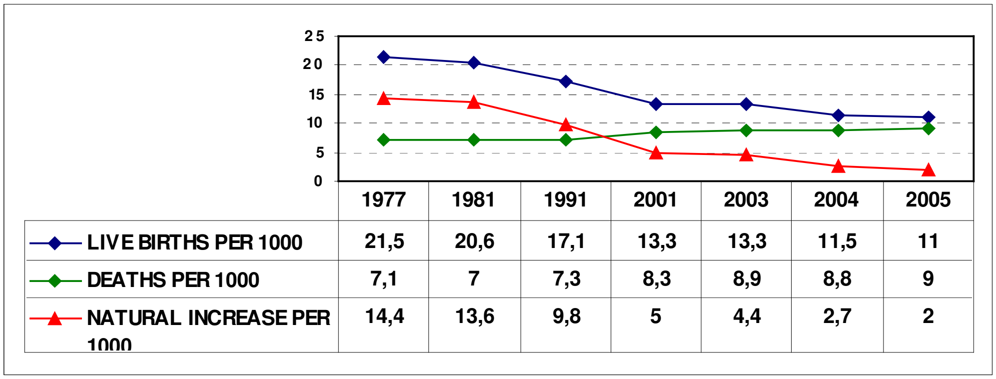
The qualitative Public Health Impact Assessment is a comprehensive study (**Volume 00_A**) about the current status and development of impacting factors on human health caused by historical and ongoing pollution. The study compared trends and tendencies of disease appearances for each site with those of Macedonia and the European Union. The following chapter focuses on the site of MHK Zletovo - Veles and the impacting situation of Lead, Zinc and Cadmium.

6.1.1 Background- General profile of the Country

In demographic terms, Macedonia is an extremely heterogeneous area. The large demographic differences, especially if observed from higher down to lower regional levels in the country, are in essence a consequence of largely differentiated directions of the natural and migration component of the total population. According to the data of the population census in 2002, Macedonia has 2.022.547 citizens of whom around 60 % live in urban areas, with an average population density of 78.6 inhabitants/km^2. The number of citizens increased by 76,615 or by 3.9 percent as compared to the previous census of 1994. The average annual population growth rate in the period amounted to 0.48 percent.

The average life expectancy is 73,5 years (Females 76 years, and males 71 years). The demographic, economical, social, ecological and health characteristics of the population showed significant differences among urban and rural areas. The birth rate in Macedonia for 2005 is 11 per 1,000 populations, and the mortality rate 9 per 1,000, resulting in a natural increase of 2 per 1.000. The distribution of deaths by age shows the highest proportion of total deaths for age 75 and over (43,6%). Age group 65-74 accounts for 28%, and age group 55-64 for 13,4% of the deaths.

Figure 6_Natural demographic changes [1977-2005][6]



	1977	1981	1991	2001	2003	2004	2005
LIVE BIRTHS PER 1000	21,5	20,6	17,1	13,3	13,3	11,5	11
DEATHS PER 1000	7,1	7	7,3	8,3	8,9	8,8	9
NATURAL INCREASE PER 1000	14,4	13,6	9,8	5	4,4	2,7	2

From 1990 to 2005 the percentage of the population over 65 years of age increased from 7,97 to 11 % (males 4,8% and females 5,8%), while the population from 0-14 years decreased to 21% (males 10,8% and females 10,2%). Such tendencies have the negative influence to the transformation of age structure of the population, i.e. the process of continuing ageing is strengthening. In the demography aging process, except

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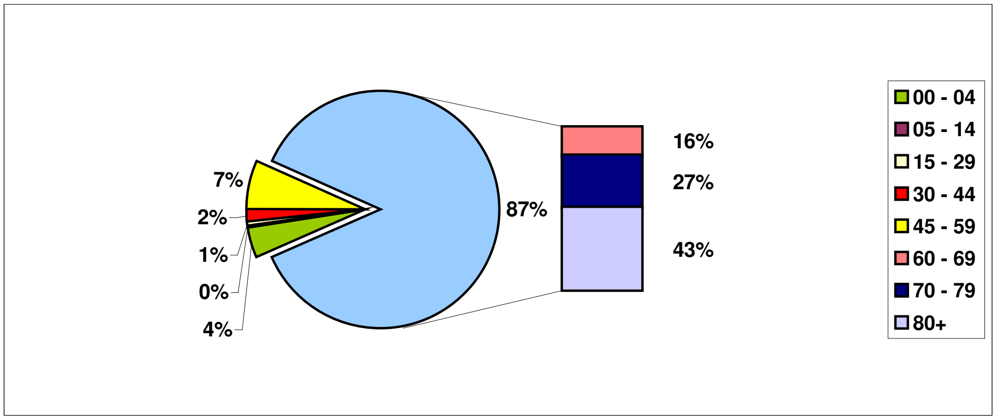
[6] Source: Statistical Yearbook of the Republic of Macedonia, 2006

natural, the big influence has the migration component of the increasing of the population. Notwithstanding the increase in the proportion of the elderly population, the population is still relatively young in comparison with the averages for the EU and for Central and Eastern European countries. However, figures also suggest that the trend towards an ageing population is far less pronounced in the Republic of Macedonia than in most neighboring central and southeastern European countries (in 2003 only Albania had a younger population with 7,87% over 65 years) or the EU (in 2003 the percentage of the population over 65 years on average amounted to 16,13%, in 2004 it was 16,42%). This is further confirmed by the healthy life expectancy estimated at 62,2 years and the Disability-Adjusted Life Expectancy of 63,7. The UNDP Human Development Index for the Republic of Macedonia is 0,799 for 2004.

Figure 7_Years of Life Lost (YLL) by age groups among males, Macedonia 2002[7]



The distribution of years of life lost among age groups in Macedonia is similar to that of the WHO EURO region. The age distribution was 87% in older ages for males and 89% for females, and 4% for males and 5% for females in age group from 0-4, respectively.

Figure 8_Years of Life Lost (YLL) by age groups among females, Macedonia 2002[8]

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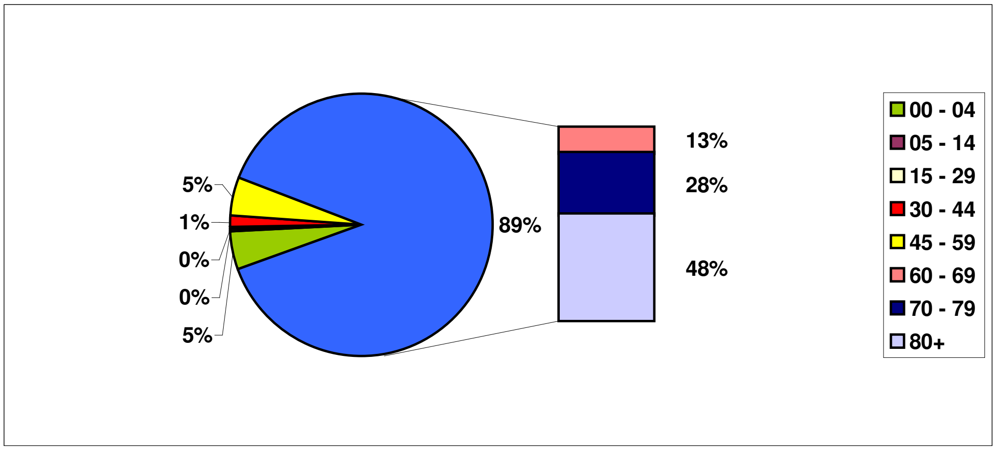
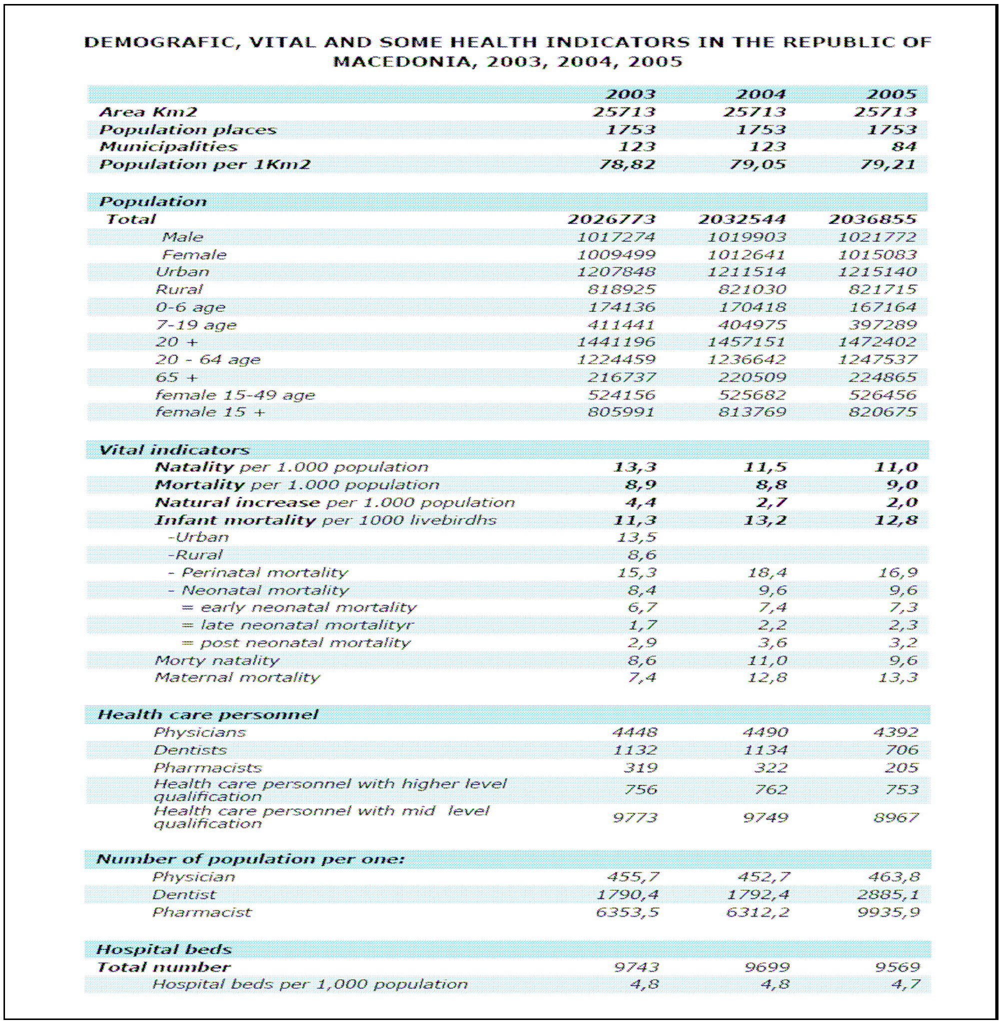
[7] Source: Kendrovski V, Gjorgjev D. The Burden of disease in the Republic of Macedonia, 2005



The per capita Gross Domestic Product for 2004 was US$ 2,382. The unemployment rate in Macedonia in 2005 was 36.5% of the total labour force, placing Macedonia among countries with an extremely high unemployment rate in Europe. The relative poverty in the former Yugoslav Republic of Macedonia for 2004 is expressed with a Poverty Gap Index - the average proportionate expenditures shortfall for the total population - of 9,4, and with a Head Count Index - the percentage of persons living below the poverty line - of 29,3% (source: State Statistical Office, 2005). The population groups identified as being most at risk of poverty are the unemployed, socially imperilled households, pensioners and farmers. Larger households in rural areas, particularly those with members that are unemployed or have low educational levels, are identified as a specific risk together with the unemployed in urban areas. Poverty has a serious impact on the health status of the population and on the access to health services.

Figure 9_(Some indicators for the Republic of Macedonia in the period 2003-2005)



DEMOGRAFIC, VITAL AND SOME HEALTH INDICATORS IN THE REPUBLIC OF MACEDONIA, 2003, 2004, 2005

	2003	2004	2005
Area Km2	**25713**	**25713**	**25713**
Population places	**1753**	**1753**	**1753**
Municipalities	**123**	**123**	**84**
Population per 1Km2	**78,82**	**79,05**	**79,21**
Population			
Total	**2026773**	**2032544**	**2036855**
Male	1017274	1019903	1021772
Female	1009499	1012641	1015083
Urban	1207848	1211514	1215140
Rural	818925	821030	821715
0-6 age	174136	170418	167164
7-19 age	411441	404975	397289
20 +	1441196	1457151	1472402
20 - 64 age	1224459	1236642	1247537
65 +	216737	220509	224865
female 15-49 age	524156	525682	526456
female 15 +	805991	813769	820675
Vital indicators			
Natality per 1.000 population	**13,3**	**11,5**	**11,0**
Mortality per 1.000 population	**8,9**	**8,8**	**9,0**
Natural increase per 1.000 population	**4,4**	**2,7**	**2,0**
Infant mortality per 1000 livebirdhs	**11,3**	**13,2**	**12,8**
-Urban	13,5		
-Rural	8,6		
- Perinatal mortality	15,3	18,4	16,9
- Neonatal mortality	8,4	9,6	9,6
= early neonatal mortality	6,7	7,4	7,3
= late neonatal mortalityr	1,7	2,2	2,3
= post neonatal mortality	2,9	3,6	3,2
Morty natality	8,6	11,0	9,6
Maternal mortality	7,4	12,8	13,3
Health care personnel			
Physicians	4448	4490	4392
Dentists	1132	1134	706
Pharmacists	319	322	205
Health care personnel with higher level qualification	756	762	753
Health care personnel with mid level qualification	9773	9749	8967
Number of population per one:			
Physician	455,7	452,7	463,8
Dentist	1790,4	1792,4	2885,1
Pharmacist	6353,5	6312,2	9935,9
Hospital beds			
Total number	9743	9699	9569
Hospital beds per 1,000 population	4,8	4,8	4,7

One of the very positive developments in the Republic of Macedonia in the last decade concerns the infant mortality rate (IMR) that continued to fall and has halved, from 28,25 infant deaths per 1000 live births in 1991 to 12,8 in 2005. However, this figure is still three times higher than the EU average of 4,75. A decrease in IMR up to 2002 can partly be attributed to the many policy interventions carried out: significant outcomes have been achieved with the Perinatal Project (1999–2001) as part of the Health Sector Transition Project.

6.1.2 Legal Framework and Institutions

Article 43 of the Constitution affirms the right of every person to a healthy environment. The Law on Health Protection (Official Gazette Nos. 38/91, 46/93 and 55/95) sets the foundations for the current health care system in the country, including the health insurance system, the rights and responsibilities of service users and service providers, the organizational structure of health care and its funding. The State is responsible for the provision of preventive care for the population through the Public Health Institutes and for ensuring that health services are available. The Health Insurance Law of April 2000 underscores the basis of the health service funding process, establishes a compulsory health insurance scheme and confirms the independence of the Health Insurance Fund and its management board. The Law on Health Protection also provides the legal framework for the Programme for Human Preventive Health Protection, which is adopted yearly by the Government upon the proposal of the Ministry of Health. The Programme forms the basis for vertical primary prevention programmes as well for monitoring the population's health and for monitoring food, drinking water, air and ionising radiation. Health indicators are monitored on the basis of the relevant legislation, including:

- The Programme for Statistical Health Research for 1998-2000 (Official Gazette Nos. 64/97, 11/00 and 54/01);
- The Law on Health Records (Official Gazette Nos. 22/78 37/79, 18/88 and 15/95);
- The Law on Health Protection;
- The Law on Protection at Work (Official Gazette No. 13/98); and
- The Health Insurance Law (Official Gazette Nos. 25/00, 34/00 and 69/00).

The Republic Institute for Health Protection is the national centre for public health and the main body responsible for environmental health. It is involved in teaching at the medical faculty, supervises and oversees the activities of ten regional Public Health Institutes, and provides technical services to the clinical centres and to the country as a whole. Its main functions are:

- The collection of data on health for all indicators;
- Monitoring the health status of the population;
- Reporting and analysing the health status and the organization of the health care system;
- Epidemiological surveillance;
- Immunization;
- Environmental monitoring (air, food, drinking water, radiation);
- Surveillance of environmental health risks;
- Drug control; and
- Advising the Ministry of Health on matters related to health policy.

The ten regional Institutes have a total of 21 branch offices that provide services in the communities. Since 1993, the Institutes have been separate from health service delivery and, amongst other functions, are charged with the delivery of vertical primary prevention programmes such as that for HIV/AIDS. The regional Institutes are located in the major municipalities: Bitola, Kochani, Kumanovo, Ohrid, Prilep, Strumica, Skopje, Tetovo, Veles and Shtip. Each regional Institute employs around 100–150 staff. The 21 branch offices, or hygiene epidemiological surveillance stations, are located in health centres throughout the country. These also provide clinical laboratory services. The Public Health Institutes have four basic functions: microbiology, hygiene, epidemiology and social medicine. In addition to these functions, the Republic Institute for Health Protection provides virological, pharmacological, and toxicological and radiation protection services to the whole country. Although their functions are similar, the different institutions have different capabilities and equipment. This difference is partly compensated by the Republic Institute for Health Protection, which provides the others with technical and analytical assistance on those aspects, with which cannot be dealt directly (e.g. for analysis of heavy metals). A form of coordination and planning of the activities of the 11 institutes takes place when the “Programme for Human Preventive Health Protection” is drawn up.

There is also an Institute of Occupational Health. It conducts health, methodological, educational and scientific activities following a multidisciplinary approach. It is a national coordination centre for the programme on Health, Environment and Safety Management in Enterprises (HESME) and is a base of the Medical Faculty Chair of Occupational Health. Occupational health comprises 146 occupational health specialists, other physicians, chemists, psychologists and other medical personnel. It has a network of 53 occupational health units as dispensaries, in health centres at municipal level, in industrial facilities, in governmental and inspection bodies as well as in private organizations. Their function is more curative than preventive. So the establishment of an adequately organized occupational health service providing monitoring, protection and the promotion of health at the workplace should be considered as an important goal for the health sector reforms.

In addition to the above structures, the Ministry of Health has inspection services, which receive expertise and technical and analytical support from the Republic Institute for Health Protection and other regional Public Health Institutes. At present, the main functions of the Inspectorate are the inspection of water (drinking and recreational), health care facilities (except medical waste), the surveillance of communicable diseases, food safety, cosmetic products, hygiene and epidemiological conditions in facilities and workplaces, drugs and medical devices, and the factories that manufacture them. In the past, the Inspectorate was also involved in the assessment of air pollution, waste and pollution from factories and in the system of permits for new activities. However, following the establishment of the Ministry of Environment and Physical Planning, the new Environment Inspectorate has in practice taken over those functions. As the redefinition of the responsibilities of each of the two Inspectorates has not yet been agreed, the consequent lack of clarity is occasionally a cause of conflict and competition between them. Total expenditure on health is around 5 per cent of GDP. More than 95 per cent of official health care finance is derived either from contributions levied by the health insurance fund or from user charges. Of the remainder, half is derived from the State budget (funding vertical primary prevention programmes, including environmental health and the care of the needy) and the other half comes from other sources such as international aid.

6.1.2.1 Approximation

By signing the Agreement for Stabilization and Association between the Republic of Macedonia and the European Union and its member countries on April 9, 2001 in Luxemburg, entering into force in June 2001, the Government of the Republic of Macedonia has undertaken activities for approximation of the national legislation to the EU legislation.

The approximation of the *Law on Air Protection* dated from 1974 was done in 2002 with technical support by the GTZ and the new Law on Air Quality was prepared. The new Law on Air Quality was adopted by the Parliament on 15th September 2004. Other environmental legislation related to air is in the process of adoption.

The EU requirements and standards in the water sector, prompted the preparation of a draft *Law on Water,* which is transposing six water related EU Directives, including the Water Framework Directive.

The *Law on Waste Management* transposes two Framework Directives *(75/442/EEC and 91/689/EEC)* has been adopted by the Parliament. MoEPP’s and other entities’ commitment in implementing the solid waste legislation will be strengthened by NEAP. That will not deny that implementation is hard and very costly. NEAP will pledge for strong support from the International Community to achieve this.

The *Law on Nature Protection* has been adopted in September 2004 and the draft Law for Environment is under the governmental procedures. Several secondary regulations for protection of nature are under preparation, inspired by EU's sixth EAP.

The *Law on Local Self Government* makes local communities responsible for the preparation and adoption of the urban plan for the settlement and the spatial plan for the municipality. The preparation of urban plans is a regular practice but depends on financiers. All the cities and big settlements have adopted urban plans. Municipalities have not prepared spatial plans since 1990. Spatial plans have to be prepared in compliance with the Law for Spatial and Urban Planning, which is under development.

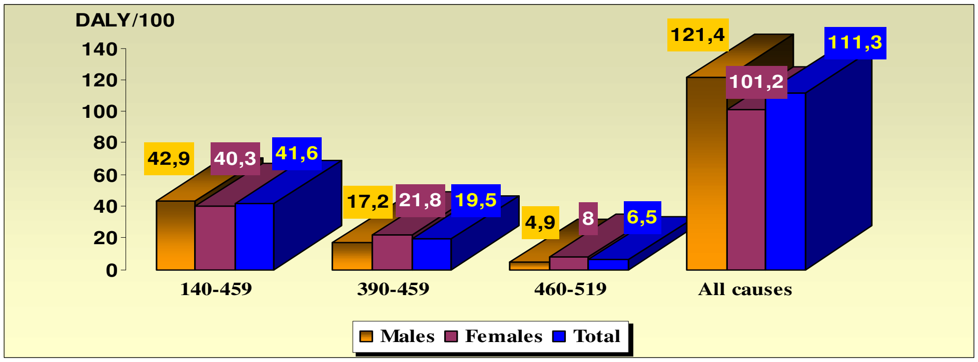
As yet this not extendedly is the case with Physical Planning and Environmental Health. However harmonization with EU Directives of the legislative framework for Regional Development has started. The same applies to the transposition of EU's Pharmaceutical Laws and Food Legislation, and specialized issues connected to chemicals, radiation, and GMOs.

The approximation of EU's laws for the protection of the environmental media is close to completion in the country. Now by-laws and directives are being transposed for air, water, waste and biodiversity.

6.1.3 State of the Environment and Health in the former Yugoslav Republic of Macedonia

The environment in which people live, work and play is an important determinant of health and well being, but the extent of its importance in developed economies is difficult to quantify. The non-communicable diseases present the biggest burden to public health analyzed by direct cost to the society as well as to the governance from aspect of disability adjusted life years (DALY) indicator. Due to fact that more and more citizens are elderly and because of that are more exposed to non-communicable diseases and disability, the needs for data, which will reflect the life quality, including the influence of environmental risk more precisely is essential. The summary measure of the population health and the methodology for the burden of diseases estimation nowadays is extraordinary indicators for the public health policy development as well as for actions needs for its reduction. The total burden of most frequent diseases in the Republic of Macedonia: circulatory, malignant and respiratory are estimated to 60,7% to DALY from all cause mortality, which is different than the percentage from the year of life lost, i.e. 52,4% respectively.

Figure 10_Total DALY for the Republic of Macedonia



The structure of deaths by cause shows that the highest number of deaths is due to circulatory diseases which present 58,4% of total number of deaths for 2005.

The standardised death rate (SDR) per 100.000 inhabitants for circulatory diseases has increased from 527/100,000 in 1991 to 599/100,000 in 2004. Overall mortality from malignant neoplasm as the second most important cause of death has also increased over the past ten years, from SDR 140 / 100.000 in 1991 to 165 / 100.000 in 2004, which is more than double that of the EU average. Injuries and poisoning are the third leading cause of death with same percentage as respiratory diseases 2003.

The most common diseases in the Republic of Macedonia – heart and circulatory diseases, cancer, respiratory diseases, injuries and non defined symptoms – have many causes which are often interconnected; including genetics, the condition people are in (via diet, exercise etc.), and the environmental circumstances to which they are exposed. Identifying cause-and-effect relationships is therefore very difficult, especially if the impact of the environment on health is delayed, or is the product of many perhaps small, environmental factors acting together.

The cancer incidence in the Republic of Macedonia has seen an increasing trend, though, unfortunately, during the last decade there have been flaws in its recording. However, the increase has been particularly notable in cancer of the lung and prostate among men, and cancer of the breast and cervix among women. Mortality from cancer related to tobacco and alcohol abuse has increased rapidly in the last decade, reflecting changes in consumption. Given the long lag phase in the progression of many types of cancer, it can be expected that rates will continue to rise for some years to come.

During the 1990s the incidence of tuberculosis (TB) decreased significantly, reaching the lowest rate of 27,61 per 100 000 inhabitants in 1999. Supported by the WHO and the World Bank, the Republic of Macedonia has successfully implemented the directly observed treatment (DOT) strategy, halving the number of patients with active tuberculosis between 1997 and 2001, and reducing the average length of hospital stay in both general and specialist hospitals by more than 20%. However, the Kosovo crisis and the conflict in the country resulting in a rise in the number of refugees and displaced citizens have had negative impacts on the health of the population, such as an increase in the incidence of TB, among other effects. In 2004 the incidence of TB was 31,72 per 100.000, representing a rate almost three times higher than the EU average of 11,85.

In international comparison the available data on lifestyle factors in the Republic of Macedonia do not seem to be very reliable and further field surveys should be conducted to consolidate these data. However, currently available data suggest that citizens of the Republic of Macedonia are less frequently victims of traffic accidents, drink much less alcohol, and eat slightly better (fewer calories, less fat, more fruits and vegetables), for example. Accurate data on smoking habits are missing. The low and overall decreasing trend regarding traffic accidents observed since 1996 (with a death rate of 8 per 100.000) seems to reflect more a stagnation of road traffic than improved road safety: the incidence of road injuries (95 per 100 000 in 2003) is three times lower than the EU average of almost 297 per 100 000 in 2004. Traffic traumatism in children and youths is a priority public health problem. The most recent mortality data show that road traffic injuries covers an amount of 30 – 50% of all injuries causing death in children and adolescents in different age groups. Severe traffic injuries are the leading cause of hospitalization (10%) and in 10% of cases the most severe traffic injuries have left children and youths disabled. A study in the year 2000 suggests that children and youths up to the age of 24 represent 43,6% of all injured people and 26,5% of casualties dying in car or traffic accidents. Over the coming years traffic is expected to increase and already a positive correlation between number of drivers, vehicles, accidents and deaths can be observed, whereas in western European countries the number of accidents and injured is higher but the death rate is much lower, owing to effective preventive interventions.

The state of oral health of the population in general and of children in particular is far from adequate. In some epidemiological studies in 2000, the registered index for decayed, missing and filled teeth (DMFT-12) is over 5 *(13)*. In comparison, in 2000 the DMFT-12 index was 1,47 in the 15 countries belonging to the EU prior to May 2004 and 3,71 in the 10 countries joining the EU in May 2004 (see European Health for All databases, January 2006. Against this background there is a need at national level for properly organized preventive programmes to improve dental hygiene.

Traditional public health activities working in concert with pre-school health protection programs have maintained vaccination coverage rates above 95%. Also, during the same period, no cases of neo-natal tetanus were reported and there have only been 27 cases of measles and 5 of pertussis. The certification for eradication of malaria has been achieved in 1973. The reported malaria cases were due to imported cases from countries where malaria existed. Since 1976 in the country there were no reported diphtheria cases and since 1987 there was no reported case of acute poliomyelitis, i.e. since 2002 the WHO has announced the Republic of Macedonia as polio free country and no cases of polio have been reported in the last five years.

Deaths due to diarrhoeal diseases among children under 5 years peaked to 100,6 per 100.000 in 1992 and have reduced to 16,4 per 100.000 in 2000. Much progress remains to be made, however, as these rates are still four times higher compared to the CEE average and almost thirty times higher compared to those of the European Union.

The Typhoid and Para-Typhoid is not an epidemiological problem in the Republic of Macedonia anymore because there has been registered only a sporadic cases during the period 1990-2003. The average registered cases for this decade were 4.1 cases per year. The Para-Typhoid was registered by 1 case per year. The Dysentery in the period 1990 - 2000 has been registered with average 258 cases per year and still presents a significant epidemiological problem, with higher registered number in 1998 (388 cases). The average morbidity rate of dysentery for the period 1990 - 2000 was 12,8 per 100.000. In 2001, only 107 cases where reported which shows a 7,3% decreasing compared with the year 2000.

This disease for the period 1990 - 2005 was registered with average 6.853 cases per year and average morbidity rate of 347,7 per 100.000 and enterocolitis is still a significant epidemiological problem in the Republic of Macedonia. The higher reported cases is detected in 2002 (Mb 335,3 per 100.000) and the smallest number in 1993. Disagreeing in criteria, methodology in practices and diagnostically procedures make some difficulties in proper definition of health condition for the diagnostics of entrocolitis. In the bigger part of the country there are laboratory capacities for its diagnostic. Therefore, there is relative high number of reported cases as well as the difference by years – 9.484 in 2000 and 3.007 in 1993.

The Hepatitis A diseases are actual epidemiological problem in the Republic of Macedonia with registered relatively high number of cases and showed high morbidity rate, too. The average number of registered cases was 1.075 per year and average morbidity rate was 53,6 per 100.000. The existing problem in the viral hepatitis diagnosed procedure is lack of markers for completely testing in some laboratories during the some period of the year, which resulted with registered a high number of so call "undiagnosed" Hepatitis (mostly Hepatitis A). The number of registered cases of Hepatitis A in 2005 was 706 registered cases.

The Republic of Macedonia adopted the “Health for All” policy after joining the World Health Organization in 1993. Cooperation with WHO started in 1992 when the WHO Humanitarian Assistance Office was opened. The WHO Liaison Office was established in Skopje in 1996.

6.1.4 Health Risk Impacting factors

There is a serious lack of data and information on exposures, effects and biological models that connect them. Therefore considerable uncertainty surrounds many issues of concern, such as air pollution, noise, water contamination, waste, climate change, chemicals (including endocrine disruptors and antibiotics), ionising and non-ionising radiation.

In many cases, however there is sufficient evidence to take preventive action, particularly where the impacts may be serious, large-scale and irreversible – circumstances which merit the use of the precautionary principle. Preventive action on many of the environmental hazards covered in this chapter is being taken, but more integrated and effective action is being proposed to reduce threats to health and well-being.

Risk and hazard are two distinct, but interrelated, concepts. A *hazard* represents a chemical, physical, or biological substance that has the potential to produce harm to health if it is present in the environment and comes into contact with people. The hazardous properties of an environmental agent are defined according to the nature and severity of its harmful consequences. Fortunately, many hazards can be either contained or avoided, so not every potential environmental hazard poses an actual health risk. A *ris*k, in turn, is defined as the likelihood of adverse health effects arising from exposure to a hazard in a human population, which is conceptually expressed as the product of two factors: the probability of exposure and the severity of the consequences.

Environmental health risk assessment is an essential element in environmental management and an important condition in precise priority setting to the necessary actions for its sanitation. At present there are not sufficient scientific data available for a large number of health-related environmental hazards representing risk on human health. In addition, even with the best possible information available on the nature and level of pollutants in the environment and about population exposure to different pollutants, environmental health risk assessment may not be complete because of difficulties in analysing the complexity of possible interactions in the case of multiple exposures. Even more complex is the assessment and comparison of costs and benefits of health risk elimination. This is partly because environmental health risk assessment is still limited in its effectiveness by the inadequacy of the information available, especially on exposure. In addition, even with the best possible information, an environmental health risk assessment may not be complete because of difficulties in analysing the complexity of possible interactions in the case of multiple exposures.

The country has a few environmental hot spots, characterized by high levels of pollution (air, water and soil), due to emissions from industrial facilities.

6.1.4.1 Air pollution

According the NEAP 2 there is a direct correlation between the air pollution and human health based on a number of research works performed in the period 1997 - 2002. The positive correlation was found between the monthly average concentrations of the black smoke and SO_2 and the increased respiratory morbidity for the children at the age 0-6 and 7-14. The air pollution problem is more acute in the winter period due to the effects of temperature inversion and climate circumstances in the country; this is supported by the 32% of all sold drugs being under the respiratory diagnosis, as reported by the Pharmacy Information System. Air pollution affects approximately 60% of the population, in particular those living in the cities of Skopje, Veles, Bitola and Tetovo.

According to the available data 66% of the total annual SO_2 air emissions originate from the combustion and transformation of energy. The major contributor to the total emissions of NO_x are energy production and mobile sources with 73% and the production processes are the main dust emission source with 85% of the total annual dust emissions in 2003.

The major source for CO emissions is the road traffic with approximately 65% of the total emissions in 2003.

In regard to the industry sector, obsolete equipment and non-existent modern technologies result that this sector represents a major air polluter. The main pressure on environment (in particular air quality) originates from the metallurgy sector (until 2003 the lead and zinc smelter MHK Zletovo in Veles and Ferro-alloy SILMAK in Jegunovce, MAKSTIL, FENI Industries-Kavadarci), and the chemical industry- refinery OKTA, OHIS chemical complex and TITAN cement factory.

Large metallurgical installations, oil refining plants, tanning and production of chemicals and cement are the main sources of pollution within the industrial sector.

Most probably due to reduced volume of production, the share of industry in overall environmental pollution is limited. However, some installations are big polluters creating severe problems to the environment and the health of the surrounding population:

- OKTA, the oil refinery, is the biggest source of VOCs emission and in addition some 3600 Mg/y SO2 are emitted into the air from the petrol desulphurisation plant;
- Huge amount of dust (9000 to 17000 Mg/y) is being emitted by Ferro-alloys plant Silmak near Tetovo. 312000 m^3/h of exhaust gas containing 2 - 6 g/m^3 dust are released without treatment.
- Until closure of MHK Zletovo in 2003, the lead and zinc smelting plant located in Veles operates a single absorption sulphuric acid plant with no additional treatment of the exhaust gas leading to an emission quantity of about 2100 t/y of SO_2. Additional 1800 Mg/y of SO2 and 2.5 Mg per year of lead have been emitted through the ventilation system and the fugitive sources.
- While in operation, the shaft furnace of the Zletovo Smelter generates about 45.000 Nm3/h low calorific value gas (LCV) containing 21% CO and about one third of it is released to the atmosphere.
- Considerable amounts of ammonia have been released to air from the mono ammonium phosphate production unit of the MHK Zletovo fertilizer plant. Both MHK Zletovo plants are closed at the moment, but their restarting is only a matter of time.
- Energy production in thermal power plants (especially significant is REK Bitola because it covers approximately 75 % of the total national demand) and in district heating facilities is an additional sector that severely impacts the environment.
- Emissions from mobile sources in the bigger cities with a high population density are also a big pressure on the environment. Air emissions from the mobile sources have been directly related to the fuel quality and the number and age structure of the vehicles. The total number of vehicles in Macedonia is about 220 per 1000 inhabitants. The average age of the vehicles is around 15,5 years, and around 51% of these vehicles were produced 20 or more years ago.

Main POPs air emission pollutants are inventoried and reported in the National Implementation Plan on reduction and elimination on Persistent Organic Pollutants

In Veles a significant correlation has been found between the emissions of lead, zinc and cadmium as well as SO_2 in the air and the health of inhabitants. The higher concentration of the lead in the blood was registered and it has been connected with occurrence of cancer, respiratory diseases, miscarriages and birth defects. The direct correlation has been found by the medical experts between the particulate matters with small dimensions ($PM_{2.5}$) in the form of dust originated by the REK Bitola Power Plant and health problems with respiratory system at adults as well as bronchia at the children age. Although there are no any study in Macedonia presenting the direct correlation between the lead from mobile sources and human health, the medical experts uses the series of publications worldwide that confirms the harmful effect of lead.

6.1.4.2 Indoor air pollution

Indoor pollution in homes is not monitored. One Study in 1999 has carried out in Bitola the second largest city in Republic of Macedonia by RIHP and 352 selected children (aged – 9 - 10 years) where distributing in two groups in separated areas according to previous data for air pollution. Health data about respiratory (allergic and non-allergic) diseases; social - economic factors, passive smoking, cooking, etc. were collected prospectively by questionnaires. 135 children from both groups were chose randomly for Spirometry. In this Case-Control Study was examined the relation between prevalence of bronchitis and runny/stuffed nose with analysed risk factors. There were found statistically significant differences ($p < 0,05$) between cases of bronchitis and air pollution; association ($p < 0,05$) between bronchitis cases and runny/stuffed nose with cooking by gas and woods, and also association between Spirometry FEV_1 Parameter between two groups.

The use of asbestos is no longer allowed, but it is still present in buildings, which have been neither cleaned up nor demolished. Any problems of exposure to asbestos are considered to be of an occupational nature. Substantial health risks come from asbestos when, the crushed asbestos crystals are aerosolised and inhaled. It is important what the size and structure of the crystal is because it determines how far down in the lungs the crystals can get before getting stuck there and causing symptoms. Since the airways in the lungs get smaller as you get deeper into the lungs, smaller crystals will go farther. Also, if the structure of the crystal is very sharp, it will be better able to penetrate the tissues and get stuck there.

Smoking prevalence was assessed in a survey among 1.203 medical doctors (i.e. about 25 per cent of the total) in 1999. The survey estimated that approximately 36 per cent of the population over 15 years of age were regular smokers, with a higher prevalence among males (40 per cent) than females (32 per cent).

6.1.4.3 Drinking water

Approximately 60 per cent of the drinking water is supplied from karstic springs, 20 per cent from surface waters, and 20 per cent from groundwater. Current control measures, frequency and standards are not in compliance with EU regulations and WHO Drinking Water Guidelines. The chemical quality of drinking water varies with the origin of drinking water sources. Almost all karstic and surface water, and significant amounts of well water, are notably short in fluoride. Some wells in Veles, Shtip and Kochani have relatively high contents of iron and manganese, and nitrates range between 1 and 5 mg/l. During the summer higher nitrate concentrations have been found in wells in Prilep and Radovis (10 - 15 mg/l). Both wells are situated in regions where the land is intensively used for agriculture. The nitrite content is generally below 1 mg/lt. Toxic parameters, such as lead, arsenic, chromium and cadmium concentrations, meet WHO- standards. A few wells in rural settlements have unusual levels of for ammonia, nitrite, nitrate and $KMnO_4$. Five per cent of all wells assessed by the Public Health Institute are microbiologically contaminated. From 1970 to 1997, there were several water-borne epidemics, caused by serious failures in the distribution networks combined with poor local hygiene practices.

Management of the sewage systems is the responsibility of the same public utilities as the drinking water supply. Only 12 cities have constructed separate sewage systems. City of Skopje has constructed separate system for wastewater (56%) and for precipitation water (18%). Collector network of City of Skopje is 280,6 km and 1.239,1 km of sewage network on national level.

6.1.4.4 Water for recreation purposes

The most seriously polluted waterways are reportedly the central and lower sections of the Vardar, Pcinja, Bregalnica and Crna rivers. Polluted groundwater is also an issue near Skopje, and especially in Veles. The most serious water pollution concerns are the discharge of untreated wastewater from mining and industry, as well was wastewater from urban centres and livestock breeding farms. Reportedly, only 6% of wastewaters in Macedonia are treated prior to their discharge in rivers

Mineral and thermal mineral water springs are used as spas, for tourism, and as a source of bottled water. Water quality and safety meet national standards. Only some artesian wells presented high mineralisation with the presence of iron, manganese and inorganic ammonia.

6.1.4.5 Wastewater discharges

Discharge of wastewater without treatment into aquatic recipients (especially groundwater) represents a serious health risk for the population in Macedonia taking into consideration very limited number of properly designed wastewater treatment plants and realistically low sewage network coverage. In practice the only treatment plants in the country are installed and operating in the areas around the three big lakes (Ohrid, Prespa, Dojran).

Consumed water by the industry is very variable, from year to year, without defined trend. It is also very important to emphasize that large number of industry facilities are not operating, due to difficult economic situation in the country. Some of the factories are closed, some of them are working with reduced capacities and other change their production. According to the data, totally consumed water for industry (water for cooling and of TPP and other industries) decreased from 240.000 m3/year in 1998 for 75% in 2002 on 67 000 (not including cooling water). The largest consumers are chemical industry, food processing, non-ferrous metal production, and textile fibre and fabric industry. Water used for production of electric energy, except for cooling of the thermo plants, is not actually spent or polluted, because it only passes through the turbines, without changing it quantity or quality. Existing thermo plants "REK-Bitola" and "REK-Oslomej", use technological water with re-circulation water supply systems. In these systems raw water is used only for covering the water losses. Thermo plant in Negotino is using running water from river Vardar. The cooling water consumption decrease in last years fro the same level as industrial water. There is no data on quality of the used water, whether that industry has water permission for abstraction of water, and if it has, whether it is respected, how much water is used for unit of product etc. Industry wastewater is one of the most dangerous polluter of the surface and groundwater. The quantity and quality are rather variable and depend on the technology process and capacity of the industry.

There is small number of industry wastewater treatment plants constructed in the Republic of Macedonia. Most of them have only mechanical treatment, while only limited number has mechanical and chemical (biological) treatment. Some of them are not under operation due to malfunction, there are no spare parts or it is too expensive to run. Even where wastewater treatment plant is functioning, the results are not meeting the requirements.

6.1.4.6 Waste

The current condition in the waste sector such as lack of integrated waste management system, illegal dumping sites or problems with the hazardous waste represent a serious health risk.

In their 2004 State of Environment Report (Republic of Macedonia, 2004), the Ministry of Environment and Physical Planning indicate that waste is a serious issue in Macedonia. They indicate that at least 150 x 106 Mg of mine waste (principally tailings containing Pb, Cd, Zn, Cu, and organic flotation reagents) are held on mine sites; that at least 6 x 106 t of metallurgical slag and cinder has been produced by smelters, and that the two largest mining-power generation complexes so far have produced about 330 x 106 Mg of waste (mine spoil/tailings, cinder and ash). Generally, this source indicates that some data on pollution and waste (and its speciation) is available, but that the affected areas have not been adequately delineated.

6.1.4.7 Noise

The current conditions in the country recognise insufficient attention to problems of noise abatement in Macedonia:

- No systematic questioning of the population about noise nuisances as an indicator of existing stage
- Sufficient attention is not given to the noise problem at early stages of planning, reducing it to general instructions which are not an adequate basis for effective implementation of the protection.

Introduction of noise abatement and protection in late stage of planning has only the nature of remediation. Measures recommended at that point are more expensive and less effective. Cross – sectional study was performed in 2002 with aim to assess community noise exposure in schoolchildren who live and study in Skopje and to make risk assessment of community noise in this vulnerable group. This study was performed by Ministry of health, Republic Institute for health protection, Clinic for paediatric diseases and Central Laboratory within the Ministry for environment and spatial planning. Noise measurements, performed within this study, showed that school children who live and study in mixed residential – administrative – market area are exposed to elevated noise level. School children who live and study in residential area in suburban area of Skopje are exposed to noise level below WHO guidelines for prevention of adverse health effects. Psychological testing of schoolchildren with aim to make assessment of mental health in those two study groups showed that schoolchildren exposed to elevated noise level have behavioural disorders (decreased social adaptability and increased opposing behaviour).

6.1.4.8 Food safety

About 25.000 samples of food are tested annually for their microbiological safety, 40 per cent of which are from imported foods and 60 per cent from domestic production. In 2006, 4,7% of domestically produced food samples of industrial origin and 11,5% of food samples from small enterprises were found to be contaminated and 14,5% of contamination cases occurred in the distribution chain. The large number of private farmers and small production enterprises, as well as the enormous number of small trade and catering firms make legal controls very difficult. Due to the ambiguity of the law, a number of those entities do not have suitable premises, equipment, staff, professional skills or standard hygiene conditions. The conditions prevailing in traditional markets are unhygienic.

6.1.5 Occupational Health

There are no official data on occupational diseases in the Republic of Macedonia, despite the numerous studies carried out by the Institute of Occupational Health. The official register for occupational diseases (under the Ministry of Labor) has not been updated to cover all relevant occupational diseases (in line with EU regulation).

6.1.5.1 Radioactivity

Exposure to ionising radiations in principle is limited to occupational exposures of health care workers, some researchers and workers in some industries where radioisotopes are used. The Ministry of Health has the responsible of controlling and authorizing the use of ionising radiations sources, with technical assistance by the RIHP. The Radiation and Dosimetry Department of the RIPH maintains the national registry of radioactive sources and controls occupational exposures. The Department participates in international projects led by the IAAE, such as one aiming at improving radiation protection. Next to the Radiation and Dosimetry Department, the Department of Radio-Ecology of the RIPH has the responsibility of monitoring ionising radiations in the environment and working areas. It also monitors radioactive contamination in domestic and imported/exported food, cosmetics, drugs and construction material, and issues certificates of compliance. Approximately 2000 samples / year are analysed, mostly for alpha- and beta-activity; others for total uranium. The Department of Radio Ecology prepares annual report on the results of his monitoring activities, provides information to the public and services to factories, municipalities, etc.

6.1.6 Health Risk Assessment methodologies

In the context of environmental health, the risk management process can be organized into several distinct activities. The three core activities that constitute the essential decision-making steps in the risk management process are each involved in examining different aspects of the risk problem:

- Risk Estimation
- Risk Evaluation
- Risk Control

6.1.6.1 Risk estimation

The use of science-based risk information and analytical methods to characterize the nature and extent of environmental health risks in the human population;

6.1.6.2 Risk evaluation

Consideration of the economic, social, political, and legal factors that influence a decision to adopt a particular course of action to reduce health risks - in some risk frameworks, the quantitative economic analysis of the benefits and costs of risk reduction is combined with results of the risk estimation process, so that a, risk assessment may subsume part or all of risk evaluation;

6.1.6.3 Risk control

The selection of options and the commencing of actions intended to reduce risk to an acceptable or tolerable level; this activity is often referred to as risk management, but the term risk control is more specific and better reflects the objectives of the activities it denotes.

Risk assessment is the process of estimating the potential impact of a chemical, physical, microbiological or psychosocial hazard on a specified human population or ecological system under a specific set of conditions and for a certain timeframe. Risk assessment is intended to provide complete information to risk managers, specifically policymakers and regulators, so that the best possible decisions are made. There are uncertainties related to risk assessment and it is important to make the best possible use of available information.

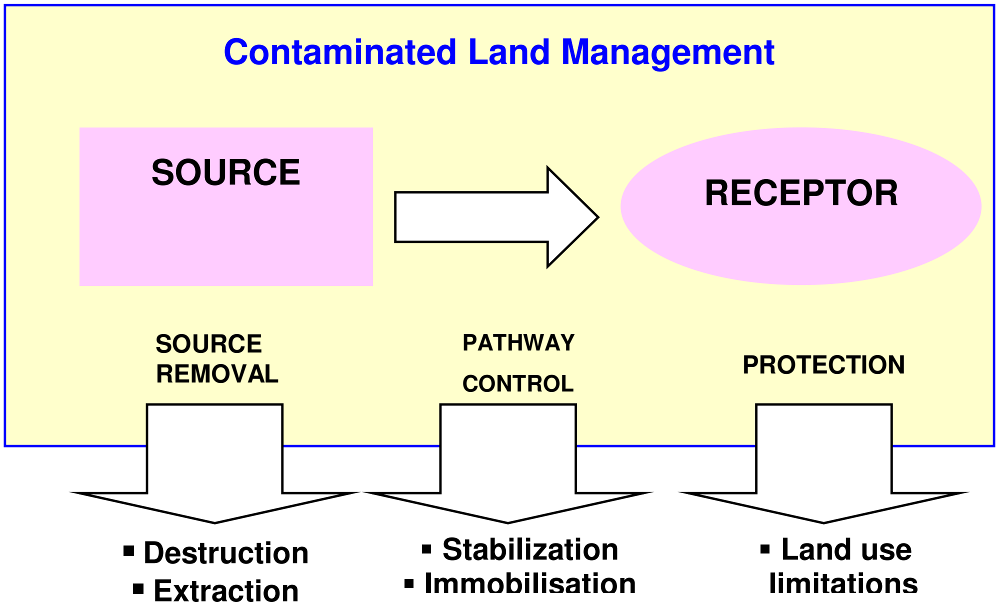
6.1.7 Methods

Retrospective epidemiological method was used in order the following four distinct and essential components of the risk assessment paradigm to be addressed:

1. Hazard identification - identification of the inherent capability of a substance to cause adverse effects by sides;
2. Assessment of dose-response relationships - involves characterization of the relationship between the dose of an agent administered or received and the incidence of an adverse effect;
3. Exposure assessment - the qualitative and/or quantitative assessment of the chemical nature, form and concentration of a chemical to which an identified population is exposed from all sources (air, water, soil and diet);
4. Risk characterization is the synthesis of critically evaluated information and data from exposure assessment, hazard identification and dose-response considerations into a summary that identifies clearly the strengths and weaknesses of the database, the criteria applied to evaluation and the validation of all aspects of methodology, and the conclusions reached from the review of scientific information.

The logical consequence of the process of assessment of potential risk is the application of the information to the development of practical measures (risk management) for the protection of human health. All available studies, articles and reports related to defined hotspots from 2000 to 2007 are included in the assessment.

The general approach for the identification of sources of contamination, associated hazards, migration pathways and sensitive receptors are as follows:



6.1.7.1 Advantage of various methods

Many organisations are now actively involved in Environmental Risk Assessment, developing methodologies and techniques to improve this environmental management tool. Such organisations include OECD, WHO and ECETOC. One of the major difficulties concerning the use of risk assessment is the availability of data and the data that is available is often loaded with uncertainty. The risk assessment may include an evaluation of what the risks mean in practice to those affected. This will depend heavily on how the risk is perceived. Risk perception involves people's beliefs, attitudes, judgements and feelings, as well as the wider social or cultural values that people adopt towards hazards and their benefits. The way in which people perceive risk is vital in the process of assessing and managing risk. Risk perception will be a major determinant in whether a risk is deemed to be "acceptable" and whether the risk management measures imposed are seen to resolve the problem. The procedures, methods and techniques for regulatory risk assessment of chemicals in the EU is described in both legislation and supporting Technical Guidance Documents. Implementation is supported by the European Chemicals Bureau, part of the Joint Research Centre, in Ispra.

Most methodologies for human health risk assessment of chemicals are based on the NAS model. A number of methodologies exist due to differences in the toxic mechanisms exerted by different classes of chemical and the toxicological end-point being assessed. The end-point being assessed could be death, or a specific pathological condition relating to exposure to a chemical. When attempting to assess the risks from an immuno-suppressant toxin, specific end-points may be difficult to determine, as may be the role of other agents and stressors on the body. This will lead to risk assessment methodology for immuno-suppressants being different from assessments for irritants for instance. All human health risk assessments of chemicals include hazard identification, dose-response assessment, and exposure assessment and risk estimation/characterisation. If the assessment is site-specific, then a release assessment would be required in the absence of good data of environmental levels or to account for non-routine, accidental releases.

6.1.7.2 Risks and constrains of various methods

Risk assessments may assess individual or population risks. Individual risks may be for the average (i.e. typical) individual or the highly exposed or particularly susceptible individual and the risks may be estimated for various duration of exposure (e.g. per year or per lifetime) or for different locations. Individual risk can only be assessed for a hypothetical individual with assume characteristics. Assessing the risk for any real individual will be frustrated by the fact that risk predictions for an individual can never be validated by experience. Any real individual will either experience the negative outcome or will not. Neither of these results can validate any risk prediction other than a probability of one or zero. Population risk may relate to the number of adverse health effects (eg. fatalities, cancers, or illnesses) in a population over a specified period of time or the rate of adverse effects for a given location or sub-population.

The UNEP/ILO/WHO International Programme on Chemical Safety (IPCS), in collaboration with the US Environmental Protection Agency (US EPA), the European Commission (EC), the Organization for Economic Cooperation and Development Cooperation, and other international and national organizations developed a working partnership to foster the integration of assessment approaches to evaluate human health and ecological risks. The overall goal of this project was to promote international understanding and acceptance of the integrated risk assessment process. Three specific objectives were identified to meet this goal: 1) enhance understanding of the benefits of integration, 2) identify and understand obstacles to integration, and 3) engage key scientific organizations to promote discussion of an integrated approach to risk assessment

A generic framework and associated documentation were developed to communicate how an integrated risk assessment could be conducted. Recognizing the similarities in risk assessment frameworks currently in use internationally, the integrated risk assessment framework is based on US EPAs framework for ecological risk assessment and its associated terminology (US EPA 1998). Ecological risk assessment frameworks have greater general applicability than do human health frameworks (or those environmental frameworks derived directly from human health frameworks) in that they 1) were developed to deal with a range of environmental stressors beyond toxic chemicals, 2) must describe the nature and role of the environment in the risk assessment process, and 3) must explicitly identify the endpoint to be assessed. Further, a well-developed body of concepts and terminology exist in the literature treating ecological risk assessment that supports integration. The integrated framework consists of three primary assessment phases. During the first of these, ***Problem Formulation***, the overall goals, objectives, scope, and activities of the assessment are delineated. The *Analysis* step consists of data collection and modelling exercises to characterize exposure in time and space, and to define the effects on humans and ecological systems resulting from exposure. The methods appropriate for the Analysis step may be stressor-specific, but also depend upon the nature of the systems identified to be at risk. Exposure and effect information are synthesized as estimates of risk in the ***Risk Characterization*** step. Ideally, these estimates are quantitative with respect to the level of risk expected under different exposure scenarios, although only qualitative estimates of risk may be possible in some circumstances. The integrated risk assessment framework treats the relationships among risk assessment, risk management, stakeholder input, and data collection activities in a general parallel and concurrent manner**.** Essentially, risk characterisation is a summary of the data compiled in the risk assessment process including the uncertainties associated with each stage and the presentation of a risk estimate.

6.1.7.3 Parameters and indicators for choosing a methodology

Risks can be managed in many ways. They can be eliminated, transferred, retained or reduced. Risk reduction activities reduce the risk to an "acceptable" level, derived after taking into account a selection of factors such as government policy, industry norms, and economic, social and cultural factors. It is important to note that although risk assessment is used extensively in environmental policy and regulation it is not without controversy. This is also true for risk management.

There are various criteria for assessing risk assessment including:

The logical soundness of the method is eg. its justification based on theoretical arguments or scientific knowledge, and the validity of the underlying methodological assumptions.

- **Completeness** - (e.g. whether it can address all aspects of the problem and the degree to which it excludes issues because they are hard to accommodate).
- **Accuracy** - (e.g. the precision reflected in the confidence level associated with the results; biases resulting from undue weight given to specific interests or considerations; and the sensitivity of results to untested or untestable assumptions).
- **Acceptability** - (e.g. compatibility with existing processes; whether it is viewed as rational and fair; the level of understanding for all parties affected by it; and the confidence and familiarity of those who will use it).
- **Practicality** - (e.g. the level of expertise, time and input data required).
- **Effectiveness** - (e.g. usefulness of results; range of applicability across different risks and problem areas; the generalisability of the conclusion to other problem areas; and effectiveness and efficiency of linkage with other types of methods).

The level of risk can be described either qualitatively (i.e. by putting risks into categories such as ‘high’, ‘medium’ or ‘low’) or quantitatively (with a numerical estimate). Current risk assessment methods do not enable accurate quantitative estimates of risk for low levels of exposure to environmental hazards. Numerical estimates of risk will rarely be feasible because of variability in the agent and population and limitations in toxicological and exposure data that will be reflected in the uncertainty assessment, but a degree of quantification may be possible for some components such as data collection and exposure assessment.

6.1.7.4 Qualitative Risk Assessment matrix

Regarding human health, the assessment was focused on exposure routes, both direct and indirect. For each of the sites we established what exposure routes exist and what routes are significant. We also established the number and type of people that may be affected to a significant extent, depending upon location, age and profession. Finally, using an expert judgement method the conclusions are based of principles used during a qualitative risk assessment for each of 4 hotspot sides.

Table 2_Illustration of principle, used during a qualitative risk assessment

Contaminant Hazard

- Significant (H)
- Moderate (M)
- Minimal (L)

Migration Pathway

- Evident (H)
- Potential (M)
- Confined (L)

Receptors

- Identified (H)
- Potential (M)
- Limited (L)

Contaminant Hazard Factor	Receptor Factor	Migration Pathway		
		Evident	**Potential**	**Confined**
Significant	Identified	HHH	HHM	HHL
	Potential	HHM	HMM	HML
	Limited	HHL	HML	HLL
Moderate	Identified	HHM	HMM	HML
	Potential	HMM	MMM	MML
	Limited	HML	MML	MLL
Minimal	Identified	HHL	HML	HLL
	Potential	HML	MML	MLL
	Limited	HLL	MLL	LLL

6.1.8 Site Specific Risk Assessment

6.1.8.1 Background

The structure of the Macedonian industry is in a favour of creating large amounts of waste. The biggest generators of waste in the industrial sector of Macedonia are: ferrous and non-ferrous metals production plants and solid fuel combustion units within the industry sector. Liquid waste is also generated from industrial operations. Most frequently it is oil or oil rich emulsion. There is no clear policy on the final faith of oily waste and some operators have been advised bay the authorities to pack liquid waste in barrels and dispose them on the nearest municipal landfill. It is estimated that about 5,5 Mt of waste are produced each year, out of which 4,5 Mt are flotation tailings. The air and water pollution as well as the waste generation contribute to the pollution of soil. During previous CARDS 2001 Project, 16 identified contaminated industrial sites were analysed and based on various environmental criteria 3 classes were developed: low, medium and high risk contaminated industrial sites. Methods for closure / remediation were developed and (unit) cost estimates made. The total remediation costs are estimated at € 70 million from the Cards 2001 project, while the Cards 2006 project estimates a budgetary need of € 200 million taking all locations into consideration requiring remediation.

This Project is a follow-up project with objective to further investigate the total pollution and health environmental impact per 4 defined sites as well as to provide a more detailed specification of the proposed remediation/closure methodology and the related costs. As a primary task for this Project the health impact assessment was done for **4 marked** as “hotspots” Macedonia sites:

- OHIS, a chemicals producing company, has accumulated and disposed on site over 15000 t of α, β and δ HCH isomers. Considerable amount of mercury has been either discharged with the wastewater or leaked from the process equipment contaminating the former chlorine electrolysis plant site soil .
- The soil in a wide area around Veles has been contaminated with zinc, lead and cadmium arising from the lead and zinc smelter operation from 1973-2003. Due to the high mobility of airborne cadmium it has been found in even wider area.

  In addition to the smelter area, the region of Veles is affected by the gypsum landfill of the fertilizer plant located some 11 km south of the town of Veles.
- Huge amount of mono-chromate containing sludge has been deposited on a landfill near to the SILMAK (a ferroalloys smelting company) in the area of the village Jegunovce. This sludge is the solid waste produced during the operation of the sodium bi-chromate production plant. The Government of Macedonia has already undertaken measures to eliminate the risk of contaminating the river Vardar and the potable water springs.
- Iron and steel work in Skopje due to dust emission from the steelwork's EAF and the ferroalloys electric furnaces along with oily scale from the hot rolling mills is a significant source of pollution and in addition, it will be very difficult to control it because of the number of different operators.
- The old landfill of the former integrated steelwork is a potential source of groundwater contamination with

6.2 Specific Situation – VELES MHK Smelter

The Municipality of Veles is located in the central part of the Republic of Macedonia and covers approximately 465 square kilometres, supports a population of over 55.000 inhabitants, making it the 8th largest municipality in the country. Established in 1973, MHK Zletovo was a lead and zinc smelter employing 1.100 workers. Each year about 130.000 Mg of lead and zinc concentrates were used to produce 30,000 Mg of lead, 60,000 Mg of zinc and 250 Mg of cadmium, as well as smaller quantities of silver, gold, copper dross and bismuth alloy. The process was producing 100,000 Mg per year of sulphuric acid as a by-product. The same company also owned and operated a nearby fertilizer plant. The smelter emits into the atmosphere large quantities of sulphur dioxide, and dust bearing lead, zinc and cadmium. MHK Zletovo-Veles during its activities has operated as the country's smelter and refinery for the production of lead, zinc and associated metals. About 45% of the concentrates were from domestic lead and zinc mines (Sasa - Makedonska Kamenica, Zletovo-Probistip, and Toranica-Kriva Planca); the balance was imported concentrate. The zinc refinery had a production capacity of 64.000 Mg/yr and the lead refinery a capacity of 40.000 Mg/yr.

6.2.1 Hazard identification

- Identification of the inherent capability of a substance to cause adverse effects. The purpose of hazard identification is to evaluate the weight of evidence for adverse effects in humans based on assessment of all available data on toxicity and mode of action.

6.2.1.1 Lead

Is a very toxic element, causing a variety of effects at low dose levels. Brain damage, kidney damage, and gastrointestinal distress are seen from acute (short-term) exposure to high levels of lead in humans. Chronic (long-term) exposure to lead in humans results in effects on the blood, central nervous system (CNS), blood pressure, kidneys, and Vitamin D metabolism. Children are particularly sensitive to the chronic effects of lead, with slowed cognitive development, reduced growth and other effects reported. Reproductive effects, such as decreased sperm count in men and spontaneous abortions in women, have been associated with high lead exposure. The developing foetus is at particular risk from maternal lead exposure, with low birth weight and slowed postnatal neurobehavioral development noted. Human studies are inconclusive regarding lead exposure and cancer.

6.2.1.2 Zinc

Zinc is essential for the function of more than 300 enzymes, including alkaline phosphatase, alcohol dehydrogenase, Cu, Zn-superoxide dismutase, carboxypeptidase, delta-aminolevulinic acid dehydratase, carbonic anhydrase, ribonucleic acid polymerase, and reverse transcriptase. Zinc is also involved in DNA and RNA synthesis and cell proliferation. Zinc coordinates with cysteine and histidine residues of certain peptides and produces a tertiary structure which has an affinity for unique segments of DNA in promoter gene regions, including zinc finger protein domains, the most common zinc motif, and the zinc thiolate cluster. Other physiological roles of zinc include enhancement of the affinity of growth hormone for its binding receptors, modulation of synaptic transmissions by interacting with specific sites on ionotrophic neurotransmitter receptor proteins, and induction of metallothionein.

6.2.1.3 Cadmium

The acute (short-term) effects of cadmium in humans through inhalation exposure consist mainly of effects on the lung, such as pulmonary irritation. Chronic (long-term) inhalation or oral exposure to cadmium leads to a build-up of cadmium in the kidneys that can cause kidney disease. Cadmium has been shown to be a developmental toxicant in animals, resulting in fetal malformations and other effects, but no conclusive evidence exists in humans. An association between cadmium exposure and an increased risk of lung cancer has been reported from human studies, but these studies are inconclusive due to confounding factors. Animal studies have demonstrated an increase in lung cancer from long-term inhalation exposure to cadmium. EPA has classified cadmium as a Group B1, probable human carcinogen.

6.2.2 Assessment of dose-response relationships

- involves characterization of the relationship between the dose of an agent administered or received and the incidence of an adverse effect;

6.2.2.1 Lead

6.2.2.1.1 Acute Effects

- Death from lead poisoning may occur in children who have blood lead levels higher than 125 µg/dL and brain and kidney damage have been reported at blood lead levels of approximately 100 µg/dL in adults and 80 µg/dL in children.
- Gastrointestinal symptoms, such as colic, have also been noted in acute exposures at blood lead levels of approximately 60 µg/dL in adults and children.
- Short-term (acute) animal tests in rats have shown lead to have moderate to high acute toxicity.)

6.2.2.1.2 Chronic Effects (Non-carcinogen)

- Chronic exposure to lead in humans can affect the blood. Anaemia has been reported in adults at blood lead levels of 50 to 80 µg/dL, and in children at blood Lead levels of 40 to 70 µg/dL.
- Lead also affects the nervous system. Neurological symptoms have been reported in workers with blood lead levels of 40 to 60 µg/dL, and slowed nerve conduction in peripheral nerves in adults occurs at blood lead levels of 30 to 40 µg/dL.
- Children are particularly sensitive to the neurotoxin effects of lead. There is evidence that blood lead levels of 10 to 30 µg/dL, or lower, may affect the hearing threshold and growth in children.
- Other effects from chronic lead exposure in humans include effects on blood pressure and kidney function, and interference with vitamin D metabolism.
- Animal studies have reported effects similar to those found in humans, with effects on the blood, kidneys, and nervous, immune, and cardiovascular systems noted. EPA has not established a Reference Concentration (RfC) or a Reference Dose (RfD) for elemental lead or inorganic lead compounds.
- EPA has established a Reference Dose (RfD) for tetraethyl lead (an organo-metallic form of lead) of 1 x 10^{-7} milligrams per kilogram body weight per day (mg/kg/d) based on effects in the liver and thymus of rats. The RfD is an estimate (with uncertainty spanning perhaps an order of magnitude) of a daily oral exposure to the human population (including sensitive subgroups) that is likely to be without appreciable risk of deleterious non-cancer effects during a lifetime. It is not a direct estimator of risk, but rather a reference point to gauge the potential effects. At exposures increasingly greater than the RfD, the potential for adverse health effects increases. Lifetime exposure above the RfD does not imply that an adverse health effect would necessarily occur.

- EPA has medium to low confidence in the RfD due to (1) medium to low confidence in the study on which the RfD for tetraethyl lead was based because, although only a few animals per sex per dose level were tested, a good histopathologic exam was conducted and a dose-severity was observed; and medium to low confidence in the data base because some supporting information was available. (7)

6.2.2.1.3 Reproductive/Developmental Effects:

- Studies on male lead workers have reported severe depression of sperm count and decreased function of the prostate and/or seminal vesicles at blood lead levels of 40 to 50 µg/dL. These effects may be seen from acute as well as chronic exposures.
- Occupational exposure to high levels of lead has been associated with a high likelihood of spontaneous abortion in pregnant women. However, the lowest blood lead levels at which this occurs has not been established. These effects may be seen from acute as well as chronic exposures.
- Exposure to lead during pregnancy produces toxic effects on the human foetus, including increased risk of pre-term delivery, low birth weight, and impaired mental development. These effects have been noted at maternal blood lead levels of 10 to 15 µg/dL, and possibly lower. Decreased IQ scores have been noted in children at blood lead levels of approximately 10 to 50 µg/dL.
- Human studies are inconclusive regarding the association between lead exposure and other birth defects, while animal studies have shown a relationship between high lead exposure and birth defects.

6.2.2.1.4 Cancer Risk

- Human studies are inconclusive regarding lead exposure and an increased cancer risk. Four major human studies of workers exposed to lead have been carried out; two studies did not find an association between lead exposure and cancer, one study found an increased incidence of respiratory tract and kidney cancers, and the fourth study found excesses for lung and stomach cancers. However, all of these studies are limited in usefulness because the route(s) of exposure and levels of lead to which the workers were exposed were not reported. In addition, exposure to other chemicals probably occurred.
- Animal studies have reported kidney tumours in rats and mice exposed to lead via the oral route.
- EPA considers lead to be a Group B2, probable human carcinogen. Human exposure to lead occurs through a combination of inhalation and oral exposure, with inhalation generally contributing a greater proportion of the dose for occupationally exposed groups, and the oral route generally contributing a greater proportion of the dose for the general population. The effects of lead are the same regardless of the route of exposure (inhalation or oral) and are correlated with internal exposure, as blood lead levels. For this reason, this fact sheet will not discuss the exposure in terms of route but will present it in terms of blood lead levels.

6.2.2.2 Zink

There are no reports on the possible carcinogenicity of zinc and compounds per se in humans. Case studies have been used to evaluate the effects of zinc administered for therapeutic reasons. There are reports which compare zinc levels in normal and cancerous tissue. Studies of occupational exposure to zinc compounds have also been conducted, but have limited value because they do not correlate exposure with cancer risk.

Either zinc deficiency or excessively high levels of zinc may enhance susceptibility to carcinogenesis, whereas supplementation with low to moderate levels of zinc may offer protection. For example, zinc deficiency enhanced carcinomas of the esophagus induced by methylbenzylnitrosamine but retarded the development of cancer of the oral cavity induced by 4-nitroquinoline-N-oxide Thus, zinc's modifying effect on carcinogenesis may depend both on the dose of zinc and the identity of the carcinogen being affected.

The mutagenicity of zinc, particularly in *Salmonella typhimurium*, appears to depend greatly on the chemical form.

6.2.2.3 Cadmium

6.2.2.3.1 Acute Effects

- Acute inhalation exposure to high levels of cadmium in humans may result in effects on the lung, such as bronchial and pulmonary irritation. A single acute exposure to high levels of cadmium can result in long-lasting impairment of lung function.
- Cadmium is considered to have high acute toxicity, based on short-term animal tests in rats.

6.2.2.3.2 Chronic Effects (Non-cancer)

- Chronic inhalation and oral exposure of humans to cadmium results in a build-up of cadmium in the kidneys that can cause kidney disease, including proteinuria, a decrease in glomerular filtration rate, and an increased frequency of kidney stone formation.
- Other effects noted in occupational settings from chronic exposure of humans to cadmium in air are effects on the lung, including bronchiolitis and emphysema. Chronic inhalation or oral exposure of animals to cadmium results in effects on the kidney, liver, lung, bone, immune system, blood, and nervous system. The Reference Dose (RfD) for cadmium in drinking water is 0.0005 milligrams per kilogram per day (mg/kg/d) and the RfD for dietary exposure to cadmium is 0.001 mg/kg/d; both are based on significant proteinuria in humans. The RfD is an estimate (with uncertainty spanning perhaps an order of magnitude) of a daily oral exposure to the human population (including sensitive subgroups) that is likely to be without appreciable risk of deleterious non-cancer effects during a lifetime. It is not a direct estimator of risk, but rather a reference point to gauge the potential effects. At exposures increasingly greater than the RfD, the potential for adverse health effects increases. Lifetime exposure above the RfD does not imply that an adverse health effect would necessarily occur.
- EPA has high confidence in both RfDs based primarily on a strong database for cadmium toxicity in humans and animals that also permits calculation of pharmaco-kinetic parameters of cadmium absorption, distribution, metabolism, and elimination.
- EPA has not established a Reference Concentration (RfC) for cadmium. The California Environmental Protection Agency (CalEPA) has established a chronic reference exposure level of 0.00001 milligrams per cubic meter (mg/m^3) for cadmium based on kidney and respiratory effects in humans. The CalEPA reference exposure level is a concentration at or below which adverse health effects are not likely to occur.

6.2.2.3.3 Reproductive/Developmental Effects

- Limited evidence exists for an association between inhalation exposure and a reduction in sperm number and viability in humans.
- Human developmental studies on cadmium are limited, although there is some evidence to suggest that maternal cadmium exposure may result in decreased birth weights.
- Animal studies provide evidence that cadmium has developmental effects, such as low fetal weight, skeletal malformations, interference with fetal metabolism, and impaired neurological development, via inhalation and oral exposure.
- Limited animal data are available, although some reproductive effects, such as decreased reproduction and testicular damage, have been noted following oral exposures.

6.2.2.3.4 Cancer Risk

- Several occupational studies have reported an excess risk of lung cancer in humans from exposure to inhaled cadmium. However, the evidence is limited rather than conclusive due to confounding factors.
- Animal studies have reported cancer resulting from inhalation exposure to several forms of cadmium, while animal ingestion studies have not demonstrated cancer resulting from exposure to cadmium compounds.
- EPA considers cadmium to be a probable human carcinogen (cancer-causing agent) and has classified it as a Group B1 carcinogen.
- EPA uses mathematical models, based on animal studies, to estimate the probability of a person developing cancer from breathing air containing a specified concentration of a chemical. EPA calculated an inhalation unit risk estimate of $1.8 \times 10^{-3} (\mu g/m^3)^{-1}$. EPA estimates that, if an individual were to continuously breathe air containing cadmium at an average of 0.0006 $\mu g/m^3$ (6×10^{-7} mg/m^3) over his or her entire lifetime, that person would theoretically have no more than a one-in-a-million increased chance of developing cancer as a direct result of breathing air containing this chemical. Similarly, EPA estimates that continuously breathing air containing 0.006 $\mu g/m^3$ (6×10^{-6} mg/m^3) would result in not greater than a one-in-a-hundred thousand increased chance of developing cancer, and air containing 0.06 $\mu g/m^3$ (6×10^{-5} mg/m^3) would result in not greater than a one-in-ten thousand increased chance of developing cancer. For a detailed discussion of confidence in the potency estimates, please see IRIS.

6.2.3 Exposure assessment

Is the qualitative and/or quantitative assessment of the chemical nature, form and concentration of a chemical to which an identified population is exposed from all sources (air, water, soil and diet); Hazardous waste generated in industry and mining create serious potential for soil and groundwater contamination and still is an important issue. Monitoring and regulation of industrial waste is inadequate. Evaluations are that at least this waste has contaminated 6.000 hectares in the country. There is no hazard assessment made on the risks these mine tailings impose on the soils, groundwater and surface water downstream. Neither the impact on public health through wind and water erosion is studied. Their potential danger is eminent and large. Hazard assessment of these hotspots is recommended, both to protect the water resources and the people. Hazard assessment of the hot spots is planned under the NWMP. The UNEP did some hazard assessments for mine tailings in regard of their risk to soil, groundwater and surface waters downstream.

6.2.3.1 Site specific exposure assessment – VELES MHK Smelter

Regarding human health, the assessment is focus on exposure routes, both direct and indirect as well as establishes the number and type of people that may be affected to a significant extend.

Although the smelter was undoubtedly polluting the groundwater beneath it, the major source of soil and groundwater contamination is the disposal of more than 850.000 Mg of solid waste containing heavy metals. This waste is deposited at a dump approximately one kilometre from the smelter. Investigations related to soil contamination have been conducted in the past and groundwater monitored due to piezometers, while the plant was in function. It is identified that groundwater and nearby areas are being contaminated with heavy metals as a result of percolate from the dump. Due to the direction of groundwater flow, the private wells are probably being affected.

Wastewater containing heavy metals and other pollutants is also a source of serious concern.

During the activity, the MHK has a treatment plant that was designed to treat 135 m3 of effluent per hour. The plant, however, generated 1,500 m3/hour of wastewater. The NEAP reported that cadmium, lead and zinc levels were 10-15 times higher in vegetables grown in Veles relative to control regions. As much as 4 to 10 times the acceptable levels for lead and cadmium were found in spinach and lettuce due to soil contamination. According to the World Health Organization (WHO), blood lead levels in children of 100 to 150 µg/l have been consistently reported as having a negative effect on measures of cognitive functioning, such as the psychometric intelligence quotient. The obtained results from Veles Study have shown slightly increased blood lead levels in randomly tested children (mean value 16,51 µg/dl), reflected correspondingly in the level of intelligence and graphomotor ability (randomly, n=31). In addition, the autonomous nervous system studied by peripheral biofeedback appeared to function normally, reacting adequately in stress situations. However, the EEG results have shown that only in two children the theta-beta ratio has normal values, while in others the obtained ratios correspond to increased attention deficit. Moreover, the two children from 31 with the highest theta-beta ratio showed pathological ADHD findings and also the highest blood lead levels (> 20 µg/dl). The suspected correlation between increased blood lead levels due to industrial pollution and changes in EEG, toward increased attention deficit in tested children has been confirmed, implying the need for corresponding health care and environmental response measures. Compared to other applied psychometric instruments, neuro-feedback appeared to be the most sensitive and discriminative modality. Analyses of monthly morbidity reports produced by the Public Health Institutes show that both preschoolers (under 6 years of age) and schoolchildren (aged between 7 and 14 years) living in polluted cities, such as Skopje and Veles, have a higher (up to 2 – 3 times) level of morbidity from respiratory diseases (J00-J99) (excluding influenza and pneumonia (J10-J18)) than children living in relatively less polluted villages. The data for 2006 has showed the distribution of heavy metals in Veles as follows:

Table_3_Monitoring of air pollution in Veles during the 2006 for Pb, Cd and Zn

Hazard	Measuring point	Average yearly concentration (mg/m^3)[9]	Minimum – maximum (mg/m^3)	WHO Recommended Value (mg/m^3)

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[9] Guidelines for Air Quality, WHO, Regional Office for Europe, 1999: Geneva.

Pb	Nova Naselba	0,117 (361)[10]	0,000 – 0,640	0,5
	Biro za Vrabotuvawe	0,125 (24)	0,000 – 0,200	
Cd	Nova Naselba	0,039 (361)	0,000 – 0,190	0,05
	Biro za Vrabotuvawe	0,006 (24)	0,000 – 0,026	
Zn	Nova Naselba	0,038 (361)	0,000 - 3,850	--
	Biro za Vrabotuvawe	0,251 (24)	0,000 – 0,501	

In accordance with results obtained from the Institute for Public Health, Veles- the average yearly concentration for Pb and Cd didn't exceed WHO recommended value.

Table 4_Monitoring of aero sediment in Veles during the 2006 for Pb, Cd and Zn[11]

Measuring point	**Number of samples**	**Hazards**	**Average concentration yearly (mg/m^3)**	**Minimum – max (mg/m^3)**
Nova Naselba	12	Pb	48,4	0,30 - 91,70
		Cd	1,18	0,029 - 4,25
		Zn	125,40	3,90 - 643,10
Biro za Vrabotuvawe	7	Pb	44,20	0,00 - 128,60
		Cd	1,27	0,00 - 3,62
		Zn	130,40	0,00 - 635,50
Kindergarden Cyril and Methodius	12	Pb	36,90	0,90 - 88,90
		Cd	0,87	0,15 - 2,20
		Zn	128,60	24,40 - 332,10
Nas. Tunel	11	Pb	28,20	0,30 - 66,10
		Cd	0,94	0,30 - 2,10
		Zn	83,80	16,60 - 278,00
Recani	11	Pb	44,30	0,50 - 73,40

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[10] ( ) – number of samples

Source: RIHP, 2007

[11] Source; RIHP, 2007

		Cd	0,93	0,10 - 2,10
		Zn	148,10	26,10 - 451,10
Basino selo	12	Pb	38,20	0,50 - 73,40
		Cd	0,77	0,09 - 1,40
		Zn	138,60	34,20 - 455,30
Zdraven Dom	12	Pb	51,30	0,30 - 168,70
		Cd	0,97	0,115 - 2,25
		Zn	95,80	29,20 - 276,60
Average-Veles	77	Pb	41,60	0,00 - 168,70
		Cd	0,97	0,00 - 4,25
		Zn	121,10	0,00 - 643,10
V. Ivankovci control area)	4	Pb	7,20	6,90 - 7,50
		Cd	0,103	0,355
		Zn	43,60	3,40 - 78,20

The average concentration of aero- sediment for heavy metals in Veles were for Pb 41,6 (mg/m^3); Cd 0,92 (mg/m^3) and Zn 121,1 (mg/m^3) with higher values for Pb in measuring points: Zdravstven Dom and Nova naselba compared with nas. Tunel or the lowest value was detected in control area, i.e. village Ivankovci. The highest value for Cd were detected in measuring points such as Biro za vrabotuvanje and Nova naselba, and 10 times less in the control area v.Ivankovci

Table 5_The monthly rate ($^o/_{oo}$) of registered patient with respiratory diseases (J00-J99) without (J10-J18) among preschool children in Veles in 2006[12]

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[12] Source; RIHP, 2007

Month	**Veles**	
	Urban	**Rural**
I	411,04	183,06
II	419,35	128,34
III	387,43	436,48
IV	435,32	142,02
V	420,69	203,26
VI	564,68	226,06
VII	298,30	126,38
VIII	351,18	96,42
IX	464,92	115,96
X	517,46	118,57
XI	390,09	418,89
XII	555,70	137,16
Average	**434,68**	**183,71**

The average monthly rate registered patient with respiratory diseases (J00-J99) without (J10-J18) among preschool children in Veles in 2006, shows that in urban area the rate is 2,5 higher than in rural area, especially in winter due to air pollution

Table 6_The monthly rate ($^{o}/_{oo}$) of registered patient with respiratory diseases (J00-J99) without (J10-J18) among school children in Veles in 2006[13]

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[13] Source; RIHP, 2007

Month	**Veles**	
	Urban	**Rural**
I	66.32	61.87
II	83.97	48.44
III	105.48	47.48
IV	71.07	35.01
V	63.6	23.02
VI	45.04	25.42
VII	34.4	23.50
VIII	42.78	16.79
IX	77.86	18.23
X	66.09	29.26
XI	92.35	34.05
XII	110.68	43.17
Average	**71.64**	**33.85**

Also, the average monthly rate registered patient with respiratory diseases (J00-J99) without (J10-J18) among school children in Veles in 2006, shows that in urban area the rate is 2,5 higher than in rural area, especially in winter due to air pollution.

Table 7 _The distributions of heavy metals in blood samples among former employees in MHK Zletovo, Veles for 2004

2004 (n=55)	**Pb [µg/dl]**	**Cd [µg/dl]**	**Zn [mg/l]**
Average	**16,4**	**4,34**	**7,92**
Maximum	**46,70**	**13,30**	**10,20**
Minimum	**3,32**	**0,00**	**5,90**
Standard Deviation	**9,00**	**2,54**	**1,10**
MPL[14]	**10,00**	**9,50**	**7,00**

The average value for Pb in blood samples among former employees in MHK Zletovo was 64% higher than MPL as well as average Zn value for almost 15%. The Cd in blood samples is 4,34 g/dl or twice less than MPL.

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[14] MPL = Maximum Permitted Level

Table 8 _The distributions of heavy metals in blood samples among mothers in Obstretics Department in Veles Hospital in 2004[15]

2004 (n=51)	Pb [µg/dl]	Cd [µg/dl]	Zn [mg/l]
Average	**6,83**	**2,50**	**7,15**
Maximum	**19,73**	**6,80**	**12.10**
Minimum	**0,46**	**0,00**	**3,60**
Standard Deviation	**3,59**	**2,11**	**1,50**
MPL	**10,00**	**9,50**	**7,00**

Even the average Pb value is less than MPL, it was reported that several mothers had high Pb contain in blood samples which posses high health risk for their newborns.

Table 9 _The distributions of heavy metals in blood samples among newborns in Obstetrics Department in Veles Hospital in 2004

2004 (n=65)	Pb [µg/dl]	Cd [µg/dl]	Zn [mg/l]
Average	**6,10**	**1,34**	**3,60**
Maximum	**19,30**	**8,30**	**8,50**
Minimum	**0,00**	**0,00**	**1,70**
Standard Deviation	**3,68**	**1,80**	**1,09**
MPL	**10,00**	**9,50**	**7,00**

In Veles for 2004 was reported several newborns with high Pb contain in blood samples.

Figure 11_General mortality in the Republic of Macedonia in Veles region and regions with lowest and higher mortality for the period 1995 - 2005[16]

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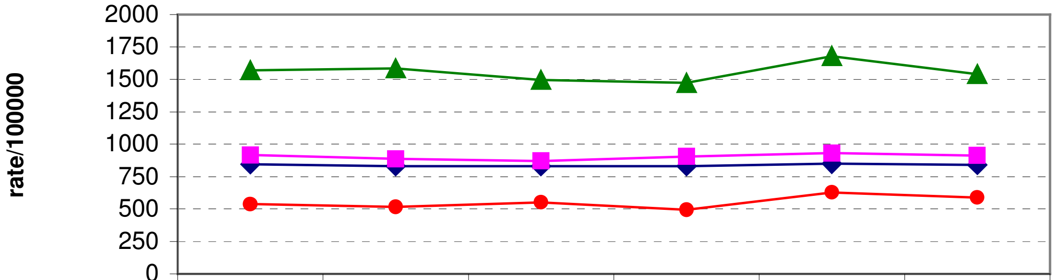
[15] Source; RIHP, 2007

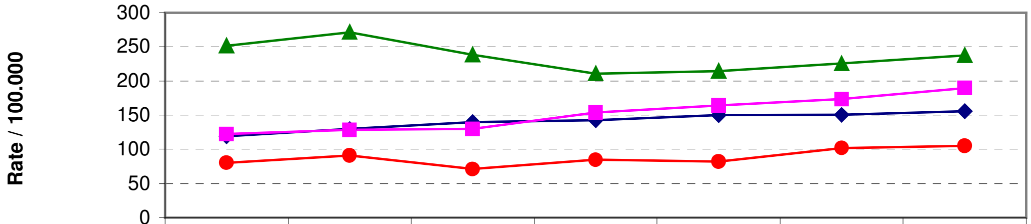
[16] Source; RIHP, 2007



	1995	1997	1999	2001	2003	2005
◆ Macedonia	843,5	830,6	829,1	830,8	849,5	839,5
■ Veles	917,2	887,2	869,3	905,7	929,9	911,2
▲ Maximum	1569,6	1582,8	1495,8	1472,3	1680,2	1540,1
● Minimum	536,9	515,8	551,6	492	627,2	588,7

During the period 1995 - 2005 in Veles region has been registered higher general mortality rate per 100.000 than Macedonian average.

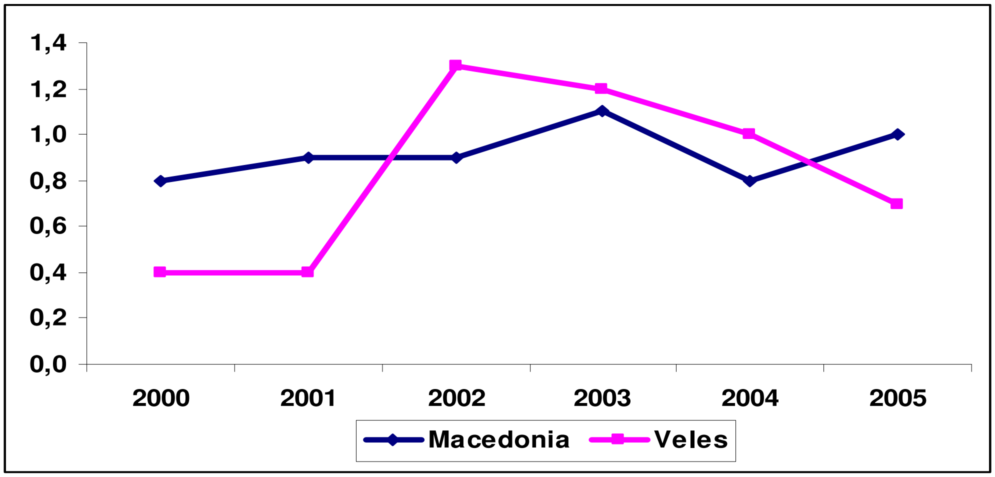
Figure 12_Distribution of mortality from malignant neoplasms in the Republic of Macedonia, Veles region and regions with higher and lowest for the period 1993 - 2005



	1993	1995	1997	1999	2001	2003	2005
◆ Macedonia	119,3	129,5	139,8	142,6	150,2	150,3	155,7
■ Veles	122,2	128,2	129,5	153,8	164,1	173,4	189,6
▲ Maximum	251,3	271,3	238,4	211	214,2	225,4	237,5
● Minimum	80,2	90,7	71	84,5	82,1	101,7	105,1

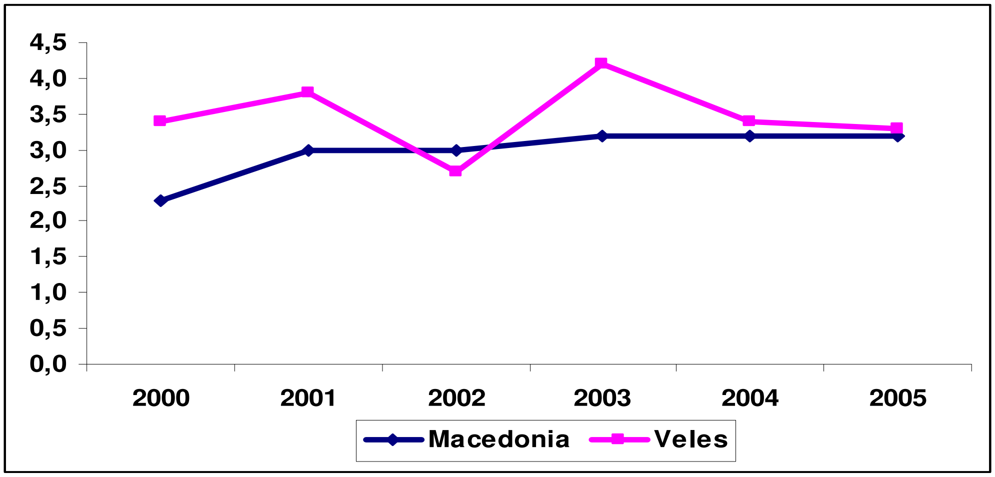
During the period 1995 - 2005 in Veles region has been registered higher mortality rate due to cancers per 100.000 than Macedonian average, especially for 2003 and 2005

Figure 13_Distribution of mortality from malignant neoplasm of liver in the Republic of Macedonia and Veles region for the period 2000 - 2005 (rate / 10.000)[17]



The distribution of mortality from malignant neoplasm of liver in the Republic of Macedonia and Veles Region for the period 2000 - 2005 (rate / 10.000) has increasing especially in Veles in 2002 compared to 2000 and 2001.

Figure 14_Distribution of mortality from malignant neoplasms of lung and bronchial tubes in the Republic of Macedonia and Veles region for the period 2000 - 2005



The distribution of mortality from malignant neoplasms of lung and bronchial tubes in the Republic of Macedonia and Veles region for the period 2000 - 2005 has showed higher values for Veles region compared to average Macedonia value.

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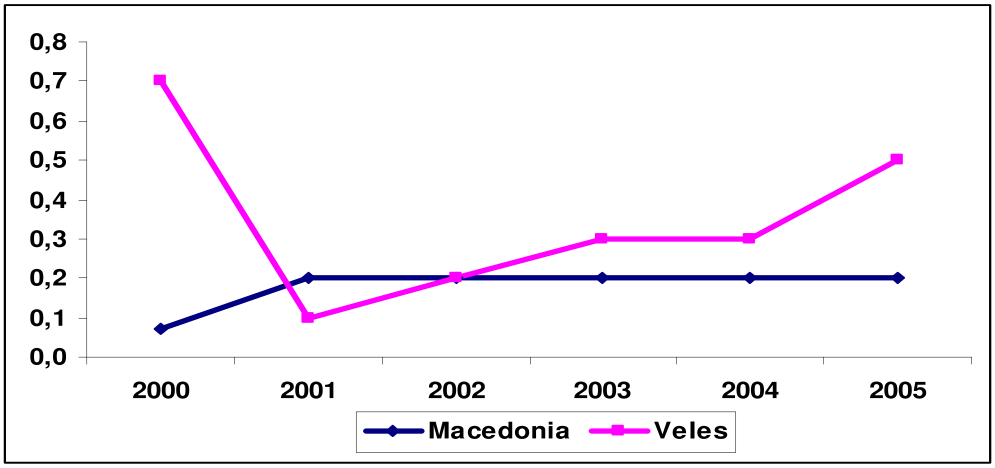
[17] Source; RIHP, 2007

Figure 15_Distribution of mortality from malignant neoplasms of kidneys in the Republic of Macedonia and Veles region for the period 2000 - 2005



The distribution of mortality from malignant neoplasms of kidneys in the Republic of Macedonia and Veles region for the period 2000 - 2005 has showed higher mortality rate per 10.000 compared to Macedonia.

6.2.4 Risk characterization

- is the synthesis of critically evaluated information and data from exposure assessment, hazard identification and dose-response considerations into a summary that identifies clearly the strengths and weaknesses of the database, the criteria applied to evaluation and the validation of all aspects of methodology, and the conclusions reached from the review of scientific information.

The defined health impacting hazards for Veles-Lead Smelter were as follows:

Toxic solid waste, airborne particulate matter and SO_2; Particulate matter: Pb, Zn, Fe, As, Sb, Cd, Cu inorganic compounds. Air emission for processes with poor control may be of the order of 30 kg Pb or Zn/Mg lead of zinc produced.

Water effluents: Pb, Zn, As etc including dissolved and suspended solids, metals and oil and grease. Discard slag up to 0,76; lead/zinc up to 3 mg of solid waste per Mg of lead/zinc produced.

The key release or exposure vectors were as follows:

- **Air (dust and gas emission)**
- **Water/groundwater**

According to recent studies, emissions were having a significant impact on the health of the population. Increasing morbidity, especially from respiratory diseases, and frequent occurrence of lung cancers and anaemia, have been noted in the local population and among factory workers. Children are especially affected. Workers have been observed to experience blood in urine, suggesting possible kidney disease. They have also had elevated concentrations of lead and cadmium in blood relative to control populations. Analyses of monthly morbidity reports produced by the Public Health Institutes show **that both preschoolers (under 6 years of age)** and schoolchildren (aged between 7 and 14 years) living in polluted cities, such as Veles, have a higher (up to 2 – 3 times) level of morbidity from respiratory diseases (excluding influenza and pneumonia) than children living in relatively less polluted villages. The difference is particularly high in winter, when heating and climatic factors (including temperature inversion) contribute to an increase in air pollutants (especially SO2 and black smoke). The health effects of particulate air pollution depend on particle size, composition and concentration, and can fluctuate with daily changes in PM10 or PM2.5 levels. This is the particulate fraction of the greatest concern for health, as it penetrates the respiratory system. Particulate matter may have acute health effects, such as increased mortality, increased hospital admissions because of the exacerbation of respiratory disease, fluctuations in bronchi-dilator use, cough and peak flow reductions.

According to the World Health Organization (WHO), blood lead levels in children of 100 to 150 µg/l have been consistently reported as having a negative effect on measures of cognitive functioning, such as the psychometric intelligence quotient. The Institute of Occupational Health, Skopje in workers occupationally exposed to cadmium, has diagnosed kidney diseases. There is no official recording of the use of occupational carcinogens. There is insufficient information on dose-effect relations in some segments of the chemical industry. Obtained recent data for morbidity and mortality showed that even the factory has stop with operation in 2003, existing health risk among vulnerable population and former employees is still high. The eventual remediation of a smelter dump will have first of all direct environmental benefit and indirect one for citizens of Veles.

6.2.5 Summary of assessment results

Environmental health risk assessment is an essential element in environmental management and an important condition in precise priority setting to the necessary actions for its sanitation. Risk assessment is intended 'to provide complete information to risk managers, specifically policymakers and regulators, so that the best possible decisions are made'. There are uncertainties related to risk assessment and it is important to make the best possible use of available information. Environmental Health Risk Assessment provides a tool for appraising health risks in the broader process of Health Impact Assessment.

Harm Potential damage to people, property, or the biophysical, social, or cultural environment associated with the primary industrial risks from affected hotspots. Found in this report include: chronic health effects associated with heavy metals poisoning in humans. The types of damage listed here have the potential to occur at site, local, sub-regional, regional and/or trans-boundary levels.

Likelihood The probability and frequency of the types of defined events that can cause harm and probability of specific outcomes were not assessed in this Report. However, as many pollution incidents have occurred, and many are ongoing, the likelihood of damage of the types discussed above (harm) are very high or certain in many instances. Further, the high number and common occurrence of "warning signals" as listed in the summary, indicate that many factors are present contributing to increased likelihood of incidents in site areas.

Hazards Many sources of potential harm and situations with a potential for harm were found in the study. Examples include: dissolved heavy metals; metals smelter stacks emitting near population centres; waste dumps for toxic materials located over groundwater resources; large uncovered toxic dust generating surfaces near agricultural land and population centres, and so forth and so on.

Consequence(s) The intermediate or final outcome(s) of events or situations affecting elements of the biophysical spheres observed in the study include: increased human mortality, and developmental problems in children;. Outcomes affecting elements of the social sphere include: rising opposition to mining and minerals processing from citizens; increased scrutiny and coordinated opposition from NGOs especially in Veles.

Risk The likelihood of damage to people, property, or the biophysical, social, or cultural environment listed above appears to be high. While only qualitative comments can be passed based upon this analysis, the fact that chronic damage is ongoing in many areas and that many major incidents resulting in acute effects have occurred, should underline the seriousness of the risks observed in this study.

Large quantities of industrial waste are generated in the mining, metallurgical, fertilizer, and chemical industries, as well as in the coal-fired power plants. Most of the larger industries have their own industrial waste sites.

The Table shows distribution of hazards, possible health effects and potential number of excised people by hazardous sides.

Table 10_Distribution of hazards, possible health effects and potential number of excised people by hazardous sides

Hazardous site	Hazards	Possible health effects	Potential number of excised people
Former Smelter Company - Veles + Fertilizer company	Lead, nickel and cadmium contamination during past years of smelter company activities	Lead: toxic and carcinogenic effects in pregnant women and children; CNS damages	47.000 inhabitants

Regarding human health, the assessment is focus on exposure routes, both direct and indirect as well as establishes the number and type of people that may be affected to a significant extend:

Contaminant Hazard

- **Significant (H)**
- Moderate (M)
- Minimal (L)

Migration Pathway

- **Evident (H)**
- Potential (M)
- Confined (L)

Receptors

- Identified (H)
- **Potential (M)**
- Limited (L)

Contaminant Hazard Factor	Receptor Factor	Migration Pathway		
		Evident	Potential	Confined
Significant	Identified	HHH	HHM	HHL
	Potential	**HHM**	HMM	HML
	Limited	HHL	HML	HLL
Moderate	Identified	HHM	HMM	HML
	Potential	HMM	MMM	MML
	Limited	HML	MML	MLL
Minimal	Identified	HHL	HML	HLL
	Potential	HML	MML	MLL
	Limited	HLL	MLL	LLL

MHK - ZLETOVO - Veles

Contaminant Hazard

- Lead
- Zinc
- Cadmium contamination during past years of smelter company activities

Migration Pathway:

- contaminated soil
- water/groundwater

Receptors: - Lead

Toxic and carcinogenic effects in pregnant women and children; CNS damages

Defined environmental health risk: HIGH

SUMMARY:

Main impacts on the human health have been caused by former production activities. Main hazardous material identified, are Lead and Cadmium. Current sources of ongoing pollution are the existing slag dumpsite and dust accumulated on the plant construction. Migration paths include the wind erosion of fine particles, soil and watercourses. The risk on human health due to lead and cadmium compounds are in principle ranked as very high. The current health impact risk is marked as moderate to high. Decommissioning of the smelter and treatment of the slag or remediation of the dumpsite will significant reduce the risk on human health. In addition have measures have to be undertaken to remediate large areas of agriculture and public land in order to cut secondary migration paths.

7 Process assessment – qualitative and quantitative waste assessment

7.1 Introduction

Metallurgical Chemical Company "Zletovo" comprises two production units: the Metallurgical Complex and the Fertilizer Plant. The Complex of Metallurgy was designed and built under the license of the ***Imperial Smelting Company Ltd*** and operated from 1973 until 2003. Its main products were lead, zinc and sulphuric acid, but later, electrolytic silver and refined cadmium were included in the production program, as well as zinc and lead based products such as zinc dust, zinc oxide, zinc sulphate, lead pipes and balancing weights, brass, soft solders, metal cans and barrels etc.

The main production line of the Complex of Metallurgy comprises the sinter and sulphuric acid plants and the lead and zinc shaft furnace. Zinc and lead refineries have been located in parallel to each other.

Apart from the main production line, Complex of Metallurgy comprises other newer plants such as: production of Lead Pipes and Balancing Weights, Electrolysis of silver, Zinc dust, Zinc oxide, Lead alloys, Metal cans and barrels, production of Silver Jewelry and caustic cadmium.

7.1.1 Sinter roasting

Lead and zinc bearing sulphide concentrates are the main raw materials for primary lead and zinc production. Introducing the Imperial Smelting process (simultaneous lead and zinc smelting) in commercial practice contributed to a significant increase in overall metal recovery by recovering lead from zinc concentrates and zinc from lead concentrates. It also accepted bulk lead and zinc concentrates thus increasing the recovery efficiency in the mines. However, this process does not allow direct smelting of sulphide concentrates. A pre smelting treatment was required in order to make the material suitable for further treatment.

Sintering is a process of simultaneous desulphurising and agglomeration of fine-grained materials (<300µ) during which the heat released through desulphurising increases the temperature to a level at which partial fusion of sinter layer occurs.

Sulphur from concentrates acts as a fuel during sintering of lead and zinc bearing materials. Air passing through the sinter layer provides enough oxygen for fuel burning in the same time acting as heat transfer medium. Approximately 450 Nm^3 air per Mg sinter mix are theoretically needed for the sintering process - this quantity however, being much greater in practice due to the inefficient air distribution through the charge layer. Considering both the shaft furnace as well as the acid plant requirements sinter plant should achieve the following goals:

Table 11_Requested Achievements in the Sinter- and Acid plant

	Zn	**Pb**	**FeO**	**SiO_2**	**Cu**	**Cd**	**S**	**CaO**
%	42	21	10	3,5	0,8	0,2	<1,0	3,8

- Production of sinter with as much constant chemical composition as possible within the following range:
- Production of hard enough sinter to withhold the delivery to the shaft furnace,
- Production of sufficient sinter quantities having above characteristics to meet shaft furnace requirements,
- Production of high SO_2 (6 %) gas to meet sulphuric acid plant requirements,
- Keep environmental pollution at the lowest possible level (within the environmental quality standards)
- Keeping production costs at the lowest possible level.

During sintering large amount of air is intensively blown through the sinter layer and the oxygen from it rapidly oxidizes sulphide particles separating sufficient amount of thermal energy to enable autogenous desulphurising and sintering process.

Oxidation reactions of metallic oxides represent the basis of roasting and simultaneous agglomeration of lead-zinc concentrates:

$$2ZnS + 3O_2 \rightarrow 2ZnO + 2SO_2 \qquad (1)$$

$$2PbS + 3O_2 \rightarrow 2PbO + 2SO_2 \qquad (2)$$

$$2FeS_2 \rightarrow 2FeS + 2SO_2 \qquad (3)$$

$$2FeS + 3O_2 \rightarrow 2FeO + 2SO_2 \qquad (4)$$

Part of the sulphur dioxide, in the presence of iron oxides, oxidizes after the reaction:

$$2SO_2 + O_2 \rightarrow 2SO_3 \qquad (5)$$

Resulting sulphur trioxide can react with metal oxides and form sulphates:

$$MeO + SO_3 \rightarrow MeSO_4 \qquad (6)$$

Reactions 1, 2, 4 and 5 are strongly exothermic whereas lead, iron and calcium oxides react forming complex low melting point silicates.

$$MeO + SiO_2 \rightarrow MeO \cdot SiO_2 \qquad (7)$$

During this, at the beginning liquid and after cooling strong links (bridges), occur between crystal zincite (ZnO) grains and zinc ferrite, according to the reaction:

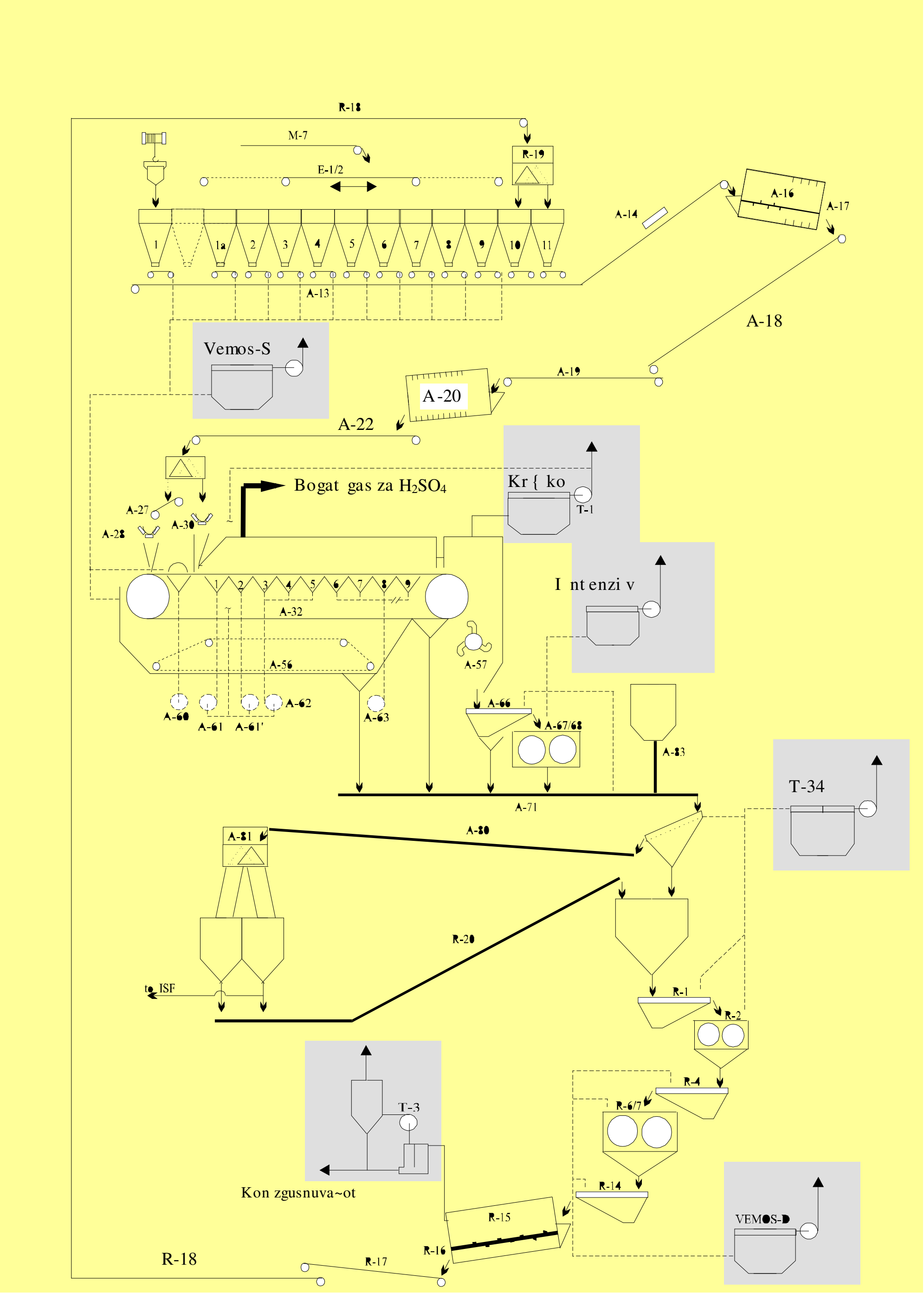
$$2Fe_2O_3 + ZnO \rightarrow 2Fe_2O_3 \cdot ZnO \qquad (8)$$

At temperatures above 1200 ℃, which are attainable in sinter layer, at increased Fe_2O_3 and CaO content in the feed, the following reaction occurs:

$$Fe_2O_3 + CaO \rightarrow Fe_2O_3 \cdot CaO \qquad (9)$$

The resulting calcium ferrite improves the thermal stability of sinter in its treatment in the shaft furnace.

Figure 16_Flowsheet – Sinterprocess



7.1.2 Sulphuric Acid Plant

Sulphur dioxide is a product of oxidation of metallic sulphides in the feed and is an important component of the gaseous phase. Therefore, the gases arising from the roasting of zinc sulphide concentrates must not be discharged into the atmosphere without their prior appropriate treatment, which will bring the SO_2 concentrations within the admissible limits. In most smelters using zinc sulphide concentrates these gases are used for production of sulphuric acid.

The rich gas with abt 6 % SO_2, containing also a great amount of dust (~ 20 g/m^3) is drawn from the beginning of the sinter machine hood. The rich gas temperature is maintained within the range of 250 to 350 °C. Lower temperatures than these have negative effect on the roasting process while higher temperatures can cause distortion of inside elements of the electrostatic precipitator through which gases pass after leaving the sinter plant building.

Basic components of the dust collected in the hot gas precipitator are lead compounds (mainly lead oxide, but sulphides and sulphates are also present, depending on the roasting conditions). Among the employees of the ISP smelters throughout the world this dust is called **"yellow dust"** due to its various yellow colour shades. The typical analysis of this dust is as follows:

Table 12_Typcial analysis of “yellow dust”

Element	**Ranges in %**
Pb	45 - 62
Zn	2 - 4
S	6 - 16
Cd	4 - 12
Fe	0.5 - 1
As	traces
Sb	traces

Due to the high cadmium content this dust is treated in the cadmium plant for production of raw cadmium. In this way accumulation of the cadmium in the slab zinc is avoided which in turn would mean blocking of zinc refinery operations.

Due to the high temperatures and dust contents at the electrostatic precipitator outlet (~ 200 mg/m^3) further cooling and treatment of the rich gases is necessary.

The gases are cooled down to a temperature of 65 °C through a system of venturi scrubbers where a portion of the remaining dust is also removed. Major part of the water evaporating in the venturi scrubbers condenses by cooling through a system of horizontal coolers.

Thus, at the horizontal coolers outlet the rich gas has a temperature of 40°C and is saturated with water vapour. Small droplets and solids are removed in the first pair of wet electric precipitators. In order to bring down the humidity content of the gas to a minimum the gases are further cooled this time in vertical coolers where the newly formed mist is captured in the next pair of wet electric precipitators and finally, the remaining humidity in the gaseous phase is absorbed in a special drying tower as a 96 % sulphuric acid.

The dedusted and dry gases are fed into a converter system. This system consists of a four bed converter and a series of heat exchangers. Oxidation of SO_2 into SO_3 takes place in the converter with the oxygen present in the gases and in the presence of V_2O_5 catalyst. During this the following reactions take place:

$$2V^{5+} + O^{2-} + SO_2 \rightarrow 2V^{4+} + SO_3 \qquad (10)$$

$$½O_2 + 2V^{4+} \rightarrow 2V^{5+} + O^{2-} \qquad (11)$$

The former reaction is very rapid whereas the latter is very slow.

The use of vanadium catalyst makes it possible to decrease the oxidation activating energy from 280 to 90 kJ/mol. At this the order of reaction is also altered:

$$2SO_2 + O_2 \rightarrow 2\ SO_3 \qquad (12)$$

After the fourth catalyst bed, about 98 % of incoming SO_2 is converted into SO_3 and as such it is taken to the absorber in which sulphuric acid with a concentration of 98.3 % recirculates through a special type of sprayers. With chemisorption of sulphur trioxide as per reaction

$$SO_3 + H_2O \rightarrow H_2SO_4 \qquad (13)$$

the strength of the sulphuric acid increases, and therefore it is diluted by either water or acid from the drying tower. The surplus acid in the recirculation system is directed to acid storage tanks through a spraying cooler.

Both the absorption reaction, and even more dilution of the sulphuric acid are exothermic processes and therefore in drying tower recirculation system and absorber heat exchanges are installed.

Since conversion takes place without intermediary stage absorption, this process is also called single absorption. The basic characteristic of this process is limited degree of total conversion to appr. 98 %.

Figure 17_Flow chart of the sulphuric acid production

Flowsheet of the Sulphuric Acid Plant

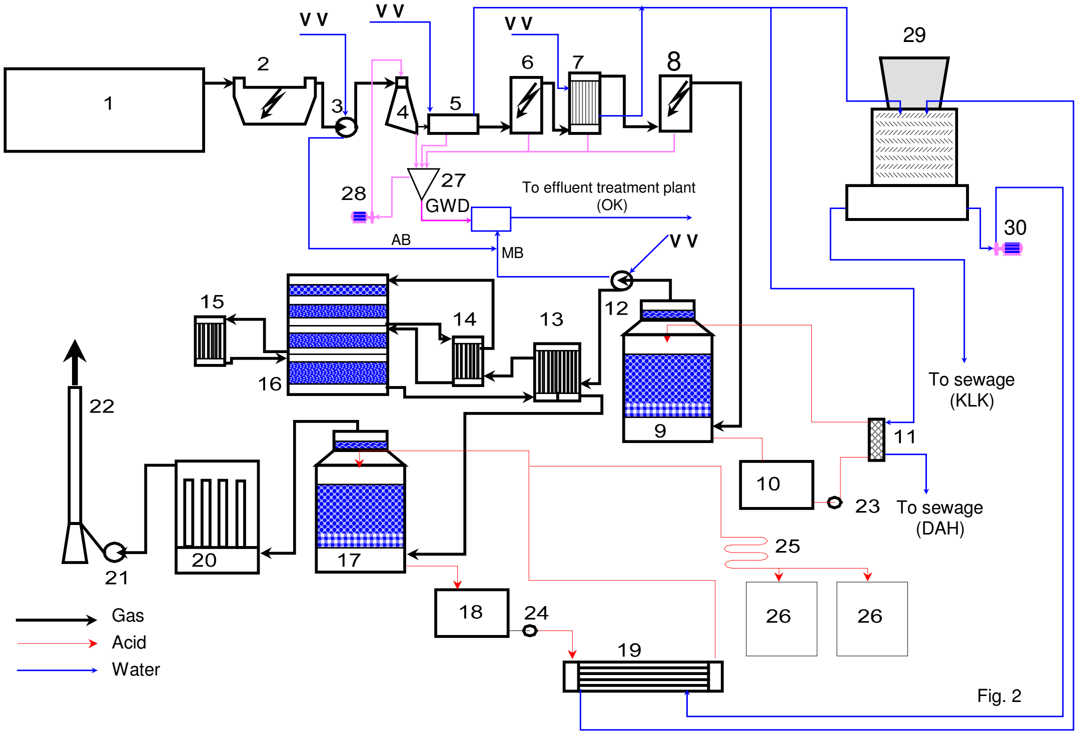


Fig. 2

Legend to the Sulphuric Acid Plant Flow sheet

1. Sinter plant
2. Hot gas precipitator (EGR)
3. Auxiliary blower
4. Venturi scrubber
5. Horizontal coolers
6. First pair of wet el. precipitators
7. Vertical coolers
8. Second pair of wet el. precipitators
9. Drying tower
10. Supply tank
11. Heat Exchanger (Alfa Laval)
12. Main blower
13. First heat exchanger gas/gas
14. Second heat exchanger gas/gas
15. Third heat exchanger gas/gas
16. Converter
17. Absorption tower
18. Supply tank
19. Tube heat exchanger (Chematics)
20. Demister
21. Fan
22. Stack
23. Recirculation pump
24. Recirculation pump
25. Produced acid cooler
26. Acid storage tanks
27. Settling tank
28. Recirculation pump
29. Cooling tower
30. Recirculation water pump

7.1.3 Imperial smelting furnace

In the IS Furnace sinter is smelted and reduced by means of carbon burning in order to produce zinc in gaseous phase at the top of the furnace and molten lead at the bottom. The chain of chemical reactions and heat transfer in order to obtain this global effect is very complex.

The greatest heat amount is generated in the tuyeres area where carbon burns on the coke surface with the oxygen in blast to carbon monoxide and then a portion of the carbon monoxide burns in the gaseous phase to carbon dioxide. In this area a major part of the reduction of zinc oxide into zinc takes place whereas the gangue is smelted to form molten dross (slag).

Gaseous, still capable for further reduction and enters into the "equilibrium" zone in which the reaction

$$CO + ZnO \rightarrow Zn_{(gas)} + CO_2 \qquad (14)$$

becomes completely close to equilibrium. Another reaction also takes place

$$CO_2 + C \rightarrow 2CO \qquad (15)$$

and it absorbs the heat but since this reaction is very slow its reach is limited. Moving up along the equilibrium zone the temperature decreases and reaches abt 1030 °C at furnace top.

The Imperial Smelting furnace charge is made of sinter, coke and a small amount of intermediaries. Product sinter from sinter plant is collected in sinter bins. A feeder with a vibrating screen is provided underneeth each of the bins. The material is discharged through weigh hoppers into the charge buckets which are placed on a transfer car while the undersize sinter is returned to the sinter plant as return fines.

The weighed coke and sinter are lifted by means of a charging crane and delivered to the furnace through a system of bells mounted at the top of the furnace. The role of this system is to provide dropping of material into the shaft without allowing the gases to escape from the shaft.A refractory lined gas offtake is provided on the side of the furnace under the bells extending to the condensing inlet through which the gases pass for the purpose of condensation. The charge level is always kept below this offtake to avoid entering of coke or sinter lumps into the condenser.

As a result of molten lead and slag being tapped from the bottom of the furnace and zinc evaporation, the charge descends down the shaft, during which time it is heated and reduction of lead oxides and reoxidation of lead take place. As the temperature rises slag is partially formed. Such material enters the hearth in which, due to the intensive blowing of hot blast through the tuyeres and burning of the coke the temperatures up to 1500 °C can be reached. The shaft is lined with refractory bricks whereas hearth walls are not lined with refractory material and their metal casing is water cooled. The slag tapping hole is on north hearth end through which lead bullion and slag are tapped. After each tapping the hole is stopped with clay.

In order to achieve intensive reactions in the shaft it is essential that the blast air which enters the shaft through tuyeres must be preheated. According to the original conception of the IS process the blast air was preheated to 550 °C. However, the new strategy of running the process imposed new criteria and at present it is quite normal this blast air to be preheated up to 950 °C, and there are smelters already applying blast air preheated up to 1100 ºC.

Preheating of blast air is carried out in heat regenerators or so called Cowper stoves. For this purpose a carbon monoxide contained in the outlet gases from the furnace is used for heating of the blast air. This gas is called LCV gas due to its Low Calorific Value.

7.1.3.1 Slagging system

Slagging as a term in the IS process practice is used to mean tapping of lead bullion and slag from the furnace shaft, their successive separation in the so called forehearth wherefrom slag passes to the granulation system.

The slagging hole is actualy on a water cooled copper block. At a determined time the hole sealed with clay is pierced with an oxygen lance and slag and lead are tapped in the forehearh where they separate due to their different specific densities. Molten lead by way of underflow (syphon) is collected in ladles and is transported by crane to the lead refinery. The slag by way of overflow flows into a special slagging launder in which a great amount of water is sprayed. Due to the substantial temperature differences the slag is granulated and together with the water is delivered to a special settling pond. From here it is collected into a bunker by an elevator and is transported by trucks to a slag dump site.

7.1.3.2 Condenser

The gases arising above the charge level, at the furnace offtake and inlet into the condenser have the following typical assay:

- 10 - 11 % CO_2
- ≈ 20 % CO
- ≈ 6 % Zn
- max 1 % H_2O
- balance N_2

Molten lead is splashed in the condenser which acts as an absorber. Namely the zinc vapour is entrained in the lead droplets at a temperature of approximately 650 °C.

The splashing of molten lead is carried out by eight rotors.

Solubility of zinc in lead changes with temperature. At a temperature of 600 °C it is abt 0.5 % whereas at 430 °C it is only 0.25 %. This phenomenon has been utilized to separate the dissolved zinc from lead. The hot lead from the condenser is fed into an immersible cooled launder in which pipes are immersed through which water is circulating. In this launder the lead is gradually cooled and at the end of the launder the temperature is down to 430 °C. At this temperature the surplus of zinc floats on the top and overflows into a zinc holding bath but prior to this both zinc and lead pass through a system of baths for the purpose of better separation. From the separation and liquation baths the lead is returned to the condenser whereas from the zinc holding bath the zinc is collected in ladles and transported to the zinc refinery by crane.

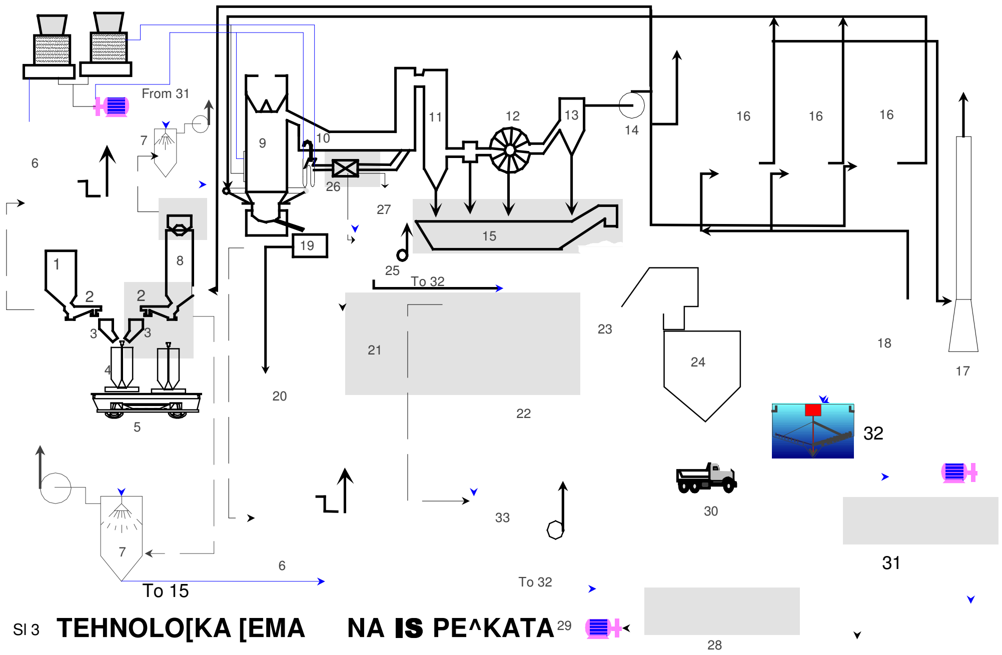
7.1.3.3 LCV-gas cleaning system

The major portion of the gas from the IS furnace is used to preheat air and coke

Immediately upon leaving the condenser the LCV gas enters the gas washing tower in which through a system of sprayers approximately 200 m^3/h are sprayed. The washing of the gas continues also in a special fan - disintegrator so called Theisen according to the name of the manufacturer. The cleaned gas from the disintegrator then passes through high pressure Booster fan and is further delivered to the Cowper stove burners and coke preheaters.

The water from the gas washing is clarified in a thickener/clarifier and a portion of it is returned into the tower whereas fresh water is always used for the Theisen.

Figure 18_Flow chart of the ISF process



Legend of the IS Furnace Plant Flow sheet

1. Sinter bunkers
2. Sinter screens
3. Hoppers
4. Charge bucket
5. Transfer car
6. Bag filter "Blagoj Davkov"
7. Scrubber
8. Coke preheaters
9. IS Furnace
10. Condenser
11. Gas washing tower
12. Fan-disintegrator (Theisen)
13. Scrubber
14. High pressure fan for LCV gas (Booster fan)
16. Cowper stoves
17. Stack
18. High pressure air blower
19. Forehearth

20. Lead ladle
21. Slag granulation launder
22. Slag pool
23. Elevator
24. Slag bunker
25. Venturi scrubber for separation system
26. Zinc separation system from condensed lead
27. Zinc ladle
28. Water cooling pond for slag granulation
29. Slag granulation pump
30. Slag delivery truck
31. Gas washing water cooling pond
32. Thickener

7.1.4 Qualitative assessment of waste streams

Slag is the only solid waste arising from Imperial smelting furnace operation. All the other by-products formed during the lead and zinc smelting such as: condenser dross, filter dusts etc. are reused mainly as raw materials in the sinter roasting.

Silicates of iron and calcium are the main constituents of the slag. In addition, it contains 6-10% Zn, 0.5-2% Pb, 3-6% Al, half of the copper fed into the furnace, some sulphur and traces of silver. Average chemical composition of the slag in 2002 is given in next table.

Table 13_Concentration of some metals in the slag in 2002

.	Zn %	Pb %	Cd %	Cu %	Ag %	S %
January	8,52	0,97	0,0000	0,4800	0,0022	2,21
February	7,96	0,85	0,0000	0,4100	0,0010	2,16
March	8,55	1,17	0,0000	0,6600	0,0010	2,47
April	7,99	1,33	0,0000	0,7200	0,0013	2,66
May	8,53	1,39	0,0000	0,6700	0,0022	2,85
June	8,11	1,29	0,0000	0,6300	0,0008	2,70
July	8,37	1,20	0,0000	0,7200	0,0016	2,56
August	8,65	1,34	0,0000	0,7800	0,0012	2,39
September	8,61	1,26	0,0000	0,7300	0,0003	2,02
October	8,49	1,08	0,0000	0,5900	0,0010	0,75
November	9,98	1,52	0,0000	0,5500	0,0020	2,62
December	8,82	1,11	0,0000	0,3600	0,0016	1,62

Arsenic, antimony and tin are also present in small concentrations in the slag.

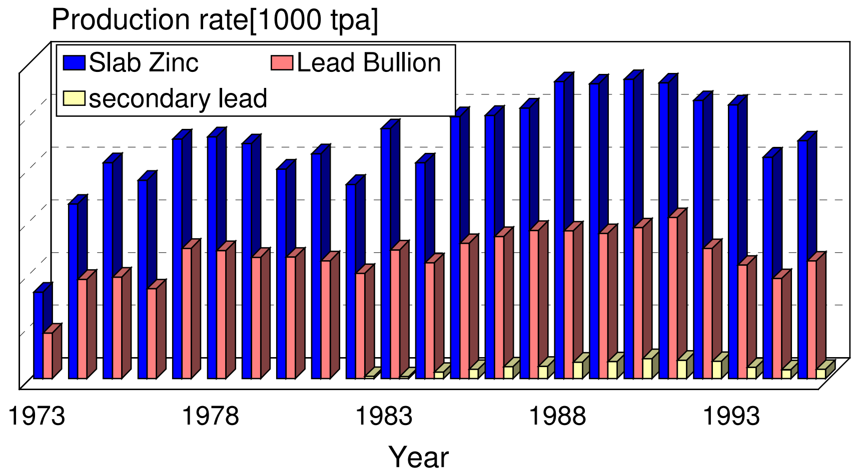
Table 14_ Assays of As, Sb and Sn content in the ISF slag

Date	As %	Sb %	Sn %
01.03.2002	0,2200	0,0000	0,0516
02.03.2002	0,3800	0,0000	0,0440
03.03.2002	0,2890	0,0000	0,0460
04.03.2002	0,1900	0,0000	0,0205
05.03.2002	0,2535	0,0000	0,0350
06.03.2002	0,0600	0,0000	0,0250
07.03.2002	0,1760	0,0000	0,0192
08.03.2002	0,1570	0,0000	0,0320
09.03.2002	0,3400	0,0000	0,0335
10.03.2002	0,2220	0,0000	0,0360
11.03.2002	0,2530	0,000	
13.03.2002	0,2340	0,000	0,0350
Average	**0,2312**	**0**	**0,03435**

7.1.5 Quantitative assessment of waste stream

There are data on quantities of slag produced each year, but these were not available to the project team. However, according to the composition of the sinter, the production of slag is about 78% of slab zinc production. The latter is shown in the figure below.

Figure 19_ Production of zinc, lead and secondary lead in the Lead and zinc smelter in Veles



More precise data on zinc and lead production over the last 18 years of operation of the smelter are shown in Table 16.

Small quantities of slag (few hundred tones) were sold in the eighties to the cement factory.

Out of the processing data a total amount of 1,8 Million Mg of Lead- and Zinc slag can be counted.

7.1.6 Slag dumsite

The dump is located in the north-north-easte dirction of the smelter plant and has a top surface of 17.422 sqm and a bottom surface of 32.981 sqm with an average height of 28m. There is a small extension in the southern part of the site with 2.200 sqm and and average height of 5 m. Since the year 1973 has slug and other wastes from the smelter production been disposed. The slopes of ths site has and gradient of 1:1 and is definitely too steep to guarantee slope stability. On the eastern and partly southern part have capping activities taken place. Almost 60% of the slopes and 70% of the top surface are not covered and therefore not protected. The coverage has been done with demolition waste and some topsoil. On the southern part of the site is a certain sort of grass growing starting to cover the area and seems to be resistant against the underlaying contamination. This kind of grass shall be taken into consideration.

Waste Amount:

17.422 x 28m height =	487.816 m³
(32.981 – 17.422) = 15.560 sqm x 14m height =	217.840 m³
2.2000 sqm x 5m height =	11.000 m³
Total:	**716.656 m³**

Taking into consideration of a bulky weight (specific density) of 2,6 Mg/m³ can an amount of 1.863.300 Mio Mg been calculated.

The site is further located on a slope with a gradient of 1:2. The heigh pressure of the slag exceeds the permitted load, which is based on the underground module 6,2 times. In the case of a migitation activity has the heap to be flattened and the surface has to be extended for 171.500 sqm (~ 17 ha) up to 204.482 sqm (~20,5 ha), with a maximum height of 5m, which is under current circumstances not feasible.

Picture 1_remarkable depressions on the site

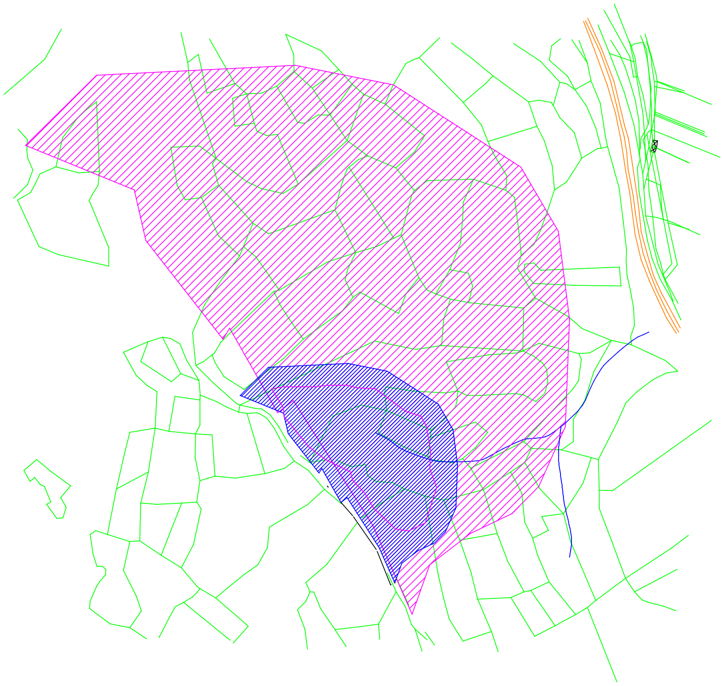
A second storage site for coke [B] is located close to the west part of the smelter and is containing mainly of coke residues from former production. The remediation of that area is under IPPC and directly linked with the production site on the one hand and has no crucial negative environmental impact on the other.

Map 1_Layout of slag dumpsite at Veles

Map 2_Demonstration of required area in the case of migitation measures

Existing Surface: 32.981 sqm [72,8 Mg / sqm]

Required Surface: 204.482 sqm [12,0 mg / sqm]



Picture 2_Dump A at Veles site

Picture 3_Dump B at Veles site

7.1.6 Relevant characteristics of the waste material

7.1.6.1 Lead

Lead is a heavy metal that exists in three oxidation states: O, +2(II), and +4(IV). Lead is generally the most widespread and concentrated contaminant present at a lead battery recycling site (i.e., battery breaker or secondary lead smelter).

Elemental lead is silvery-white and turns blue-grey when exposed to air. It is dense, malleable, readily fusible, and has a low melting point. It is soft enough to be scratched with a fingernail. Because of these characteristics, lead has been one of the most widely used metals in the history of mankind. The first uses of lead date back to 4000 BC, and toxicological effects have been linked to lead since antiquity. Lead is known to bio accumulate in most organisms, whereas it is generally not biomagnified up the food web.

7.1.6.2 Zinc

Zinc is one of the most common elements in the earth's crust. It is found in air, soil, and water, and is present in all foods. Pure zinc is a bluish-white shiny metal.

Zinc forms complexes with inorganic and organic ligands, which will affect its adsorption reactions with the soil surface. It attaches to soil, sediments, and dust particles in the air.

7.1.6.3 Cadmium

Cadmium is a soft, malleable, ductile, toxic, bluish-white bivalent metal. Cadmium (Cd) most often occurs in small quantities associated with zinc ores, but also with copper and lead ores.

With regard to end-of-life disposal of products containing cadmium, it should be emphasised that, in many of its applications, cadmium is embedded in a product matrix and hence not directly bioavailable. In the very long term, the limited traces of cadmium eventually released from waste products will transform to a stable chemical form (oxide or sulphide) and so return to the original state found in nature.

7.1.7 Pollution dilution of Lead and Zinc from the slag dump

7.1.7.1 Current ongoing pollution by Lead and Zinc

The Lead and Zinc slag dumpsite is a potential sourcse of pollution. The dump has an ground surface of 3,3 ha and is located onto a slope with gradients into the direction of the Vardar river with an inclination of almost 1:2,5. The sourses of pollution might have two reasons, ones due to wind transmission due to the fact, that most of the site is not covered and second, more significant, due to water infiltration and disbursion. The site has been investigated into the eastern direction (according to the gradient) in a distance of 25m and a second in a distance of 200m, where the main water shed has to be expected. In order to evaluate the pollution dilution, caused by Lead and Zinc and other traces of heavy metals, geoelectrical resistivity measures have been undertaken and slightly pollution dedected.

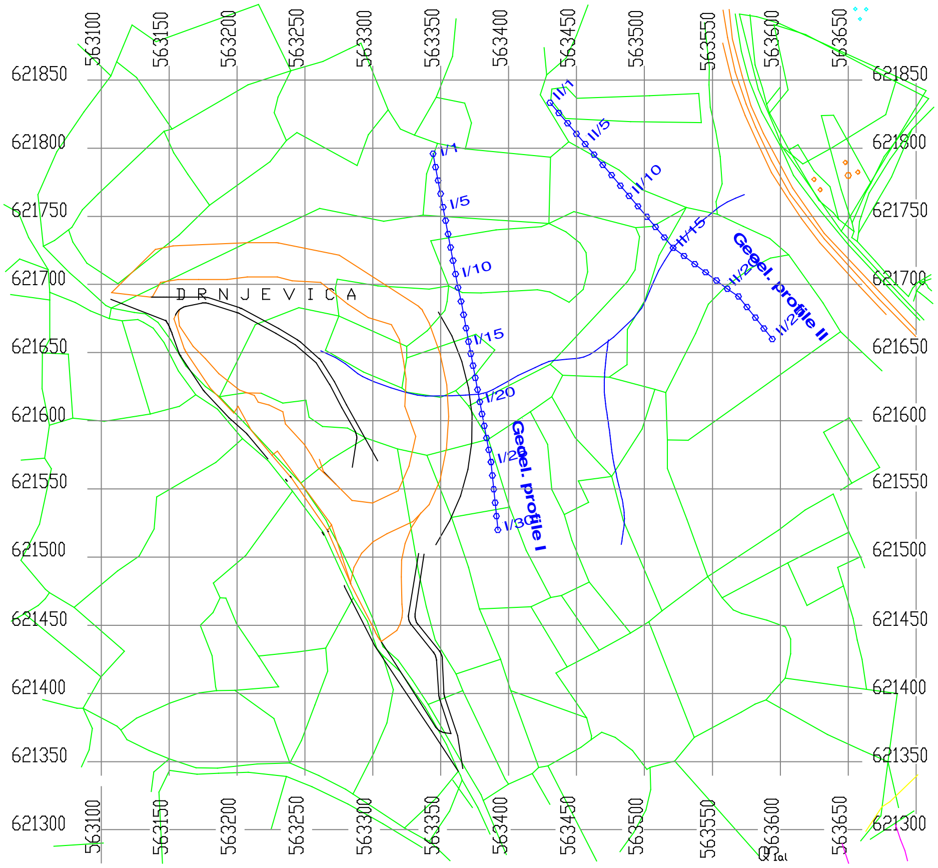
The geo-electrical investigation has been performed on the region east from the disposal area and tests are done at the area around the waste dump. The geoelectrical testing is performed with the method of geoelectrical mapping of 3 depth entrances.Two profiles have been performed with total 55 points, which is equal to 128 points for all three entrances (Table 1 and Map 1 – [11.7.1]).

Table 15_Scope of performed geoelectrical measuring

Profile	Length L (m)	Number of points	Points per depth entrances AB/2			
			AB/2=10m	AB/2=20m	AB/2=30m	Σ
I	290,00	30	28	24	19	71
II	240,00	25	22	19	16	57
Total:	**530,00**	**55**	**50**	**43**	**35**	**128**

The terrain measurements are consisted of measuring of specific electrical resistance of the bottom, by emission of direct current in the ground (per two deliverable current steel electrodes A and B) and measuring the accepted voltage on the terrain surface (per two potential copper electrodes M and N). As a source for supply are used dry batteries with maximal voltage of 300 V. Profile I and II are facing on the pollution dilution of Lead and Zinc.

Figure 20_Profiles for pollution dilution determination at Veles site

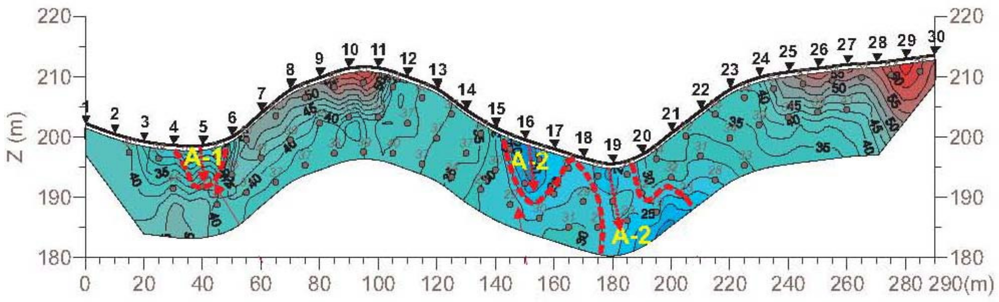


The values of ρ_p have been reduced with increasing of the depth, because of the presence of underground water and the content of the metals.

The presence of the pollution in the investigated geo-area, caused mostly of Pb, Zn and other metals from the slag on the disposal place, should be reflected with reducing of the values ρ_p. With penetration of the surface water, these metals from the disposal can migrate in the underground water in the hydro collectors. Because of the bigger volume weight, they are settling in the smooth grain fractions of the soil through which the underground water filtrates.

With the geo-electrical investigations, it is registered summary influence of the lithological structure, of the underground water and the migrated polluters in the soil and the underground water. The registered values of ρ_p are shown per probe profiles with regions in 3 intervals as stated in Chapter [11.7.2]. At 2,5 m depth, the shallowest depth, which could be mapped, data from the profile was taken and a contour map rendered, for a illustration of the low resistivity zones, which could be possible contamination zones.

Figure 21_Apparent resistivity cross section - example



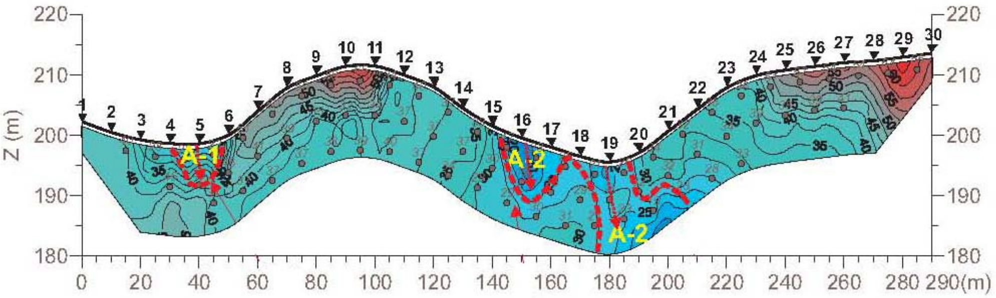
7.2 Interpretation of pollution dilution

7.2.1 Profile VE I

- is located in the crest of the east side of the disposal, to define the contaminated space and the way of moving of the underground water and pollution. On the same level with this profile have been registered values of ρ_{ρ} of 17-65 Ωm (average 37 Ωm). The underground water along this profile is probably deeper than the investigated depth, below 15m.

The anomaly zone with low values of $\rho_{\rho} < 25\Omega$m, which can point on contaminated space, has been appeared on two parts of the profile (Figure 21) The first anomaly zone (A1) has been registered shallow, between the spots 4 and 6 (in the space of the valley) on depth up to 7m. More interesting is the second anomaly zone (A2), which has been registered in the middle part of the profile around the ravine, around spot 15 to 20. This zone is not completely edged in the depth, which points that the earth is contaminated under the final investigated depth of 15m. In the frames of the second zone three minimums has been appeared, with the centres around the spots 16, 19 and 20, which points on most intensive pollution.

Figure 22_vertical profile VE I

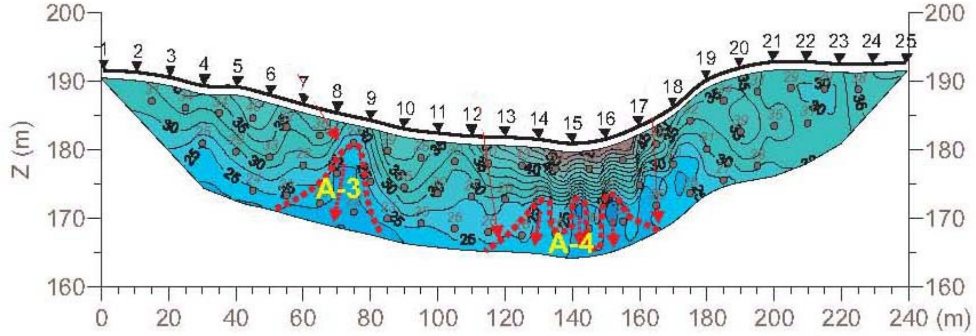


Profile VE II:

Has been located on distance 95 - 246 m east from the previous profile, with purpose to find the depth covering of the pollution in the space near the river Vardar. The values of ρ_ρ have been registered in interval of 16 - 54 Ωm (average 32 Ωm). Generally the values are lower, probably because of the influence of the underground water which should be expected on the deepest depth intake of AB / 2 = 45 m, or on depth of approximately 15 m. On this profile, similar to the profile I, two anomaly zones has been registered; the first in the valley between the probe 8 and 9 (A3), and the second anomaly zone (A4) in the middle part of the profile, around the ravine, from probe 13 to 17 (Figure 22).

Compared with the previous profile, here the zones has been registered deeper, the first one 5 m from the surface of the terrain and the second one 10 m and they are spreading deeper than 15 m. In the frames of the second zone three minimums has been appeared in the centre near the probes 14, 15 and 16.

Figure 23_vertical profile VE II



On the maps of the iso – Ωm lines showing horizontal distribution of ρ_ρ has been presented by depth intakes AB/2=15, 30 and 45m (Figure 4, 5 and 6).

On the depth intake AB/2=15m (orientation depth 5m), the previously mentioned two anomaly zones has been registered only on profile VE I (A1 and A2). This shows that the disposal and the space around it, the pollution infiltrates very fast in the depth of the layers to the insulator (clay and dust layers) and further by gravity is moving to east.

On the depth intake AB/2=30m (orientation depth10m), the second anomaly zone around the ravine has been indicated on the both profiles (A2 and A4), but with bigger intensity on profile VE II near the probe 15. The centre of this zone on profile VE I is near the probes 16 and 17. The first anomaly zone is not enough indicated only on profile VE II near the spot 8 (A3) that points that it can be of local character.

On the deepest intake AB/2=45m (orientation depth 15 m), the situation is the same as the previous intake, except that the centre of the second anomaly zone of profile I has been removed on south near the spot 20. It means that in the frames of the second anomaly zone (A2), the pollution is increased on the north side of the ravine.

7.3 Recommendations

7.4 Conclusion and recommendations

Geo-electric investigations of the pollution migration from the disposal of solid technological waste on the location, MHK "Zletovo" Topilnica - Veles, has been realized in the frames of the Project for investigation of highest ranked polluters on four, hot spots.

With the geo-electric investigations the terrain has been investigated east of the disposal up to the railway Skopje - Gevgelija. From the disposal of solid technological waste, with Pb, Zn, Cd and other solid metals, soil and the ground waters showing characteristics of pollution.

The terrain on the location, MHK "Zletovo" Smelting plant-Veles is geologically based of Pliocene sediment layers, which are containing send, clay, dust and gravel. Under the layers are appearing Triassic limes and schist.

The geo-electric investigations have been performed with the method of electrical resistance and geo-electrical mapping (Wener schedule of electrodes) on 3 depth intakes (AB/2=15, 30 and 45m), which are correlating with depths of 5, 10 and 15 m.

The registered values of ρ_ρ have been varied in interval of **16 - 65 ohmm**. The varying of the values of ρ_ρ is interpreted with the influence of the electric resistivity of the lithological content, underground water and migrated Pb, Zn and other heavy metals in the earth and the underground water.

The slag residues from the disposal, under influence of the atmospheric rainfalls and chemical and mechanical processes, has been decaying and migrating onto and into the underground to the underground waters and diluted in the surrounding area. With geo-electrical investigation two, respectively four anomaly zones have been registered which probably exist due to pollution of those areas.

The pollution with small intensity (first anomaly zone A1 and A3) appeared on the north in very steep slope of the disposal, which builds one of the sheds into the direction of the valley through the profile VE I (between the probes 4 and 7) and the profile VE II (between the probes 7 and 9) close to the direction west - east.

More intensive pollution (second anomaly zone A2 and A4) has been found on the east side of the disposal area. The pollution is distributed to the ravine through the profile VE I (between the probes 15 and 20) and the profile VE II (between the probes 12 and17) towards Vardar, near the direction northwest / southeast. The results show that on the north side appears more intensive infiltration of the pollution in comparison with the south side of the disposal area, linked with profile VE I.

15 Piezometers have been investigated by the former factory and monitored in regular intervals. Currently are most of them abandoned. Additional 7 shall be installed directly on the location of identified anomaly zones and in the direction of the watershed.

- It is suggested to construct piezometer within anomaly zones, in order to define the lithological content, rate- and the chemical content of the underground waters, also as providing monitoring of the pollution.

Table 16_Recommended locations for drills and piezometer locations

Coding	Anomaly Zone	x-coordinates[18]	y-coordinates	Remarks
P1	A1	563352	621757	Anomalyzone 1
P2	A2	563375	621632	Anomalyzone 2
P3		563392	621520	South of Dump
P4	A3	563476	621781	Anomalyzone 3
P5	A4	563521	621727	Anomalyzone 4
P6		563618	621828	Behind Railway North
P7		563813	621582	Behind Railway South

- No drills on the slag disposal site shall take place in order not to destroy potential layers
- Additional detailed investigation of the surrounding agriculture area shall be conducted
    - 3 x 300 m northeast of the slag dump
    - 3 x 300 m southwest of the slag dump as reference measure
- The monitoring intervals shall be within the first year monthly, within the first year after remediation two-monthly, within the second year after remediation quarterly and shall included following parameter:
    - Heavy Metals
        - Pb
        - Zn
        - Cd
    - Organoleptic Parameters
        - COD
        - Temperature
        - Conductivity
        - pH
        - Oxygen saturation

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[18] all coordinates are in Gauss-Krueger (Potsdam date)

7.4.1 Seismic characteristics and risk assessment of Veles field

The wider area of the city of Veles is exposed to earthquakes originating from local, regional and remote seismic hot spots, having different impact on the terrain and the constructions.

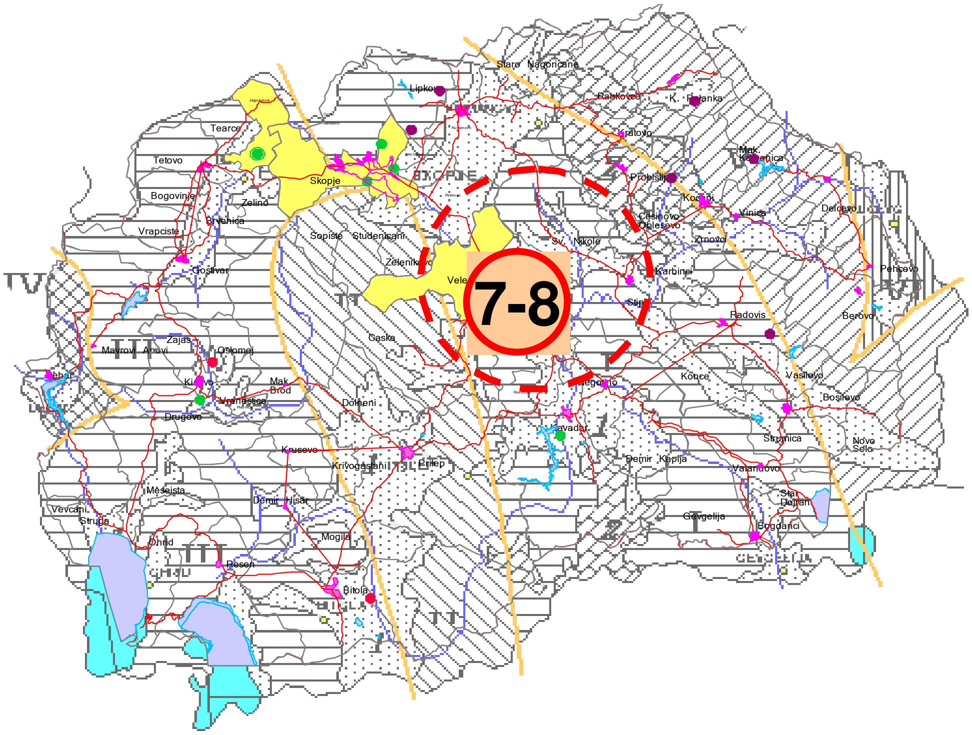
The Veles epicenter area is located in a contact zone of opposite tectonic movements, more precisely, in the zone of crossing of the fault in the Vardar direction with the North-South one. Vertical and some left oriented horizontal movements dominate these faults.

Earthquakes originated from remote (Romania, Greece, Bulgaria, Albania and Montenegro) and neighboring local seismic hot spots (Pehchevo-Kresna, Valandovo, Ohrid-Korcha, Debar-Pishkopeya etc.) also impact the seismic profile of this particular area.

Table 17_Expected seismic intensity within defined return periods

Epicenter Area	**Return Period (Years)**					
	50	**100**	**200**	**500**	**1000**	**∞**
Expected mean level of the basic EMS98 seismic intensity (I_{os})						
Skopje (lokal)	6.9	8.0	8.4	8.7	8.8	9.1
Neighbouring and Remote	6.1	6.3	6.5	6.7	6.8	7.0
Expected regional accelerations of the base rock (α_0), in g, g=9.81 m/s^2						
Skopje (lokal)	0.129	0.190	0.251	0.324	0.364	0.460
Neighbouring and Remote	0.086	0.102	0.115	0.128	0.136	0.140

7.4.2 Seismic map



7.4.3 Site Stability, E-module and permitted loads

Investigation have shown, that a permitted load of 1,2 kg/cm² accures (equal to 12 N/cm²) which does not limit any proposed activities on site. The current load is average 28 m x 2,6 Mg/m³ = 72,9 Mg/sqm = 7,29 kg/sqm = 72,9 N/sqm. Therefore dumpsite stability is 6,2 times above the permitted level and has to be flattened in the case of remediation masures such as capping (mitigation). In addition is the slag dump located on a slope (gradient 1:2,5), which increases in combination with the high load the risk for handslidings along the wathershed.

7.4.4 Conclusion

According to the building code have all buildings to be constructed to resist an earthquake rank 7 - 8 on the Mercali Ranks. The seismic risk can be evaluated as moderate till high.

The permitted load is 6,2 times exceeded. In addition to the circumstance of a slope situation can the risk for hang sliding along the watershed been ranked as high.

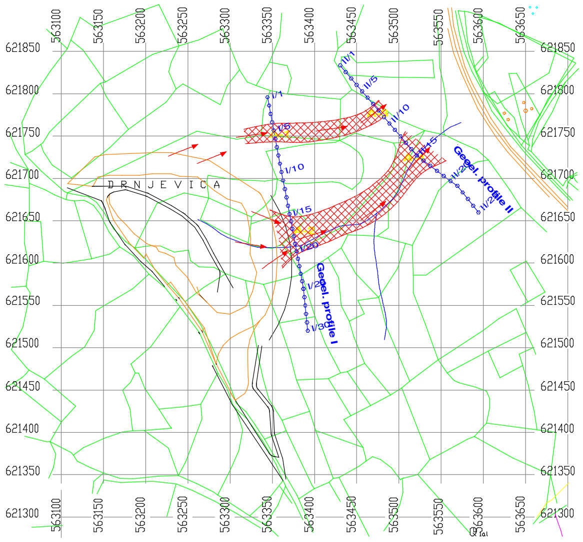
The slag dump has to be removed or flattened up to a maximum height of 5 m, which would require and area of 20 ha (17 ha in addition).

8 Environmental impact evaluation of existing contamination

8.1 Environmental impact of Lead and Zinc from the slag dumpsite

Established in 1973, MHK Zletovo was a lead and zinc smelter employing 1,100 workers. Each year it uses lead and zinc concentrates to produce 30,000 Mg of lead, 60,000 Mg of zinc and 250 Mgof cadmium, as well as smaller quantities of silver, gold and copper dross, and bismuth alloy. The main production line of the Complex of Metallurgy comprises the sinter and sulphuric acid plants and the lead and zinc shaft furnace. Zinc and lead refineries have been located in parallel. Apart from the furnace Complex of Metallurgy comprises other new plants such as: production of Lead Pipes and Balancing Weights, Electrolysis of silver, Zinc dust, Zinc oxide, Lead alloys, Metal cans, production of Silver Jewellery and Bullion cadmium. MHK Zletovo did stop its operation 4 years ago. Tender is opened for investors that will continue its operation on an environmentally allowed manner. Data were collected on the former production and existing hot spots (dump sites for metallurgical slag, raw materials, etc.). Importance of the plant's operation on the economic state of the whole town stressed. Independent of the future of the plant for the time being there are 2 hotspots, with serious impact on the environment that should be remediate. The quantity and quality of the waste has been described in chapter Process assessment – qualitative and quantitative waste assessment7 - [page 98].

Figure 24_Pollution dilution profile



Following table main qualitative characteristics and impacts of lead and hotspot are given.

Table 18_Qualitative characteristics and impacts of treated hotspots

LOCATION	MEDIA	IMPACT and RISK	DURATION and DIMENSION
Slag – Dumpsite: Pile, Slug from smelter plant **Slag Dumpsite** Surface of dumpsite: 33.000 m^2 Partially covered with soil	**Zinc, lead, Cadmium, heavy metals -** 1.800.000 t **Zn**: ≈ 70.000 mg/kg (7%) **Pb:** ≈ 10.000 mg/kg (1%) **Heavy metals :** 2-4000 mg/kg (Mn, Ni, As, Cu)	Impact: on health and environment Low Risk: Low Risk of dump stability - high	Non If any – local
Production Plant	**Cd:** 2 - 10 mg/kg **Heavy metals** : 2 - 4000 mg/kg (Mn, Ni, As, Cu)	Impact is ongoing – risk is moderate to high	Local
Coke - Dumpsite: Pile, coke and slag Surface of dumpsite: 5.000 m^2	**Coke, zinc, lead, cadmium, heavy metals -** 10.000 t	Low	If any - local
Green public area – approx. 219.747 sqm	**Accumulated pollution from former industrial activities**	Moderate, but evident	Local
Agriculture area – aprpox. 403,21 ha	**Different impacts**	Moderate, but evident	Local

8.2 Impact of slag dumspite

8.2.1 Impact of lead on air

In the atmosphere, elemental lead will deposit on surfaces or exist as a component of atmospheric aerosols. The residence time ranges from hours to weeks. Transport of atmospheric lead is linked to the characteristics of aerosols.

8.2.2 Impact of lead on soil

Lead tends to accumulate in the soil surface, usually within 3 to 5 centimetres of the surface. Concentrations decrease with depth. Insoluble lead sulphide is typically immobile in soil as long as reducing conditions are maintained. Lead can also be biomethylated, forming tetra methyl and tetraethyl lead. These compounds may enter the atmosphere by volatilization. The capacity of soil to adsorb lead increases with pH, cation exchange capacity, organic carbon content, soil/water Eh (redox potential), and phosphate levels. Lead exhibits a high degree of adsorption on clay-rich soil. In soil, lead is generally not very mobile. The downward movement of elemental lead and inorganic lead compounds from soil to groundwater by leaching is very slow under most natural conditions. Clays, silts, iron and manganese oxides, and soil organic matter can bind lead and other metals electrostatically (cation exchange) as well as chemically (specific adsorption). Soil pH, content of humic acids and amount of organic matter influence the content and mobility of lead in soils..

Only a small percent of the total lead is leachable; the major portion is usually solid or adsorbed onto soil particles.

8.2.3 Impact of lead on water

Though lead is not very mobile in soil, lead may enter surface waters as a result of erosion of lead-containing soil particles Surface runoff, which can transport soil particles containing adsorbed lead, facilitates migration and subsequent description from contaminated soils. On the other hand, ground water (typically low in suspended soils and leachable lead salts) does not normally create a major pathway for lead migration. Lead compounds are soluble at low pH and at high pH, such as those induced by solidification/stabilization treatment.

8.2.4 Impact of Lead on health

See chapter Qualitative Health Impact Assessment, heading number 6.2.1.1 page number 80.

During the past has Lead due to accumulated and permanent contact caused heatlh disease. The level of Lead in blood didn't declain even after stoppage of the production, which means that other sources such as contaminated soil and throughout the food chain are reasons for an ongoing impact.

Health impact of Lead is widely described in the Volume 00_A - Qualitative Health Impact Assessment.

8.2.5 Impact of Zinc on air

Zinc appears in the air as dust particles. Rain and snow remove zinc dust particles from the air. Industries also can release dust containing higher levels of zinc into the air we breathe. Eventually, the zinc dust will settle out onto the soil and surface waters. Rain and snow also can remove zinc dust from the air.

8.2.6 Impact of Zinc on soil

Depending on the type of soil, some zinc compounds can move into the groundwater and into lakes, streams, and rivers. Most of the zinc in soil stays bound to soil particles and does not dissolve in water. When high levels of zinc are present in soils, such as at a hazardous waste site, the metal can seep into the groundwater.

8.2.7 Impact of Zinc on water

Rainfall removes zinc from soil because the zinc compounds are highly soluble. As with all cationic metals, zinc adsorption increases with pH. Zinc hydrolyzes at a pH >7.7.Most of the zinc in bodies of water settles to the bottom. However, a small amount may remain either dissolved in water or as finely suspended particles.

8.2.8 Impact of Zinc on health

See chapter Qualitative Health Impact Assessment, heading number 6.2.1.2, page number80. During the past has Zinc due to accumulated and permanent contact caused health impacts. The level of Zinc in human didn't declain even after stoppage of the production, which means that other sources such as contaminated soil and throughout the food chain are reasons for an ongoing impact.

Health impact of Zinc is widely described in the Volume 00_A - Qualitative Health Impact Assessment.

8.3 Impact of the improper commissioned production facility

8.3.1 Impact of Cadmium on air

Cadmium in ambient air represents, by far, the majority of total airborne cadmium.

8.3.2 Impact of Cadmium on soil

The adsorption of cadmium onto soils and silicon or aluminum oxides is strongly pH-dependent, increasing as conditions become more alkaline. When the pH is below 6-7, cadmium is desorbed from these materials. Cadmium has considerably less affinity for the absorbents tested than do copper, zinc, and lead and might be expected to be more mobile in the environment than these materials.

8.3.3 Impact of Cadmium on water

Cadmium is a natural, usually minor constituent of surface and groundwater. It may exist in water as the hydrated ion, as inorganic complexes such as carbonates, hydroxides, chlorides or sulphates, or as organic complexes with humic acids (OECD 1994). Cadmium may enter aquatic systems through weathering and erosion of soils and bedrock, atmospheric deposition direct discharge from industrial operations, leakage from landfalls and contaminated sites, and the dispersive use of sludge and fertilisers in agriculture. Partitioning of cadmium between the adsorbed-in-sediment state and dissolved-in-water state is therefore an important factor in whether cadmium emitted to waters is or is not available to enter the food chain and affect human health. Rivers containing excess cadmium can contaminate surrounding land, either through irrigation for agricultural purposes, dumping of dredged sediments or flooding. It has also been demonstrated that rivers can transport cadmium for considerable distances, up to 50 km, from the source (WHO 1992). Cadmium oxide and sulfide are relatively insoluble while the chloride and sulfate salts are soluble.

8.3.4 Impact of Cadmium on health

See chapter Qualitative Health Impact Assessment, heading number 6.2.1.3, page number 80. During the past has Cadmium due to accumulated and permanent contact caused heatlh disease. The level of Cadmium in blood didn’t declain even after stoppage of the production, which means that other sources such as dust from the plant, contaminated soil and throughout the food chain are reasons for an ongoing impact.

Health impact of Cadmium is widely described in the Volume 00_A - Qualitative Health Impact Assessment.

8.4 Impact from the Dumpsite

For the purpose of the Environmental Audit in 2003, samples of material at the slag landfill were taken for analyses. These analyses and all others cited in the present report were generated by Chemex International Limited, an accredited laboratory located in Cambridge, England. The values obtained are similar to those taken over the past decade by the smelter. The heavy metal levels are generally higher at the bottom of the slag heap, especially for metals such as cadmium which are more soluble in rainwater. Elevated arsenic levels are of particular note as a known contaminant.

Table 19_Slag dumpsite analytical results

Material[19]	Arsenic	Cadmium	Copper	Lead	Manganese	Nickel	Zinc
Top of heap, new slag 1	3.720	<2,37	3.480	6.480	5.130	117	74.100
Top of heap, new slag 2	3.090	<2,44	3.580	14.500	9.140	176	106.000
Bottom of heap, old slag 1	880	9,89	5.570	13.400	11.100	28,4	86.600
Bottom of heap, old slag 2	4.040	4,06	4.230	39.300	7.520	267	88.400
Coke tip	67,8	59,6	341	6.610	218	20,5	10.400
ICRCL UK Upper Limits, Soils	40	15	130	2.000	-	70	300
Dutch C-values, Soils	55	12	190	530	-	210	720

Table 20_Chemical content of slag from dump site in mg/kg[20]

Element	Pb	Zn	Cd	Cu	Sb	As	Sn
Sample 1	11.500	78.928	11,4	7.028	1,8	0,44	<0,8
Sample 2	9.808	86760	13,32	7.844	2,56	0,92	<0,8

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[19] All data are shown as mg/kg dry weight (parts per million)

[20] in mg/kg

8.5 Generally impacts

8.5.1 Impact on soil

The smelter has taken soil samples at eleven locations around the smelter for the past decade. These locations were again sampled at 10 cm and 20 cm depths as part of this project. They clearly indicate higher levels of contamination in the surface soils compared to those at greater depth, supporting the assumption that most pollution is airborne.

Samples taken downwind of the prevailing wind at the smelter showed higher values than those located to the north. These findings have been clearly demonstrated in analytical results from moss samples, taken by the Institute of Chemistry, Skopje. Results for various have metals from this recent research demonstrate the regional as well as local pollution impact of the smelter.

Table 21_Soils samples at sites around the Veles smelter

Samples[21]	**Arsenic**	**Cadmium**	**Copper**	**Lead**	**Manganese**	**Nickel**	**Zinc**
Upper soils	<8-15	<0,2-75	10-47	44-1.210	189-730	13-219	73-1.700
Lower soils	<6-15	<1-19	<6-37	27-515	205-652	38-594	59-594
ICRCL UK Upper limits, soils	40	15	130	2.000	-	70	300
Dutch C-values, soils	55	12	190	530	-	210	720

Based on the results given in next Table, it could be concluded that the soil on particular location isn't highly contaminated.

Table 22_Chemical analysis of top soil sample taken from the Well-1 (near piezometer P7)

Parameter	Concentration Unit	MPC	Obtained value	Method
Lead, Pb	mg/kg	85	33,84	ISO 11885/1996
Zinc, Zn	mg/kg	140	118,04	ISO 11885/1996
Cadmium, Cd	mg/kg	0,8	3,08	ISO 11885/1996
Copper, Cu	mg/kg	36	33,92	ISO 11885/1996
Antimony, Sb	mg/kg	3	0,88	ISO 11885/1996
Arsenic, As	mg/kg	29	<0,4	ISO 11885/1996
Tin, Sn	mg/kg	-	<0,8	ISO 11885/1996

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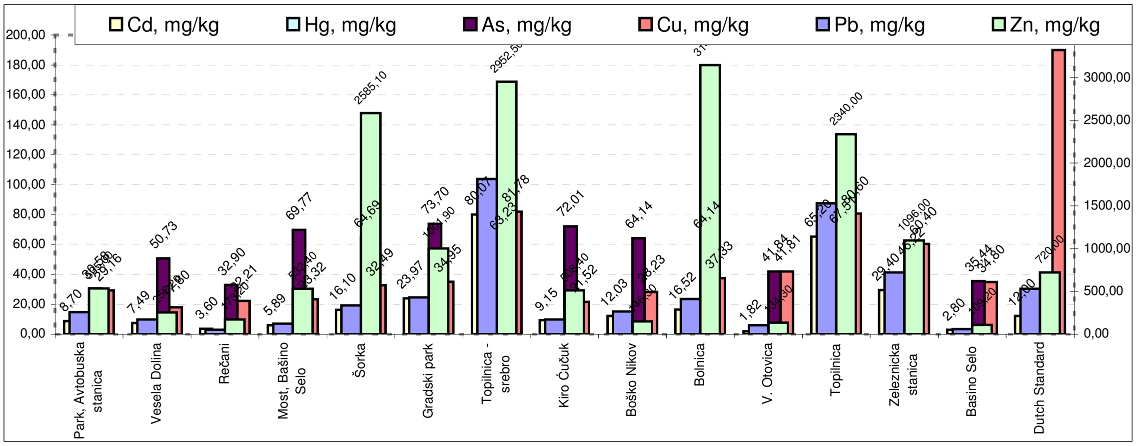
[21] All data are shown as mg/kg dry weight (parts per million).

Table 23_Soil samples recently[22] taken in the surrounding area in Veles

Sampling point	Pb mg/kg	Zn mg/kg	Cd mg/kg	Hg mg/kg	As mg/kg	Cu mg/kg
Park, Avtobuska stanica	257,10	535,00	8,70	0,20	30,58	29,16
Vesela Dolina	172,00	252,20	7,49	0,31	50,73	17,80
Rečani	54,50	173,20	3,60	0,17	32,90	22,21
Most, Bašino Selo	123,60	532,40	5,89	0,27	69,77	23,32
Šorka	333,50	2.585,10	16,10	0,46	64,69	32,49
Gradski park	430,70	1.001,90	23,97	0,37	73,70	34,95
Topilnica - srebro	1.813,90	2.952,50	80,07	0,23	63,23	81,78
Kiro Ćučuk	173,70	508,40	9,15	0,12	72,01	21,52
Boško Nikov	263,30	146,30	12,03	0,19	64,14	28,23
Bolnica	412,00	3.147,50	16,52	0,32	64,14	37,33
V. Otovica	102,60	134,30	1,82	0,26	41,84	41,81
Topilnica	1.531,20	2.340,00	65,20	0,27	67,51	80,60
Zeleznicka stanica	721,20	1.096,00	29,40	0,15	46,22	60,40
Basino Selo	60,60	109,20	2,80	0,12	35,44	34,80
Dutch Standard	530,00	720,00	12,00	10,00	55,00	190,00

Figure 25_Result chart from recently taken samples in the surrounding of Veles



The lead contamination is located in the close surrounding area of the smelter, Zinc, Cadmium and Arsenic have a wider impacting area, while Cupper and Mercury does not show any contamination level. The expected impact in the village Bosino Selo does not occure. The impact is almost proportional to the distance of the smelter plant in the mainwind direction. The impact nearby the smelter can be attested as moderate, while in a more distance as **low till moderate**, but evident. A wider range of extended investigation of soils of the public green areas and agriculture area will be taken into consideration within the development of the Terms of References.

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[22] Soil samples taken and analysed by the chemical institute of Skopje; 10/2007

8.5.2 Impacts on waters

The general impact is based on the potential of leackage based on mobilisation and airborne transmission due to particle sizes.

Table 24_ Chemical analysis of the leachate from slag - sample taken from the onsite lab at pH=4 and pH=7 (TCLP EPA 1311)

Parameter	mg/L	mg/kg	mg/L	mg/kg	Standard Leaching rate for Landfills	Method
	At pH 4		At pH 7			
Lead, Pb	84,04	1680,8	0,0012	0,0242	1,0	ISO 11885/1996
Zinc, Zn	69,96	1399.2	0,2122	42,440		ISO 11885/1996
Cadmium, Cd	0,0745	1,49	0,004	0,0830	0,1	ISO 11885/1996
Copper, Cu	11,37	227.4	0,018	0,3636		ISO 11885/1996
Antimony, Sb	0,0025	0,05	-	-		ISO 11885/1996
Arsenic, As	0,0207	0,414	-	-	0,5	ISO 11885/1996
Tin, Sn	<0,002	<0,04	<2	<0,0400		ISO 11885/1996

Table 25_ Chemical analysis of the leachate from slag - sample taken from the external lab at pH=4 and pH=7 (TCLP EPA 1311)

Parameter	mg/L	mg/kg	mg/L	mg/kg	Standard Leaching rate for Landfills	Method
	At pH 4		At pH 7			
Lead, Pb	80,85	1617	0,006	0,1272	1,0	ISO 11885/1996
Zinc, Zn	202,52	4050,4	14,58	0,2916		ISO 11885/1996
Cadmium, Cd	0,0528	1,056	0,00014	0,0028	0,1	ISO 11885/1996
Copper, Cu	0,2115	4,23	0,003	0,0676		ISO 11885/1996
Antimony, Sb	0,018	0,36	0,0038	0,0758		ISO 11885/1996
Arsenic, As	<0,001	<0,02	0,0014	0,284	0,5	ISO 11885/1996
Tin, Sn	<0,002	<0,04	<2	<0,0400		ISO 11885/1996

As it is shown the slag is relatively (very) stable on the leaching tests. Exception is only lead by pH = 4. This was a risk during the smelter operation and high acidity of participations. In the fact this isn't any more the case because the smelter isn't in the operation.

Impact of leaching waters from the existing landfill on ground waters could be estimated as (very) low. The slag from the Veles dumpsite isn't hazardous one and could be practically managed and disposed as inert one.

8.5.2.1 Impact on groundwater

To confirm that leachate from the slag landfill is not significantly contaminating local groundwater down slope of the slag landfill, the smelter staff re-sampled in July 2003 at piezometer locations that have been monitored over the past decade for heavy metals and pH. The results indicated that relatively low levels of metals are being leached from the slag landfill, although it is difficult to separate pollution arising from airborne, leachate and zinc pipe sources. It has generally been held that the slag landfill is polluting the underlying groundwater and thus nearby wells. While there is cause for concern, this seems to be of far lesser significance than contamination by atmospheric contaminants.

Analysis of metal levels in crops grown locally noted that elevated values of heavy metals were found. These were again presumed to originate primarily for airborne sources.

In the following Tables results of the ground water analysis are given. Only zinc concentration is exceeding the MPC concentrations for drinking water.

Table 26_Chemical analysis of groundwater sample taken from the Well-1 (near piezometer P7)

Parameter	Concentration Unit	MPC[23]	Obtained value	Method
pH	-	6,5-8,5	7,57	ISO 10523
Conductivity	µS/cm	-	1311,0	ISO 7888
Lead, Pb	µg/L	10	4,71	ISO 11885/1996
Zinc, Zn	µg/L	100	776,18	ISO 11885/1996
Cadmium, Cd	µg/L	0,1	0,038	ISO 11885/1996
Copper, Cu	µg/L	10	0,38	ISO 11885/1996
Antimony, Sb	µg/L	30	2,73	ISO 11885/1996
Arsenic, As	µg/L	30	<1	ISO 11885/1996
Tin, Sn	µg/L	100	<2	ISO 11885/1996

Table 27_Chemical analysis of groundwater sample taken from the Well-1 (near piezometer P5)

Parameter	Concentration Unit	MPC	Obtained value	Method
pH	-	6,5-8,5	7,34	ISO 10523
Conductivity	µS/cm	-	2904,0	ISO 7888
Lead, Pb	µg/L	10	3,10	ISO 11885/1996
Zinc, Zn	µg/L	100	35,48	ISO 11885/1996
Cadmium, Cd	µg/L	0,1	0,041	ISO 11885/1996
Copper, Cu	µg/L	10	6,38	ISO 11885/1996
Antimony, Sb	µg/L	30	24,55	ISO 11885/1996
Arsenic, As	µg/L	30	<1	ISO 11885/1996
Tin, Sn	µg/L	100	<2	ISO 11885/1996

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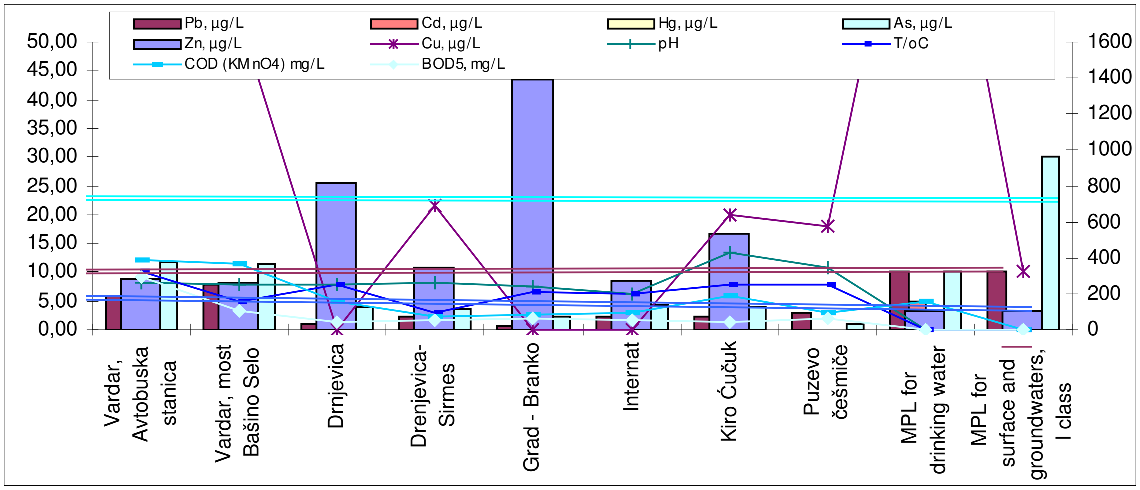
[23] MPC = maximum permitted concentration

Table 28_Chemical analysis of groundwater sample taken recently from the chemical institute

Sampling point	pH	T/oC	EC µS/cm	COD (KMnO4) mg/L	BOD5 mg/L	Pb µg/L	Zn µg/L	Cd µg/L	Hg µg/L	As µg/L	Cu µg/L
Vardar, Avtobuska stanica	8,10	10,20	138,4	12,23	9,00	6,03	280,4	0,24	0,116	11,80	51,00
Vardar, most Bašino Selo	7,99	4,90	136,0	11,32	3,40	7,92	264	0,22	0,095	11,30	54,40
Drnjevica	7,90	7,70	149,4	4,89	1,30	0,97	820,9	<0,01	0,106	3,91	<2,0
Drenjevica-Sirmes	8,08	2,90	127,9	2,44	1,70	2,38	343,7	0,046	0,088	3,64	21,70
Grad - Branko	7,57	6,50	154,1	2,75	1,90	0,76	1395	0,029	0,088	2,16	<2,0
Internat	6,30	6,30	149,3	3,05	1,50	2,22	269,3	0,015	0,092	4,32	<2,0
Kiro Ćučuk	13,50	7,91	135,1	5,81	1,30	2,27	528,4	0,093	0,099	4,05	19,90
Puzevo češmiče	10,80	7,83	139,0	3,05	1,90	2,92	<10	0,03	0,095	1,03	17,90
MPL for drinking water	6,5-8,5	-	1000	5	-	10	100	5	1	10	100
MPL for surface and groundwaters, I class	>8	-	-	<2,5	<2,0	10	100	1	0,2	30	10
MPL for surface and groundwaters, II class	7,99-6,00	-	-	2,51-5,0	2,01-4,0	10	100	0,1	0,2	30	10
MPL for surface and groundwaters, III class	5,99-4,00	-	-	5,01-10,0	4,01-7,0	30	200	10	1	50	50
MPL for surface and groundwaters, IV class	3,99-2,00	-	-	10,01-20,0	7,01-15,0	30	200	10	1	50	50

Figure 26_Chemical analyses from various wells in the surrounding of Veles



The results reflects no direct impact of lead into the groundwater – all levels have been below the limits. Similar results occure by Cadmium, while Zinc is increased 2 to 8 times of the permitted concentrations. The generally impact in groundwater can therefore be attested as LOW to moderate.

8.6 Health impacts

See chapter Qualitative Health Impact Assessment, heading number 6.1, page number 59. In the Veles case, the impact on health is definitely higher because of an onging impact due to airborne distribtion from the not proper decommissioned plant and contaminated soil and due to the food chain.

Health impact of Lead, Zinc and Cadmium is widely described in the Volume 00_A - Qualitative Health Impact Assessment.

8.7 Hazardous risk assessment

According to the chemical characteristic of the elements present in the slag and characteristics of the soil where are located dumpsites and distance of the dumpsites of the inhabited places the impacts must be taken into consideration. The soil around the factory and dumpsites is contaminated as a result of mobility of the elements and its long terms impacts (long life) also its solubility in water they provoked contamination of ground water and at the same time contamination of drinking water. In the wells for drinking water are determined these element in high concentration. Also the air around the dumpsite and its surrounding is polluted of speeded dust from the dumpsites. Lead levels near the smelter may pose a health hazard, particularly to children, if ingested or inhaled in sufficient quantities. Individuals can be exposed to lead by breathing contaminated dust, by swallowing contaminated soil, and by eating food not thoroughly washed that has been grown in contaminated soil. The NEAP reported that cadmium, lead and zinc levels were 10- 15 times higher in vegetables grown in Veles relative to control regions. As much as 4 to 10 times the acceptable levels for lead and cadmium were found in spinach and lettuce due to soil contamination.

The risk exposed from the current dumpsite is low to moderate; the risk exposed from impacted soil, groundwater, surfacewater and through the foodchain is Moderate to High.

9 REMEDIATION TECHNIQUE

9.1 Specification of source of site contamination

In Veles are 4 different types of contaminants to be taken into consideration:

9.1.1 A - Slag dumpsite

– from the previous investigations is the dumpsite not the mainpollutant. Only the watershed in the direction of Vardard river is slightly contaminated and can be remediated by phytoremediation activities. It shall be taken note, that no food producing plants shall be grown. 4 Anomalyzones have been identified. The location is on the slopes into the eastern direction. The dumpsite itself cannot be remediated by bioremediaton methods due to the 28m height of the site, while those remediation activities would only have surface effect. In addition is the content of lead and zinc within the slag too high as seen in Table 19_Slag dumpsite analytical results.

There are only two potential rememediation possibilities available, those to migitate the site due to flattening, profiling and capping, while the surface has to be increased from 3,3 up to 20 ha and to remove the material from current location. The slag has still 1% of Lead and 7% of Zinc content and would be possible to be reprocessed in a fuming process. This process will recover the remaining material, while the material can be sold.

9.1.2 B - Production facility

– the production facility has to be recommissioned or decommissioned, which can from current project only be proposed, but has to be inforced by the government, respectively by the Ministry of Environment and Physcial Planning (MoEPP). The recommissioning activities have to focus on the clean up of the current facility from all airborn causing dust and the surrounding area has to be remediated.

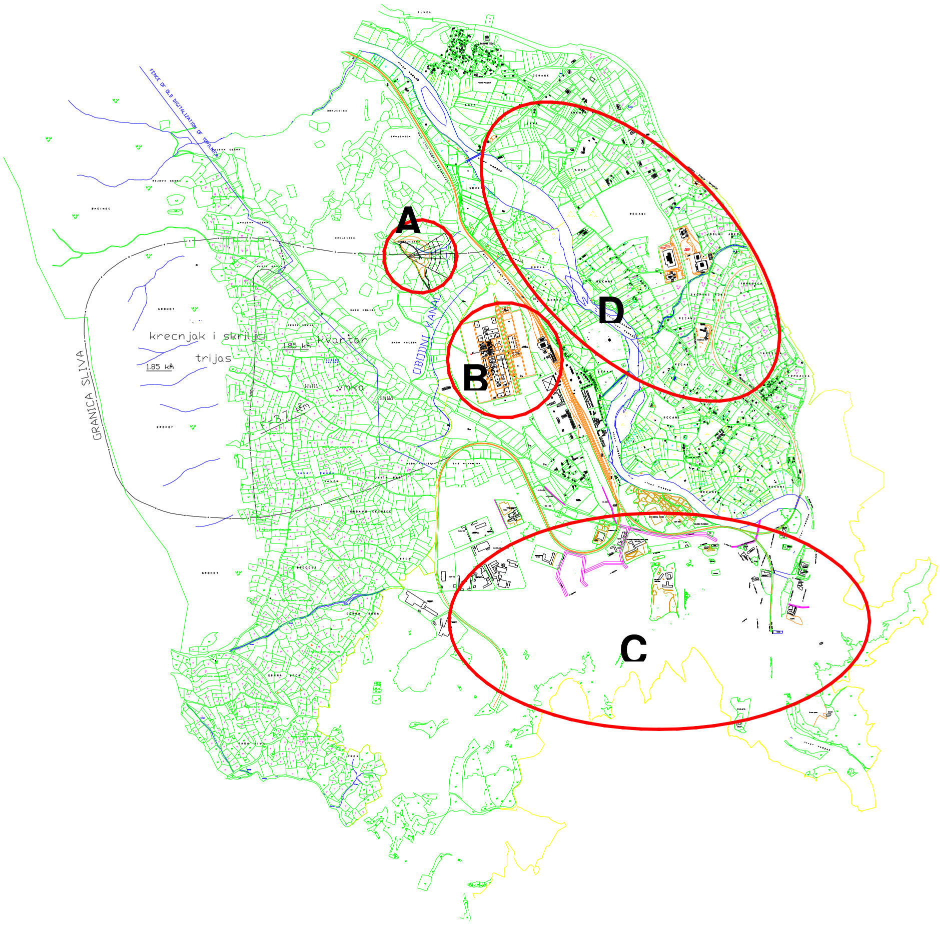
9.1.3 C - Green public areas

– the green public areas have been impacted due to air pollution, which accumulated during the decades in the top soil and can current impact health due to wind erosion and dust. There are two possibilities of remediation – once due to phytoremediation which is not appropriate in pubic areas or otherwise due to soil exchange. The total area is 228.237 sqm and included the green areas around public facilities, such as schools, kindergardens, municipal buildings, hospitals and play- and sport grounds. A remediation of a soil depths of minimum 50 cm (grass root depth) shall be taken into consideration. A detailed investigation will be part of the terms of references and shall include a surface and depth soil investigation. It can be assumed, that Lead, Cadmium and Zinc and even Arsenic are located in the upper located top soil layers. The soluability of these heavy metals is rather low, so that a transmission into deeper layer can almost be excluded.

9.1.4 D - Agriculture land

– the total surface of agriculture and/or horticulture land is 403,21 ha, while only about 20% are used for food processing, which are 80,6 ha. A soil exchange of only 30 cm would cause an amount of 242.000 m^3 or equal to 387.000 Mg of impacted soil. A disposal facility has to be identified. One proposal can be the transport to the abandoned tailing damn of Lojan, which shall be prepared for national hazard waste disposal purpose as several times suggested or to use this soil for the start of the coverage of the gypsum dumspite for profiling issues. Another problem occurs under this proposal, where to extract the required amount for replacing the soil. In addition would be an anormous transport and excavation fluctuation created, which would in addition impact the enviroment. Similar to the public green areas can be assumed, that the main content of heavy metals are in the topsoil layer. Due to plouing activities on the field can a mechanical transmission of 25 – 35 cm be assumed, while a 50 cm impacted zone shall be taken into consideration. This thesis can be underlined due to the low impacted groundwater and higher impacted soil layers as shown in the investigated results.

Figure 27_Location of required activities



9.2 Selected alternatives for recycling and slag dumpsite remediation

Independent from the selected remediation technique on the long-term time permitted levels in soil and groundwater, according the existing standards (given in Annex) have to be reached and following possibilities taken into consideration:

9.2.1 Identification of recycling and reuse potential

A relatively recent idea in waste management has been to treat the waste material as a resource to be exploited, instead of simply a challenge to be managed and disposed of. There are a number of different methods by which resources may be extracted from waste: the materials may be extracted and recycled, or the calorific content of the waste may be converted to electricity. There are a number of methods of recovering resources from waste materials, with new technologies and methods being developed continuously.

There is also a growing acknowledgement that simply disposing of waste materials is unsustainable in the long term, as there is a finite supply of most raw materials.

9.2.2 Slag reuse alternatives

9.2.2.1 Reuse the slag in a Zn/Pb smelter with appropriate technology

The recent Zn/Pb smelters are designed to recycle generated slag by sending it back to the fuming process. The slag from Zletovo dump site could be added to that slag stream generated in the existing process and sent it to be recycled in the furnace.

The resulting slag from such a process is poor on zinc and lead. Due to the silicate character it can be not considered as a source of soil or ground water pollution with heavy metals and could be used in the cement industry as an additive to the clinker, in road construction and civil engineering or could be safely land filled.

There are few Zn/Pb smelters in Europe which could use the slag from dump site. The potential user of Zletovo slag should be contacted. As the China market should be investigated.

9.2.2.2 Build a new fuming facility tailored to the solid slag as a feed

To build a new Zn/Pb smelter plant which will use as the feed the slag from the dump site instead of Zn/Pb concentrate, is an idea which was taken into consideration years ago, and the project proposal was made. The aim of the project was to remove the slag rich on heavy metals from the dump site; i.e. eliminate the slag with heavy metals as the potential source of environmental impact and use it as a feed in new fuming facility. Resulting slag from this process should not contain heavy metals and could be used in cement or construction industry or safely land filled.

The preliminary cost assessment shows that the investment costs for a fuming plant of a capacity of 90,000 t/year slag (50,000 t/y liquid + 40,000 t/y solid) are within the range of Euro 20 Mio to 25 Mio.

At that time of project proposal the price of zinc was about 900 –1.000 USD/Mg. Nowadays with the price of zinc of about 3.000 USD / Mg, this project becomes very attractive from economical point of view.

9.2.3 Description of slag reuse/recycling technology

9.2.3.1 Existing Zn/Pb smelter which can use solid slag from another facility

Some recent IS smelters are already designed to recycle the generated slag. In the IS Furnace process sinter is smelted and reduced by means of carbon burning in order to produce zinc in gaseous phase at the top of the furnace and molten lead and the slag at the bottom. Due to their different specific densities lead bullion and slag are separated. Molten lead by way of underflow (syphon) is collected in ladles and is transported by crane to the lead refinery. The separated slag by way of overflow is sent back to IS furnace i.e. fuming process.

Depleted slag (the slag from which the zinc and lead are taken out) flows into a special slagging launder in which a great amount of water is sprayed and the slag is granulated and together with the water is sent to a special settling pond. From here it is collected into a bunker slag.

The resulting slag from this improved IS process do not contain heavy metals and could be used in cement or construction industry or safely land filled.

9.2.3.2 Build a new fuming facility tailored to the solid slag as a feed

The process of zinc, lead and cadmium depletion in the slag is known as fuming. Liquid slag fuming plants are more compact and more attractive from the environmental point of view. According to the information received so far, it seems that appreciable results have been achieved in the Hachinohe smelter of Mitsui in Japan. Hachinohe smelter is an Imperial Smelting licensee and uses an AUSMELT fuming technology for slag fuming. The process is flexible enough to receive not only new liquid slag, but slag from the landfill as well. Zinc oxides extracted from the slag are in a form of a very fine powder and should be fed directly into the IS furnace after being briquetted. Additional charge bin and modification of the charging system are required.

Table 29_Metallurgical performances

	Quantity [Mg/y]	Zn [%]	Pb [%]	Efficiency [%]	
Feed				Zn	Pb
ISF Slag	90.000	6-10	0.5-2		
Cole for reduction	4.500				
Cole for combustion	5.500				
Production					
Pb/Zn oxides	9.900	65	13	90	95
Depleated slag	78.000				

According to the above table, apart from protecting the soil and ground water from pollution, slag fuming will result in zinc and lead production by 6.400 and 1.290 Mg/year respectively. This is equivalent to 12500 Mg/y zinc and 1800 Mg/y lead concentrates.

9.2.4 Potential reuse of remaining slag

There are several possibilities of slag reuse:

- Cement industry; as a raw material (Portland cement contains up to 70 % of slag)
- Road construction material

There are no specific technological requirements for the reuse of slag or scrap iron or treatment alternatives. Taken a reuse of the slag (fuming process) into consideration a remaining slag amount of 82.400 Mg/year occurs to be disposed or treated. The material can be attested as inert one and does not more occure any harm to the environement dispite dust (PM10, PM2,5)

9.2.4.1 Slag in cement industry

Portland cement is the most common type of cement in general usage, as it is a basic ingredient of concrete, mortar and most non-speciality grout. The most common use for cement is in the production of concrete. Portland Cement contains up to 70% ground granulated slag, with the rest Portland clinker is increased, early strength is reduced, while sulfate resistance increases and heat evolution diminishes. Taken the lead and zink slag recovery into consideration as recyclables, remains an amount of 1.648.000 Mg for the reuse in the cement kiln. The closest cement kiln is that of Skopje, 50 km far from the Veles plant. Infrastructure such as road or rail connection is existing.

9.2.4.2 Slag as construction material

Due to its mechanical properties and inertness slag is an ideal material in road construction, but as well in many others civil engineering activities, such as infilling material for profiling issues for remediation purposes of old municipal dumpsites. In additon could the material be used to cover the gypsum dumpsite in Veles. An amount of minimum 15.000 m³ is required, which easily can be achieved.

9.3 Selected alternatives for slag dumpsite remediation

Independent from the selected remediation technique on the long-term time permitted levels in soil and groundwater, according the existing standards (given in Annex) have to be reached.

From the environmental view of point, for the remediation of slag dumpsite there are following possibilities:

- **No activities** – no activities will undertake. Impact on environment will remain at it is: pollution of ground water and pollution of soil is bay particle emissions. The visual impact will also remain for long time, because the natural planting is very slow. Anyhow this alternative should be excluded and isn't recommending.
- **In situ improvement of the situation** – mitigation measures for reducing of wind erosion and improving of visual impact should be at least introduced.
- **Excavation and off site remediation with waste return** - waste will be excavated, transported to the remediation (funig) plant. Remaining waste material will be returned on the present dump. Outlook of the dumpsite will be adequately adopted to the landscape. Impact on the environment during the excavation would need care, particularly related to local dust emissions and in case that during the excavation some hazardous waste will be found. This alternative is recommended in case of win-win effects.
- **Excavation and off site remediation without waste return** - waste will be excavated, transported to the remediation (fuming) plant. Remaining waste material will be deposited on new location. After material will be removed location will be adequately re-cultivated. Impact on the environment during the excavation would need care, particularly related to local dust emissions and in case that during the excavation some hazardous waste will be found. This alternative is recommended in case of win-win effects.
    - **Offsite Treatment** – material will be excavated and removed from the site and transported from the buyer (possible option would be Plovdiv) – remaining material would remain outside the country.
    - **Pseudo Onsite Treatment** – material will be excavated and removed to a local installed fuming process plant. The waste will be used in the cement plant, street construction purposes, covering of existing gypsum dumpsite or as infill material for existing sites (municipal sites).

In the evaluation of different options, environmental impact was evaluated according the international practice (see e.g. EPA USA) and enlarged in the broader content of sustainability. Evaluation was done only in the relation to present location and Macedonian availability. General environmental relevant information's, different sustainable impacts and rough ranking of possibilities for different technical options are given in next Table.

From the environmental point of view capping and excavation and reuse of material with or without return of remaining waste are possible.

Table 30_Environmental evaluation of proposed slag dump remediation options

	No activities	**Capping – mitigation measures**	**Excavation and off site treatment with return of remaining waste**	**Excavation and off site treatment and disposal or treatment of remaining waste**
Hazard	M[24]	L	L	L
Risk	M	L	L	L
Environmental impact – FINAL	M	L	L	L
Environmental impact – during the remediation	L	L	M	M
• **on air**	L	L	M	M
• **on water**	L	L	M	M
• **on soil**	L	L	M	M
Time needed to complete solve the problem	H	H	L	L
Monitoring needs – time and frequency	H	H	L	L
Best practice – world wide use of the technology – Development status	H	L	L	L
Technical and technology assistance needed - Macedonia is self-sufficient	L	L	H	H
Sustainability - Potential use of location	H	H	L	L
Sensibility of the public (Acceptance)	H	M	L	L
SCORE	5/3/5 **39**	3/1/9 51	1/4/8 53	1/4/8 **53**
Ranked	**4**	3	**1-2**	**1-2**

9.3.1 Selection of alternative for dumpsite remediation

From the environmental point of view capping and excavation and reuse of material with or without return of remaining waste are possible.

Remediation – re-cultivation technique should be decided by cost efficiency, according win-win approach.

If the price of metals is higher as the recovery costs, no direct remediation but treatment should be undertaken.

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[24] H - HIGH – Always means most unfavourable or worse alternative/solution/costs (scored as 1) ; M – MODERATE – something between H and L (scored as 3); L – LOW - Always means most favourable or best alternative/solution/costs (scored as 5)

9.3.2 Chriteria of slag dumpsite remediation technique

As it was mentioned before, from the environmental view of point different, almost equal options are possible. From sustainable one (possible use of location for other purposes, sensibility of public, technical possibilities of Macedonian economy and practice), the best practice is excavation and final treatment (on or outside the location) or disposal (outside the location).

Before the final decision basic data about the dump site (volume, quantities, shape, monitoring data) shall be carefully recorded. Treatment should be performed based on main project design approved by authorities.

Treatment technology should be practice only with the equipment with all needed environmental protection measures, whereby the emission standards particularly on air must be fulfilled. Before the introduction of any treatment technology, operator must submit relevant evidence about the compliance to the environmental standards. If requested trough the technology, monitoring of emissions should be installed.

Main pollution during any on or outs site treatment process will probably occur during the excavation so that adequate measures need to be implemented as e.g.:

- For the excavation appropriate project must be prepared
- Whole process should recorded
- Open (excavation) dump area should be keep a small as possible
- Intrusion of water should be prohibited and eventually entered one should be treated
- In case of high dust or odor emissions excavation must be done under shelter and in “under pressure atmosphere” with gas cleaning (absorption, burning and washing) or spraying facility
- Chance finds of hazardous waste or other interested materials should be recorded, temporary safe storage and safe dispose
- Adequate monitoring of underground water and soil should be introduce
- The excavation should be executed until the virgin unpolluted soil will be remain
- Final geodetic measurements should be done (as built)

9.4 Selected alternatives for remediation of impacted agriculture areas

9.4.1 Introduction

Some of the agricultural areas around Veles have been heavily polluted by the activities of the smelter MHK Zletovo, which have been ongoing for more than 30 years. The pollution is primarily transported by air to the areas and has resulted in high concentrations of heavy metals and in particular lead, zinc and cadmium.

The owners of the areas have serious problems using the land for commercial agriculture, since the products are considered to be of low quality and unhealthy.

It has therefore been proposed to initiate activities in order to remediate this situation.

The agriculture land had been investigated for heavy metal contamination in the soil by a high amount of soil samples in the area.

In Table below the result of heavy metal samples are shown for lead, zinc and cadmium. Only 9% of the samples for lead fulfilled the Danish legislation for using the area for agriculture practice. 18% of the lead samples are above the cut off criteria for high polluted soil criteria in Denmark (of this 3% of samples are 3 times cut off criteria). 80% of zinc samples fulfilled the high quality criteria and only 5% above the cut off criteria. All samples with cadmium were above the high soil quality criteria and here again 40% were above cut off criteria. Last part of the table show the same data with the Dutch legislation, cut off limits are higher than the limits for Denmark. Using the Dutch limits gives a contaminated area of 10%.

Table 31_Tabel. Percentage distribution of samples in the different Danish and Dutch cut off limits for agriculture soil, between agriculture soil and high contaminated, high contaminated and 3 times the cut off value for high contaminated soil. The last column gives numbers of samples.

	Fulfil **Danish** criteria for agricultural soil	Between high quality cut off and cut off for high polluted soil	Above cut off limit for high contaminated soil	Above 3 times cut off limit	No. Of samples
Pb	9	73	18	3	148
Zn	80	16	5	1	148
Cd	0	60	40	8	111
	Fulfil **Dutch** criteria for agricultural soil	Above cut off limit for Dutch soil	Above cut off limit for high contaminated soil	Above 3 times cut off limit	No. Of samples
Pb	89	11			148
Zn	91	9			148
Cd	92	8			111

The high lead concentration can be a problem for soil quality and agriculture practice. The remediation techniques for lead can be removing the soil, or adding chemicals to the area together will phytoremidiation, which is difficult and hazardous for the surrounding environment to practice. The bioavailability of lead is usually very low in well fertilized areas with high clay content, high cation adsorption capacity and pH above 6.0. This gives that the lead in this area will be adsorbed or bounded hard to the soil minerals.

The zinc concentration is high in the area, but the low toxicity for humans and animals gives high values for soil quality criteria's. The soil chemical responses for zinc are analogues with cadmium, so high focus on cadmium and cadmium remediation will also result in zinc reduction in the soil.

The cadmium concentration in the soil is high and together with very low values for soil quality criteria's, coursed by the high toxicity for humans and animals gives that cadmium is the biggest problem of the area. Further a high focus on cadmium resulting in removing of zinc and plant available lead together with other heavy metals in the soil.

Amongst several technologies available for this purpose it has been concluded that phytoremediation will have the most favourable effect to this particular area.

9.4.2 Phytoremediation

Plants as poplar and willow trees can extract heavy metals from the soil and transport it via the xylem into shoots and leaves where it can accumulate. This is called phytoextraction and has been referred to be when heavy metals are removed from a contaminated site by harvesting and remove the plant biomass. Some plants have demonstrated a remarkable high ability to accumulate several hundred times more metal in shoot tissue than most other plants. There are called hyperaccumulation plants, but those plants have often a slow growth rate, low biomass production and weak in competition with weeds. This gives that hyperaccumulated crops not is attractive in this application. Another term in phtoremediation is phytostabilization, here plants will simply stabilize the heavy metal pollution in the soil by preventing soil water run off, leaching or erosion.

Phytoremediation is an attractive alternative both environmental and economically compare to removing huge amounts of polluted soil. Further the fields can turn to account by selling plant biomass as e.g. wood chips for burning and heating.

Phytoremediation does have some limitations in use. It is a slow process and takes more time than removing the soil. Plants remove only small amounts of contaminants each growing season, so it can take several decades to adequately clean up a site. Additionally, there are limits to plant growth such as temperature, soil type and water availability that may make a site unsuitable for phytoremediation. Lastly, only lightly polluted soils can be phytoremediated because most plants will not grow on heavily-polluted sites.

9.4.2.1 Bioavailability of heavy metals

It is important that the metals are available for the plants. This means for zinc and cadmium that pH not must be below 6. (The optimal range for Cd and plant uptake is 4,5 to 5,5). Along the period of phytoremediation it is important not to add calcium, because this cation reduces cadmium bioavailability by increasing pH and in calcium – cadmium competition during plants uptake. When fertilizers are used it will be preferred to use ammonium fertilizer, because this increase plant availability of cadmium. It is not recommended changing the pH in the soil in one step from e.g. pH 6,5 to 5,5 because this will release a range of the adsorbed metals in one step and result in a toxic level for plants and a risk of high leaching levels to ground water and the surrounding environment.

9.4.2.2 Selection of plants (species and variety)

Salix or Poplar trees is obvious for use to remediate the agriculture area. Species are well known in this purpose and are found to grow in this climate.

A range of species and variants of poplar and willow are shown in the scientific literature as an excellent choice for this purpose. Field studies using trees for phytoremediation show different survival after one year, it is depend on toxic effect of heavy metals, soil and weather condition, competition with weed. The soil texture and the soil fertile condition level in the agriculture area of Vardar near Veles seem to be satisfactorily for poplar and willow, with high clay content. The climate in June to October is warm in combination with low precipitation. Here a problem with dry soil can be a problem especial the first season where rooting depth of the trees will be shallow.

It is recommended to select different variants of willow and poplar and mix when trees are planted, for a higher survival of the trees in the different spots.

Follow species and variants are recommended to use in the area.

- Salix viminalis
- Salix burjatica
- Salix smithiana
- Populus deltoides

- Populus trichocarpa

9.4.2.3 Treatment between project completion and harvesting

In the agricultural area, the weeding procedure is important to ensure the trees optimal conditions for growth. One month after planting it will be recommended to replant where cuttings are dead. This replanting could be replicated in spring the year after planting by making cuttings direct in the field from another tree.

Harvesting

Harvest in winter:

Harvest in winter time when soil are frozen for easier use of machines in wet areas.

1. Method

The trees are cut down 10 cm aboveground. The trunks are stored in stack near a permanent road and dries until summer. When the trunk of the trees is expected dry it will be favourable to make wood chips of the trees for burning as bio energy. It will be important to handle the wood chips with machinery because the trees might be infected by fungus and risk of in jury the lungs.

2. Method

Harvest the trees and make wood chips in the same operations in winter time. This operation is fast, but a special machine is required.

Harvest in summer

Harvest in summer time can be recommended in this application. Here the whole plant included leaves will be removed. The content of cadmium, zinc and other heavy metals are found in the literature to be higher in leaves than the trunk, therefore an effort to remove both. Fresh wood chips had water content about. 50%, therefore a lower effect of burning this right after harvest. Storage in stank will result in biomass loss up to 25% and a risk of fungi contamination. When trees are used for biofuel it is important to handle ash carefully and store this as polluted waste.

Removing of leaves after defoliation in autumn from soil surfaces in years where trees not are cut down will speed further up the effect of the phytoremediation.

9.4.2.4 Expected effects

Heavy metal accumulation in tree tissues is found in the literature to follow the order: leaves > bark > twigs > wood for Zn and Cd, and bark > wood > twigs leaves for Pb. Therefore a harvest of the trees is preferred each tree years for optimal biomass production and ratio between leaves/ bark / twigs and trunk. And further that harvest will do done right before defoliation to utilize the high metal content in leaves.

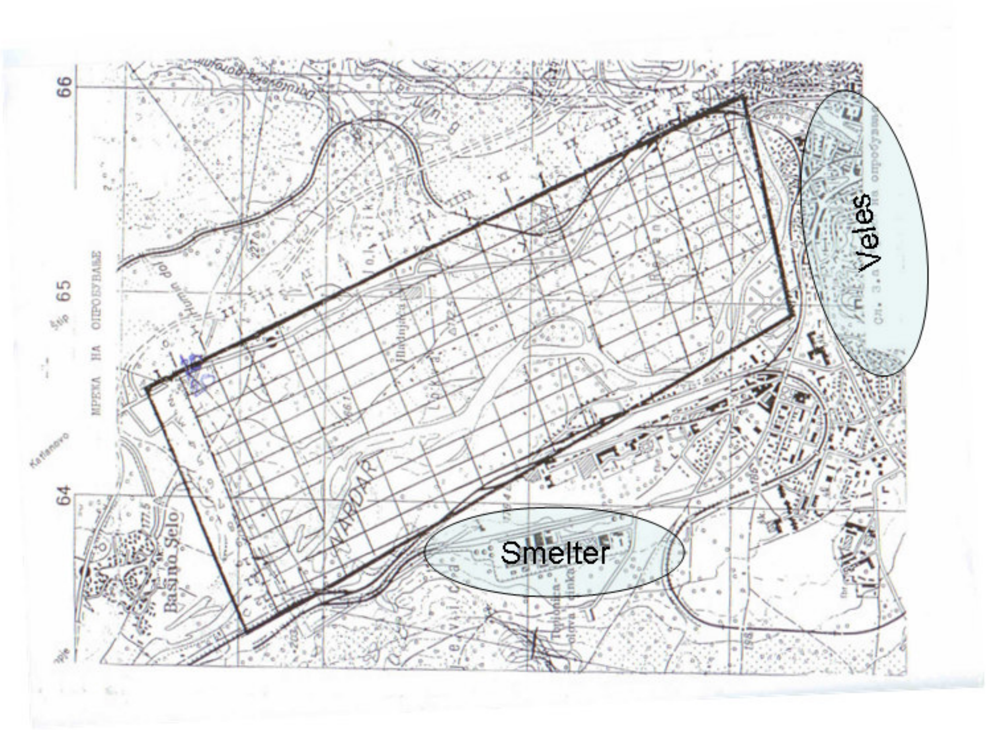
In the literature willow trees are found to remove all from 3 to 26 g cadmium each ha a year depending on crop species, soil conditions, growing season and harvest with or without leaves.

A way to utilize willows ability to remove cadmium from the soil and other unwanted heavy metals is to remove the leaves after defoliation from the area. Because leaves will decompose fast and bring back the metals to the soil surface.

9.4.3 Contamination of the agriculture area of Veles

This is a summary of the result of the soil samples from the agricultural area affected of the Veles smelter plant. Soil samples had been taken in the area from the river Vadar near the smelter plant and in the agriculture land between Basino Selo, Veles and where the area of agriculture use stops. A map with overview of the area and grids for soil sampling is shown in Figure below.

Figure 28_Overview for soil samples in the agricultural area. Smelter is placed in the bottom of the map.



In the grids soil samples had been taken and analyse of a range of metals had been done. In this document there will be a focus on Lead (Pb), zinc (Zn) and cadmium (Cd). The contamination concentration of the heavy metals will be compared with Danish legislation for soil quality. In Table below the criteria for Danish soil quality are shown.

Table 32_Cut off values for Danish and Dutch soils. Concentrations limits of heavy metals for agriculture soil and for high contaminated soil.

	Criteria for agricultural use in Denmark (mg/kg)	Criteria for high contaminated soil in Denmark (mg/kg)	Criteria for agricultural use in The Nederland (mg/kg)
Pb	40	400	530
Cd	0,5	5	12
Zn	100	1500	720

The heavy metals in presented by concentration in the grids and by symbols to have a better overview for special hotspots in the area. Table below shows the symbols used in the following tables. The following tables are spilt in three sections, one for each metal. First the absolute value in ppm in the soil samples, next part of the table is use of symbols for a faster overview of results. First the Danish criteria for cut off values and then the Dutch criteria for cut off values. Tables will fit the grids in the map from the overview figure above.

Table 33_Symbols used in the following tables for heavy metals

Using Danish criteria

C: Danish criteria for agricultural use is fulfil

X: Between criteria for agricultural use and cut off value for special contaninated soil

XX: Above Danish cut off values

XXX: Remarkable high value (3 times cut off value)

Pb: C: < 40 ppm.	X: < 400 ppm	XX: > 400 ppm	XXX: > 1200 ppm
Zn: C: < 500 ppm	X: < 1000 ppm	XX: > 1000 ppm	XXX: > 3000 ppm
Cd: C: < 0,5 ppm	X: < 5 ppm	XX: > 5 ppm	XXX: > 15 ppm

Using Dutch criteria

C: Dutch criteria for agricultural use is fulfil

X: Above Dutch cut off values

Pb: C: < 530 ppm	X: > 530 ppm
Zn: C: < 720 ppm	X: > 720 ppm
Cd: C: < 12 ppm	X: > 12 ppm

nn: Not measured in this grid

Table 34_Lead concentration (ppm) in grids

		0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
1	**Pb**	700	100	30	30	200	1500	200	300	500	5000	50	2000	50	20	30	n
2	**Pb**	1000	200	50	50	300	70	30	300	100	300	200	300	200	20	300	n
3	**Pb**	20	30	100	1000	200	70	50	300	200	200	100	100	200	100	300	70
4	**Pb**	50	50	200	500	100	70	50	500	300	1000	500	70	100	100	500	150
5	**Pb**	70	70	100	150	300	50	100	700	2000	500	1500	200	100	200	70	100
6	**Pb**	70	70	50	150	200	50	300	500	30	700	1000	100	200	100	200	50
7	**Pb**	70	70	70	100	200	50	200	300	200	300	n	50	300	150	200	70
8	**Pb**	100	50	200	150	200	300	200	200	400	200	n	300	200	70	n	n
9	**Pb**	100	50	150	200	200	500	1000	300	300	3000	n	n	n	n	n	n
10	**Pb**	200	30	50	150	300	70	700	1000	300	n	n	n	n	n	n	n
11	**Pb**	n[25]	30	30	500	300	n	n	n	n	n	n	n	n	n	n	n
12	**Pb**	n	30	20	n	500	n	n	n	n	n	n	n	n	n	n	n

Table 35_ Lead contamination in soil after Danish cut off limits

		0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
1	**Pb**	XX	X	C	C	X	XX	X	X	XX	XXX	X	XXX	X	C	C	nn
2	**Pb**	XX	X	X	X	X	X	C	X	X	X	X	X	X	C	X	nn
3	**Pb**	C	C	X	XX	X	X	X	X	X	X	X	X	X	X	X	X
4	**Pb**	X	X	X	XX	X	X	X	XX	X	XX	XX	X	X	X	XX	X
5	**Pb**	X	X	X	X	X	X	X	XX	XXX	XX	XX	X	X	X	X	X
6	**Pb**	X	X	X	X	X	X	X	XX	C	XX	XX	X	X	X	X	X
7	**Pb**	X	X	X	X	X	X	X	X	X	X	nn	X	X	X	X	X
8	**Pb**	X	X	X	X	X	X	X	X	X	X	nn	X	X	X	nn	nn
9	**Pb**	X	X	X	X	X	XX	XX	X	X	XXX	nn	nn	nn	nn	nn	nn
10	**Pb**	X	C	X	X	X	X	XX	XX	X	nn	nn	nn	nn	nn	nn	nn
11	**Pb**	nn	C	C	XX	X	nn	nn	nn	nn	nn	nn	nn	nn	nn	nn	nn
12	**Pb**	nn	C	C	nn	XX	nn	nn	nn	nn	nn	nn	nn	nn	nn	nn	nn

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[25] n = no measurement

Table 36_ Lead contamination in soil after Dutch cut off limits

		0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
1	**Pb**	X	C	C	C	C	X	C	C	C	X	C	X	C	C	C	nn
2	**Pb**	X	C	C	C	C	C	C	C	C	C	C	C	C	C	C	nn
3	**Pb**	C	C	C	X	C	C	C	C	C	C	C	C	C	C	C	C
4	**Pb**	C	C	C	C	C	C	C	C	C	X	C	C	C	C	C	C
5	**Pb**	C	C	C	C	C	C	C	X	X	C	X	C	C	C	C	C
6	**Pb**	C	C	C	C	C	C	C	C	C	X	X	C	C	C	C	C
7	**Pb**	C	C	C	C	C	C	C	C	C	C	nn	C	C	C	C	C
8	**Pb**	C	C	C	C	C	C	C	C	C	C	nn	C	C	C	nn	nn
9	**Pb**	C	C	C	C	C	C	X	C	C	X	nn	nn	nn	nn	nn	nn
10	**Pb**	C	C	C	C	C	C	X	X	C	nn	nn	nn	nn	nn	nn	nn
11	**Pb**	nn	C	C	C	C	nn	nn	nn	nn	nn	nn	nn	nn	nn	nn	nn
12	**Pb**	nn	C	C	nn	C	nn	nn	nn	nn	nn	nn	nn	nn	nn	nn	nn

Table 37_Zinc concentration (ppm) in grids

		0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
1	**Zn**	500	100	200	70	200	1500	300	300	700	1500	70	1500	200	50	50	n
2	**Zn**	2000	300	150	100	1000	200	100	300	200	200	300	300	200	50	200	n
3	**Zn**	70	100	200	1000	300	200	200	300	200	200	100	100	200	200	300	100
4	**Zn**	70	150	300	500	200	300	300	300	700	100	50	100	200	200	500	300
5	**Zn**	70	100	200	200	300	100	300	700	1000	300	1500	300	200	300	70	200
6	**Zn**	100	100	150	300	200	100	500	300	100	300	1000	150	200	200	200	70
7	**Zn**	150	70	200	200	200	100	300	500	150	300	n	150	500	200	70	200
8	**Zn**	100	70	200	200	300	300	300	3000	600	200	n	500	500	150	n	n
9	**Zn**	300	70	100	400	300	500	1000	300	300	2000	n	n	n	n	n	n
10	**Zn**	1000	50	100	200	300	200	700	700	200	n	n	n	n	n	n	n
11	**Zn**	n	70	100	500	300	n	n	n	n	n	n	n	n	n	n	n
12	**Zn**	n	100	100	n	500	n	n	n	n	n	n	n	n	n	n	n

Table 38_ Zinc contamination in soil after Danish cut off limits

		0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
1	**Zn**	X	C	C	C	C	XX	C	C	X	XX	C	XX	C	C	C	nn
2	**Zn**	XX	C	C	C	X	C	C	C	C	C	C	C	C	C	C	nn
3	**Zn**	C	C	C	X	C	C	C	C	C	C	C	C	C	C	C	C
4	**Zn**	C	C	C	X	C	C	C	C	X	C	C	C	C	C	X	C

5	**Zn**	C	C	C	C	C	C	C	X	X	C	XX	C	C	C	C	C
6	**Zn**	C	C	C	C	C	C	X	C	C	C	X	C	C	C	C	C
7	**Zn**	C	C	C	C	C	C	C	X	C	C	nn	C	X	C	C	C
8	**Zn**	C	C	C	C	C	C	C	XXX	X	C	nn	X	X	C	nn	nn
9	**Zn**	C	C	C	C	C	X	X	C	C	XX	nn	nn	nn	nn	nn	nn
10	**Zn**	X	C	C	C	C	C	X	X	C	nn	nn	nn	nn	nn	nn	nn
11	**Zn**	nn	C	C	X	C	nn	nn	nn	nn	nn	nn	nn	nn	nn	nn	nn
12	**Zn**	nn	C	C	nn	X	nn	nn	nn	nn	nn	nn	nn	nn	nn	nn	nn

Table 39_ Zinc contamination in soil after Dutch cut off limits

		0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
1	**Zn**	C	C	C	C	C	X	C	C	C	X	C	X	C	C	C	nn
2	**Zn**	X	C	C	C	X	C	C	C	C	C	C	C	C	C	C	nn
3	**Zn**	C	C	C	X	C	C	C	C	C	C	C	C	C	C	C	C
4	**Zn**	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C
5	**Zn**	C	C	C	C	C	C	C	C	X	C	X	C	C	C	C	C
6	**Zn**	C	C	C	C	C	C	C	C	C	C	X	C	C	C	C	C
7	**Zn**	C	C	C	C	C	C	C	C	C	C	nn	C	C	C	C	C
8	**Zn**	C	C	C	C	C	C	C	X	C	C	nn	C	C	C	nn	nn
9	**Zn**	C	C	C	C	C	C	X	C	C	X	nn	nn	nn	nn	nn	nn
10	**Zn**	X	C	C	C	C	C	C	C	C	nn	nn	nn	nn	nn	nn	nn
11	**Zn**	nn	C	C	C	C	nn	nn	nn	nn	nn	nn	nn	nn	nn	nn	nn
12	**Zn**	nn	C	C	nn	C	nn	nn	nn	nn	nn	nn	nn	nn	nn	nn	nn

Table 40_Cadmium concentration (ppm) in grids

		0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
1	**Cd**	10	5	7	n	7	10	n	n	5	10	n	10	n	n	n	n
2	**Cd**	20	5	5	5	10	3	n	3	5	3	10	n	n	n	5	n
3	**Cd**	3	5	5	15	10	5	n	3	5	3	5	n	n	3	5	n
4	**Cd**	3	5	5	10	5	5	n	3	3	5	n	n	5	3	7	5
5	**Cd**	3	3	5	7	7	n	10	7	7	5	30	7	n	3	n	5
6	**Cd**	5	n	n	n	n	n	10	7	3	5	20	5	5	5	5	n
7	**Cd**	7	n	5	n	3	10	7	7	5	5	n	n	5	3	3	5
8	**Cd**	n	n	5	5	5	10	7	10	20	5	n	5	5	3	n	n
9	**Cd**	7	n	5	10	3	n	20	7	7	70	n	n	n	n	n	n
10	**Cd**	7	n	5	5	5	n	15	15	7	n	n	n	n	n	n	n
11	**Cd**	n	n	5	10	7	n	n	n	n	n	n	n	n	n	n	n
12	**Cd**	n	7	5	n	5	n	n	n	n	n	n	n	n	n	n	n

Table 41_ Cadmium contamination in soil after Danish cut off limits

		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	**Cd**	XX	X	XX	nn	XX	XX	nn	nn	X	XX	nn	XX	nn	nn	nn	nn
2	**Cd**	XXX	X	X	X	XX	X	nn	X	X	X	XX	nn	nn	nn	X	nn
3	**Cd**	X	X	X	XXX	XX	X	nn	X	X	X	X	nn	nn	X	X	nn
4	**Cd**	X	X	X	XX	X	X	nn	X	X	X	nn	nn	X	X	XX	X
5	**Cd**	X	X	X	XX	XX	nn	XX	XX	XX	X	XXX	XX	nn	X	nn	X
6	**Cd**	X	nn	nn	nn	nn	nn	XX	XX	X	X	XXX	X	X	X	X	nn
7	**Cd**	XX	nn	X	nn	X	XX	XX	XX	X	X	nn	nn	X	X	X	X
8	**Cd**	nn	nn	X	X	X	XX	XX	XX	XXX	X	nn	X	X	X	nn	nn
9	**Cd**	XX	nn	X	XX	X	nn	XXX	XX	XX	XXX	nn	nn	nn	nn	nn	nn
10	**Cd**	XX	nn	X	X	X	nn	XXX	XXX	XX	nn	nn	nn	nn	nn	nn	nn
11	**Cd**	nn	nn	X	XX	XX	nn	nn	nn	nn	nn	nn	nn	nn	nn	nn	nn
12	**Cd**	nn	XX	X	nn	X	nn	nn	nn	nn	nn	nn	nn	nn	nn	nn	nn

Table 42_Cadmium contamination in soil after Dutch cut off limits

		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	**Cd**	C	C	C	nn	C	C	nn	nn	C	C	nn	C	nn	nn	nn	nn
2	**Cd**	X	C	C	C	C	C	nn	C	C	C	C	nn	nn	nn	C	nn
3	**Cd**	C	C	C	X	C	C	nn	C	C	C	C	nn	nn	C	C	nn
4	**Cd**	C	C	C	C	C	C	nn	C	C	C	nn	nn	C	C	C	C
5	**Cd**	C	C	C	C	C	nn	C	C	C	C	X	C	nn	C	nn	C
6	**Cd**	C	nn	nn	nn	nn	nn	C	C	C	C	X	C	C	C	C	nn
7	**Cd**	C	nn	C	nn	C	C	C	C	C	C	nn	nn	C	C	C	C
8	**Cd**	nn	nn	C	C	C	C	C	C	X	C	nn	C	C	C	nn	nn
9	**Cd**	C	nn	C	C	C	nn	X	C	C	X	nn	nn	nn	nn	nn	nn
10	**Cd**	C	nn	C	C	C	nn	X	X	C	nn	nn	nn	nn	nn	nn	nn
11	**Cd**	nn	nn	C	C	C	nn	nn	nn	nn	nn	nn	nn	nn	nn	nn	nn
12	**Cd**	nn	C	C	nn	C	nn	nn	nn	nn	nn	nn	nn	nn	nn	nn	nn

Table 43_Percentage distribution of samples in the different Danish and Dutch cut off limits for agriculture soil, between agriculture soil and high contaminated, high contaminated and 3 times the cut off value for high contaminated soil. The last column gives numbers of samples.

	Fulfil **Danish** criteria for agricultural soil	Between high quality cut off and cut off for high polluted soil	Above cut off limit for high contaminated soil	*Above 3 times cut off limit*	No. Of samples
Pb	9	73	18	*3*	148
Zn	80	16	5	*1*	148
Cd	0	60	40	*8*	111
	Fulfil **Dutch** criteria for agricultural soil	Above cut off limit for Dutch soil	Above cut off limit for high contaminated soil	*Above 3 times cut off limit*	No. Of samples
Pb	89	11			148
Zn	91	9			148
Cd	92	8			111

The Danish cut off limits of Pb, Zn and Cd for agriculture soil is very high compare with the Dutch ones. Especially, for Cd. here the Danish value is 0,5 ppm and The Dutch is 12 ppm but also for Pb where Danish is 40ppm and Dutch 530ppm. This result in two different conclusions for the area as shown in the table above. Here no soil samples fulfil the Danish limits for Cd, and only 9% for Pb, this is 92 and 89% by using the Dutch criteria.

Below two tables are shown, one where samples are coloured after Danish cut off criteria for polluted soil and below this cut off criteria for soil use as agriculture land in The Nederlands. Those two tables show the agriculture area with the highest degree of contamination of Pb, Zn and Cd, and where remediation is needed to reduce this.

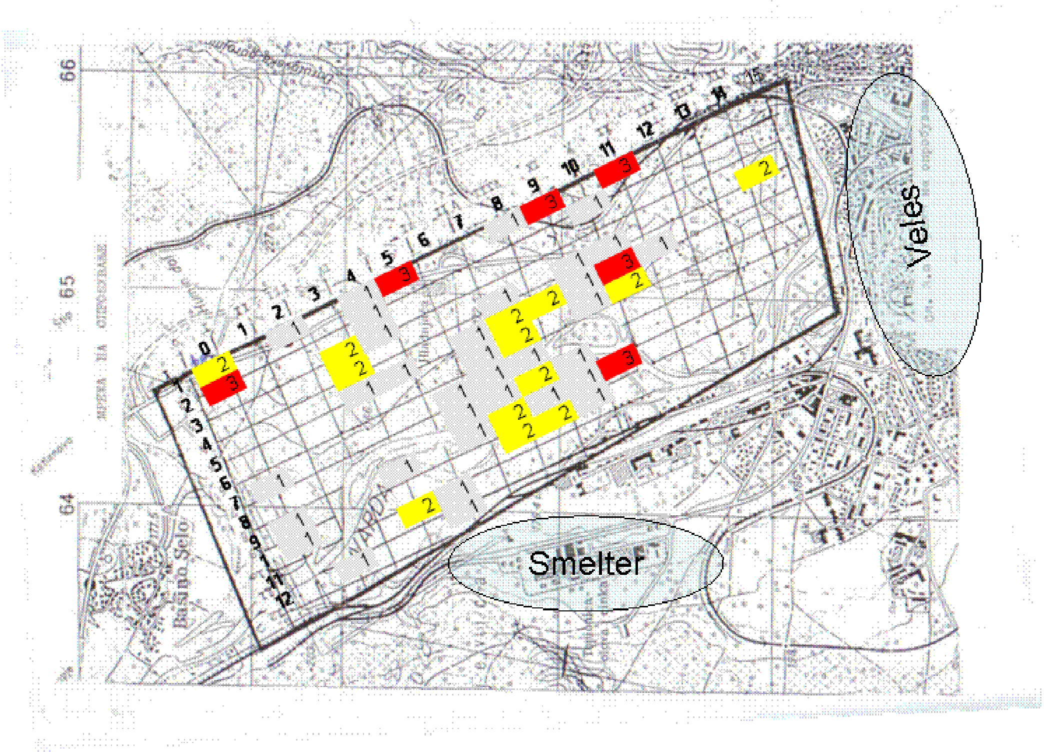
Table 44_Grids where concentration in soil samples is above the Danish cut off limit for polluted soil marked with XX and XXX in tables. All three metals are colour with red, two metals with yellow and one metal with gray.

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	2		1		1	3			1	3		3				
2	3				1						1					
3				2	1											
4				2				1		1	1				2	
5				1	1		1	2	2	1	3	1				
6							1	2		1	2					
7	1					1	1	1								
8						1	1	2	1							
9	1			1		1	2	1	1	3						
1	1						2	2	1							
11				2	1											
12		1			1											

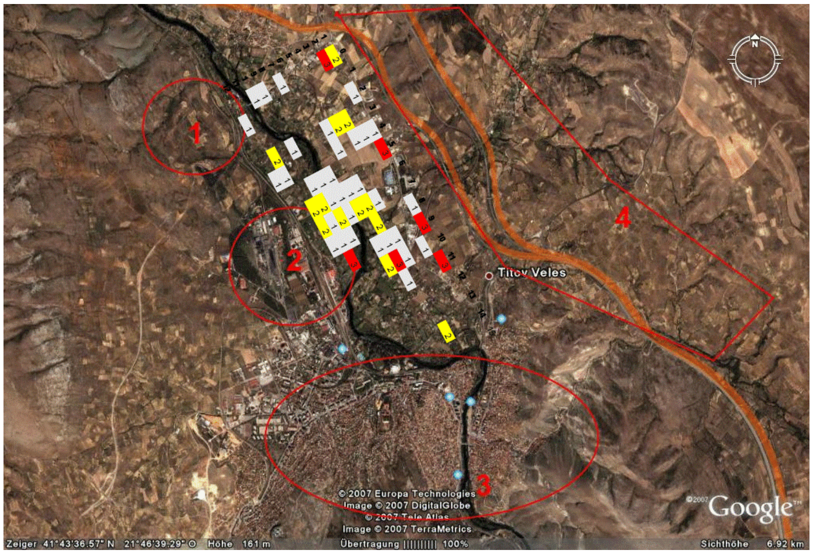
Table 45_Grids where concentration in soil samples is above the Dutch cut off limit for agricultural use, marked with X in tables. All three metals are colour with red, two metals with yellow and one metal with gray.

		1	2	3	4	5	6	7	8	9	1	11	12	13	14	15
1	1					2				2		2				
2	3				1											
3				3												
4										1						
5								1	2		3					
6										1	3					
7																
8								1	1							
9							3			3						
1	1						2	2								
11																
12																

Figure 29_Denish Limits

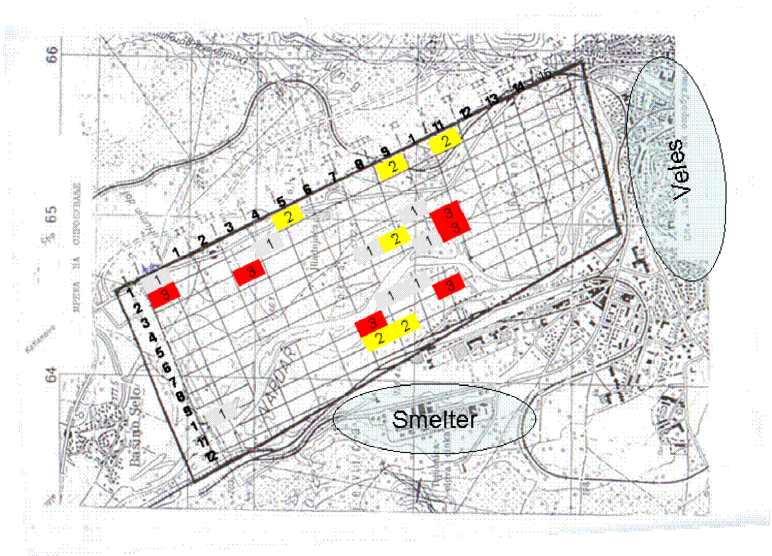


Map where concentration in soil samples is above the Danish cut off limit for polluted soil marked with XX and XXX in tables. All three metals are colour with red, two metals with yellow and one metal with gray.

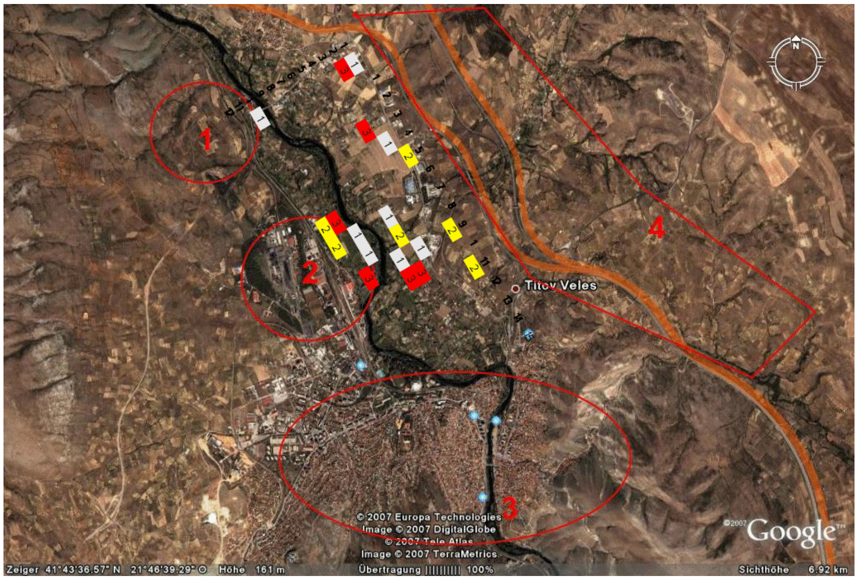


Map where concentration in soil samples is above the Danish cut off limit for polluted soil marked with XX and XXX in tables. All three metals are colour with red, two metals with yellow and one metal with gray.

Figure 30_Dutch Limits



Map where concentration in soil samples is above the Dutch cut off limit for agricultural use, marked with X in tables. All three metals are colour with red, two metals with yellow and one metal with gray.



Map where concentration in soil samples is above the Dutch cut off limit for agricultural use, marked with X in tables. All three metals are colour with red, two metals with yellow and one metal with gray.

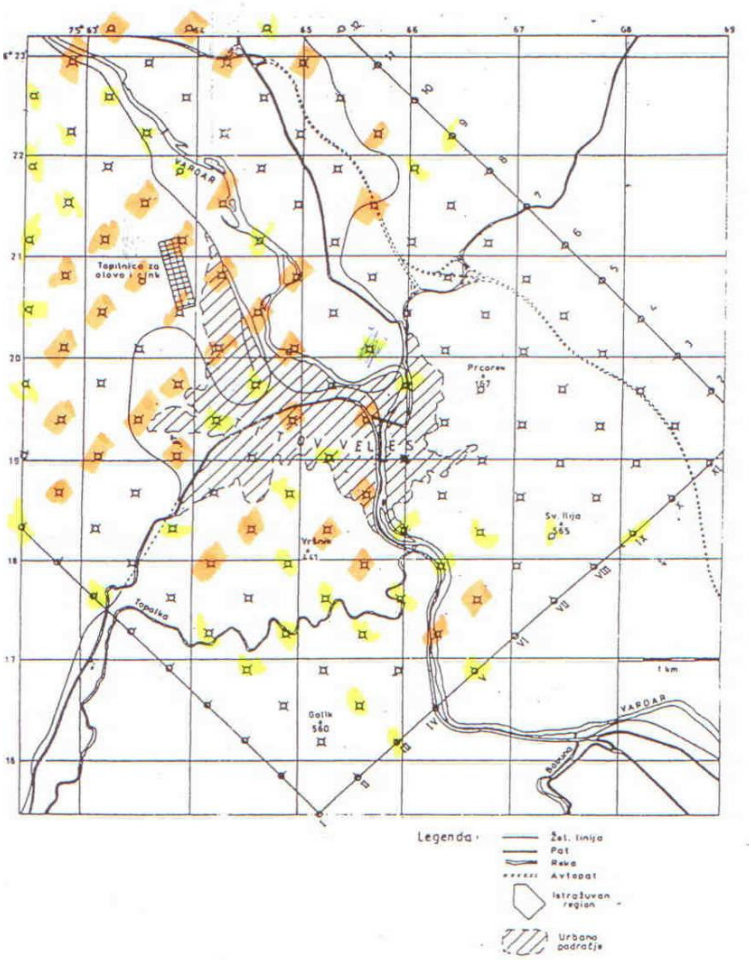
9.5 Selected alternatives for remediation of impacted public green areas

9.5.1 Introduction

9.6 Intro

The work includes the removal of polluted soil and replacement with clean soil from the public areas within the city of Veles. The soil pollution situation has been investigated several times.

Figure 31_ Results of semiqantitative analysis 2004.



Orange marking: Pb > 400 ppm or Cd > 5 ppm

Yellow marking: Pb > 40 ppm and Cd < 5 ppm

No marking: Pb < 40 ppm and Cd < 5 ppm

Table 46_ Data from sampling in 2004 using Danish classification system

Classification (DK)[26]	Cd ppm	Pb ppm
Clean soil	< 0.5	< 40
Slightly polluted soil	< 5	< 400
Remediation criteria	> 5	> 400

Remediation criteria: In the Danish classification system the remediation criteria is the pollution level above which contact with the soil should be prevented.

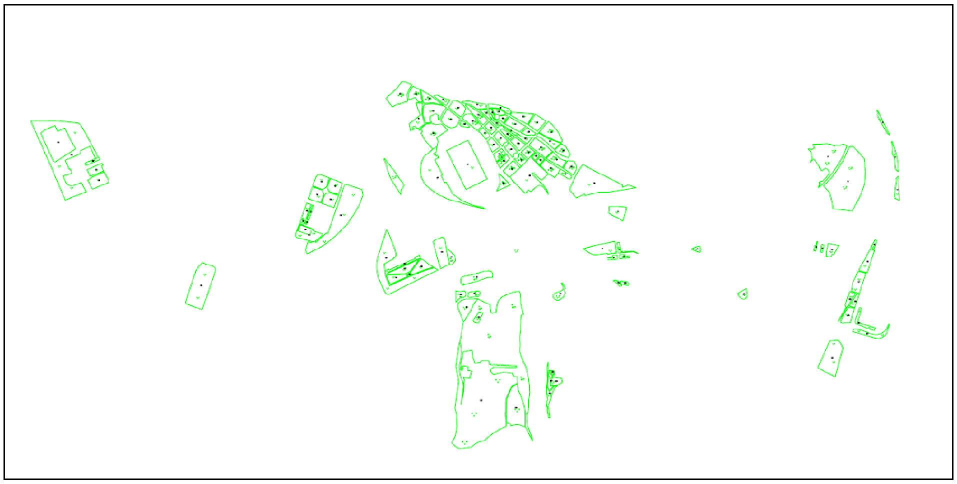
Slightly polluted soil: The slightly polluted soil can only be used for most sensitive use (kindergardens, public playgrounds, housing, etc.) when used according to instructions from the public).

In the figure the orange soil sampling points are above the reme-diation criteria, the yellow marked points are slightly polluted and the unmarked points are clean or slightly polluted (uncertain because the chemical analysis methods detection limit for these data are about 3 ppm and thus much higher than the criteria for clean soil, 0,5 ppm Cd). For the city of Veles most data show heavy or slight pollution. In summary, within the Veles city perimeter nearly all area can be assumed to be polluted. Cd is the most critical parameter making most soil sampling sites heavily polluted

9.6.1 Location

The location of the works is the green public areas within the city of Veles, Macedonia. The areas to be remediated will be provided in Autocad format. The figure below gives an overview. The figure does not include kindergardens and some public schools that are also part of the areas to be remediated.

Figure 32_Map of impacted public areas[27]



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[26] Criteria based on analysis using standard DS259 for sample preparation (partial dissolution of soil sample using HNO3). Analysis using AAS-flame/ICP for Pb and AAS-graphitefurnace/ICP for Cd

[27] Layer 19 on the AutoCad Drawing

9.6.2 Areas and depths

9.6.2.1 Areas

The figure above includes a total of 44 areas divided into 114 plots that are included in the Veles city cadastre. The table below includes the areas of these 114 plots, in total 22.8 ha.

9.6.2.2 Depths

The excavation depths shall be decided for each sub-area according to:

- Depth down to the level where the soil is only slightly polluted, Pb < 400 ppm and Cd < 5 ppm (mg/kg Dry Solids (DS))
- minimum depth shall be 0.20 meter if any samples in the plot have shown heavily polluted soil (Pb > 400 ppm and Cd > 5 ppm (mg/kg Dry Solids (DS))
- maximum depth shall be 0.70 cm below existing surface level
- near existing structures (buildings, pavements, etc) and bigger trees the maximum depth shall be less than 0,70 meters and regulated according to geotechnical practice. Slope less that 1:3 (33%) (rise to run). This could e.g. be 20 cm depth near the structure and 53 cm depth 1 meter from the structure.

Depths will be decided by the Supervisor based mainly on the chemical analysis of soil samples.

9.6.2.3 Volumes

Preliminarily the estimated total volume (soil in place) is 22,8 ha at 50 cm depths totaling 228.000 x 0,5= 114000 m3. Assuming in-situ density of 1,8 Mg/m3 this amounts to 114.000 x 1,8 = **205.200 Mg**.

9.6.3 Management plan for selected alternative

Mitigation Activities - include it in decision-making process on construction or reconstruction, and during Conceptual Design Draft

Table 47_Mitigation and Environmental Management Plan

Phase	**Issues – Activities**	**Mitigation measure and possible impact**	**Responsibility**	**Costs**	**Comment**
Preliminary estimation of the site	Monitoring data Geodetic data Others	NON	Operator	Cover by operator	Data should be recorded present situation
	Project design		Checking of proposed measures by Authority		
Excavation		Small open spaces Sheltered excavation and spraying facility Control of water intrusion	Operator		
	Chance finds of hazardous waste	Temporary storage and safe disposal	Operator and Authority		
Transport (if any)	Loading and transporting	Closed lories or big bag	Operator		
Treatment (if any)	According the selected treatment technique				
Final re-cultivation activities	Monitoring of soil Geodetic data		Authority		Recording of final stage of the activities
Excavation and soil exchange		Small open spaces	Operator		Site safety
Transport (if any)	Loading and transporting	Closed lories or big bag	Operator		
Disposal	Monitoring of amunt and tipping	Stepwise covering of the disposed soil	Operator	Covered within the bid	
Phyto-remediation	Monitoring of plant species, amount and area	Control that no food producing activities are taking place	Authority		
Harvesting and disposal	Monitoring of amunt and tipping	Stepwise covering of the disposed soil	Operator	Covered within the bid	

9.6.4 Monitoring

Monitoring schemes according selected remediation activity and relevant existing legislation Development of a monitoring plan (Monitoring Activities- during construction and use**)** including cost structure (monitoring action plan)

Table 48_Monitoring Plan for the remediation of the slag dumpsite

Phase	**What** **- parameter is to be monitored?**	**Where** ***is the parameter to be monitored?***	**How** ***is the parameter to be monitored/ type of monitoring equipment?***	**When** ***is the parameter to be monitored- frequency of measurement or continuous?***	**Who** **Responsibility and Reporting**	**How much** **Costs** **Investment /** **Operational**
Preliminary estimation of the site	Metals	Soil and underground water pollution	Taking the samples and out site analysis	Before the work will start	Operator to Authority	NO/According the market price
Excavation	Metals	Soil and underground water pollution	Taking the samples and out site analysis	During the excavation on regular basis	Operator	
Transport (if any)	Quantity - monitoring needs	Close to site	Notification if abroad In any case amount measures	During excavation and transport	Operator	
Treatment (if any)	According the selected treatment technique					
Final re-cultivation activities	Metals	State of the virgin soil pollution	Taking the samples and out site analysis		Authority	

Table 49_Monitoring Plan for the remediation of the public [green] areas

Phase	**What** **- parameter is to be monitored?**	**Where** ***is the parameter to be monitored?***	**How** ***is the parameter to be monitored/ type of monitoring equipment?***	**When** ***is the parameter to be monitored- frequency of measurement or continuous?***	**Who** **Responsibility and Reporting**	**How much** **Costs** **Investment /** **Operational**
Preliminary estimation of the site	Metals	Soil and underground water pollution	Taking the samples and out site analysis	Before the work will start	Operator to Authority	NO/According the market price
Excavation	Metals	Soil and underground	Taking the samples and off site analysis	During the excavation on regular basis	Operator	
Transport (if any)	Quantity - monitoring needs	Close to site	Notification if abroad In any case amount measures	During excavation and transport	Operator	
Final soil exchange	Metals and soil texture	Off site	Taking the samples and off site analysis	All 1000 m³	Authority	According administrative fee

Disposal	According disposal standards	Lojane or equal	Amount	During disposal	Autority	During whole time period

Table 50_Monitoring Plan for the phytoremediation of the agriculture areas

Phase	**What** **- parameter is to be monitored?**	**Where** ***is the parameter to be monitored?***	**How** ***is the parameter to be monitored/ type of monitoring equipment?***	**When** ***is the parameter to be monitored- frequency of measurement or continuous?***	**Who** **Responsibility and Reporting**	**How much** **Costs** **Investment** / **Operational**
Preliminary estimation of the site	Metals	Soil and underground water pollution	Taking the samples and out site analysis	Before the work will start	Operator to Authority	NO/According the market price
Planting	Amount and distance of plant	On site	Planting pan	Amount and sqm covered	Operator	
Remediation period	Metals and underground characteristics	Heavy metal content in soil, groundwater and plants	Sampling and off site analyses	Every half year	Authority	According administrative fee
Plant harvesting and disposal	According disposal standards	Lojane or equal	Amount	During disposal	Autority	During whole time period

9.7 Conclusion

For the remediation of the slag dumpsite (heavy metal contaminated site) have following options been ranked from the environmental assessment as most appropriate for further financial and economical evaluation:

Excavation and off site treatment and residues treatment	**– 1**
Excavation and off site treatment and back disposal	**– 2**
On site mitigation measures – Capping	**– 3**
No activites	**[– 4]**

For the remediation of public area (green areas) have following options been ranked from the environmental assessment as most appropriate for further financial and economical evaluation:

Phytoremediation with non-food production plants	**– 1**
Excavation, off site disposal and soil exchange	**– 1**
No activities	**[– 2]**

For the remediation of the agriculture areas have following options been ranked from the environmental assessment as most appropriate for further financial and economical evaluation:

Phytoremediation with non-food production plants	**– 1**
Excavation, off site disposal and soil exchange	**– 1**
No activities	**[– 2]**

All measures have to be implemented in parallel steps – a single stated activity will not lead to the required and objected results.

10 Economical - Financial Evaluation on Veles site

10.1 Site specific Economical Evaluation

10.2 Objective

>>Designing an ecological end-use as an integral component of the remediation system will realize more pronounced benefits from the remediation process, and in no way is intended to jeopardizeor compromise the selected remediation goals and objectives. Incorporation of ecological enhancements can benefit multiple stakeholders, such as regulatory agencies, the regulated community (industry), local communities, and the general public[28]*<<*

10.3 Possible solutions

There a lot of possible possible impacts due to remediation. The difficulty might occure to the fact, that all proposed activities have to be implemented at the same time in order to achieve the required results and most economical benefit.

The economical effects are based on the commissioning of the slag, the increase quality of agriculture products and the increased life standard due to the minimization of impacting pollutants (slag, contaminated soi, dust). The added values are benchmarkable, while the socio economic effect is hardly to define in montetary figures.

10.3.1 No activites [Option 0]

One option is taking no activites into consideration. There are no positive effects from this option.

10.3.2 Disposal facility for reused slag [Option 1]

In the case that the fuming process takes place within the area of Veles municipality, the current location offers a possibility for redisposal of inert, non-hazard waste. The potential much more due to the fuming processing, the direct and indirect revenues will have a bigger positive impact than the loose of added values such as land price decrease.

10.3.3 Agriculture used area [Option 2]

The restablishing of agriculture used land might be due to reafforstation measures, which would have a carbon neutral effect, would increase the slope stabilisation and reduce erosion due to wind braking effects. The added value would be in the increase of the value of the land from current 2-4 Euro up to 10-12 Euro per sqm. In addition has to be taken into consideration the income from fire wood, the reduced Co2 emission and indirect revenues due to labour force, and productivity. That canonly be taken into consideration by moving the residues to other potential locations or reuse facilities.

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[28] Source: "Planning and Promoting of Ecological Re Use of Remediated Sites " prepared by Interstate Technology and Regulatory Council ITRC#

10.4 Evaluation of Options

All of these five former mentioned options are valued according to the certain indicators which are presented in the table number 1, presented bellow.

In this table with the sign minus "-" is marked if the presented option does not have any positive effect on the presented indicator and with plus "+" if there are influence of the option to the certain indicator.

Table 51_Ranking different opportunities (+ and -)

Indicator	**Option 0** **No Activities**	**Option 1** **Disposal facility for residues slag**	**Option 1** **Agriculture used land**
Development of the region	-	+	+
Wider development impact	-	-	+
Direct Revenue Generator	-	+	+
Low start up-costs	-	-	+
Return of Investment	-	+	+
Social impact	-	-	+
Technological impact	-	+	-
Competitive advantage	-	-	+
Capacity to organize	-	+	+
Sustainability	-	+/-	+
TOTAL	**-**	**5,5**	**9**
Ranking	**[3]**	**2**	**1**

Influence of the different options to the indicators is presented through numbers from 0 which mean without any influence to 5 which means high influence.

Table 52_Ranking different opportunities (from 0 to 5)

Indicator	**Option 0** **No Activities**	**Option 1** **Disposal facility for residues slag**	**Option 1** **Agriculture used land**
Development of the region	0	3	5
Wider development impact	0	0	3
Direct Revenue Generator	0	2	4
Low start up-costs	0	4	4
Return of Investment	0	2	5
Social impact	0	0	5
Technological impact	0	3	0
Competitive advantage	0	0	4
Capacity to organize	0	5	5
Sustainability	0	3	5
TOTAL	**0**	**22**	**40**
Ranking	**3**	**2**	**1**

10.4.1 Conclusion of previous ranking:

The most economic feasible option according to positive influence to different indicators is to force the removal of the slag and to reuse it for Lead and Zinc production without redisposal of the inter material, but to reuse it in street construction, cement factories, as infill material for municipal dumpsites or as cover material for the existing gypsum dumpsite.

The reactivation of agriculture used land will generate income, on the one hand due to CO2 neutral activites, reafforstation including soil and slope stabilisation and selling of agriculture products and fire wood.

With the income generating activites due to commissioning of land will lead to the following positive impacts:

- Farmers will have benefit
- personnel tax – as a income for the municipal budget
- payment for health insurance (income for the health fund – Ministry of Health)
- payment for the retirement and social insurance – income for the Social and Pension Fund
- payment for the unemployment fund – Social Fund

All these positive effects cannot be seen immediately but their effects and the benefits from this are on a long term run.

10.5 Agricultue and CDM approaching activities

10.5.1 Description and evaluation

In the table bellow are all positive and negative aspects are mentinoned using remediate land as an agricultural one. This opportunity, as all others have its positive and negative sides. The most important for the government is to be aware of all of them in order to make a good decision and try to manage all not so positive aspects of choosing certain opportunity. Another important question is whether the selected opportunity is leading to achieving long term national goals.

Table 53_SWOT of reactivation to agricultural land

Strengths +	Weaknesses -
✓ Low start up costs ✓ To offer only land ✓ Incentive for new activites ✓ Increased added value (land value) ✓ Close to the main road ✓ Close to rail way connection ✓ Close to the international airport ✓ Close to the administrative center ✓ Landuse question and property issue solved	❖ Limited area ❖ Missuse of low income situation and gaps in working safety ❖ Technological development ❖ Close to industrial area (public sensitivity)
Opportunities +	Threats -

10.6 Financial Evaluation of remaiming remediation alternatives

Those treatment methods, which have been evaluated as environmental accepted and ranked from 1 till 3 have been taken further into consideration for the financial evaluation. An amount of **1.800.000 Mg** is base for calculation for removal and reusal of slag material. An amount of **1.648.000 Mg** of residues inert material after fuming has to be either redisposed or reused in the cement factory or for construction purposes.

The public area has been identified with **228.237 sqm** and soil investigation and focused soil exchange activities have to be taken into consideration. For a a standardized calculation was suggested to remove a grass root depth of 50 cm and to refill it with topsoil.

The surface of potential impacted agriculture area of more than 400 ha has been measured, while in worst case 20% of the soil is above the Dutch standards and have to be phytoremediated, which is equal to **80,6 ha.**

Transportation has been calculated once with trucks (1,30 Euro/km) and once with wagons (250 Euro/wagon), while a critical distance of 100 km has been taken into consideration (above 100 km by train, below by truck). The costs for public awareness have been handles like fix costs due to the fact, that independent from the chosen alternative, those costs will be raised.

In the case of “on site” treatment in new installed fuming process (located at the area of the old abandoned fertilizer plant), an investment of 20.000.000 Euro can be expected, not included the set up for disposal.

Monitoring wells have to have a maximum depths of 15 m, while the costs are 35 Euro/meter. The supervision of the activities have been calculated with 3% of the total operational costs (investments included). The costs have been capitalised with 2,5 % per anu for a period of 7 years, which indicates the depreciation period.

The various options are not ranked at this stage due to the fact, that not always the cheapest alternative is also the most economical one. The figures (total costs) will economical evaluated.

Table 54_Investment and cost structure of remaining treatment options

VELES - Financial Evaluation of various Alternatives						
		On Site	Off Site			
	Units	Capping	Excavation; Transport of Material abroad; no residues disposal	Excavation; Transport to "on site" facility; Residues for Gypsum dumpsite	Excavation; Transport to "on site" facility; Residues to Cement factory	Excavation and off site disposal - Lojane
Environmental Ranking		3	2	2	1	4
Investment	**Euro**	0	250.000	23.375.000	22.600.000	0
Depreciation	**Euro/year**	0	35.714	3.339.286	3.228.571	0
Landcosts	**Euro**	340.000	0	0	0	0
Depreciation for land	**Euro**	17.000	0	0	0	0
Excavation costs	**Euro**	2.016.000	0	2.520.000	2.520.000	2.520.000
Transport costs Slag (Truck)	**Euro**	0	148.200.000	936.000	936.000	10.920.000
Transport costs Slag (Train)	**Euro**	0	11.250.000	11.250.000	11.250.000	11.250.000
Transport costs Residues (Truck)	**Euro**	0	0	1.269.000	15.228.000	0
Treatment costs	**Euro**	0	0	58.140.000	36.900.000	18.000.000
Capping material costs	**Euro**	765.000	66.800	66.800	66.800	66.800
Material Transport costs	**Euro**	5.712.000	467.600	467.600	467.600	467.600
Profiling and compacting	**Euro**	408.000	66.800	66.800	66.800	133.600
Other Costs						
Public Awareness	**Euro**	10.000	10.000	10.000	10.001	10.000
Drilling of Piecometers	**Euro**	3.675	3.675	3.675	3.675	3.675
Monitoring	**Euro**	30.600	30.600	30.600	30.600	30.600
Investment	**Euro**	340.000	250.000	23.375.000	22.600.000	0
Total Operational Costs	**Euro**	9.285.275	12.145.475	86.885.475	78.829.476	32.152.275
Supervision	**Euro**	278.558	364.364	2.606.564	2.364.884	964.568
Capitalisation of Invest	**Euro**	5.950	4.375	409.063	395.500	0
Total Costs	**Euro**	**9.569.783**	**12.514.214**	**89.901.102**	**81.589.860**	**33.116.843**
specific costs	**Euro/Mg**	**6,64**	**6,95**	**49,72**	**45,11**	**18**
Output Lead/Zinc	**Mg**	**0**	**108.000**	**108.000**	**108.000**	**0**
Output Residues	**Mg**	**0**	**0**		**1.692.000**	**0**
Income Lead/Zinc	**Euro**	**0**	**216.000.000**	**216.000.000**	**216.000.000**	**0**
Income Cement	**Euro**	**0**	**0**	**0**	**101.520.000**	**0**
Total Income	**Euro**	**0**	**216.000.000**	**216.000.000**	**317.520.000**	**0**
specific income	**Euro/Mg**	**0**	**120**	**120**	**176**	**0**
specific turn over	**Euro/Mg**	**-6,64**	**113**	**70**	**131**	**-18**
Financial Ranking		**4**	**2**	**3**	**1**	**5**

10.6.1 Fuming process calculation

10.6.1.1 Basic Data

Parameter	**Amount**	**UNIT**
Inputmaterial	1800000	Mg
Plant capacity	90.000	Mg/year
Treatment Period	20,0	years
Recovery rate	6,0[29]	%
Remaining Slag	84600,0	Mg/year
Bulk Density	2,0	
Truck Loads	4230,0	Load/year
Truck Loads	14,1	Load/24 hours
Truck Loads	0,6	Load/hour
Distance to Gypsum site	6,0	Km one line
Distance to dump	70,0	km one line

10.6.1.2 Required investment costs for a fuming process and for disposal activities

Slag fuming plant	1	20.000.000,00	20.000.000,00
Depleated slag granulation	1	600.000,00	600.000,00
Filter oxides granulation	1	1.000.000,00	1.000.000,00
Infrastructure	1	1.000.000,00	1.000.000,00
Trucks	2	215.000,00	430.000,00
Bulldozer	1	270.000,00	270.000,00
Roller	1	75.000,00	75.000,00
Total			**23.375.000,00**

10.6.1.3 Operation costs of fuming process

Transport	17,625	hours/day	
Transport	5287,5	hours/year	13,50
Transport Costs	71381,25	Euro/year	
Investment Costs	430.000	Euro	for two trucks
Capatilasation	86.971	during depreciation	0,03
Depreciation	7	years	
Trnsport Costs total	**145.234**	**Euro/year**	

Item	Units	Unit costs	Total costs [€]
Manpower	14	7500	105.000,00
Coal	16000	70	1.120.000,00
Masut	300	250	75.000,00
Electricity [KW]	6000000	0,04	240.000,00
Refractories	100	1000	100.000,00

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[29] worst case calculation

Maintenance		200000	200.000,00
Transportation		145.234	145.234,27
Dumpsite operation		125.481	125.481,04
Recultivation		795.284	795.284,13
Total			**2.905.999,43**

10.6.1.4 Disposal costs

Dumpsite Operation			
Input	84.600	Mg/year	
Operation	50	Mg/hour	
Operation	2.115	hours	80% Efficiency
Operation	264	days	35,00
Dozing Costs	74025	Euro/year	
Investment Bulldozer	270.000	Euro	
Capatilasation	90.192	during depreciation	0,03
Depreciation	7	years	
Dozing Costs total	**125.481**	**Euro/year**	

Capping and Recultivation			
Size of site	160.000	sqm	
Material	1,0	m	
Material	160000	m³	
Material Costs	640000	Euro	4,00
Truckloads	8000	Loads	20,00
Truckloads	400	per year	
Transport Costs	24000	per year	60,00
Profiling	48000	Euro	0,30
Compacting	32000	Euro	0,20
Investment Roler	75.000	Euro	75.000,00
Capatilasation	38.989	during depreciation	0,03
Depreciation	7	years	
Seed	2.000	kg	125,00
Greening Costs	35.000	Euro	0,20
Recultivation Costs	**795.284**	**Euro/year**	

10.6.2 Calculation of further remediation activities

Table 55_Investment and cost structure of surface remediation options

VELES - Financial Evaluation of various Alternatives			
		On Site	**Ex Situ**
	Units	**Green Area - soil exchange**	**Agriculture area remediation**
Investment	**Euro**	0	250.000
Depreciation	**Euro/year**	0	50.000
Landcosts	**Euro**	0	0
compensation for land	**Euro**	0	783.835
Excavation costs	**Euro**	159.600	0
Transport costs soil	**Euro**	691.600	0
Transport costs soil (Train)	**Euro**	712.500	0
Treatment costs	**Euro**	0	1.209.000
Capping material costs	**Euro**	456.000	0
Material Transport costs	**Euro**	760.000	0
Profiling and compacting	**Euro**	228.000	0
Other Costs			
Public Awareness	**Euro**	10.000	10.000
Sampling	**Euro**	30.000	90.000
Monitoring	**Euro**	30.600	30.600
Investment	**Euro**	0	250.000
Total Operational Costs	**Euro**	2.365.800	1.589.600
Supervision	**Euro**	70.974	95.376
Capitalisation of Invest	**Euro**	0	4.375
Total Costs	**Euro**	**2.436.774**	**1.689.351**
specific costs	**Euro/m^3**	**21,38**	**2,09**

The public green areas have a surface of 228.237sqm, while extensive investigation (depth investigation shall be undertaken). The material shall be covered and off site disposed (worst case 70 km to Lojane). 500 samples have been calculated. The total operation costs will reach **2,4 Mio Euro**, which results in specific treatment costs of 21, 38 Euro / m^3 excavated and exchanged soil.

The Agriculture area will be phytoremdiated, while 250.000 Euro are required as investment for plants. 20% of the total surface has been assumed to be impacted above the Dutch standards, which is a surface of 80,6 ha. The operation periode is assumed with 5 years. During this time a compensation fee of 0,194 Euro/sqm and year has been taken into consideration. This reflects the losses of productivity during this period. 1500 Samples shall been taken within a period of 5 years in order to analyse the heavy metal declaining in the soil. A specific cost of 2,09 Euro has been calculative identified. Overall costs of 1,7 Mio Euro are resulting out of that costs.

Out of requird investments 2,4 Mio Euro for the public area remediation and 1,7 Mio Euro for the rehabilitation of agriculture land (a total of 4,1 Mio Euro) a **break even**

concession fee of 9,11 Euro / Mg slag shall be minimum contracted (bottom line) in order to reach a 5 years implementation period.

10.7 Economical comparison of remediation activities

The most economical benefit can be achieved by the combination of Excavaton, “on site” treatment and the reuse of the residues in the cement factory. Excavation companies, production facility staff and capping of final bottom soil. The specific turnover is 131 Euro / Mg of Slag. The worst case calculation has been taken into cosideration with a reuse efficiency of 6%, which can be easily achieved. The cross benefit and idirect benefit in this manner the highest with approximate 500.000 Euro per year during an operation period of 20 years. The ROI is less than 4 years.

Second feasible possibility is the purely marketing (concessioning) of the material, due to the fact, that no disposal costs are occurring. 113 Euro / Mg slag can be achieved, excluding the transport and remediation costs. The cross benefit and indirect benefit situaton is far not that feasible than previous described option. Less than 250.000 Euro per year within a period of 10 years.

Next feasible option is the combination of “on site” treatment and disposal of residues on the current gypsum dumpsite, while this option has to be investigated in itself due to the fact, that the project assumes a potential reuse of gypsum in various production processes. A turnover of 70 Euro / Mg slag can be achieved.

Off site dipsoal in Lojane and the migitation process (capping) a minus positions and have no positive turn over. Investments are required. The cross benefit is similar low those of above mentioned options. The retention period for the off site disposal is 5 to 10 years, while capping can be achieved within a few months.

Economical Ranking [in Euro/Mg]

Excavation + Onsite Treatment + Reuse of Residues	
+ remediation of bottom soil	**131**
Excavation + offsite Treatment + remediation of bottom soil	**113**
Excavation + onsite Treatment + remediation of bottom soil	**70**
Flattening of ara and capping	**-6,64**
Excavation + off site disposal	**-18**

It is highly recommended to treat the current slag material on site and the residues inert material in construction activities.

11 Attachments

11.1 Legal frame

11.1.1 Terms of Reference for Legal, Institutional and Technical Expert

Beneficiary country

The former Yugoslav Republic of Macedonia

Contracting authority

Ministry of ……………………………………..

11.1.2 Team staff:

- Foreign Institutional Expert- 4 months within 9
- Local Legal Expert- 6 months within 9
- Local Institutional Expert- 3 months within 9
- Local Technical Expert- 3 months within 9

11.1.3 Position: Legal Expert

The legal gap analysis made within the project identified crucial gaps in missing hotspots" terminology, unclear environmental liability, no guidelines and solutions for "hotspots" remediation, set up of an earmarked environmental trust fund. Therefore the obligations and responsibilities for the Legal Expert Position will include: amending existing laws in the area of environment, more particularly the Law on Environment, Law on Waste Management, Draft Law on Hazardous Waste. Not only law amendments are needed, but also drafting new legislation, for example Law on soil protection, Law on establishment of trust funds, Rulebook on Remediation of "hotspots", Rulebooks on monitoring, Rulebook on protection from pollution from priority substances. The issue of environmental liability is not clear, therefore the legal expert will need to recommend how this question will be solved, whether the state is responsible, and for how long or the new owner. The Legal Expert will need to cooperate closely with Institutional, as well as with an technical expert, when drafting the changes of the laws or drafting new laws. The cooperation with the Institutional expert will be considerable especially in the area of the funding mechanisms. The technical expert will be needed to provide inputs when drafting the laws and especially the rulebooks which will be in form of technical guidelines (monitoring, remediation, soil protection). The legal expert will have to write progress reports, as well as inception and final reports.

The Legal expert should have: a degree in law (preferably environmental law group), professional experience of minimum 10 years in law related fields, drafting of legislation; making of analysis. The legal expert also should have a knowledge of the national legislation (especially in environment and finance, because most of the changes required are in those fields), intensive knowledge of local (national) legal structure and related stakeholders, as well as institutional set up knowledge. Cards program and procedure experience would be considered an asset. He/she should be familiar especially with the Hotspots issue, environmental liability, funding mechanisms. Regarding the language skills, proficiency in oral and written English is required.

The general requirements for such an expert include analytical capability to deal with legislation; good interpersonal skills; team player; presentation skills; able to follow rules of confidentiality and independent and free from conflicts of interest in the responsibilities accorded to them; skilled in Microsoft Office (Word, Excel, PowerPoint);

The terms of engagement for the Legal Expert will be 6 within 9 months (132 working days), starting from xxxx 2008. The main beneficiary will be the Ministry of Environment and Physical Planning, and the contractor will be the EAR (European Agency for Reconstruction).

11.1.4 Position: Institutional Expert

The responsibilities of the Institutional Expert will be making proposals and solutions for the existing institutional gaps; develop a regional or national funding mechanism for hot spot remediation activities, and cooperate with the legal expert regarding legal matters for the needed funding mechanism. He will describe responsibilities, interlinks between various institutions, evaluate the various budget sources in accordance with national and international institutional, legal and economical principals such as polluter or risk related fees. Development of an institutional strategy for the implementation of further remediation works, and establishment of an implementation body, as well as describing responsibilities of such a body. The Institutional Expert will have to help the legal expert in drafting legislation, as well as preparation of a presentation workshop, together with the legal expert.

The Institutional Expert should have a degree in social or natural science, professional experience of minimum 10 years in environmental management and related activities; knowledge in international funding facilitation and institutional set ups (international networking); relevant knowledge of national legislation related to Public Information and international related conventions (Aarhus Convention), and be familiar with the legislation on funding mechanisms. Cards program and procedure experience will be considered as an asset. Proficiency in oral and written English is required as well as knowledge of Microsoft Office (Word, Excel, PowerPoint);The general requirements are analytical capability to deal with environmental assessment; able to follow rules of confidentiality and independent and free from conflicts of interest in the responsibilities accorded to them; performing of field and office work; good interpersonal skills; The terms of engagement will be 3 months (66 working days), starting from xxxx 2008. The main beneficiary will be the Ministry of Environment and Physical Planning, and the contractor will be the EAR (European Agency for Reconstruction).

11.1.5 Position: Technical Expert

A technical expert will closely cooperate with the legal and institutional expert, in execution of the technical and legal parts. The required expertise will mainly be technical, but some environmental law expertise will also be needed. The responsibilities of the Technical Expert will include supporting the legal expert in drafting legislation in the environmental area by providing technical input during the entire project. He should contribute in the preparation of the new legislation that is recommended to be adopted (Law on soil protection, Rulebook for remediation of “hotspots” as well as the drafting of the changes of the legislation that need to be done. Also the technical expert will participate in writing the reports (Inception, Progress, and Final). The qualifications required for the technical expert are the following: a degree in life science, engineering, minimum 10 years of working experience in the relevant environmental area (Waste, Water, Air, IPPC), knowledge of the situation of the country regarding the “hotspots” matter, as well as knowledge of the waste sector, water sector, air sector. Preferable is to have some knowledge of the environmental legislation, as the tasks will be changes in the environmental legislation. Cards program and procedure experience will be considered as an asset. Proficiency in oral and written English is required as well as knowledge of Microsoft Office (Word, Excel, PowerPoint);The general requirements are analytical capability to deal with environmental assessment; able to follow rules of confidentiality and independent and free from conflicts of interest in the responsibilities accorded to them; performing of field and office work; good interpersonal skills; The terms of engagement will be 3 months (66 working days), starting from xxxx 2007 within a period of 3 months. The main beneficiary will be the Ministry of Environment and Physical Planning, and the contractor will be the EAR (European Agency for Reconstruction).

11.1.6 Position: Foreign Institutional Expert:

The overall objective of the Foreign Institutional Expert will be to coach and support the project team in their legal and institutional needs. The Expert will support the local institutional expert in the proposals and solutions for the existing institutional gaps; in developing the regional or national funding mechanism for hot spot remediation activities, support the legal expert regarding legal matters for the needed funding mechanism. He will help in the development of an institutional strategy for the implementation of further remediation works, and the establishment of an implementation body. He will have to report to the project team and develop a final report. The expert shall have: a degree in social or natural science, professional experience of minimum 10 years in environmental management and related activities in a country that has passed successfully the transitional development process (experience throughout the transitional period, and after); knowledge in international funding facilitation and institutional set ups. The foreign Expert should possess relevant knowledge of national legislation related to Public Information and international related conventions (Aarhus Convention), as well as relevant knowledge in relevant European Directives and International Standards and Legislations. He should also be proficient in oral and written English, and have analytical capability to deal with environmental assessment; good communication skills, excellent knowledge of Microsoft Office (Word, Excel, PowerPoint);

The foreign Expert will be based in Skopje (Project Office), The period of activity will be 4 months within 9.

11.1.7 Office Accommodation

Office accommodation of a reasonable standard and of approximately 10 square metres for each expert working on the contract is to be provided by the beneficiary. This will include basic furnishings and communication lines (at least two fixed telephone lines with hand-sets and the technical possibility for the consultant to establish high speed internet access) as well as electricity, air conditioning, heating, water and general cleaning and maintenance. The consultant’s experts will be located in the same building or as near as possible to the MEPP core functions to be supported under this contract.

The beneficiary will also provide desktop computers, printers, a fax machine and a photocopier for use by the consultants. These will remain the property of the beneficiary. However, the suitability and reliability of these machines cannot be guaranteed, and all associated operating and maintenance costs will be borne by the contractor and included within fee rates. Any additional equipment (for example laptop computers) will also be provided by the consultant at no cost to the project (i.e. included within fee rates).

11.1.8 Facilities to be provided by the beneficiary

The Consultant is responsible for organizing the project office space provided by the beneficiary and for providing any additional furnishings and equipment needed to provide an appropriate working environment for all members of the Consultant’s staff funded under this contract, and to allow Working Groups of up to ten people to meet and operate as necessary. The Consultant will ensure that all members of its team in fYR Macedonia are equipped with adequate computing, document processing and dedicated electronic mail facilities and other means required to perform the tasks requested under these ToR.

The consultant will moreover ensure the mobility of all his/her staff for all work related purposes. In particular he/she shall ensure that there is sufficient administrative, secretarial and interpreting provision to enable experts to concentrate on their primary responsibilities.

The cost of all of these inputs must be included in the fee rates. In particular, the Consultant shall make available, within the fee rates of its experts, the necessary resources for:

- office equipment,
- backstopping services at headquarters;

11.1.9 Equipment

No equipment is either to be purchased on behalf of the beneficiary country as part of this service contract or transferred to the beneficiary country at the end of this contract. Any equipment related to this contract, which is to be acquired by the beneficiary country, must be purchased by means of a separate supply tender procedure.

11.1.10 Reporting requirements

All reports shall be written in UK English, and, where necessary, working documents and reports should be translated into the local language(s) as described below. Standard reporting formats to be used are attached to this ToR.

The Consultant shall prepare and submit the following reports:

An Inception Report shall be submitted 2 months after the commencement date of the project The report shall clearly define the aims, objectives and methodology of the contract; set out a detailed work plan for the provision of each activity, area of expertise and list of deliverables; identify the experts and local personnel required, the management of the project and any possible commitments required from the beneficiary etc. The inception report shall show all activities pertaining to results and outputs in a cart highlighting milestones. The report will list and comment on any developments (legal, institutional, other donor activities etc.) that have taken place since these ToR were drafted and which might have an impact on project design and relevance of activities to be developed under it. The use of locally available moderators familiar with this methodology is strongly recommended. The inception report will feature an extended executive summary in English and Macedonian language providing decision makers with sufficiently detailed information to understand concept and implications and form an opinion. The main report will not exceed 25 pages of text.

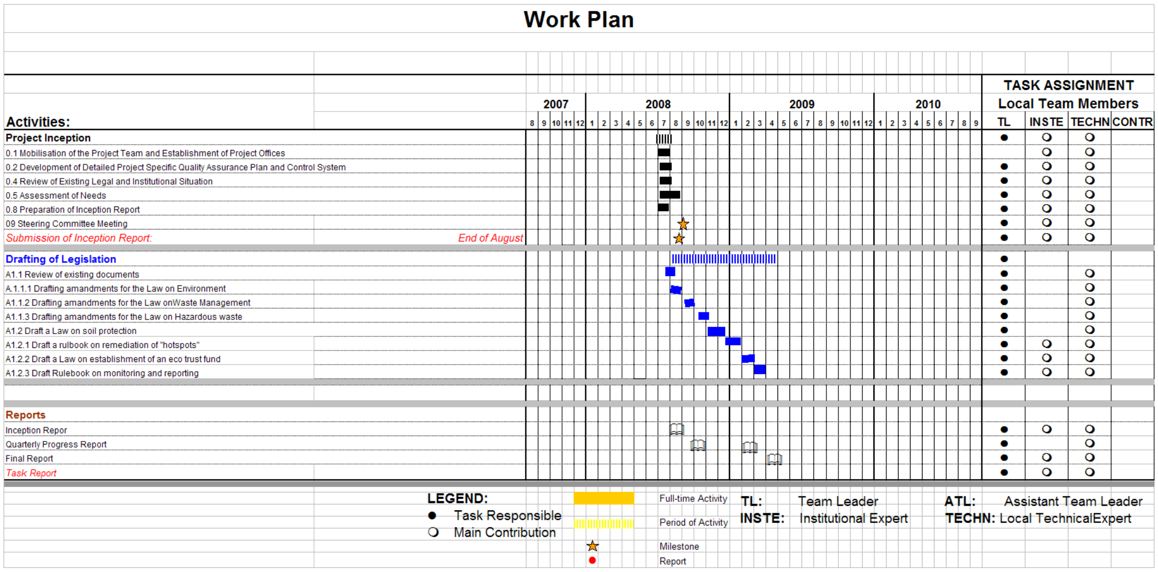
Quarterly Progress Reports shall be submitted within two weeks after the end of each three-month period. The first Quarterly Progress Report shall be delivered at the end of the third month after the inception period. Quarterly progress reports will feature an extended executive summary in English and Macedonian, highlighting project progress against each output, key activities undertaken, obstacles hampering project progress and proposed solutions, consumption of contract inputs and essentials of the work plan for the following quarter, including recommendations and requests (ToRs, Specifications and Tender Dossiers). The Quarterly Progress Report will also identify relevant progress and general developments in the sector in general and in the specific thematic areas covered by this contract (legislative, institutional, activities of other donors, private sector initiatives and others of interest) and, as far as these developments affect contract implementation and/or validity, of its objectives and outputs.

The Final Report will contain prioritised follow up proposals to the activities developed under this contract for funding consideration under the project. They will contain a description of all documents prepared under the contract (reports, proceedings from conferences, minutes of relevant meetings, findings from workshops), all previously approved reports, documents and other on CD-ROM. The main reports shall not exceed 50 pages. The exact table of contents of the draft final and final report is subject to approval by the contracting authority. The draft final and final report shall contain an extended executive summary in English and Macedonian language(s).

The Draft Final Report is due one month before the end of the contract. The Final Report will be delivered within one month after the completion of the contract. The Final Report shall be provided on CD - ROM as well. The Final Report must be accompanied by the final invoice and an audit certificate (as defined in Article 30 of the General Conditions and in accordance with the template in Annex VI of the contract) confirming the final certified value of the contract.

The reports shall be submitted to the MEPP National Project Co-ordinator (for the beneficiary) and the EAR Project Manager (for the contracting authority). Approval of all reports rests solely with the EAR Project Manager. The beneficiary shall communicate his observations on all reports to the consultant and to the Contracting Authority within 15 calendar days of receipt of the report in question. The Project Manager when requesting amendments to the report, and prior to its approval shall take these into account.

11.1.11 Action Plan



Work Plan

Activities:		TL	INSTE	TECHN	CONTR
Project Inception		●	○	○	
0.1 Mobilisation of the Project Team and Establishment of Project Offices			○	○	
0.2 Development of Detailed Project Specific Quality Assurance Plan and Control System		●	○	○	
0.4 Review of Existing Legal and Institutional Situation		●	○	○	
0.5 Assessment of Needs		●	○	○	
0.8 Preparation of Inception Report		●	○	○	
09 Steering Committee Meeting		●	○	○	
Submission of Inception Report:	*End of August*	●	○	○	
Drafting of Legislation		●			
A1.1 Review of existing documents		●		○	
A.1.1.1 Drafting amandments for the Law on Environment		●		○	
A1.1.2 Drafting amandments for the Law onWaste Management		●		○	
A1.1.3 Drafting amandments for the Law on Hazardous waste		●		○	
A1.2 Draft a Law on soil protection		●		○	
A1.2.1 Draft a rulbook on remediation of "hotspots"		●	○	○	
A1.2.2 Draft a Law on establishment of an eco trust fund		●	○	○	
A1.2.3 Draft Rulebook on monitoring and reporting		●	○	○	
Reports					
Inception Repor		●	○	○	
Quarterly Progress Report		●		○	
Final Report		●	○	○	
Task Report		●	○	○	

TASK ASSIGNMENT
Local Team Members

LEGEND:
- ● Task Responsible
- ○ Main Contribution

Full-time Activity
Period of Activity
Milestone
Report

TL: Team Leader
INSTE: Institutional Expert
ATL: Assistant Team Leader
TECHN: Local TechnicalExpert

11.2 Institutional

11.2.1 Action Plan for setting up the Remediation Fund

Action	Implementing Institution	Time frame	Resources required
Definition of Terms of References for local and international assistance (experts)	MOEPP; Donor	2007	Local / international expert
Tendering and recruiting national and international experts	Donor	2007	Procurement officer
Revision of legislation regarding environmental liabilities for past pollution.	MoEPP, MoE	2007	6 man-months of local and int. experts
Introduction of economic instruments (sources of funding for the Remediation Fund).	MoEPP, MoF	2007	6 man-months of local and int. experts
Introduction of cleanup standards and recommended guidelines.	MoEPP, MoA	2007	man-months of local and int. experts
Drafting and adoption the Law on establishing the Remediation Fund.	MoEPP	2007	2 man-month of local and int. experts
Establishment of the Fund's Management Board and Technical Committee.	MoEPP	2008	N/A
Recruitment/appointment of the General Director, Financial Director and Technical Director.	MoEPP	2008	N/A
Hiring and training of staff.	Fund's Director	2008	N/A
Development of operating procedures for the Fund.	Fund	2008	Fund's staff, int. experts
Setting up data base of contaminated sites	Fund	2008-2009	Fund's staff, Information Centre of Environment
Development of prioritisation methodology (risk assessment based)	Fund	2008	Fund's staff, int. experts
Preparation of draft investment strategy, work programme, and business plan.	Fund	2008-2009	Fund's staff
Establishment of the Fund' website.	Fund	2009	Fund's staff
Preparation of the first annual operating programme.	Fund	2009	Fund's staff

11.2.2 Terms of Reference for Short Term Consultant for Public Awareness Campaign (PAC)

11.2.2.1 Background

“Development and support of Implementation of a public information system in regard to Remediation Plans with Financial Requirements for Elimination of Industrial Hotspots”

The overall objective of the project is to support the remediation of industrial hotspots on a environmentally and financially sustainable manner for an improved life quality of the population of the former Yugoslav Republic of Macedonia.

11.2.2.2 Scope of the Work:

This ToR describes the work that should be done by the mentor during implementation of separate activities within the PA Campaign on remediation activities at Veles sites.

It is expected that Mentor will help Veles Municipality and local NGOs in preparation and realization of particular activities focused on PA rising.

11.2.2.3 Beneficiary

Main beneficiary is the potential impacted population

Duties and Responsibilities

1. To continue with the training of local NGOs and municipal staff for preparing applications for certain PA raising activities related to the proposals in the Report on Public Awareness
2. Building the link between various intuitions (focal point) and responsible for information dissemination
3. Support of the MoEPP and Municipality of Veles to define certain PA activities, staff-, budget and time scheduling (Action Plan)
4. Support the local stakeholders (NGOs, Local Self Government, schools etc.) in realization of the activities
5. Identification of Indicators
6. To prepare a questionnaire and to initiate a yearly public satisfaction study within the project area in close cooperation with independent survey staff
7. Evaluation of the survey results and using it as a planning tool for further activities
8. Preparation of various presentation
9. To be present on the place of realisation of the activities
10. To make evaluation of realisation of the separate activities and to deliver the evaluated reports to the MoEPP
11. Activity-, indicator-, project result-, and cost control (supervisory function)

11.2.2.4 Output

- List of Indicators
- To deliver 6-month progress reports and forecast planning with specific activities to MOEPP
- Information Dissemination plan followed

- Yearly satisfaction study and form of representation
- Consultant should submit detail report on previous realized activities in accordance with Terms. Special attention should be paid on problems appeared and achievements from realized activities. The reports should contain results, proposals for follow up activities, constrains and needs and requirements
- The reports and supporting material shall be prepared and submitted to MOEPP in Macedonian (and English if required)

11.2.2.5 Required Expert Input

- National expert and/or consultant company, no more than 180 working days in a period of one year and 100 in the second year
- Consultant should travel in the region in order to conduct meetings with relevant stakeholders (NGOs, village communities, schools etc.) and to provide specific training and directions for realization of activities.
- Consultant should closely cooperate with Veles Bancruptcy Management, relevant Ministries and impacted local authorities to specify certain activity, time, budget, and staff input scheduling

11.2.2.6 Qualifications

- University degree in the fields relevant to the project;
- Minimum 5 years of relevant experience in developing of institutional schemes
- Strong communication and interpersonal skills;
- Prior experience in working with local governments and NGO's;
- Previous experience in developing and realization of PAC;
- Team management and moderator skills;

11.2.3 Sample Plan for Public Participation

Subject	**Example**
What is the basic activity?	Public participation in the EIA procedure concerning the proposed clean up of the XXXX site
Objectives: what effect has to be obtained?	• Notifying the public about the project and the possible decisions • Notifying the public about the ways in which it may participate in the procedure and about the authority competent for making a decision • Notifying the public about the course of the public participation procedure • Enabling the public to submit comments and recommendations • Examining the submitted comments and recommendations during the project's evaluation before issuing the decision
Dates of initiating and finalizing the procedure	• Initiation: date • Notification of the public: date • Press release: date • Distributing the leaflets: date • Visiting the site: date • Meeting interested parties: date • Administrative trial with the public participation: date • Analysing the documentation and comments submitted by the public: date • Making the decision • Finalisation: date
Results and activities What are the expected results? What activities have to be concluded?	• Plan of public participation • Notifying the public • Press release • Leaflet directed to the public • Members of public visit the site • Interested parties visit the site • Meeting with the members of public • Seminar for the interested parties

	• EIA report • Assessment of EIA report • Decision made • Note on the outcome of the public participation procedure
Responsibilities of the team and resources needed	• Xx hours project manager • Xx hours cleanup expert • Xx hours for journalism • Xx hours for technical editor • Xx hours for inspector • Xx hours for facilitator
Financial resources needed	

11.2.4 Environmental active NGOS in the Region of Veles

#	NGO	Main activities	Contact Person	Tel/fax	e-mail
1	Villa Zora – Veles	The organization aims at protection of the environment and improvement of the quality of living.	Nenad Kocic	043 233 023	**vilazora@mt.net.mk**
2	Federation of Farmers in the Republic of Macedonia Association of Bee-Keepers "Pcela", Veles,	Allis activities of different agriculture associations in developing of Contribute to sustainable agriculture and life quality	Blagojce Najdovski	043 229 401	pcelaveles@yahoo.com
3	Green Power	Propose creative solutions for mitigation of the environmental degradation and pollution in the city and its surroundings.	Emil Smilev	043 211 586	greenpowermk@yahoo.com
4	Parents Union for Care of Healthy Generations	Health population Enhancing quality of life	Sonja Gavrilova	043 228 591	drgzp@yahoo.com
5	Scout force – Dimitar Vlahov - Veles	Promoting of eco tourism Environmental researching and learning	Angelce Gusev	043 223 715	scout_veles@mt.net.mk
6	Regional Center for Cleaner Production	Promotion of cleaner production in the Region	Petar Stojanov	043 222 114	rcpp@netscape.net
7	Association for protection and raizing birds "Rubino",	Environmental protection, promotion of Policy for birds protection and raizing birds		043 231 376	rubino21veles@yahoo.com

11.3 References

11.3.1 References – Legal Frame

[1]… National Waste Management Plan (NWMP)

[2]… National Environmental Action Plan II (NEAP II)

[3]… Law on Waste Management (Off. Gazette no. 6/2004);

[4]… Law on Environment (Off. Gazette no. 53/05 and 81/05);

[5]… Law on Privatisation (Off. Gazette no. 37/96; 25/99; 81/99; 49/2000; 6/2002; 74/05);

[6]… The draft Law on Hazardous Waste (which is being produced in the CARDS 2004 Programme, and was provided by them).

[7]… Law on Ambient air Quality (Off. Gazette no. 67/2004);

[8]… Draft Law on Waters

[9]… Law on Budgets (Official Gazette of the Republic of Macedonia no. 79/93; 3/94; 71/96; 46/2000;11/2001, 93/2001; 46/2002; 24/2003; 85/2003 and 96/2004 and Decision of the Constitutional Court no. 180/98 (Official Gazette of the Republic of Macedonia no. 15/99)

[10]… Decree on the criteria and manner for B IPPC permit (Off. Gazette no. 04/2006); Decree on the level of charges for A IPPC permit (Off. Gazette no. 04/2006);

[11]… IPPC Ordinance - A permits (Off. Gazette no. 4/06);

[12]… IPPC Ordinance - Adjustment permits (Off. Gazette no. 04/2006);

[13]… IPPC Ordinance - B permits (Off. Gazette no. 4/06);

[14]… Rulebook on the form and content of the application form, and the content of the permit for collecting and transporting urban and other types of non-hazardous waste as well as on the minimum technical requirements for performing the economic activity of collecting and transporting urban and other types of non-hazardous waste (Off. Gazette no. 23/2007);

[15]… Rulebook on the format and the content of the Journal for records keeping on the waste handling, the format and the content of the forms for the annual report on waste handling by legal entities and natural persons and the format and the content of the annual report on waste handling by the mayor (Off. Gazette no. 7/2006);

[16]… Rulebook on the functioning methods and conditions of the integrated waste disposal network (Off. Gazette no. 29/2007);

[17]… List of Waste Types (Off. Gazette no. 100/05);

[18]… Waste Framework Directive;

[19]… Landfill Directive;

[20]… Directive for PCB's and PCT's;

[21]… Hazardous Waste Directive;

[22]… IPPC Directive.

[23]… Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their disposal

11.3.2 References – health risk assessment

[24]… Agency for Toxic Substances and Disease Registry (ATSDR). Toxicological Profile for Chromium. U.S. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA. 1998

[25]… American Conference of Governmental Industrial Hygienists (ACGIH). 1999 TLVs and BEIs. Threshold Limit Values for Chemical Substances and Physical Agents, Biological Exposure Indices. Cincinnati, OH. 1999.

[26]… California Environmental Protection Agency (CalEPA). Technical Support Document for the Determination of Noncancer Chronic Reference Exposure Levels. Draft for Public Comment. Office of Environmental Health Hazard Assessment, Berkeley, CA. 1997.

[27]… California Environmental Protection Agency (CalEPA). Air Toxics Hot Spots Program Risk Assessment Guidelines: Part II. Technical Support Document for Describing Available Cancer Potency Factors. Office of Environmental Health Hazard Assessment, Berkeley, CA. 1999.

[28]… Occupational Safety and Health Administration

[29]… Environmental Protection Agency. Guideline for exposure assessment, Washington, 1992

[30]… http://www.health.gov.au/internet/wcms/publishing.nsf/Content/ohp-ehra-2004.htm~ohp-ehra 2004-background.htm

[31]… http://reports.eea.europa.eu/GH-07-97-595-EN-C2/en/chapter1h.html

[32]… http://www.who.int/ipcs/publications/ehc/methodology_alphabetical/en/index.html

[33]… http://www.who.int/ipcs/publications/ehc/ehc_numerical/en/index.html

[34]… IARC monographs on the evaluation of the carcinogenic risk of chemicals to humans - Some halogenated hydrocarbons, IARC, October 1979.

[35]… Kendrovski V., Gjorgjev D. The burden of diseases in the Republic of Macedonia. I-st International Congress of Occupational Medicine, Ohrid, 2006

[36]… National Environmental Action Plan. Government of the Republic of Macedonia, Skopje, 1996

[37]… National Health Environmental Action Plan. Government of the Republic of Macedonia, Skopje, 1999

[38]… National Waste Management Plan 2006-2012. Government of the Republic of Macedonia, Skopje, 2005

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[40]… National Institute for Occupational Safety and Health (NIOSH). Pocket Guide to Chemical Hazards. U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention. Cincinnati, OH. 1997.

[41]… Rai D. et all. Environmental chemistry of chromium., Total Environ., 25, 807-816, 1989.

[42]… Republic Institute for Health Protection. Yearbook of preventive programs in the Republic of Macedonia, 2007

[43]… Republic Institute for Health Protection. Internal data on request, Department for Social Medicine, 2007

[44]… Republic Institute for Health Protection. Internal data on request, Department for Hygiene and Environmental Health, 2007

[45]… State Statistical Office. Statistical Yearbook of the Republic of Macedonia, Skopje, 2000,2001,2002,2003,2004,2005,2006

[46]… The Second National Environmental Action Plan. Government of the Republic of Macedonia, Skopje, 2005

[47]… UN - Environmental Performed Review for FYR of Macedonia, 2002

[48]… UNEP.Post-Conflict Environmental Assessment—FYR of Macedonia, Geneva, 2000.

[49]… UNEP. Feasibility Study for urgent Risk Reduction Measures at hot spots In FYR of Macedonia, Geneva, 2001.

[50]… U.S. Department of Health and Human Services. Registry of Toxic Effects of Chemical Substances (RTECS, online database). National Toxicology Information Program, National Library of Medicine, Bethesda, MD. 1993.

[51]… WHO. Biomarkers and risk assessment: Concept and principles. Environmental Health Criteria 155, 1993

[52]… WHO. Assessing human risk of chemical: Derivation of guideline values for health based exposure limits. Geneva, Environmental Health Criteria 170, 1994

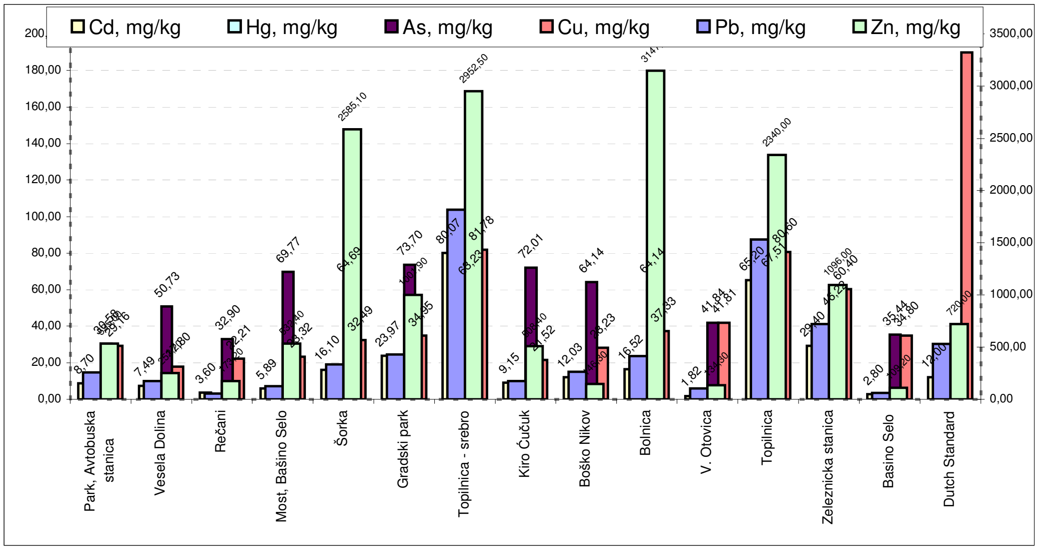
[53]… WHO. International Programme on Chemical Safety, The WHO recommended classification of pesticides by hazard and guidelines to classification 1994-1995, UNEP/ILO/WHO 1994.

11.4 Samples and Results

11.4.1 Veles Surrounding

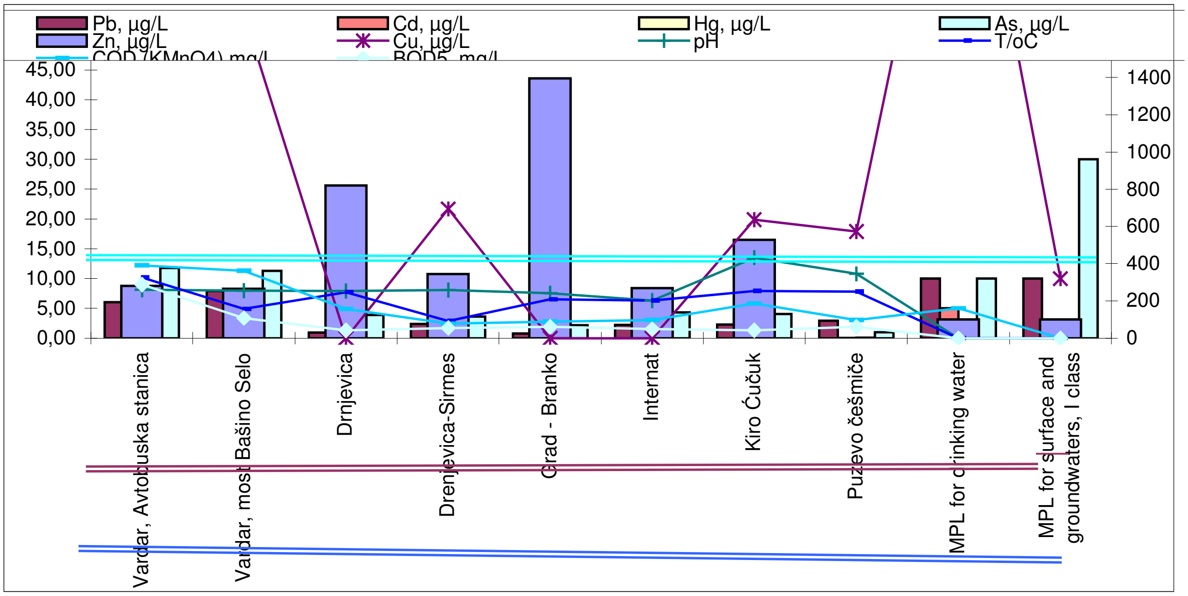
11.4.1.1 Soil

Sampling point	Northing	Easting	Pb mg/kg	Zn mg/kg	Cd mg/kg	Hg mg/kg	As, mg/kg	Cu mg/kg
Park, Avtobuska stanica	41°43,22'	21o 47,23	257,10	535,00	8,70	0,20	30,58	29,16
Vesela Dolina	41°43,65	21o 46,89	172,00	252,20	7,49	0,31	50,73	17,80
Rečani	41°44,38	21o 46,44	54,50	173,20	3,60	0,17	32,90	22,21
Most, Bašino Selo	41°44,50'	21o 45,65'	123,60	532,40	5,89	0,27	69,77	23,32
Šorka	41°43,71'	21o 46,21'	333,50	2585,10	16,10	0,46	64,69	32,49
Gradski park	41°43,22	21o 46,52	430,70	1001,90	23,97	0,37	73,70	34,95
Topilnica - srebro	41°43,64	21o 45,48	1813,90	2952,50	80,07	0,23	63,23	81,78
Kiro Ćučuk	41°42,8'	21o45,20'	173,70	508,40	9,15	0,12	72,01	21,52
Boško Nikov	41°42,45'	21o 45,79	263,30	146,30	12,03	0,19	64,14	28,23
Bolnica	41°	21°4	412,00	3147,50	16,52	0,32	64,14	37,33
V. Otovica	41°	21°4	102,60	134,30	1,82	0,26	41,84	41,81
Topilnica	41°43'41"	21°45'56"	1531,20	2340,00	65,20	0,27	67,51	80,60
Zeleznicka stanica	41°43'38"	21°45'56"	721,20	1096,00	29,40	0,15	46,22	60,40
Basino Selo	41°44'49"	21°45'56"	60,60	109,20	2,80	0,12	35,44	34,80
Dutch Standards			530,00	720,00	12,00	10,00	55,00	190,00



11.4.1.2 Groundwater

Sampling point	Northing	Easting	pH	T/oC	EC µS/cm	COD mg/L	BOD5 mg/L	Pb µg/L	Zn µg/L	Cd µg/L	Hg µg/L	As µg/L	Cu µg/L
Vardar, Avtobuska stanica	41°43,05'	21°47,23	8,10	10,20	138,4	12,23	9,00	6,03	280,4	0,24	0,116	11,80	51,00
Vardar, most Bašino Selo	41°44,49'	21°45,66'	7,99	4,90	136,0	11,32	3,40	7,92	264	0,22	0,095	11,30	54,40
Drnjevica			7,90	7,70	149,4	4,89	1,30	0,97	820,9	<0,01	0,106	3,91	<2,0
Drenjevica-Sirmes	41°44,21'	21°45,87'	8,08	2,90	127,9	2,44	1,70	2,38	343,7	0,046	0,088	3,64	21,70
Grad - Branko	41°43,14'	21°46,00'	7,57	6,50	154,1	2,75	1,90	0,76	1395	0,029	0,088	2,16	<2,0
Internat	41°43,08	21°45,84'	6,30	6,30	149,3	3,05	1,50	2,22	269,3	0,015	0,092	4,32	<2,0
Kiro Ćučuk	41°42,8'	21°45,95'	13,50	7,91	135,1	5,81	1,30	2,27	528,4	0,093	0,099	4,05	19,90
Puzevo češmiče	41°42,31'	21°45,61'	10,80	7,83	139,0	3,05	1,90	2,92	<10	0,03	0,095	1,03	17,90
MPL for drinking water			6,5 -8,5	-	1000	5	-	10	100	5	1	10	100
MPL for surface and groundwaters, I class			>8	-	-	<2,5	<2,0	10	100	1	0,2	30	10
MPL for surface and groundwaters, II class			7,99 -6,00	-	-	2,51 -5,0	2,01 -4,0	10	100	0,1	0,2	30	10
MPL for surface and groundwaters, III class			5,99 -4,00	-	-	5,01 -10,0	4,01 -7,0	30	200	10	1	50	50
MPL for surface and groundwaters, IV class			3,99 -2,00	-	-	10,01 -20,0	7,01 -15,0	30	200	10	1	50	50



11.5 Geoelectrical Profiles – Veles Site

11.5.1 Profile VE I

Region:	**Skopje**
Location:	**“MHK Zletovo” Lead and Zinc Smelter - Veles**
Method:	**Geoelectrical mapping - resistivity**
Arrangement:	**Wenner: AM=MN=NB=a=10, 20, 30 m**
Instruments:	**Resistivity meter type IC/1B made in Serbia; Geophysical institute - Belgrade**
Azimuth:	**169**
Date:	**29/30.07.2007**
Operator:	**Novica Stolic**

Profile VE I:		**AM=MN=NB=a=10 m**						**a=10m; AB/2=15 m**				**Control measures**			
Points	**Y**	**X**	**Z**	**L**	**Elektrodes**		**a**	**K**	**dV**	**I**	**Ra**	**dV**	**I**	**R**	
No.	**UTM (m)**	**UTM (m)**	**(m)**	**(m)**	**AB**	**MN**	**(m)**		**(mV)**	**(mA)**	**(ohmm)**	**(mV)**	**(mA)**	**(ohmm)**	
I/2-3	563346,5	621784,7	197,4	15,0	1-4	2-3	10,0	62,8	34,5	54,0	40,1	34,0	53,5	39,9	
I/3-4	563348,4	621774,8	196,4	25,0	2-5	3-4	10,0	62,8	16,5	37,0	28,0				
I/4-5	563350,2	621765,0	196,0	35,0	3-6	4-5	10,0	62,8	21,5	62,0	21,8				
I/5-6	563352,1	621755,2	196,8	45,0	4-7	5-6	10,0	62,8	14,0	39,0	22,6	13,5	39,1	21,7	
I/6-7	563353,9	621745,4	199,5	55,0	5-8	6-7	10,0	62,8	17,8	21,9	51,1				
I/7-8	563355,8	621735,5	203,5	65,0	6-9	7-8	10,0	62,8	23,0	28,8	50,2				
I/8-9	563357,6	621725,7	206,5	75,0	7-10	8-9	10,0	62,8	22,5	28,2	50,1				
I/9-10	563359,4	621715,9	208,3	85,0	8-11	9-10	10,0	62,8	24,9	26,8	58,4				
I/10-11	563361,3	621706,0	209,0	95,0	9-12	10-11	10,0	62,8	16,0	15,5	64,9				
I/11-12	563363,3	621696,0	208,3	105,0	10-13	11-12	10,0	62,8	16,0	29,4	34,2	15,5	27,5	35,4	
I/12-13	563365,3	621686,0	206,5	115,0	11-14	12-13	10,0	62,8	28,0	44,5	39,5				
I/13-14	563367,2	621676,1	203,8	125,0	12-15	13-14	10,0	62,8	10,6	18,2	36,6				
I/14-15	563369,0	621666,3	200,5	135,0	13-16	14-15	10,0	62,8	28,2	54,0	32,8				
I/15-16	563370,8	621657,0	198,0	145,0	14-17	15-16	10,0	62,8	9,6	34,5	17,5	9,7	35,0	17,4	
I/16-17	563372,4	621648,1	196,3	155,0	15-18	16-17	10,0	62,8	14,8	39,9	23,3				
I/17-18	563374,1	621639,3	194,8	165,0	16-19	17-18	10,0	62,8	7,4	17,8	26,1				
I/18-19	563375,7	621630,4	193,5	175,0	17-20	18-19	10,0	62,8	6,5	19,6	20,8				
I/19-20	563377,4	621621,6	193,8	185,0	18-21	19-20	10,0	62,8	13,2	31,6	26,2	12,5	30,5	25,8	
I/20-21	563379,0	621612,7	196,4	195,0	19-22	20-21	10,0	62,8	7,6	14,2	33,6				
I/21-22	563380,7	621603,9	200,1	205,0	20-23	21-22	10,0	62,8	11,5	22,6	32,0				
I/22-23	563382,4	621595,0	203,8	215,0	21-24	22-23	10,0	62,8	13,0	22,8	35,8				
I/23-24	563384,0	621586,2	206,5	225,0	22-25	23-24	10,0	62,8	7,9	13,8	36,0	7,9	13,7	36,2	
I/24-25	563385,7	621577,3	208,0	235,0	23-26	24-25	10,0	62,8	11,0	13,5	51,2				

I/25-26	563387,0	621567,9	208,8	245,0	24-27	25-26	10,0	62,8	12,0	13,3	56,7				
I/26-27	563388,0	621558,0	209,4	255,0	25-28	26-27	10,0	62,8	24,1	27,8	54,5	23,5	27,0	54,7	
I/27-28	563389,0	621548,0	209,9	265,0	26-29	27-28	10,0	62,8	11,3	13,2	53,8				
I/28-29	563390,0	621538,1	210,3	275,0	27-30	28-29	10,0	62,8	13,7	13,5	63,8				
I/29-30	563391,0	621528,1	210,9	285,0	28-31	29-30	11,0	69,1	11,0	13,5	56,3				

Profile VE I: **AM=MN=NB=a=20 m** **a=20m; AB/2=30 m**

Control measure

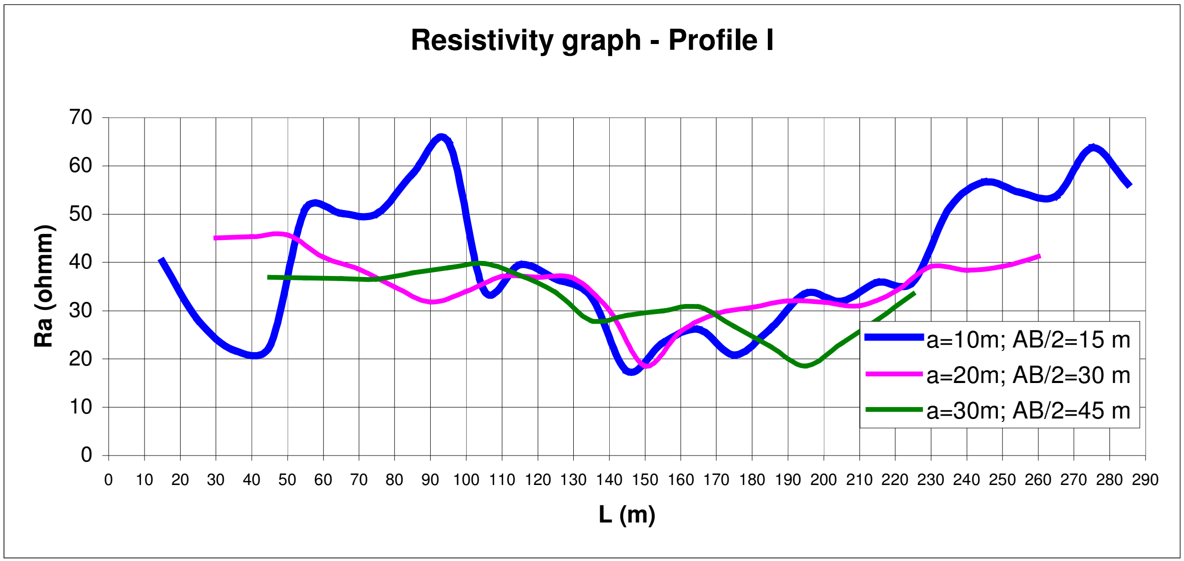
Points	Y	X	Z	L	Elektrodes		a	K	dV	I	Ra	dV	I	R	Note
No.	UTM (m)	UTM (m)	(m)	(m)	AB	MN	(m)		(mV)	(mA)	(ohmm)	(mV)	(mA)	(ohmm)	
I/4	563349,3	621769,9	191,4	30,0	1-7	3-5	20,0	125,7	75,0	209,0	45,1	74,0	208,7	44,6	
I/5	563351,2	621760,1	191,8	40,0	2-8	4-6	20,0	125,7	59,5	165,0	45,3				
I/6	563353,0	621750,3	193,8	50,0	3-9	5-7	20,0	125,7	44,0	121,0	45,7				
I/7	563354,8	621740,4	196,5	60,0	4-10	6-8	20,0	125,7	55,8	170,5	41,1				
I/8	563356,7	621730,6	199,5	70,0	5-11	7-9	20,0	125,7	67,5	220,0	38,6	66,0	218,0	38,0	
I/9	563358,5	621720,8	202,3	80,0	6-12	8-10	20,0	125,7	66,0	237,5	34,9				
I/10	563360,4	621711,0	203,3	90,0	7-13	9-11	20,0	125,7	64,5	255,0	31,8				
I/11	563362,2	621701,1	203,3	100,0	8-14	10-12	20,0	125,7	59,3	219,0	34,0				
I/12	563364,4	621690,9	202,3	110,0	9-15	11-13	20,0	125,7	54,0	183,0	37,1	54,0	182,0	37,3	
I/13	563366,2	621681,1	199,8	120,0	10-16	12-14	20,0	125,7	53,8	183,0	36,9				
I/14	563368,1	621671,2	197,3	130,0	11-17	13-15	20,0	125,7	53,5	183,0	36,7				
I/15	563369,9	621661,4	194,5	140,0	12-18	14-16	20,0	125,7	34,5	144,0	30,1				
I/16	563371,6	621652,5	192,3	150,0	13-19	15-17	20,0	125,7	15,5	105,0	18,6	15,5	95,0	20,5	
I/17	563373,2	621643,7	190,5	160,0	14-20	16-18	20,0	125,7	32,5	158,5	25,8	15,5	95,0	20,5	
I/18	563374,9	621634,9	189,3	170,0	15-21	17-19	20,0	125,7	49,5	212,0	29,3				
I/19	563376,6	621626,0	189,3	180,0	16-22	18-20	20,0	125,7	50,3	206,0	30,7				
I/20	563378,2	621617,2	190,6	190,0	17-23	19-21	20,0	125,7	51,0	200,0	32,0	50,0	198,0	31,7	
I/21	563379,9	621608,3	193,3	200,0	18-24	20-22	20,0	125,7	37,6	149,0	31,7				
I/22	563381,5	621599,5	196,9	210,0	19-25	21-23	20,0	125,7	24,2	98,0	31,0				
I/23	563383,2	621590,6	199,8	220,0	20-26	22-24	20,0	125,7	21,5	79,5	34,0				
I/24	563384,8	621581,8	202,0	230,0	21-27	23-25	20,0	125,7	19,0	61,0	39,1				
I/25	563386,5	621572,9	203,3	240,0	22-28	24-26	20,0	125,7	18,5	60,5	38,4				
I/26	563387,5	621563,0	204,1	250,0	23-29	25-27	20,0	125,7	19,0	61,0	39,1				
I/27	563388,5	621553,0	204,5	260,0	24-30	26-28	20,0	125,7	10,0	30,5	41,2				

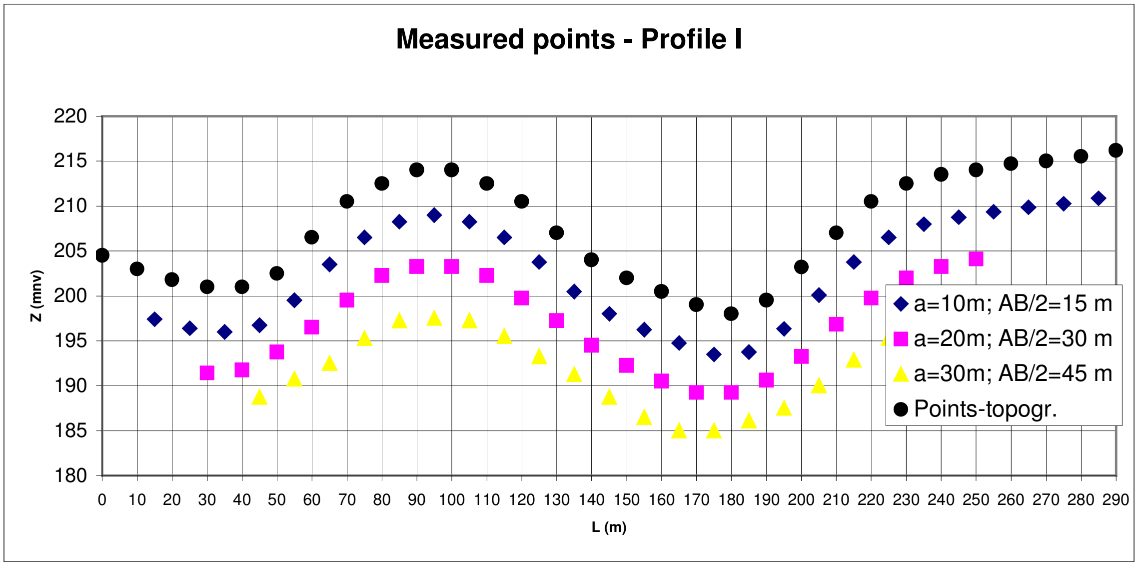
Profile VE I: **AM=MN=NB=a=30 m** **a=30m; AB/2=45 m**

Control measure

Points	Y	X	Z	L	Elektrodes		a	K	dV	I	Ra	dV	I	R	Note
No.	UTM (m)	UTM (m)	(m)	(m)	AB	MN	(m)		(mV)	(mA)	(ohmm)	(mV)	(mA)	(ohmm)	
I/5-6	563352,1	621755,2	188,8	45,0	1-10	4-7	30,0	188,5	37,0	189,0	36,9	35,0	182,0	36,2	
I/6-7	563353,9	621745,4	190,8	55,0	2-11	5-8	30,0	188,5	35,0	179,3	36,8				
I/7-8	563355,8	621735,5	192,5	65,0	3-12	6-9	30,0	188,5	33,0	169,7	36,7				

I/8-9	563357,6	621725,7	195,3	75,0	4-13	7-10	30,0	188,5	31,0	160,0	36,5				
I/9-10	563359,4	621715,9	197,3	85,0	5-14	8-11	30,0	188,5	36,0	179,3	37,8				
I/10-11	563361,3	621706,0	197,5	95,0	6-15	9-12	30,0	188,5	41,0	198,7	38,9				
I/11-12	563363,3	621696,0	197,3	105,0	7-16	10-13	30,0	188,5	46,0	218,0	39,8	45,0	215,0	39,5	
I/12-13	563365,3	621686,0	195,5	115,0	8-17	10-14	30,0	188,5	36,2	182,7	37,4				
I/13-14	563367,2	621676,1	193,3	125,0	9-18	10-15	30,0	188,5	26,4	147,3	33,8				
I/14-15	563369,0	621666,3	191,3	135,0	10-19	13-16	30,0	188,5	16,6	112,0	27,9	16,0	111,0	27,2	
I/15-16	563370,8	621657,0	188,8	145,0	11-20	14-17	30,0	188,5	18,9	122,7	29,0				
I/16-17	563372,4	621648,1	186,5	155,0	12-21	15-18	30,0	188,5	21,2	133,3	30,0				
I/17-18	563374,1	621639,3	185,0	165,0	13-22	16-19	30,0	188,5	23,5	144,0	30,8				
I/18-19	563375,7	621630,4	185,0	175,0	14-23	17-20	30,0	188,5	20,5	145,0	26,6				
I/19-20	563377,4	621621,6	186,1	185,0	15-24	18-21	30,0	188,5	17,5	146,0	22,6				
I/20-21	563379,0	621612,7	187,5	195,0	16-25	19-22	30,0	188,5	14,5	147,0	18,6	14,5	146,8	18,6	
I/22-22	563380,7	621603,9	190,0	205,0	17-26	20-23	30,0	188,5	17,4	141,3	23,2				
I/22-23	563382,4	621595,0	192,9	215,0	18-27	21-24	30,0	188,5	20,2	135,7	28,1				
I/23-24	563384,0	621586,2	195,3	225,0	19-28	22-25	30,0	188,5	23,1	130,0	33,5				




Measured points - Profile I
Z (mnv)
220
215
210
205
200
195
190
185
180
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230
240
250
260
270
280
290
L (m)
◆ a=10m; AB/2=15 m
■ a=20m; AB/2=30 m
▲ a=30m; AB/2=45 m
● Points-topogr.

11.5.2 Profile VE II

Region: **Skopje**

Location: **“MHK Zletovo” Lead and Zinc Smelter - Veles**

Method: **Geoelectrical mapping - resistivity**

Arrangement: **Wenner: AM=MN=NB=a=10, 20, 30 m**

Instruments: **Resistivity meter type IC/1B made in Serbia; Geophysical institute - Belgrade**

Azimuth: **140°**

Date: **31.07.2007**

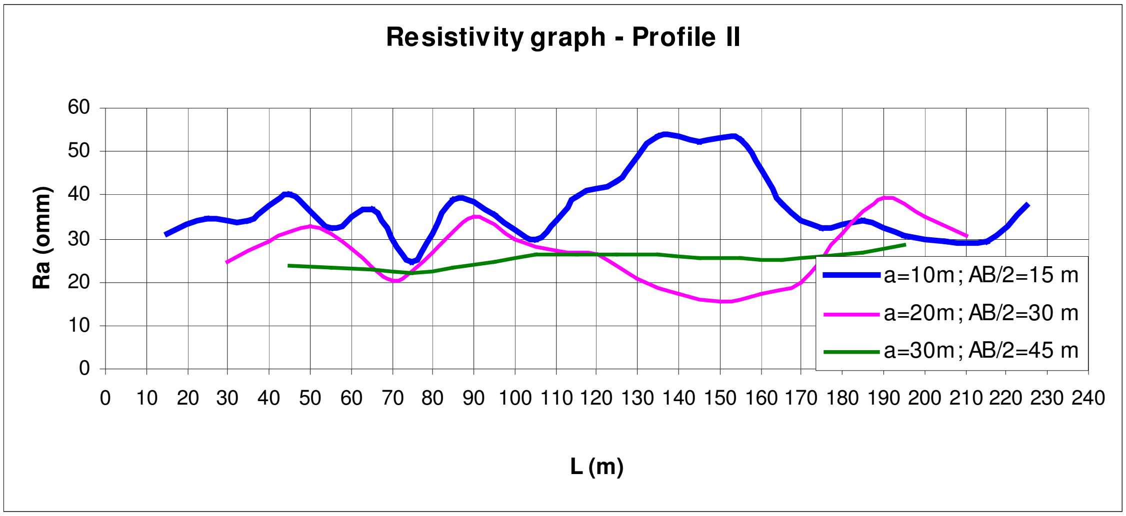
Operator: **Novica Stolic**

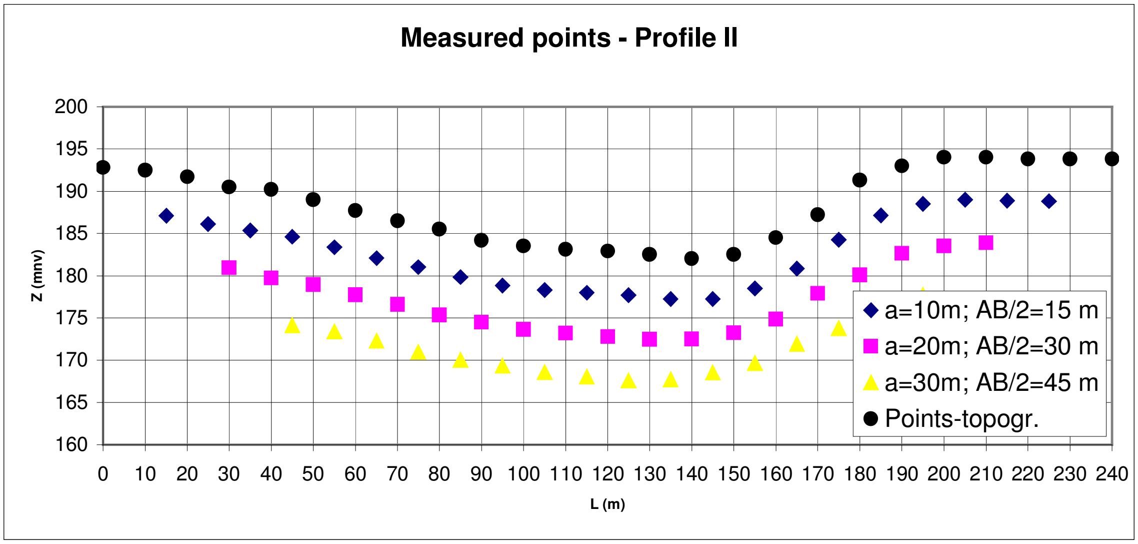
Profile VE II:		AM=MN=NB=a=10 m					a=10m; AB/2=15 m					Control measure			
Points	Y	X	Z	L	Elektrodes		a	K	dV	I	Ra	dV	I	R	Note
No.	UTM (m)	UTM (m)	(m)	(m)	AB	MN	(m)		(mV)	(mA)	(ohmm)	(mV)	(mA)	(ohmm)	
II/2-3	563439,8	621825,5	187,1	15,0	1-4	2-3	10,0	62,8	17,0	34,2	31,2	16,0	34,1	29,5	
II/3-4	563446,2	621817,9	186,1	25,0	2-5	3-4	10,0	62,8	22,8	41,6	34,4				
II/4-5	563452,7	621810,2	185,4	35,0	3-6	4-5	10,0	62,8	52,5	97,0	34,0				
II/5-6	563459,2	621802,6	184,6	45,0	4-7	5-6	10,0	62,8	11,0	17,2	40,2				
II/6-7	563465,7	621795,0	183,4	55,0	5-8	6-7	10,0	62,8	14,0	27,2	32,3	13,5	27,1	31,3	
II/7-8	563472,2	621787,4	182,1	65,0	6-9	7-8	10,0	62,8	27,0	46,5	36,5				
II/8-9	563478,7	621779,8	181,0	75,0	7-10	8-9	10,0	62,8	28,0	72,0	24,4				
II/9-10	563485,1	621772,2	179,9	85,0	8-11	9-10	10,0	62,8	98,0	158,0	39,0	96,0	156,0	38,7	
II/10-11	563491,6	621764,6	178,9	95,0	9-12	10-11	10,0	62,8	13,0	23,2	35,2				
II/11-12	563498,1	621756,9	178,3	105,0	10-13	11-12	10,0	62,8	40,0	84,5	29,7				
II/12-13	563504,6	621749,3	178,0	115,0	11-14	12-13	10,0	62,8	69,0	109,0	39,8	69,0	105,1	41,3	
II/13-14	563511,1	621741,7	177,7	125,0	12-15	13-14	10,0	62,8	45,5	66,5	43,0	33,0	50,3	41,2	
II/14-15	563517,5	621734,1	177,3	135,0	13-16	14-15	10,0	62,8	23,5	27,5	53,7				T15-pies.
II/15-16	563524,8	621727,3	177,3	145,0	14-17	15-16	10,0	62,8	17,5	21,0	52,4				
II/16-17	563532,8	621721,3	178,5	155,0	15-18	16-17	10,0	62,8	52,0	62,0	52,7				
II/17-18	563540,8	621715,3	180,9	165,0	16-19	17-18	10,0	62,8	12,0	19,8	38,1	12,5	21,0	37,4	
II/18-19	563548,8	621709,3	184,3	175,0	17-20	18-19	10,0	62,8	19,2	37,5	32,2				
II/19-20	563556,8	621703,3	187,2	185,0	18-21	19-20	10,0	62,8	12,5	23,0	34,1				T20-pies.
II/20-21	563564,9	621697,4	188,5	195,0	19-22	20-21	10,0	62,8	11,5	23,5	30,7	11,0	23,0	30,1	
II/21-22	563572,1	621690,6	189,0	205,0	20-23	21-22	10,0	62,8	29,5	63,0	29,4				
II/22-23	563578,3	621682,8	188,9	215,0	21-24	22-23	10,0	62,8	9,8	21,0	29,3				
II/23-24	563584,5	621675,0	188,8	225,0	22-25	23-24	10,0	62,8	60,0	100,5	37,5	60,0	100,0	37,7	

Profile II:		**AM=MN=NB=a=20 m**						**a=20m; AB/2=30 m**				**Control measure**			
Points	**Y**	**X**	**Z**	**L**	**Elektrodes**		**a**	**K**	**dV**	**I**	**Ra**	**dV**	**I**	**R**	**Note**
No.	**UTM (m)**	**UTM (m)**	**(m)**	**(m)**	**AB**	**MN**	**(m)**		**(mV)**	**(mA)**	**(omm)**	**(mV)**	**(mA)**	**(omm)**	
II/4	563449,5	621814,1	181,0	30,0	1-7	3-5	20,0	125,7	20,5	105,0	24,5				
II/5	563456,0	621806,4	179,8	40,0	2-8	4-6	20,0	125,7	28,8	123,0	29,4				
II/6	563462,4	621798,8	179,0	50,0	3-9	5-7	20,0	125,7	37,0	141,0	33,0	36,8	140,0	33,0	
II/7	563468,9	621791,2	177,8	60,0	4-10	6-8	20,0	125,7	27,1	123,5	27,5				
II/8	563475,4	621783,6	176,6	70,0	5-11	7-9	20,0	125,7	17,1	106,0	20,3	17,0	106,0	20,2	
II/9	563481,9	621776,0	175,4	80,0	6-12	8-10	20,0	125,7	20,1	94,5	26,7				
II/10	563488,4	621768,4	174,5	90,0	7-13	9-11	20,0	125,7	23,0	83,0	34,8				
II/11	563494,9	621760,8	173,7	100,0	8-14	10-12	20,0	125,7	31,0	131,5	29,6				
II/12	563501,3	621753,1	173,2	110,0	9-15	11-13	20,0	125,7	39,0	180,0	27,2	39,0	180,0	27,2	
II/13	563507,8	621745,5	172,8	120,0	10-16	12-14	20,0	125,7	22,0	105,0	26,3				
II/14	563514,3	621737,9	172,5	130,0	11-17	13-15	20,0	125,7	4,9	30,0	20,5	4,7	27,0	21,9	
II/15	563520,8	621730,3	172,5	140,0	12-18	14-16	20,0	125,7	6,3	45,5	17,3				
II/16	563528,8	621724,3	173,3	150,0	13-19	15-17	20,0	125,7	7,6	61,0	15,7	23,0	61,0	47,4	
II/17	563536,8	621718,3	174,9	160,0	14-20	16-18	20,0	125,7	7,3	52,5	17,5				
II/18	563544,8	621712,3	177,9	170,0	15-21	17-19	20,0	125,7	7,0	44,0	20,0				
II/19	563552,8	621706,3	180,1	180,0	16-22	18-20	20,0	125,7	13,0	52,5	31,1				
II/20	563560,8	621700,3	182,7	190,0	17-23	19-21	20,0	125,7	19,0	61,0	39,1	20,2	74,0	34,3	
II/21	563569,0	621694,6	183,5	200,0	18-24	20-22	20,0	125,7	17,2	62,0	34,8				
II/22	563575,2	621686,7	183,9	210,0	19-25	21-23	20,0	125,7	15,3	63,0	30,5				

Profile VE II:		**AM=MN=NB=a=30 m**						**a=30m; AB/2=45 m**				**Control measure**			
Points	**Y**	**X**	**Z**	**L**	**Elektrodes**		**a**	**K**	**dV**	**I**	**Ra**	**dV**	**I**	**R**	**Note**
No.	**UTM (m)**	**UTM (m)**	**(m)**	**(m)**	**AB**	**MN**	**(m)**		**(mV)**	**(mA)**	**(ohmm)**	**(mV)**	**(mA)**	**(ohmm)**	
II/5-6	563459,2	621802,6	174,1	45,0	1-10	4-7	30,0	188,5	22,5	178,0	23,8				
II/6-7	563465,7	621795,0	173,4	55,0	2-11	5-8	30,0	188,5	19,1	154,0	23,4				
II/7-8	563472,2	621787,4	172,3	65,0	3-12	6-9	30,0	188,5	15,8	130,0	22,9				
II/8-9	563478,7	621779,8	171,0	75,0	4-13	7-10	30,0	188,5	12,4	106,0	22,1	12,2	105,1	21,9	
II/9-10	563485,1	621772,2	170,0	85,0	5-14	8-11	30,0	188,5	12,3	99,3	23,3				
II/10-11	563491,6	621764,6	169,3	95,0	6-15	9-12	30,0	188,5	12,1	92,7	24,7				
II/11-12	563498,1	621756,9	168,6	105,0	7-16	10-13	30,0	188,5	12,0	86,0	26,3	11,5	84,5	25,7	
II/12-13	563504,6	621749,3	168,0	115,0	8-17	11-14	30,0	188,5	11,3	81,3	26,3				
II/13-14	563511,1	621741,7	167,6	125,0	9-18	12-15	30,0	188,5	10,7	76,5	26,3				
II/14-15	563517,5	621734,1	167,7	135,0	10-19	13-16	30,0	188,5	10,0	71,8	26,3	9,1	67,0	25,6	
II/15-16	563524,8	621727,3	168,5	145,0	11-20	14-17	30,0	188,5	15,0	110,5	25,6				
II/16-17	563532,8	621721,3	169,6	155,0	12-21	15-18	30,0	188,5	20,0	149,3	25,3				
II/17-18	563540,8	621715,3	171,9	165,0	13-22	16-19	30,0	188,5	25,0	188,0	25,1	24,0	185,0	24,5	

II/18-19	563548,8	621709,3	173,8	175,0	14-23	17-20	30,0	188,5	21,6	158,0	25,8
II/19-20	563556,8	621703,3	175,6	185,0	15-24	18-21	30,0	188,5	18,2	128,0	26,8
II/20-21	563564,9	621697,4	177,7	195,0	16-25	19-22	30,0	188,5	14,8	98,0	28,5



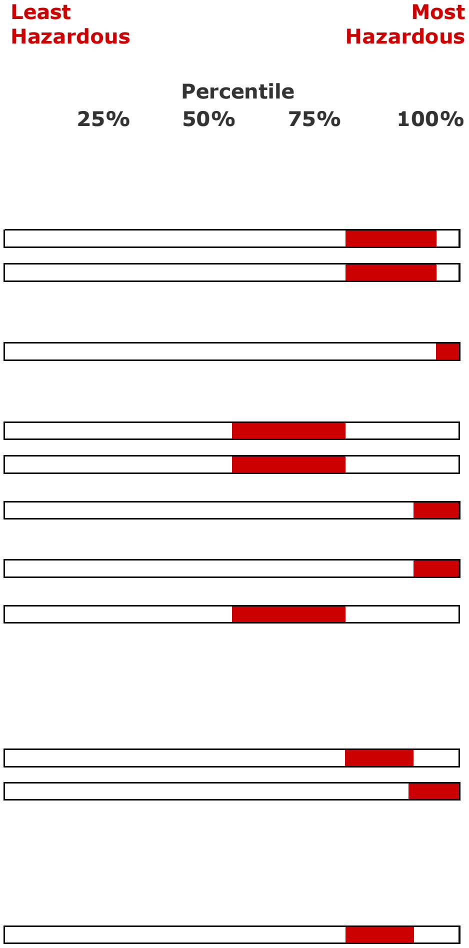


11.6 Environmental related annexes

11.6.1 Hazard ranking of Lead

More hazardous than most chemicals in 11 out of 11 ranking systems
Ranked as one of the most hazardous compounds (worst 10%) to ecosystems and human health.

Chemical: LEAD
CAS Number: 7439-92-1



Human Health Rankings

Toxicity only

- Ingestion Toxicity Weight (RSEI)
- Inhalation Toxicity Weight (RSEI)

Toxicity and persistence

- Human Health Risk Screening Score (WMPT)

Toxicity and exposure potential

- Cancer Risk Score - Air Releases (EDF)
- Cancer Risk Score - Water Releases (EDF)
- Noncancer Risk Score - Air Releases (EDF)
- Noncancer Risk Score - Water Releases (EDF)
- Worker Exposure Hazard Score (IRCH)

Ecological Health Rankings

Toxicity and persistence

- Environmental Hazard Value Score (IRCH)
- Ecological Risk Screening Score (WMPT)

Integrated Environmental Rankings

Combined human and ecological scores

- Total Hazard Value Score (IRCH)

11.6.2 Hazard Ranking of Zinc

11.6.3 Hazard Ranking of Cadmium

11.6.4 Permit level for waters and soil and disposal

Parameter	**Surface Water**	**Groundwater**	**Drinking Water**	**Soil (Dutch)**	**Landfill Directive EU**	
					Limit values for non-hazardous wast	
					L/S = 2 l/kg	**L/S= 10 l/kg**
Cu	µg/l Class I/II 10 Class III/IV50 Class IV > 50	µg/l Class I/II 10	0,1	190	25	50
Hg	µg/l ClassI/II 0.2 ClassIII/IV 1 Class IV > 1	µg/l ClassI/II 0.2	0,001	10	0.05	0.2
Cd	µg/l ClassI/II 0.1 ClassIII/IV 10 ClassIV >10	µg/l ClassI/II 0.1	0,005	12	0.6	1
Cr	µg/l ClassI/II 10 ClassIII/IV 50 ClassIV >50	µg/l ClassI/II 10	Cr(VI) 0,05 Cr(III) 0,10	100	4	10
Pb	µg/l ClassI/II 10 ClassIII/IV 30 ClassIV >30	µg/l ClassI/II 10	0,01	530	5	10
Zn	µg/l ClassI/II 100 ClassIII/IV200 ClassIV >200	µg/l ClassI/II 100	0,1	720	25	50
Ni	µg/l Class I/II 50 ClassIII/IV 100 ClassIV >100	µg/l Class I/II 50	0,01	210	5	10
α-HCH		1		0,003		
γ-HCH		1		0,00005		
β-HCH		1		0,009		
δ-HCH		1		0,00006		
Aldrin		0,003				
Dieldrin		0,001		0,005		
DDE		0,001		0,01		
DDD		0,001				
$CHCl_3$		2				
CCl_4		2				
C_2HCl_3		3				
$CHCl_2Br$		2				
C_2Cl_4		2				
$CHBr_3$		2				
Naphtalene		1				
Fenantrene		5				
Acenaphtene		5				
Antracene		5				
Fluorantrene		0,01				
Pyrene		0,01				
Benz antracene		0,01				
Krizen		0,01				
Benz(b)fluorantrene		0,01				
Benz(k)fluorantrene		0,01				
Benz(a)pyrene		0,01				
Indeno(1,2,3,cd)pyrene		0,01				
Dibenz(a,h)antracene		0,01				
Benzo(g,h,i)perylene		0,01				

11.6.5 Data needs for treatment technologies for slag and contaminated soil

Technology	Data requirement
Capping	• Extent of contamination • Depth of ground water table • Climate conditions • Waste volume
Solidification/stabilization	• Material concentration • Moisture content • Bulk density • Grain size distribution • Waste volume • Inorganic salt content • Organic content • Debris size and type • Toxicity-TCLP
Soil washing/acid leaching	• Soil type and uniformity • Moisture content • Bulk density • Moisture content • Clay content • Metal concentration/species • pH • Cation exchange capacity • Organic mater content • Waste volume • Mineralogical characteristics • Debris size and type • Toxicity-TCLP[30]
Off-site land disposal	• Soil characterization as dictated by the landfill operator and the governing regulatory agency • Waste volume • Toxicity-TCLP
Reuse/Recycling	• Potential buyer/user • Waste volume/weight • Metal content for acceptance by smelter

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[30] TCLP-Toxicity Characteristic Leaching Procedure

11.6.6 Required Standards for Capping

The landfill rehabilitation should include the following components.

- Landscaping of slopes and surfaces to a conductive and stable profile
- The completion of the final capping layer system
- The construction of access roads on the Landfill
- The construction of surface water drains
- The supply, installation and maintenance of vegetative covering.

11.6.6.1 Landfill capping system

The capping system should be considered as comprising the respective composite layers between the final level of the waste and the final topsoil cover to be seeded and planted upon completion and closure of the landfill.

It is recommended that the maximum use is to be made of locally available earthen material for this purpose.

- Foundation trimming and profiling of the top slag layer
- Compacted Clay Layer permeability **$< 1 \times 10^{-8}$ m. s^{-1}**
- Granular soil drainage Layer
- Sub-soil cover
- Vegetative topsoil layer

No	Layer Zone Top - Down
1	Vegetative topsoil layer
2	Sub – soil cover (optional)
3	Granular soil drainage Layer (optional)
4	Compacted Clay Layer permeability **$< 1 \times 10^{-7}$ ms^{-1}**
5	Slag – Waste

11.6.6.2 Foundation trimming and profiling of the top slag layer (gradient 3%)

Trimming and profiling (compacting if necessary) of the top slag layer determine the design and the final shape of the rehabilitated landfill.

11.6.6.3 Compacted Clay layer

- The natural clay liner **(total 500mm thickness)** shall be placed in two layers each 250mm. The upper surface of each layer shall be parallel to the final design of the liner as appropriate. If any layer of the mineral liner will not be covered with a subsequent layer **within 24 hours** of its placement, then measures should be taken to prevent damage to or desiccation of the mineral liner until such time as the cover is placed. The liner constructed on slopes, construction shall take place from the bottom of the slope, upwards.

- All joints between adjacent areas of material placed at different periods shall be benched into by the depth of each layer and overlapped by **at least 500 mm per layer.**
- **The moisture content of the material at the point of deposition shall lie within the range of the OMC, to OMC+5%.The material should be compacted to at least 95% of Standard Proctor maximum dry density.**
- The contracting company shell submit a Method statement detailing the proposed sources and processing of materials and the plant to be employed in its placement and compaction for approval of the owner companies representative consultant.
- Compaction field trials shall be carried out by the contractor under the supervision and to the acceptance of the representative consultant, prior to the acceptance of any material for inclusion in the capping layer..
- The position and level of each test or sampling location on the mineral liner shall be surveyed.

11.6.6.4 Drainage Layer - optional

A 300 mm thick layer of drainage sand or suitable granular material has to be placed to discharge infiltrated storm water to the storm water drainage placed at the outside borders of the landfill.

11.6.6.5 Sub-soil cover

A 750 mm layer of subsoil is required in order to provide further protection for the mineral liner. This protection is required against the possibility of establishment of self sown plants with deep root system and to minimize the impacts of borrowing animals. The layer will also help with the uptake of excessive rainfall on the surface of the Landfill

11.6.6.6 Vegetative Topsoil

The topsoil shall be taken from on-site and off-site stockpiles or borrow pits wherever available. The total thickness of the topsoil shall be a **minimum of 150 mm.**

The topsoil shall have been temporarily stored, placed and handled in a manner so as not adversely affect its vegetation supporting qualities and characteristics.

Topsoil operations shall commence within one week of completion of placement of the underlying subsoil layer.

11.6.6.7 Access Roads and surface water drainage

Access roads shall be designed and installed on the restored cap

11.6.6.8 Surface Drainage ditches

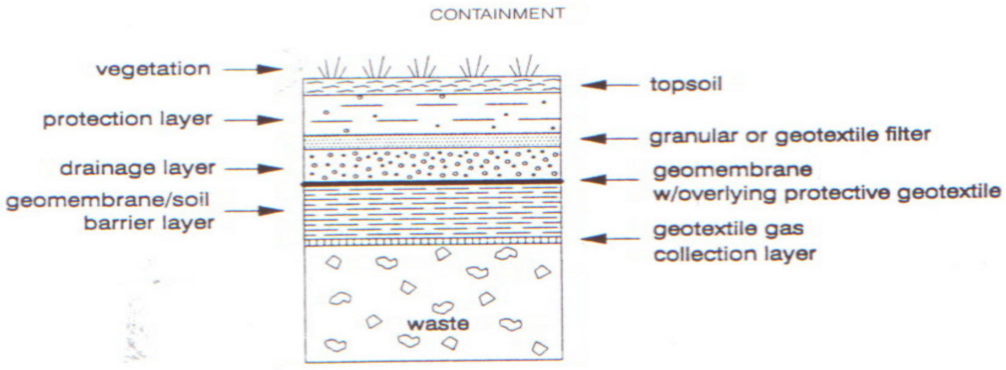
Surface water ditches shall be constructed either side of access roads to **a maximum depth of 600 mm** with a cross sectional area of 0,30 m².

11.6.6.9 Erosion measures

The access roads and surface water drains shall be constructed immediately after the placement of topsoil to ensure that no erosion may occur.

11.6.6.10 Vegetation on Landfill

- Establish an erosion control program to stabilize the soil soon after final capping of the landfill, in order to prevent erosion.
- Determine the soil nutrient status; before or during grass and ground cover trials soil tests
- Should be carried out to determine; ph, major nutrients content (nitrogen, potassium and phosphorus.
- Determine soil bulk density, since cover soil is frequently compacted by Landfill equipment during spreading operations increasing bulk densities, and this could severely restrict plant root growth.
- Modify soil cover is required: The soil over the entire planting area should be modified with lime, fertilizer in accordance with results of soil tests carried out prior to planting. These measures should be incorporated into the **top150mm of soil.**
- Select Landfill-tolerant species: Grass and other ground covers can be selected for planting in the soil cover by evaluating the results of the environmental plots established earlier to determine such Landfill-tolerant species.
- Plant grass and ground covers: It is generally desirable to embed the seed in the soil. Mulches can be used as an alternative to embedding the seed.



11.6.7 List of public green areas in Veles Municipality

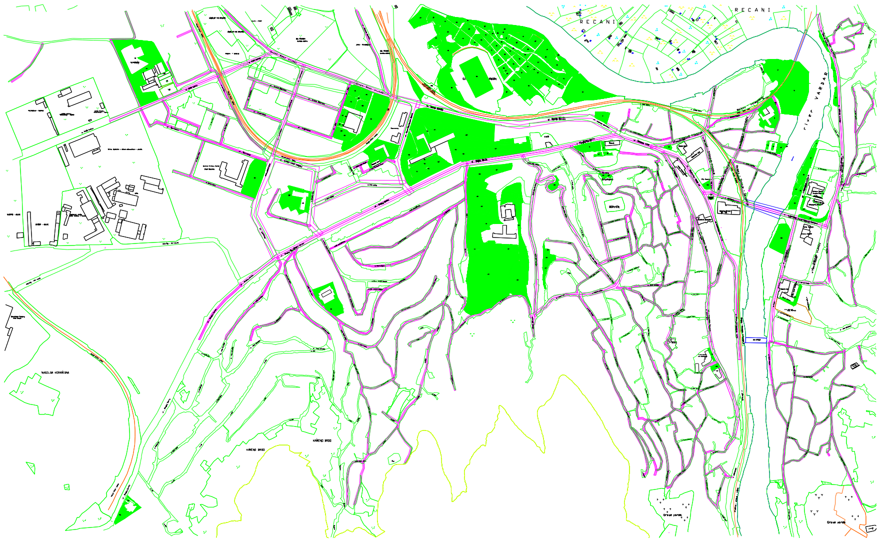
List of GREEN AREAS - CITY VELES				
No	**LAND USE**	**AREA NAME**	**AREA**	**TOT. AREA**
1	PARK	**KEJ**		**471**
2	PARK	**KEJ**		**517**
3	PARK	**KEJ**		**309**
4	PARK-GRASS	**BRIDGE**		**4800**
5	PARK-GRASS	**BRIDGE**		**10611**
6	PARK	**Primary School TRAJKO ANDREEV**		**2499**
7	PARK	**PARK**		**1110**
8	PARK	Medical Center Poliklinika	1808	
9	PARK	Medical Center Poliklinika	286	
10	PARK	Medical Center Poliklinika	186	
11	PARK	Medical Center Poliklinika	187	
		Medical Center Poliklinika	**TOTAL**	**2467**
12	PARK	**Sqare**	**227**	**227**
13	PARK	Kindergarden DIMCE MIRCEV	96	
14	PARK	Kindergarden DIMCE MIRCEV	691	
15	PARK	Kindergarden DIMCE MIRCEV	118	
		Kindergarden DIMCE MIRCEV	**TOTAL**	**905**
16	PARK	**PARK BUS STATION**	**146**	**146**
17	PARK	**PARK BUS STATION**	**1029**	**1029**
18	PARK	**PARK BUS STATION**	**1179**	**1179**
19	PARK-TREES	CITY PARK	1518	
20	PARK-TREES	CITY PARK	557	
21	PARK-TREES	CITY PARK	983	
22	PARK	CITY PARK	1007	
23	PARK-TREES	CITY PARK	314	
24	PARK-TREES	CITY PARK	969	
25	PARK	CITY PARK	166	
26	PARK	CITY PARK	422	
27	PARK-TREES	CITY PARK	377	
28	PARK-TREES	CITY PARK	1068	
29	PARK-TREES	CITY PARK	1047	
30	PARK	CITY PARK	626	
31	PARK-TREES	CITY PARK	858	
32	PARK-TREES	CITY PARK	359	
33	PARK	CITY PARK	140	
34	PARK-TREES	CITY PARK	311	
35	PARK-TREES	CITY PARK	985	
36	PARK-TREES	CITY PARK	226	
37	PARK-TREES	CITY PARK	256	
38	PARK	CITY PARK	491	
39	PARK	CITY PARK	405	

40	PARK-TREES	CITY PARK	877	
41	PARK-TREES	CITY PARK	830	
42	PARK-TREES	CITY PARK	406	
43	PARK-TREES	CITY PARK	1145	
44	PARK-TREES	CITY PARK	1764	
45	PARK-TREES	CITY PARK	1416	
46	PARK-TREES	CITY PARK	2553	
47	PARK-TREES	CITY PARK	2166	
53	PARK-TREES	CITY PARK	432	
54	PARK-TREES	CITY PARK	624	
55	PARK-TREES	CITY PARK	376	
56	PARK-TREES	CITY PARK	616	
57	PARK-TREES	CITY PARK	1380	
58	PARK-TREES	CITY PARK	568	
59	PARK-TREES	CITY PARK	585	
60	PARK-TREES	CITY PARK	193	
61	PARK-TREES	CITY PARK	471	
62	PARK-TREES	CITY PARK	412	
63	PARK	CITY PARK	52	
64	PARK-TREES	CITY PARK	220	
65	PARK-TREES	CITY PARK	4629	
66	PARK-TREES	CITY PARK	861	
67	PARK-TREES	CITY PARK	613	
68	PARK-TREES	CITY PARK	4937	
69	PARK-TREES	CITY PARK	758	
70	PARK-TREES	CITY PARK	744	
71	PARK-TREES	CITY PARK	869	
72	PARK-TREES	CITY PARK	1141	
73	PARK-TREES	CITY PARK	797	
51	PARK	CITY PARK	610	
75	PARK-TREES	CITY PARK	370	
		CITY PARK	**TOTAL**	**46503**
49	PARK	**SQUARE**	**263**	**263**
50	PARK	CITY FOOTBALL STANION	5714	
52	PARK	CITY FOOTBALL STANION	6600	
		CITY FOOTBALL STANION	**TOTAL**	**12314**
74	PARK	CHILDRENS PLAYGROUND	6402	6402
76	PARK	HIGH SCHOOL 'BORIS KIDRIC	6848	6848
77	SPORT FIELD	HIGH SCHOOL 'BORIS KIDRIC	(-)1944	1944
		HIGH SCHOOL 'BORIS KIDRIC	**TOTAL**	**6848**
79	PARK	MUNICIPALITY VELES	1018	
80	PARK	MUNICIPALITY VELES	7201	
81	PARK	MUNICIPALITY VELES	1053	
82	PARK	MUNICIPALITY VELES	58	
83	PARK	MUNICIPALITY VELES	1052	

84	PARK	MUNICIPALITY VELES	465	
85	PARK	MUNICIPALITY VELES	149	
86	PARK	MUNICIPALITY VELES	93	
87	PARK	MUNICIPALITY VELES	26	
88	SPORT FIELD	MUNICIPALITY VELES	(-)513	
89	PARK	MUNICIPALITY VELES	1285	
48	PARK	MUNICIPALITY VELES	1046	
		MUNICIPALITY VELES	**TOTAL**	**13446**
90	PARK	PARK - GIMNASYUM	5740	
91	PARK	PARK - GIMNASYUM	749	
92	PARK	PARK - GIMNASYUM	1990	
93	PARK	PARK - GIMNASYUM	443	
94	PARK	PARK - GIMNASYUM	1011	
95	PARK	PARK - GIMNASYUM	1018	
96	PARK	PARK - GIMNASYUM	42	
		PARK - GIMNASYUM	**TOTAL**	**10992**
97	PARK	MLADINSKI PARK	8452	
98	PARK-TREES	MLADINSKI PARK	534	
		MLADINSKI PARK	**TOTAL**	**8985**
100	PARK	HIGH SCHOOL "KOLE NEDELKOVSKI	10376	
101	SPORT FIELD	HIGH SCHOOL "KOLE NEDELKOVSKI	(-)4704	
102	PARK	HIGH SCHOOL "KOLE NEDELKOVSKI	262	
103	PARK	HIGH SCHOOL "KOLE NEDELKOVSKI	744	
104	PARK	HIGH SCHOOL "KOLE NEDELKOVSKI	1313	
		HIGH SCHOOL "KOLE NEDELKOVSKI	**TOTAL**	12696
105	PARK	**Central Primary School 'Vasil**	**5125**	**5125**
106	PARK-GRASS	**PARK**	**594**	**594**
107	PARK-GRASS	School Blaze Koneski	(-)664	
108	PARK-TREES	School Blaze Koneski	(-)877	
109	PARK-GRASS	School Blaze Koneski	(-)1984	
110	PARK-TREES	School Blaze Koneski	11784	
		School Blaze Koneski	**TOTAL**	**8259**
99	PARK	**KINDER GARDEN**	**1160**	**1160**
112	PARKING	Medical Center 'General Hospit	(-)1726	
111	PARK-GRASS	Medical Center 'General Hospit	5060	
113	PARK-TREES	Medical Center 'General Hospit	7599	
114	PARK-TREES	Medical Center 'General Hospit	1050	
118	PARK-GRASS	Medical Center 'General Hospit	3836	
119	PARK-GRASS	Medical Center 'General Hospit	19829	
		Medical Center 'General Hospit	**TOTAL**	**31812**
115	PARK-GRASS	**GREEN**	**106**	**106**
116	PARK-GRASS	**GREEN**	**396**	**396**
117	PARK-GRASS	**GREEN**	**728**	**728**
120	PARK	**PARK BUS STATION**	**486**	**486**
121	PARK	**PARK BUS STATION**	**350**	**350**

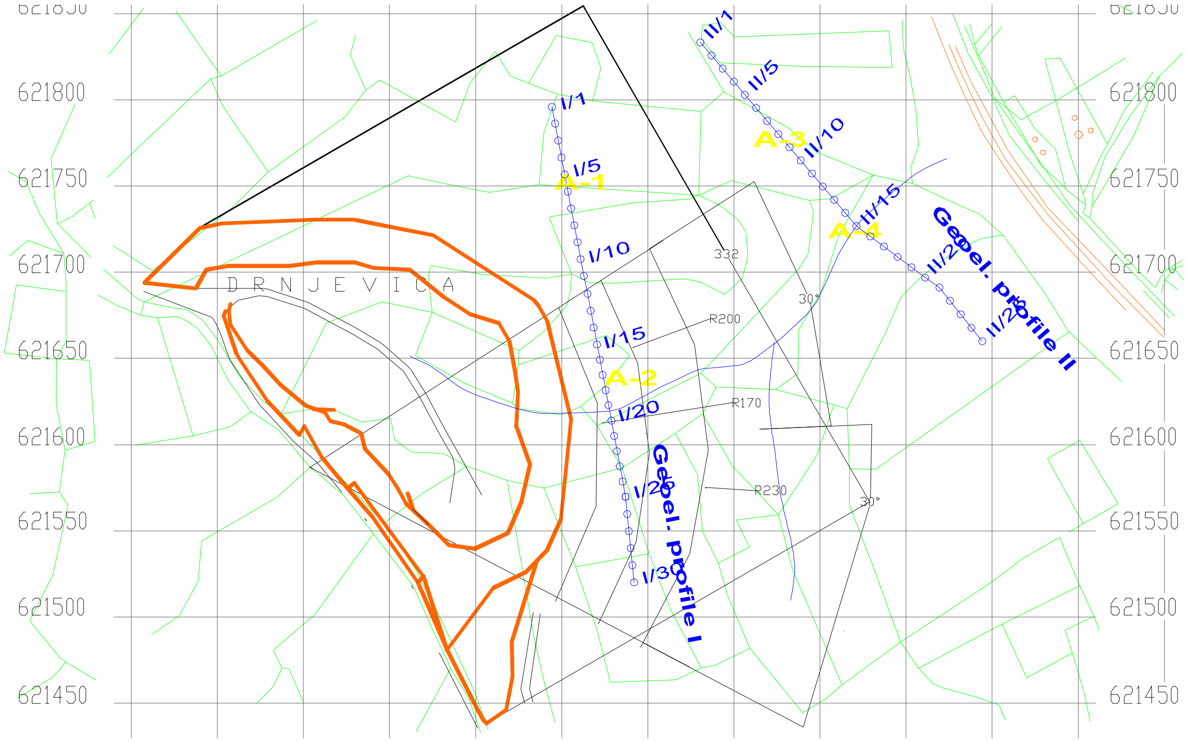
123	PARK	**PARK BUS STATION**	**869**	**869**
122	PARK	**Primary School Trajko Andreev**	**123**	**123**
124	PARK	**PARK**	**547**	**547**
125	PARK	**Sqare**	**398**	**398**
126	PARK	Shumsko	119	
127	PARK	Shumsko	149	
		Shumsko	**TOTAL**	**269**
128	PARK	**PARK**	**3476**	**3476**
129	PARK	**PARK**	**846**	**846**
130	PARK	**Economic School Jovce Teslicko**	**789**	**789**
131	PARK-GRASS	**Primary School Kiril and Metod**	**273**	**273**
132	PARK-GRASS	**KINDERGARDEN**	**335**	**335**
133	PARK-GRASS	**PARK**	**11753**	**11753**
134	PARK	**KINDERGARDEN**	5685	
135	PARK	**KINDERGARDEN**	(-)1390	
			TOTAL	**4295**
136	PARK	**KINDERGARDEN**	1667	
137	PARK	**KINDERGARDEN**	70	
			TOTAL	**1737**
	TOTAL GREEN AREAS			**228.237**

11.6.7.1 Map of public “green” areas in Veles municipality

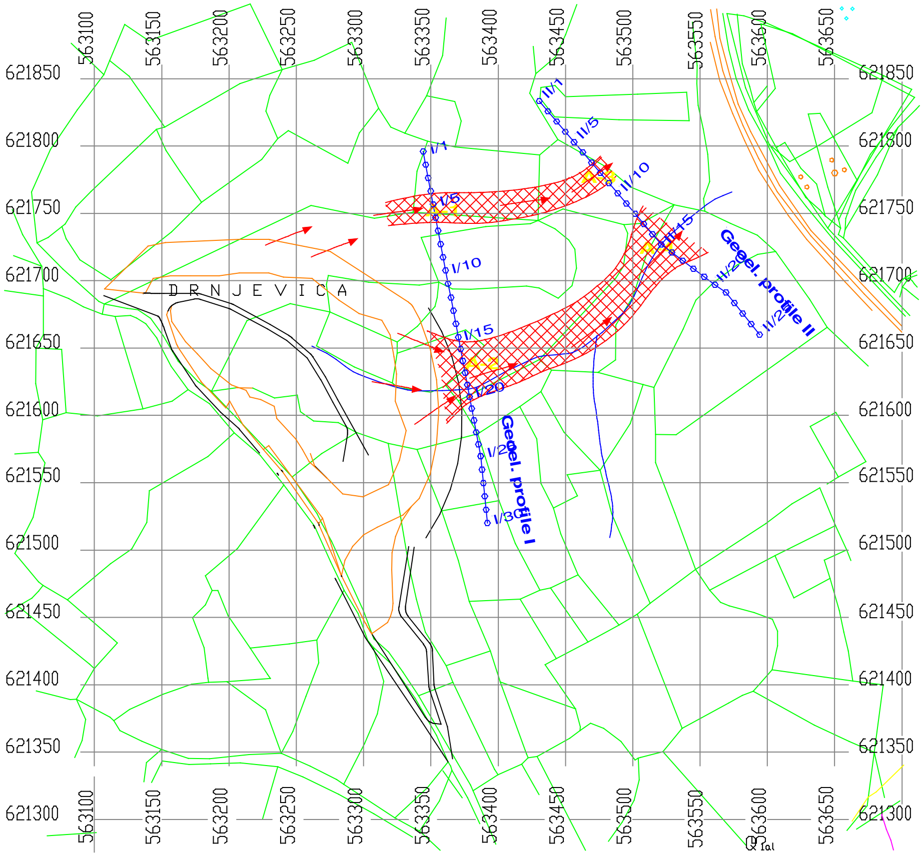


11.7 Maps

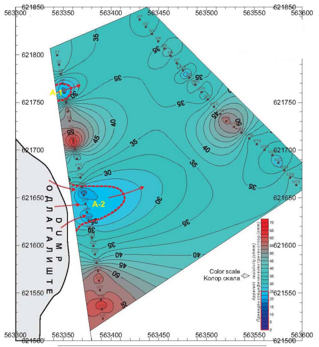
11.7.1 Maps – Veles – Profiles I till II



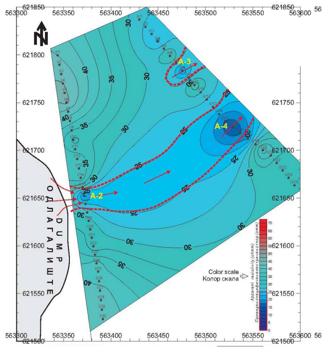
11.7.2 Maps – Veles Slag Dump – Horizontal Anomaly Zones



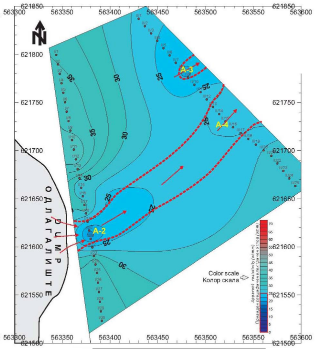
Layer – 05 meter:



Layer – 10 meter:

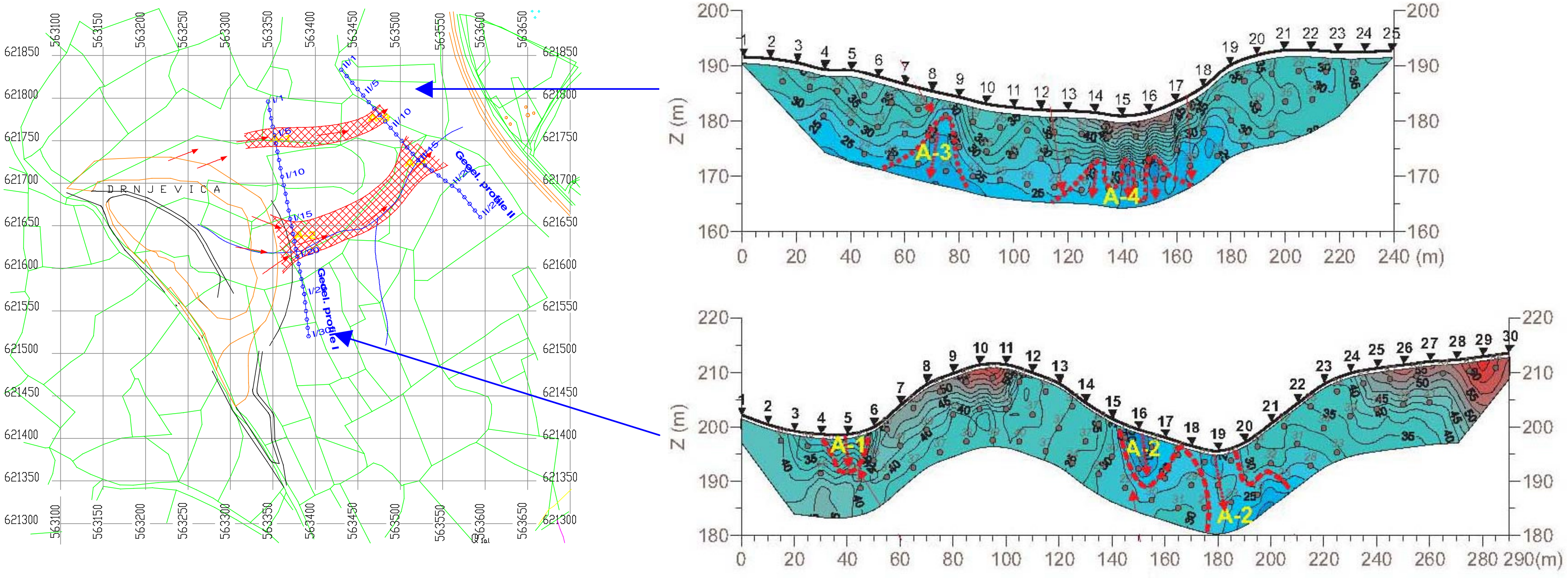


Layer – 15 meter:

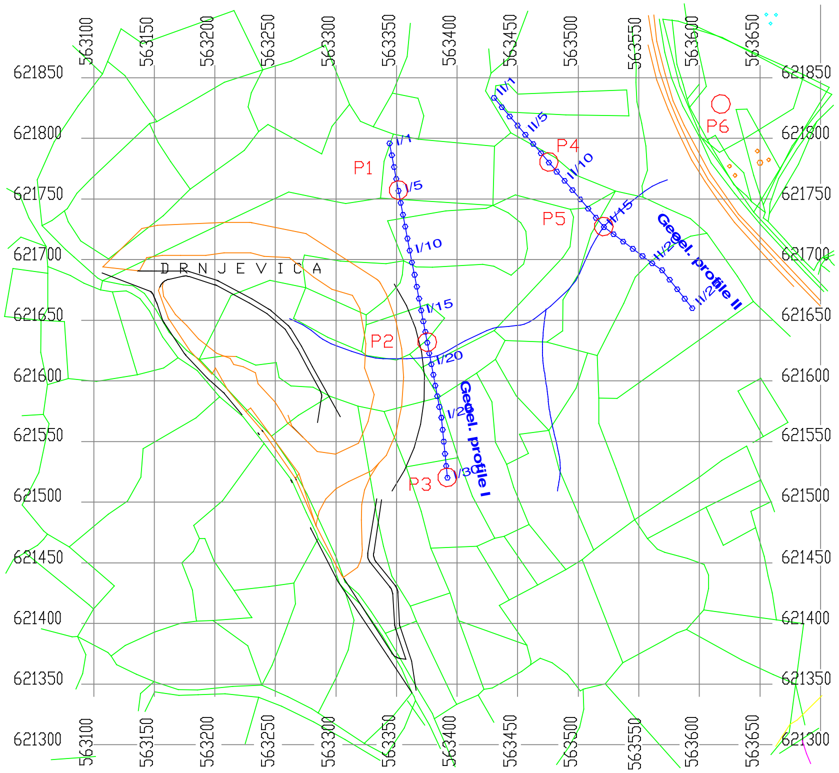


11.7.3 Maps – Veles – Vertical Anomaly Zones

11.7.4 Maps – Veles Slag Dump – Vertical Anomaly Zones



11.7.5 Proposal of core drills and piezometer



11.8 Example of yearly production protocol

TITOV VELES

BLAST FURNACE	**JAN 95**	**FEB 95**	**MAR 95**	**APR 95**	**MAY 95**	**JUN 95**	**JUL 95**	**AUG 95**	**SEP 95**	**OCT 95**	**NOV 95**	**DEC 95**	**YEAR**
MATERIAL FLOWS AND ASSAYS													
(All T Dry)													
Coke (Cold T)													0,00
Assay (%): Ash	9,50	9,50	9,50	9,50	9,80	9,30	9,30	9,50	9,50	9,50	9,50	12,55	
C	89,50	89,50	89,60	89,60	89,20	89,70	89,70	89,50	89,50	89,50	89,60	86,45	#DIV/0!
Ash Assay (%): FeO	9,89	10,47	10,17	10,24	10,93	13,17	13,16	11,52	11,40	11,51	18,73	11,20	
SiO2	40,49	40,00	40,00	40,00	39,25	39,06	39,06	38,15	39,25	38,15	39,95	42,89	
Al2O3	_	_	_										
Coke (Hot T)	1587,96	3296,00	3057,20	5321,00	5293,80	5144,50	5139,90	4030,00	1020,00	4482,50	4093,00	3725,10	46190,96
Sinter (T)	4285,00	8894,00	8087,00	14526,00	14584,63	14081,98	14106,72	10689,02	2519,00	11900,00	11411,00	9254,00	124338,35
Zn (T)	1758,99	3607,41	3291,41	5701,45	5511,09	5599,42	5670,48	4212,33	1002,56	4811,17	4913,57	3975,52	50055,40
Pb (T)	878,43	1846,39	1634,38	2974,92	3000,77	2828,93	2911,16	2381,94	499,52	2388,33	2227,43	1895,22	25467,42
Hot Briquettes (T)	_	_	_										0,00
Zn (T)	_	_	_										0,00
Pb (T)	_	_	_										0,00
Cold Briquettes (T)	_	_	_										0,00
Zn (T)	_	_	_										0,00
Pb (T)	_	_	_										0,00
Hard Zinc (T)	19,50	184,90	45,36	107,41	96,31	148,74	60,96	68,89		14,40	33,27	19,89	799,63
Zn (T)	16,76	158,83	37,58	88,99	82,95	128,11	52,75	59,34		12,40	28,61	17,13	683,45
Pb (T)	2,61	24,40	7,62	18,05	12,79	19,78	7,77	9,16		1,92	4,42	2,65	111,17

Composite Other Shaft Feed (T)	_	182,30	183,10	94,26	181,65	385,00	563,00	291,00	18,50	77,00	145,35	119,20	2240,36
Zn (T)	_	85,72	104,57	36,96	73,56	176,11	288,99	136,33	3,38	7,65	49,18	49,69	1012,14
Pb (T)	_	40,22	43,67	17,02	37,72	61,19	47,28	30,51	5,40	25,00	56,12	49,35	413,48
TOTAL SHAFT FEED (T)	4304,50	9261,20	8315,46	14727,67	14862,59	14615,72	14730,68	11048,91	2537,50	11991,40	11589,62	9393,09	127378,34
Zn (T)	1775,75	3851,96	3433,56	5827,40	5667,60	5903,64	6012,22	4408,00	1005,94	4831,22	4991,36	4042,34	51750,99
Pb (T)	881,04	1911,01	1685,67	3009,99	3051,28	2909,90	2966,21	2421,61	504,92	2415,25	2287,97	1947,22	25992,07
New Condenser Lead Pb (T)	163,15	82,11	231,93	545,78	433,36	356,11	326,34	420,96	224,28	271,55	265,05	292,81	3613,43
Zn Added To Condenser (T)	1,70	0,19	1,39	2,41	1,26	1,02	1,16	1,08	1,29	0,68	1,24	1,37	14,79
Zinc Volatilised (T)	1705,56	3699,02	3326,04	5596,95	5370,59	5690,45	5775,04	4197,30	959,07	4570,25	4747,12	3795,64	49433,03
Lead Volatilised (T)	138,51	339,27	240,25	413,16	212,97	179,64	192,93	441,05	224,28	553,60	609,68	692,52	4237,86
MATERIAL FLOWS AND ASSAYS													
(All T Dry) - Continued													
Slag (T)	1286,30	2583,83	2305,39	4329,50	4909,65	4178,00	4286,00	3582,76	836,77	4173,20	3312,77	3016,70	38800,87
Assay (%): Zn	7,36	7,34	6,85	7,24	7,43	7,03	7,30	7,09	7,20	7,38	7,41	8,43	0,00
Pb	1,18	1,09	1,16	1,99	1,65	1,52	1,59	1,94	1,92	1,58	1,36	1,92	0,00
Cu	0,42	0,45	0,40	0,40	0,37	0,34	0,40	0,54	0,55	0,48	0,51	0,36	0,00
As	_	_	_										
Sb	_	_	_										
Sn	_	_	_										
S	2,00	2,12	1,28	1,99	1,56	1,69	2,05	2,26	2,15	1,96	2,43	2,16	0,00
FeO	40,04	40,77	38,49	41,40	41,17	41,35	40,21	39,04	37,23	38,45	41,56	34,64	0,00
CaO	13,27	13,57	15,03	12,89	11,85	13,29	12,83	12,30	10,85	12,04	13,44	13,94	0,00
SiO2	19,12	18,53	19,95	18,17	19,26	19,61	19,61	19,58	19,68	19,43	18,80	20,66	0,00
MgO	_	2,26	3,22	3,02									

Al2O3	_	5,33	6,20	5,38									
MnO	_	1,95	2,06	1,53									
BaO	_	_	_										
ISF Zinc (T)	1593,00	3487,00	3121,00	5226,00	4963,00	5199,00	5300,00	3601,00	662,00	4230,00	4250,00	3449,00	45081,00
Zn (T)	1564,17	3425,98	3065,45	5139,77	4886,57	5103,86	5210,96	3537,26	651,87	4151,32	4175,20	3390,71	44303,12
Pb (T)	21,98	46,73	39,95	62,71	55,58	72,78	66,25	48,97	8,14	63,45	62,05	41,39	589,98
Assay (%): Fe	_	_	_										
As	0,0090	0,0840	0,0220	0,0180	0,0153	0,0160	0,0960	0,2600	0,0320	0,0140	0,0107	0,0140	
Cu	0,0170	0,0160	0,0140	0,0150	0,0098	0,0087	0,0117	0,0160	0,0330	0,0165	0,0163	0,0310	
Sn	0,0650	0,0550	0,0490	0,0630	0,0530	0,0500	0,0530	0,0029	0,0280	0,0560	0,0078	0,0620	
Cd	0,3000	0,2640	0,3440	0,3200	0,3150	0,3200	0,3000	0,3000	0,1560	0,2120	0,1980	0,2280	
Blue Powder (T)	180,00	300,00	270,00	480,00	348,80	326,70	404,10	482,40	270,00	557,00	500,00	440,00	4559,00
Zn (T)	48,96	99,78	90,64	158,40	131,08	132,31	162,17	181,14	101,38	194,95	188,80	126,06	1615,67
Pb (T)	93,60	129,30	114,05	192,05	143,43	108,49	145,15	198,17	132,57	267,36	227,50	198,05	1949,72
C (%)	_	_	_										
MATERIAL FLOWS AND ASSAYS													
(All T Dry) - Continued													
Pump Sump Dross (T)	210,00	370,00	315,00	700,00	702,00	603,00	603,00	500,00	400,00	500,00	650,00	603,00	6156,00
Zn (T)	56,70	90,28	86,06	182,70	142,23	197,46	192,96	144,20	132,40	114,70	163,15	178,67	1681,51
Pb (T)	106,05	172,42	100,45	368,20	353,32	261,33	241,20	266,80	213,44	253,55	358,80	342,98	3038,54
C (%)	_	_	_										
Other ISF Drosses (T)	51,00	86,90	109,72	180,90	152,00	179,14	164,64	113,56	35,02	118,30	101,35	117,50	1410,03
Zn (T)	22,89	36,93	50,40	80,61	66,72	79,48	75,44	42,25	12,09	46,43	49,18	49,69	612,11
Pb (T)	17,64	37,02	38,28	62,19	62,28	75,77	54,96	58,66	18,46	56,59	30,53	47,99	560,37

Lead Bullion (T)	767,00	1616,00	1487,00	2660,00	2660,00	2822,00	2860,00	2030,00	338,00	1909,00	1678,00	1231,00	22058,00
Zn (T)	_	_	_										0,00
Pb (T)	744,99	1575,60	1448,34	2593,50	2593,50	2742,42	2780,09	1969,71	327,96	1852,30	1633,20	1176,78	21438,39
Assay (%): Cu	2,1900	2,0000	2,0000	1,8800	1,8200	2,1100	1,9400	2,4200	2,4000	2,4200	1,9500	2,0700	
As	0,0350	0,0190	0,0600	0,0600	0,0640	0,0600	0,1710	0,1200	0,1220	0,1240	0,0236		
Sb	0,2900	0,3000	0,2900	0,2900	0,3450	0,3960	0,5000	0,2330	0,2400	0,2330	0,3200		
Bi	0,1420	0,1000	0,1670	0,1860	0,2230	0,1690	0,0890	0,0760	0,0800	0,0765	0,0830		
Sn	_	_	_	0,0230		0,0300	0,0260	0,0260	0,0250	0,0263			
Ag	0,0850	0,0880	0,0800	0,0800	0,0800	0,0853	0,0880	0,0765	0,0800	0,0760	0,0900	0,0830	
Copper Dross (T)	_	_	_	_	_	_	_	_	_				0,00
Zn (T)	_	_	_	_	_	_	_	_	_				0,00
Pb (T)	_	_	_	_	_	_	_	_	_				0,00
Assay (%): Cu	_	_	_	_	_	_	_	_	_				
As	_	_	_	_	_	_	_	_	_				
Sb	_	_	_	_	_	_	_	_	_				
Fe	_	_	_	_	_	_	_	_	_				
Sn	_	_	_	_	_	_	_	_	_				
Ag	_	_	_	_	_	_	_	_	_				
S	_	_	_	_	_	_	_	_	_				
P.R. Lead Production Pb (T)	_	_	_										0,00
OPERATING DATA													
Target Blast (Nm3/hr)	34000,00	34000,00	34000,00	34000,00	34000,00	34000,00	34000,00	34000,00	34000,00	34000,00	34000,00	34000,00	34000,00
Average Blast (Nm3/hr)	30900,00	30000,00	30550,00	30750,00	30141,00	31008,00	29725,00	28079,00	25795,00	30093,00	29681,00	29004,00	29643,83
Top Air (Nm3/hr)	2103,00	2343,00	2200,00	2270,00	2433,00	1989,00	2105,00	2523,00	2772,00	2393,00	2443,00	2340,00	

Condenser Exit Volume (Nm3/hr)	38500,00	37620,00	38310,00	38560,00	37797,00	38884,00	36401,00	34312,00	31351,00	36424,00	35448,00	36150,00	
Preheat (C)	957,00	859,00	829,00	841,00	846,00	851,00	916,00	878,00	866,00	891,00	879,00	882,00	
Bustle Pressure(mbar)	379,00	378,00	429,00	457,20	440,50	392,60	405,40	405,10	389,20	404,10	429,70	463,30	
LCV Gas Composition													
Assay (%): CO	23,54	23,66	23,14	23,41	23,15	23,66	23,66	23,85	23,70	23,72	23,01	23,52	
CO2	10,04	10,14	9,99	10,10	10,09	10,15	10,14	9,70	10,00	10,00	9,67	9,66	
H2	0,63	0,40	0,42	0,56	0,90	1,10	1,19	1,30	0,80	1,01	0,70	0,94	
Oxygen To Tuyeres (T)	_	_	_										0,00
Oil To Tuyeres (T)	_	_	_										0,00
Coal To Tuyeres (T)	_	_	_										0,00
Electricity (MWh)	1168,00	1542,00	1474,00	2204,00	2138,00	2151,00	2096,00	1805,00	754,00	1949,00	1648,00	1704,00	20633,00
Fuels (KJ)	6210,00	4490,00	5295,00	4116,00	4082,00	5511,00	2402,00	4382,00	5223,00	4308,00	4634,00	5368,00	56021,00
Hours (Decimal) Available	744,00	672,00	744,00	720,00	744,00	720,00	744,00	744,00	720,00	744,00	720,00	744,00	8760,00
Hours Lost: Copper Block	_	_	_									8,23	8,23
Furnace Bottom	12,67	8,37	_	4,08	_	6,44	4,40	21,34	_		15,59	43,49	116,38
Rotors/Condensers/Theisens	4,83	11,17	1,92	10,26	25,09	4,11	14,48	7,13	_	26,28	22,04	1,44	128,75
Planned Cleanout & Campaign SD	_	31,17	13,08	27,67	34,07	43,47	36,27	123,54	514,10	15,59	16,30	14,41	869,67
Charging	_	55,08	_	7,25	11,31	5,30	6,41		17,06				102,41
Balance Other	505,67	131,88	339,00	0,00	22,69	12,81	21,91	67,31	43,27	188,36	151,66	226,98	1711,54
TOTAL	523,17	237,67	354,00	49,26	93,16	72,13	83,47	219,32	574,43	230,23	205,59	294,55	2936,98
Hours (Decimal) On Blast	220,83	434,33	390,00	670,74	650,84	647,87	660,53	524,68	145,57	513,77	514,41	449,45	5823,02
Hours Below Target Blast	108,17	181,08	87,50	354,42	390,18	346,35	391,50	331,38	105,22	196,59	162,13	196,34	2850,86
DESIGN DATA													
Shaft Width (mm)	3005,00	3005,00	3005,00										

Furnace Length (mm)	6365,00	6365,00	6365,00										
H'rth Width @ Tuyere Lvl (mm)	2442,00	2442,00	2442,00										
Height Of Inclined Casing (mm)	3220,00	3220,00	3220,00										
Tuyere Penetration (mm)	298,00	298,00	298,00										
Tuyere Diameter (mm)	168,00	168,00	168,00										
Tuyere Separation (mm)	710,00	710,00	710,00										
Tuyere Nose CL-F'ce O/T (mm)	6864,00	6864,00	6864,00										
Tuyere Nose CL-Top T/Hole (mm)	428,00	428,00	428,00										
H'rth Area @ Tuyere Level (m2)	14,60	14,60	14,60										
Shaft Area (m2)	17,20	17,20	17,20										
Number Of Tuyeres	16,00	16,00	16,00										
End Tuyeres To F'ce CL (Deg)	90,00	90,00	90,00										
Declination Of Tuyeres (Deg)	10,00	10,00	10,00										
Design Preheat (C)	900,00	900,00	900,00										
Design Blast Rate (Nm3/hr)	34000,00	34000,00	34000,00										34000,00
Curvature @ H'rth Ends (C/SC)	C	C	C										
FUNDAMENTAL CALCULATED DATA													
Utilisation On-line (%)	29,68	64,63	52,42	93,16	87,48	89,98	88,78	70,52	20,22	69,06	71,45	60,41	66,47
Blast:													
Avg As % Of Target	90,88	88,24	89,85	90,44	88,65	91,20	87,43	82,59	75,87	88,51	87,30	85,31	87,19
As Proportion Of Design (%)	90,88	88,24	89,85	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	87,19
Intensity (Nm3/hr/Hearth m2)	2116,44	2054,79	2092,47	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	
Intensity (Nm3/hr/Shaft m2)	1796,51	1744,19	1776,16	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	
C Burnt (T/1000Nm3 Blast)	0,208	0,226	0,230	0,231	0,241	0,230	0,235	0,245	0,243	0,259	0,240	0,247	

C Burnt/24hrs Operation (T)	154,46	163,01	168,57	170,59	174,13	170,95	167,52	164,99	150,51	187,41	171,10	171,96	#DIV/0!
Hot Coke/T ISF Zinc	1,00	0,95	0,98	1,02	1,07	0,99	0,97	1,12	1,54	1,06	0,96	1,08	
Zn Volatilised(T/1000Nm3 Blast)	0,250	0,284	0,279	0,271	0,274	0,283	0,294	0,285	0,255	0,296	0,311	0,291	
ISF Zinc (T/1000Nm3 Blast)	0,233	0,268	0,262	0,253	0,253	0,259	0,270	0,244	0,176	0,274	0,278	0,265	
ISF Zinc/24 hrs Operation (T)	173,13	192,68	192,06	186,99	183,01	192,59	192,57	164,72	109,14	197,60	198,29	184,17	185,80
Pb Volatilised(T/1000Nm3 Blast)	0,020	0,026	0,020	0,020	0,011	0,009	0,010	0,030	0,060	0,036	0,040	0,053	
ISP Carbon Estimation (%)	75,76	73,31	75,79	77,15	77,49	74,02	72,76	76,62	84,57	77,38	71,03	76,52	#DIV/0!
Cond & Sep Efficiency (%)	91,61	92,61	92,12	91,79	90,96	89,67	90,21	84,25	67,83	90,82	87,93	89,30	
New Cond'r Pb (Kg/T F'ce Zn)	102,42	23,55	74,31	104,44	87,32	68,50	61,57	116,90	338,79	64,20	62,36	84,90	80,15
Electricity (KWh/T ISF Zinc)	733,21	442,21	472,28	421,74	430,79	413,73	395,47	501,25	1138,97	460,76	387,76	494,06	457,69
Fuels (KJ/T ISF Zinc)	3,90	1,29	1,70	0,79	0,82	1,06	0,45	1,22	7,89	1,02	1,09	1,56	1,24

11.9 Pictures

11.9.1 Veles – location of geoelectrical resistivity measurement

11.9.2 Areas of pollutants and impacts