

Draft Final report responses to comments

Text referred to	Comment	Response
General comments		
	a.Executive summary – same text as standalone summary	We have revised the executive summary
	Each chapter should begin with a one or two page summary. The summary should avoid statements such as “it is very complicated”	We have amended the chapters with the summaries.
	Begin each annex with a summary. This could be the text from the main report	We have amended the annexes
	Some redistribution of text should be considered. For instance there is text in section 2 that could be in the economic analysis part or the environmental impact part. One reviewer thought that the legal chapter should be moved forward because it helps the understanding of other parts of the report. We could consider a separate chapter on comparison with terrestrial mining and recycling that summarises what is in annexes and other parts.	We have revised the structure as agreed on the meeting of the 29 th
	The comparison with terrestrial and recycling is not satisfactorily covered at present. The crucial issues are security of supply and environmental impact. The security of supply issue is partly covered by the tables but most of the text could be moved to an annex and a clearer conclusion drawn. We do not need to know if we want to recycle more. This is already an objective. Rather, can we recycle enough to meet supply needs? And what is the environmental impact compared to mining? There is one sentence about energy use but it is not clear if this refers to all metals or some of them. It is clear that impacts depend on the type of ore, the method of mining and the geographical location but you could look at different issues – energy use, transport needs, disturbance to ecosystems, impact on local community, use of toxic chemicals – and discuss how they apply to specific deposit types. It may be difficult to generalise but there are concrete examples you can use. For	We have added a separate chapter to recycling as agreed on the meeting of the 29 th of July, and have revised the content in line with the comments.

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	instance we know how the Solara 1 mine is going to operate – the reprocessing will be done in China whereas tailings from terrestrial mining in Papua New Guinea are dumped in the sea. Maybe a summary table could help.	
	The technology section and the environmental impact section are separate whereas the choice of technology can have an impact on environmental impact One of the reviewers said “Which exploitation technologies are likely to be most acceptable, i.e. which disturb least (whomever and whatever)?	We have revised the chapters and the structure and brought together the implications that may arise
Style		
	Justify paragraphs	Have done so
	The English is poor in places. It needs to be improved in the main report including the executive summary.	We have improved the language.
	Acronyms should be avoided where possible. If they are felt to be necessary, they should be written out the first time they appear in a chapter and also in a glossary.	Have limited the use of acronyms
	Some references are footnotes, some endnotes and some are in the form (Hodgson et al, 2014). Be consistent although the annexes could each use a different form	We have used footnotes consistently
	The annexes should all have the same look and feel.	Structured annexes
Executive summary		
	This should be kept short but be more specific. It should say something about environmental impact – not that we don't know anything at all.	We have revised the text
The primary goal for the European Union is to identify the economic feasibility and environmental impact of accessing and extracting deep sea minerals deemed strategic, as well as to ensure the competitive position of European stakeholders.	Rephrase “ <i>The aim is to provide the European Commission with information on the current state of knowledge of the legal framework, economic feasibility and environmental impact of accessing and extracting deep sea minerals deemed strategic, as well as a summary of ongoing exploration and exploitation efforts and the competitive position of European industry.</i> ”	We have revised the text.
	Table 1 should refer to “On the review of the list of critical raw materials for the EU and the	We have corrected the text

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	implementation of the Raw Materials Initiative”	
	Table 1 should spell out SMS	We have corrected the heading
(and recycling can be done better than it is done now)	Does this mean “even when recycling technologies improve	We have revised this chapter
But can we actually get this up?	Not sure what this means. It sounds like publicity for Viagra	We have revised this chapter
Introduction		
<i>While it is presumed that seabed deposits of minerals can possibly outweigh those of land-based deposits</i>	Provide reference	We have revised the sentence
Marine mining and deep sea mining are part of the EU’s Blue Growth strategy under the thematic area of marine mineral resources.	Not sure what this means	We have removed this paragraph
Securing supply of raw materials that are an essential part of consumer products and industrial applications around the world.	The main point here is that Europe’s manufacturing industry needs a secure supply of raw materials but you don’t actually say it	We have revised the text.
The Seabed potential		
Figure 2.1 Location of seafloor massive sulphide occurrences investigated for this report (N=306)	What is N? (number of samples we assume but then it changes from 306 to thousands to 130 ???)	N is the number of sulfide occurrences on the seafloor. These can be either active black smoker-type vent sites or inactive occurrences that were active in the past, deposited sulfides at the seafloor and are now extinct.
	Is MOR mid-ocean ridge?	Yes, it is spelt out in chapter Factors controlling geochemistry
REE concentrations are smaller than in poly-metallic crusts, so they are a possible driver for their exploitation.	Not sure what this means	The sentence has been rewritten to make the statement clearer: “REE concentrations in nodules are smaller than in ferromanganese crusts, so investigations of possible exploitation of marine resources for REE will likely focus on ferromanganese crusts.
Conservative resource estimates, e.g. neglecting the recovery of trace elements as valuable components, commonly use a combined Cu+Ni+Co grade of >2.5 wt.% as a cut-off grade.	As a cut-off grade for what?	The cut-off grade defines the level of an element concentration in an ore below which it is not economically feasible to mine. Here it states that interest is only given to areas exceeding this grade of combined Cu+Ni+Co of 2.5 % in the

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		<p>nodules.</p> <p>Sentence has been rewritten to make clear that it refers to „ ... economically feasible future mining operations„</p>
Another metal of great interest is Te	Spell out the element name when it occurs for the first time in a section	Have done so.
This higher research potential in Pacific over Atlantic or Indic crusts is mainly attributed to the higher Co content in poly-metallic crusts from the Pacific when compared to other areas of the global oceans	What does higher research potential mean?	Sentence has been rewritten for clarification.
Most relevant metals in DSM deposits		
Table 2.4 Most relevant metals for DSM	You need to provide a source for the security of supply column	All the info for the last three columns comes from the source indicated in footnote 182 (“Criticality”). We have clarified this.
Key commodity trends and market structure		
State control and “resource nationalism”	Make clear that this is largely about terrestrial mining	clarified
	What percentage of ISA concessions for exploration are to state companies?	Clarified in box 7.1
Table 2.6 Metal resources and reserves at land an in poly-metallic crusts and poly-metallic nodules	Units?	Millions of tons added
Table 2.6 gives an overview of expected resources in poly-metallic crusts (Prime Crust Zone)	Where is Prime Crust Zone? This is the first time it is mentioned.	Explanation added: This is an area the size of Europe in the Western Pacific about 3000 kilometers southwest of Japan where crusts are particularly abundant
The potential of recycling as an alternative to DSM		
	This section is too long. It describes recycling rather than comparing it to deep-sea mining. Most can be put in annex.	We have revised this section as agreed in the meeting on the 29 July

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Table 2.9 Deep sea mined metal and its common uses in products	This is misplaced under recycling and does not add anything to information provided in table 2.7	We have revised the chapter
Regarding the metals that are considered to be relevant in deep sea mining, however the average EOL-RR above 50%, which would put current recycling at an already more advantageous position.	I don't believe that "average" means anything – it depends on the metal concerned. And in any case it is not only the EOL-RR that counts. It is the percentage of metal that comes from recycled sources and your figures show that this is rather low for copper at least.	We have clarified this in the text.
TECHNICAL CAPABILITIES AND LIMITATIONS		
In general two techniques have been tested: hydrometallurgy, where the metals are separated with acids (hydrochloric or sulphuric) or basic reagents (ammonia), and smelting	Don't underline. Use bold if you want to emphasise	Have done so.
Main components of each value chain step and their TRL levels		
	I don't see anything about gravimetry	We have amended the text
Critical components		
	Same comment as above. Nautilus put gravimetry at the top of their wish list.	We have amended the text
<i>Figure 3.4 Conceptual Drum-cutter ROV (left) and Auxiliary cutter ROV (right)</i>	You could probably show a real one rather than a concept	There are no real ones, concepts from nautilus are at the most advanced stage of the industry.
	We need something about ongoing EU efforts in research	An additional section has been added.
Position of the EU industry		
	Since, as you say, commercial application has not yet begun, In this section you could provide an indication of how European industry is doing in analogous industries such as oil and gas exploration, pipe or cable laying.	We have added some info on Europe`s influence in the pipe laying business.

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Generally speaking, the EU manufacturing industry is believed to have a strong competitive position when it comes to:	It has, it hasn't or you don't know. Which is it?	It has.
In terms of commercialisation of innovations, EU enterprises are not always able to maintain their advancement vis-à-vis third country competitors especially from Asia. Furthermore in some labour intensive industries EU based manufacturers have developed strategies of outsourcing part of their activities to affiliations in China, or to set-up production bases of their own (e.g. Damen shipyards in Vietnam).	This general remark does not add anything unless you can relate it to seabed mining	We can't, so deleted.
	On page 48 the TRLs are colour-coded, but on the main graph on page. 49 there are different colours to separate the different stages of the mining process	We have amended the large table as well.
EXPERIENCES FROM ONGOING PROJECTS		
The size of the expected deposits is in most projects not known yet and if known, the information is confidential.	I believe that there is some information from Solwara 1.	We have amended this paragraph.
Almost all countries lack a strong and clear policy framework for this new sector.	Presumably this means the country in whose EEZ the deposits lie?	Yes, clarified this in the text.
ENVIRONMENTAL IMPLICATIONS		
	We could have a short summary of comparisons with recycling and terrestrial mining.	We have added the comparison table
and are thus in the middle of a four-year EU supported exercise to develop environmental and economic regulatory frameworks.	The four years are complete but the money was not all spent so the project was extended. Check.	Corrected the text
The existence of a specialised fauna associated with weathered sulphide deposits is at present unknown (Van Dover 2007).	Does weathered mean inactive? It would be better to keep a consistent vocabulary	It describes the surface of inactive hydrothermal vents. Areas of sulphide deposits that are not hydrothermally active may provide a weathered surface
will also generate increased turbidity related to the extraction/operational plume on the seafloor	How does this differ from natural volcanic processes?	These plumes may have different properties to the naturally occurring hydrothermal plumes and may impact different areas. This is especially the case for any plumes released in mid water that could potentially affect large areas.

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and from the release of waste-water and fine particulate material (< 8 um) in a discharge plume following initial on-board processing and dewatering of the ore.	I understood that Nautilus were reprocessing on land.	Modelling done by Nautilus suggests that there will be an increase above background levels in turbidity related to the crushing and grinding of the deposit during extraction and also from the released waste water
The mining of SMS will create permanently (human timescale) disturbed areas at the mine site. The geographical extent of the physical disturbance from an individual mine is likely to be less than for comparable land operations. For example the Solwara 1 site in Papua New Guinea is only 0.112 km	0.112 km long or wide? How big would a comparable land operation be?	We have amended and clarified the text. Since the duration of mining at each site will be short (c 2-3 years) large numbers of sites may be targeted leading to overall similar sizes to land operations.
While localised hydrothermal vent ecosystems are the focus of some commercial activities, such as Nautilus Minerals Inc. within the Exclusive Economic Zone (EEZ) of Papua New Guinea, the largest seafloor massive sulphides are likely to occur at inactive sites on mid ocean ridges	So the Solwara1 site is active?	Yes, it is active
Ultimately the optimal conservation zone size	What does "Optimal" mean in this context?	We have amended and clarified the text
	In the context of plumes, it is probably worth mentioning that there will be considerable plume generation occurring naturally in active sites.	We have amended the text
Indeed some fauna may be adversely affected in relation to the 'habitat grain size'.	Presumably the grain size of the sediments – not the nodules themselves	We have corrected the text.
Subsequent sampling, however, has challenged these initial thoughts, and today the 'distinctness' of assemblages on seamounts appears unproven	Either it is proven or it isn't.	Corrected.
The large differences between seamounts in terms of the characteristics listed above has made their study difficult	Does this not contradict the statement that the distinctness of assemblages is unproven?	We have corrected the text.
Consideration of the lessons learned from terrestrial mining, particularly those that address conservation and minimum impact objectives, may aid in developing sound policy	An example should be given here. The environments look so different that it is difficult to see what specific lessons can be learned other than general statements about careful monitoring, stakeholder consultation etc.	We have listed examples
	Noise could be an issue (not only blasts). If it is beyond the scope of the current study, then it should	Noise is taken into consideration; see the table of impacts.

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	at least be mentioned	
the Marine Strategy Framework Directive (MSFD) may provide useful inputs, such as to the developing Regulations for the exploitation of polymetallic nodules	What about SMS then? Not sure if the term regulation should be used here – possible legal instruments	Corrected
LEGAL AND REGULATORY REGIME		
	Can we have a summary table?	Yes
Instead it takes a more market-oriented approach that combines a reduction in the size of the institutions of ISA	How can the ISA be reduced if it didn't exist yet?	We have rephrased this sentence.
This is not really surprising given that DSM does not yet take place in EU waters and its prospects in this respect are not entirely clear. The seabed in many areas within European waters is simply not suitable for DSM.	Azores?	Project are not yet being developed even for exploration in the Azores. Meaning the statement is still true though but we can mention the Azores
are likely to have significant effects on environment by virtue, inter alia, of their nature, size or location to be assessed before authorisation.	Who decides? Presumably this is the crucial paragraph if deep sea mining is not explicitly mentioned	The text has been altered to clarify that projects are only subject to EIA if they are included in the lists contained in Annexes I and II.
The Mining Waste Directive does not apply to waste generated from DSM	Why?	New text has been added.
Finally European companies engaged in DSM both in European waters and elsewhere in the world are subject to the specific reporting requirements of extractive industries under the Accounting Directive	Reporting on what?	Amended the text.
ECONOMIC VIABILITY OF DEEP SEA MINING		
	Does Hein et al. <i>Ore Geology Reviews</i> 51 (2013) 1–14 give useful input?	We have used that as reference
	The tabular form is useful but we need some summaries. For instance a graph showing the relative costs of each stage (extraction, processing, transport) for each type of mining would be useful and a comparison with recycling and terrestrial mining.	We have added summaries after the tables and have added comparison with terrestrial mining. We have not compared recycling costs as the recycling the same amount as the one being mined would not result in the same final content. With recycling processing would minimise the recycled content.
	I don't see anything about the potential impact of a large supply increase caused significant mining of	It is not so much the nodules as their cobalt content that could cause stir on the

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	nodules.	market. We have highlighted this under the chapter economic viability
CONTRIBUTION TO BLUE GROWTH		
According to the Communication, up to 10% of global production of minerals such as cobalt, copper and zinc could come from the ocean floors by 2030, providing global annual turnover of up to €10 billion.	Give an opinion as to whether this is justified	We have amended this section
CONCLUSIONS AND RECOMMENDATIONS		
	Interesting but do not follow from the text. We understand that processing is key for nodules and crusts but do not believe that rare earth elements will be the only target.	We have revised the conclusions chapter
GEOLOGICAL ANALYSIS		
Currently the occurrence farthest away from the ridge axis is the St. Petersburg site at the Mid-Atlantic Ridge	How far?	The deposit is located 16 km away from the ridge axis. This information has been added to the text
An analysis of known deposits indicates that only about ten individual deposits may have sufficient size and grade to be considered for future mining (Hannington et al., 2011).	How many known deposits? Where are the ten?	Nobody knows, how many deposits are large enough and which of the ones that has too little information might show to be commercially interesting - this is speculation! We simply do not have the information on deposit size that is needed. (See below). Our intention is to show that there is limited data out there, but even if you start drilling those deposits the number of potentially interesting deposits will be limited.
on the modern seafloor.	Are there any others?	Yes, there are plenty. Globally we mine a lot of copper, zinc, lead and silver, and gold from numerous ancient black smoker deposits (co-called VMS deposits) that were transferred from the ancient seafloor onto land through geological processes (obduction). They occur in various countries. Next to us are deposits in Spain and Portugal, Russia

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		and Cyprus that are actively mined. Other deposits, even in Germany, have been mined out. Additionally venting occurs on land as geysers or associated with volcanic activity.
Lithium in CCZ nodules averages 131 ppm and is especially high in diagenetic nodules of the Peru Basin (mean of 311 ppm; Hein et al., 2013).	How does this compare with terrestrial concentrations?	A sentence has been added to reflect the concentrations of land-based mining operations.
Current exploration activities involve all three deep-sea marine resources (Fig. a.15). For seafloor massive sulphides 5 licences	Never underline unless it is a hyperlink. Use bold	We have removed underlines text and replaced it with bold.
<i>Few areas near the western and eastern boundaries of the Atlantic are clearly underexplored</i>	Does it mean "A few"?	Yes, it does and the wording has been changed accordingly.
Annex COMMODITY MARKETS ANALYSIS		
The EOL recycling rate of copper is estimated at 45%, caused by a low efficiency in gathering of scrap and separating it from other metals in recycling processes	Globally or EU? Both figures would be useful. Is the figure increasing or decreasing. Nonetheless the figure, together with the next sentence, shows that recycling is not the answer.	The global rate is 45% the EU rate is around 41.5%. We have amended the text.
	It would be useful to see time-series of production from different sources as well as descriptive text (eg page 35)	We have production time series tables for the commodities with descriptions in the report.
	I don't see anything about the potential impact of a large supply increase caused significant mining of nodules.	It is not so much the nodules as their cobalt content that could cause stir on the market. We have highlighted this under the chapter economic viability in the main report. We have also bolded the relevant text for cobalt in the annex.
Annex TECHNOLOGY ANALYSIS		
	I don't see anything about gravimetry. Nautilus thought this could be useful.	Actually gravity concentration is mentioned in the text in chapter 5.13 as well as gravity corers under chapter 3.4. Gravity gradiometers are referred to in the main text as a conclusion of where efforts can be concentrated in the future.
	Could you add a section on ongoing research efforts in technology (particularly those funded by EU)	We have added a section on ongoing EU research
	Probably this would look neater if the figures were	We have centered the figures where

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	centred rather than left justified. Thin ones could be placed side by side. e.g. 5.8, 5.9 etc.	possible
	Some of the headings e.g. "Sensor based sorting" are at the bottom of pages and some figure captions are separate from the figures	Kept lines with figures
ANNEX 4 PROJECT LICENCES OVERVIEW		
	Could be combined with annex 5 together with maps from main report	We have created a separate annex for all projects
ANNEX 5. PROJECT SHEETS		
	the term 'project' needs definition.	added
ANNEX 6. ENVIRONMENTAL ANALYSIS		
The EU's Marine Strategy Framework Directive is one of several important approaches for regulating the environmental aspects in the deep sea, especially within EU waters.	The "especially" is not needed here	Corrected
	The recycling in this chapter should only consider the environmental impact. For instance use of energy or toxic materials. A table, similar to the one used for a comparison with terrestrial mining, would be useful.	We have amended the text
ANNEX 7. LEGAL ANALYSIS: INFORMATION ON SELECTED COUNTRIES + INTERNATIONAL LAW		
	Avoid discussion of task 3. Assume this is a standalone report	Reference to task 3 has been removed.
is important to note the ongoing importance of customary international law	can you give an example?	Yes this is now done with the reference to the fact that the UNCLOS provisions on maritime zones are generally considered to be part of customary international law
To date no such global and regional rules have been specifically developed to prevent, reduce and control pollution from seabed activities such as DSM in areas subject to national jurisdiction.	You can go further than that. Have any rules been specifically developed to prevent any activities at all in areas under national jurisdiction? Is there any mechanism for reporting or complaining? In other words is article 208(5) just empty words?	Text has been added here.
There is currently around 40 technical and non-technical staff.	There are?	Typo has been corrected
As noted above, one of the objectives of the Part XI Deep Sea Mining Agreement was to reduce the size of the institutions of ISA including the Enterprise.	How can you reduce the size of an organisation that does not exist? The Enterprise is mentioned frequently in the text without ever being properly	The wording has been altered to make it clear that the Enterprise was foreseen by Part XI of UNCLOS.

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	defined.	
	At the workshop organised by DG-ENTR, Antje Wittenberg made quite a nice presentation of how ISA licence holders have to set aside some area for conservation or other stakeholders. I don't find any of this here.	Amended the text.
There are no sanctions for non-compliance for failing to make such reports.	Do you have a list of who does make reports?	These are on the CBD website the link for which is provided
	Same comment on Environmental Impact Assessment as in the main report	See above.
	Who does Accounting Directive apply to? Use Nautilus as a test example.	Text amended.
	For national laws, a summary table would be useful. Try to make it simple with yes/no/partially columns rather than a lot of text.	Text amended.