

INFOMAR
Marine Mapping Study
Options Appraisal Report:
Final Report
30 June 2008



PricewaterhouseCoopers LLP does not accept or assume any liability or duty of care for any other purpose for which this report may be used or in relation to any other third party or other person(s) or organisation(s), who may read and / or rely on this report, save where expressly agreed in writing with PricewaterhouseCoopers LLP. The reader is therefore advised to seek their own professional advice before placing reliance upon the contents of this report. Further this report has been produced subject to important qualifications, reservations and assumptions and, without prejudice to that set out above, it should be read in the context of those qualifications, reservations and assumptions.

In the event that, pursuant to a request which GSI/MI has received under the Freedom of Information Act 1997, it is required to disclose any information contained in this draft report, it will notify PwC promptly and consult with PwC prior to disclosing such draft report. GSI/MI agrees to pay due regard to any representations which PwC may make in connection with such disclosure and GSI/MI shall apply any relevant exemptions which may exist under the Act to such draft report. If, following consultation with PwC, GSI/MI discloses this draft report or any part thereof, it shall ensure that any disclaimer which PwC has included or may subsequently wish to include in the information is reproduced in full in any copies disclosed.

Contents

Section	Page No.
Executive Summary	4
I Introduction.....	8
TERMS OF REFERENCE	10
REPORT STRUCTURE	10
II INFOMAR Project Review	11
INTRODUCTION.....	11
PROJECT DELIVERABLES	11
EXPENDITURE TO DATE (2006 TO 2008)	13
REVIEW OF ACTIVITIES AND OUTPUTS.....	14
CONCLUSIONS	23
III Needs and Objectives	24
INTRODUCTION.....	24
MARKET FAILURE	25
LEGISLATIVE REQUIREMENTS AND OBLIGATIONS.....	26
MARINE RESOURCES INFORMATION	29
RESEARCH AND CONTRIBUTION TO THE KNOWLEDGE ECONOMY	33
OBJECTIVES.....	34
CONCLUSIONS	35
IV Potential Constraints	36
INTRODUCTION.....	36
FUNDING CONSTRAINTS	36
STAFF/ SKILLS CONSTRAINTS	36
CROSS-DEPARTMENTAL STRUCTURE.....	37
REGULATORY CONSTRAINTS	37
ENVIRONMENTAL CONSTRAINTS.....	37
CONCLUSION	37
V Identification of Options	38
INTRODUCTION.....	38
OPTIONS IDENTIFIED	39
OPTION 1 – DO MINIMUM	40
OPTION 2 – PRIORITY AREAS ONLY	41
OPTION 3 – INFOMAR STRATEGY IN FULL (BY 2016)	42
OPTION 4 – INFOMAR STRATEGY IN FULL (BY 2026)	43
CONCLUSIONS ON OPTIONS.....	44
VI Cost of options	45
INTRODUCTION.....	45
COSTS INCURRED FROM 2006 TO 2008	45
COSTS TO BE INCURRED POST 2008	46
COST BASIS	48
SUMMARY OF COSTS.....	50
VII Wider Project Benefits	51
INTRODUCTION.....	51
COMMERCIAL/RESOURCE BENEFITS (INDIRECT BENEFITS).....	53
KNOWLEDGE ECONOMY (DIRECT BENEFITS)	67
LEGISLATIVE REQUIREMENTS AND OBLIGATIONS	70
ENVIRONMENTAL BENEFITS (NOT QUANTIFIED).....	75
SUMMARY OF PROJECT BENEFITS.....	76
VIII Risk Analysis	78
INTRODUCTION.....	78
IX Cost Benefit Analysis.....	81

INTRODUCTION.....	81
BENEFIT COST RATIOS.....	82
CONCLUDING COMMENTS	83
X Conclusions and Recommendation	84
INTRODUCTION.....	84
CONCLUSIONS	84
RECOMMENDATION.....	86

Appendices:

Appendix A – Detailed Cost Calculations

Appendix B – Net Present Value Calculations

Executive Summary

Introduction

The Integrated Mapping for the Sustainable Development of Ireland's Marine Resource (INFOMAR) programme is Ireland's national marine mapping programme. It is the successor to the Irish National Seabed Survey (INSS), and is a joint venture of the Geological Survey of Ireland (GSI) and the Marine Institute (MI).

The INFOMAR programme builds on the work of the INSS, which was undertaken between 1999 and 2005. The initial scope of the INSS, for which €27 million was allocated, was to survey and map all of Ireland's off-shore waters. At an early stage of implementation, the project scope was revised to the mapping of the entire Zone III (water depths 200m to 4000m) and as much of Zone II (water depths 50m to 200m) as possible.

The focus of the INFOMAR programme, therefore, is to create a range of integrated mapping products of the physical, chemical and biological features of the seabed, in the near-shore, or Zone 1 (0m to 50m) area and remaining Zone II area, thus completing the mapping programme for the entirety of Ireland's off-shore waters.

Terms of Reference

Against this background, and to fulfil the NDP Value For Money reporting requirements for Large Capital Projects (>€30 million), PricewaterhouseCoopers (PwC) were commissioned by the Department of Communications, Energy and National Resources (DCENR) to undertake a detailed appraisal of the INFOMAR project. The appraisal is to be carried out in line with the requirements of the 'Guidelines for the Appraisal and Management of Capital Expenditure Proposals in the Public Sector (February 2005)'.

Methodology

The methodology for undertaking the appraisal involved both primary and secondary research, including extensive consultation with stakeholders of the INFOMAR. These included members the INFOMAR Project team from both the GSI and Marine Institute, other staff members at these organisations, senior management of the Department of Communication, Energy and National Resources (DCENR), and other users of the INFOMAR outputs, including the Commissioner of Irish Lights, the Coastal and Marine Resources Centre, UCC and the Petroleum Affairs Division of the DCENR.

Following the guidelines set out, the research undertaken considered the following in relation to the INFOMAR:

- Review of Project activities and achievements to date;
- Needs and Objectives for undertaking INFOMAR, including market failure, legislative and regulatory requirements, marine resource information requirements and contribution to the knowledge economy;
- Potential Constraints, including funding constraints, staff/skill constraints and environmental constraints;
- Identification of Options for INFOMAR, including their advantages and disadvantages;
- Identification of Option Costs, from 2006-2008 and from 2009 onwards;
- Option Benefits, including 'Direct' and 'Indirect' and Quantifiable and Non-Quantifiable Benefits;

- Risk analysis of potential issues which may affect the successful implementation of the project;
- Cost-Benefit analysis of each of the identified options, through the calculation of the Net Present Value for each of the options; and
- Conclusions and recommendations, which identifies a Preferred Option.

Summary of Options

A range of options for the INFOMAR programme were identified and appraised in financial and qualitative terms:

- Option 1: Do Minimum – continue the project for the remainder of the current funding period (i.e. until December 2008) and then stop;
- Option 2: Priority Areas only – complete the mapping of the 26 priority bays and 3 priority coastal areas (Phase 1). This would also include implementation of other aspects of the overall Strategy as far as possible. It is anticipated this would be completed by 2016;
- Option 3: INFOMAR Strategy in full – this includes mapping of phases 1 and 2 and the implementation of other components of the strategy across Programmes 1, 2 and 3. It is anticipated this could be completed by 2016; and
- Option 4: INFOMAR Strategy in full, phased – this is similar to option 3 above, but only the Phase 1 mapping would be completed by 2016. Phase 2 mapping would be completed by 2026. The three INFOMAR programmes would be implemented over the extended time period.

Cost of Options

In consultation with the INFOMAR project team, the costs for undertaking each of the selected options were identified. As funding for the project is guaranteed to end 2008, the table below outlines the estimated budget costs from 2009 onwards.

Costs were divided into Data Acquisition (including use of the National Research Vessels, Research and Programme Operation Costs); and Data Management (which includes the maintenance and further development of an infrastructure for the storage and distribution of data). Given the period over which this project will run, an uplift for inflation has also been included.

Table 1: Project Costs

Option	1 €000	2 €000	3 €000	4 €000
Data Acquisition	0	19,643	55,758	60,921
Data Management	0	3,810	3,810	3,825
Uplift for Inflation	0	4,103	10,345	29,109
Total	0	27,556	69,913	93,855

Benefits Identified

The benefits attributable to the INFOMAR programme are broad ranging and potentially very significant in financial/ economic terms. For each of the selected options, benefits were identified and categorised as follows:

- Commercial/ Resource Benefits;
- Knowledge Economy;
- Legislative requirements and obligations; and
- Environmental Benefits (not quantified).

Whilst these benefits can be difficult to measure in financial terms, a prudent approach has been identified to estimate the potential impact the programme could have across a range of industries. The estimated 'Present Value' of the benefits of the INFOMAR programme are outlined in Table 2 below.

Table 2: Estimated Present Value of INFOMAR Benefits

Option	1 Do Min €000	2 Priority Bays Only €000	3 INFOMAR By 2016 €000	4 INFOMAR By 2026 €000
Commercial				
Fishing Sector	2,083	15,610	156,102	95,404
Aquaculture	6,112	46,252	57,816	57,816
Biodiversity	1,028	7,783	11,118	11,118
Renewable Energy	6,671	20,013	40,026	40,026
Energy Exploration	0	0	64,887	49,309
Aggregate Industry	23,077	65,754	85,480	85,480
Knowledge Economy				
Research	2,226	8,111	16,222	10,193
Legislative				
Non-Compliance Fines	2,028	6,083	8,111	7,453
Total PV of Benefits	43,226	169,607	439,763	356,799

Furthermore, there are a number of factors which have not been included within the financial benefits:

- There are a large number of non quantifiable benefits which have been identified in this analysis, in particular relating to the environment; and
- Speculative benefits such as a **hydrocarbon find**, a **major biotechnology discovery**, **major inward investment project** and the avoidance of major costs such as an environmental disaster (eg. **oil spillage** from a tanker running aground) have not been quantified but could potentially be **worth billions to the Ireland economy**;

Summary of Recommendations

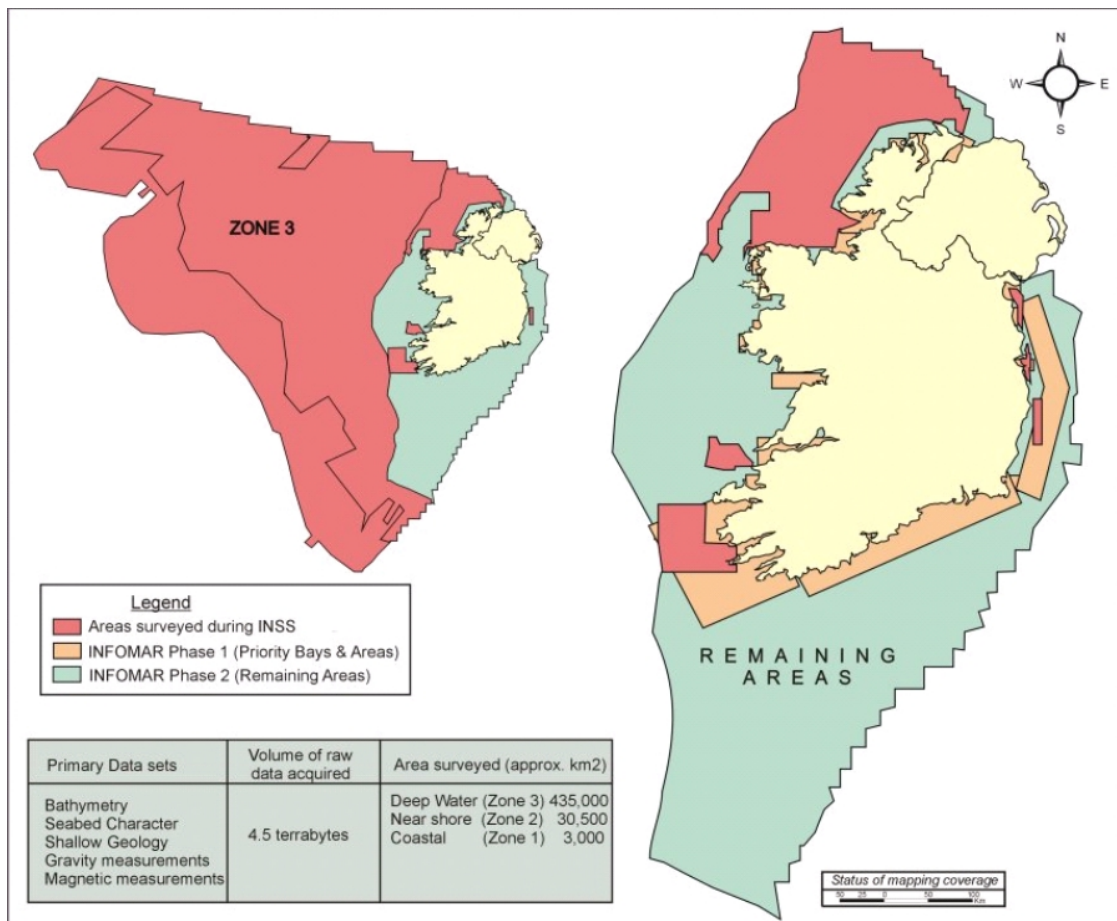
Based on the analysis above, **Option 3 is recommended** as it delivers the greatest level of benefits (both quantifiable/ commercial and also environmental) and in the shortest time period. In particular accelerating the programme would deliver the following advantages:

- Environment – the data collected from this project can be used to improve climate change models, therefore the sooner all information is collated the more quickly benefits can be realised. Also related to the environment issue is the need for seabed geology and physical habitat maps by National Parks and Wildlife Service (NPWS) to help designate Marine Special Areas of Conservation (SACs) and aquaculture license. If these designations are not made then the Government could have sanctions imposed, including fines, by the EU.
- Safety – Government has an obligation to provide accurate charts for shipping and if an accident occurs in national waters, under MARPOL (Marine Pollution) convention, the State is liable for total cost of clean up if the accident is attributable to poor charting in national waters. Given the increased level of shipping traffic in Irish waters, the sooner areas are surveyed then the reduced likelihood of accidents; and
- Energy/ Infrastructure Market – there is now increased demand for accurate data to support marine spatial planning and development including aggregates planning and offshore wind and wave farms. This is likely to increase in future given DCENR's announcement in February 2008 on subsidies for renewable energy;
- Technology Issue – as data is acquired and stored in digital format, changes in acquisition and storage systems over a long project life could create potential IT issues and costs;
- Personnel/ Staffing – staff indicated that it would be important that the project be completed within the working careers of staff working on the project. It is also important that momentum is maintained on a project to ensure that experience and expertise gained stays with the project team until its completion;
- Access to Staff and other Resources – with the likely long term upward trend in oil prices there are big issues for the project in terms of accessing survey staff and equipment. In particular the oil and gas industry have the financial resources and incentive to procure these survey resources, which in turn increases the cost and makes other projects unaffordable;

I Introduction

- 1.1 The Integrated Mapping for the Sustainable Development of Ireland's Marine Resource (INFOMAR) programme is Ireland's national marine mapping programme. It is the successor to the Irish National Seabed Survey (INSS), and is a joint venture of the Geological Survey of Ireland (GSI) and the Marine Institute (MI).
- 1.2 The INSS was undertaken between 1999 and 2005. The initial scope of the INSS, for which €27 million was allocated, was to survey and map all of Ireland's off-shore waters. At an early stage of implementation, the project scope was revised to the mapping of the entire Zone III (water depths 200m to 4000m) and as much of Zone II (water depths 50m to 200m) as possible. The final cost of the INSS was €32 million. The area covered by the INSS project is coloured red in Figure 1.1 below. The remaining area is to be covered by the INFOMAR project.

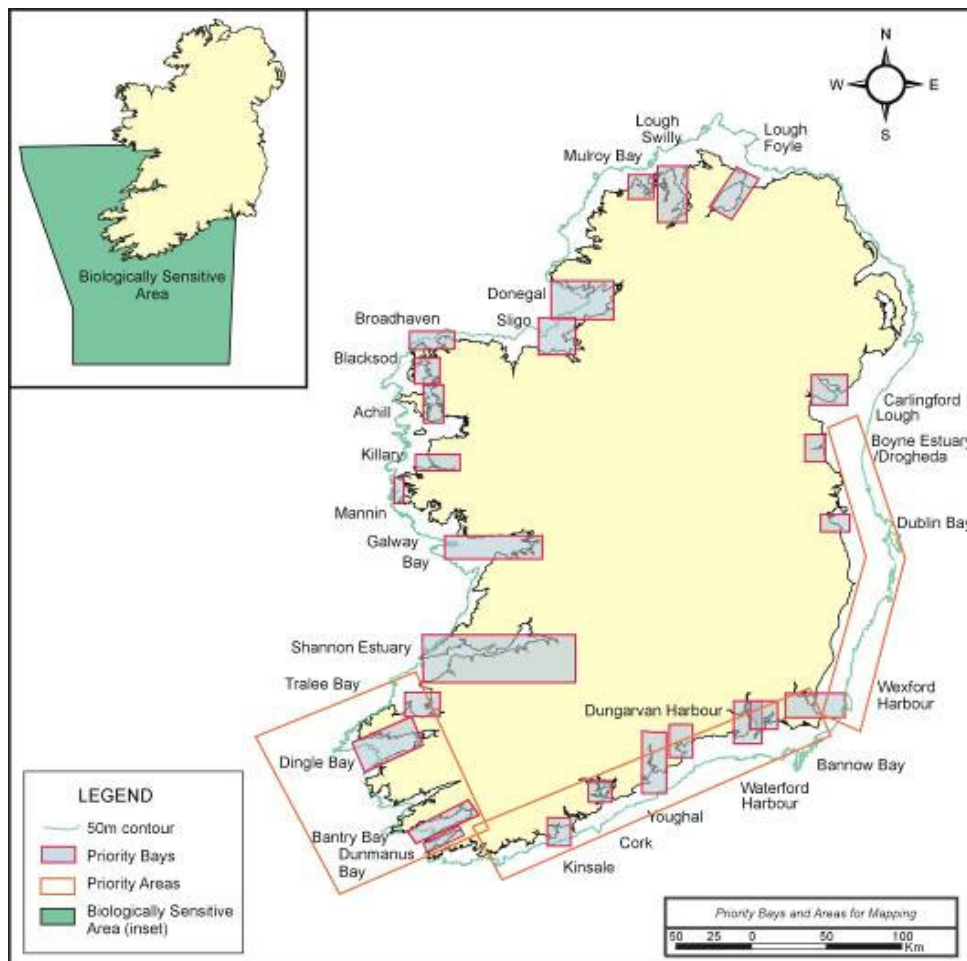
Figure 1.1: Area Mapped by INSS and to be mapped by INFOMAR



- 1.3 The focus of the INFOMAR programme, therefore, is to create a range of integrated mapping products of the physical, chemical and biological features of the seabed, in the near-shore, or Zone 1 (0m to 50m) area and remaining Zone II area, thus completing the mapping programme for the entirety of Ireland's off-shore waters.

- 1.4 There are three major programme components to the INFOMAR programme. These are:
- Data Acquisition, Data Management and Interpretation;
 - Data Exchange and Integration; and
 - Value Added Exploitation.
- 1.5 The INFOMAR programme, which commenced in 2006, was initially designed to be completed over a 20 year period, with an associated estimated cost of €84 million, a cost estimate loosely based on the expenditure incurred in respect of the previous INSS programme. However, for this INFOMAR appraisal report, a more robust and detailed cost estimate has been derived. This is detailed in section 6 of this report.
- 1.6 As part of the INFOMAR strategy, priority has been given to the surveying of 26 bays and 3 priority areas during the first 10 years of the programme's operations.

Figure 1.2: INFOMAR Bays and Priority Areas



- 1.7 Funding of €4 million per annum was allocated to the INFOMAR programme for the period 2006-2008. The INFOMAR programme has subsequently been incorporated into the National Development Plan (NDP) 2007-2013, under the Enterprise, Science and Innovation Priority in the Geoscience sub programme, with the same annual budget of €4 million, i.e. projected to €28 million to 2013. It is also listed in the Strategy for Science, Technology and Innovation (SSTI) as a Key Action under the Marine component of Research in the Public Sector.
- 1.8 As part of the NDP incorporation process, the possibility of completing the entire work programme of the INFOMAR project within the lifecycle of the NDP was examined by the INFOMAR programme. It was proposed that the project would now have an eight year lifecycle (2006-2013), with the costs of €84 million to be disbursed over this revised timeline. The INFOMAR project budget and timeline is scheduled for review in 2008.

Terms of Reference

- 1.9 Against this background, and to fulfil the NDP Value For Money reporting requirements for Large Capital Projects (>€30 million), PricewaterhouseCoopers (PwC) were commissioned by the Department of Communications, Energy and National Resources (DCENR) to undertake a detailed appraisal of the INFOMAR project. The appraisal is to be carried out in line with the requirements of the 'Guidelines for the Appraisal and Management of Capital Expenditure Proposals in the Public Sector (February 2005)'.

Report Structure

- 1.10 The remainder of the report is divided into the following sections:
- Section 2 provides a Review of the INFOMAR project to date;
 - Section 3 presents an assessment of the Needs and Objectives of the project;
 - Section 4 sets out the Potential Constraints to the successful completion of the project;
 - Section 5 identifies the main Options for the project;
 - Section 6 calculates the Financial Costs of the Options;
 - Section 7 identifies the benefits of the main Options, including discussion of the monetary and non-monetary factors;
 - Section 8 provides a Risk Analysis and contingencies of the main Options;
 - Section 9 presents the Cost Benefit Analysis; and
 - Section 10 concludes on the Preferred Option.

II INFOMAR Project Review

Introduction

- 2.1 The focus of the INFOMAR programme is to create a range of integrated mapping products of the physical, chemical and biological features of the seabed, concentrating in the near-shore, or Zone 1 (0m to 50m) area, and the remaining Zone 2 (50m to 200m) area, completing the mapping programme for the entirety of Ireland's off-shore waters. Funding for the project was secured in mid-2006 and has been 'operational' since that date
- 2.2 This section of the report, therefore, considers the work undertaken to date and how the experience gained can be used to influence the project moving forward. In conducting this section of the report, the NDP Monitoring Returns were reviewed and consultees were questioned on key issues arising. In addition our observations are also documented.
- 2.3 This section of the report is set out as follows:
- Project Deliverables;
 - Review of Activities;
 - Key Issues; and
 - Conclusions.

Project Deliverables

- 2.4 A range of deliverables, or outputs, have been identified for each of the work programmes of the INFOMAR. The deliverables can be summarised as follows by work programme:

Programme 1 – Data Acquisition, Data Management and Interpretation
<ul style="list-style-type: none"> • Production of a range of information products resulting from surveys of the 26 priority bays and 3 priority coastal areas. These will include: <ul style="list-style-type: none"> - hydrographic (bathymetric/water depth) maps, - seabed classification and habitat maps; and - baseline data to underpin environmental impact assessments and management plans for inshore fishing, aquaculture and coastal protection. • Maintenance and strengthening of a National Repository for Hydrographic and Geophysical data; • Publication of surveying standards to be issued by relevant statutory licensing authorities in the marine area; • Provision of an Advisory Service to public agencies or private sector companies undertaking mapping activities; <i>and</i> • Contribution to Value-Added research projects, resulting from the secondary analysis of data acquired under INFOMAR.

Programme 2 – Data Exchange and Integration

- Development of a mechanism to establish a National Marine Data Discovery and Exchange Service, thus providing improved dissemination of information to policy makers, private sector and the public;
- Adoption of standard data management procedures to facilitate inter-agency data integration, and avoid duplication of effort;
- Development of shared cost approaches to identifying the requirements of and implementing data integration;
- Creation of increased capacity for the analysis and management of large data volumes through access to high performance computing systems;
- Production of new information products and services based on the ability to deliver new outputs from integrated data sets; and
- Integration of data and information policies such as the INSPIRE (Infrastructure for Spatial Information in the European Community) Directive, and the Irish Spatial Data Framework (ISDI) into the overall INFOMAR data policy.

Programme 3 – Value Added Exploitation

- Development of advanced decision support tools and solutions driven by either policy or commercial requirements;
- Targeting of international marine survey and consultancy contracts through a Public Private Partnership approach; and
- Contribution to a programme of national and international Value-Added research to leverage the skills, expertise and data from the INSS and INFOMAR.

2.5 Overall, it is expected that the programme outputs will contribute to and further enhance Ireland's international status as a leader in seabed mapping techniques and infrastructure. This enhanced profile should support commercial operators in securing survey and consultancy contracts and academic researchers in securing EU and other funding.

Expenditure to Date (2006 to 2008)

- 2.6 The original budget approval for the project was for €84 million over a 20 year period, with the project to be completed in 2026. In mid 2006 approval was given for €12 m for the first three years of the project (2006-2008). An additional €2.2 million for capital purchases was made available in 2006, (with related €0.2m capital in 2007 and 2008) thus total funding available for the 2006-2008 period was €14.6 million.
- 2.7 Table 2.1 below summarises expenditure over this period with actual spend in 2006 and 2007 and also the current budget for 2008.

Table 2.1: Costs incurred to December 2008

	2006 €000 Actual	2007 €000 Actual	2008 €000 Budget	TOTAL
Salaries and overheads	579	1,024	920	2,523
T&S	126	139	219	484
Consultants	98	106	140	344
Shiptime (state vessels)	494	1,209	507	2,210
Shiptime (other vessels)	175	185	75	435
LiDAR	1,122	-	1,210	2,332
Contractors	142	579	222	943
Equipment	651	396	202	1,249
Ground truthing	5	1	50	56
Data management	385	266	255	906
Magnetic/Gravity processing	4	-	20	24
Applied research	250	-	90	340
Value added research	25	80	90	195
Programme Total	4,054	3,984	4,000	12,038
Launch	2,102	247	242	2,591
Total	6,156	4,231	4,242	14,629

Source: GSI/ MI

Note 1: Headings used above are based on the original memorandum to Government

Note 2: There may be some small differences in Total calculations due to roundings

- 2.8 By the end of 2008, it is anticipated that a total of €12m will have been incurred on the programme plus a further €2.6 million relating to the purchase of a dedicated hydrographic/geophysical launch.

Review of Activities and Outputs

Activities

- 2.9 In reviewing the activities undertaken to date, the INFOMAR Project Team are required to complete quarterly reports. The latest quarterly reports produced (Q4 2007) have been reviewed to determine the level of activity undertaken.
- 2.10 The key initial task of this project is to undertake the seabed survey/ mapping exercise. This data can then be used to deliver the remaining outputs (such as hydrographic and habitat maps) and associated benefits. It is not essential that the survey/ mapping activity be complete before other outputs can start to be delivered, but it is the essential first step.
- 2.11 Table 2.2 below sets out the activities undertaken to date against targets to 2013.

Table 2.2: Activity Schedule

Year	Target	Outturn
End 2007	<ul style="list-style-type: none"> 4,000 sq kms of marine mapping and sampling to be completed in 2007 	<ul style="list-style-type: none"> 4,600 sq kms in 2007; 7,000 sq kms since 2006
	<ul style="list-style-type: none"> 25% of all processed marine survey data to be made publicly available 	<ul style="list-style-type: none"> Over 30%
	<ul style="list-style-type: none"> 3 Bays and 1 Priority Area 	<ul style="list-style-type: none"> 2 bays and 1 Priority Area in 2007; 3 bays and 1 priority area (since 2006)
End 2008	<ul style="list-style-type: none"> Total of 6 Bays 500 sq kms of in-shore mapping 	
End 2013	<ul style="list-style-type: none"> 18 Bays and 2 Priority Areas ⁽¹⁾ 100% of all marine survey data available 	

Source: GSI, NDP Reporting Template (Q4 2007)

- 2.12 To date 3 Bays and 1 Priority Area have been mapped, this is equivalent to 7,000 km.sq (or 6%) of the seabed. In addition, over 25% of all processed marine survey data has been made available to the public, this is in line with the targets identified in 2006. It is intended that 100% of processed data will be available by 2013, including the data captured in the INSS project.

Outputs

- 2.13 Overall the intended output of this project is the completion of the mapping of the Irish seabed. Phase 1, to be completed in the first ten years (i.e. by 2016) involves the completion of 26 bays and 3 Priority Coastal Areas. Phase 2 of the project is the remaining inshore and offshore area not included in the INSS project (see Figure 1.2 above).

2.14 In addition to the activities set out above, a key element of the project is the value added component and in particular developing the knowledge based economy. In this regard a number of research related projects have been initiated since 2006 as set out below:

- Under the National Marine Research and Innovation Strategy, Sea Change, a project on the modelling of marine related Geophysical data has been initiated.
- The INFOMAR project directly funds two full-time and one part time post-graduate researcher, two in GSI and one in MI, to develop research linkages and manage associated research projects. Their expertise is in marine geology, specifically applied acoustics, seabed classification and marine glacial geology.
- INFOMAR has directly funded research on INSS/INFOMAR datasets as follows:
 - Coral Atlas project (UCC), producing a map/database of all known/possible cold water coral occurrences in Irish waters from map data obtained to date. Has been used to leverage participation in FP7 funded Carbonate Project.
 - LiDAR Reflectivity Characterisation (QTC), collaborative project with Quester Tangent Corporation, Canadian software developer, to produce a toolbox for classification of LiDAR data, in a similar manner to research completed on Acoustic (multibeam data).
 - Carbon in Marine Sediments (DCU), PhD funding provided for geochemical analysis of offshore samples looking at Carbon load and multi-element values and including physical sample analyses.
- Griffiths Research Awards – GSI manage these NDP funded awards, initiated in 2007 with the signing of contracts providing total funding of €9.1 million to successful research applicants. Three of the nine awards made utilise INFOMAR/INSS data, including the largest single award of €3.1 million to the Earth and Ocean Sciences Dept at NUIG. The aim is that by 2013, there will be a significant increase in the Geoscience research capacity in Irish Universities (110 staff in place compared to a baseline of 75 in 2007).
- Sea Change – MI manage and are involved in a range of research activities under this initiative. Included in this is a project called GEODI (CMRC¹), looking at data modelling of marine geophysical data based on INSS/INFOMAR. INFOMAR data is also fundamental to research being carried out on Oceanographic modelling in the Climate Change area.

2.15 By the end of 2008 the following outputs are anticipated:

- Products; A full suite of products (Bathymetry Maps, Seabed Geology, Physical Habitat Maps, Sample Details, Digital Datasets, 3D Models, Reports) for at least 6 Priority Bays and 1 Priority area.
- Data Delivery; A fully working Interactive Web Data Delivery System, providing all the 2006-2008 project outputs and 100% of the processed popular INSS Data.
- Added Value: Data from the project will be incorporated into at least one commercial digital navigation package and therefore readily available to mariners.

¹ Coastal Marine and Resources Centre

- Equipment; The project will have a fully operational dedicated inshore hydrographic/geophysical launch, equipped with a full range of marine mapping and sampling equipment.
- Research; Report outputs from all directly funded projects, and activity with leveraged funding of over €1 million in associated projects, such as those funded by Griffiths and Sea Change.

Key Issues

2.16 In addition to reviewing background documents and monitoring reports, there are a number of key issues in respect of the project which are discussed below. These issues relate to the project from its inception in 2006 (ie. it does not consider the INSS project) and have been identified from our observations reviewing project documentation and also the result of our series of consultations. In respect of the consultations, this report provides a composite view of the comments made and none are attributed to specific individuals. The following key issues are discussed in turn:

- Project Structure and Resource Requirements;
- Project Outcomes;
- Accelerating the Project;
- Making data freely available;
- Acquisition of the Launch; and
- Project Strengths and Areas for Development.

Project Structure and Resource Requirements

2.17 The INFOMAR project structure is a product of the stakeholder groups (primarily GSI and MI) who are responsible for its implementation. In this instance it is clear that both organisations bring complementary skills to the project, broadly GSI have a specific expertise in geology (in effect the sea floor and below) and charting, while MI bring biology skills to the project (in effect the sea floor and above). In addition both organisations have complementary competence in aspects of marine surveying and data management. Therefore together they can identify and interpret data relating to the entire sea and under sea resource.

2.18 In addition, in 2006 both the GSI and MI were under the responsibility of the Department of Communications, Marine and Natural Resources (DCMNR). However since then the Marine Institute's sponsoring department has changed to the Department of Agriculture Fisheries and Food. On the basis that INFOMAR is listed under the GeoSciences section of the NDP the budget for the INFOMAR project remains within the DCENR.

2.19 Reflecting the origins of the project, it has a joint Project Manager structure, one from the GSI and one from MI. In this regard, the following comments are relevant.

2.20 Whilst it is generally recognised that the relationship between both organisations was not always smooth in the past, there is a unanimous view that the current joint project managers have a very good working relationship, which has been a fundamental part of the success of the INFOMAR project to date.

- 2.21 This is obviously very welcome, however in moving forward, it must be recognised that these two individuals may not remain in their current positions for the remainder of the project. Therefore it is important that appropriate structures are in place to ensure continued good working relations continue. This has been recognised from the outset by GSI and MI and there is now an agreed procedure for dispute resolution:
- There is recourse to an external arbitrator to resolve issues on which the project managers cannot reach agreement. To date, only one issue has been taken to the arbitrator and was readily resolved;
 - In addition, there is also recourse to the GSI and MI CEOs, who together would then seek to find an accommodation. Since this approach has been established, there has been no need to put it into action.
- 2.22 In addition to the measures above, it is recommended that in future there should be a formal agreement between GSI and MI regarding the level of staff resources to be devoted to the INFOMAR project each year. This may include the implementation of a common or compatible time recording system to monitoring time spent on INFOMAR (and other projects). Furthermore, if staff are to be transferred to other projects, this should be formally agreed across both organisations. There is a view that if these arrangements are formalised then there will be greater transparency in terms of the exact resources each organisation provides.
- 2.23 Finally in this regard, from discussions with staff across both organisations, there is a clear recognition of the benefits of working together on this project and a strong desire to see it succeed. Furthermore, consultees also indicated that relations at an organisational level are much stronger, and so the 'success' of the project to date is not solely dependent on the two individuals who are joint project managers and that if issues do arise in future, senior management are confident these can be quickly overcome.

Accelerating the Programme

- 2.24 Moving forward this project has the benefit of lessons learned from the original INSS project and also the INFOMAR project from June 2006. In this regard one point that has been highlighted is the potential for accelerating the programme. At its current pace the INFOMAR project will only be completed by 2026, however from the experience to date a number of benefits have been identified from accelerating the programme:
- Personnel/ Staffing – staff indicated that it would be important that the project be completed within the working careers of staff working on the project. It is also important that momentum is maintained on a project to ensure that experience and expertise gained stays with the project team until its completion;
 - Technology Issue – as data is acquired and stored in digital format, changes in acquisition and storage systems over a long project life could create potential IT issues and costs;
 - Energy/ Infrastructure Market – there is now increased demand for accurate data to support marine spatial planning and development including aggregates planning and offshore wind and wave farms. This is likely to increase in future given DCENR's announcement in February 2008 on subsidies for renewable energy;
 - Access to Staff and other Resources – with the likely long term upward trend in oil prices there are big issues for the project in terms of accessing survey staff and equipment. In particular the oil and gas industry have the financial resources and incentive to procure these survey resources, which in turn increases the cost and make other projects unaffordable;

- Safety – Government has an obligation to provide accurate charts for shipping and if an accident occurs in national waters, under MARPOL (Marine Pollution) convention, the State is liable for total cost of clean up if the accident is attributable to poor charting in national waters. Given the increased level of shipping traffic in Irish waters, the sooner areas are surveyed then the reduced likelihood of accidents; and
- Environment – the data collected from this project can be used to improve climate change models, therefore the sooner all information is collated the more quickly benefits can be realised. Also related to the environment issue is the need for seabed geology and physical habitat maps by National Parks and Wildlife Service (NPWS) to help designate Marine Special Areas of Conservation (SACs) and aquaculture license. If these designations are not made then the Government could have sanctions imposed, including fines, by the EU.

Project Outcomes

2.25 There are a wide range of project outcomes and benefits identified in respect of this project. To date, it is not possible to make a determination on the achievement of these outcomes given the limited progress made to date (the NDP monitoring tables set out above tend to focus on measuring activities at this point). It is anticipated that these benefits/ outcomes will only be fully measurable after the project has been completed so it is therefore important that a full evaluation is undertaken when the project is complete. However there has been some specific work undertaken which has resulted in positive outcomes as detailed below:

- Wave Energy Mapping – a survey exercise was undertaken in 2007 off the Dingle peninsula and Belmullet to inform the site selection of a wave energy project. This project has now received Government funding and is being implemented;
- Dublin Port Authority – the channel to Dublin port was surveyed and the information used to confirm that traffic could enter and exit the port safely. If this information was not available, it would have had potentially catastrophic implications for Dublin port (and the wider economy);
- National Parks and Wildlife Service (NPWS) – as mentioned above the NPWS are required to identify habitat maps and SACs in order to avoid fines from the EU. In 2007, some survey work was undertaken in the Irish Sea as part of an overall approach by Department of the Environment and NPWS to capture the information needed for potential new designations, which may help to avoid the fines;
- Geoscience Council of South Africa – GSI and Marine Institute have been approached by the Geoscience Council of South Africa to assist them in developing and implementing a similar proposal to INSS/ INFOMAR. This is likely to lead to a Memorandum of Understanding being drawn up to cover knowledge transfer and staff upskilling;
- Galway Bay “SmartBay” Project – data gathered by INFOMAR has centrally informed the decision to locate a flagship marine research infrastructure project in Galway Bay. This project will see Galway Bay becoming a wired environment to be used for advanced sensor development and advanced environmental monitoring. The SmartBay project is to be the subject of a Higher Education Authority PRTLII infrastructures call, and it’s establishment has been a key component in the decision by IBM to establish a centre of excellence in water quality technologies in Ireland.

- 2.26 The Port of Foynes has also requested a mapping exercise of the Shannon Estuary to support the potential Liquefied Natural Gas (LNG) project. The lack of up to date mapping of the Shannon Estuary was identified as specific risk in the evaluation of the project proposal. This project has the potential to deliver significant economic benefits to Ireland and the area will be prioritised for 2009.

Making Data Freely Available

- 2.27 In 2007, the Minister for DCMNR took the decision to make all the digital geoscience data produced by the INSS and INFOMAR projects freely available to the public and organisations with an interest in marine data. This includes organisations with an academic interest such as universities as well private sector companies with a commercial interest. As noted above, over 25% of all marine survey data is now publicly available through an interactive web data delivery system. Under the NDP timetable schedule, 100% of all processed digital data will be available by the end of 2013.

- 2.28 The consensus view from the consultations is that this decision was a very positive step for the programme, for the following reasons:

- This has created momentum in organisations using the data, which in turn maximises the added value which the project can deliver. For example, since the data was made available, up to end April, it has been accessed by over 200 users, downloading 2,304 files, typically for infrastructural, engineering and research projects.
- This is particularly the case as the data become relevant to the near-shore area. Efforts to have INSS data incorporated into Electronic Charting/Navigation Systems have previously proved fruitless. Under the new regime it has been possible to reach agreement to have INSS/INFOMAR data incorporated into a commercially available system at no cost to the project;
- INSS/INFOMAR data will now be incorporated into the next update of the GEBCO map (General Bathymetric Chart of the Oceans). GEBCO operates under the auspices of the International Hydrographic Organisation (IHO) and the United Nations' (UNESCO) Intergovernmental Oceanographic Commission (IOC). This is the de facto world map of the seabed, used by Google Earth, National Geographic, NASA etc;
- As more information becomes available, covering a greater geographical area, demand should increase further;
- Whilst Ireland is currently one of the leading players in the area of marine mapping, maximising the benefits and increasing momentum is seen as an important factor in maintaining this competitive advantage; and
- Both GSI and MI accept that the uses for this type of data could be significantly greater than they are aware. As a result, if data is freely available organisations may be more likely to use the data and explore its potential.

- 2.29 In terms of moving forward, many of these issues are discussed in greater detail in the 'Project Benefits' section of this appraisal.

Acquisition of the Launch

- 2.30 Later in 2008, GSI will take possession of a specifically commissioned Launch. The data acquisition methods for the INFOMAR programme are principally the Marine Institute National Research Vessels in deeper water (>30 metres), airborne laser mapping systems (LIDAR) in clear waters up to 10 metres and smaller contracted vessels to carry out surveys between 10 metres and 30 metres in depth and to carry out ground truth surveys in areas flown by LIDAR.
- 2.31 The business case indicated that smaller contracted vessels are rarely optimised for survey work and often require extensive modification or survey quality is compromised. A call for expressions of interest to undertake this work received a limited response and as a result the INFOMAR team considered the acquisition of a dedicated inshore vessel.
- 2.32 This would have a number of benefits including:
- A financial saving could be made – rental of this type of launch is estimated to cost approximately €350k per annum, equivalent to €5-6 million over the course of the INFOMAR programme. The Launch cost is estimated at €2.4 million (including the purchase and fitting out now estimated at €1 million plus a further €0.6 million of specialised mapping equipment). The operating cost of the launch is estimated to be approximately 50% of that of commercial vessels and should result in a saving of over €2 million during the programme;
 - Reduced reliance on contract vessels – a single launch would not be capable of carrying out all the work but would reduce considerably the level of contract vessel time required;
 - Increased flexibility – a dedicated launch provides greater flexibility, and, building on the experience of use of National Vessels managed by MI, this means that ship time and survey work can be scheduled without falling prey to commercial pressures or sudden price fluctuations; and
 - Safety – working on a single launch where staff can become familiar with the craft and machinery is judged to be safer than being deployed to work on different contract vessels for each survey.
- 2.33 In addition, initial discussions have taken place with other state agencies and Government Departments regarding possible use of the launch when not engaged in INFOMAR Survey work. Therefore on the basis of a cost estimated at €2 million and benefits/ savings estimated at over €2 million, the recommendation was made to commission a launch.

Project Strengths and Areas for Development

Strengths

2.34 This review of the INFOMAR project to date has identified a number of positive aspects of the project which are discussed in turn:

- Environment – there have been a number of environmental outputs from the project to date including the provision, in 2007, of site selection data by INFOMAR for the offshore wave energy project at Belmullet. In addition, INFOMAR data is being used as a key baseline dataset in climate change studies and has already been used for areas mapped, for example Clew Bay;
- International Recognition – INFOMAR and INSS have received international recognition for the leading and innovative nature of the work being undertaken. This obviously reflects positively on the team at GSI/ MI but also enhances Ireland's reputation as a knowledge based economy;
- Business Development – the work of the project and its predecessor has led to the upskilling of a range of people in the area of marine surveying. It has also led directly to the establishment of new business ventures. One example is the IMAR Survey, an Irish contract marine surveying company, managed by former INSS staff who are working on marine survey contracts in both Ireland and abroad, principally on infrastructure and energy projects;
- Approach – the experience gained to date has resulted in tried and tested methodologies for surveying and the expertise to operate technical equipment needed for near shore hydrographic mapping and habitat mapping. In addition the approach adopted with the range of surveying and mapping work, using a range of equipment on one boat and being undertaken at the same time is much more efficient than a piecemeal approach which would otherwise be adopted in the absence of INFOMAR;
- Added Value Component – one noted advantage of INFOMAR over INSS is that the intended focus has broadened to include not just collecting data but also the analysis and dissemination of data, which in turn encourages the added value components. In this regard it is important that this focus is not lost if INFOMAR continues;
- Relationship between GSI and MI – although historically the relationship between both the GSI and MI has been mixed, there now appears a positive working relationship between both organisations which would appear to be as a result of the successful implementation of a common project by a joint project team; and
- Provision of Digital Data – as the data is available in digital format it is much more flexible in terms of how it can be distributed. In addition, digital data can be much more easily analysed which is important to encourage the value added activity which is an obvious priority for the project.

Areas for Development

2.35 In addition to some of the strengths discussed above, a number of potential areas for development have also been identified

- Promotion – there was a general view that the project does not have a sufficiently high profile and more should be done to promote the work being done and the potential benefits derived. The target for this promotional work is also significant and includes other parts of Government, the private sector (and general public) as well as other organisations internationally. To that end, the project team developed a communication plan in February 2008, which identifies stakeholders, key messages and how the communication will take place. This is obviously a positive development, but it is too early to make any determination on the success of the plan;
- Use of Indigenous staff – in resourcing any project it is always important to get the balance right between the use of indigenous staff and use of consultants. Consultants can be very useful for providing either specialist knowledge which will be required for only a specified period of time or to help resource peaks in activity which cannot be met by internal staff resources. In the transfer from INSS to INFOMAR we understand there was a reduction in field staff from 10 to 4 personnel. The concern was therefore raised that consultants will leave with a lot of knowledge and expertise that would be better if retained within the organisation. In addition, if there are small numbers of staff and one of them leaves, then a significant knowledge gap is left in the project, which cannot easily be replaced.

A key barrier in the use of indigenous staff has been the embargo on recruitment to new positions in the public service. It is not possible for the GSI, as a line division of a Government Department to recruit staff other than on a consultancy basis. The Marine Institute has in the past been in a position to recruit staff under contracts directly linked to the funding of the project. Sanction for these posts is subject to rigorous scrutiny;

- High Staff Turnover – one point noted by several consultees was that there was a high turnover of staff on the project. This obviously makes it difficult to maintain momentum in the project and retain knowledge. The reason provided for this problem was the current funding regime which is short term in nature. It was universally acknowledged that if the project secured long term funding, the staff turnover problem should be resolved;
- Data dissemination – linking with one of the key strengths noted above, the dual focus on data capture as well as dissemination is to be welcomed, however there was a view expressed that activity to date has focused more on data collection than dissemination. Whilst it is reasonable that in the early stages of this project, particularly in the current 20 year configuration, there should be a greater emphasis on collection, the INFOMAR project team should be aware of the wider desire to see the information disseminated and value added activities encouraged;

In this regard it is recommended that a project plan is developed to identify how the value added benefits of INFOMAR can be achieved and the return on the investment maximised. This should include the establishment of targets for research projects, commercial investments etc;

- Funding – linked to the point above it is important that the balance of funding on any programme moving forward reflects the appropriate emphasis on data analysis and dissemination and value added components;

- Financial Reporting – the financial subheads tracked are those put forward in the original Memorandum to Government and do not adequately reflect all of the operating areas of the programme that require analysis. For example, no provision is made to capture items such as administration and marketing.

Conclusions

- 2.36 The INFOMAR project is progressing as planned and is ahead of schedule for some aspects of its work. As at December 2007, the project had surpassed its NDP targets, with over 30% of all processed marine survey data publicly available through an interactive web data delivery system (against a target of 25%) and 7,000 sq. km mapped, including all of the South West Priority Area.
- 2.37 In terms of outputs, a key element of the project is the value added component and in particular developing the knowledge based economy. In this regard a number of research related projects have been initiated and in addition the project is strongly linked to new initiatives under the Griffiths Research Awards and Sea Change (this has leveraged over €5 million of research expenditure to date).
- 2.38 Regarding practical outputs the project has benefited from the decision to provide digital data free of charge. This has led to a measurably higher level of use of project outputs and significant developments in the incorporation of Irish marine data in international products and commercial systems.
- 2.39 Overall it is still too early to make a final judgement on project outcomes, however a number of specific activities and outputs have been undertaken which should deliver benefits to the economy and/ or environment. In time, it is important that a more comprehensive evaluation is undertaken to capture the full extent of outcomes/ benefits which this project could deliver. It is likely this could only be done in the latter stages of this project.
- 2.40 In this review period, there have been significant arguments put forward for accelerating the programme which are considered within this appraisal report and a number of key issues arising which are either being addressed or should be addressed in 2008.

III Needs and Objectives

Introduction

3.1 The INFOMAR strategy argues that “*Failure to proceed with a follow on strategy to INSS leaves Ireland seriously exposed to censure, or worse, on a number of legislative/ treaty obligations and jeopardises the market opportunity to maximise the potential return on investment achievable with our current world leadership position in integrated ocean mapping “know how”.*”

3.2 Public expenditure for the INFOMAR project may be justified if there is a clearly identified need for the outputs that will arise from the project, and if the project would not otherwise be completed without government intervention. This section of the appraisal considers why there should be public expenditure on the INFOMAR project from four perspectives:

(a) *Market failure*

The direct costs of, and the scale of direct benefits from, the comprehensive seabed mapping project of INSS and INFOMAR are such that it is unlikely that it would be undertaken by a private operator. Therefore, for the project to be undertaken in its entirety, and for the benefits to be freely available, it requires government intervention and funding.

(b) *Legislative and regulatory requirements*

The information that will be provided through the completion of the seabed mapping is necessary to assist the government, both directly and indirectly, in complying with a variety of international, EU and Irish legislative and regulatory requirements.

(c) *Marine Resource Information Requirements*

Demographic changes, economic development and changing social and environmental policies will all contribute to the need to develop a cohesive national policy for the integrated management of the coastal zone. The existence of the comprehensive dataset from the INFOMAR and INSS projects will assist in the decision-making processes for policy makers and commercial and recreational stakeholders in the Irish marine sector.

(d) *Research and Contribution to the Knowledge Economy*

The INSS and INFOMAR have contributed and will continue to contribute to an increase in technical, infrastructural and human capacity relating to seabed mapping, marine geoscience and other areas informed by such mapping. This increased capacity will provide Ireland with a competitive advantage in generating academic and commercial marine-related research funding.

3.3 These four areas are now discussed in turn below.

Market failure

- 3.4 The direct output of the INFOMAR project will be the provision, free of charge, of data collected and products generated from the comprehensive mapping of the Irish seabed. This information will be available to all stakeholders, including policy makers, the public and commercial interests.
- 3.5 It is unlikely that the direct benefits that would be derived by any one user from the data would be of a scale that would offset the costs of undertaking this comprehensive mapping project. Therefore, in the absence of government intervention, it is concluded that the project would not be undertaken. This is evidenced by the fact that internationally this is only done by the public sector. There are no cases where a private/ commercial organisation has undertaken a comprehensive mapping exercise on this scale for the 'wider good'.
- 3.6 As has occurred in the past², it is likely that private sector providers would only survey a small geographic area for their own specific needs. For example, major ports undertake their own surveys (with a specific focus on safety of passage) however this is limited to active channel areas, because of the commercial interest to them. Gaps in information would result (both geographically and in terms of a focus on either geology or habitat), inefficiencies would arise, due to the potential for duplication of effort from mapping of the same areas by a range of organisations and the potential for information to be shared (and in turn generation of wider benefits) would be significantly reduced.
- 3.7 A specific example is the current situation in the UK. At the recent Committee on Shipping Hydrography Seminar, (COSH, 2008²³), ten different state funded organisations presented updates on their UK marine mapping activities, in some cases mapping similar areas with different ships for different projects. We understand that the Maritime and Coastguard Agency and the UK Hydrographic Office, requested support for a single coordinated national mapping programme and data sharing initiative, such as is taking place in Ireland. A submission to the UK government is currently being prepared.
- 3.8 By undertaking the INFOMAR project and by making the data available free of charge to all stakeholders, the government is ensuring that no stakeholder is prevented from accessing and utilising the data for policy-making, commercial, recreational, environmental or decision processes.
- 3.9 In the event of the INFOMAR project not being undertaken, public policy decisions in related sectors, e.g. energy, may be adversely affected due to an absence of comprehensive and accurate supporting data. In some cases such policy decisions are required under EU and international law and failure to adequately legislate could attract significant financial penalties for the state. This may result in individual state organisations undertaking survey activities in an uncoordinated and ad-hoc manner, in effect resulting in some spending that would take place under INFOMAR but without the benefits of a coordinated programme. This furthermore justifies the rationale for Government intervention in this area.

² Feasibility Study on the Establishment of a Large Scale Inshore Resource Mapping Project, MI, 2004, Chapter 8

³ UK Committee on Shipping Hydrography Seminar 2007-2008, February 27th, Southampton, MCA

- 3.10 Taking a much broader view, at a national level, it is very difficult for a Government/nation to effectively manage a resource without having a detailed 'picture' of what that resource includes. Historically, one of the first steps Governments took to manage their land domains was to map it (The Ordnance Survey of Ireland was founded in 1824 and the Geological survey in 1845). This principle remains equally valid in respect of the marine resource.
- 3.11 Finally, INFOMAR may contribute directly to economic growth. For example, data provided from INFOMAR will input into site investigations for marine energy sites and detailed habitat maps. These may be used both by policy makers and by private operators involved in fishing, aquaculture and other sectors some of which may not yet be fully defined such as bio-discovery. This is discussed in greater detail in the Benefits section of this appraisal.

Legislative Requirements and Obligations

- 3.12 Ireland is subject to a number of EU directives and Irish legislation related to the marine and the environment. In addition, it is a signatory to a number of international marine conventions. The information that has been, and will be, made available from the findings of the INFOMAR project will assist Ireland in complying with these requirements. It is important to note that non-compliance with EU Directives could lead to significant fines being incurred. Whilst these are difficult to estimate, this is discussed further in the benefits section of this report.
- 3.13 A selection of the legislative and regulatory requirements that are being and could be addressed through the outputs of the INFOMAR project is provided below. These are the:
- SOLAS Convention;
 - Ports of Refuge
 - UNCLOS;
 - Oil Pollution of the Sea (Civil Liability and Compensation) Act;
 - Water Framework Directive;
 - Marine Framework Directive;
 - OSPAR Convention; and
 - EU Habitats Directive.

- 3.14 Each of these are now discussed in turn.

*SOLAS Convention (UN)*⁴

- 3.15 The 1974 International Convention for the Safety of Life at Sea (SOLAS) identifies the navigation safety services that should be provided by government. In particular, since 2002, it is a requirement of a contracting government to '*Undertake to arrange for the collection of hydrographic data and the publication, dissemination and keeping up to date of all nautical information necessary for safe navigation*'. The INFOMAR project, which will complete the mapping of the Irish seabed, will fulfil these requirements for the Irish government.

⁴ A convention of the International Maritime Organisation (IMO), which is the United Nations Agency concerned with the safety of shipping and cleaner oceans

Identification of ports of refuge

- 3.16 A port of refuge is the nearest safe haven for a ship in trouble. The port or anchorage is selected on the basis that it has adequate depth to safely accommodate the ship, as well as shelter from the prevailing winds and swells to facilitate the timely and controlled transfer of people and cargo either to another ship or to land. It should be noted that a 'port of refuge' is not exclusively a man made harbour/ port, but also includes bays which can provide a natural shelter from dangerous weather.
- 3.17 In response to an EU request to designate places of refuge (Directive 2002/59/EC) the approach to be taken in Ireland will be to assess each incident as it arises. A report (Briggs Marine Environmental Services, 1997) considers such factors as coastal characteristics, booming arrangements and road access as a basis for decision making/risk analysis. This will be used to identify suitable ports and bays. Accurate bathymetric charts, as produced from the INFOMAR Programme, ensuring safe anchorage depths, are a valuable tool in the identification of ports and places of refuge.

UNCLOS

- 3.18 The United Nations Convention on the Law of the SEA (UNCLOS) is the overarching international policy framework for all ocean policies. A requirement of UNCLOS is for signatory nations to define the limits of their continental shelf and to project the limits of other maritime jurisdictions including the exclusive fishery zone. Using the data provided from the INSS and earlier surveys, Ireland made a submission to the UN in 2005 outlining the proposed outer limits of the continental shelf of Ireland. Most significantly, Ireland has been one of the first countries in the world to have a claim approved, in 2007, with a resulting grant of rights over more than 56,000km.sq.
- 3.19 Parts of the area that will be mapped by the INFOMAR are the subject of discussion between Ireland, France, Spain and the UK in terms of the exact positioning of Ireland's territorial claim. Therefore, the availability of data from mapping of this area will be essential to reconcile existing and future competing claims.

Oil Pollution of the Sea (Civil Liability and Compensation) Act (1988)

- 3.20 Under the terms of this 1988 Act⁵, which gives effect in Irish law to the Civil Liability Convention⁶, there is exemption from liability on the owner of a vessel which causes pollution damage if the accident is due to negligence by the government or authority in the provision of navigational aids in the area in which the accident occurred. In other words, if a significant oil spillage were to occur in the inshore area of Ireland due to defective marking of a hazard on a chart, the liability for clean-up and compensation would reside with the Irish government.

⁵ Section 8, Oil Pollution Of The Sea (Civil Liability And Compensation) Act, 1988

⁶ International Convention on Civil Liability for Oil Pollution Damage (CLC), 1969 (IMO Convention)

Water Framework Directive⁷

- 3.21 The Water Framework Directive (WFD) is a key initiative towards improving water quality throughout the EU. It applies to rivers, lakes, groundwater, and coastal waters. The fundamental objective of the Water Framework Directive aims at “*maintaining “high status” of waters where it exists, preventing any deterioration in the existing status of waters and achieving at least “good status” in relation to all waters by 2015⁸*”. An output from the INFOMAR project will be near shore bathymetry and sampling as well as physical habitat maps, which will potentially assist in identifying appropriate sampling locations for the WFD monitoring programmes.

Marine Framework Directive (Proposed)

- 3.22 Linked to the Water Framework Directive above, the aim of the proposed Marine Framework Directive would be to protect, conserve and improve the quality of the marine environment through the achievement of good environmental status in European seas within a defined time period. The directive will define/ establish ecosystem-based marine regions as the implementation unit. They will be defined on the basis of their hydrological, oceanographic and bio-geographic features.
- 3.23 An Implementation Plan would be prepared for each marine region, in which there would be an obligation to:
- assess the pressures and threats impacting upon the marine environment and the costs (including environmental costs) of these pressures; and
 - develop a monitoring and assessment programme to be carried out.
- 3.24 In order to comply with this directive and develop an implementation plan, hydrographic and habitat information is required to identify the baseline status and thus the nature of any problems and then in turn to monitor the environment. This is fully consistent with the data which would be captured by the INFOMAR project.

OSPAR Convention⁹ and EU Habitats Directive¹⁰

- 3.25 Ireland has a number of obligations to protect marine biodiversity and safeguard the marine environment. Under the OSPAR Convention and the EU Habitats Directive, Ireland has agreed to firstly identify and subsequently designate Special Areas of Conservation (SACs), including cold water coral reefs. To date INSS datasets have been key in defining the first four candidate Marine SACs off the western coast, protecting the cold water corals. Many of the potential candidate SACs are found within the inshore area and have yet to be mapped. Information from the INFOMAR, particularly bathymetry and ground truthing, will contribute to identifying the range and nature of the seabed habitats in the inshore area.

⁷ EU Water Framework Directive ([2000/60/EC](#))

⁸ <http://www.wfdireland.ie/>

⁹ Convention for the Protection of the Marine Environment of the North-East Atlantic (1992)

¹⁰ Council Directive 92/43/EEC on the Conservation of natural habitats and of wild fauna and flora

Marine Resources Information

- 3.26 The potential of Ireland's marine resources has not yet been fully explored. In order to ensure the sustainable development of the marine sector, it will be necessary to create and successfully manage a cohesive marine strategy, which will address the sometime conflicting needs of different stakeholders, e.g. the fishing and aquaculture sector, conservationists, the public, private operators, policy makers, environmentalists etc. The data that will be provided from the INFOMAR integrated mapping project will assist in decision making processes for the development of this cohesive strategy.
- 3.27 Information from the INFOMAR project may contribute to coastal development and infrastructure, sustainable development of renewable resources, efficient exploitation of non-renewable resources, preservation of Ireland's natural marine heritage, and information on coastal erosion. Overall, the data provided should contribute to integrated coastal zone management, which will allow for the management of coastal zone activities in an efficient and non-duplicative manner, taking account of economic, social and environmental needs. Examples of the Information Requirements that could be addressed by outputs from the INFOMAR project are provided below, under the following headings:
- Coastal development and infrastructure;
 - Renewable Resources;
 - Non-Renewable Resources;
 - Marine environment;
 - Maritime archaeology; and
 - Coastal erosion and climate change.
- 3.28 These are now discussed in turn.

Coastal development and infrastructure

Navigation

- 3.29 With increased commercial and fishing traffic, accurate charts are required to assist in easing congestion and increasing safety within Irish ports. The selection of a port is based on the site having adequate depth to safely accommodate a ship, as well as shelter from winds and waves to allow for safe transfer of people and cargo. The INFOMAR project will provide a comprehensive set of charts, which will include approaches to harbours and areas outside existing channels (where Ports may undertake their own mapping) and therefore help to identify the most suitable sites for port development and selection as ports and will overall improve the efficiency of the transport network within the shipping channels, bays and harbours.

Marine tourism and leisure

- 3.30 In 2003, the Marine Tourism and Leisure sector had a turnover of over €630 m. The outputs from the INFOMAR project could assist in the development of this sector. For example, the provision of survey data from an inshore mapping programme could be used to develop charted sailing routes around Ireland. Survey data may also provide information on inshore angling, such as identifying reefs and sandbanks. The information provided should increase participation in marine leisure activities and reduce the risks of accidents associated with these activities.

Renewable Resources

Fishing Resources

- 3.31 The inshore fishing sector is worth approximately €32 million per annum¹¹. INFOMAR survey results may be used to provide information to fishermen in order to identify the most desirable fishing areas, and thus reduce fuel use, carbon emissions, exposure to risk and time at sea. In addition, they will provide information on seabed obstacles, thus reducing potential gear loss and damage to wrecks and marine habitats. Finally, improved data on inshore fish habitats could identify sensitive fish spawning and nursery areas, thus assisting with stock management and recovery measures, which will ultimately benefit the fishing sector.

Aquaculture Development

- 3.32 In 2003, the Irish Aquaculture industry had a turnover of €101 million¹². Further development of the industry will occur through the selection of the most appropriate sites for cultivation. Outputs from the INFOMAR project, including habitat maps, bathymetric maps¹³ and seabed type, and their use in carrying capacity studies should assist in the selection processes.

¹¹ Steering a New Course. Strategy for a Restructured, Sustainable and Profitable Irish Seafood Industry (Cawley Report) 2006

¹² Ireland's Ocean Economy and Resources, Marine Institute, 2005

¹³ Bathymetry is the study of underwater depth (underwater equivalent of topography)

Renewable energy

- 3.33 The marine area holds significant potential for the production of renewable or alternative sources of energy. The optimal location of power generators to harness wind, wave or tidal energy can depend on a number of factors including water depth, sea bed conditions and distances from shore. Outputs from the INFOMAR project, e.g. bathymetry, or sea bed characteristics, may assist in future site selection, and licensing policies for renewable energy developments. In particular, INFOMAR outputs may inform the identification and quantification of the near shore wave energy resource potential. Evidence for INFOMAR's potential in this area already exists in the use of data acquired by INFOMAR in the evaluation and selection of an offshore wave energy test site in 2007.

Seaweed industry

- 3.34 The seaweed industry is fully based within the inshore area. While the industry was worth €10 million in 2003, it has the potential to expand through the identification and quantification of commercially exploitable seaweed species¹⁴. The outputs of the INFOMAR project, in particular physical habitat maps and ground truth data, could assist in the identification and selection of the most appropriate areas for potential seaweed harvesting sites.

Non-renewable resources

- 3.35 To date, Ireland has not explored the potential for commercial extraction of marine aggregate (sand and gravel). At present, there is no national policy on marine aggregate extraction, although this is being addressed through the Irish Sea Marine Aggregate Initiative (IMAGIN). A comprehensive dataset based on the mapping of the Irish inshore area will contribute to the decision making process relating to extraction of marine aggregate, its potential impact on biological communities and the most efficient methods of extraction. A specific recommendation of the IMAGIN study is the application of the project methodology to other areas and infill of widely spaced mapping lines by the INFOMAR Project.
- 3.36 The extraction of marine aggregate has environmental as well as commercial implications as the 'carbon footprint' associated with the extraction and transport of marine aggregate has been found to be significantly less than that associated with land-based extraction activities¹⁵.

Cables and pipelines

- 3.37 A comprehensive bathymetric and physical mapping of the seabed may contribute to the decision making process for the most effective laying of cables and pipelines for electricity, communications, commercial oil, gas and other energy sources in the marine area.

¹⁴ Ireland's Ocean Economy and Resources, Marine Institute, 2005

¹⁵ IMAGIN Report: Issues and Recommendations for the Development and Regulation of Marine Aggregate Extraction in the Irish Sea, 2008

Marine Environment

- 3.38 The conservation and preservation of marine biodiversity to which Ireland has committed can lead to a conflict of interest between fishing and other commercial sectors, interest groups and policy makers. It is becoming increasingly important to obtain accurate information on the location and extent of habitat types to facilitate the sound management, development and protection of sensitive areas. The information provided from the INFOMAR project will assist in the designation of Special Areas of Conservation in the inshore area, will provide decision support for the best practices in fishing and aquaculture, and will identify the least environmentally disruptive areas for other commercial activities.

Maritime archaeology

- 3.39 In addition to preserving the marine biological environment, Ireland is committed to preserving its maritime archaeology. Outputs from the INFOMAR will include the identification and investigation of anomalies in the seabed, which may be caused by wrecks, the exact location of which may not be known. This information, when combined with further investigation, e.g. diver surveys, will contribute to the preservation of specific areas of archaeological interest and ensure that commercial activities do not adversely affect these areas. It is expected that the INFOMAR dataset may contribute to the further refinement of the Maritime Sites and Monument Record's (MSMR) database, as has already taken place in some deepwater areas using INSS data. However the majority of known wrecks are in inshore waters only now being mapped under INFOMAR.

Coastal erosion and climate change

- 3.40 It is necessary to develop an accurate set of measurements of the physical impact of the sea on Irish environmental and socio-economic development. For example, rising sea levels and increasing storm frequency may contribute to an increased rate of coastal erosion and the incidence of storm and flood-related events. Accurate bathymetry and land boundary information for the Irish marine area, which will be outputs of the INFOMAR project, will be required to inform the development of the Irish Coastal Protection Strategy Study¹⁶.

¹⁶ Department of Communications, Energy & Natural Resources

Research and Contribution to the Knowledge Economy

- 3.41 The Vision outlined in the Strategy for Science, Technology and Innovation (SSTI) is that *“Ireland by 2013 will be internationally renowned for the excellence of its research, and will be to the forefront in generating and using new knowledge for economic and social progress, within an innovation driven culture¹⁷”*. The INFOMAR project is listed in the SSTI as a Key Action under the Marine component of Research in the Public Sector.
- 3.42 By 2005, the INSS database and associated expertise had leveraged earnings in excess of €5 million for Irish research and services associated with integrated seabed mapping and geosciences¹⁸. By end 2007, the INFOMAR project was directly supporting six marine/ geoscience research collaborations with international third level, public and private institutions¹⁹.
- 3.43 The INSS and INFOMAR provide the largest Exclusive Economic Zone survey conducted so far in the world. The result of these projects has been and will be an increase in technical, infrastructural and human capacity, through:
- an integrated marine dataset;
 - an upgraded marine surveying infrastructure; and
 - personnel skilled in the design, planning, implementation and use of a large scale marine resource evaluation programme.
- 3.44 By proceeding with the INFOMAR project, and completing the mapping of the Irish seabed, Ireland should increase its competitive advantage in this area, further attract increasing numbers of researchers and be at the forefront in securing increased international academic and commercial research funding.
- 3.45 In respect of the Knowledge Economy, it is also important to consider the following two strategies which both identify INFOMAR as an enabler:
- SeaChange – A Marine Knowledge, Research and Innovation Strategy for Ireland 2007–13. This strategy seeks to provide a clear picture of future opportunities and challenges to inform marine research and innovation to 2013. The strategy sets out the following high level objectives:
 - Strengthen the competitiveness and environmental sustainability of the marine sector by developing greater alignment between public sector & third-level research capacity and industry needs;
 - Build new multidisciplinary research capacity and capability in fundamental technologies that can be applied to marine-related activities, leading to the acquisition of new technical skills, the flow of personnel between the research community and industry and the creation of new commercial opportunities and applications;
 - Deliver a comprehensive planned policy research programme which will apply the knowledge gained from research and monitoring to inform public policy, governance and regulation.

¹⁷ Strategy for Science, Technology and Innovation, 2006-2013, p 8, Department of Enterprise, Trade & Employment

¹⁸ INFOMAR Proposal and Strategy, MI, 2005

¹⁹ NDP Reporting Template, INFOMAR Project, Q1 2008

- National GeoScience Programme (GSI and RIA²⁰) – the overarching aim of this programme is to enhance and highlight the contribution that geoscience makes to Irish Society such as the sustainable management of the environment and development of natural resources. In doing this the following specific aims have been identified:
 - Support the government's Strategy for Science, Technology and Innovation (SSTI);
 - Increase the level and quality of research investment nationally, including in particular private sector participation;
 - Position the geoscience sector to increase its contribution to the government's agenda on the knowledge economy by developing its industry, services, research and education;
 - Enable the geoscience sector to provide expert advice to the government on key issues, which are relevant to the sector; and
 - Maximise the effectiveness of the geoscience sector by prioritising key themes and mobilising resources to tackle them.

Objectives

- 3.46 The overall objective of INFOMAR is to complete the mapping of the Irish seabed and build on the achievement of the INSS, which was to establish a national asset composed of:
- A marine data set to underpin present and future Irish economic, environmental, infrastructure and social policy decisions;
 - Upgraded Irish marine surveying infrastructure;
 - Personnel skilled in the design, planning, implementation and management of a large scale integrated marine resource evaluation programme; and
 - The body of knowledge required to design, procure, build and operate the largest Exclusive Economic Zone (EEZ) survey conducted so far in the world.
- 3.47 To achieve this there are 3 distinct work programmes identified in the INFOMAR project. Each work programme will contribute directly to the objectives of the project. The work programmes are:
- Work Programme 1: Data Acquisition, Data Management and Interpretation
 - Work Programme 2: Data Exchange and Integration
 - Work Programme 3: Value Added Exploitation
- 3.48 The following project objectives have been identified, each of which links directly to a discrete work programme
- Objective 1 'Contribute to the Management of activities and resources in Irish inshore areas by completing a comprehensive mapping and data interpretation programme of priority areas followed by completion of remaining areas';

²⁰ Royal Irish Academy

- Objective 2 'Create an Inter-Agency National Marine Data Discovery and Exchange Service'; and
 - Objective 3: 'Deliver a range of Value Added Opportunities linked to user demands, commercial markets and external funding sources (e.g. EU Framework Programme 7).
- 3.49 To achieve these objectives, a set of measurable deliverables has been identified under each of the work programmes. The achievement of the specific deliverables can act as bases for measuring the success of achieving the objectives of the project. These deliverables include:
- provision of a range of information products such as hydrographic and habitat maps;
 - developing common surveying standards;
 - establishing a National Marine Data Discovery and Exchange Service; and
 - delivering a programme of national and international value added research.

Conclusions

- 3.50 Public expenditure on the INFOMAR project may be justified through demonstrating a need for the outputs of the project, and through demonstrating that these outputs would not be achieved without government intervention.
- 3.51 It has been demonstrated that it is unlikely that the INFOMAR project would be undertaken by any one individual, as the scale of benefits specific to any one individual would not offset the costs of undertaking the project.
- 3.52 In addition, by making the information generated by the INFOMAR project publicly available and free of charge, the Irish government will ensure that no-one is excluded from using the data for decision making processes.
- 3.53 The Irish government has a set of international, EU and national regulatory and legislative marine and environmental requirements. Compliance with these may be enabled through the use of data from the INFOMAR project.
- 3.54 In addition, the data provided by the INFOMAR project may contribute, both directly and indirectly, to developing and managing effectively the commercial, social and environmental potential of Ireland's marine and environmental sectors.
- 3.55 Finally, the outputs of the INFOMAR project should contribute to the further development of research excellence in the area of sea-bed mapping techniques, and marine geoscience, through improvements in research infrastructure, research methodologies and the growth of a cohort of skilled personnel.

IV Potential Constraints

Introduction

- 4.1 Before progressing to outline the options that will deliver the objectives of the INFOMAR project, the potential constraints to the project must be identified. A number of constraining factors have been identified below. These constraints will influence the process for selecting the preferred option.

Funding Constraints

- 4.2 Since 2007, the INFOMAR programme has been incorporated into the National Development Plan (NDP) 2007-2013, with an approved annual budget of €4 million, i.e. €28 million to 2013. The NDP is a €184 billion plan of investment in enterprise, science and innovation, human capital and the economic and social infrastructure of Ireland. The INFOMAR programme is funded under the Geosciences Sub-Programme, a sub-section of Priority 2 of the NDP, Enterprise Science and Innovation. Funding for the project may be constrained within the overall funding envelope that is available for the Geosciences Sub-Programme of the NDP.

Staff/ Skills Constraints

- 4.3 There are a number of personnel constraints identified in respect of this project and these are discussed in turn:
- Loss of staff through retirement – the current project is scoped for 20 years, running to 2026. This will see the project extend beyond the working life of many of the key personnel, losing vital skills and expertise built up during the project;
 - Access to Skills and Resources – given the increasing cost of oil, the financial return to the oil industry of exploration activities has increased significantly in recent months and years. As a result there is increasing competition with the oil industry for access to skilled geologists and equipment, which in turn places a constraint on the supply of appropriately skilled staff;
 - Access to Foreign Workers – to undertake the INFOMAR project, it is expected that skilled overseas personnel will be required. The safety certification of foreign contract staff may not be accepted by the Irish Authorities, thus reducing the pool of available skilled personnel to undertake the INFOMAR project activities or increasing the costs of the programme in order to pay for contract workers to undertake the accepted certification. In this regard, we understand the Irish Maritime Development Office is developing a case for PETO certification. As a result the acceptance of PETO certification should be considered by Irish Authorities.
 - Lack of Hydrography Training in Ireland – a further potential constraint on accessing appropriately qualified staff, from within Ireland, is that no education institution in Ireland offers hydrography training. This further shows the reliance on foreign trained staff to help deliver the project.
 - Ramp up in activity – the availability of appropriately skilled staff is an issue for this project particularly if the option to ramp up activity is taken forward. Discussions with project staff have acknowledged this but indicated that it is manageable. In addition, the important point was made that with a ramp up in activity and the project being completed within a 10 year rather than 20 year timeframe it would be easier to retain and attract staff.

- Value-added Skills Base – a key focus of this project is on the value added component and developing the knowledge economy. One key way this is being taken forward is through the commissioning of research related projects in Irish universities, therefore it is important that these institutions have the technical capabilities and capacity to maximise this opportunity. In addition, another key area for development is the potential to identify and exploit new niche markets such as renewable off-shore energy. The INFOMAR project will provide the base data for these niche markets to be developed, but it is important that there are sufficient numbers of skilled staff to take advantage of these opportunities.
- Ban on Recruiting Public Servants – given the potential need to ramp up activity and the associated need for additional staff, it is important to recognise the constraining factor of the freeze on public servant recruitment. In the consultations undertaken as part of completing this appraisal, one potential solution identified was to give personnel a 7 year fixed term contract, rather than employ them as public servants with pension entitlements.

Cross-Departmental Structure

- 4.4 The INFOMAR project now has a cross-Departmental Governance structure. The GSI is a line division of the Department for Communications, Energy and Natural Resources (DCENR). At the time of the INFOMAR project initiation the Marine Institute was an agency of that department but has recently transferred to the Department of Agriculture, Fisheries and Food (DAFF). Therefore whilst the budget for INFOMAR still comes through DCENR, the Departmental stakeholder environment is a little more complex which could potentially lead to difficulties securing agreement around project priorities.

Regulatory constraints

- 4.5 Particular survey activities require permitting, such as sparker surveys (see Environmental constraints) and Air Traffic Clearance for Lidar. These are not normally an issue once adequate time is allowed for clearance.

Environmental constraints

- 4.6 Many parts of the Irish near shore waters are designated as sanctuaries for marine mammals. As a result there are requirements on the ways in which surveys can be carried out, for example, the need for a marine mammal observer (MMO) on board a survey ship if seismic or sparker surveys are being carried out. Also certain areas will be off limit for surveying at certain times of the year due to breeding and surveys need to be conducted in certain ways. Discussions on best practice are ongoing with the relevant authorities, National Parks and Wildlife on these issues.

Conclusion

- 4.7 The successful undertaking of the INFOMAR project will be dependent on overcoming these potential constraints. In particular, it will be necessary to secure sufficient funding and attract and retain skilled labour, from within a scarce resource envelope, for the entirety of the project. The INFOMAR project team should put in place processes, such as ensuring the safety certification of overseas personnel, which will ensure that the constraints encountered are minimised as far as possible.
- 4.8 In terms of addressing these issues, it should be noted that the project team have been working within these constraints for some time and therefore have identified ways in which they can be addressed although in some instances this has resulted in an increased cost to the project.

V Identification of Options

Introduction

- 5.1 This section of the report sets out a range of options to meet the ‘need’ identified previously. This will include a description of each, advantages and disadvantages and conclusions relating to their suitability for shortlisting for further analysis.
- 5.2 As detailed previously in this appraisal report the overarching INFOMAR Strategy has three major programme components:

- **Programme 1 – Data Acquisition, Data Management & Interpretation;**

Programme 1 is the primary focus of the INFOMAR project and is made up of the following measures:

Measure 1	- Map 26 priority bays and 3 priority coastal areas (Phase 1) - Complete the mapping of the Irish marine territories (Phase 2)
Measure 2	- Data Interpretation programme to provide geological and habitat maps - Develop a single national repository of hydrographic and marine geophysical data (expanding the existing INSS Repository)
Measure 3	- Applied Research Programme to support the data interpretation programme which will undertake value added projects for a range of clients as demanded.

- **Programme 2 – Data Integration and Exchange**

Measure 1 Integration	- Develop and build the marine knowledge base over time; - Develop standard procedures to ensure the quality of marine data captured and stored across all relevant stakeholders; - Link with the Marine Data Warehouse for storage of integrated data.
Measure 2 Exchange	- Providing data to bona fide researchers and commercial operators as appropriate. - Link with INSPIRE compliancy projects such as Irish Spatial Data Exchange (ISDE) and Irish Spatial Data Infrastructure (ISDI)

- **Programme 3 – Value Added Exploitation**

Measure 1	- Develop ways to provide access to the data and which demonstrates its impact and value.
Measure 2	- Identify marine mapping related opportunities internationally with MI and Enterprise Ireland.
Measure 3	- Use the skills and assets developed for additional research within Irish waters and also internationally.

5.3 The options are therefore developed based on the overarching strategy set out above. However in developing these options the following factors have been taken into account:

- Current Project Status – the INFOMAR Strategy first received funding approval in mid-2006 for a three year period to end 2008. The initial years funding in 2006 was spent over a six month period. The project has subsequently received two further annual tranches of funding, for 2007 and 2008 and therefore a number of activities have already been undertaken. Value for money and relevance of the programmes undertaken has been dealt with elsewhere in this report.
- Prioritisation of Programmes – the INFOMAR Strategy is very detailed and sets out a range of objectives and activities to capture the data initially and then to ensure that the data is fully exploited. Whilst the Programmes identified can run ‘semi-concurrently’ there is an obvious need for the data acquisition and interpretation to form the basis of the strategy.
- Balance of INFOMAR expenditure and input across the Programmes – the full implementation of the strategy will require input from a wide range of organisations including other publicly funded bodies and programmes, as well as universities and also the private sector who would be well placed to take advantage of the opportunities this project can provide. (This relates more to Programme 2 and in particular Programme 3). As a result the project resources and the activity components of this project are more concentrated in Programme 1.
- Project Timing – the initial strategy was to deliver Phase 1 (i.e. the mapping of the 26 Bays and 3 Coastal areas) over the 10 year period from 2006-16, and then to complete the mapping of Phase 2 over the subsequent 10 year period (2016-26). With the inclusion of the strategy in the NDP, there is now an opportunity to consider the potential to deliver the project over the period of the existing NDP (i.e. 7 years), or at least a shorter timescale.

Options Identified

5.4 The following options are discussed:

- Option 1: Do Minimum – continue the project for the remainder of the current funding period (i.e. until December 2008) and then stop;
- Option 2: Priority Areas only – complete the mapping of the 26 priority bays and 3 priority coastal areas (Phase 1). This would also include implementation of other aspects of the overall Strategy as far as possible. It is anticipated this would be completed by 2016;
- Option 3: INFOMAR Strategy in full – this includes mapping of phases 1 and 2 and the implementation of other components of the strategy across Programmes 1, 2 and 3. It is anticipated this could be completed by 2016; and
- Option 4: INFOMAR Strategy in full, phased – this is similar to option 3 above, but only the Phase 1 mapping would be completed by 2016. Phase 2 mapping would be completed by 2026. The three INFOMAR programmes would be implemented over the extended time period.

5.5 These options are now discussed in greater detail in the following pages.

Option 1 – Do Minimum

5.6 This option represents the minimum level of activity which could be undertaken in respect of this project. The INFOMAR project currently has funding until December 2008 and this option proposes to discontinue the project after that date. Under this option the following activities would have been completed:

- 6 Priority Bays and 1 Priority Coastal Areas mapped;
- Bathymetry, geological and physical habitat maps completed for 6 Priority Bays and 1 Priority Coastal Areas; and
- A small repository of hydrographic and geophysical data would be available.

5.7 With the programme discontinued, it would then be necessary for other organisations (either public or private sector) to complete any unfinished data interpretation. In addition, as a launch will be completed prior to December 2008, a number of alternatives would need to be considered for the craft. A strategy would also be required for the continuing maintenance, archival and delivery of data acquired under the INFOMAR programme to date and the INSS.

Advantages

5.8 The following advantages have been identified in respect of this option:

- Lower capital investment required relative to other options;
- The work undertaken to date would provide important information on those areas mapped which would be made available to all interested and relevant stakeholders.

Disadvantages

5.9 The following disadvantages have been identified:

- The bulk of the overarching work programme would be uncompleted and given the private sector has shown a lack of appetite for undertaking this type of activity in the past, either in Ireland or internationally, it is very unlikely that this work would be undertaken;
- Ireland is currently at the forefront of hydrographic and geophysical mapping and the associated interpretation of this data. If this project were to be discontinued prior to completion, then the nation could lose its advantageous position and the associated expertise and skillsets would disperse;
- Other significant benefits would be lost in terms of:
 - the safety implications of those areas left unmapped (and SOLAS convention requirements);
 - the loss of information on significant aggregates located offshore and most environmentally sound areas for fishing or development; and
 - the potential to leverage existing skills and infrastructure to earn significant revenues internationally.
- The full potential of the launch which has been commissioned and will be completed in 2008 would not be achieved.

Conclusion

5.10 Whilst this option will not address the need issues raised previously, in line with relevant guidance it is shortlisted as a baseline option.

Option 2 – Priority Areas only

5.11 This option involves the completion of the mapping of the 26 priority bays and 3 priority coastal areas (Phase 1). As noted above, completion of many aspects of the overall INFOMAR Strategy requires input from a range of stakeholders, however, GSI/MI input is required to provide the basis for this activity and encourage the participation of other interested parties. As a result, the following additional aspects of the strategy would also be undertaken:

- Interpretation of data captured and production of geological and habitat maps;
- Development of a repository of hydrographic and geophysical data;
- Establishment of an applied research programme; and
- Working with other stakeholders to:
 - Develop standard procedures for on-going data capture and to facilitate data integration and storage;
 - Develop ways to improve access to the data and to identify opportunities nationally and internationally.

5.12 It is recognised that the scope of this option would be reduced given the smaller area mapped.

5.13 It is anticipated this could be completed at the present expenditure rate by 2016.

Advantages

5.14 The following advantages have been identified in respect of this option:

- The priority areas will be covered which should deliver many of the safety benefits identified;
- Lower capital investment required relative to other 'do something' options;
- Maintains to some extent the development of the skills base in Ireland which can be used to take advantage of marine mapping opportunities elsewhere; and
- Provides the infrastructure (launch, data interpretation tools, database storage and linkages with other relevant stakeholders) which may allow the completion of mapping the Irish off-shore waters at a later date.

Disadvantages

5.15 The following disadvantages have been identified:

- In geographic terms the vast proportion of the outstanding area to be mapped would remain unmapped. This would therefore result in the reduction of benefits which can be achieved, in terms of:
 - Information on sustainable areas to fish;
 - Environmental benefits such as protection of coral and information to inform climate change;
 - Data to support the development of off-shore wind-farms, wave energy and aggregates; and

- The currently designated Biologically Sensitive Area would not be mapped and therefore Ireland's case for retaining this fishery controlled area would be reduced and may be lost.
- As this would represent a reduction in the scope of the project, it is possible there would be a loss of momentum and expertise;
- This option would effectively preclude the programme from supporting research or other activities (such as opportunistic surveys) that have as their focus, the area identified for Phase II.
- The full potential of the launch which has been commissioned and will be completed in 2008 would not be achieved.

Conclusion

- 5.16 This option has the potential to address some (but not all) of the need issues raised previously, and is therefore shortlisted for further analysis.

Option 3 – INFOMAR Strategy in full (by 2016)

- 5.17 This involves the mapping of phases 1 and 2 and the implementation of other GSI components of the strategy across Programmes 1, 2 and 3 as set out in the 'Introduction' to this options section. It is anticipated this would be completed by 2016.

Advantages

- 5.18 This allows the INFOMAR Strategy to be implemented in full and within a relatively short timeframe. As a result, the following advantages have been identified in respect of this option:
- A broad range of benefits will be secured, including:
 - Safety benefits around the bays and coastal areas (SOLAS compliance);
 - Economic benefits in terms of data on potential locations of aggregates and hydrocarbons;
 - Information on sustainable areas to fish and the Biologically Sensitive Area;
 - Environmental benefits such as protection of habitats, coral and information to inform climate change; and
 - Data to support the development of off-shore wind-farms and wave energy available in a timely manner
 - Increases the momentum of the project, which will ensure the benefits are realised in a shorter period and help to keep the expertise together for the duration of the project;
 - Allows the build up of indigenous capacity through training of junior personnel;
 - The increased activity levels could result in more leverage with contractors; and
 - Maintains the development of the skills base in Ireland which can be used to take advantage of marine mapping opportunities elsewhere.

Disadvantages

5.19 The following disadvantage has been identified:

- This option would require a greater concentration of resources in the accelerated timeframe than other options.

Conclusion

5.20 This option will meet all project objectives and is therefore shortlisted for further analysis.

Option 4 – INFOMAR Strategy in full (by 2026)

5.21 This involves the mapping of phases 1 and 2 and the implementation of other components of the strategy across Programmes 1, 2 and 3 as set out in the 'Introduction' to this options section. It is anticipated this would be completed by 2026.

Advantages

5.22 This allows the INFOMAR Strategy to be implemented in full. As a result, the following advantages have been identified in respect of this option:

- A broad range of benefits will be secured, including:
 - Safety benefits around the bays and coastal areas (SOLAS compliance);
 - Economic benefits in terms of data on potential locations of aggregates and hydrocarbons;
 - Information on sustainable areas to fish;
 - Environmental benefits such as protection of habitats, coral and information to inform climate change;
 - Data to support the development of off-shore wind-farms and wave energy.
- Maintains the development of the skills base in Ireland which can be used to take advantage of marine mapping opportunities elsewhere.

Disadvantages

5.23 The following disadvantages have been identified:

- Phasing would delay the realisation of many benefits, both in terms of economic benefits and also safety and environmental factors. In addition, slowing down the delivery of data to research bodies slows down the development of a critical mass at research institutions;
- Phasing a large component of the overall project would push completion beyond the operational/ working careers of many existing staff. This loss of momentum could result in a loss of expertise;
- Running the project over a longer period of time would also increase the overall cost (this is assessed further in the next section of the report);
- The reduced level of activity would result in a lack of leverage with contractors; and

- With data being collated over such a long period of time there could be potential issues around the integrity of data (i.e. it is not a 'picture' of the sea captured in a relatively short period of time). In addition, with the general evolution of data acquisition technology, extending the period of the project could result in the data being captured to a variety of quality standards.

Conclusion

- 5.24 This option will address all of the need issues raised previously and is therefore shortlisted for further analysis.

Conclusions on Options

- 5.25 The following options are shortlisted for further consideration:

- Option 1: Do Minimum – continue the project for the remainder of the current funding period (i.e. until December 2008);
- Option 2: Priority Areas only – complete the mapping of the 26 priority bays and 3 priority coastal areas (Phase 1). This would also include implementation of other aspects of the overall Strategy as far as possible. It is anticipated this would be completed by 2016;
- Option 3: INFOMAR Strategy in full – this includes mapping of phases 1 and 2 and the implementation of other GSI components of the strategy across Programmes 1, 2 and 3. It is anticipated this would be completed by 2016;
- Option 4: INFOMAR Strategy in full, phased – this is similar to option 3 above, but only the Phase 1 mapping would be completed by 2016. Phase 2 mapping would be completed by 2026. Other INFOMAR programmes would be implemented over the extended time period.

VI Cost of options

Introduction

- 6.1 This section of the report identifies the capital and revenue costs of the short-listed options identified previously. The short-listed options are as follows:

Table 6.1 Short-listed options

Option	Description
1	Do minimum – continue the project for the remainder of the current funding period (i.e. until December 2008)
2	Complete Priority Areas only – complete the mapping of the 26 priority bays and 3 priority coastal areas (Phase 1). This would also include implementation of other GSI/MI aspects of the overall Strategy as far as possible. It is anticipated this would be completed by 2016.
3	INFOMAR Strategy in full – this includes mapping of phases 1 and 2 and the implementation of other GSI/MI components of the strategy across Programmes 1, 2 and 3. It is anticipated this would be completed by 2016
4	INFOMAR Strategy in full, phased – this is similar to option 3 above, but only the Phase 1 mapping would be completed by 2016 and Phase 2 mapping would be completed by 2026. Other INFOMAR programmes would be implemented over the extended time period.

- 6.2 This section of the report is set out as follows:

- Costs incurred from 2006 to 2008; and
- Costs to be incurred post-2008.

- 6.3 The Shadow Price of Public Funds rate of 125% is applied in the cost benefits analysis in Section 9 of this report.

Costs incurred from 2006 to 2008

- 6.4 As detailed in Section 2 of this appraisal report, this project received initial funding in July 2006 for the period to December 2008. A summary of this expenditure is set out in Table 6.2 below.

Table 6.2: Costs incurred to December 2008

2006 €000 Actual	2007 €000 Actual	2008 €000 Budget
6,156	4,231	4,242
Total		14,629

Source: GSI/ MI

- 6.5 By the end of 2008, it is anticipated that a total of €12 million will have been incurred on the programme plus a further €2.6 million relating to the purchase of a launch. As these costs have already been incurred or committed, they could be considered sunk costs and excluded from the analysis, however as some benefits will be derived from the work undertaken to date, it is considered appropriate to show the costs incurred to deliver those benefits.

Costs to be incurred post 2008

- 6.6 The cost of each option is summarised in the table below and further detail is then provided. It should be noted that as funding has been made available to end of 2008, these are the budget costs from the period 2009 onwards.

Table 6.3: Project Costs

Option	1	2	3	4
	€000	€000	€000	€000
Data Acquisition				
State Agency Resources				
State Vessel Surveys		6,455	22,190	28,305
Other Programmes		4,100	4,100	8,500
Programme Operation Costs (@25%)		2,639	6,573	9,201
Commercial Resources				
Commercial/ Inshore Vessels		4,138	19,089	11,834
Research		1,725	1,725	1,725
Contract Management (@10%)		586	2,081	1,356
Total Data Acquisition		19,643	55,758	60,921
Data Management		3,810	3,810	3,825
Uplift for Inflation		4,103	10,345	29,109
Total	0	27,556	69,913	93,855

Source: GSI/ MI

- 6.7 Detailed cost profiles for each option are included at Appendix A which sets out the phasing of costs across each option. These cost categories are discussed in turn below.

Data Acquisition Costs

- 6.8 This represents the significant portion of overall project costs (approximately 90%) and will use both public and private sector assets. These costs groups are discussed in turn below:
- Data Acquisition using the National Research Vessels: this refers to the state vessels Celtic Explorer and Celtic Voyager. As there is a finite capacity of ship time available each year available to the programme these costs remain constant throughout;
 - Data Acquisition using commercial and inshore vessels: These include the use of ocean-going vessels for data acquisition in deeper waters, inshore vessels and new launch for data acquisition in shallower waters, ground truthing and sampling, and LiDAR for hydrographic data acquisition in shallow water;
 - Other programmes: These are costs where the INFOMAR contributes to the operating costs of other programmes on the understanding that data will be acquired to INFOMAR standards;
 - Research: These are costs where INFOMAR provides funding to research projects directly related to the development of value-added products or improved acquisition techniques arising from the INFOMAR programme; and
 - Programme Operation Costs: this includes staff salaries, travel and subsistence, licensing of software and data required for data processing. It should be noted that all GSI and MI staff salaries are paid from the INFOMAR budget, including core staff. The cost of operating the programme is calculated as a percentage of data acquisition costs, 25% on activities undertaken directly by GSI/ MI and 10% on most activities undertaken by commercial and other contracted bodies.

Data Management Costs

- 6.9 Data Management costs include the maintenance and further development of an infrastructure for the storage and distribution of data arising from both the INSS and INFOMAR. It is anticipated that there will be a need for a significant investment of this infrastructure, followed by ongoing costs that will follow the profile of data acquisition and other basic costs for the remainder of the programme.
- 6.10 Data management costs are estimated at approximately 10% of the total programme.

Inflation

- 6.11 Given the length of period over which this project would run (potentially to 2026), the impact of general inflation could be very significant. In addition, given the significant increase in the cost of oil in recent years, the costs in chartering commercial vessels and operating state vessels have increased. In addition, there is significant competition from oil exploration companies for the services of both the marine mapping vessels and specialist staff. As a result, in the last 2 years, the project has experienced a significant increase in the daily rate of state and commercial vessels. These new higher rates have been factored into the costs used in this appraisal.
- 6.12 In recognition of the impact of inflation on this project costs associated with each option have been uplifted by 4% annually. The impact of this uplift is clear from Table 6.3 which shows that running the INFOMAR programme to 2026 (as per option 4) rather than to 2016 would increase the cost by approximately €22 million (€32m less €10m) in inflation terms alone.

6.13 In addition, the following comments are made in respect of these costs:

- Use of State and Commercial Vessels – because the availability of state vessels is fixed each year, option 4 makes greater use of the state vessels over the longer period of the project. In contrast if project activity was to be increased (as per option 3) then there would be greater reliance on the use of commercial vessels, but also optimum available use of state vessels. This is reflected in the costs identified across these two options;
- Other Programmes Expenditure – this is assumed to last for the period of the project and therefore option 4 has a higher cost than the other options; and
- Programme Operation Costs – this has increased significantly for option 4 reflecting the greater use of state vessels, however the cost of contract management has gone down (albeit by a smaller amount) due to reduced usage of commercial vessels.

Cost Basis

6.14 The costs for this project are driven mainly by the time taken to complete the survey. Based on their experience of INFOMAR from 2006, the project team has a good understanding of the likely time it will take to complete the outstanding areas. For options 3 and 4 the area to be covered is the same (but the rate at which it is completed is different), but for option 2, which is to complete the 26 bays and priority areas only, the area is much smaller.

6.15 Table 6.4 below sets out the area to be covered and the number of days this should take.

Table 6.4: Area to be Surveyed

	Water Depth	Option 2			Option 3 and 4		
		Area to be Surveyed by Vessels Sq Kms	Sq Kms Surveyed Per day	No. of Days ⁽¹⁾	Area to be Surveyed by Vessels Sq Kms	Sq Kms Surveyed Per day	No. of Days ²¹
Zone 1	0 – 10 metres	360	5	80	2,200	5	440
	10 – 50 metres	5,744	15	383	8,000	15	533
Zone 2	50 – 100 metres	10,000	90	111	15,500	90	172
	100 – 200 metres	10,000	125	72	96,800	125	774
Total		26,104		646	122,500		1,920
LIDAR		1,000	65	20	5,000	65	80

Note 1: The total number of days calculated has been rounded up

6.16 One of the key aspects of the project, as demonstrated in Table 6.4 above, is the significantly lower area of shallow water than can be surveyed daily. In addition, LiDAR (airborne radar) system can survey shallow water (i.e. less than 50 metres) at a significantly faster rate than ships and areas which are suitable for LiDAR use have been identified. However, this must be balanced with the limited set of data that may be gathered with LiDAR compared to ship mounted methods and its increased cost.

²¹ The total number of days calculated has been rounded up

6.17 Table 6.5(a) – (c) below sets out the basis of the cost calculation for using state and commercial vessels.

Table 6.5(a): Cost of State and Commercial Vessels (Option 2)

	Number of Days	Rate per Day €	Cost €000
Celtic Explorer	140	24,000	3,360
Celtic Voyager	201	15,400	3,095
Coastal Vessel	233	7,000	1,631
Inshore Vessel	72	7,000	504
Total	646		8,590
	Area to Cover Kms	Sq Km Rate €	Cost €000
LiDAR	1,000	2,000	2,000

Table 6.5(b): Cost of State and Commercial Vessels (Option 3)

	Number of Days	Rate per Day €	Cost €000
Celtic Explorer	700	24,000	16,800
Celtic Voyager	350	15,400	5,390
Coastal Vessel (1)	166	25,000	4,166
Coastal Vessel (2) ²²	263	7,000	1,843
Inshore Vessel	440	7,000	3,080
Total	1,919		31,279
	Area to Cover Kms	Sq Km Rate €	Cost €000
LiDAR	5,000	2,000	10,000

Table 6.5(c): Cost of State and Commercial Vessels (Option 4)

	Number of Days	Rate per Day €	Cost €000
Celtic Explorer	850	24,000	20,400
Celtic Voyager	510	15,500	7,905
Coastal Vessel	121	7,000	849
Inshore Vessel	440	7,000	3,080
Total	1,921		32,234
	Area to Cover Kms	Sq Km Rate €	Cost €000
LiDAR	5,000	2,000	10,000

²² Coastal Vessel (1) is for deeper water (>50 metres), Coastal Vessel (2) is for shallower water (10 metres to 50 metres)

- 6.18 Different vessels are used for different water depths. For deeper waters (greater than 50 metres) a more expensive vessel is required; in option 3 a commercial vessel is used. In options 2 and 4, where more time is available or there is less water to be surveyed, the additional work is undertaken by the national research vessels.

Summary of Costs

- 6.19 Table 6.6 below sets out a summary of the costs across each option. **The cost benefit analysis undertaken in Section 9 of this report applies the Shadow Price of Public Funds (at a rate of 125%).**

Table 6.6: Summary of Costs

Option	1 €000	2 €000	3 €000	4 €000
Total Project Costs	0	27,556	69,913	93,855

VII Wider Project Benefits

Introduction

7.1 The benefits attributable to this project are broad ranging and potentially very significant in financial/ economic terms, however given their nature, they are difficult to quantify in monetary terms. In particular, the following factors should be considered:

- the INFOMAR project itself will only deliver a small number of 'direct' benefits, in contrast the project is the necessary first step of capturing and analysing seabed data for a wide range of 'indirect' benefits to be realised;
- these 'indirect' benefits are likely to impact on a large number of sectors across the economy and society as a whole and it is important that this breadth of impact is considered in full; and
- as Ireland is at the forefront of seabed mapping, there are few if any examples of previous projects where outturn benefits have been measured and quantified.

7.2 In terms of the two main types of benefits identified, the following approach has been taken.

'Direct' Benefits

7.3 There are a few direct benefits in respect of this project, and where these have been identified, for example in the case of commissioned research, a value is determined. In consultation with GSI and the Marine Institute, reasonable but conservative assumptions have then been made on the likely annual value of commissions moving forward.

'Indirect' Benefits

7.4 For 'indirect' benefits, the following approach has been developed:

- **Step 1 – is there a reasonable causal link?** Only where there is a reasonable causal link between the use of INFOMAR information and the achievement of the reported benefit, is it considered further;
- **Step 2 – how big is the overall economic sector?** The potential financial value of the sector which should benefit from the project is then identified;
- **Step 3 – how big an impact can INFOMAR have on this area?** The impact of the project on each relevant sector is estimated in percentage terms. Given the level of uncertainty associated with quantification, a range of scenarios (High Impact, Medium Impact and Low Impact) has been determined in consultation with GSI and MI;
- **Step 4 – what are the benefits across each option?** The benefits quantified in 'Step 3' above are typically for option 3, therefore in consultation with GSI and MI, the extent to which these benefits can be attributed across the other options has been estimated. In some instances these benefits will be broadly similar across options and in others, they will vary considerably;

- **Step 5 – over what period will the benefits be accrued across each option?**
With this approach the benefits are typically derived annually (for example the project has an impact of €5 million per annum to the fishing industry). In this appraisal we have assumed that these annual benefits can only be attributable to the INFOMAR project for finite period of time (between 10 and 20 years depending on the option). Whilst the benefits could be much further reaching, it is not considered prudent, given the inherent uncertainties, to forecast such a long period in the future.

7.5 It is recognised that this approach is subjective in nature, but in the absence of an evidence base from previous impact/ evaluation studies of marine mapping projects, a more robust estimation is not possible. Determining the impact of the project and the benefits achieved across each of the options has been discussed and agreed with GSI and Marine Institute personnel. In undertaking this process a very prudent approach has been adopted and as a result, whilst the quantification is subjective, the overall benefits identified are likely to be conservative in nature.

7.6 Prior to quantifying these benefits, there are two other factors to consider in relation to benefits, which have not been quantified in this appraisal but have been noted below. These include:

- Avoidance of cost; and
- Developing new uses for the data.

Avoidance of Cost

7.7 One of the overarching outputs of the project will be the establishment of a comprehensive dataset and maps which will be available to all relevant users, both from the public and private sectors. This should reduce significantly duplication of effort, for example a number of organisations may need to survey the same area of water/ seabed but for different purposes. As each organisation will have a specific set of requirements, the scope of each survey would be limited to their needs only, therefore another organisation with different survey requirements, using different equipment, would have to survey the same area again.

7.8 The level of duplication could increase further if organisations did not share their information, either because they were not aware that the work had been carried out previously or more likely in the private sector for commercial reasons.

7.9 In this regard, INFOMAR will greatly contribute to the work of a number of agencies who, in the absence of this project, would have to undertake their own bespoke mapping studies and, given the lack of coordinated approach, it is unlikely the information would be shared more widely. As a result the cost of mapping would otherwise be incurred but few of the benefits to the wider economy would be generated. These organisations include:

- National parks and Wildlife Society – who are required to identify Special Areas of Conservation (SACs) including the marine and coastal areas;
- National Underwater Archaeological Unit – to identify sites of ship wrecks;
- Port and Harbour Authorities – to ensure safe passage into and out of ports;
- Department of Transport – in order to provide the data for hydrographic maps to be produced; and
- Potentially a wide range of Private sector organisations – for commercial reasons such as in the oil/ gas, renewable energy and off-shore aggregates industries.

Developing new uses for the data

- 7.10 Whilst every effort has been made to identify all relevant benefits, it is also recognised that INFOMAR could stimulate or act as a catalyst for activities and benefits which are currently unknown. It is possible that when a full data set has been captured and analysed other uses and benefits could be identified, which, on the basis of current knowledge, it is not possible to anticipate. These may include areas such as sensor development, spatial technology, visualisation and mathematical modelling/ simulation. Furthermore, it is important to note that this analysis does not speculate on potential benefits which may accrue in the future due to technological advances but which may not be identifiable at this point in time.
- 7.11 The remainder of this section of the report sets out in detail the benefits which have been identified and are categorised as follows:
- Commercial/ Resource Benefits (Indirect Benefits);
 - Knowledge Economy (Direct and Indirect Benefits);
 - Legislative requirements and obligations (Indirect Benefits); and
 - Environmental Benefits (Not Quantified).

Commercial/Resource Benefits (Indirect Benefits)

- 7.12 In 2005 the Marine Institute completed a study 'Ireland's Ocean Economy and Resources'. This report provided an economic insight into the overall maritime sector and much of the quantification of benefits in this section of the appraisal has been sourced from this Marine Institute report. Whilst some of the information within the report is now a number of years old, it provides a consistent and reliable basis against which benefits can be identified across a wide range of sectors.
- 7.13 By way of overview, total value-added to the economy (i.e. the contribution to GNP) of the commercial marine sectors was estimated at just under €2 billion, with direct and indirect employment at 43,930 FTEs. More specifically, there are a number of commercial/ resource benefits which the INFOMAR project can help deliver and are therefore indirect in nature. The sectors most likely to gain benefits from this project are:

Table 7.1: Summary of commercial benefits

Industry	Benefit
Fishing	<ul style="list-style-type: none"> • Efficiencies • Reduction in gear loss • Ability to identify and protect fish spawning and nursery areas
Aquaculture	<ul style="list-style-type: none"> • Selection of appropriate sites for cultivation
Biodiversity	<ul style="list-style-type: none"> • Mapping/ identification of commercially exploitable species e.g. seaweed
Energy	<ul style="list-style-type: none"> • Suitable locations for wind farms • Off shore oil industry site studies • Cables and pipeline routes • Tidal energy • Wave Energy (still at R&D stage)
Aggregates	<ul style="list-style-type: none"> • Potential commercial value of utilisation of marine aggregates
Tourism/leisure	<ul style="list-style-type: none"> • Development of sailing routes/ angling/ diving

- 7.14 We will now look at each of these industries in more detail.

Fishing

- 7.15 The Marine Institute study, 'Ireland's ocean economy and resources' referred to above, estimated the added value of fish landings in 2002 at €235 million (with seafood processing worth an additional €321 million, 60% of which is exported). The "Cawley Report"²³, gave more up to date figures in 2005 of €702m contribution of the fishing sector to the Irish economy, with only €32m of that coming from the inshore area (inside 12 nautical miles). Whilst this represents a significant portion of the overall economy, the socio-economic contribution of the fishing industry is critical in some of the most peripheral areas where there are few alternative sources of employment. Furthermore, the importance of the fishing sector in coastal communities is recognised by BIM²⁴ who have estimated that one job at sea creates/ supports two jobs ashore in processing, transportation, net making, electronics, boat building and maintenance sectors²⁵.

Fish Stocks

- 7.16 Irish coastal waters are amongst the richest fishing grounds in the world in terms of primary productivity, however landings in 2002 of 245,000 tonnes are considerably lower than the all-time high of 320,000 tonnes in 1998. Given the poor state of fish stocks and with several recovery plans operational in the waters around Ireland, the MI, the fishing industry and DCENR are seeking to work with EU Commission on developing special conservation measures for fish stocks in the water around Ireland. To do this effectively 'essential fish habitat maps' are required to provide a robust evidence base to the EU Commission to inform the decision making process.
- 7.17 In order to implement effective conservation measures it is essential to identify sensitive fish spawning and nursery areas. Improved data on seabed habitats and topography could assist with stock recovery measures which will ultimately benefit the fishing sector, such as exclusion of fishermen from specific locations during spawning season.
- 7.18 In addition to habitat mapping, other factors such as currents, oceanography and hydrography play a vital role in determining where fish habitats are located. Therefore mapping of the physical processes and their effect on fish resources will be increasingly important in determining appropriate ways to manage future fish resources. INFOMAR will provide data which can assist in this regard also.

Reducing time at sea

- 7.19 Acoustic techniques are currently in use to assess fish/ shellfish habitats and may also be used to provide information to fishermen in order to localise the most desirable fishing areas, thus reducing time at sea. For example data generated from a seabed mapping survey on Browns Bank on the western Scotia Shelf, provided information on the distribution of mature scallops for Canadian scallop fishermen²⁶. This derived the following benefits to fishermen:

²³ Steering a New Course. Strategy for a Restructured, Sustainable and Profitable Irish Seafood Industry (Cawley Report) 2006.

²⁴ Bord Iascaigh Mhara

²⁵ Irish inshore Fisheries Sector Review & Recommendations, BIM, Dublin, 1999

²⁶ GSC 1998, Todd, B.J., Fader, G.B.J., Courtney, R.C., Pickrill, R.A. and Robert, G. Browns Bank, Scotian Shelf: Using multibeam bathymetry for geological interpretation and scallop habitat mapping. GAC Annual Meeting, May 1998, Quebec, Canada.

- for the same amount of scallops to be caught, the dragging area was reduced by 75%, resulting in a substantial saving for fishermen; and
- allowed fishing effort to focus on areas without seabed obstacles thus reducing gear loss and avoiding the beds of young scallops.

7.20 The quantitative benefits identified in the Brown's Bank study from the use of multi-beam data, this is set out below.

	1998 Before Multi-beam	1999 After Multi-beam
Scallop Quota	13,640 kgs	13,640 kgs
Time on Bottom	162 hours	43 hours
Distance Towed	1,176 kms	311 kms
Hours Lost	15	0
Lost Gear	\$10,000	0
Fuel Use	27,697 Litres	17,545 Litres
Equipment	Heavy	Light

7.21 A similar study, ADFISH (Application of Seabed Acoustic Data in Fish Stocks Assessment & Fishery Performance) has been carried out by a group led by BIM in Irish waters, demonstrating the applicability of the same methodologies to the Irish fishing industry, where good multi-beam data coverage is available.

7.22 On this basis, INFOMAR (and INSS) data has significant environmental benefits, including:

- reduced instances of nets destroying coral and spawning grounds; and
- lower fuel consumption.

- 7.23 In terms of quantifying the economic benefits of the fishing industry, the three step approach discussed above is undertaken.

Table 7.2: Benefits to the Fishing Industry

Step	Detail
Step 1 Causal Link	Having habitat and geology maps is the first step to identifying more effective measures to protect the fishing resource for the long term.
Step 2 Size of the Sector	The sector has an estimated €702 million contribution to GNP.
Step 3 % impact of INFOMAR	The following % improvements to the fishing industry have been estimated across the three scenarios in the long term. <ul style="list-style-type: none"> • High Impact Scenario: 3% (€21.06 million) • Medium Impact Scenario: 2% (€14.04 million) • Low Impact Scenario: 1% (€7.02 million)
Step 4 Benefits across options (Based on medium impact scenario only)	<ul style="list-style-type: none"> • Option 1 – €468k p.a. • Option 2 – €1,404k p.a. • Option 3 – €14,040k p.a. • Option 4 – €7,020k p.a.
Step 5 Period over which benefits accrue	<ul style="list-style-type: none"> • Option 1 – 5 years (2009 – 2013) • Option 2 – 15 years (2009 – 2023) • Option 3 – 15 years (2009 – 2023) • Option 4 – 20 years (2009 – 2028)

- 7.24 The following rationale is provided to explain the benefits attributed across each of the options and the profile over which those benefits will accrue:

- Option 1 – benefits in respect of option 1 are estimated as 33% of benefits identified for option 2 because approximately one third of the priority bays and areas will be completed by end of 2008 (compared to all priority bays and areas under option 2). The benefits are assumed to be accrued over 5 years only because of the reduced focus on value added activities at this stage in the project;
- Option 2 – the benefits derived in respect of near shore mapping are assumed to be approximately 10% of the overall benefits which can be achieved from mapping all remaining areas, based on figures of 5% in the Cawley report for Inshore fishing, the overall value of fishing industry, and allowing for some of the Priority areas which extend beyond 12 nautical miles. The benefits are assumed to accrue for 15 years; this was considered a reasonable period after the project had been completed for the benefits to be realised;
- Option 3 – the benefits identified in this appraisal are based on the option 3 proposal. While much of the richer fishing grounds lie outside of the area to be completed in Option 3, it includes the Biologically Significant area. In addition completion of “the whole picture” allows more meaningful interpretations to be carried out; and
- Option 4 – due to the longer timescale of this option, it is anticipated that the annual benefits will be approximately 50% of those in option 3 (as the project will be effectively running at half the pace) however the benefits are assumed to run for a longer period (20 years rather than 15).

- 7.25 Table 7.3 below sets out the Present Value of Benefits across each of the options for each scenario. In relation to the fishing industry it is anticipated that the following quantifiable benefits could be achieved across each of the options:

Table 7.3: Present Value of Benefits to the fishing industry

Scenario	1 €000	2 €000	3 €000	4 €000
High Impact	3,125	23,410	234,153	143,106
Medium Impact	2,083	15,610	156,102	95,404
Low Impact	1,042	7,805	78,051	47,702

Aquaculture

- 7.26 The marine aquaculture industry is made up primarily of finfish aquaculture (mainly salmon but also includes rainbow trout) and also shellfish aquaculture (mussels, oysters, clams and scallops). It contributes significantly to the Irish economy. In 2003 it had an estimated contribution to GNP of €131 million and employed almost 2,500 FTEs.
- 7.27 Accurate bathymetric data would provide useful information towards developing hydrographic models of bays. These assist in the calculations of the bay carrying capacity and provide a better understanding of harmful algae bloom events, which have resulted in major closures of shellfish growing areas over the last number of years. This has been done to date in areas such as Clew Bay, under the CLAMS Project (Co-ordinated Local Aquaculture Management Systems), where INSS has been able to provide accurate bathymetry for use in modelling.
- 7.28 A report commissioned by the then Department of Marine and Natural Resources to examine future strategies for the Irish aquaculture industry (2000) stated that there were still many suitable sites available for the expansion of the industry. It was recognised that accurate knowledge of bathymetry, bottom type and hydrodynamic factors would assist in the selection of the most appropriate sites for future development.
- 7.29 A further example of how the absence of this type of data is constraining growth in the sector is in respect of the issue of aquaculture licenses. New aquaculture licenses cannot be issued until the bio-habitat environment has been identified in the priority bays. This will be undertaken as part of INFOMAR but organisations have to wait until this has been completed. One example of this is in Mulroy Bay in Donegal, which was inadequately mapped. A commercial organisation 'Marine Harvest' wished to establish an aquaculture interest in the area but had to wait until it was surveyed before they could put in navigational aids (bouys) and start operations. A LiDAR survey was completed under INSS, with assistance from Donegal County Council. The INFOMAR project would deliver a much more efficient approach to bathymetric and habitat mapping for this industry.
- 7.30 As a result this sector could grow significantly with the information provided by the INFOMAR project. In terms of quantifying the economic benefits of the aquaculture industry, the same approach discussed above is undertaken.

Table 7.4: Benefits to the Aquaculture Industry

Step	Detail
Step 1 Causal Link	Having habitat maps allows the issue of aquaculture licenses and identification of other suitable sites (and their carrying capacity).
Step 2 Size of the Sector	The sector has an estimated contribution of €131 million to GNP.
Step 3 % impact of INFOMAR	Given the greater potential for growth in this sector, the following % improvements to the aquaculture industry have been estimated across the three scenarios in the long term. <ul style="list-style-type: none"> • High Impact Scenario: 6% (€7,800k) • Medium Impact Scenario: 4% (€5,200k) • Low Impact Scenario: 2% (€2,600k)
Step 4 Benefits across options (Based on medium impact scenario only)	<ul style="list-style-type: none"> • Option 1 – €1,373k p.a. • Option 2 – €4,160k p.a. • Option 3 – €5,200k p.a. • Option 4 – €5,200k p.a.
Step 5 Period over which benefits accrue	<ul style="list-style-type: none"> • Option 1 – 5 years (2009 – 2013) • Option 2 – 15 years (2009 – 2023) • Option 3 – 15 years (2009 – 2023) • Option 4 – 15 years (2009 – 2023)

7.31 The following rationale is provided to explain the benefits attributed across each of the options and the profile over which those benefits will accrue:

- Benefits across each option – as this is typically an industry which is based in the in-shore area, many of the benefits would be shared across all options. However given that a number of bays will not be included under option 2, these benefits are assumed to be equivalent to 80% of option 3 and 4. As above, the benefits of option 1 reflect the approximate 33% coverage of priority bays and areas compared to the other option 2;
- Period over which benefits accrue – same rationale as per fishing industry above, with the exception of option 4, which in this instance is the same as options 2 and 3. The reason for this is that across these three options the timing of mapping the inshore area is the same.

7.32 Table 7.5 below sets out the present value of benefits across each of the options.

Table 7.5: Present Value of Benefits to the Aquaculture Industry

Option	1 €000	2 €000	3 €000	4 €000
High Impact	9,169	69,379	86,723	86,723
Medium Impact	6,112	48,252	57,816	57,816
Low Impact	3,056	23,126	28,908	28,908

Biodiversity

- 7.33 The biodiversity sector is potentially enormous and very difficult to quantify. In general the diverse nature of the marine eco-system provides the basis on which a very significant contribution could be made to medical science. In effect the financial/economic impact of a major biotechnology discovery on its own could be worth billions (aside from the health benefits), however given the high level of uncertainty and in line with our prudent approach this is not included in our analysis.
- 7.34 One proxy for a quantifiable measure of the economic benefit of biodiversity is in the potential growth of the seaweed sector. This sector ranges from low-tech labour intensive harvesting of raw materials to seaweed processing. There is considerable scope for expansion of the range of products including the alginate industry, health and snack foods and body-care products. The National Seaweed Forum in 2000 estimated that the seaweed sector had the potential to expand from a turnover of €8.9 million in 2000 to €25.4m after five years, to €63.5m after 10 years. The Marine Institute study, 'Ireland's ocean economy and resources' estimated the added value of the seaweed sector at €10 million.
- 7.35 The Forum also identified the need for resource surveys (mapping, identification and quantification) of commercially exploitable seaweed species as a priority area of research to facilitate the expansion of the industry.
- 7.36 In terms of quantifying the economic benefits to the biodiversity sector, the same approach is undertaken.

Table 7.6: Benefits to the Biodiversity Sector

Step	Detail
Step 1 Causal Link	Having accurate bathymetric and habitat maps allows areas of potentially commercially exploitable seaweed species to be identified.
Step 2 Size of the Sector	In 2003 the sector was worth an estimated €10 million.
Step 3 % impact of INFOMAR	Given the significant potential for growth in this sector, the following % improvements to the biodiversity sector have been estimated across the three scenarios in the long term: <ul style="list-style-type: none"> • High Impact Scenario: 15% (€1,500k) • Medium Impact Scenario: 10% (€1,000k) • Low Impact Scenario: 5% (€500k)
Step 4 Benefits across options (Based on medium impact scenario only)	<ul style="list-style-type: none"> • Option 1 – €231k p.a. • Option 2 – €700k p.a. • Option 3 – €1,000k p.a. • Option 4 – €1,000k p.a.
Step 5 Period over which benefits accrue	<ul style="list-style-type: none"> • Option 1 – 5 years (2009 – 2013) • Option 2 – 15 years (2009 – 2023) • Option 3 – 15 years (2009 – 2023) • Option 4 – 15 years (2009 – 2023)

7.37 The following rationale is provided to explain the benefits attributed across each of the options and the profile over which those benefits will accrue:

- Benefits across each option – as this is primarily a near shore activity with some benefits for areas further off shore, option 2 is considered to have 70% of the benefits of options 3 and 4. As above, the benefits of option 1 reflect the approximate 33% coverage of priority bays and areas compared to the other options;
- Period over which benefits accrue – same rationale as per fishing industry above, with the exception of option 4, which in this instance is the same as options 2 and 3.

7.38 Table 7.7 below sets out the present value of benefits across the options.

Table 7.7: Present Value of Benefits to the Biodiversity Industry

Option	1 €000	2 €000	3 €000	4 €000
High Impact	1,543	11,674	16,678	16,678
Medium Impact	1,028	7,783	11,118	11,118
Low Impact	514	3,891	5,559	5,559

Energy – Renewable

7.39 The marine area holds significant potential for the production of renewable energy (wind, wave and tidal). The Marine Institute estimate that the entire renewable industry sector in Ireland is worth an annual €18 million per annum. This is primarily in respect of wind power as both wave and tidal energy technologies are at the early stages of research and development and not yet commercially viable. This sector however has the potential to grow significantly. Airtricity, which operates the Arklow Bank offshore windfarm with 25MW of capacity have indicated this is the first phase of a development which could extend to 520MW. At present this project has not increased in scale, however there have been a number of new licenses issued for off-shore wind farms on the east coast.

7.40 The Marine Institute have indicated that a development potential of 800 MW (approximately 12% of the current installed capacity) has already been identified at prime sites for shoreline and near shore devices. This is against a backdrop of a 'practical' wave energy resource estimated at more than 6,000MW (ESBI/ETSU 1996). However, site suitability is governed by a number of factors including the potential resource itself, proximity to grid connection and suitable paths for laying cables from the devices to the grid. Given the pace of development in this sector, new generation devices can offer greater flexibility and potential.

7.41 The Marine Institute have indicated that in the long term, given Ireland's geographic location, off shore renewable energy has the potential to meet all Ireland's energy demands.

7.42 The data collected during INFOMAR is necessary to assist in site selection for offshore renewable energy developments, which require detailed and accurate information on bathymetry as well as sediment characteristics. This information will be important for all types of renewable energy discussed here, and with technology advancements is likely to become more useful.

7.43 In terms of quantifying the economic benefits to the renewable energy sector, the same approach is undertaken.

Table 7.8: Benefits to the Renewable Energy Sector

Step	Detail
Step 1 Causal Link	Geology and bathymetry maps are a fundamental part of the information required for site selection.
Step 2 Size of the Sector	In 2002 the sector was worth an estimated €18 million.
Step 3 % impact of INFOMAR	Given the significant potential for growth in this sector, the following % improvements to the renewable energy sector have been estimated across the three scenarios: <ul style="list-style-type: none"> • High Impact Scenario: 30% (€4,800k) • Medium Impact Scenario: 20% (€3,600k) • Low Impact Scenario: 10% (€1,800k)
Step 4 Benefits across options (Based on medium impact scenario only)	<ul style="list-style-type: none"> • Option 1 – €600k p.a. • Option 2 – €1,800k p.a. • Option 3 – €3,600k p.a. • Option 4 – €3,600k p.a.
Step 5 Period over which benefits accrue	<ul style="list-style-type: none"> • Option 1 – 15 years (2009 – 2013) • Option 2 – 15 years (2009 – 2023) • Option 3 – 15 years (2009 – 2023) • Option 4 – 15 years (2009 – 2023)

7.44 The following rationale is provided to explain the benefits attributed across each of the options and the profile over which those benefits will accrue:

- Benefits across each option – while renewable energy is primarily a near shore activity, the benefits of this project would be largely derived outside of the priority bays with wind most favourable on the exposed west coast.. Therefore option 2 would only provide 50% of the benefits of option 3. In the longer term there may be the potential for renewable energy to be developed further off shore and the information captured in options 3 and 4 would be of significant benefit. However this would require significant technological advancements and therefore it is not prudent to include in this cost benefit analysis. As above, the benefits of option 1 reflect the approximate 33% coverage of priority bays and areas and therefore 33% of the value of option 2 compared to the other options;
- Period over which benefits accrue – it is assumed in this instance that the benefits are likely to accrue over the same period of time for all options.

7.45 Table 7.9 below provides an estimate of these present value benefits across the options.

Table 7.9: Present Value Benefits to the Renewable Energy Sector

Option	1 €000	2 €000	3 €000	4 €000
High Impact	10,007	30,020	60,039	60,039
Medium Impact	6,671	20,013	40,026	40,026
Low Impact	3,336	10,007	20,013	20,013

Energy – Oil and Gas

- 7.46 The geology off the coast of Ireland is less well explored and mostly in deeper and more challenging waters than, for example, the North Sea. Despite this Ireland has been a producer of gas since 1978 from fields off the south coast at Kinsale and Ballycotton. These resources are now progressing towards depletion, however new production has come on-stream at the Seven-Heads field, Co. Cork and scheduled at the Corrib Field Co. Mayo.
- 7.47 The Marine Institute estimated that gas production had a turnover of €115 million in 2003. In addition, hydrocarbon exploration was estimated to have contributed €81 million to GNP in the same year. The INFOMAR project will provide geological information on the seabed surface which can assist greatly with the exploration of hydrocarbons (oil and gas) and also importantly the selection of sites for rigs, cables and pipes. Methane gas escapes can be located from pock markings on the sea floor, which is identifiable from hydrographic mapping and other analyses. These areas can become a target for oil exploration companies and are also potential hazards for the siting of exploration rigs and equipment. This is important because with this new information available, oil exploration companies will be better informed and in turn more inclined to invest in exploration activities.

7.48 In terms of quantifying the economic benefits to the energy sector, the same approach is undertaken.

Table 7.10: Benefits to the Energy Exploration Sector

Step	Detail
Step 1 Causal Link	Having survey maps of the seafloor can provide exploration companies with the information required to target sites. Habitat maps are also required for environmental assessments.
Step 2 Size of the Sector	In 2002 the oil and gas exploration sector was worth an estimated €81 million.
Step 3 % impact of INFOMAR	Given the significant potential for growth in this sector, the following % improvements to the energy exploration sector have been estimated across the three scenarios: <ul style="list-style-type: none"> • High Impact Scenario: 15% (€12,000k) • Medium Impact Scenario: 10% (€8,000k) • Low Impact Scenario: 5% (€4,000k)
Step 4 Benefits across options (Based on medium impact scenario only)	<ul style="list-style-type: none"> • Option 1 – €0 p.a. • Option 2 – €0 p.a. • Option 3 – €8,000k p.a. • Option 4 – €8,000k p.a.
Step 5 Period over which benefits accrue	<ul style="list-style-type: none"> • Option 1 – N/A • Option 2 – N/A • Option 3 – 10 years (2009 – 2019) • Option 4 – 10 years (2016 – 2026)

7.49 The following rationale is provided to explain the benefits attributed across each of the options and the profile over which those benefits will accrue:

- Benefits across each option – as these exploration activities would typically be undertaken further off shore, these benefits are likely only to be accrued across options 3 and 4;
- Period over which benefits accrue – it is assumed these benefits will be accrued over a 10 year period, however, as the off shore mapping in option 4 will not be undertaken until 2016 onwards, the benefits under this option will not start to accrue until that time.

7.50 The present value of benefits are set out in Table 7.11 below.

Table 7.11: Present Value of Benefits to the Energy Exploration Sector

Option	1 €000	2 €000	3 €000	4 €000
High Impact	0	0	97,331	73,963
Medium Impact	0	0	64,887	49,309
Low Impact	0	0	32,444	24,654

- 7.51 This calculation excludes the benefits to the economy from a significant hydrocarbon find, which could be worth several billion euros, but as this is speculative and in line with the prudent approach adopted throughout, this has not been quantified.
- 7.52 An additional benefit in respect of energy, albeit not hydrocarbons, is that mapping data can help identify potential sites for electricity interconnectors and reduce significantly the amount of surveying required. To insure security of energy and power supply, there is an increasing trend of linking electricity markets through interconnectors. There are currently two interconnectors between Ireland and Northern Ireland which in turn is linked to Scotland through an interconnector. In addition, EirGrid are currently progressing a proposal to put in place an interconnector, linking Ireland with the GB market directly.

Aggregates

- 7.53 The use of marine aggregates is becoming an increasingly important issue in Ireland. As a result of the country's economic growth, the national consumption of aggregates per head of population has spiralled upward and is standing at four times the European average at peak. (Irish Sea Marine Aggregate Initiative (IMAGIN) report August 2007). These aggregates are currently drawn from the land, however, there are significant aggregate (sand and gravel) resources in Irish off-shore waters. Extraction of marine aggregates is a long established industry and is carried in many European maritime countries including the UK, Belgium and Holland.
- 7.54 Despite considerable interest from commercial companies due to the rapid depletion of land-based resources in many areas, there has been no extraction of marine aggregates on a commercial basis. A recent assessment of the requirements for the development of aggregate resources identified the following:
- Continued and enhanced support for existing areas of research including sedimentological studies, environmental modelling, biotope and seabed mapping;
 - Investigation of use of innovative techniques for resource evaluation; and
 - Development of higher resolution hydrodynamic models leading to improved predictive capacity and better understanding of coastal systems.
- 7.55 To date, Ireland has not explored the potential for commercial extraction of marine aggregate and one of the key reasons for this is the absence of a national policy on marine aggregate extraction. Although this policy issue is being addressed through the IMAGIN initiative, a comprehensive dataset based on the mapping of the Irish inshore area will contribute to the decision making process relating to extraction of marine aggregate, its potential impact on biological communities and the most efficient methods of extraction. Currently offshore areas appropriate for aggregate extraction may be licensed for offshore renewable energy development, thus neutralising the possible resources. With increased pressure for development of both energy and aggregate resources there is a timing imperative to provide the appropriate mapping and data for best offshore "land use" to be decided.
- 7.56 The extraction of marine aggregate has environmental as well as commercial benefits as the 'carbon footprint' associated with the extraction and transport of marine aggregate has been found to be significantly less than that associated with land-based extraction activities²⁷.

²⁷ IMAGIN report: Issues and Recommendations for the Development and Regulation of Marine Aggregate Extraction in the Irish Sea, 2008.

- 7.57 In 2003 the consumption of aggregates per annum was estimated to be in the region of 50 million tonnes (€810m). It is estimated that 'hundreds of millions' of cubic metres of gravel resources lie in the inshore zone, much of it within the 50m contour – the operational range of conventional dredging equipment. As land based reserves become depleted, there is a necessity to seek alternative sources. Information on the location and extent of aggregates is vital to enable the quantification of the resource and also to initiate the development of protocols and procedures for assessing suitable locations for extraction obligations whilst maintaining conservation obligations. To date, the IMAGIN project has relied heavily on information from the INSS survey but could also benefit significantly from the information provided by INFOMAR.
- 7.58 IMAGIN concluded that a number of areas with potential to support marine aggregate extraction exist within the Irish Sea. It was a conclusion of IMAGIN that marine aggregates can contribute to the sustainable management of demand and future use of aggregates in Ireland and Wales and they estimated that within the IMAGIN study area in the Irish Sea alone the resource equates to approximately 5-7 billion cubic metres.
- 7.59 In terms of quantifying the potential benefit of the INFOMAR project to the aggregates sector, the following prudent assumptions have been made.

Table 7.12: Benefits to the Aggregate Sector

Step	Detail
Step 1 Causal Link	The production of seabed and hydrodynamic maps are essential to identify and exploit off shore aggregates
Step 2 Size of the Sector	<ul style="list-style-type: none"> • 100 million cubic metres (1 cubic metre broadly equivalent to 1 tonne) of aggregates in the near shore area – the estimates indicate the outturn could be multiples of this assumed level. As any resources outside the 50 metre contour area is beyond the limits of current technology, these are also not considered; • Value of aggregate €10 per tonne – a conservative estimate based on value of the industry (€810m) and the estimated number of tonnes extracted (50 million); • Overall Value of Aggregates €1 billion
Step 3 % impact of INFOMAR	<p>Given the significant potential for aggregate finds the increase in known aggregates across each of the three scenarios is assumed at:</p> <ul style="list-style-type: none"> • High Impact Scenario: 15% (€150 million) • Medium Impact Scenario: 10% (€100 million) • Low Impact Scenario: 5% (€50 million)
Step 4 Benefits across options (Based on medium impact scenario only)	<ul style="list-style-type: none"> • Option 1 – €24 million one-off benefit • Option 2 – €80 million one-off benefit • Option 3 – €100 million one-off benefit • Option 4 – €100 million one-off benefit
Step 5 Period over which benefits accrue	<ul style="list-style-type: none"> • Option 1 – 1 year (2010) • Option 2 – 1 year (2013) • Option 3 – 1 year (2013) • Option 4 – 1 year (2013)

- 7.60 To place the benefit value of €100 million in context, this is equivalent to approximately 12% of the land-based aggregates industry in 2003.
- 7.61 The following rationale is provided to explain the benefits attributed across each of the options and the profile over which those benefits will accrue:
- Benefits across each option – as current technology in the aggregates sector is primarily a near shore activity, these benefits are broadly equivalent across options 2, 3 and 4. However as resources could exist in areas not covered in option 2, then benefit is considered equivalent to 80% of option 3. In respect of option 1, the lower benefit reflects the reduced level of area mapped;
 - Period over which benefits accrue – This is assumed to be a one-off benefit and is assumed to apply in 2013 as near shore mapping is coming to an end. For option 1 this benefit is assumed to accrue earlier as the mapping will be completed earlier.
- 7.62 The present value of benefits are set out in Table 7.13 below

Table 7.13: Benefits to the Aggregate industry

Option	1 €000	2 €000	3 €000	4 €000
High Impact	34,615	98,631	128,221	128,221
Medium Impact	23,077	65,754	85,480	85,480
Low Impact	11,538	32,877	42,740	42,740

Water-based Tourism and leisure

- 7.63 In 2003, the Water-based tourism sector made a total contribution of €398 million to the Irish economy, and supported the employment of over 8,000 FTEs (3,000 of these jobs supported by overseas visitors). The outputs from the INFOMAR project could assist in the development of this sector. For example, the provision of survey data from an inshore mapping programme could be used to develop chartered sailing routes around Ireland. The provision of survey data may allow people (~130,000) that currently engage in sailing and boating in the sea to extend the areas in which they undertake their activity. Survey data may also provide information on inshore angling, such as identifying reefs and sandbanks. The information provided should increase participation in marine leisure activities and reduce the risks of accidents associated with these activities.
- 7.64 In addition, recent trends have shown an increase in leisure activities such as diving and these would be particularly enhanced with the provision of information regarding the location of shipwrecks and coral reefs as well as the potential for creation of artificial reefs.
- 7.65 It is important to recognise the importance of the tourism sector to the Ireland economy, however whilst INFOMAR could provide information to enhance the water-based tourism offering, quantifying its financial impact on the sector is considered speculative.

Knowledge Economy (Direct Benefits)

Increased Research Collaborations (Direct Benefit)

- 7.66 As stated previously in this appraisal report the Vision outlined in the Strategy for Science, Technology and Innovation (SSTI) is that “Ireland by 2013 will be internationally renowned for the excellence of its research, and will be to the forefront in generating and using new knowledge for economic and social progress, within an innovation driven culture²⁸”. **The INFOMAR project is listed in the SSTI as a Key Action under the Marine component of Research in the Public Sector.** To that end, by the end 2007, the INFOMAR project was supporting six marine/ geoscience research collaborations with international third level, public and private institutions²⁹.
- 7.67 By proceeding with the INFOMAR project, and completing the mapping of the Irish seabed, Ireland should increase its competitive advantage in this area, attract increasing numbers of researchers and be at the forefront in securing increased international academic and commercial research funding.
- 7.68 By the end of 2008 the following outputs are anticipated:
- Six projects/researchers fully funded directly by INFOMAR, working at Irish and overseas Universities and with Private Sector input, with research to the value of €750k;
 - Griffith Research Awards – release of funding for marine related projects at NUIG, UCD and CMRC (UCC) totalling €3.5 million including recruitment of geological research staff (PhD, graduates and undergraduates). Further leveraged research and equipment to the value of €1.5M; and
 - Development of new commercial application in the area of Seabed Classification applied to LIDAR mapping, from research work between GSI, Questar Tangent Corporation of Canada and Tenix LADS of Australia.
- 7.69 In addition to the research commissions and reflecting Ireland’s leading position in this field, GSI and Marine Institute have been approached by organisations including the Geoscience Council of South Africa, to assist them in developing a similar proposal to INSS/ INFOMAR. This is likely to lead to a Memorandum of Understanding being drawn up to cover knowledge transfer and staff upskilling.
- 7.70 The INSS database and associated expertise has already leveraged earnings of €5 million for leading edge Irish research institutions and organisations associated with integrated seabed mapping and geosciences. As the EU focuses on deep ocean research and observation systems improve, there is significant scope for increased earnings in future, which from a research perspective has averaged approximately €2 million per annum in recent years. In this regard, we understand there is an EU proposal for a Maritime Digital Map of Europe. The INFOMAR methodology is to be followed in undertaking this project, which could result in Ireland receiving significant resources to undertake or advise on EU mapping exercises. This would provide opportunities for both the public and private sectors.

²⁸ Strategy for Science, Technology and Innovation, 2006-2013, p 8, Department of Enterprise, Trade & Employment

²⁹ NDP Reporting Template, INFOMAR Project, Q1 2008

7.71 Examples of leveraged research by the INSS database and associated expertise are shown in the table 7.14 below.

Table 7.14: Examples of leveraged research

Project	Value to Irish Partners €000	Funding Source	Description
ESONIM	269	EU	Seabed Observatory
HERMES	622	EU F.P.	Deep Ocean Research
MESH	231	EU INTERREG	Habitat Mapping
HABMAP	283	EU INTERREG	Habitat Mapping
IMAGIN	464	EU INTERREG	Irish Sea Aggregate Resources Mapping
Researchers/ Fellowships	640	HEA	NUIG, Earth and Ocean Sciences
Total	2,509		

7.72 The data obtained from INSS has already been utilised in the following areas:

- Selecting sites for cold-water reef conservation in offshore areas as candidate Marine SACs under Habitats Directive and OSPAR obligations;
- Enhancement of the National wrecks database;
- Orange roughy research;
- Adding value to fisheries surveys;
- Updating of hydrographic charts contributing to improvements in marine safety, specifically for UKHO Charts of Clew Bay and Mulroy Bay;
- Incorporation of geophysical (magnetic and gravity) data with industry information to provide reports for the assessment of potential hydrocarbon resources; and
- Provision of fundamental habitat mapping information.

7.73 Whilst INSS focused on the Zone 3 area (ie. 200m to 4,000m depth), INFOMAR will cover zones 1 and 2 (ie. less than 200m). Therefore there should be complementarity from a research perspective and INFOMAR can build on the expertise developed through the analysis and research of INSS data.

7.74 The INSS and INFOMAR projects together provide the largest Exclusive Economic Zone survey conducted so far in the world. The result of these projects has been and will be an increase in technical, infrastructural and human capacity, through:

- An integrated marine dataset;
- An upgraded marine surveying infrastructure; and
- Personnel skilled in the design, planning and implementation of a large scale marine resource evaluation programme.

7.75 In terms of quantifying the direct economic benefit of continued research, the project has delivered to date an average of €2 million per annum of commissions. It is important that the momentum of this project is continued in order to maintain the level of research activity in this area and with increased interest from the EU, there is significant potential for growth. Table 7.15 below sets out the potential benefits of research work.

Table 7.15: Benefits of Research Collaborations

Step	Detail
Step 1 Causal Link	The production of INFOMAR data directly leads to the commissioning of research projects.
Step 2 Size of the Sector	As noted above, the market is currently worth approximately €2 million per annum
Step 3 % impact of INFOMAR	Given the potential for research commissions over the medium to longer term the benefits across each of the three scenarios is assumed at: <ul style="list-style-type: none"> • High Impact Scenario: €3 million • Medium Impact Scenario: €2 million • Low Impact Scenario: €1 million
Step 4 Benefits across options (Based on medium impact scenario only)	<ul style="list-style-type: none"> • Option 1 – €500k p.a. • Option 2 – €1 million p.a. • Option 3 – €2 million p.a. • Option 4 – €750k p.a.
Step 5 Period over which benefits accrue	<ul style="list-style-type: none"> • Option 1 – 5 years (2009 – 2013) • Option 2 – 10 years (2009 – 2018) • Option 3 – 10 years (2009 – 2018) • Option 4 – 20 years (2009 – 2028)

7.76 The following rationale is provided to explain the benefits attributed across each of the options and the profile over which those benefits will accrue:

- Option 1 – if the project was to cease at the end of 2008, then research activity would also reduce significantly therefore the annual benefit would be much lower and would only be derived over a 5 year period;
- Option 2 – given only the priority bays and areas would be covered, the scope for research projects is limited compared to options 3 and 4. The benefits however are expected to run for a period similar to option 3;
- Option 3 – the estimated benefits are based on current levels of research commissions being achieved. The 10 year period is a reasonable estimate identified in consultation with GSI/ MI; and
- Option 4 – with the reduced momentum in the project the research community could find it more difficult to reach a critical mass of activity and personnel and therefore commissions are likely to be significantly lower. However as the project will run over a much longer period, the research commissions would also likely run for a longer period.

7.77 Table 7.16 below shows the present value of benefits across each of the options.

Table 7.16: Present Value of Benefits to the Research Community

Option	1 €000	2 €000	3 €000	4 €000
High Impact	3,339	12,166	24,333	15,289
Medium Impact	2,226	8,111	16,222	10,193
Low Impact	1,113	4,055	8,111	5,096

Development of Niche High Tech Industries (Not Quantified)

7.78 There is significant potential for developing niche high-tech industries which build on the expertise and competitive advantage gained by Ireland in this field. Examples of this include materials and technology development, the development of biotechnology sector and the development of the renewable energy sector (discussed above), where the recent selection of a wave energy test site used INFOMAR data. Whilst this is an indirect benefit, the existence of INFOMAR data will attract people and organisations that require this information to develop and build their businesses. Thus a cluster effect can be created which encourages both indigenous and/ or inward investment activity of a high value added nature.

7.79 Given this type of benefit is by its nature innovative and at the cutting edge of science, there is a strong argument supporting the acceleration of the programme. In effect, the longer the period of the INFOMAR project, the greater the opportunity for other nations to erode the competitive advantage Ireland currently enjoys. By proceeding with the INFOMAR project, and completing the mapping of the Irish seabed, Ireland should maintain its competitive advantage in this area, attract increasing numbers of researchers and be at the forefront in securing increased international academic and commercial research funding.

7.80 Whilst this benefit is potentially very significant in financial/ economic terms, it remains reasonably speculative at this time and in line with our overall prudent approach in estimating benefits, these benefits have not been quantified.

Legislative requirements and obligations

7.81 Under legislative benefits, the following sub-groups are considered in turn:

- Compliance with legislative requirements (Indirect Benefit);
- Safety (Not Quantified); and
- Identification of ports of refuge (Not Quantified).

Compliance with legislative requirements (Indirect Benefit)

7.82 As discussed in Section 3 above, Ireland is subject to a number of International Marine Conventions, EU Directives and national legislation related to the marine environment. Information captured through the INFOMAR project is a fundamental first step which will assist Ireland in complying with these requirements.

7.83 A summary of the key legislative instruments and the benefits which will be provided are shown in the table 7.17 overleaf.

Table 7.17: Legislative requirements

Legislation	Obligation	Benefit
Convention for Safety of life at sea (SOLAS)	Requirement of a contracting government to 'undertake to arrange for the collection of hydrographic data and the publication, dissemination and keeping up to date of all nautical information necessary for safe navigation'	The INFOMAR project, which will complete the mapping of the Irish seabed, will fulfil these requirements for the Irish Government.
United Nations Convention on the Law of the SEA (UNCLOS)	Signatory nations to define the limits of their continental shelf and to project the limits of other maritime jurisdictions including the exclusive fishery zone.	Ireland made a submission to the UN in 2005 outlining the proposed outer limits of the continental shelf of Ireland. Parts of the area that will be mapped by INFOMAR are the subject of discussion between Ireland, France and the UK in terms of the exact positioning of boundaries. Therefore, the availability of data from mapping of the disputed area will be essential to reconcile existing and future competing claims.
Oil Pollution of the Sea (Civil Liability and Compensation) Act (1988) MARPOL	Exemption from liability on the owner of a vessel which causes pollution damage if the accident is due to negligence by the government or authority in the provision of navigational aids in the area in which the accident occurred.	If a significant accident were to occur (eg. oil spillage) in the inshore area of Ireland due to defective marking of a hazard on a chart, the liability for clean-up and compensation would reside with the Irish government. Safety aspects of having areas mapped to prevent loss of life and state liability, particularly given increasing use of inshore waters and commercial traffic. The earlier they are surveyed, the earlier a revised chart can be produced, the less likely an accident will occur due to poor charting. Under MARPOL (Marine Pollution) convention, a state is liable for the total costs of clean-up, vessel and cargo loss if it can be shown that the accident was attributable to poor charting in their national waters.
Water Framework Directive	Maintaining "high status" of waters where it exists, preventing any deterioration in the existing status of waters and achieving at least "good status" in relation to all waters by 2015	An output from the INFOMAR project will be baseline seabed geochemical information and detailed habitat maps, which will potentially assist in identifying appropriate sampling locations for the WFD monitoring programmes.
OSPAR Convention ³⁰ and EU Habitats Directive ³¹	Ireland has agreed to firstly identify and subsequently designate Special Areas of Conservation (SACs), including cold water coral reefs.	Many of these candidate SACs are found within the inshore area and have yet to be mapped. Information from the INFOMAR, particularly physical habitat maps, will contribute to identifying the range and nature of the seabed habitats in the inshore area.

³⁰ Convention for the Protection of the Marine Environment of the North-East Atlantic (1992)

³¹ Council Directive 92/43/EEC on the Conservation of natural habitats and of wild fauna and flora

- 7.84 In addition the environmental benefits which will be derived as a result of compliance with this legislation. In financial terms the most immediate benefits is avoidance of fines and in terms of quantifying the benefits the three step approach is used.

Table 7.18: Benefits of Legislative Compliance

Step	Detail
Step 1 Causal Link	The hydrographic and habitat maps are required to provide the base data to develop policies and programmes to ensure legislative compliance. In the absence of INFOMAR a specific mapping exercise would have to be undertaken.
Step 2 Scale of Fines	Whilst the levels of fines are difficult to forecast, consultations have indicated the following range: <ul style="list-style-type: none"> • High: €15 million • Medium: €10 million • Low: €5 million
Step 3 % impact of INFOMAR (Based on Option 3)	As this is only the first step in obtaining legislative compliance (albeit fundamental), it is prudent to credit INFOMAR with only 10% of this potential cost saving. <ul style="list-style-type: none"> • High Impact Scenario: €1.5 million • Medium Impact Scenario: €1 million • Low Impact Scenario: €0.5 million
Step 4 Benefits across options (Based on medium impact scenario only)	<ul style="list-style-type: none"> • Option 1 – €250k p.a. • Option 2 – €750k p.a. • Option 3 – €1 million p.a. • Option 4 – €750k (years 1 – 10) and €250k (years 1 – 20)
Step 5 Period over which benefits accrue	<ul style="list-style-type: none"> • Option 1 – 10 years (2009 – 2018) • Option 2 – 10 years (2009 – 2018) • Option 3 – 10 years (2009 – 2018) • Option 4 – 20 years (2009 – 2028) – see above

- 7.85 The following rationale is provided to explain the benefits attributed across each of the options and the profile over which those benefits will accrue:

- Option 1 – only one third of all priority areas will be mapped and therefore benefits have been reduced accordingly. The period over which the benefit can be attributed however remains the same across all options;
- Option 2 – most of the legislative requirements refer to near shore areas and therefore €750k was estimated as an appropriate benefit in respect of all priority areas;
- Option 3 – As set out above, this is only the first step in obtaining legislative compliance, therefore it is prudent to credit INFOMAR with only 10% of this potential cost saving; and
- Option 4 – as the near shore mapping will be undertaken first, these greater benefits will be accrued first (as per option 2), then the benefits in respect of zone 2 areas will be achieved in the second half of this project.

- 7.86 It is also important to note that if INFOMAR was not taken forward, then mapping would have to be carried out for this single task to avoid fines and there would be no additional benefit from the data captured.
- 7.87 Table 7.19 below shows the present value of benefits across each of the options.

Table 7.19: Present Value of Benefits of Legislative Compliance

Option	1 €000	2 €000	3 €000	4 €000
High Impact	3,042	9,125	12,166	11,180
Medium Impact	2,028	6,083	8,111	7,453
Low Impact	1,014	3,042	4,055	3,727

- 7.88 Other legislative benefits which have not been quantified are discussed in turn below.

Environmental Clean-up Liability (Not Quantified)

- 7.89 In addition to the avoidance of fines, as noted above the Marine Pollution Convention (MARPOL), indicates that a state is liable for the total costs of clean-up, vessel and cargo loss if it can be shown that the accident was attributable to poor charting in their national waters. In 2002, the cost of clean up of the Prestige oil spill off the coast of Spain was estimated by the Barrie de la Maza Economic Institute at approximately €2.8 billion. In addition to the environmental clean up costs associated with an accident of this nature, there can also be significant economic costs. For example in 1993, the Braer ran aground off Shetland and the oil spillage resulted in exclusion zones for fishing and mussels being put in place. The final exclusion zone was not lifted until 2000.
- 7.90 The INFOMAR project therefore provides information which should remove state liability if a major environmental accident of this nature were to occur in Irish national waters. A liability on this scale would cause significant financial and economic problems for the Government. However given the difficulty in identifying the impact of the project in reducing the probability of an accident, it is considered prudent not to quantify this benefit.

Safety (Not Quantified)

- 7.91 A number of the legislative requirements discussed above directly relate to a variety of safety aspects.

Safety – Trading Routes

- 7.92 Measured by volume, 99% of foreign trade uses the maritime supply chain. It is estimated that the value of exports and imports through seaports for Republic of Ireland was €134bn in 2004, with port traffic forecast to increase by some 35% by 2014 (Government Ports Policy Statement 2005). Approximately 17,000 vessels visited Irish ports in 2003, with considerably more travelling through Irish waters. The identification of shallows, banks and other obstacles in the approach to the trading, fishing and leisure ports is crucial for the continued safety and development of this traffic.
- 7.93 Safety of trading routes is obviously of key importance to the continued growth of the Irish economy, however this is considered more of a non-financial benefit rather than financial.

Safety – Accidents and Pollution

- 7.94 As discussed above, a major pollution incident was seen in 2002 with the Prestige oil spill in Spain. It was estimated by Barrie de la Maza Economic Institute that the cost of the clean up of the Galician coast alone was €2.8bn.
- 7.95 Given the prevailing south westerly winds and an estimated 4,000 vessels per annum passing the south-west/west coast, it is considered likely that accidents could occur (previous incidents include Kowloon Bridge grounding in 1986 and the Sea Empress disaster in 1996). An event of this nature in Irish waters, could create major liabilities for Ireland given the legislative obligations discussed above.
- 7.96 The financial value of this benefit has already been considered in our analysis above.

Safety – Access to Ports

- 7.97 All major ports have ongoing requirements to carry out dredging to maintain water depth in shipping lanes, approach channels and alongside berths. As part of these dredging operations regular hydrographic surveying is required. However whilst surveying within the port limits to maintain access is ongoing, outside the port limits accurate charts are often not available. In early 2003 Shannon Foynes Port Company wrote to DCMNR to express their concern about the most recently published chart covering the approaches to the mouth of the Shannon estuary. Within five miles of the port limits there was an area of the chart that was marked 'Unsurveyed'. The Port Company expressed the view that the situation 'may have a damaging effect on the reputation, safety and insurance liability of the Port'.
- 7.98 With increased commercial and fishing traffic in Irish waters, congestion and safety, especially in the vicinity of ports and harbours, is of concern. Poor navigational charts, especially with respect to bathymetry data, may give rise to these problems by curtailing vessels to travel on sufficient tides. Accurate bathymetry from an inshore seabed survey would considerably improve the data available on shipping channels, bays and harbours and therefore improve the efficiency of the transport network. Finally availability and general improvement of the bathymetric coverage should permit further expansion of the commercial and fishing port areas and their use. In 2004 the Shannon Foynes Port Company announced a 5 year €53.5 million development programme.
- 7.99 Whilst there is a potential economic benefit in terms of increasing the level of investment in ports, there is no basis on which to calculate any investment attributable to INFOMAR.

Identification of ports of refuge (Not Quantified)

- 7.100 A port of refuge is the nearest safe haven for a ship in trouble. The port or anchorage is selected on the basis that it has adequate depth to safely accommodate the ship, as well as shelter from the prevailing winds and swells to facilitate the timely and controlled transfer of people and cargo to another ship or to land. In response to an EU request to designate places of refuge (Directive 2002/59/EC) the approach to be taken in Ireland will be to assess each incident as it arises. A report (Briggs Marine Environmental Services, 1997) considers such factors as coastal characteristics, booming arrangements and road access as a basis for decision making/risk analysis. This will be used to identify suitable ports and bays. Accurate charts are a valuable tool in the identification of ports and places of refuge.
- 7.101 Whilst a financial value cannot be placed on this benefit it is a very significant non-quantifiable benefit.

Environmental Benefits (Not Quantified)

7.102 The INFOMAR project should also provide information which could result in a number of significant environmental benefits. Given their nature, **these benefits have not been quantified in financial terms** but are obviously important for long term social and economic well being. The benefits have been identified as follows:

- Protection of marine life e.g. fish, coral;
- Protection of heritage – ship wrecks; and
- Provision of information to inform coastal erosion and climate change.

Protection of marine life

7.103 The conservation and preservation of marine biodiversity can lead to a conflict of interest between fishing/ other commercial sectors, interest groups and policy makers. It is becoming increasingly important to obtain accurate information on the location and extent of habitat types in Ireland's waters to put in place the policies and infrastructure which will help with the sound management, development and protection of sensitive areas. In particular, the information provided from the INFOMAR project will provide the following benefits:

- assist in the designation of Special Areas of Conservation in the inshore area;
- provide decision support for the best practices in fishing and aquaculture; and
- identify the least environmentally disruptive areas for other commercial activities.

7.104 Without the INFOMAR project, decisions on coastal zone management could be made using insufficient or incomplete data.

Protection of heritage

7.105 In addition to preserving the marine biological environment, Ireland is committed to preserving its maritime archaeology. Outputs from the INFOMAR will include the identification of anomalies in the seabed, which may be caused by wrecks, the exact location of which may not be known.

7.106 This information, when combined with further investigation, e.g. diver surveys, will contribute to the preservation of specific areas of archaeological interest and ensure that commercial activities do not adversely affect these areas. Furthermore, the INFOMAR dataset should contribute to the refinement of the Maritime Sites and Monument Record's (MSMR) database, as the INSS database has in the past.

Provision of information to inform coastal erosion and climate change

7.107 The INFOMAR project will provide detailed bathymetry and habitat information which can provide the following coastal erosion and climate change benefits:

- accurate measurements of the physical impact of the sea tied with land boundary information for the Irish marine area can significantly inform the development of the Irish Coastal Protection Strategy Study³²;
- the data can be input into climate change models which should help improve their accuracy in estimating the impact of changing environmental factors;
- the habitat information captured can be used to inform actions required and also act as a baseline to consider the impact of climate change on the marine environment in future.

7.108 In terms of the environmental benefits, typically the greater the area mapped and the faster that this is undertaken, the greater the benefit. As an example, INFOMAR data from survey work in Galway Bay in 2006 and 2007 was incorporated into Oceanographic modelling studies at MI in 2008.

Summary of Project Benefits

7.109 This section has set out in detail a wide range of benefits in relation to the INFOMAR project. As indicated many of these benefits are indirect and a subjective judgement has been taken in terms of the financial/ economic impact the INFOMAR project could have. Furthermore, in estimating these benefits every effort has been taken to be very prudent and avoid overstating the benefits which could be derived. Table 7.20 below summarises the present value of benefits quantified in this section of the appraisal.

Table 7.20: Present Value of INFOMAR Benefits (Med Impact)

Option	1 Do Min €000	2 Priority Bays Only €000	3 INFOMAR By 2016 €000	4 INFOMAR By 2026 €000
Commercial				
Fishing Sector	2,083	15,610	156,102	95,404
Aquaculture	6,112	46,252	57,816	57,816
Biodiversity	1,028	7,783	11,118	11,118
Renewable Energy	6,671	20,013	40,026	40,026
Energy Exploration	0	0	64,887	49,309
Aggregate Industry	23,077	65,754	85,480	85,480
Knowledge Economy				
Research	2,226	8,111	16,222	10,193
Legislative				
Non-Compliance Fines	2,028	6,083	8,111	7,453
Total PV of Benefits	43,226	169,607	439,763	356,799

³² Department of Communications, Energy & Natural Resources

7.110 This analysis shows that based on reasonably prudent assumptions (medium impact scenario), the INFOMAR project could deliver up to €440 million of benefits to the Ireland economy over the next 20 years if the project is accelerated and completed by 2016. If the project is not accelerated and runs at its current pace until completion in 2026, then the benefits will be reduced significantly to €357 million. If the project is not completed and only the priority areas mapped then benefits fall further to €170 million. Lastly if the project is discontinued at the end of 2008 then benefits of €43 million are likely to accrue from work undertaken to date and up to the end of 2008.

7.111 The following summary comments are also made in respect of INFOMAR benefits:

- There are a large number of non quantifiable benefits which have been identified in this analysis in particular relating to the environment;
- Speculative benefits such as a hydrocarbon find, a major biotechnology discovery, major inward investment project and the avoidance of major costs such as an environmental disaster (eg. oil spillage from a tanker running aground) have not been quantified but could potentially be worth billions to the Ireland economy;
- One of the largest annual benefits identified is in respect of the contribution to the fishing industry. In this regard it is important to recognise that the marine sector in general and the fishing industry in particular is critical from a socio-economic perspective to some of the most peripheral areas of Ireland where there are few alternative sources of employment; and
- Finally, taking INFOMAR forward results in the avoidance of costs in respect of bespoke mapping work which would have to be undertaken in any case but without any of the wider benefits which have been outlined in this report.

VIII Risk Analysis

Introduction

- 8.1 It is reasonable to anticipate that in a project of this scale and nature, a number of areas of risk may arise which could potentially affect the successful implementation of the project and securing of maximum potential benefits. These risks are set out initially in a risk register in Table 8.1 below and then discussed with possible mitigating factors.

Table 8.1: Risk Register

Risk	Probability	Impact
Potential for cost increase	L	H
Competition for Staff and Equipment from Hydrocarbon sector	H	M
Value added benefits not realised	L	H
Potential for loss of momentum	(1)	H
Reliance on UKHO	H	L

Note 1: The probability of 'loss of momentum' is option specific

- 8.2 **In general, the risks identified refer to all options equally, however where these risks relate to a specific option or a specific component of an option, this has been highlighted.**

Potential for Cost Increases

- 8.3 Experience has shown that the outturn cost of large scale projects have a history of being greater than those anticipated at appraisal/ budget stage. This was evidenced by the INSS project which ran over budget and had to be re-scoped as a result. This is a particular risk in this project given the increasing cost of hiring boats and staff for marine surveying and mapping, driven particularly by the hydrocarbon sector.
- 8.4 In mitigation of this risk, the following comments are made:
- The experience of INSS and running INFOMAR since 2006 has resulted in GSI and MI staff being more realistic in estimating the cost of mapping activities;
 - The costs used in this appraisal already make special provision for the increasing costs from external sources;
 - The costs of options to 2016 are by their nature more certain than cost forecasts to 2026. As a result the longer the project duration, the greater the potential for cost overrun.
- 8.5 Overall this is judged to be a medium risk.

Competition for Staff and Equipment from Hydrocarbon Sector

8.6 As noted throughout this appraisal report, with the increase in the price of oil and gas, energy companies are significantly ramping up exploration activity in a bid to replace falling reserves. This includes using the same survey/ mapping equipment and staff as is being used by the INFOMAR project. The impact of this competition is two fold, firstly it bids up the cost of staff and equipment (discussed above) but also has the potential to reduce access time to both state and commercial vessels thus resulting in the completion of the project being delayed.

8.7 In mitigation of this risk the following comments are made:

- Procurement of the Launch has resulted in the project having access to a further national research vessel, which would not be subject to the same availability restrictions as other state and commercial vessels for inshore work; and
- Under option 3, where the project would be accelerated, the project team would be in a position to enter into agreements to use the state and commercial vessels when availability can be assured. If the project is run out over a longer period (to 2026), then commercial vessels would not be used until 2016. The availability of those vessels at that time is unknown and could be further constrained.

8.8 Overall this is a medium risk.

Value Added Benefits not Realised

8.9 Many of the major benefits associated with this project are in respect of the value added components (primarily the programme 2 and programme 3 elements). Therefore it is of fundamental importance that the project group ensure these value added activities are undertaken. In mitigation of this risk the following comments are made:

- There have been a number of successes achieved to date, such as selling expertise to the EU and South Africa; ramp up of research projects and personnel; and use of INFOMAR data in renewable energy sector; and
- The project group (including senior management in GSI and MI) are committed to ensuring a focus on information dissemination and value added is maintained.

8.10 In this regard and as noted in the review of the project to date, it is recommended that a project plan is developed to identify how the value added benefits of INFOMAR can be achieved and the return on the investment maximised. This should include the establishment of targets for research projects, commercial investments etc.

8.11 Overall this is considered a medium risk.

Potential for Loss of Momentum

8.12 This risk is more applicable to options 2 and 4 and refers to the potential for the project benefits not to be realised because the timescale for the project is run out over a much longer period or it continues at its current pace and only the priority areas are completed by 2016. In these instances, the following factors would impact on the project:

- Outside career span of project team – it is unlikely the project would be completed within the career span of many of the existing team, some of whom will retire before 2026. This may reduce enthusiasm for the project and other team members could also leave;

- Lose competitive advantage – other countries, such as Norway, are developing their marine related technologies and Ireland can only hope to retain its competitive advantage if the project is taken forward at a faster pace; and
- Research Critical Mass – in order for the marine research community to reach a critical mass in terms of personnel undertaking research projects using INFOMAR related data, then it is important the information being created is forthcoming at a reasonable pace. If project activity is ramped up (as per option 3) this creates a momentum which should encourage research activity to increase accordingly.

8.13 Overall this is considered a medium risk.

Reliance on the UK Hydrographic Office

8.14 At present Ireland does not have the capacity to produce its own maps and charts for shipping and INFOMAR data is currently forwarded to the UKHO who produce charts for the Irish Government. The following mitigation factors have been identified:

- There are no indications that the existing arrangement cannot continue indefinitely, consultations with the UKHO indicated a positive working relationship between both organisations/ countries;
- The project outputs and benefits are much broader than producing information for charts for shipping; and
- While the Department of Transport has now formally joined Ireland to the International Hydrographic Office and announced the establishment of an Irish Hydrographic Office, this is still at the preliminary stage.

8.15 Overall this is considered a low risk.

IX Cost Benefit Analysis

Introduction

- 9.1 The appraisal process requires an examination of both costs and benefits and one way to undertake this is through the calculation of a Net Present Value for each of the options. This expresses the stream of costs and quantifiable benefits occurring over the appraisal period (in this case up to 20 years) discounted to 2008. The NPV calculations consist of the capital costs (ie. the costs associated with implementing the project, such as use of state and commercial vessels, staff costs, costs of research and data management costs) and the quantifiable benefits (such as benefits to the wide range of commercial sectors/ industries who can gain from the use of INFOMAR data). These costs and benefits were all identified in sections VI and VII of this appraisal report.
- 9.2 **In addition, the NPV calculations include costs which have applied the Shadow Price of Public Funds (SPPF) at a rate of 125%.**
- 9.3 The cash flows of each option have been discounted at 4% (the Test Discount Rate) and the detailed calculations are set out in Appendix B. Table 9.1 below presents a summary of the NPV calculations.

Table 9.1: NPV Calculations

Option	Description	Net Present Value (NPV)		
		Low Impact €000	Med Impact €000	High Impact €000
1	Do Minimum	21,613	43,226	64,839
2	Priority Areas Only	55,486	140,290	225,093
3	Zones 1 and 2 by 2016	145,421	365,302	585,183
4	Zones 1 and 2 by 2026	97,466	275,866	454,266

- 9.4 The following comments are made in respect of these results:
- Overall the results show the benefits of the INFOMAR project to be significantly greater than the costs incurred, however as discussed in the preceding sections of this appraisal, the costs are incurred by Government and the benefits are largely enjoyed by society and the private sector;
 - Option 1: Do Minimum option – this option shows the smallest Net Present Value across all scenarios, reflecting the much lower levels of benefits which can be achieved. It should be noted that NPV for option 1 is the same as the Present Value of benefits because a zero cost has been attributed to this option (in effect all costs up to the end of 2008 are 'sunk' costs and therefore should not be considered in the analysis, in contrast the benefits associated with option 1 are not yet guaranteed and therefore are not 'sunk');
 - Option 2: Priority Areas Only – the NPV of completing the priority areas is significantly greater than discontinuing the project at the end of 2008, however it is still ranked third in under all three impact scenarios;

- Option 3: Zones 1 and 2 by 2016 – across all scenarios, option 3 has the highest NPV. Accelerating the programme delivers a greater level of benefits and delivers them in a shorter time resulting in a higher ‘present value’ of benefits. Furthermore, completing the project in a shorter period, results in lower overall costs because project management costs are incurred over a shorter time and anticipated cost escalation of using commercial mapping vessels;
- Option 4: Zones 1 and 2 by 2026 – this is the second ranked option. As this option is run over a considerably longer period of time, management costs and inflation result in this option being the most expensive. In addition, as many of the benefits will not be derived for a longer period of time the ‘present value’ of these benefits is reduced; and
- As noted in the benefits section the NPV analysis excludes all the non-monetary benefits identified above.

Benefit Cost Ratios

9.5 In addition to the NPV analysis above it can also be useful to consider the ratio of benefits to costs, particularly in large projects of this nature. Table 9.2 below sets out these ratios for each option across the three impact scenarios.

Table 9.2: Benefit Cost Ratios

	Option 1	Option 2	Option 3	Option 4
Low Impact Scenario				
PV of Benefits (€000)	21,613	84,803	219,881	178,400
PV of Costs (€000)	0	29,317	74,461	80,933
Ratio	NA	2.89	2.95	2.20
Medium Impact Scenario				
PV of Benefits (€000)	43,226	169,607	439,763	356,799
PV of Costs (€000)	0	29,317	74,461	80,933
Ratio	NA	5.79	5.91	4.41
High Impact Scenario				
PV of Benefits (€000)	64,839	254,410	659,644	535,199
PV of Costs (€000)	0	29,317	74,461	80,933
Ratio	NA	8.68	8.86	6.61

9.6 The following comments are made in respect of this ratio analysis:

- Across all scenarios, option 3 – to complete the entire mapping project by 2016, delivers the highest benefit to cost ratio. However this is only marginally higher than option 2 (to complete the priority areas only). This reflects the following factors in respect of the benefits identified:
 - Near shore mapping delivers a large number of the benefits identified (the exceptions are fisheries, renewable energy and hydrocarbon exploration which requires mapping outside of the priority bays and areas);

- Whilst mapping slightly further off shore also delivers many of the same benefits, significantly in excess of the additional costs incurred, these benefits are not as high a multiple of costs as priority bays and areas; and
 - These results justify the priority status given to these particular areas by GSI and MI and the phasing of this mapping activity.
- A final point, also raised in the benefits section of the appraisal, is that current technology constraints means that some benefits from off-shore mapping cannot currently be realised (e.g. recovery of off-shore aggregates and wind farm development is currently limited to areas of water up to 50 metre in depth). Therefore in future there is potential for greater benefits to be realised further off-shore which have not been quantified in the analysis.

Concluding Comments

9.7 The following concluding comments are made in respect of the NPV and Cost to Benefit ratio calculations:

- Option 3 delivers the highest NPV reflecting the high level of benefits which can be achieved if the project is accelerated;
- Option 3 also has the highest cost : benefit ratio, albeit this is only marginally higher than for option 2; and
- The results are unchanged under the three impact scenarios.

X Conclusions and Recommendation

Introduction

- 10.1 This appraisal sets out the rationale for Government intervention in the INFOMAR project. This is based primarily on market failure given that the organisation which would fund the mapping exercise could not derive all benefits for itself, therefore the expenditure could not be justified from a private sector perspective. In addition, if a private sector company were to undertake mapping it would be very specific to their requirements, would not provide comprehensive coverage and the benefits would not be shared. Finally, under a number of international laws and conventions, the state is required to provide mapping information, for example to ensure safe passage through national waters.
- 10.2 In meeting this need, the following options were identified and considered in full:
- Option 1 – Do Minimum – discontinue the project after the current funding period has expired (i.e. until December 2008);
 - Option 2 – Priority Bays and Areas Only – complete the mapping of the 26 priority bays and 3 priority coastal areas (Phase 1). This would also include implementation of other GSI/MI aspects of the overall Strategy as far as possible. It is anticipated this would be completed by 2016.
 - Option 3 – Complete Zones 1 and 2 by 2016 – this represent the INFOMAR Strategy in full and includes mapping of entire remaining waters up to 200 metres in depth (all deeper water was mapped as part of INSS; and
 - Option 4 – Complete Zones 1 and 2 by 2026 – as per option 3 above but activity phased, where zone 2 mapping would not commence until 2016 and to be completed by 2026.

Conclusions

- 10.3 Table 10.1 below sets out a summary of the quantitative results based on the 'medium impact' scenario.

Table 10.1: Summary Results

	Option 1 €000	Option 2 €000	Option 3 €000	Option 4 €000
Total Costs	0	34,446	87,393	117,320
Total Benefits	48,360	218,460	567,600	492,400
PV of Costs	0	29,317	74,461	80,933
PV of Benefits	43,226	169,607	439,763	356,799
Net Present Value	43,226	140,290	365,302	275,866
Benefit – Cost Ratio	NA	5.79	5.91	4.41

10.4 The following comments are made in respect of these results:

- Overall the results show the benefits of the INFOMAR project to be significantly greater than the costs incurred, however as discussed in the preceding sections of this appraisal, the costs are incurred by Government and the benefits are largely enjoyed by society and the private sector;
- Option 1: Do Minimum option – this option shows the smallest Net Present Value across all scenarios, reflecting the much lower levels of benefits which can be achieved.
- Option 2: Priority Areas Only – the NPV of completing the priority areas is significantly greater than discontinuing the project at the end of 2008, however it is still ranked third.
- Option 3: Zones 1 and 2 by 2016 – this has the highest NPV and Benefit: Cost ratio of all options. Accelerating the programme delivers a greater level of benefits and delivers them in a shorter time resulting in a higher ‘present value’ of benefits. This also results in lower overall costs because of lower project management costs and lower anticipated cost escalation of using commercial mapping vessels; and
- Option 4: Zones 1 and 2 by 2026 – this is the second ranked option. As this option is run over a considerably longer period of time, management costs and inflation result in this option being the most expensive.

10.5 Whilst the results above are in respect of the ‘medium impact’ scenario, it is important to note that even under the low impact scenario, where benefits identified have been quantified based on very conservative assumptions, the project still shows a positive NPV.

10.6 Furthermore across all scenarios, there are a number of factors which cannot/ have not been included in the NPV calculation:

- There are a large number of non quantifiable benefits which have been identified in this analysis in particular relating to the environment;
- Speculative benefits such as a **hydrocarbon find**, a **major biotechnology discovery**, **major inward investment project** and the avoidance of major costs such as an environmental disaster (eg. **oil spillage** from a tanker running aground) have not been quantified but could potentially be **worth billions to the Ireland economy**;
- One of the largest annual benefits identified is in respect of the contribution to the fishing industry. In this regard it is important to recognise that the marine sector in general and the **fishing industry in particular is critical** from a socio-economic perspective **to some of the most peripheral areas of Ireland** where there are few alternative sources of employment; and
- Finally, taking INFOMAR forward results in the **avoidance of costs** in respect of bespoke mapping work which would have to be undertaken in any case but without any of the wider benefits which have been outlined in this report.

Recommendation

10.7 Based on the analysis above, **Option 3 is recommended as the preferred option.** In particular this option delivers the greatest level of benefits (both quantifiable/ commercial and also environmental) and in the shortest period of time. Furthermore, the following advantages have also been identified:

- The project would be completed within the working careers of staff which should make it easier to retain project staff, thus keeping lost expertise to a minimum;
- The increased momentum should help ensure that value added activity is maintained;
- As the data will be acquired and stored over a relatively short period of time, the same technology will be used, thereby reducing potential IT data collection issues;
- Where data is captured over a shorter period, it provides more of a 'picture in time' and is therefore more useful for establishing a baseline position (for example in environmental analysis); and
- Helps to ensure Ireland retains its competitive advantage in this technical/ knowledge based area.

10.8 However it is important to note that this recommendation is based on the following actions being undertaken:

- Focus on Realising Benefits – as highlighted throughout this appraisal, the INFOMAR project delivers very few direct benefits and therefore achieving the 'indirect' benefits identified is largely outside the direct control of GSI/ MI. Therefore it is important that sufficient focus is given to the value added component of the overall programme;
- Identification of Key Personnel – as option 3 represents a significant ramp up in activity levels it is important that appropriate levels of personnel with the right skill sets are identified for the project; and
- Management of Risks – the INFOMAR project team have identified a range of risks associated with this project. It is important these risks are reviewed and managed on a regular basis.

Appendix 1
Detailed Cost Calculations

Appendix 1a

Appendix 1b

Appendix 1c

Appendix 1a

INFOMAR Project Costs – Option 2

TABLE 1

TABLE 1 - INFOMAR SEVEN YEAR PROFILE, PRIORITY BAYS & AR

Figures are corrected for cumulative inflation plus increasing Oil&Gas Factors

		2009	2010	2011	2012	2013	2014	2015	Totals	% total of costs	
Programme costs	State Agency Effort	State Vessel Based Surveys Table 6	922,200	922,200	922,200	922,200	922,200	922,200	922,200	6,455,400	23
		Other programmes	500,000	500,000	500,000	500,000	700,000	700,000	700,000	4,100,000	15
		Subtotal	1,422,200	1,422,200	1,422,200	1,422,200	1,622,200	1,622,200	1,622,200	10,555,400	
		Programme Operation costs @ 25%	355,550	355,550	355,550	355,550	405,550	405,550	405,550	2,638,850	10
		Sub total A	1,777,750	1,777,750	1,777,750	1,777,750	2,027,750	2,027,750	2,027,750	13,194,250	
	Contracted/ Supported Effort	Launch effort Table 7	206,866	620,597	827,462	827,462	827,462	620,597	206,866	4,137,311	15
		Research	275,000	300,000	300,000	300,000	250,000	200,000	100,000	1,725,000	6
		Subtotal	481,866	920,597	1,127,462	1,127,462	1,077,462	820,597	306,866	5,862,311	
		Contract Management costs 10%	48,187	92,060	112,746	112,746	107,746	82,060	30,687	586,231	2
	Sub total B	530,052	1,012,656	1,240,208	1,240,208	1,185,208	902,656	337,552	6,448,542		
	State Agency + Contracted Effort (Subtotal A + Subtotal B)		2,307,802	2,790,406	3,017,958	3,017,958	3,212,958	2,930,406	2,365,302	19,642,792	
Data Management	Data management costs	510,000	500,000	500,000	600,000	600,000	600,000	500,000	3,810,000	14	
Total cost for programme		2,817,802	3,290,406	3,517,958	3,617,958	3,812,958	3,530,406	2,865,302	23,452,792		
Inflators	Inflation	Euro value with inflation from Table 2	1.0400	1.0816	1.1249	1.1699	1.2167	1.2653	1.3159		
		Cost of Inflation	112,712	268,497	439,266	614,541	826,089	936,684	905,240	4,103,029	15
totals	Totals	Annual total	2,930,514	3,558,903	3,957,225	4,232,500	4,639,047	4,467,090	3,770,542	27,555,821	
		rounded up	2,940,000	3,560,000	3,960,000	4,240,000	4,640,000	4,470,000	3,780,000	27,590,000	
		% Total of costs	11	13	14	15	17	16	14		

TABLE 2 - General & Oil & Gas Inflation

Year	2007	2008	2009	2010	2011	2012	2013
CPI%	3.5	3.5	3.5	3.5	3.5	3.5	3.5
Oil&Gas%	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Enter Annual Inflation	4	4	4	4	4	4	4
Base Unit (e.g. €1)	1.00	1.0400	1.0816	1.1249	1.1699	1.2167	1.2653
Euro worth	1.0400	1.0816	1.1249	1.1699	1.2167	1.2653	1.3159

Table 3 The PRIORITY areas only to be surveyed during the INFOMAR Programme

The Areas to be surveyed								Comments
Zones	total Area sq km after INSS	Total Area (sq km) Rounded up	Areas surveyed INFOMAR 2006-2008	Area Unsurveyed km2 (Following INFOMAR 2006-08 Operations)	Water Depths	Priority Areas Only	Areas remaining (sq km) Predicted for end 08	
Zone 2	122,221	122,300	10,000	112,300	100 to 200m	20,000	10,000	Areas have been rounded up to permit at least 10% overlap with adjoining surveys to permit heterogeneity
					50 to 100m	10,000	10,000	
Zone1	17,185	17,200	1,500	15,200	10 to 50m*	7,444	5,944	This figure represents the area around the coast of Ireland, assuming a straight line across the river mouths.
					0 to 10m	1,660	1,160	
Totals	139,406	139,500	12,000	127,500	Totals		27,104	
					Potential lidar areas- Priority Bays		1,000	The areas that would be suitable for Lidar were assessed by both the GSI & MI and the maximum area that could potentially utilise Lidar technology is 7100sq km

2,444 in Priority Bays & 5,000 Areas

Table 4 - Time in days to survey areas

Priority Areas to be surveyed					Days to survey			
Zones	Water depth	Areas to be surveyed (sq km) updated Sept 2006	Anticipated LiDAR Coverage	Area to be surveyed using vessels	sq km survey per day	Comments	Number of days by areas /day coverage	rounded up
Zone 2	100 to 200m	10,000	-	10,000	125	This figure has been taken as an average of the day covered in similar waters by the R.V. Celtic Explorer between 2003-2005	80	80
	50 to 100m	10,000	-	10,000	90	This figure has been taken as an average of the day covered in similar waters by the R.V. Celtic Explorer between 2003-2005	111	120
Zone1	10 to 50m	5,944	200	5,744	15	See table 5	383	390
	0 to 10m	1,160	800	360	5	See table 5 (nb. 12 hour operations only)	72	80
Totals	Totals	27,104	1,000	26,104			646	650
Airborne LiDAR			1,000		65	This figure has been taken assuming a flying height of 300m required to achieve IHO 1st Order	15	20

Table 5 - How coverage is worked out for 0-10m waters

Depth zone	Area sq km	Average depth (m)	line spacing (Water depth x6) Comment 1&4	total line km	turnarounds Comment 2	time to turnaround (day)	line km/day Comment 3	total days 100% coverage Comment 4	Total Days	Comments
0-10m	5	7	42	119	7	0.15	80	1.6	1.0	Assume 60% coverage Comment 4
10-50m	15	25	150	100	5	0.10	90	1.2	1.0	Assume 100% coverage

Comments			
1	A typical multibeam system will achieve a minimum of 3.5x water depth swathe coverage. However, in order to permit at least 10% overlap on adjacent lines, the factor of 3.0x water depth is allocated. Revised in 2008 to X 6 due to new EM3002 Multibeam system		<p><i>Exerpt from Inshore Mapping Consultative Document</i></p> <p>In the event that LIDAR is an inappropriate tool, an appropriate vessel should be equipped with single beam echo sounder and side scan sonar, as the primary tools and multibeam echo sounder and sub bottom profilers as secondary tools.</p> <p>Although in operation, each shallow water survey will be planned individually, generally two methods are employed for the acoustic mapping of the intertidal zone (a) a series of coast-parallel (c.10m separation) closely spaced lines which permit the identification of any shoals or anomalies, which can then be surveyed in with additional lines; providing the 100% bottom coverage required by IHO 1st and Special Order surveys, or, (b) a particularly common approach for sandy bays is to survey coast-perpendicular lines with a 20-25m separation and infill the missing areas with occasional coast-parallel lines. Depending on which method is used, line spacing will vary between 10 to 25m, and thus coverage per day will change. Revised coverage of 5km per day in shallowest and 15km in 10-20m is considered a good indicator of time, based on new EM - assuming</p>
2	The time taken to turnaround the vessel between lines is taken as 15mins. Times vary from vessel to vessel, depending on the weather, handler and length of towed equipment. 15minutes is considered to be a good viable time to work with. This formula assumes the vessel will be operating in a square.	4	
3	It is assumed that the vessel will be travelling at an average speed of 5.5knots. This is c. 10.45km per hour. However, assuming short lines with frequent stops for obstacles, it is practical to assume overground coverage of 65km per 12 hour day		

Table 6 - Utilisation of State Research Vessels

Table 3		Table 4	State vessel effort							Areas remaining sq km	Days effort remaining
Areas to be surveyed		Days to survey	R.V. Celtic Explorer			R.V. Celtic Voyager		Totals			
Water depth	Areas to be surveyed (sq km) updated Sept 2006	Number of days by areas /day coverage	day cost (€)	Survey days at 30 days per year for 7 years	Cost (€)	day cost (€)	Survey days at 30 days per year for 7 years	Cost (€)	Total cost (€)	Total area surveyed	
100 to 200m	10,000	80	24,000	80	1,920,000	15,400	0	0	1,920,000	10,000	
50 to 100m	10,000	111		60	1,440,000		51	785,400	2,225,400	9,990	10
10 to 50m	5,944	383	n/a	0	0	n/a	150	2,310,000	2,310,000	2,250	
0 to 10m	1,160	72	n/a	0	0	n/a	0	0	-	-	
Totals	27,104	646		140	3,360,000		201	3,095,400	6,455,400	22,240	

division of costs equal as can only get vessels for set days per annum (note any inflation in price is catered for under inflation applied to overall cost)

2007	2008	2009	2010	2011	2012	2013	total
922,200	922,200	922,200	922,200	922,200	922,200	922,200	6,455,400

Table 7 - Commercial Effort

Type of survey	Areas to be surveyed	Areas remaining sq km (from Table 6)	LiDAR Coverage (from table 4)	Areas remaining for vessel survey	Costs for commercial survey						
					Coastal Vessel		Inshore Vessel		LiDAR		Totals
Vessels	Water depth				Commercial day rate Coastal vessel (€^^)	Days effort	Commercial day rate inshore vessel (€^^)	Days effort	LiDAR sq km rate* (€)	Days effort	Potential costs
	100 to 200m	-	-	-		0		0			0
	50 to 100m	10	-	10	25,000	0	n/a	0	n/a		2,778
	10 to 50m	3,694	200	3,494	€7,000.00	233		0			1,630,533
	0 to 10m	1,160	800	360	n/a	n/a	€7,000.00	72			504,000
LiDAR	0 to 25m		1,000	1,000					€2,000.00	80	2,000,000
Totals		4,864		4,864		233		72			€4,137,311.11

Division of costs								
Year	2009	2010	2011	2012	2013	2014	2015	total
Amount	€206,865.56	€20,596.67	€27,462.22	€27,462.22	€27,462.22	€20,596.67	€206,865.56	€4,137,311.11
%	5	15	20	20	20	15	5	100

Table 8 - Programme Costs

Year	total allocation	Vessel costs	Contract personnel	Equipment & DGPS Signal rental	Support costs (salaries, training, data management, T&S & consumables)	Support cost %
2003 (*)	3,435,000	1,895,000	920,333	154,654	465,013	14
2004	3,714,000	2,200,000	582,682	128,963	802,355	22
2005	3,404,500	1,888,000	612,831	106,784	796,885	23
Average						19.52
Reaslistic operating average						25.00

(*) Costs were very tight in 2003 - much of the equipment had been bought during shipbuild of the R.V. Celtic Explorer - this made operating costs appear lower than they actually were

This figure further revised to 25% based on experience 06/07 Infomar

Appendix 1b

INFOMAR Project Costs – Option 3

TABLE 1

TABLE 1 - INFOMAR SEVEN YEAR PROFILE

Figures are corrected for cumulative inflation plus increasing Oil & Gas Factors

			2009	2010	2011	2012	2013	2014	2015	Totals	% total of costs
Programme costs	State Agency Effort	State Vessel Based Surveys Table 6	3,170,000	3,170,000	3,170,000	3,170,000	3,170,000	3,170,000	3,170,000	22,190,000	32
		Other programmes	500,000	500,000	500,000	500,000	700,000	700,000	700,000	4,100,000	6
		<i>Subtotal</i>	3,670,000	3,670,000	3,670,000	3,670,000	3,870,000	3,870,000	3,870,000	26,290,000	
		Programme Operation costs @ 25%	917,500	917,500	917,500	917,500	967,500	967,500	967,500	6,572,500	9
		Sub total A	4,587,500	4,587,500	4,587,500	4,587,500	4,837,500	4,837,500	4,837,500	32,862,500	
	Contracted/ Supported Effort	Commercial effort Table 7	954,444	2,863,333	3,817,778	3,817,778	3,817,778	2,863,333	954,444	19,088,889	27
		Research	275,000	300,000	300,000	300,000	250,000	200,000	100,000	1,725,000	2
		<i>Subtotal</i>	1,229,444	3,163,333	4,117,778	4,117,778	4,067,778	3,063,333	1,054,444	20,813,889	
		Contract Management costs 10%	122,944	316,333	411,778	411,778	406,778	306,333	105,444	2,081,389	3
		Sub total B	1,352,389	3,479,667	4,529,556	4,529,556	4,474,556	3,369,667	1,159,889	22,895,278	
State Agency + Contracted Effort (Subtotal A + Subtotal B)		5,939,889	8,067,167	9,117,056	9,117,056	9,312,056	8,207,167	5,997,389	55,757,778		
Data Management	Data management costs	510,000	500,000	500,000	600,000	600,000	600,000	500,000	3,810,000	5	
Total cost for programme		6,449,889	8,567,167	9,617,056	9,717,056	9,912,056	8,807,167	6,497,389	59,567,778		
Inflation	Inflation	Euro value with inflation from Table 2	1.0400	1.0816	1.1249	1.1699	1.2167	1.2653	1.3159		
		Cost of Inflation	257,996	699,081	1,200,824	1,650,525	2,147,476	2,336,709	2,052,732	10,345,341	15
totals	Totals	Annual total	6,707,884	9,266,247	10,817,880	11,367,581	12,059,531	11,143,875	8,550,121	69,913,119	
		rounded up	6,710,000	9,270,000	10,820,000	11,370,000	12,060,000	11,150,000	8,560,000	69,940,000	
		% Total of costs	10	13	15	16	17	16	12		

TABLE 2 - General & Oil & Gas Inflation

Year	2007	2008	2009	2010	2011	2012	2013
CPI%	3.5	3.5	3.5	3.5	3.5	3.5	3.5
Oil&Gas%	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Enter Annual Inflation	4	4	4	4	4	4	4
Base Unit (e.g. €1)	1.00	1.0400	1.0816	1.1249	1.1699	1.2167	1.2653
Euro worth	1.0400	1.0816	1.1249	1.1699	1.2167	1.2653	1.3159

Table 3 The areas to be surveyed during the INFOMAR Programme (Excluding Zone 3)

The Areas to be surveyed							Comments
Zones	total Area sq km after INSS	Total Area (sq km) Rounded up	Areas surveyed INFOMAR 2006-2008	Area Unsurveyed km2 (Following INFOMAR 2006-08 Operations)	Water Depths	Areas remaining (sq km) Predicted for end 08	
Zone 2	122,221	122,300	10,000	112,300	100 to 200m	96,800	Areas have been rounded up to permit at least 10% overlap with adjoining surveys to permit heterogeneity
					50 to 100m	15,500	
Zone1	17,185	17,200	1,500	15,200	10 to 50m	12,200	
					0 to 10m	3,000	This figure represents the area around the coast of Ireland, assuming a straight line across the river mouths.
Totals	139,406	139,500	12,000	127,500	Totals	127,500	
					Potential lidar areas	5,000	The areas that would be suitable for Lidar were assessed by both the GSI & MI and the maximum area that could potentially utilise Lidar technology is 7100sq km

Table 4 - Time in days to survey areas

Areas to be surveyed					Days to survey			
Zones	Water depth	Areas to be surveyed (sq km) updated Sept 2006	Anticipated LiDAR Coverage	Area to be surveyed using vessels	sq km survey per day	Comments	Number of days by areas /day coverage	rounded up
Zone 2	100 to 200m	96,800	-	96,800	125	This figure has been taken as an average of the day covered in similar waters by the R.V. Celtic Explorer between 2003-2005	774	780
	50 to 100m	15,500	-	15,500	90	This figure has been taken as an average of the day covered in similar waters by the R.V. Celtic Explorer between 2003-2005	172	180
Zone1	10 to 50m	12,200	4,200	8,000	15	See table 5	533	540
	0 to 10m	3,000	800	2,200	5	See table 5 (nb. 12 hour operations only)	440	440
totals	Totals	127,500	5,000	122,500			1,920	1,920
Airborne LiDAR			5,000		65	This figure has been taken assuming a flying height of 300m required to achieve IHO 1st Order	77	80

Table 5 - How coverage is worked out for 0-10m waters

Depth zone	Area sq km	Average depth (m)	line spacing (Water depth x6) Comment 1&4	total line km	turnarounds Comment 2	time to turnaround (day)	line km/day Comment 3	total days 100% coverage Comment 4	Total Days	Comments
0-10m	5	7	42	119	7	0.15	80	1.6	1.0	Assume 60% coverage Comment 4
10-50m	15	25	150	100	5	0.10	90	1.2	1.0	Assume 100% coverage

Comments	
1	A typical multibeam system will achieve a minimum of 3.5x water depth swathe coverage. However, in order to permit at least 10% overlap on adjacent lines, the factor of 3.0x water depth is allocated. <i>Revised in 2008 to X 6 due to new EM3002 Multibeam system</i>
2	The time taken to turnaround the vessel between lines is taken as 15mins. Times vary from vessel to vessel, depending on the weather, handler and length of towed equipment. 15minutes is considered to be a good viable time to work with. This formula assumes the vessel will be operating in a square.
3	It is assumed that the vessel will be travelling at an average speed of 5.5knots. This is c. 10.45km per hour. However, assuming short lines with frequent stops for obstacles, it is practical to assume overground coverage of 65km per 12 hour day
4	<p><i>Exerpt from Inshore Mapping Consultative Document</i></p> <p>In the event that LIDAR is an inappropriate tool, an appropriate vessel should be equipped with single beam echo sounder and side scan sonar, as the primary tools and multibeam echo sounder and sub bottom profilers as secondary tools.</p> <p>Although in operation, each shallow water survey will be planned individually, generally two methods are employed for the acoustic mapping of the intertidal zone (a) a series of coast-parallel (c.10m separation) closely spaced lines which permit the identification of any shoals or anomalies, which can then be surveyed in with additional lines; providing the 100% bottom coverage required by IHO 1st and Special Order surveys, or, (b) a particularly common approach for sandy bays is to survey coast-perpendicular lines with a 20-25m separation and infill the missing areas with occasional coast-parallel lines. Depending on which method is used, line spacing will vary between 10 to 25m, and thus coverage per day will change. Revised coverage of 5km per day in shallowest and 15km in 10-20m is considered a good indicator of time, based on new EM - assuming</p>

Table 6 - Utilisation of State Research Vessels

Table 3		Table 4	State vessel effort							Areas remaining sq km	Days effort remaining	
Areas to be surveyed		Days to survey	R.V. Celtic Explorer			R.V. Celtic Voyager		Totals				
Water depth	Areas to be surveyed (sq km) updated Sept 2006	Number of days by areas /day coverage	day cost (€)	Survey days at 100 days per year for 7 years	Cost (€)	day cost (€)	Survey days at 50 days per year for 7 years	Cost (€)	Total cost (€)	Total area surveyed		
100 to 200m	96,800	774	24,000	615	14,760,000	15,400	0	0	14,760,000	76,875	19,925	159
50 to 100m	15,500	172		85	2,040,000		80	1,232,000	3,272,000	14,850	650	7
10 to 50m	12,200	533		0	0		270	4,158,000	4,158,000	4,050	8,150	263
0 to 10m	3,000	440	n/a	0	0	n/a	0	0	-	-	3,000	440
Totals	127,500	1,920		700	16,800,000		350	5,390,000	22,190,000	95,775	31,725	703

division of costs equal as can only get vessels for set days per annum (note any inflation in price is catered for under inflation applied to overall costs)

2007	2008	2009	2010	2011	2012	2013	total
3,170,000	3,170,000	3,170,000	3,170,000	3,170,000	3,170,000	3,170,000	22,190,000

Table 7 - Commercial Effort

Type of survey	Areas to be surveyed	Areas remaining sq km (from Table 6)	LiDAR Coverage (from table 4)	Areas remaining for vessel survey	Costs for commercial survey						
					Coastal Vessel		Inshore Vessel		LiDAR		Totals
vessels	Water depth				Commercial day rate Coastal vessel (€^^)	Days effort	Commercial day rate inshore vessel (€^^)	Days effort	LiDAR sq km rate* (€)	Days effort	Potential costs
	100 to 200m	19,925	-	19,925	25,000	159	n/a	0	n/a		3,985,000
	50 to 100m	650	-	650		7		0			180,556
	10 to 50m	8,150	4,200	3,950	€7,000.00	263		0			1,843,333
	0 to 10m	3,000	800	2,200	n/a	n/a	€7,000.00	440			3,080,000
LiDAR	0 to 25m		5,000	5,000				€2,000.00			80
	Totals	31,725		31,725		430		440			€19,088,888.89

Division of costs								
Year	2009	2010	2011	2012	2013	2014	2015	total
Amount	€54,444.44	€2,863,333.33	€3,817,777.78	€3,817,777.78	€3,817,777.78	€2,863,333.33	€54,444.44	€19,088,888.89
%	5	15	20	20	20	15	5	100

Table 8 - Programme Costs

Year	total allocation	Vessel costs	Contract personnel	Equipment & DGPS Signal rental	Support costs (salaries, training, data management, T&S & consumables)	Support cost %
2003 (*)	3,435,000	1,895,000	920,333	154,654	465,013	14
2004	3,714,000	2,200,000	582,682	128,963	802,355	22
2005	3,404,500	1,888,000	612,831	106,784	796,885	23
Average						19.52
Reaslistic operating average						25.00

(*) Costs were very tight in 2003 - much of the equipment had been bought during shipbuild of the R.V. Celtic Explorer - this made operating costs appear lower than they actually were

This figure further revised to 25% based on experience 06/07 Infomar

Appendix 1c
INFOMAR Project Costs – Option 4

TABLE 1

TABLE 1 - INFOMAR SEVENTEEN YEAR PROFILE

		2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	Totals	% total of costs		
Programme costs	State Agency Effort	State Vessel Based Surveys Table 6	1,665,000	1,665,000	1,665,000	1,665,000	1,665,000	1,665,000	1,665,000	1,665,000	1,665,000	1,665,000	1,665,000	1,665,000	1,665,000	1,665,000	1,665,000	1,665,000	1,665,000	28,305,000	30	
		Other programmes	500,000	500,000	500,000	500,000	500,000	500,000	500,000	500,000	500,000	500,000	500,000	500,000	500,000	500,000	500,000	500,000	500,000	8,500,000	9	
		Subtotal	2,165,000	2,165,000	2,165,000	2,165,000	2,165,000	2,165,000	2,165,000	2,165,000	2,165,000	2,165,000	2,165,000	2,165,000	2,165,000	2,165,000	2,165,000	2,165,000	2,165,000	36,805,000		
		Programme Operation costs @ 25%	541,250	541,250	541,250	541,250	541,250	541,250	541,250	541,250	541,250	541,250	541,250	541,250	541,250	541,250	541,250	541,250	541,250	541,250	9,201,250	10
	Sub total A	2,706,250	2,706,250	2,706,250	2,706,250	2,706,250	2,706,250	2,706,250	2,706,250	2,706,250	2,706,250	2,706,250	2,706,250	2,706,250	2,706,250	2,706,250	2,706,250	2,706,250	2,706,250	46,006,250		
	Contracted/ Supported Effort	Commercial effort Table 7	696,137	696,137	696,137	696,137	696,137	696,137	696,137	696,137	696,137	696,137	696,137	696,137	696,137	696,137	696,137	696,137	696,137	696,137	11,834,333	13
		Research	105,000	105,000	105,000	105,000	105,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	1,725,000	2
		Subtotal	801,137	801,137	801,137	801,137	801,137	796,137	796,137	796,137	796,137	796,137	796,137	796,137	796,137	796,137	796,137	796,137	796,137	796,137	13,559,333	
		Contract Management costs 10%	80,114	80,114	80,114	80,114	80,114	79,614	79,614	79,614	79,614	79,614	79,614	79,614	79,614	79,614	79,614	79,614	79,614	79,614	1,355,933	1
	Sub total B	881,251	881,251	881,251	881,251	881,251	875,751	875,751	875,751	875,751	875,751	875,751	875,751	875,751	875,751	875,751	875,751	875,751	875,751	875,751	14,915,267	
	State Agency + Contracted Effort (Subtotal A + Subtotal B)		3,587,501	3,587,501	3,587,501	3,587,501	3,587,501	3,582,001	3,582,001	3,582,001	3,582,001	3,582,001	3,582,001	3,582,001	3,582,001	3,582,001	3,582,001	3,582,001	3,582,001	3,582,001	60,921,517	
	Data Management		Data management costs	225,000	225,000	225,000	225,000	225,000	225,000	225,000	225,000	225,000	225,000	225,000	225,000	225,000	225,000	225,000	225,000	225,000	225,000	3,625,000
Total cost for programme			3,812,501	3,812,501	3,812,501	3,812,501	3,807,001	3,807,001	3,807,001	3,807,001	3,807,001	3,807,001	3,807,001	3,807,001	3,807,001	3,807,001	3,807,001	3,807,001	3,807,001	3,807,001	64,746,517	
Inflation	Euro value with inflation from Table 2	1.0400	1.0816	1.1249	1.1699	1.2167	1.2653	1.3159	1.3686	1.4233	1.4802	1.5395	1.6010	1.6651	1.7317	1.8009	1.8730	1.9479				
	Cost of inflation	152,500	311,100	476,044	647,586	825,989	1,010,070	1,202,753	1,403,143	1,611,548	1,828,290	2,053,702	2,288,130	2,531,935	2,785,493	3,049,193	3,323,440	3,608,658	3,909,576	29,109,576	31	
Totals	Totals	Annual total	3,965,001	4,123,601	4,288,545	4,460,087	4,638,490	4,817,071	5,009,754	5,210,144	5,418,549	5,635,291	5,860,703	6,095,131	6,338,936	6,592,494	6,856,194	7,130,441	7,415,659	93,856,092		
		rounded up	3,970,000	4,130,000	4,290,000	4,470,000	4,640,000	4,820,000	5,010,000	5,220,000	5,420,000	5,640,000	5,870,000	6,100,000	6,340,000	6,600,000	6,860,000	7,140,000	7,420,000	93,940,000		
		% Total of costs	4	4	5	5	5	5	5	6	6	6	6	6	7	7	7	8	8			

TABLE 2 - General & Oil & Gas Inflation

Year	2009	2010	2011	2012	2013	2014
CPI%	3.5	3.5	3.5	3.5	3.5	3.5
Oil&Gas%	0.5	0.5	0.5	0.5	0.5	0.5
Enter Annual Inflation	4	4	4	4	4	4
Base Unit (e.g. €1)	1.0000	1.0400	1.0816	1.1249	1.1699	1.2167
Euro worth	1.0400	1.0816	1.1249	1.1699	1.2167	1.2653

Table 3

The areas to be surveyed during the INFOMAR Programme

The Areas to be surveyed						Comments
Zones	total Area sq km	Total Area (sq km) Rounded up	Area Unsurveyed km2 (Following INFOMAR 2006-08 Operations)	Areas (sq km) updated Sept 2006	Areas remaining (sq km) Spetember 2006	
Zone 2	122,221	122,300	112,300	100 to 200m	96,800	Areas have been rounded up to permit at least 10% overlap with adjoining surveys to permit heterogeneity
				50 to 100m	15,500	
				10 to 50m	12,200	
Zone1	17,185	17,200	15,200	0 to 10m	3,000	This figure represents the area around the coast of Ireland, assuming a straight line across the river mouths.
Totals	139,406	139,500	127,500	Totals	127,500	
				Potential lidar areas	5,000	The areas that would be suitable for Lidar were assessed by both the GSI & MI and the maximum area that could potentially utilise Lidar technology is 7100sq km

Table 4 - Time in days to survey areas

Areas to be surveyed					Days to survey			
Zones	Water depth	Areas to be surveyed (sq km) updated Sept 2006	Anticipated LiDAR Coverage	Area to be surveyed using vessels	sq km survey per day	Comments	Number of days by areas /day coverage	rounded up
Zone 2	100 to 200m	96,800	-	96,800	125	This figure has been taken as an average of the day covered in similar waters by the R.V. Celtic Explorer between 2003-2005	774	780
	50 to 100m	15,500	-	15,500	90	This figure has been taken as an average of the day covered in similar waters by the R.V. Celtic Explorer between 2003-2005	172	180
Zone1	10 to 50m	12,200	4,200	8,000	15	See table 5	533	540
	0 to 10m	3,000	800	2,200	5	See table 5 (nb. 12 hour operations only)	440	440
Totals	Totals	127,500	5,000	122,500			1,920	1,920
Airborne LiDAR			5,000		65	This figure has been taken assuming a flying height of 300m required to achieve IHO 1st Order	77	80

Table 5 - How coverage is worked out for 0-10m waters

Depth zone	Area sq km	Average depth (m)	line spacing (Water depth x6) Comment 1&4	total line km	turnarounds Comment 2	time to turnaround (day)	line km/day Comment 3	total days 100% coverage Comment 4	Total Days	Comments
0-10m	5	7	42	119	7	0.15	80	1.6	1.0	Assume 60% coverage Comment 4
10-50m	15	25	150	100	5	0.10	90	1.2	1.0	Assume 100% coverage

Comments	
1	A typical multibeam system will achieve a minimum of 3.5x water depth swathe coverage. However, in order to permit at least 10% overlap on adjacent lines, the factor of 3.0x water depth is allocated. Revised in 2008 to X 6 due to new EM3002 Multibeam system
2	The time taken to turnaround the vessel between lines is taken as 15mins. Times vary from vessel to vessel, depending on the weather, handler and length of towed equipment. 15minutes is considered to be a good viable time to work with. This formula assumes the vessel will be operating in a square.
3	It is assumed that the vessel will be travelling at an average speed of 5.5knots. This is c. 10.45km per hour. However, assuming short lines with frequent stops for obstacles, it is practical to assume overground coverage of 65km per 12 hour day
4	<p><i>Exerpt from Inshore Mapping Consultative Document</i></p> <p>In the event that LIDAR is an inappropriate tool, an appropriate vessel should be equipped with single beam echo sounder and side scan sonar, as the primary tools and multibeam echo sounder and sub bottom profilers as secondary tools.</p> <p>Although in operation, each shallow water survey will be planned individually, generally two methods are employed for the acoustic mapping of the intertidal zone (a) a series of coast-parallel (c.10m separation) closely spaced lines which permit the identification of any shoals or anomalies, which can then be surveyed in with additional lines; providing the 100% bottom coverage required by IHO 1st and Special Order surveys, or, (b) a particularly common approach for sandy bays is to survey coast-perpendicular lines with a 20-25m separation and infill the missing areas with occasional coast-parallel lines. Depending on which method is used, line spacing will vary between 10 to 25m, and thus coverage per day will change. Revised coverage of 5km per day in shallowest and 15km in 10-20m is considered a good indicator of time, based on new EM - assuming</p>

Table 8 - Programme Costs

Year	Total allocation	Vessel costs	Contract personnel	Equipment & DGPS Signal rental	Support costs (salaries, training, data management, T&S & consumables)	Support cost %
2003 (*)	3,435,000	1,895,000	920,333	154,654	465,013	14
2004	3,714,000	2,200,000	582,682	128,963	802,355	22
2005	3,404,500	1,888,000	612,831	106,784	796,885	23
Average						19.52
Realistic operating average						22.00

(*) Costs were very tight in 2003 - much of the equipment had been bought during shipbuild of the R.V. Celtic Explorer - this made operating costs appear lower than they actually were

Appendix 2
Net Present Value Calculations

- Appendix 2a – Low Impact Scenario**
- Appendix 2b – Medium Impact Scenario**
- Appendix 2c – High Impact Scenario**

Appendix 2a
Low Impact Scenario

INFOMAR - Ireland's Marine Mapping Project - LOW IMPACT SCENARIO

OPTION 1: Do Minimum (Cease Project at end of 2008)

YEAR	YEAR	DISCOUNT FACTOR	CAP COST	CAPITAL COST CAP COST (inc SPPF)	PV of CAP COST	PV of CAP COST (inc SPPF)	Fishing Industry Annual Benefits	PV of Benefits	Aquaculture Industry Annual Benefits	PV of Benefits	Biodiversity Sector Annual Benefits	PV of Benefits	Renewable Energy Annual Benefits	PV of Benefits	Energy Exploration Annual Benefits	PV of Benefits	Aggregates Sector Annual Benefits	PV of Benefits	Research Commissions Annual Benefits	PV of Benefits	Legislative Compliance Annual Benefits	PV of Benefits	Total Benefits	PV of Benefits	Net Benefits	Net Present Value	NPV (inc SPPF)		
0	2008	4.00%	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k		
1	2009	0.9615	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
2	2010	0.9246	0	0	0	0	234	225	687	660	116	111	300	288	0	0	12,000	11,538	250	240	125	120	13,711	13,184	13,711	13,184	13,184		
3	2011	0.8890	0	0	0	0	234	216	687	635	116	107	300	277	0	0	0	0	250	231	125	116	1,711	1,582	1,711	1,582	1,582		
4	2012	0.8548	0	0	0	0	234	208	687	610	116	103	300	267	0	0	0	0	250	222	125	111	1,711	1,521	1,711	1,521	1,521		
5	2013	0.8219	0	0	0	0	234	200	687	567	116	99	300	256	0	0	0	0	250	214	125	107	1,711	1,463	1,711	1,463	1,463		
6	2014	0.7903	0	0	0	0	234	192	687	564	116	95	300	247	0	0	0	0	250	205	125	103	1,711	1,406	1,711	1,406	1,406		
7	2015	0.7599	0	0	0	0	0	0	0	0	0	0	300	237	0	0	0	0	0	125	99	425	336	425	336	336	336		
8	2016	0.7307	0	0	0	0	0	0	0	0	0	0	300	228	0	0	0	0	0	125	95	425	323	425	323	323	323		
9	2017	0.7026	0	0	0	0	0	0	0	0	0	0	300	219	0	0	0	0	0	125	91	425	311	425	311	311	311		
10	2018	0.6756	0	0	0	0	0	0	0	0	0	0	300	211	0	0	0	0	0	125	88	425	299	425	299	299	299		
11	2019	0.6496	0	0	0	0	0	0	0	0	0	0	300	203	0	0	0	0	0	125	84	425	287	425	287	287	287		
12	2020	0.6246	0	0	0	0	0	0	0	0	0	0	300	195	0	0	0	0	0	0	0	0	300	195	300	195	195		
13	2021	0.6006	0	0	0	0	0	0	0	0	0	0	300	187	0	0	0	0	0	0	0	0	300	187	300	187	187		
14	2022	0.5775	0	0	0	0	0	0	0	0	0	0	300	180	0	0	0	0	0	0	0	0	300	180	300	180	180		
15	2023	0.5553	0	0	0	0	0	0	0	0	0	0	300	173	0	0	0	0	0	0	0	0	300	173	300	173	173		
16	2024	0.5339	0	0	0	0	0	0	0	0	0	0	300	167	0	0	0	0	0	0	0	0	300	167	300	167	167		
17	2025	0.5134	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
18	2026	0.4936	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	2027	0.4746	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	2028	0.4564	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			0	0	0	0	1,170	1,042	3,433	3,056	578	514	4,500	3,336	0	0	12,000	11,538	1,250	1,113	1,250	1,014	24,180	21,613	24,180	21,613	21,613		

OPTION 2: Complete Bays and Priority Bays Only

YEAR	YEAR	DISCOUNT FACTOR	CAP COST	CAPITAL COST CAP COST (inc SPPF)	PV of CAP COST	PV of CAP COST (inc SPPF)	Fishing Industry Annual Benefits	PV of Benefits	Aquaculture Industry Annual Benefits	PV of Benefits	Biodiversity Sector Annual Benefits	PV of Benefits	Renewable Energy Annual Benefits	PV of Benefits	Energy Exploration Annual Benefits	PV of Benefits	Aggregates Sector Annual Benefits	PV of Benefits	Research Commissions Annual Benefits	PV of Benefits	Legislative Compliance Annual Benefits	PV of Benefits	Total Benefits	PV of Benefits	Net Benefits	Net Present Value	NPV (inc SPPF)		
0	2008	4.00%	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k		
1	2009	0.9615	-2,931	-3,664	-2,818	-3,523	702	675	2,080	2,000	350	337	900	865	0	0	0	0	500	481	375	361	4,907	4,718	1,976	1,900	1,195		
2	2010	0.9246	-3,559	-4,449	-3,290	-4,113	702	649	2,080	1,923	350	324	900	832	0	0	0	0	500	462	375	347	4,907	4,537	1,348	1,246	424		
3	2011	0.8890	-3,957	-4,946	-3,518	-4,397	702	624	2,080	1,849	350	311	900	800	0	0	0	0	500	444	375	333	4,907	4,362	950	845	-35		
4	2012	0.8548	-4,233	-5,291	-3,618	-4,523	702	600	2,080	1,778	350	299	900	769	0	0	0	0	500	427	375	321	4,907	4,195	674	576	-328		
5	2013	0.8219	-4,639	-5,799	-3,813	-4,766	702	577	2,080	1,710	350	288	900	740	0	0	0	0	500	411	375	308	4,907	3,910	40,268	33,097	32,144		
6	2014	0.7903	-4,467	-5,564	-3,530	-4,413	702	555	2,080	1,644	350	277	900	711	0	0	40,000	32,877	500	395	375	296	4,907	3,876	440	348	-335		
7	2015	0.7599	-3,771	-4,714	-2,866	-3,582	702	533	2,080	1,581	350	266	900	684	0	0	0	0	500	380	375	285	4,907	3,729	1,136	863	147		
8	2016	0.7307	0	0	0	0	702	513	2,080	1,520	350	256	900	658	0	0	0	0	500	365	375	274	4,907	3,585	4,907	3,585	3,585		
9	2017	0.7026	0	0	0	0	702	493	2,080	1,461	350	246	900	632	0	0	0	0	500	351	375	263	4,907	3,448	4,907	3,448	3,448		
10	2018	0.6756	0	0	0	0	702	474	2,080	1,405	350	236	900	608	0	0	0	0	500	338	375	253	4,907	3,315	4,907	3,315	3,315		
11	2019	0.6496	0	0	0	0	702	456	2,080	1,351	350	227	900	585	0	0	0	0	0	0	0	0	4,032	2,619	4,032	2,619	2,619		
12	2020	0.6246	0	0	0	0	702	438	2,080	1,299	350	219	900	562	0	0	0	0	0	0	0	0	4,032	2,518	4,032	2,518	2,518		
13	2021	0.6006	0	0	0	0	702	422	2,080	1,249	350	210	900	541	0	0	0	0	0	0	0	0	4,032	2,422	4,032	2,422	2,422		
14	2022	0.5775	0	0	0	0	702	405	2,080	1,201	350	202	900	520	0	0	0	0	0	0	0	0	4,032	2,328	4,032	2,328	2,328		
15	2023	0.5553	0	0	0	0	702	390	2,080	1,155	350	194	900	500	0	0	0	0	0	0	0	0	4,032	2,239	4,032	2,239	2,239		
16	2024	0.5339	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
17	2025	0.5134	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
18	2026	0.4936	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	2027	0.4746	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	2028	0.4564	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			-27,557	-34,446	-23,454	-29,317	10,530	7,805	31,200	23,126	5,250	3,891	13,500	10,007	0	0	40,000	32,877	5,000	4,055	3,750	3,042	109,230	84,803	81,673	61,350	55,486		

Appendix 2b
Medium Impact Scenario

INFOMAR - Ireland's Marine Mapping Project - MEDIUM IMPACT SCENARIO

OPTION 1: Do Minimum (Cease Project at end of 2008)

YEAR	YEAR	DISCOUNT FACTOR	CAP COST	CAPITAL COST (inc SPPF)	PV of CAP COST	PV of CAP COST (inc SPPF)	Fishing Industry Annual Benefits	Fishing Industry PV of Benefits	Aquaculture Industry Annual Benefits	Aquaculture Industry PV of Benefits	Biodiversity Sector Annual Benefits	Biodiversity Sector PV of Benefits	Renewable Energy Annual Benefits	Renewable Energy PV of Benefits	Energy Exploration Annual Benefits	Energy Exploration PV of Benefits	Aggregates Sector Annual Benefits	Aggregates Sector PV of Benefits	Research Commissions Annual Benefits	Research Commissions PV of Benefits	Legislative Compliance Annual Benefits	Legislative Compliance PV of Benefits	Total Benefits	PV of Benefits	Net Benefits	Net Present Value	NPV (inc SPPF)	
0	2008	4.00%	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	
1	2009	0.9615	0	0	0	0	468	450	1,373	1,320	231	222	600	577	0	0	24,000	23,077	500	481	250	240	27,422	26,367	27,422	26,367	26,367	
2	2010	0.9246	0	0	0	0	468	433	1,373	1,269	231	214	600	555	0	0	0	0	500	462	250	231	3,422	3,164	3,422	3,164	3,164	
3	2011	0.8890	0	0	0	0	468	416	1,373	1,221	231	205	600	533	0	0	0	0	500	444	250	222	3,422	3,042	3,422	3,042	3,042	
4	2012	0.8548	0	0	0	0	468	400	1,373	1,174	231	197	600	513	0	0	0	0	500	427	250	214	3,422	2,925	3,422	2,925	2,925	
5	2013	0.8219	0	0	0	0	468	385	1,373	1,129	231	190	600	493	0	0	0	0	500	411	250	205	3,422	2,813	3,422	2,813	2,813	
6	2014	0.7903	0	0	0	0	0	0	0	0	0	0	600	474	0	0	0	0	0	250	198	183	850	672	850	672	672	
7	2015	0.7599	0	0	0	0	0	0	0	0	0	0	600	456	0	0	0	0	0	250	190	176	850	646	850	646	646	
8	2016	0.7307	0	0	0	0	0	0	0	0	0	0	600	438	0	0	0	0	0	250	183	169	850	621	850	621	621	
9	2017	0.7026	0	0	0	0	0	0	0	0	0	0	600	422	0	0	0	0	0	250	176	169	850	597	850	597	597	
10	2018	0.6756	0	0	0	0	0	0	0	0	0	0	600	405	0	0	0	0	0	250	169	169	850	574	850	574	574	
11	2019	0.6496	0	0	0	0	0	0	0	0	0	0	600	390	0	0	0	0	0	0	0	0	600	390	600	390	390	
12	2020	0.6246	0	0	0	0	0	0	0	0	0	0	600	375	0	0	0	0	0	0	0	0	600	375	600	375	375	
13	2021	0.6006	0	0	0	0	0	0	0	0	0	0	600	360	0	0	0	0	0	0	0	0	600	360	600	360	360	
14	2022	0.5775	0	0	0	0	0	0	0	0	0	0	600	346	0	0	0	0	0	0	0	0	600	346	600	346	346	
15	2023	0.5553	0	0	0	0	0	0	0	0	0	0	600	333	0	0	0	0	0	0	0	0	600	333	600	333	333	
16	2024	0.5339	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	2025	0.5134	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	2026	0.4936	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	2027	0.4746	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	2028	0.4564	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			0	0	0	0	2,340	2,083	6,865	6,112	1,155	1,028	9,000	6,671	0	0	24,000	23,077	2,500	2,226	2,500	2,028	48,360	43,226	48,360	43,226	43,226	

OPTION 2: Complete Bays and Priority Bays Only

YEAR	YEAR	DISCOUNT FACTOR	CAP COST	CAPITAL COST (inc SPPF)	PV of CAP COST	PV of CAP COST (inc SPPF)	Fishing Industry Annual Benefits	Fishing Industry PV of Benefits	Aquaculture Industry Annual Benefits	Aquaculture Industry PV of Benefits	Biodiversity Sector Annual Benefits	Biodiversity Sector PV of Benefits	Renewable Energy Annual Benefits	Renewable Energy PV of Benefits	Energy Exploration Annual Benefits	Energy Exploration PV of Benefits	Aggregates Sector Annual Benefits	Aggregates Sector PV of Benefits	Research Commissions Annual Benefits	Research Commissions PV of Benefits	Legislative Compliance Annual Benefits	Legislative Compliance PV of Benefits	Total Benefits	PV of Benefits	Net Benefits	Net Present Value	NPV (inc SPPF)	
0	2008	4.00%	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	
1	2009	0.9615	-2,931	-3,664	-2,818	-3,523	1,404	1,350	4,160	4,000	700	673	1,800	1,731	0	0	0	0	1,000	962	750	721	9,814	9,437	6,883	6,618	5,914	
2	2010	0.9246	-3,559	-4,449	-3,290	-4,113	1,404	1,298	4,160	3,846	700	647	1,800	1,664	0	0	0	0	1,000	925	750	693	9,814	9,074	6,255	5,783	4,960	
3	2011	0.8890	-3,957	-4,946	-3,518	-4,397	1,404	1,248	4,160	3,698	700	622	1,800	1,600	0	0	0	0	1,000	889	750	667	9,814	8,725	5,857	5,207	4,327	
4	2012	0.8548	-4,233	-5,291	-3,618	-4,523	1,404	1,200	4,160	3,556	700	598	1,800	1,539	0	0	0	0	1,000	855	750	641	9,814	8,389	5,581	4,771	3,866	
5	2013	0.8219	-4,639	-5,799	-3,813	-4,766	1,404	1,154	4,160	3,419	700	575	1,800	1,479	0	0	80,000	65,754	1,000	922	750	616	89,814	73,821	85,175	70,008	69,054	
6	2014	0.7903	-4,467	-5,564	-3,530	-4,413	1,404	1,110	4,160	3,298	700	553	1,800	1,423	0	0	0	0	1,000	790	750	593	9,814	7,756	5,347	4,226	3,343	
7	2015	0.7599	-3,771	-4,714	-2,866	-3,582	1,404	1,067	4,160	3,161	700	532	1,800	1,368	0	0	0	0	1,000	760	750	570	9,814	7,458	6,043	4,592	3,876	
8	2016	0.7307	0	0	0	0	1,404	1,026	4,160	3,040	700	511	1,800	1,315	0	0	0	0	1,000	731	750	548	9,814	7,171	9,814	7,171	7,171	
9	2017	0.7026	0	0	0	0	1,404	986	4,160	2,923	700	492	1,800	1,265	0	0	0	0	1,000	703	750	527	9,814	6,895	9,814	6,895	6,895	
10	2018	0.6756	0	0	0	0	1,404	948	4,160	2,810	700	473	1,800	1,216	0	0	0	0	1,000	676	750	507	9,814	6,630	9,814	6,630	6,630	
11	2019	0.6496	0	0	0	0	1,404	912	4,160	2,702	700	455	1,800	1,169	0	0	0	0	0	0	0	0	8,064	5,238	8,064	5,238	5,238	
12	2020	0.6246	0	0	0	0	1,404	877	4,160	2,598	700	437	1,800	1,124	0	0	0	0	0	0	0	0	8,064	5,037	8,064	5,037	5,037	
13	2021	0.6006	0	0	0	0	1,404	843	4,160	2,498	700	420	1,800	1,081	0	0	0	0	0	0	0	0	8,064	4,843	8,064	4,843	4,843	
14	2022	0.5775	0	0	0	0	1,404	811	4,160	2,402	700	404	1,800	1,039	0	0	0	0	0	0	0	0	8,064	4,657	8,064	4,657	4,657	
15	2023	0.5553	0	0	0	0	1,404	780	4,160	2,310	700	389	1,800	999	0	0	0	0	0	0	0	0	8,064	4,478	8,064	4,478	4,478	
16	2024	0.5339	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	2025	0.5134	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	2026	0.4936	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	2027	0.4746	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	2028	0.4564	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			-27,557	-34,446	-23,454	-29,317	21,060	15,610	62,400	46,252	10,500	7,783	27,000	20,013	0	0	80,000	65,754	10,000	8,111	7,500	6,083	218,460	169,607	190,903	146,153	140,290	

OPTION 3: Complete Zones 1 and 2 by 2016

YEAR	YEAR	DISCOUNT FACTOR	CAPITAL COST				Fishing Industry Annual Benefits	Fishing Industry PV of Benefits	Aquaculture Industry Annual Benefits	Aquaculture Industry PV of Benefits	Biodiversity Sector Annual Benefits	Biodiversity Sector PV of Benefits	Renewable Energy Annual Benefits	Renewable Energy PV of Benefits	Energy Exploration Annual Benefits	Energy Exploration PV of Benefits	Aggregates Sector Annual Benefits	Aggregates Sector PV of Benefits	Research Commissions Annual Benefits	Research Commissions PV of Benefits	Legislative Compliance Annual Benefits	Legislative Compliance PV of Benefits	Total Benefits	PV of Benefits	Net Benefits	Net Present Value	NPV (inc SPPF)
			CAP COST	CAP COST (inc SPPF)	PV of CAP COST	PV of CAP COST (inc SPPF)																					
		4.00%	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	
0	2008	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
1	2009	0.9615	-6,708	-8,385	-6,450	-8,063	14,040	13,500	5,200	5,000	1,000	962	3,600	3,462	8,000	7,692	0	2,000	1,923	1,000	962	34,840	33,500	28,132	27,050	25,438	
2	2010	0.9246	-9,266	-11,583	-8,567	-10,709	14,040	12,981	5,200	4,808	1,000	925	3,600	3,328	8,000	7,396	0	2,000	1,849	1,000	925	34,840	32,212	25,574	23,645	21,503	
3	2011	0.8890	-10,818	-13,523	-9,617	-12,021	14,040	12,482	5,200	4,623	1,000	889	3,600	3,200	8,000	7,112	0	2,000	1,778	1,000	889	34,840	30,973	24,022	21,355	18,951	
4	2012	0.8548	-11,368	-14,210	-9,717	-12,147	14,040	12,001	5,200	4,445	1,000	855	3,600	3,077	8,000	6,838	100,000	85,480	2,000	1,710	1,000	855	134,840	115,262	123,472	105,544	103,115
5	2013	0.8219	-12,060	-15,075	-9,912	-12,391	14,040	11,540	5,200	4,274	1,000	822	3,600	2,959	8,000	6,575	0	2,000	1,644	1,000	822	34,840	28,636	22,780	18,723	16,245	
6	2014	0.7903	-11,144	-13,930	-8,807	-11,009	14,040	11,096	5,200	4,110	1,000	790	3,600	2,845	8,000	6,323	0	2,000	1,581	1,000	790	34,840	27,535	23,696	18,727	16,525	
7	2015	0.7599	-8,550	-10,688	-6,497	-8,122	14,040	10,669	5,200	3,952	1,000	760	3,600	2,736	8,000	6,079	0	2,000	1,520	1,000	760	34,840	26,476	26,290	19,978	18,354	
8	2016	0.7307	0	0	0	0	14,040	10,259	5,200	3,800	1,000	731	3,600	2,630	8,000	5,846	0	2,000	1,461	1,000	731	34,840	25,457	34,840	25,457	25,457	
9	2017	0.7026	0	0	0	0	14,040	9,864	5,200	3,653	1,000	703	3,600	2,529	8,000	5,621	0	2,000	1,405	1,000	703	34,840	24,478	34,840	24,478	24,478	
10	2018	0.6756	0	0	0	0	14,040	9,485	5,200	3,513	1,000	676	3,600	2,432	8,000	5,405	0	2,000	1,351	1,000	676	34,840	23,537	34,840	23,537	23,537	
11	2019	0.6496	0	0	0	0	14,040	9,120	5,200	3,378	1,000	650	3,600	2,338	8,000	5,200	0	2,000	1,300	1,000	650	34,840	22,636	34,840	22,636	22,636	
12	2020	0.6246	0	0	0	0	14,040	8,769	5,200	3,248	1,000	625	3,600	2,249	8,000	5,000	0	2,000	1,250	1,000	625	34,840	21,769	34,840	21,769	21,769	
13	2021	0.6006	0	0	0	0	14,040	8,432	5,200	3,123	1,000	601	3,600	2,162	8,000	4,800	0	2,000	1,200	1,000	601	34,840	20,931	34,840	20,931	20,931	
14	2022	0.5775	0	0	0	0	14,040	8,108	5,200	3,003	1,000	577	3,600	2,079	8,000	4,600	0	2,000	1,150	1,000	577	34,840	19,200	34,840	19,200	19,200	
15	2023	0.5553	0	0	0	0	14,040	7,796	5,200	2,887	1,000	555	3,600	1,999	8,000	4,400	0	2,000	1,100	1,000	555	34,840	17,600	34,840	17,600	17,600	
16	2024	0.5339	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2,000	1,050	1,000	533	0	0	0	0	0	
17	2025	0.5134	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2,000	1,000	1,000	513	0	0	0	0	0	
18	2026	0.4936	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2,000	950	1,000	493	0	0	0	0	0	
19	2027	0.4746	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2,000	900	1,000	474	0	0	0	0	0	
20	2028	0.4564	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2,000	850	1,000	456	0	0	0	0	0	
			-69,914	-87,393	-59,569	-74,461	210,600	156,102	78,000	57,816	15,000	11,118	54,000	40,026	80,000	64,887	100,000	85,480	20,000	16,222	10,000	8,111	567,600	439,763	497,686	380,194	365,302

OPTION 4: Complete Zones 1 and 2 by 2026

YEAR	YEAR	DISCOUNT FACTOR	CAPITAL COST				Fishing Industry Annual Benefits	Fishing Industry PV of Benefits	Aquaculture Industry Annual Benefits	Aquaculture Industry PV of Benefits	Biodiversity Sector Annual Benefits	Biodiversity Sector PV of Benefits	Renewable Energy Annual Benefits	Renewable Energy PV of Benefits	Energy Exploration Annual Benefits	Energy Exploration PV of Benefits	Aggregates Sector Annual Benefits	Aggregates Sector PV of Benefits	Research Commissions Annual Benefits	Research Commissions PV of Benefits	Legislative Compliance Annual Benefits	Legislative Compliance PV of Benefits	Total Benefits	PV of Benefits	Net Benefits	Net Present Value	NPV (inc SPPF)
			CAP COST	CAP COST (inc SPPF)	PV of CAP COST	PV of CAP COST (inc SPPF)																					
		4.00%	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	
0	2008	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
1	2009	0.9615	-3,965	-4,956	-3,813	-4,766	7,020	6,750	5,200	5,000	1,000	962	3,600	3,462	0	0	0	750	721	750	721	18,320	17,615	14,355	13,803	12,850	
2	2010	0.9246	-4,124	-5,155	-3,813	-4,766	7,020	6,490	5,200	4,808	1,000	925	3,600	3,328	0	0	0	750	693	750	693	18,320	16,938	14,196	13,125	12,172	
3	2011	0.8890	-4,289	-5,361	-3,813	-4,766	7,020	6,241	5,200	4,623	1,000	889	3,600	3,200	0	0	0	750	667	750	667	18,320	16,286	14,031	12,474	11,520	
4	2012	0.8548	-4,460	-5,575	-3,812	-4,766	7,020	6,001	5,200	4,445	1,000	855	3,600	3,077	0	0	100,000	85,480	750	641	750	641	118,320	101,140	113,860	97,328	96,375
5	2013	0.8219	-4,638	-5,798	-3,812	-4,765	7,020	5,770	5,200	4,274	1,000	822	3,600	2,959	0	0	0	750	616	750	616	18,320	15,058	13,682	11,246	10,293	
6	2014	0.7903	-4,817	-6,021	-3,807	-4,759	7,020	5,548	5,200	4,110	1,000	790	3,600	2,845	0	0	0	750	593	750	593	18,320	14,479	13,503	10,672	9,720	
7	2015	0.7599	-5,010	-6,263	-3,807	-4,759	7,020	5,335	5,200	3,952	1,000	760	3,600	2,736	0	0	0	750	570	750	570	18,320	13,922	13,310	10,115	9,163	
8	2016	0.7307	-5,210	-6,513	-3,807	-4,759	7,020	5,129	5,200	3,800	1,000	731	3,600	2,630	8,000	5,846	0	750	548	750	548	26,320	19,232	21,110	15,425	14,473	
9	2017	0.7026	-5,419	-6,774	-3,807	-4,759	7,020	4,932	5,200	3,653	1,000	703	3,600	2,529	8,000	5,621	0	750	527	750	527	26,320	18,492	20,901	14,685	13,733	
10	2018	0.6756	-5,635	-7,044	-3,807	-4,759	7,020	4,742	5,200	3,513	1,000	676	3,600	2,432	8,000	5,405	0	750	507	750	507	26,320	17,781	20,685	13,974	13,022	
11	2019	0.6496	-5,861	-7,326	-3,807	-4,759	7,020	4,560	5,200	3,378	1,000	650	3,600	2,338	8,000	5,197	0	750	487	750	487	25,820	16,772	19,959	12,965	12,013	
12	2020	0.6246	-6,095	-7,619	-3,807	-4,759	7,020	4,385	5,200	3,248	1,000	625	3,600	2,249	8,000	4,997	0	750	468	750	468	25,820	16,127	19,725	12,320	11,368	
13	2021	0.6006	-6,339	-7,924	-3,807	-4,759	7,020	4,216	5,200	3,123	1,000	601	3,600	2,162	8,000	4,805	0	750	450	750	450	25,820	15,507	19,481	11,700	10,748	
14	2022	0.5775	-6,592	-8,240	-3,807	-4,758	7,020	4,054	5,200	3,003	1,000	577	3,600	2,079	8,000	4,620	0	750	433	750	433	25,820	14,910	19,228	11,104	10,152	
15	2023	0.5553	-6,856	-8,570	-3,807	-4,759	7,020	3,898	5,200	2,887	1,000	555	3,600	1,999	8,000	4,442	0	750	416	750	416	25,820	14,337	18,964	10,530	9,578	
16	2024	0.5339	-7,130	-8,913	-3,807	-4,758	7,020	3,748	0	0	0	0	0	0	8,000	4,271	0	750	400	750	400	16,020	8,553	8,890	4,746	3,795	
17	2025	0.5134	-7,416	-9,270	-3,807	-4,759	7,020	3,604	0	0	0	0	0	0	8,000	4,107	0	750	385	750	385	16,020	8,224	8,604	4,417	3,465	
18	2026	0.4936	0	0	0	0	7,020	3,465	0	0	0	0	0	0	0	0	0	750	370	750	370	8,020	3,959	8,020	3,959	3,959	
19	2027	0.4746	0	0	0	0	7,020	3,332	0	0	0	0	0	0	0	0	0	750	356	750	356	8,020	3,807	8,020	3,807	3,807	
20	2028	0.4564	0	0	0	0	7,020	3,204	0	0	0	0	0	0	0	0	0	750	342	750	342	8,020	3,660	8,020	3,660	3,660	
			-93,856	-117,320	-64,747	-80,933	140,400	95,404	78,000	57,816	15,000	11,118	54,000	40,026	80,000	49,309	100,000	85,480	15,000	10,193	10,000	7,453	492,400	356,799	398,544	292,053	275,866

Appendix 2c
High Impact Scenario

INFOMAR - Ireland's Marine Mapping Project - HIGH IMPACT SCENARIO

OPTION 1: Do Minimum (Cease Project at end of 2008)

YEAR	YEAR	DISCOUNT FACTOR	CAP COST	CAPITAL COST CAP COST (inc SPPF)	PV of CAP COST	PV of CAP COST (inc SPPF)	Fishing Industry Annual Benefits	PV of Benefits	Aquaculture Industry Annual Benefits	PV of Benefits	Biodiversity Sector Annual Benefits	PV of Benefits	Renewable Energy Annual Benefits	PV of Benefits	Energy Exploration Annual Benefits	PV of Benefits	Aggregates Sector Annual Benefits	PV of Benefits	Research Commissions Annual Benefits	PV of Benefits	Legislative Compliance Annual Benefits	PV of Benefits	Total Benefits	PV of Benefits	Net Benefits	Net Present Value	NPV (inc SPPF)
0	2008	4.00%	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k
1	2009	0.9615	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	2010	0.9246	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	2011	0.8890	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	2012	0.8548	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	2013	0.8219	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	2014	0.7903	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	2015	0.7599	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	2016	0.7307	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	2017	0.7026	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	2018	0.6756	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	2019	0.6496	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	2020	0.6246	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	2021	0.6006	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	2022	0.5775	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	2023	0.5553	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	2024	0.5339	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	2025	0.5134	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	2026	0.4936	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	2027	0.4746	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	2028	0.4564	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			0	0	0	0	3,510	3,125	10,298	9,169	1,733	1,543	13,500	10,007	0	0	36,000	34,615	3,750	3,339	3,750	3,042	72,540	64,839	72,540	64,839	64,839

OPTION 2: Complete Bays and Priority Bays Only

YEAR	YEAR	DISCOUNT FACTOR	CAP COST	CAPITAL COST CAP COST (inc SPPF)	PV of CAP COST	PV of CAP COST (inc SPPF)	Fishing Industry Annual Benefits	PV of Benefits	Aquaculture Industry Annual Benefits	PV of Benefits	Biodiversity Sector Annual Benefits	PV of Benefits	Renewable Energy Annual Benefits	PV of Benefits	Energy Exploration Annual Benefits	PV of Benefits	Aggregates Sector Annual Benefits	PV of Benefits	Research Commissions Annual Benefits	PV of Benefits	Legislative Compliance Annual Benefits	PV of Benefits	Total Benefits	PV of Benefits	Net Benefits	Net Present Value	NPV (inc SPPF)
0	2008	4.00%	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k
1	2009	0.9615	-2,931	-3,664	-2,818	-3,523	2,106	2,025	6,240	6,000	1,050	1,010	2,700	2,596	0	0	0	0	1,500	1,442	1,125	1,082	14,721	14,155	11,790	11,337	10,632
2	2010	0.9246	-3,559	-4,449	-3,290	-4,113	2,106	1,947	6,240	5,769	1,050	971	2,700	2,496	0	0	0	0	1,500	1,387	1,125	1,040	14,721	13,610	11,162	10,320	9,497
3	2011	0.8890	-3,957	-4,946	-3,518	-4,397	2,106	1,872	6,240	5,547	1,050	933	2,700	2,400	0	0	0	0	1,500	1,333	1,125	1,000	14,721	13,087	10,764	9,569	8,690
4	2012	0.8548	-4,233	-5,291	-3,618	-4,523	2,106	1,800	6,240	5,334	1,050	898	2,700	2,308	0	0	0	0	1,500	1,282	1,125	962	14,721	12,584	10,488	8,965	8,061
5	2013	0.8219	-4,639	-5,799	-3,813	-4,766	2,106	1,731	6,240	5,129	1,050	863	2,700	2,219	0	0	0	0	1,500	1,233	1,125	925	14,721	11,731	10,082	8,618	7,665
6	2014	0.7903	-4,467	-5,584	-3,530	-4,413	2,106	1,664	6,240	4,932	1,050	830	2,700	2,134	0	0	0	0	1,500	1,185	1,125	889	14,721	11,034	9,254	8,104	7,221
7	2015	0.7599	-3,771	-4,714	-2,866	-3,582	2,106	1,600	6,240	4,742	1,050	798	2,700	2,052	0	0	0	0	1,500	1,140	1,125	855	14,721	11,187	10,950	8,321	7,605
8	2016	0.7307	0	0	0	0	2,106	1,539	6,240	4,560	1,050	767	2,700	1,973	0	0	0	0	1,500	1,096	1,125	822	14,721	10,756	10,756	10,756	10,756
9	2017	0.7026	0	0	0	0	2,106	1,480	6,240	4,384	1,050	738	2,700	1,897	0	0	0	0	1,500	1,054	1,125	790	14,721	10,343	10,343	10,343	10,343
10	2018	0.6756	0	0	0	0	2,106	1,423	6,240	4,216	1,050	709	2,700	1,824	0	0	0	0	1,500	1,013	1,125	760	14,721	9,945	10,756	9,945	9,945
11	2019	0.6496	0	0	0	0	2,106	1,368	6,240	4,053	1,050	682	2,700	1,754	0	0	0	0	1,500	972	1,125	730	14,721	9,549	10,756	9,549	9,549
12	2020	0.6246	0	0	0	0	2,106	1,315	6,240	3,897	1,050	656	2,700	1,686	0	0	0	0	1,500	932	1,125	700	14,721	9,156	10,756	9,156	9,156
13	2021	0.6006	0	0	0	0	2,106	1,265	6,240	3,748	1,050	631	2,700	1,622	0	0	0	0	1,500	893	1,125	670	14,721	8,772	10,756	8,772	8,772
14	2022	0.5775	0	0	0	0	2,106	1,218	6,240	3,603	1,050	606	2,700	1,559	0	0	0	0	1,500	855	1,125	640	14,721	8,397	10,756	8,397	8,397
15	2023	0.5553	0	0	0	0	2,106	1,169	6,240	3,465	1,050	583	2,700	1,499	0	0	0	0	1,500	818	1,125	610	14,721	8,030	10,756	8,030	8,030
16	2024	0.5339	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	2025	0.5134	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	2026	0.4936	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	2027	0.4746	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	2028	0.4564	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			-27,557	-34,446	-23,454	-29,317	31,590	23,415	93,600	69,379	15,750	11,674	40,500	30,020	0	0	120,000	98,631	15,000	12,166	11,250	9,125	327,690	254,410	300,133	230,957	225,093

OPTION 3: Complete Zones 1 and 2 by 2016

YEAR	YEAR	DISCOUNT FACTOR	CAPITAL COST				Fishing Industry		Aquaculture Industry		Biodiversity Sector		Renewable Energy		Energy Exploration		Aggregates Sector		Research Commissions		Legislative Compliance		Total Benefits	PV of Benefits	Net Benefits	Net Present Value	NPV (inc SPPF)
			CAP COST	CAP COST (inc SPPF)	PV of CAP COST	PV of CAP COST (inc SPPF)	Annual Benefits	PV of Benefits	Annual Benefits	PV of Benefits	Annual Benefits	PV of Benefits	Annual Benefits	PV of Benefits	Annual Benefits	PV of Benefits	Annual Benefits	PV of Benefits	Annual Benefits	PV of Benefits	Annual Benefits	PV of Benefits					
		4.00%	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	
0	2008	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
1	2009	0.9615	-6,708	-8,385	-6,450	-8,063	21,060	20,250	7,800	7,500	1,500	1,442	5,400	5,192	12,000	11,538	0	0	3,000	2,885	1,500	1,442	52,260	50,250	45,552	43,800	42,188
2	2010	0.9246	-9,266	-11,583	-8,567	-10,709	21,060	19,471	7,800	7,212	1,500	1,387	5,400	4,993	12,000	11,095	0	0	3,000	2,774	1,500	1,387	52,260	48,317	42,994	39,750	37,609
3	2011	0.8890	-10,818	-13,523	-9,617	-12,021	21,060	18,722	7,800	6,934	1,500	1,333	5,400	4,801	12,000	10,668	0	0	3,000	2,667	1,500	1,333	52,260	46,459	41,442	36,842	34,437
4	2012	0.8548	-11,368	-14,210	-9,717	-12,147	21,060	18,002	7,800	6,667	1,500	1,282	5,400	4,616	12,000	10,258	150,000	128,221	3,000	2,564	1,500	1,282	202,260	172,893	190,892	163,175	160,746
5	2013	0.8219	-12,060	-15,075	-9,912	-12,391	21,060	17,310	7,800	6,411	1,500	1,233	5,400	4,438	12,000	9,863	0	0	3,000	2,466	1,500	1,233	52,260	42,954	40,200	33,041	30,563
6	2014	0.7903	-11,144	-13,930	-8,807	-11,009	21,060	16,644	7,800	6,164	1,500	1,185	5,400	4,268	12,000	9,494	0	0	3,000	2,371	1,500	1,185	52,260	41,302	41,116	32,495	30,293
7	2015	0.7599	-8,550	-10,688	-6,497	-8,122	21,060	16,004	7,800	5,927	1,500	1,140	5,400	4,104	12,000	9,119	0	0	3,000	2,280	1,500	1,140	52,260	39,713	43,710	33,216	31,592
8	2016	0.7307	0	0	0	0	21,060	15,388	7,800	5,699	1,500	1,096	5,400	3,946	12,000	8,768	0	0	3,000	2,192	1,500	1,096	52,260	38,186	52,260	38,186	38,186
9	2017	0.7026	0	0	0	0	21,060	14,796	7,800	5,480	1,500	1,054	5,400	3,794	12,000	8,431	0	0	3,000	2,108	1,500	1,054	52,260	36,717	52,260	36,717	36,717
10	2018	0.6756	0	0	0	0	21,060	14,227	7,800	5,269	1,500	1,013	5,400	3,648	12,000	8,107	0	0	3,000	2,027	1,500	1,013	52,260	35,305	52,260	35,305	35,305
11	2019	0.6496	0	0	0	0	21,060	13,680	7,800	5,067	1,500	974	5,400	3,508	0	0	0	0	0	0	0	0	35,760	23,229	35,760	23,229	23,229
12	2020	0.6246	0	0	0	0	21,060	13,154	7,800	4,872	1,500	937	5,400	3,373	0	0	0	0	0	0	0	0	35,760	22,336	35,760	22,336	22,336
13	2021	0.6006	0	0	0	0	21,060	12,648	7,800	4,684	1,500	901	5,400	3,243	0	0	0	0	0	0	0	0	35,760	21,477	35,760	21,477	21,477
14	2022	0.5775	0	0	0	0	21,060	12,162	7,800	4,504	1,500	866	5,400	3,118	0	0	0	0	0	0	0	0	35,760	20,651	35,760	20,651	20,651
15	2023	0.5553	0	0	0	0	21,060	11,694	7,800	4,331	1,500	833	5,400	2,998	0	0	0	0	0	0	0	0	35,760	19,856	35,760	19,856	19,856
16	2024	0.5339	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	2025	0.5134	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	2026	0.4936	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	2027	0.4746	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	2028	0.4564	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			-69,914	-87,393	-59,569	-74,461	315,900	234,153	117,000	86,723	22,500	16,678	81,000	60,039	120,000	97,331	150,000	128,221	30,000	24,333	15,000	12,166	851,400	659,644	781,486	600,075	585,183

OPTION 4: Complete Zones 1 and 2 by 2026

YEAR	YEAR	DISCOUNT FACTOR	CAPITAL COST				Fishing Industry		Aquaculture Industry		Biodiversity Sector		Renewable Energy		Energy Exploration		Aggregates Sector		Research Commissions		Legislative Compliance		Total Benefits	PV of Benefits	Net Benefits	Net Present Value	NPV (inc SPPF)
			CAP COST	CAP COST (inc SPPF)	PV of CAP COST	PV of CAP COST (inc SPPF)	Annual Benefits	PV of Benefits	Annual Benefits	PV of Benefits	Annual Benefits	PV of Benefits	Annual Benefits	PV of Benefits	Annual Benefits	PV of Benefits	Annual Benefits	PV of Benefits	Annual Benefits	PV of Benefits	Annual Benefits	PV of Benefits					
		4.00%	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	€k	
0	2008	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
1	2009	0.9615	-3,965	-4,956	-3,813	-4,766	10,530	10,125	7,800	7,500	1,500	1,442	5,400	5,192	0	0	0	0	1,125	1,082	1,125	1,082	27,480	26,423	23,515	22,611	21,657
2	2010	0.9246	-4,124	-5,155	-3,813	-4,766	10,530	9,736	7,800	7,212	1,500	1,387	5,400	4,993	0	0	0	0	1,125	1,040	1,125	1,040	27,480	25,407	23,356	21,594	20,641
3	2011	0.8890	-4,289	-5,361	-3,813	-4,766	10,530	9,361	7,800	6,934	1,500	1,333	5,400	4,801	0	0	0	0	1,125	1,000	1,125	1,000	27,480	24,430	23,191	20,617	19,663
4	2012	0.8548	-4,460	-5,575	-3,812	-4,766	10,530	9,001	7,800	6,667	1,500	1,282	5,400	4,616	0	0	150,000	128,221	1,125	962	1,125	962	177,480	151,711	173,020	147,898	146,945
5	2013	0.8219	-4,638	-5,798	-3,812	-4,765	10,530	8,655	7,800	6,411	1,500	1,233	5,400	4,438	0	0	0	0	1,125	925	1,125	925	27,480	22,587	22,842	18,774	18,221
6	2014	0.7903	-4,817	-6,021	-3,807	-4,759	10,530	8,322	7,800	6,164	1,500	1,185	5,400	4,268	0	0	0	0	1,125	889	1,125	889	27,480	21,718	22,663	17,911	16,959
7	2015	0.7599	-5,010	-6,263	-3,807	-4,759	10,530	8,002	7,800	5,927	1,500	1,140	5,400	4,104	0	0	0	0	1,125	855	1,125	855	27,480	20,883	22,470	17,075	16,124
8	2016	0.7307	-5,210	-6,513	-3,807	-4,759	10,530	7,694	7,800	5,699	1,500	1,096	5,400	3,946	0	0	12,000	8,768	1,125	822	1,125	822	39,480	28,848	34,270	25,041	24,069
9	2017	0.7026	-5,419	-6,774	-3,807	-4,759	10,530	7,398	7,800	5,480	1,500	1,054	5,400	3,794	12,000	8,431	0	0	1,125	790	1,125	790	39,480	27,738	34,061	23,931	22,979
10	2018	0.6756	-5,635	-7,044	-3,807	-4,759	10,530	7,114	7,800	5,269	1,500	1,013	5,400	3,648	12,000	8,107	0	0	1,125	760	1,125	760	39,480	26,671	33,845	22,864	21,913
11	2019	0.6496	-5,861	-7,326	-3,807	-4,759	10,530	6,840	7,800	5,067	1,500	974	5,400	3,508	12,000	7,795	0	0	1,125	731	1,125	731	39,480	25,558	32,869	21,351	20,399
12	2020	0.6246	-6,095	-7,619	-3,807	-4,759	10,530	6,577	7,800	4,872	1,500	937	5,400	3,373	12,000	7,495	0	0	1,125	703	1,125	703	38,730	24,491	32,635	20,384	19,432
13	2021	0.6006	-6,339	-7,924	-3,807	-4,759	10,530	6,324	7,800	4,684	1,500	901	5,400	3,243	12,000	7,207	0	0	1,125	676	1,125	676	38,730	23,260	32,391	19,453	18,501
14	2022	0.5775	-6,592	-8,240	-3,807	-4,758	10,530	6,081	7,800	4,504	1,500	866	5,400	3,118	12,000	6,930	0	0	1,125	650	1,125	650	38,730	22,366	32,138	18,559	17,607
15	2023	0.5553	-6,856	-8,570	-3,807	-4,759	10,530	5,847	7,800	4,331	1,500	833	5,400	2,998	12,000	6,663	0	0	1,125	625	1,125	625	38,730	21,505	31,874	17,699	16,747
16	2024	0.5339	-7,130	-8,913	-3,807	-4,758	10,530	5,622	0	0	0	0	0														