How to Evaluate Environmental Impact Assessments for Oil and Gas Projects

ELAW

Environmental Law Alliance Worldwide

How to Evaluate Environmental Impact Assessments for Oil and Gas Projects
Environmental Law Alliance Worldwide (ELAW)

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HOW TO EVALUATE ENVIRONMENTAL IMPACT ASSESSMENTS FOR OIL AND GAS PROJECTS

Introduction

This guidebook aims to provide public interest environmental advocates and the communities they represent with sufficient understanding to challenge oil and gas projects that are unacceptable from an environmental or social perspective.

This guidebook builds on several other resources available for evaluating EIAs for oil and gas projects.[1] However, these other resources are either out-of-date or limited in scope, omitting discussion of critical issues, such as the climate impacts of oil and gas projects, especially within the evolving framework of international commitments to limit global warming.

This guidebook aims to be comprehensive in scope. Oil and gas projects can be categorized by stage of development — exploration versus production phase; and by location — onshore versus offshore. Different categories of oil and gas projects have distinct environmental and social aspects that warrant separate discussions. This guidebook aims to encompass all four major upstream[2] categories of oil and gas projects: 1) onshore oil and gas exploration projects; 2) offshore oil and gas exploration projects; 3) onshore oil and gas production projects; and 4) offshore oil and gas production projects.

This guidebook is organized in the following manner:

- **Chapter 1** provides a discussion of the EIA process, describing its intended purpose and key stages;

- **Chapter 2** identifies and discusses the potential environmental and social impacts of the four categories of oil and gas projects, illustrating technical details that are essential to understanding the impacts that oil and gas projects can cause; and

- **Chapter 3** provides a guide to reviewing the adequacy of EIAs for oil and gas projects by focusing on expected data and analyses found in the following sections of EIAs: the project description, the environmental and social baseline, assessment of impacts, proposed mitigation measures, and proposed financial assurances.

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[1] Lu, M., & López Wong, C. (2015). *Guía práctica para la revisión técnica de estudios de impacto ambiental de proyectos de exploración y explotación de hidrocarburos en la Amazonía*. https://repositorio.dar.org.pe/bitstream/handle/20.500.13095/80/Lu-Lopez_Hidrocarburos.pdf

[2] This guidebook does not cover downstream oil and gas projects, such as oil and gas transportation pipelines, LNG terminals, or petroleum refineries.

1. An Overview of the EIA Process

1.1. What is the Purpose of the EIA process?

The environmental impact assessment (EIA) process is an interdisciplinary and multi-step procedure to ensure that decision-makers and the public are informed about the potential consequences of proposed projects. EIA,[3] as the name implies, examines the potential environmental impacts of a proposed activity and how those impacts may be avoided or reduced. As the process has evolved over several decades, EIAs now frequently examine various impacts, including social, cultural, health, human rights, economic, and gender. For ease of reference, this guide uses "socio-environmental impacts" to refer to the varying scope of issues addressed in EIAs worldwide.

EIA is most effective at an early stage of planning and before commitments are made to the location or design of a project. However, EIA is not limited to new projects. If the implementation of a permitted oil and gas field development is delayed, and environmental, social, or economic conditions have changed, it may be possible to seek a supplemented or revised EIA. Similarly, EIA plays a vital role in decisions to expand projects or extend their lifespan.

The EIA document is a technical tool that identifies, predicts, and analyzes impacts against baseline conditions. If the EIA process is successful, it identifies alternatives and mitigation measures to reduce the adverse effects of a proposed project. The EIA process also serves an essential procedural role in the overall decision-making by promoting transparency and public involvement.

An EIA is now part of domestic legislation in almost every country worldwide and is considered an essential environmental governance tool.[4] Courts and other tribunals are holding governments accountable for implementing EIA and public participation rigorously, observing that the process upholds important principles of prevention and precaution, helps protect the right to a healthy environment for current and future generations, and ensures compliance with international climate commitments.[5]

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[3] The term "EIA" encompasses other terms used in countries with an EIA process, including: 1) Environmental and Social Impact Assessment (ESIA); 2) Environmental Impact Statement (EIS); 3) Environmental Impact Report (EIR); 4) Étude d'Impact Environnemental et Social (EIES) and 5) Evaluación de Impacto Ambiental (EIA).

[4] Environmental Law Alliance Worldwide (ELAW) maintains a comparative law database of environmental impact assessment laws from more than 40 countries around the world. EIA Law Matrix: elaw.org/elm

[5] Earthlife Africa Johannesburg v. Minister of Environmental Affairs and others, Case No. 65662/16 (2017); Yang, T. (February 2019). "The Emergence of the Environmental Impact Assessment Duty as a Global Legal Norm and General Principle of Law," *Hastings Law J. 70:525*, 545 (available at https://www.hastingslawjournal.org/wp-content/uploads/70.2-Yang.pdf).

1.2. Who Prepares an EIA?

Depending on the EIA system, responsibility for producing an EIA will be assigned to one of two parties: 1) a government agency or ministry; or 2) the project proponent. It is not uncommon for parties to use consultants to prepare the EIA or handle specific portions of the EIA process, such as public participation or technical studies.

When a project proponent hires a consultant to prepare an EIA, there is a significant risk of conflicts of interest. A consultant may exhibit bias in favor of proceeding with a project if the consultant believes it will receive additional work once the project is approved or has other financial interests.

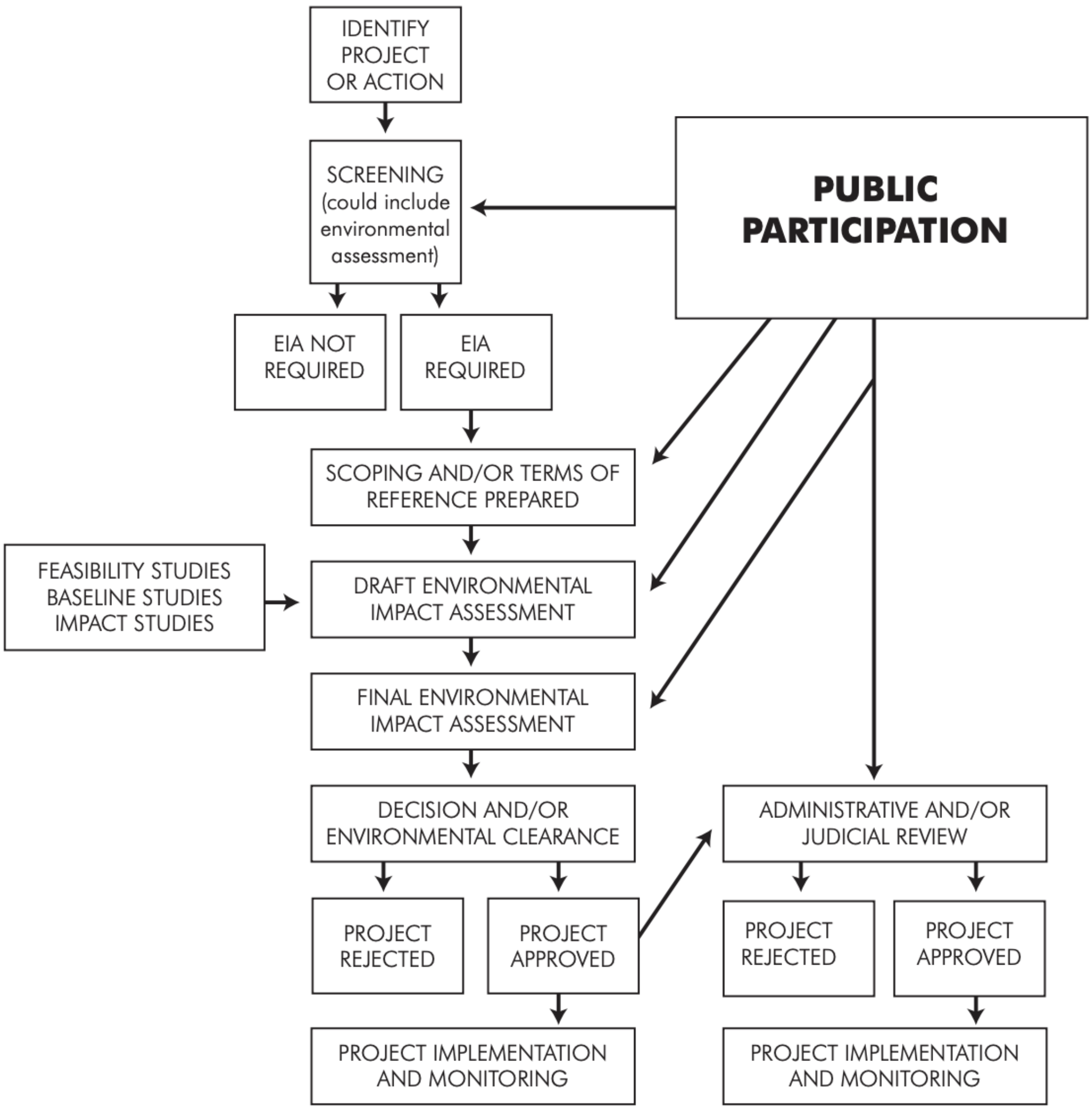
In recognition of this inherent conflict, some countries include provisions in their EIA laws to reduce the potential for bias. For example, a consultant may be required to file a statement disclosing any financial or other interest in the project's outcome. Some jurisdictions allow regulators to disqualify or withdraw accreditation of consultants who fail to provide objective and independent information and conclusions in EIAs.

Sometimes, consultants provide poor quality EIAs or even "cut and paste" information from previously published impact assessments that is not applicable or accurate. Some countries require consultants to be registered with the government and/or professionally accredited in EIA preparation. Regulators may even require advance approval of specific consultants responsible for preparing an EIA to ensure their qualifications are appropriate. EIA laws can impose additional accountability by holding consultants liable for civil or criminal penalties if the information presented in an EIA proves inaccurate, misleading, or false.

1.3. Stages of the EIA Process

While the EIA process is not uniform from country to country, it generally consists of a set of procedural steps culminating in a written impact assessment report that informs the decision-maker and the public of a proposed project's potential consequences.

THE FLOWCHART BELOW DEPICTS THE BASIC ELEMENTS OF GOOD EIA PRACTICE:



Identifying and Defining the Project or Activity: Although this step may seem relatively straightforward, defining a "project" for an EIA can become complex and even controversial if an oil and gas project is large, has several phases, or involves multiple sites. This step aims to define the project with enough specificity to determine the zone of possible impacts accurately and to include activities closely connected with the proposal so that the entire scope of socio-environmental impacts is evaluated.

Screening: The screening process determines whether a particular project warrants the preparation of an EIA. The threshold requirements for an EIA vary from country to country. Some laws list the types of activities or projects that will require an EIA; others require an EIA for any project that may significantly impact the environment or for projects that exceed a certain monetary value. In some cases, particularly if a project's possible impacts are unknown, a preliminary environmental analysis will be prepared to determine whether the project warrants an EIA.

Scoping: Scoping is a stage, usually involving the public and other interested parties, that identifies the key issues that should be addressed in an EIA. This step provides one of the first opportunities for members of the public or NGOs to learn about a proposed project and to voice their opinions. Scoping may also reveal similar or connected activities occurring near a project or identify problems that need to be mitigated, or that may cause the project to be canceled.

Preparing Terms of Reference: The Terms of Reference serve as a roadmap for EIA preparation and should ideally encompass the issues and impacts identified during the scoping process.

A draft of the Terms of Reference may be made available for public review and comment. It may be presented as a Tracking Table where requests and comments can be posted. The public and parties that must be consulted must provide their input within a given timeframe (e.g., two weeks to one month). Therefore, it is crucial to pay attention to public consultation postings to meet deadlines and to optimize the time for review, including from internal or external technical experts. Public review at this early stage of the process provides a pivotal opportunity to ensure that the EIA is appropriately framed and will address issues of community concern.

Preparing Draft EIA: A draft EIA is prepared in accordance with the Terms of Reference and/or the range of issues identified during the scoping process. The draft EIA must also meet the content requirements of the overarching EIA law or regulations. As a best practice, cumulative impacts should also be considered. This step should involve technical specialists to evaluate baseline conditions, predict the project's likely impacts, and design mitigation and monitoring plans.

Public Participation: Best EIA practice involves and engages the public at numerous points throughout the process with a two-way exchange of information and views. Public participation may include informational meetings, public hearings, and opportunities to comment on a proposed project. However, there are no consistent rules for public participation among current EIA systems. Even within a particular country, there can be variations in the quality and extent of public involvement in the EIA process, depending on the type of project being considered, the communities that may be affected, the willingness of the proponent to engage with the communities, and/or funds provided to support the process or government agencies that are overseeing the project.

Practitioners should pay close attention to the public participation process to ensure that it is not treated as an empty formality to be checked off by decision-makers and the project proponent. The process must be tailored to the local context, accommodating each community's cultural and linguistic customs for learning and engagement, and including mechanisms to respect and incorporate traditional and local knowledge.

Preparing Final EIA: This step produces a final impact assessment report that addresses the viewpoints and comments of the parties that reviewed the draft EIA. These comments may prompt revisions or additions to the draft EIA's text. In some cases, the final EIA will contain an appendix summarizing all comments received from the public and other interested parties and providing responses to those comments.

Decision: A decision to approve or reject an oil and gas project is generally based on the final EIA, but in some instances, an environmental clearance may be just one step in the overall permitting process. The decision may be accompanied by certain conditions that must be fulfilled, such as posting financial assurances for environmental cleanup or filing an environmental management plan.

Administrative or Judicial Review: Depending on the jurisdiction, there may be opportunities for a party to seek administrative and/or judicial review of the final decision and the EIA process. An appeal may address procedural flaws in the EIA process, such as a failure to hold any required public hearings, or may point to substantive issues that the decision-maker failed to consider. A country's judicial review or Administrative Procedure Act, or sometimes the EIA law itself, will usually identify the issues that can be raised in an appeal and the type of relief that may be granted.

Project Implementation: Provided all regulatory requirements are met and permits are obtained, oil and gas field development will proceed following the project decision and once administrative and/or judicial review opportunities are exhausted.

Monitoring: Monitoring is an integral part of project implementation. Monitoring serves three purposes: 1) ensuring that safeguards and permitting conditions are being implemented, 2) evaluating whether mitigation measures are working effectively, and 3) validating the accuracy of models or projections that were used during the impact assessment process. Monitoring may provide the opportunity to question the adequacy of the bonds/securities posted for financial assurances and request adjustments (e.g., to consider the cost of an unplanned water treatment system, including long-term operation and monitoring).

There is growing recognition of the benefits of community-based monitoring as a formal or informal supplement to regulatory oversight. In the Philippines, for example, a multipartite monitoring team (MMT) is formed immediately following the issuance of environmental clearance. The MMT is responsible for monitoring compliance with environmental clearance conditions and includes representatives of local government, NGOs, communities, and other government agencies with related mandates on the type of project. Although the project proponent funds the MMT's auditing activities, the team is independent and does not include any participants representing the proponent or environmental regulator.[6]

1.4. The EIA document

The format of the EIA itself is usually specified by regulation or other guidance. The sections outlined below are typical of many EIAs, but not all EIAs will include all components and additional sections may be required.

For a detailed analysis of each section, see Chapter 3.

[6] Philippines, DAO 2003-30, Sec. 9; DAO 2017-15, Art. IV.

Environmental Impact Statement

Executive Summary: A brief description in non-technical language of the project and its impacts.

Project Purpose / Statement of Needs: Describes the reason that the project is being pursued, and what the expected outcome will be.

Proposed Project Description: A detailed description of the project, including location, technical processes, inputs and outputs, details of construction and operation, etc. This section should also discuss available mitigation options.

Assessment of Alternatives: Describes a reasonable range of alternatives that could feasibly accomplish the same purpose and meet the need of the proposed action. In some cases, the alternatives are discussed along with the proposed project as a range of possible scenarios. The "no action" alternative, in which the project is not approved and no other action is taken, should be included and assessed.

Environmental Baseline: A detailed description of the area that may be affected by the project or its alternatives, its ecology, its current status, vulnerable species or populations, etc.

Environmental Impacts: A discussion of the anticipated environmental effects under different scenarios, both for the proposed action and its alternatives, as well as the significance of these impacts.

Environmental Management and Monitoring: Describes in detail the specific technical and administrative ways in which the environmental protection, mitigation, and monitoring practices will be put into action and assessed.

Consultation: Documents the consultations with government, the public, and other stakeholders that have occurred during the preparation of the EIA. Projects proposed by government agencies will often be held to stringent standards for public participation and public comment.

List of preparers: The identities and technical qualifications of the people who prepared the EIA. (Some EIA processes require that EIA preparers must be licensed or meet other specific standards.)

Appendices: Background and technical documentation supporting the text of the EIA (e.g., background data, model outputs, etc).

2. Oil and Gas Projects and Their Impacts

2.1. Impacts of Exploration

Oil and gas are fossil fuels that formed over millions of years from the decay of dead vegetation that once grew on the surface of the Earth. Now buried deep below the land or seabeds, oil and gas companies first use various tools to identify subsurface locations where commercially valuable deposits of oil and gas may exist. These oil and gas exploration projects are often assessed in separate EIAs because there is no guarantee that commercially valuable deposits will be found, justifying subsequent oil and gas production.

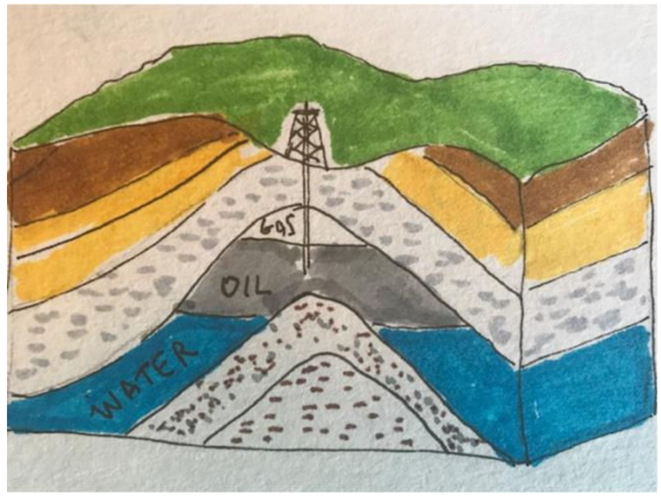


Photo 1 Drawing by Dr. Meche Lu, ELAW Scientist.

Onshore and offshore oil and gas exploration projects have distinct sets of potential socio-environmental impacts, discussed separately below.

2.1.1. Onshore Exploration

Photo 2 Mobile unit set up to drill the pilot exploratory hole for fossil fuel. Jens Lambert/ Shutterstock.com

The search for onshore oil and gas begins with desk studies (such as analysis of satellite images or review of existing data about the geological and geomorphological characteristics of the area) followed by two types of field testing: ***seismic surveys*** and ***exploratory drilling***.

Field testing for onshore deposits almost always requires ***base camps***, especially for projects in tropical forests. Oil companies must bring in many workers and large equipment. Depending on the location of the oil and gas deposit, companies will transport workers either by ground, river, or helicopter. Base camps include a kitchen, laundry, primary health care service, and workshops for repairing and maintaining equipment, machines, and helipads. Base camps are sources of non-hazardous and hazardous wastes. Inadequate management and treatment of base camp garbage and sewage is a frequent problem, especially in tropical ecosystems.[7] Other common problems include hunting and poaching by workers, alcoholism, prostitution, and conflicts with local communities. In areas where local people depend on wildlife species for subsistence, the presence of workers and their transportation by land, air, or water are related to a sharp decline in wildlife availability for local people's subsistence.[8] A review of the implications of global oil exploration for the conservation of terrestrial wildlife was published in 2023.[9]

Photo 3 Base camp for oil and gas. Raja Shoiab Turk on Shutterstock.com

2.1.1.1. Onshore seismic surveys

Onshore seismic exploration uses sound energy to locate potential terrestrial deposits of petroleum and natural gas. According to the U.S. Department of Transportation:

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[7] Government of Saskatchewan (October 2012). "Sewage Handling Practices at Work Camps and Temporary Work Sites." https://pubsaskdev.blob.core.windows.net/pubsask-prod/108422/108422-Sewage_Handling_Practices_at_Work_Camps_and_Temporary_Work_Sites_rvsd_Mar_16.pdf

[8] Suarez, E., & Zapata-Ríos, G. (2019). "Managing subsistence hunting in the changing landscape of Neotropical rain forests." *Biotropica*, *51(3)*, 282–287. https://doi.org/10.1111/btp.12662; Cannon, J. (2019). "Altered forests threaten sustainability of subsistence hunting." *Mongabay Environmental News*. https://news.mongabay.com/2019/05/altered-forests-threaten-sustainability-of-subsistence-hunting/

[9] Mudumba et al. (2023). "The implications of global oil exploration for the conservation of terrestrial wildlife." *Environmental Challenges, 11*:100710. https://doi.org/10.1016/j.envc.2023.100710

“In onshore seismic exploration, seismic waves may be produced by dynamite detonated several feet below the ground surface. However, due to environmental concerns and improved technology, seismic crews increasingly use non-explosive seismic technology. ***This usually consists of large, heavy, wheeled or tracked vehicles carrying special equipment designed to create a large impact or series of vibrations***. These impacts or vibrations create seismic waves similar to those created by dynamite. In the seismic truck shown, called a buggy-mounted drill, the large piston in the middle is used to create vibrations on the surface of the earth, sending seismic waves deep below ground. Sensitive instruments called geophones are used at the surface to record reflected waves and transmit the data to seismic trucks for later analysis.”[10]

Photo 4 Buggy mounted drill. Photo: Duchesne Ranger District.

Seismic surveys in forested areas require logging of trees and clearing vegetation to create linear corridors or paths, called *seismic lines*, that allow seismic equipment to access the area. Seismic lines are comparable to trails and small roads. Seismic lines are generally five meters wide and several kilometers long. The typical density of seismic lines is 1700 meters of line per square kilometer of surface area.[11] These seismic lines remain
deforested for several years after seismic prospecting, as they can take up to 35 years to recover.[12]

The practices and machinery used to create seismic lines, along with the time of the year when they are cleared and the type of habitat they disturb, all contribute to a complex network of environmental changes. These changes affect various factors, such as microclimate, hydrology, and biogeochemistry. The initial damage to the ground surface and vegetation removal can have long-lasting effects on the environment, altering overall ecosystem functioning and hindering recovery.[13]

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[10] http://primis.phmsa.dot.gov/comm/Technologies.htm

[11] Fiori, S.M. et al. (2003). “Potential impacts of petroleum exploration and exploitation on biodiversity in a Patagonian Nature Reserve, Argentina.” *Biodiversity and Conservation*, *12*, 1261-1270

[12] Lee, P. & Boutin, S (2006). “Persistence and developmental transition of wide seismic lines in the western Boreal Plains of Canada.” *J. Environ Management*, *78(3)*, 240-50

[13] Dabros et al. (2018). “Seismic lines in the boreal and arctic ecosystems of North America: environmental impacts, challenges, and opportunities.” *Environmental Reviews*, *26(2)*, 214-229. https://doi.org/10.1139/er-2017-0080

Clearing seismic lines, which involves removing vegetation and flattening the terrain, can profoundly impact ecosystems. Scientists have documented how seismic lines alter soil's physical and chemical properties in boreal forests and peatlands. Seismic lines can alter hydrological pathways, affect biogeochemical processes, and disturb the microtopography of the area. Seismic line disturbances in these ecosystems have increased bulk density and volumetric and reduced organic matter content of the soil, which implies changes to carbon cycling, increased mineralization rates, and carbon loss from the system.

Land use change and fragmentation are major drivers of biodiversity change.[14] A study in the Auca Mahuida Nature Reserve in the Argentinean Patagonia found that seismic lines impact all levels of ecological organization. The study found that, similar to trails and small roads, seismic lines cause many well-known ecological effects, such as fragmenting forest-dependent populations, favoring invasive species, increasing the success of generalist predators, facilitating poaching activities, and interfering with ecological processes.[15] Research in Canada and the northern United States has shown the extent to which seismic lines impact mammal populations.[16] Research in Africa has demonstrated the impact of intense human-generated noise during seismic oil exploration on the distribution of large mammals. It has also been studied at Loango National Park in Gabon, documenting temporary habitat loss for threatened species with large habitat ranges.[17]

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[14] IPBES (2018). *The IPBES assessment report on land degradation and restoration*. In: Montanarella L., Scholes R., and Brainich A. (eds.). Secretariat of the intergovernmental science-policy platform on biodiversity and ecosystem services, Bonn, Germany. 10.5281/zenodo.3237392.

[15] Fiori, S.M. et al. (2003). "Potential impacts of petroleum exploration and exploitation on biodiversity in a Patagonian Nature Reserve, Argentina." *Biodiversity and Conservation, 12*, 1261-1270.

[16] Pattison, C. A. et al. (2020). "Seismic linear clearings alter mammal abundance and community composition in boreal forests." *Forest Ecology and Management, 462*: 117936. https://doi.org/10.1016/j.foreco.2020.117936

[17] Rabanal et al. (2010). "Oil prospecting and its impact on large rainforest mammals in Loango National Park, Gabon." *Biological Conservation, 143(4)*, 1017-1024.

2.1.1.2. Onshore drilling

Photo 5 Oil well and production. Liteheavy on Shutterstock.com

Onshore drilling is the second phase in the search for oil and gas. Onshore drilling typically includes the following steps:

Site selection: Oil and gas companies will evaluate potential sites for exploratory drilling based on geological surveys and other data that indicate the presence of hydrocarbon deposits.

Drilling: Once a site has been selected, drilling operations can begin. A drilling rig is set up on the site and a borehole is drilled into the ground using a drill bit attached to a string of drill pipe. The drilling process can take several weeks or months and may involve multiple boreholes at different depths.

Core sampling: As the borehole is drilled, core samples are taken periodically to evaluate the rock and sediment layers and to determine whether there are any signs of hydrocarbon deposits. These samples are analyzed in a laboratory to determine the rock's chemical and physical properties and identify potential oil and gas reservoirs.

Testing: Once a potential hydrocarbon deposit has been identified, additional testing may be conducted to evaluate the size, quality, and productivity of the deposit. This may involve hydraulic fracturing (fracking) or other techniques to stimulate the flow of oil and gas from the reservoir.

Production: If the exploratory drilling is successful and a viable deposit is identified, the site may be developed for oil and gas production. However, the well is abandoned if the exploratory drilling fails to find a viable deposit.

Onshore drilling can cause the following kinds of environmental impacts:

Contamination caused by the disposal of drill cuttings and drilling muds: Drilling muds are used to lubricate the drill bit, remove drill cuttings, and maintain the pressure in the wellbore during drilling operations. The composition of drilling muds varies depending on the drilling type, but they generally contain chemicals, heavy metals, and other pollutants. Cuttings, on the other hand, are rock fragments that are excavated during drilling operations. They can contain naturally occurring radioactive materials (NORMs)[18] and other pollutants harmful to aquatic life.[19]

Impacts of water use: Water is required for drilling and can be sourced from surface water (lake or river intake), groundwater (wells), or water stored in impoundments (large dugouts). Depending on the number of wells included in the exploration program and whether hydraulic fracturing is completed, large volumes of water may be required, resulting in the depletion and/or contamination of local water resources.[20]

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[18] Badertscher, L. M. (2023). "Elevated sediment radionuclide concentrations downstream of facilities treating leachate from landfills accepting oil and gas waste." *Ecological Indicators*, *154*, 110616. https://doi.org/10.1016/j.ecolind.2023.110616

[19] Bashir, I. et al. (2020). "Concerns and Threats of Contamination on Aquatic Ecosystems." *Bioremediation and Biotechnology*, 1–26. https://doi.org/10.1007/978-3-030-35691-0_1

[20] Hitaj, C., Boslett, A. J., & Weber, J. G. (2020). "Fracking, farming, and water." *Energy Policy*, *146*, 111799. https://doi.org/10.1016/j.enpol.2020.111799

2.1.2. Offshore exploration

Photo 6 Oil platform during sunset. Dabarti CGI on Shutterstock.com

Similar to onshore oil and gas exploration projects, offshore oil exploration involves two general kinds of field surveys: ***seismic surveys*** and ***exploratory drilling***.

2.1.2.1. Offshore seismic exploration

Offshore exploration for oil and gas deposits is a complex and expensive process involving various methods and technologies. One commonly used method is vessel-mounted air guns to generate seismic waves that help identify potential oil and gas deposits beneath the ocean floor. The process of offshore exploration for oil and gas deposits involves the following steps:

Survey planning: Before the exploration process can begin, a detailed area survey is conducted to identify the most promising locations for oil and gas deposits. This survey may involve using satellite imagery, geologic maps, and other data to identify potential sources of hydrocarbons.

Deployment of the seismic equipment: Once the survey has been completed, a vessel equipped with air guns, hydrophones, and other equipment is deployed to the survey area. The air guns are typically mounted on the back of the vessel, and the hydrophones are placed on the ocean floor.

Air gun firing: The air guns are activated, sending powerful shockwaves through the water and into the ocean floor. These shockwaves travel through the Earth's crust and are reflected to the hydrophones by the rock layers beneath the ocean floor.

Photo 7 Silhouettes of persons recovering source (gun) array on seismic survey vessel. Sources are used to produce underwater acoustic sound waves with high pressure air. Jouni Niskakoski on Shutterstock.com

Data collection and analysis: The hydrophones record the seismic waves as they bounce back from the rock layers beneath the ocean floor. This data is then transmitted back to the vessel, where it is analyzed to identify potential oil and gas deposits.

Drill site identification: The exploration team can identify potential drill sites where oil and gas deposits may be present based on the seismic data. These drill sites are then marked for further exploration and possible drilling.

Using vessel-mounted air guns can harm marine life, including whales, dolphins, and other marine mammals.[21] The shockwaves generated by the air guns can harm or disrupt these animals,[22] leading to concerns about their welfare, as detailed below.

Impacts on marine mammals

Photo 8 Humpback whales. Vivek Kumar on Unsplash.

The use of vessel-mounted air guns has been shown to cause the following impacts on marine mammals:

[21] University of Rhode Island Graduate School of Oceanography. (n.d.). *Seismic Airguns*. Discovery of Sound in the Sea. https://dosits.org/animals/effects-of-sound/anthropogenic-sources/seismic-airguns/; Weilgart, L. (2013). "A review of the impacts of seismic airgun surveys on marine life." Submitted to the CBD Expert Workshop on Underwater Noise and its Impacts on Marine and Coastal Biodiversity, 25-27 February 2014, London, UK. Available at: http://www.cbd.int/doc/?meeting=MCBEM-2014-01

[22] Tibbetts, J. H. (2018). "Air-Gun Blasts Harm Marine Life across the Food Web." *BioScience, 68(12)*, 1024. https://doi.org/10.1093/biosci/biy123

Hearing damage: The loud noise produced by air guns can cause hearing damage in marine mammals. Exposure to loud noise can lead to temporary or permanent hearing loss,[23] which can impact their ability to communicate, locate prey, and navigate.[24]

Behavioral disruption: The noise from air guns can disrupt the normal behavior of marine mammals, causing them to change their migration patterns, feeding behavior, or mating habits. For example, whales may avoid areas where air guns are operating, which can impact their feeding and breeding success.[25]

Masking of communication: The noise from air guns can mask or interfere with the communication signals that marine mammals use to communicate with each other. This can make it difficult for them to locate each other or coordinate their activities, which can impact their ability to survive and reproduce.[26]

Physiological stress: The noise from air guns can cause physiological stress in marine mammals, leading to changes in their hormone levels, heart rate,[27] and other biological functions.[28] This can impact their overall health and well-being and increase their susceptibility to disease and other environmental stressors.

Stranding events: In some cases, the loud noise from air guns can cause marine mammals to become disoriented and strand themselves on beaches or other coastal areas. This can result in injury or death and can have significant impacts on local populations.[29]

Impacts on fisheries

The use of vessel-mounted air guns can also have significant impacts on fisheries. These impacts can be direct or indirect and affect commercial and subsistence fishing operations. Some ways in which the use of air guns can impact fisheries include:

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[23] Finneran, J. J. (2015). "Noise-induced hearing loss in marine mammals: A review of temporary threshold shift studies from 1996 to 2015." *The Journal of the Acoustical Society of America, 138(3)*, 1702–1726. https://doi.org/10.1121/1.4927418

[24] Bain, D. & Williams, R. (2006). "Long-range Effects of Airgun Noise on Marine Mammals: Responses as a Function of Received Sound Level and Distance." *Sea Mammal Research Unit (SMRU)*. https://tethys.pnnl.gov/sites/default/files/publications/Bain-and-Williams-2006.pdf

[25] Miller, P. J. et al. (2009). "Using at-sea experiments to study the effects of airguns on the foraging behavior of sperm whales in the Gulf of Mexico." *Deep Sea Research Part I: Oceanographic Research Papers, 56(7),* 1168–1181. https://doi.org/10.1016/j.dsr.2009.02.008

[26] Blackwell, S. B. et al. (2015). "Effects of Airgun Sounds on Bowhead Whale Calling Rates: Evidence for Two Behavioral Thresholds." *PLOS ONE, 10(6),* e0125720. https://doi.org/10.1371/journal.pone.0125720

[27] Miksis, J. et al. (2001). "Cardiac Responses to Acoustic Playback Experiments in the Captive Bottlenose Dolphin (Tursiops truncatus)." *Journal of Comparative Psychology* (Washington, D.C. : 1983*), 115*, 227–232. https://doi.org/10.1037/0735-7036.115.3.227

[28] Elmegaard, S. L. et al. (2021). "Heart rate and startle responses in diving, captive harbour porpoises (Phocoena phocoena) exposed to transient noise and sonar." *Biology Open, 10(6)*, bio058679. https://doi.org/10.1242/bio.058679

[29] Parsons, E. C. M. (2017). "Impacts of Navy Sonar on Whales and Dolphins: Now beyond a Smoking Gun?" *Frontiers in Marine Science, 4*. https://www.frontiersin.org/articles/10.3389/fmars.2017.00295

Disruption of fish behavior: The loud noise from air guns can disrupt the behavior of fish in the area, causing them to move away from the noise or become disoriented.[30] This can impact the ability of fisherfolk to catch fish in the affected area.[31]

Damage to fish and fish habitats: The powerful shockwaves generated by air guns can cause physical damage to fish and their habitats. This damage can include ruptured swim bladders, internal injuries,[32] or damage to critical habitats such as coral reefs or other structures.[33]

Displacement of fish populations: The noise from air guns can cause fish to move away from the affected area, potentially causing a displacement of fish populations. This can impact the catch rates of fisherfolk in the area and potentially impact the long-term viability of fisheries in the region.[34]

Economic impacts on fishing communities: The disruption or displacement of fish populations can significantly impact fishing communities that rely on these resources. Reduced catch rates from changes in fish behavior could lead to reduced income and increased economic hardship for fisherfolk and their families.[35]

Impacts on invertebrate species

Marine invertebrates, such as corals, crustaceans, and mollusks, play critical ecological roles in marine ecosystems, and their loss or degradation can have cascading impacts on other species and ecosystem functions. Some ways in which the use of air guns can impact marine invertebrates include:

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[30] Fewtrell, J. L., & McCauley, R. D. (2012). "Impact of air gun noise on the behaviour of marine fish and squid." *Marine Pollution Bulletin, 64(5)*, 984–993. https://doi.org/10.1016/j.marpolbul.2012.02.009

[31] Løkkeborg, S., Ona, E., Vold, A., & Salthaug, A. (2012). "Sounds from seismic air guns: Gear- and species-specific effects on catch rates and fish distribution." *Canadian Journal of Fisheries and Aquatic Sciences, 69(8)*, 1278–1291. https://doi.org/10.1139/f2012-059

[32] Popper, A. et al. (2014). ASA S3/SC1.4 TR-2014 Sound Exposure Guidelines for Fishes and Sea Turtles: A Technical Report prepared by ANSI-Accredited Standards Committee S3/SC1 and registered with ANSI. https://doi.org/10.1007/978-3-319-06659-2

[33] Dabros, A., Pyper, M., & Castilla, G. (2018). "Seismic lines in the boreal and arctic ecosystems of North America: Environmental impacts, challenges, and opportunities." *Environmental Reviews, 26(2)*, 214–229. https://doi.org/10.1139/er-2017-0080

[34] Engås, A., Løkkeborg, S., Ona, E., & Soldal, A. V. (1996). "Effects of seismic shooting on local abundance and catch rates of cod (Gadus morhua) and haddock (Melanogrammus aeglefinus)." *Canadian Journal of Fisheries and Aquatic Sciences, 53(10)*, 2238–2249. https://doi.org/10.1139/f96-177; de Jong, K. et al. (2018). "Noise can affect acoustic communication and subsequent spawning success in fish." *Environmental Pollution, 237*, 814–823. https://doi.org/10.1016/j.envpol.2017.11.003

[35] Løkkeborg, S., Ona, E., Vold, A., & Salthaug, A. (2012). "Effects of sounds from seismic air guns on fish behavior and catch rates." *The effects of noise on aquatic life* , 415-419. Springer New York.

Physical damage: The powerful shockwaves generated by air guns can cause physical harm to marine invertebrates,[36] such as breaking or dislodging coral colonies or damaging the shells of mollusks. This damage can lead to reduced survival, growth,[37] and reproductive success.[38]

Disruption of behavior: The loud noise from air guns can disrupt the behavior of marine invertebrates, causing them to change their feeding, mating, or other essential behaviors. This can lead to reduced fitness and reproductive success and contribute to population declines.[39]

Loss or degradation of habitat: The physical damage caused by air guns can lead to the loss or degradation of critical habitat for marine invertebrates, such as coral reefs or other structures that provide shelter or food. This can lead to population declines and potentially impact the ecological functions of the affected ecosystem.

Indirect impacts: The impacts of air guns on other marine species, such as fish and sea turtles, can also indirectly impact marine invertebrates by altering the ecological interactions and relationships within the ecosystem.

Impacts on sea turtles

Sea turtles are particularly vulnerable to the loud noise generated by air guns. Some ways in which air guns can impact sea turtles include:

Hearing damage: The loud noise generated by air guns can cause hearing damage in sea turtles, impacting their ability to listen and navigate underwater. This can increase the risk of injury or death from collisions with boats or other hazards.[40]

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[36] Day, R. D. et al. (2017). "Exposure to seismic air gun signals causes physiological harm and alters behavior in the scallop Pecten fumatus." *Proceedings of the National Academy of Sciences, 114(40)*, E8537–E8546. https://doi.org/10.1073/pnas.1700564114

[37] de Soto, N. A. et al. (2013). "Anthropogenic noise causes body malformations and delays development in marine larvae." *Scientific Reports, 3(1)*, Article 1. https://doi.org/10.1038/srep02831

[38] Solé, M. et al. (2018). "A critical period of susceptibility to sound in the sensory cells of cephalopod hatchlings." *Biology Open, 7(10)*, bio033860. https://doi.org/10.1242/bio.033860; Hudson, D. M. et al. (2022) "Potential impacts from simulated vessel noise and sonar on commercially important invertebrates." *PeerJ, 10*, e12841. https://doi.org/10.7717/peerj.12841

[39]Rising, K. et al. (2022). "Anthropogenic noise may impair the mating behaviour of the Shore Crab Carcinus Maenas." PLOS ONE, 17(10), e0276889. https://doi.org/10.1371/journal.pone.0276889; Fewtrell, J. L., & McCauley, R. D. (2012). "Impact of air gun noise on the behaviour of marine fish and squid." *Marine Pollution Bulletin, 64(5)*, 984–993. https://doi.org/10.1016/j.marpolbul.2012.02.009

[40] Hazel, J., & Gyuris, E. (2006). "Vessel-related mortality of sea turtles in Queensland, Australia." *Wildlife Research, 33(2)*, 149–154. https://doi.org/10.1071/WR04097

Photo 9 Sea turtles in Guatemala. Andre Julian on Unsplash.

Behavioral disruption: The loud noise from air guns can disrupt the normal behavior of sea turtles,[41] causing them to change their feeding or migration patterns or alter their nesting behavior. This can impact their ability to find food, mate, and reproduce.[42]

Physiological stress: The noise from air guns can cause physiological stress in sea turtles, leading to changes in their hormone levels, heart rate, and other biological functions. This can impact their health and well-being and increase their susceptibility to disease and other environmental stressors.

Injury or mortality: In some cases, the shockwaves generated by air guns can cause direct physical injury or mortality to sea turtles. Shockwaves can cause ruptured eardrums and internal injuries or cause the turtles to become disoriented and collide with boats and other hazards.

2.1.2.2. Offshore exploratory drilling

The environmental impacts of offshore exploratory drilling include:

Discharge of drilling waste. Large volumes of drilling muds and cuttings, which contain various chemicals and heavy metals, are generated. Disposal of these wastes can impact the surrounding marine environment, causing contamination and smothering of seabed habitats.[43]

Habitat disturbance. Offshore drilling activities involve the construction of platforms and infrastructure, which can disrupt and destroy sensitive marine habitats such as coral reefs, seagrass beds, and underwater rock formations. These habitats serve as critical

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[41] DeRuiter, S., & Kamel, L. (2023). "Loggerhead turtles dive in response to airgun sound exposure." *Endangered Species Research, 16*: 55–63. https://doi.org/10.3354/esr00396

[42] Nelms, S. E. et al. (2016). "Seismic surveys and marine turtles: An underestimated global threat?" *Biological Conservation, 193*, 49–65. https://doi.org/10.1016/j.biocon.2015.10.020

[43] Antia, M. et al. (2022). "Environmental and public health effects of spent drilling fluid: An updated systematic review." *Journal of Hazardous Materials Advances, 7*, 100120. https://doi.org/10.1016/j.hazadv.2022.100120; Trannum, H. C. et al. (2010). "Effects of sedimentation from water-based drill cuttings and natural sediment on benthic macrofaunal community structure and ecosystem processes." *Journal of Experimental Marine Biology and Ecology, 383(2)*, 111–121. https://doi.org/10.1016/j.jembe.2009.12.004

breeding and feeding grounds for marine species, and their destruction can lead to declines in biodiversity.[44]

Oil Spills: The risk of oil spills is a significant concern in offshore drilling. Accidents during drilling or oil production, equipment failures, or natural disasters can lead to oil spills that can devastate marine ecosystems, coastal habitats, and wildlife.[45]

The discharge of drilling waste, habitat disturbance, and oil spills are also a part of offshore production of oil and gas. Please find a more comprehensive discussion of these impacts from oil and gas production in the sub-chapter below.

2.2. Impacts Of Production

2.2.1. Climate Impacts

The oil and gas sector is a major contributor to global greenhouse gas (GHG) emissions, playing a significant role in climate change. The extraction, production, and combustion of fossil fuels (including oil and gas) release large quantities of greenhouse gases into the atmosphere, primarily ***carbon dioxide (CO_2)*** and ***methane (CH_4)***. When these gases accumulate in the atmosphere, they trap heat and contribute to the greenhouse effect, leading to global warming and climate change. The combustion of fossil fuels for energy production, transportation, and industrial processes is a major source of CO_2 emissions.

Methane, a potent greenhouse gas, is released during oil and gas extraction, processing, and transportation. Methane leaks occur at various supply chain stages, including drilling, production, processing, storage, and distribution. Methane also frequently leaks from closed and abandoned wells. Methane has a significantly higher warming potential than CO_2 over shorter timeframes, making it a crucial contributor to global warming.[46]

Recent studies in the United States have shown that methane losses can range from 1-9% of total gas production with a production-weighted loss rate average of roughly

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44 Jones, G. P. et al. (2004). "Coral decline threatens fish biodiversity in marine reserves." *Proceedings of the National Academy of Sciences, 101(21)*, 8251–8253. https://doi.org/10.1073/pnas.0401277101; Hanski, I. (2011). "Habitat Loss, the Dynamics of Biodiversity, and a Perspective on Conservation." *Ambio, 40(3)*, 248–255. https://doi.org/10.1007/s13280-011-0147-3

45 Barron, M. G. et al. (2020). "Long-term ecological impacts from oil spills: Comparison of Exxon Valdez, Hebei Spirit and Deepwater Horizon." *Environmental Science & Technology, 54(11)*, 6456–6467. https://doi.org/10.1021/acs.est.9b05020; Cubit, J. D. et al. (n.d.). *An Oil Spill Affecting Coral Reefs And Mangroves On The Caribbean Coast Of Panama*. Smithsonian Tropical Research Institute. https://biogeodb.stri.si.edu/oilspill/page/background

46 https://www.epa.gov/ghgemissions/understanding-global-warming-potentials

3%.[47] The latest Intergovernmental Panel on Climate Change (IPCC) estimate of methane's 100-year global warming potential (GWP) is 29.8 for methane of fossil origin,[48] meaning loss rates of this scale can make up a significant fraction of lifecycle GHG emissions for oil and natural gas.

The oil and gas sector often drives ***deforestation and land use change***. Forests often act as carbon sinks by absorbing CO_2 from the atmosphere. Still, when cleared for oil and gas exploration or infrastructure development, significant carbon stocks are released into the atmosphere, contributing to global warming. Oil and gas extraction and refining processes require substantial energy inputs, often derived from fossil fuels. The energy consumed in these operations contributes to greenhouse gas emissions. Additionally, the energy-intensive nature of extracting unconventional fossil fuel sources, such as oil sands or shale gas, further increases carbon emissions.

The oil and gas sector also contributes to global warming through ***indirect emissions*** associated with the production and transportation of equipment and infrastructure. These emissions, often referred to as "embodied emissions," result from manufacturing and transporting materials like steel and concrete, which are used in constructing oil rigs, pipelines, refineries, and other related infrastructure.

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[47] Sherwin, E., Rutherford, J., Zhang, Z., Chen, Y., Wetherley, E., Yakovlev, P., ... & Cusworth, D. (2023). *Quantifying oil and natural gas system emissions using one million aerial site measurements.* *https://assets-eu.researchsquare.com/files/rs-2406848/v1/5cb675b0-cb6b-4b8f-ba6c-97fe6eff5442.pdf?c=1710399992*

[48] https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_Chapter_07.pdf

According to the IPCC's Sixth Assessment Report, the energy sector, which includes oil and gas, accounted for approximately 34% of global GHG emissions in 2019.[49] Studies suggest that the oil and gas industry is responsible for a significant share of anthropogenic methane emissions, potentially ranging from 20% to 25% or even higher. Combining CO_2 and methane emissions, it is reasonable to estimate that the oil and gas sector contributes to a substantial portion of global greenhouse gas emissions.

> ***Can we reduce greenhouse emissions from fossil fuels?***
>
> When fossil fuels are used to produce heat or electricity, we often remove as much of the air pollution as possible from the emissions stream. For example, a coal-powered power station might use electrostatic precipitators to remove particulate matter pollution before they can exit the stack. So, what about CO_2 and other greenhouse gases — can we remove those as well?
>
> CO_2 is the primary molecule emitted from fossil fuel combustion: When fossil fuels are burned, the carbon in the fuel combines with oxygen in the air to produce CO_2. This process generates a massive amount of CO_2. For example, a single gallon (about 4 liters) of gasoline produces nearly 20 pounds (about 10 kg) of CO_2 when burned. This is far too much CO_2 for us to remove in most cases.
>
> Oil companies have often promoted the possibility of carbon capture and storage (CCS). This process would remove CO_2 from power plant emissions, liquify it, and inject it deep underground. While some pilot CCS plants have been constructed, CCS is not currently used in any major facility in the world. Using CCS would greatly increase the complexity and costs of a power plant, which would need to remove and permanently store thousands of tons of CO_2 per day. Therefore, even when a power plant promises to "scrub" air pollutants from its emissions, the amounts of CO_2 emitted will not be significantly reduced.
>
> The biggest source of methane, by contrast, is not from fossil fuel combustion but from leakage in natural gas pipelines and facilities. Because these small leaks can be located anywhere in the system, they are very difficult to identify and to stop.

International bodies and organizations have made recommendations and calls to address future oil and gas development to avert catastrophic climate change. The IPCC highlights the need for rapid and substantial reductions in greenhouse gas emissions to limit global warming to well below 2 degrees Celsius above pre-industrial levels, preferably to 1.5 degrees Celsius. To achieve this, ***the IPCC emphasizes the necessity of phasing out fossil fuel use*** and transitioning to low-carbon and renewable energy sources.[50] The Paris Agreement is an international treaty aiming to combat climate change. Under the agreement, nations have committed to limiting global warming well below 2 degrees Celsius and pursuing efforts to limit it to 1.5 degrees Celsius. To achieve these goals, countries are expected to undertake measures to reduce greenhouse gas emissions, including ***the mitigation of fossil fuel use*** and promoting sustainable development pathways.[51] The International Energy Agency (IEA) in its recent report, "Net Zero by

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[49] IPCC [Core Writing Team, H. Lee and J. Romero (eds.)]. (2023). *Climate Change 2023: Synthesis Report*. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. IPCC, Geneva, Switzerland, 184 pp., doi: 10.59327/IPCC/AR6-9789291691647. https://www.ipcc.ch/report/ar6/syr/downloads/report/IPCC_AR6_SYR_FullVolume.pdf

[50] Ibid.

[51] https://www.un.org/en/climatechange/paris-agreement

2050," provides a roadmap to achieve global net-zero emissions by 2050. It highlights the need for ***no new investments in oil and gas exploration and development projects*** to align with the Paris Agreement goals.[52] It recommends that governments should prioritize investment in clean energy technologies and infrastructure and phase out the use of unabated fossil fuels. These recommendations collectively emphasize the urgency of reducing dependence on fossil fuels, to mitigate climate change effectively. They underscore the importance of transitioning to renewable energy sources, improving energy efficiency, and implementing sustainable development practices.

2.2.2. Onshore Production

2.2.2.1. Impacts on Air Quality

The operation of oil and gas wells can have significant impacts on ***ambient air quality*** — that is, the amount of pollution in the air in some area, site, neighborhood, or city — due to emissions from various stages of the extraction and production processes.[53] Many countries or regions set standards (maximum permissible amounts) for the most dangerous air pollutants in ambient air using a regulation that is often called the ***National Ambient Air Quality Standards (NAAQS)***. These pollutants are commonly referred to as the NAAQS pollutants or the ***criteria pollutants***.

Photo 10 Gas flaring during oil extraction, Russia. Solodov Aleksei on Shutterstock.com.

Volatile organic compounds (VOCs) are emitted during oil and gas extraction and production processes. VOCs include various hydrocarbons that can react with nitrogen oxides in the atmosphere to form ground-level ozone (smog). Ozone is a harmful air pollutant that can cause respiratory problems and other health issues. Emissions from nitrogen oxides (NO_x) occur during combustion processes, such as those in gas turbines or engines used for drilling and transportation. NO_x contribute to the formation of ground-level ozone and particulate matter (PM), impacting air quality and human health. Oil and gas well operations can release PM, consisting of tiny solid particles and liquid droplets suspended in the air. These particles can be directly emitted from combustion processes or formed as secondary particles through chemical reactions. PM can have adverse health effects, particularly when inhaled, leading to respiratory and cardiovascular problems. Some oil and gas wells produce hydrogen sulfide (H_2S), a toxic gas with a foul odor. Exposure to high concentrations of H_2S can be

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[52] IEA. (2021). *Net Zero by 2050*. IEA, Paris https://www.iea.org/reports/net-zero-by-2050

[53] USEPA. (04 October 2023). “Basic Information about Oil and Natural Gas Air Pollution Standards.” *Controlling Air Pollution from the Oil and Natural Gas Operation*. https://www.epa.gov/controlling-air-pollution-oil-and-natural-gas-operations/basic-information-about-oil-and-natural

hazardous to human health and poses risks to both workers and nearby communities. During oil and gas production, flaring (burning off excess gas) and venting (releasing gas directly into the atmosphere) are common practices. According to the World Bank, the volume of flared gas worldwide in 2021 was estimated to be 144 billion cubic meters (BCM), which emitted around 0.4 billion tons of carbon dioxide equivalent.[54] This accounts for 0.01% of total global anthropogenic carbon dioxide (CO_2) emissions. The heat released to the environment from gas flaring is detectable through remote sensing imagery.[55] Flaring and venting release CO_2, methane, VOCs, and other pollutants directly into the air, contributing to local and regional air quality issues.

Oil spills can have an impact on air quality. Oil contains toxic volatile compounds like benzene, toluene, ethylbenzene, and xylene, collectively known as BTEX. These compounds are toxic, mutagenic, and carcinogenic in nature and can have adverse effects on human health and ecosystems. Due to their persistence in the environment and potential risk to public health, the United States Environmental Protection Agency (USEPA) has classified them as priority environmental contaminants.[56]

2.2.2.2. Impacts to Water

The impacts to surface and groundwater of oil and gas projects are illustrated below (source: Avner Vengosh[57]) and include the following:

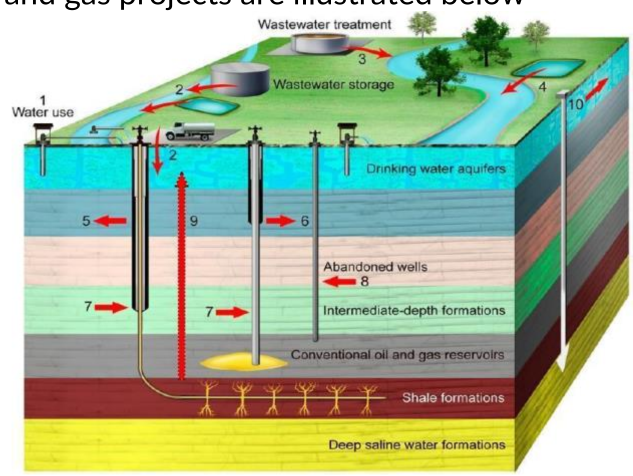

Figure 1: Schematic illustration (not to scale) of possible modes of water impacts associated with shale gas development (Source Vengosh 2014)

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[54] World Bank Group, Hu et al. (2022). Global Flaring and Methane Reduction Partnership (GFMR) Formerly the Global Gas Flaring Reduction Partnership (GGFR). https://www.worldbank.org/en/programs/gasflaringreduction

[55] Elvidge, C.D., Zhizhin, M., Baugh, K., Hsu, F.C., Ghosh, T. (2019). "Extending nighttime combustion source detection limits with short wavelength VIIRS data." *Remote Sens. (Basel) 11*, 395; Hu et al. (2023). "An approach to detect gas flaring sites using sentinel-2 MSI and NOAA-20 VIIRS images." *International Journal of Applied Earth Observation and Geoinformation 124*: 103534

[56] Samantha, S. K. et al. (2002). "Polycyclic aromatic hydrocarbons: environmental pollution and bioremediation." *Trends in Biotechnology , 20(6)*, 243-248.

[57] Vengosh et al. (2014). "A Critical Review of the Risks to Water Resources from Unconventional Shale Gas Development and Hydraulic Fracturing in the United States." *Environmental Science and Technology*. https://pubs.acs.org/doi/10.1021/es405118y

Depletion of local water resources

Large quantities of water are required for the drilling, completion, and fracking of unconventional natural gas wells. Volumes of around 30,000 m^3 per well may be required.[58] Water is sourced from aquifers, rivers, and reservoirs, allocated through long-term or short-term licenses. Accessing large quantities of water over a short period of time requires temporary storage of large amounts of water in large ponds or reservoirs. The industry also uses ponds and dugouts to both access and store water. Unfortunately, a portion of the water cannot be recycled, and this will therefore stress the local water resources, especially when this water consumption conflicts with periods of droughts or low stream flows, and in regions with little monitoring of surface water, rendering the negative effects difficult to quantify.

Degradation of water quality

In addition to spills and leaks of wastewater stored in open pits near drilling sites, oil and gas projects can degrade water quality in three ways discussed in more detail below: 1) The disposal and injection of produced water; [59] 2) The injection of fracturing fluids with toxic additives; and 3) the loss of well integrity of thousands of wells that lie abandoned.[60]

Disposal of produced water

Produced water is the name of water that is extracted along with oil and gas during petroleum production. Also, some of the chemicals added when processing reservoir fluids might end up in the produced water. Produced water is typically of poor quality (i.e., very saline and containing toxic metals). During exploratory drilling, the quantity of produced water is limited. Therefore, the infrastructure to manage it (treatment and disposal) may not be fully available. As a result, there is a higher risk that the produced water may not be dealt with and disposed of in the safest way.

Improper disposal of produced water can result from poor and unethical behavior during transport (e.g., illegal dumping), leakage of storage and transport infrastructure, and injection into leaky disposal wells. Contaminants present in the produced water can contaminate surface water and shallow groundwater. In the case of the disposal wells,

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[58] Ben Parfitt, B. (February 2023). *Fractured Land* [Webinar]. StandEarth.

[59] Kharaka et al. (2024). *Groundwater and Petroleum*.

[60] Approximately 6 million wells have been drilled in USA and Canada (ibidem).

impacts may occur at great depths that are challenging to identify and monitor, causing delayed contamination of aquifers.[61, 62, 63] At most offshore production installations, produced water is separated from the petroleum process stream and, after treatment, is discharged to the marine environment, or disposed of in subsurface formations.

Toxicity of hydraulic fracturing additives

Multiple additives are used in fracking fluids to improve the efficiency of extraction of the fluids and prevent clogging of the fracked zones. Additives may include a mixture of acids, bactericides, dispersants, etc. These products can be toxic when released to the environment, whether at the surface during handling and use (see section on contamination of aquifers and water sources, above) or during and following fracking operations, particularly if the well has experienced loss of integrity (see below).

Long-term loss of well integrity

The loss of well integrity (LOWI) refers to the reduction in the capacity of a well to act as a sealed conduit due to the degradation of the steel casing (e.g., breaking, pitting, corrosion) and/or the degradation of the concrete and/or grout (e.g., cracking, microfractures, geochemical degradation) placed in the inter-annular space. Over the length of the boreholes (vertical lengths can exceed 2000 meters), many zones in the subsurface containing fluids at various pressures may be encountered. When pathways are opened along the borehole due to LOWI, fluids will migrate, driven by the pressure gradient. This can result in poor-quality deep fluids moving upwards and contaminating shallow and intermediate aquifers, and the release of methane and CO_2 to the atmosphere. This can also result in shallow aquifers leaking to deeper zones and losing their piezometric pressure over time, causing lowered water tables that could be very detrimental to surface water bodies (e.g., lowering of lake levels, reduction of river low flows, drying of lakes, rivers, and wetlands).[64] Unfortunately, when a well is drilled, the borehole is created forever. Therefore, LOWI needs to be considered over very long times (i.e., decades, centuries), corresponding to the time scale typical of groundwater movement.

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[61] Ryan, C. et al. (2015). "Subsurface Impacts of Hydraulic Fracturing." *Canadian Water Network*.

[62] Darrah, T. H. et al. (2014). "Noble gases identify the mechanisms of fugitive gas contamination in drinking-water wells overlying the Marcellus and Barnett Shales." *PNAS 111(39)*. www.pnas.org/cgi/doi/10.1073/pnas.1322107111

[63] Aker, A. M., Friesen, M., Ronald, L. A., Doyle-Waters, M. M., Takaro, T. J., Thickson, W., ... & McGregor, M. J. (2024). "The human health effects of unconventional oil and gas development (UOGD): A scoping review of epidemiologic studies." *Canadian Journal of Public Health*, 1-22.

[64] Chesnaux, R., Dal Soglio, L., & Wendling, G. (2013). "Modeling the impacts of shale gas extraction on groundwater and surface water resources." *GeoMontreal*.

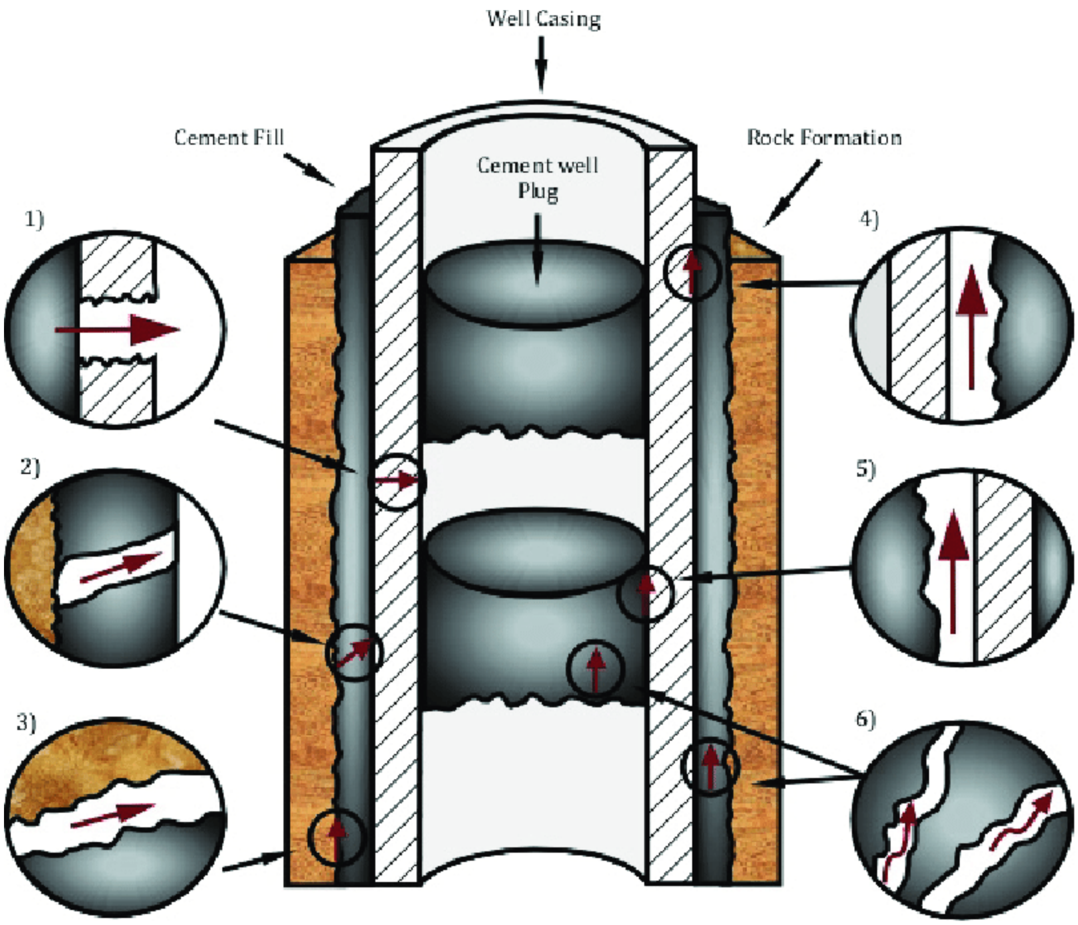

Photo 11 Recasens, M., Garcia, S., Mackay, E., Delgado, J., & Maroto-Valer, M. M. (2017). Experimental study of wellbore integrity for CO2 geological storage. Energy Procedia, 114, 5249-5255. https://www.researchgate.net/figure/Overview-of-potential-leakage-pathways-along-an-existing-wellbore-through-the-casing_fig1_319194372

2.2.2.3. Habitat loss

Onshore oil and gas projects can have significant environmental impacts in tropical or forested areas, where biodiversity is often high.[65] Habitat loss globally has resulted in a 30% reduction in terrestrial habitat integrity. As there is a relationship between habitat area and species numbers, this suggests that over 500,000 of the world's estimated 5.9 million terrestrial species, or about 9%, do not have enough habitat to survive in the long term. Unless these habitats are restored, these species are at risk of extinction, and many may disappear within decades.[66] Clearing forests has reduced the contribution of biodiversity to pollination, climate regulation, water quality regulation, opportunities for

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[65] Agbagwa, I. O., & Ndukwu, B. C. (2014). "Oil and gas pipeline construction-induced forest fragmentation and biodiversity loss in the Niger Delta, Nigeria." *Natural Resources, 5(12)*, 698.

[66] IPBES. (2018). *The IPBES assessment report on land degradation and restoration*. In: Montanarella L., Scholes R., and Brainich A. (eds.). Secretariat of the intergovernmental science-policy platform on biodiversity and ecosystem services, Bonn, Germany. 10.5281/zenodo.3237392

learning and inspiration, and the maintenance of options for the future.[67] To access drilling sites, companies often build roads and well pads, necessitating the clearing of large areas of forest. These infrastructure developments also fragment habitats, changing microclimatic conditions, decreasing habitat availability, impacting species and ecosystems' resilience to tolerate or recover from extreme events,[68] and making it difficult for species to move freely and access resources.[69] Building pipelines to transport extracted oil and gas can involve clearing wide swaths of forest for the pipeline route. This linear infrastructure can further fragment habitats and pose a barrier to the movement of wildlife. Construction activities and the movement of equipment can introduce invasive alien species to the area, disrupting the balance of local ecosystems.[70] The effects of invasive alien species are often severe for native species on islands and in places with high proportions of endemic species.[71] Changes in land use and the introduction of infrastructure can alter the natural dynamics of ecosystems, affecting species composition and biodiversity.[72] Land clearing and habitat fragmentation can worsen emerging infectious diseases in people, domestic animals, wildlife, or plants. The deterioration of nature disrupts its benefits to people, having direct and indirect implications for public health, and can worsen existing inequalities in access to healthcare and healthy diets.[73]

The heat released by gas flaring increases the soil temperature, soil respiration, and CO_2 emissions. Microbial biomass, basal respiration, and the input of labile organic matter pool may increase with the distance from the flare.[74] The air and soil temperatures at the flare site rise, while relative humidity and soil moisture decrease towards the flaring, and all soil chemical parameters decrease towards the flare. Flares can create a microclimatic condition that adversely affects the soil and result in a decrease in maize yield, as has

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[67] Ibid.

[68] Koelemeijer, I. A. et al. (2022). "Interactive effects of drought and edge exposure on old-growth forest understory species." *Landscape Ecology 37(7)*, 1839–1853.

[69] Brittingham, M. C., Maloney, K. O., Farag, A. M., Harper, D. D., & Bowen, Z. H. (2014). "Ecological risks of shale oil and gas development to wildlife, aquatic resources and their habitats." *Environmental science & technology, 48(19)*, 11034-11047.

[70] Ibid.

[71] IPBES. (2018). *The IPBES assessment report on land degradation and restoration*. In: Montanarella L., Scholes R., and Brainich A. (eds.). Secretariat of the intergovernmental science-policy platform on biodiversity and ecosystem services, Bonn, Germany. 10.5281/zenodo.3237392

[72] Harfoot, M. B., Tittensor, D. P., Knight, S., Arnell, A. P., Blyth, S., Brooks, S., ... & Burgess, N. D. (2018). "Present and future biodiversity risks from fossil fuel exploitation." *Conservation Letters, 11(4)*, e12448.

[73] IPBES. (2018). *The IPBES assessment report on land degradation and restoration*. In: Montanarella L., Scholes R., and Brainich A. (eds.). Secretariat of the intergovernmental science-policy platform on biodiversity and ecosystem services, Bonn, Germany. 10.5281/zenodo.3237392

[74] Yevdokimov, I. V. et al. (2017). "Thermal Impact of Gas Flares on the Biological Activity of Soils." *Eurasian Soil Science, 50 (12)*, 1455–1462.

been found in the Niger Delta, where yield is reduced by over 58% or more within two kilometers from the flare site.[75]

2.2.2.4. Oil spills

Photo 12 Volunteers clean up oil after a tanker wreck in Mauritius. Ohrim on Shutterstock.com

Each year, thousands of oil spills occur globally on land. Although most of these spills are minor, many can be major environmental disasters.[76] The rate at which an oil spill spreads in the environment will determine its effect. Onshore oil spills can have devastating and lasting impacts on terrestrial environments, affecting soil, vegetation, wildlife, and water resources, and can be more severe than those oil spills occurring offshore, as water movement is minimized in freshwater ecosystems.[77] While onshore oil spills are less common than offshore spills, they can still occur due to accidents, equipment failures, human errors, war, vandalism of oil facilities, or inadequate infrastructure. Oil spills can lead to soil contamination, compaction, impaired aeration, and infiltration of water into the soil, affecting nutrient availability and inhibiting plant growth and development, resulting in reduced biomass and changes in leaves and roots of plants[78] and transforming the soil microbial communities and enzymatic activities within the soil.[79]

Some toxic substances of spilled oil may evaporate quickly. In consequence, the exposure of plants, animals, and humans to the most toxic substances decreases with time and usually are limited to the initial spill area.[80] However, some organisms can be

[75] Odjugo, P.A.O. and Osemwenkhae, E.J. (2009). "Natural gas flaring affects microclimate and reduces maize (Zea mays) yield." *International Journal of Agriculture and Biology, 11*, 408—412.

[76] Michael-Igolima, U. et al. (2022). "A systematic review on the effectiveness of remediation methods for oil contaminated soils". *Environmental Advances 9*:100319. https://doi.org/10.1016/j.envadv.2022.100319

[77] United States Environmental Protection Agency (1999) Understanding oil spills and oil spill response. Oil Program Center. 48 pp. https://www.epa.gov/sites/default/files/2018-01/documents/ospguide99.pdf

[78] Da Silva Correa, H., et al. (2022). "Effects of oil contamination on plant growth and development: A review." *Environmental Science and Pollution Research, 29*, 43501-43515; Ewetola, E. (2013). "Effect of crude oil pollution on some soil physical properties" *IOSR Journal of Agriculture and Veterinary Science 6(3)*, 14-17.

[79] Huang, L. et al. (2021). "Oil contamination drives the transformation of soil microbial communities: Co-occurrence pattern, metabolic enzymes and culturable hydrocarbon-degrading bacteria." *Ecotoxicology and Environmental Safety, 225*:112740.

[80] United States Environmental Protection Agency. (1999). *Understanding oil spills and oil spill response*. https://www.epa.gov/sites/default/files/2018-01/documents/ospguide99.pdf

killed or seriously damaged after contacting an oil spill. Sublethal toxic effects can last longer and be more subtle. The death or damage of vegetation can lead to habitat loss and impact the food web. Terrestrial wildlife, including insects, mammals, and birds, can be directly affected by oil spills. Animals may come into contact with contaminated soil, water, or vegetation, leading to poisoning, habitat disruption, and potential population declines.

Oil spilled on land can find its way into water bodies, contaminating surface water and groundwater.[81] In standing water bodies, oil can remain in the environment for years, as oil tends to pool. These ecosystems, such as swamps, inland lakes, and ponds, are home to different species of fishes, mammals, and birds, which may suffer severe impacts caused by an oil spill. Spilled oil can also interact with sediments at the bottom of freshwater bodies, impacting organisms that feed or live off sediments.[82]

In flowing rivers and streams, as the water moves, oil spills tend to have less severe effects than those with calm water conditions. In rivers and streams, spilled oil tends to be retained in plants and grasses growing on the riverbanks. When rivers are drinking water sources for people, oil spills can directly threaten human health.[83]

Contamination from oil spills can have cascading effects on aquatic ecosystems and impact the availability of clean water for both wildlife and human populations. Oil spills can reduce the stability of soil, leading to increased erosion and sedimentation in nearby water bodies. This can degrade water quality and harm aquatic habitats. The long-term ecological consequences of onshore oil spills can be profound, with impacts persisting for years or even decades; the recovery of affected ecosystems may be slow, especially in areas with complex and sensitive ecological dynamics.[84]

An oil spill can harm wildlife through direct contact, toxic contamination, destruction of food sources and habitats, and reproductive issues.[85] Physical contact can be harmful to animals when their fur or feathers come into contact with oil. This contact causes matting of fur or feathers, which results in the loss of their insulating properties. This puts animals at risk of freezing to death. In the case of birds, the risk of drowning increases as their feathers' complex structure, which allows them to float or fly, gets damaged.

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[81] Duffy, J. J. et al. (1980). "Oil spills on land as potential sources of groundwater contamination." *Environment International, 3(2)*:107-120.

[82] United States Environmental Protection Agency. (1999). *Understanding oil spills and oil spill response*. https://www.epa.gov/sites/default/files/2018-01/documents/ospguide99.pdf

[83] Ibid.

[84] Wekpe, V. O., & Idisi, B. E. (2024). "Long-Term Monitoring of Oil Spill Impacted Vegetation in the Niger Delta Region of Nigeria: A Google Earth Engine Derived Vegetation Indices Approach." *Journal of Geography, Environment and Earth Science International, 28(2)*, 27-40.

[85] United States Environmental Protection Agency. (1999). *Understanding oil spills and oil spill response*. https://www.epa.gov/sites/default/files/2018-01/documents/ospguide99.pdf

Photo 13 Bird covered in oil. Mike Shooter on Shutterstock.com

Toxic contamination can harm certain species due to the inhalation of oil vapors. These vapors can harm an animal's central nervous system, liver, and lungs. Moreover, animals can be at risk of ingesting oil, which can damage cells in their intestinal tract, reducing their ability to eat or digest food. Oil spills can cause harm to wildlife and their habitats, even those that are not directly affected by the spill. If predators consume contaminated prey, they may be exposed to oil through ingestion. The unpleasant taste and smell of oil contamination can cause predators to refuse to eat their prey, leading them to starve. In some cases, a local prey population may be destroyed, leaving no food available for predators. The effects of oil spills can last for long periods, especially in calm water conditions, where oil interacting with rocks or sediments can remain indefinitely in the environment. Oil spills can cause various reproductive problems for birds and mammals. The oil can easily be transferred from the bird feathers to the hatching eggs, smothering them by sealing pores and blocking gas exchange. Additionally, exposure to oil has shown developmental effects on bird embryos. The number of breeding animals and nesting habitats can also be reduced by oil spills. Furthermore, long-term reproductive problems have been observed in animals exposed to oil.

Recent examples of onshore oil spills include:

- North Dakota, USA (July 2015): A pipeline operated by Tesoro Logistics in North Dakota ruptured, releasing more than 20,000 barrels of crude oil into a creek. The spill affected farmland, contaminated water sources, and caused the death of fish and other aquatic life.

- Alberta, Canada (March 2015): An oil spill occurred in Alberta, Canada, when a Nexen Energy pipeline released about 31,000 barrels of bitumen emulsion. The spill impacted wildlife and raised concerns about the effectiveness of oil sands reclamation.
- Ogoniland, Nigeria (Various Incidents): Nigeria has experienced numerous onshore oil spills over the years due to pipeline sabotage, equipment failure, and operational issues. These spills have had significant impacts on terrestrial ecosystems, farmland, and local communities.

Photo 14 Coffeyville, KS, July 19, 2007 - A contractor working on removing pools of oil released by a local refinery. Flooding and oil contamination destroyed much of the low lying town. Leif Skoogfors/FEMA

2.2.2.5. Noise, infrastructure, and light pollution

All activities associated with oil and gas involve heavy machinery (excavators, loaders, trucks, drilling rigs, pumps, etc.) and facilities (compressor stations, etc.) that will produce noise day and night for facilities that operate 24 hours a day. Such noise can have negative impacts on the abundance of sensitive species, affect predator-prey dynamics, affect acoustic communication, and act as a physiological stressor. In Alberta, Canada, the oil drilling noise, the oil extraction operation noise, the power grid noise, and the infrastructure had a negative effect on habitat use, nesting success, and nesting quality of migratory breeding prairie songbirds.[86]

Photo 15 Working drilling rig at night. Huyangshu on Shutterstock.com

Drilling pads also use powerful lights to allow drilling at night. Both noise and light will have negative and deterring effects for wildlife and will also negatively affect local populations.[87] The traffic generated by supplying equipment and material during construction, drilling, and operation activities will also affect wildlife and populations at distances from the main drilling sites.[88]

2.2.2.6. Increased and induced seismic activity (earthquakes)

Hydraulic fracking, and the operation of injection and disposal wells have triggered seismic activities, with events recorded as high as 5.8 on the Richter scale.[89] This is referred to as induced seismicity and can have negative impacts on subsurface infrastructure (e.g., damaging breaking of casing), thus increasing the risk of LOWI (described above), surface infrastructure, and landscapes (e.g., landslides).

2.2.2.7. Cumulative effects

Cumulative effects refer to the combined impacts of multiple stressors or activities on the environment, society, or economy over time. These effects result from the accumulation or interaction of various factors, often occurring simultaneously or

[86] Rosa, P. & Koper, N. (2021). "Impacts of oil well drilling and operating noise on abundance and productivity of grassland songbirds." *Journal of Applied Ecology 59*, 574–584. https://doi.org/10.1111/1365-2664.14075

[87] Rutherford, T. K., Maxwell, L. M., Kleist, N. J., Teige, E. C., Lehrter, R. J., Gilbert, M. A., ... & Carter, S. K. (2023). *Effects of noise from oil and gas development on ungulates and small mammals—A science synthesis to inform National Environmental Policy Act analyses (No. 2023-5114)*. US Geological Survey.

[88] Feinstein, L. C., Phillips, S., Banbury, J., Hamdoun, A., CT, S., & Nicklisch, B. L. (2015). "Potential impacts of well stimulation on wildlife and vegetation." *An Independent Scientific Assessment of Well Stimulation in California, 2*, 310-373.

[89] https://www.usgs.gov/faqs/how-large-are-earthquakes-induced-fluid-injection; https://inducedearthquakes.org

sequentially, leading to compounded impacts that may exceed the effects of individual stressors alone. For onshore oil production, these cumulative effects will typically include disruption of ecosystems and wildlife, land degradation and modification of the landscape, of ecosystems and the water regime, and the release of contaminants to air, water, and ground from the following activities:

- Construction of access (e.g., roads, railways, airports, harbors)
- Power supply (e.g., power lines, power plants)
- Deforestation
- Water extraction and consumption
- Contamination risk
- Land fragmentation
- Building of infrastructure
- Operations
- Changes in populations

Cumulative effects need to be assessed at the scale of entire watersheds and ecosystems and cover long periods of time (decades).

2.2.3. Offshore Production

2.2.3.1. Disposal of drilling muds and cuttings

Improper disposal of drilling muds and cuttings can lead to several negative impacts on marine environments. Drilling muds and cuttings can contain toxic chemicals that can harm marine life. These chemicals can be absorbed by algae, plants, and animals, and can accumulate in their tissues over time, leading to long-term health effects. Drilling muds and cuttings can contaminate sediments and water, affecting the quality of the marine environment. This can impact the survival and reproduction of marine organisms and affect the overall biodiversity of the ecosystem. The deposition of drilling muds and cuttings on the ocean floor can also physically disrupt the marine environment. This can impact benthic communities, which are important habitats for many marine organisms.[90]

2.2.3.2. Oil spills

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[90] Chen, Z., Cameron, T. C., Couce, E., Garcia, C., Hicks, N., Thomas, G. E., ... & O'Gorman, E. J. (2024). Oil and gas platforms degrade benthic invertebrate diversity and food web structure. Science of the Total Environment, 929, 172536. https://www.sciencedirect.com/science/article/pii/S0048969724026822 Fraser, G. S. (2014). "Impacts of offshore oil and gas development on marine wildlife resources." *Peak Oil, Economic Growth, and Wildlife Conservation*, 191-217. New York, NY: Springer New York; Sil, A., Wakadikar, K., Kumar, S., Babu, S. S., Sivagami, S. P. M., Tandon, S., ... & Hettiaratchi, P. (2012). "Toxicity characteristics of drilling mud and its effect on aquatic fish populations." *Journal of Hazardous, Toxic, and Radioactive Waste, 16(1)*, 51-57.

Offshore oil spills resulting from well blowouts can have catastrophic consequences, causing significant environmental and economic damage. Some of the worst offshore oil spills involving well blowouts in history include:

Photo 16 24 May 2010 satellite image of Deepwater Horizon oil spill in Gulf of Mexico Michon Scott, NASA's Earth Observatory, NASA Goddard Space Flight Center

- The Deepwater Horizon oil spill (2010): This is considered the worst offshore oil spill in history, caused by a well blowout in the Gulf of Mexico. The blowout led to an explosion on the Deepwater Horizon drilling rig, killing 11 workers and injuring 17 others. The spill released approximately 4.9 million barrels of oil into the ocean over a period of 87 days, causing extensive environmental damage and costing billions of dollars in cleanup and compensation.

- The Ixtoc I oil spill (1979): This oil spill was caused by a blowout in the Gulf of Mexico off the coast of Mexico. The well blew out on June 3, 1979, and the spill continued for nine months before the well was finally capped. During that time, an estimated 3.3 million barrels of oil were released into the ocean, making it one of the largest oil spills in history at the time.

- The Montara oil spill (2009): This spill occurred off the coast of Western Australia and was caused by a blowout on an oil rig owned by PTTEP Australasia. The spill released an estimated 2,000 barrels of oil per day for more than two months, resulting in an estimated 148,000 barrels of oil being released into the ocean.

- The Ekofisk Bravo oil spill (1977): This oil spill was caused by a blowout on an oil rig in the North Sea off the coast of Norway. The spill released an estimated 202,000 barrels of oil into the ocean, making it one of the largest oil spills in history at the time. The spill caused significant environmental damage and led to new regulations for offshore oil drilling in Norway.

- The West Atlas oil spill (2009): This oil spill was caused by a blowout on an oil rig in the Timor Sea off the coast of Australia. The spill released an estimated 300-400 barrels of oil per day for more than 70 days, resulting in an estimated 30,000 barrels of oil being released into the ocean. The spill caused significant environmental damage and led to calls for greater regulation of offshore oil drilling in Australia.

More frequent but lower volume oil spills from offshore oil and gas operations can still have significant impacts on the marine environment, though the extent of the impact may depend on factors such as the size and location of the spill, as well as the response time and effectiveness of cleanup efforts. According to the U.S. Bureau of Safety and Environmental Enforcement (BSEE), there were a total of 85 reported oil spills in the Gulf of Mexico from offshore oil and gas production wells in 2020. Most of these spills were considered minor, involving less than 100 barrels of oil.[91]

The potential impacts of these more frequent but lower volume oil spills include:

Cumulative harm: While individual smaller spills may not cause the same level of immediate damage as a large spill, their cumulative impact over time can still harm marine life and ecosystems. This can be particularly problematic in areas where oil and gas drilling is concentrated, such as the Gulf of Mexico.[92]

Chronic exposure: Smaller spills can result in chronic exposure of marine life to oil, which can have long-term effects on their health and reproduction. This can include effects on immune function, growth, and survival rates.

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[91] U.S. Bureau of Safety and Environmental Enforcement's (BSEE) 2020 Annual Report. https://www.bsee.gov/stats-facts/offshore-incident-statistics

[92] Sharp, J. M., & Appan, S. G. (1982). "The cumulative ecological effects of normal offshore petroleum operations contrasted with those resulting from continental shelf oil spills." *Philosophical Transactions of the Royal Society of London. B, Biological Sciences*, *297*(1087), 309-322.

Economic impacts: Even if the immediate impacts of a smaller spill are relatively minor, the cumulative effect of multiple spills can lead to economic impacts for industries that depend on the marine environment, such as fishing and tourism.[93]

2.2.4. Socio-Economic Impacts

2.2.4.1. Impacts on communities

Areas where oil and gas activities are conducted typically have two types of populations: a resident population, including families present before oil and gas activities, and a temporary and transient population, associated with workers in work camps and present for short-term and temporary jobs. Lack of belonging and a lifestyle with high spending, in part, to compensate for hard and unbalanced working conditions, generate a situation where the local economy becomes highly dependent on oil and gas revenues.[94] The lack of diversity of revenues generates vulnerability to changing conditions and a "boom and bust" cycle that is detrimental to the health of communities. High revenues combined with hard working conditions and lack of belonging to a community increase the risk of drug abuse, crime, and prostitution, negatively impacting communities.[95]

2.2.4.2. Economic impacts

Stranded assets are investments that, due to changes in market conditions or regulations, lose their economic value or become unviable before the end of their expected economic life. Proposed oil and gas projects face the risk of becoming stranded assets due to a combination of factors related to changes in market dynamics, regulatory developments, and growing concerns about climate change.[96]

The global push towards decarbonization and the transition to renewable energy sources pose a significant risk to traditional fossil fuel projects. Policies aimed at reducing greenhouse gas emissions and increasing renewable energy adoption may lead to decreased demand for oil and gas. Governments worldwide are implementing more stringent environmental regulations to address climate change concerns. New policies, carbon pricing mechanisms, and emissions reduction targets may impact the economic

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[93] Meltzer, G. Y., Merdjanoff, A. A., Gershon, R. R., Fothergill, A., Peek, L., & Abramson, D. M. (2024). "Adverse Effects of the Deepwater Horizon oil spill Amid Cumulative Disasters: A Qualitative Analysis of the Experiences of Children and Families." *Journal of Child and Family Studies*, 1-17.

[94] Ekales, F. E. (2019). *Influence of oil drilling on the socioeconomic wellbeing of Turkana community in Lokichar Location, Turkana County, Kenya* [Doctoral dissertation, Africa Nazarene University]; Ikechukwu, M. (2012). *Community perception of environmental and socio-economic impacts of oil exploitation: A Case Study of the Niger Delta*.

[95] Klasic, M., Schomburg, M., Arnold, G., York, A., Baum, M., Cherin, M., ... & Zialcita, L. (2022). "A review of community impacts of boom-bust cycles in unconventional oil and gas development." *Energy Research & Social Science*, *93*, 102843.

[96] Zhao, H., Wu, C., & Wen, Y. (2023). "Determinants of Corporate Fossil Energy Assets Impairment and Measurement of Stranded Assets Risk." *Energies*, *16*(17), 6340.

viability of fossil fuel projects. The oil and gas industry is subject to price volatility influenced by geopolitical events, economic downturns, and fluctuations in global energy markets. Sudden drops in oil prices can negatively impact the profitability and economic viability of projects. Technological advancements in renewable energy, energy storage, and energy efficiency may accelerate the shift away from traditional fossil fuels. This can make oil and gas projects less competitive or economically unviable in the long term. Oil and gas projects often have long development and operational lifecycles. Changes in market and regulatory conditions over these extended periods increase the risk of projects becoming economically unviable before reaching their full potential.

For governments investing in new oil and gas projects, several economic risks arise, including:

- Dependence on oil and gas revenue can expose governments to significant revenue volatility due to fluctuations in commodity prices.[97] This can impact budget planning and public spending. Governments heavily invested in oil and gas projects are exposed to global market conditions.

- Changes in demand, geopolitical events, and global economic trends can influence the profitability of the sector. If oil and gas projects become stranded assets due to changing market dynamics or regulatory shifts, governments may face the economic consequences of investments that do not generate expected returns. Governments investing in fossil fuel projects may face risks associated with the transition to a low-carbon economy.

- Policy changes favoring renewable energy could impact the economic viability of oil and gas assets. Governments may be responsible for addressing liabilities associated with abandoned or decommissioned oil and gas infrastructure. These costs can be significant and impact public finances.

3. Reviewing a Typical EIA

EIAs for oil and gas projects typically are organized into a common set of chapters. Below we provide a description of these EIA chapters, identifying material that is often lacking or inadequate.

3.1. The Executive Summary

The Executive Summary outlines key aspects of the full EIA, including the negative impacts of the proposed project. The Executive Summary is a key chapter because some

[97] Durand-Lasserve, O., & Karanfil, F. (2023). “Fiscal policy in oil and gas-exporting economies: Good times, bad times and ugly times.” *Energy Economics*, *126*, 106987.

reviewers, including non-technical government decision-makers, might read only the Executive Summary but no other chapters of the EIA. Defects in the Executive Summary chapter of EIAs for oil & gas projects occur when *the Executive Summary does not provide a thorough, complete, and accurate summary of all important information provided in the full EIA*. Too often, the Executive Summary section will omit, mischaracterize, gloss over, or whitewash negative information contained in the body of the EIA.

3.2. The Project Description

The Project Description, as its name implies, describes the project whose environmental impacts are being assessed. The Project Description is a key chapter because it defines the scope of the project under consideration that might be approved for development. Too often, the Project Description for a proposed oil and gas project is incomplete, leaving out key components of the project, or lacking key information needed to adequately assess its impacts. The Project Description is also a key chapter because it should contain all reasonable location and design alternatives that must be considered alongside the preferred alternative, to select an alternative with the least environmental impact. Defects in the Project Description of EIAs for oil and gas projects occur when the following questions cannot be answered affirmatively:

Does the Project Description <u>identify all the entities</u> (e.g., companies, consortiums, joint ventures) that are part of the project?

If a government entity is part of a consortium for a proposed oil & gas project, then this should be clearly stated. An inquiry of project owners is highly recommended because it may reveal recent changes of ownership and/or identify entities with poor environmental or human rights records, limited experience, or limited assets to cover the costs of repairing environmental damages.

Does the Project Description describe <u>all the anticipated components</u> of the proposed oil and gas project?

The layout of all components of the project should be presented in maps with adequate definition of the topography. For example, an EIA for a proposed oil & gas project should include a description of any access roads and waste disposal sites that would be necessary to undertake the project.

Does the Project Description describe <u>the rationale and purpose</u> of the proposed oil and gas project in order to identify reasonable alternatives that would achieve the same purpose?

Clearly defining the rationale and purpose of the project allows decision-makers and stakeholders to understand the objectives and goals of the proposed oil and gas project. Evaluating reasonable alternatives is a fundamental aspect of the EIA process. This involves considering different ways of achieving the project's purpose with varying technologies, locations, scales, or methodologies. Assessing alternatives allows for the identification of options that may have fewer environmental impacts or that better align with sustainability goals. For example, if the stated purpose of a proposed gas project is to meet projected future electrical energy demand, then reasonable alternatives, such as generating electrical energy from renewable sources, would also need to be considered in the EIA.

Does the Project Description describe in full detail all reasonable location and design alternatives for the project?

When planning an oil and gas project, the location and design alternatives play a crucial role in determining the environmental and social impacts of the project. For onshore projects, it is important to consider how location alternatives or reducing the size of the project would prevent habitat disruption, land use conflicts, and community displacement. Avoiding seismic risks, unstable slopes, and poor soil conditions is required to ensure the safety and stability of infrastructure. Spatial alternatives to onshore oil and gas projects can reduce impacts to ecologically or culturally sensitive areas such as wetlands, wildlife habitats, and Indigenous communities. For onshore projects, design alternatives include traditional versus enhanced recovery techniques that consider factors like well spacing, drilling fluids, and reservoir pressure and the pros and cons of concentrating extraction and processing facilities in a central location or spreading facilities across multiple smaller sites.

Does the Project Description adequately describe the location of all anticipated components of the proposed oil and gas project?

High-resolution (1:5000) maps with geographic coordinates should be provided illustrating the location and footprint of various elements of the project, including proposed drilling pads, boreholes, access roads, power lines, buildings, and infrastructure, showing relationships to natural and manmade features, such as boreholes, water storage impoundments, water intakes, water wells, and residences.

Does the Project Description describe the water needs (how much, from where, when, for what) for the project?

Sufficient information about water use must be provided to assess whether the proposed extraction and use of the water is feasible, practical, and acceptable in terms of impacts on both water quality and quantity for existing users, whether communities or ecosystems. A thorough description of both surface water and groundwater regimes is therefore required. Regarding water demand, the EIA must include an estimate of the volume of water to be used, the source of the water, the duration and period of the year of the extraction, and whether any temporary authorization or long-term permits are required.

Does the Project Description provide a detailed chronology of proposed events, including timelines for project construction, operation, and decommissioning?

Providing a detailed chronology of proposed events, including timelines for project construction, operation, and decommissioning, in an EIA for a proposed oil and gas project is crucial for several reasons. It helps in assessing the potential environmental, social, and economic impacts at different stages of the project. Understanding the timing of events allows for a more accurate evaluation of the cumulative effects over time. Timelines aid in identifying potential risks and uncertainties associated with each phase. This is essential for developing effective risk management strategies and contingency plans, especially during construction and decommissioning. A detailed chronology facilitates effective communication with local communities and stakeholders. It allows them to anticipate and understand the project's timeline, fostering better engagement and addressing concerns related to construction activities, operational impacts, and eventual decommissioning. This is crucial for assessing long-term sustainability and ensuring that impacts are adequately mitigated throughout the project's lifecycle. Clearly outlining the decommissioning timeline is essential for planning site closure, rehabilitation, and restoration activities. It ensures that environmental and social impacts are addressed responsibly once the project reaches the end of its operational life.

Does the Project Description identify <u>the consultants</u> who prepared the EIA?

Identifying the consultants who prepared the Environmental Impact Assessment (EIA) is important for transparency, accountability, and ensuring the credibility of the assessment. Knowing the consulting team allows stakeholders, regulatory bodies, and the public to assess the qualifications, expertise, and potential biases of the experts involved in shaping the environmental and social evaluation of a project. It enhances trust in the EIA process and the reliability of the information provided.

3.3. The Environmental Baseline

The Environmental Baseline describes the existing environmental characteristics of potentially affected resources and demographics of communities within the project's area of influence. The Environmental Baseline encompasses 1) the **physical environment**, including the characteristics of the existing climate, water resources, soil and geological resources, and air quality; 2) the **biological environment**, including the extent and abundance of terrestrial and marine flora and fauna, including populations of threatened and endangered species; and 3) the **socio-economic environment**, including the nature of human communities potentially affected by the project. The Environmental Baseline is a key chapter because without knowledge of existing environmental and social conditions, it is difficult, if not impossible, to predict what would be the potential environmental and social impacts of a proposed oil and gas project. Defects in the Environmental Baseline chapter of EIAs for oil and gas projects occur when the following questions cannot be answered affirmatively:

Does the Environmental Baseline contain accurate information about the <u>local climate</u> of the area?

The adequate design of measures to minimize pollution from oil and gas projects must take into account the local climate, such as rainfall patterns and storm frequencies. Preventative measures that fail to take into account accurate information about the local climate of the area, including predicted changes in the climate, can result in unnecessary environmental impacts. Adequate information about the local climate will include at least the following:

- Maps showing the location of climate stations and distribution of annual precipitation and temperature;
- Seasonal (monthly) fluctuations of precipitation and temperature; and
- Climate projections based on climate models that predict changes in precipitation (amplitude, time delay) and changes in temperature.

Does the Environmental Baseline contain accurate and complete information about <u>surface water</u> in the area?

Surface water information will mainly be presented in the hydrology section. It must include:

- Maps of major and minor watersheds, showing streams, lakes, and wetlands;
- Monitoring stations where stream flows are measured. Their coordinates must be presented in a table and shown on a map. Data from these stations must be presented in figures presenting discharge rates for low and high flows. The stations must provide data covering the most recent years, and a minimum of 3 years is required. Information on the method used to estimate stream flow must be provided. Stations must be within the local area (i.e., the area potentially impacted by the project) and outside of the local area for background comparison; and
- Identification and description of environmental flow needs and time-sensitive windows (e.g., fish spawning periods).

The section must characterize surface water quality and include the number and location of stations, including maps and a table listing coordinates. Locations must include stations outside of the area expected to be impacted so that impacts within the impacted area can be compared to these non-impacted reference/background locations.

Does the Environmental Baseline contain accurate and complete information about <u>groundwater</u> in the area?

Groundwater information will mainly be presented in the hydrogeology section. It must include:

- The locations of all the wells used to define the hydrogeological conditions and tables providing details (e.g., coordinates, depth interval monitored, depth to groundwater, monitoring dates);
- Map(s) of boundaries of aquifers;
- Maps illustrating the piezometric conditions (elevations of the water table);
- Seasonal fluctuations of the elevation of the water table in the various aquifers;
- Cross-sections or illustrations from 3D models describing the lithology of the ground, bedrock units, and interpreted aquifers, aquitards, aquicludes, and piezometric levels;
- A description of the surface and groundwater interconnection and interaction; and
- Existing conditions of the saltwater and freshwater interface and risks of saltwater intrusion, if applicable.

The section must characterize groundwater quality and include:

- Number and location of water wells and monitoring wells, with maps and tables listing coordinates and depth/span of the monitoring zones (Locations must include stations outside of the area expected to be impacted so that impacts within the impacted area can be compared to the non-impacted reference/background locations.); and
- Tables listing parameters, sampling dates, results, and comparisons to applicable standards or guidelines. Sampling dates must cover several seasons to represent the amplitude of variations. Selected parameters must cover and represent potential contaminants. For example, for oil and gas projects, analyses covering the various classes of hydrocarbons (e.g., light aromatics – BETX, light and heavy hydrocarbons, PAHs), metals, and ions (e.g., chloride) should be completed. Laboratory results with detection limits and quality control, including chain of custody forms, must be appended. For results obtained with field equipment, the type of equipment used and confirmation that equipment was properly calibrated before use must be provided.

Does the Environmental Baseline contain accurate and complete information about the <u>ambient air quality</u> of the area?

Information about existing pollutant levels in ambient air at a location determines what assimilative capacity the area has, if any, for additional emissions from a proposed oil and gas project. Ambient air quality varies by season. Therefore, accurate information about the ambient air quality of an area requires measurements for a period of more than one season, ideally over the course of an entire year or multiple years.

If a country or state has ambient air quality standards, the Environmental Baseline should clearly assess whether those standards are being met. If the standards are not being met before the project, the creation of new pollution sources should be viewed with extreme skepticism. If a country has weak ambient air quality standards that do not adequately protect public health and the environment, then the air quality guidelines developed by the World Health Organization[98] can be used for comparison instead.

Does the Environmental Baseline contain accurate and complete information about the geology of the area?

The geology section must provide information on surficial geology (e.g., soil deposits, types, and thickness — illustrated in maps), bedrock geology, with maps, and the location of faults and fractures.

Does the Environmental Baseline contain accurate and complete information, based on comprehensive methods, about ecological communities that would be impacted by the proposed oil and gas project, including areas that are within reach of a worst-case scenario oil spill?

For onshore projects, characterization of the ecological baseline should include characterization of terrestrial and freshwater species, land cover characterization, identification of biogeographic origin of species and conservation status, distribution and abundance of threatened species, and characterization of habitats critical to ecological processes and threatened species.

For offshore projects, characterization of the ecological baseline should include fisheries, marine mammals, coastal and shoreline species and habitats, benthic species (including deep sea corals), pelagic invertebrates, sea turtles, seabirds, and distribution and abundance of threatened species and sensitive habitats.

Field surveys are an important element of the EIAs. They are conducted to observe, qualify, and quantify species and their ecosystems. They must be thorough and follow protocols, so their results are representative and reliable. Therefore, they must cover areas scaled to the territory of the analyzed species; be conducted for long enough periods of time when species are present and observable (e.g., function of the seasons as well as the time in the day for nocturnal species); and use properly calibrated field equipment. The data should be presented in their raw and original forms as much as possible (e.g., field notes, laboratory reports – usually presented in appendices), compiled in tables, and presented in maps and charts for ease of visualization and interpretation.

Does the Environmental Baseline contain accurate and complete information about potentially affected human communities?

Accurate demographic information provides a clear understanding of the existing human population in and around the project area. This is vital for assessing the potential social and economic impacts of the project accurately. Demographic data, such as age, income

[98] World Health Organization. (22 September 2021). *What are the WHO Air quality guidelines?* https://www.who.int/news-room/feature-stories/detail/what-are-the-who-air-quality-guidelines

levels, and employment patterns, allows for a vulnerability and sensitivity analysis. Identifying groups that may be disproportionately affected helps in developing targeted mitigation measures to address potential social disparities. Accurate information about the cultural composition of communities helps in identifying potential impacts on cultural heritage, traditional practices, and community identity. This is essential for developing measures to preserve cultural integrity. Demographic data is crucial for conducting a thorough health impact assessment, especially in relation to potential exposure to pollutants, changes in access to healthcare, and other factors that may affect the well-being of the community.

For projects that may result in displacement or resettlement, understanding the demographic characteristics of affected communities is fundamental. It informs the planning and implementation of adequate resettlement programs, ensuring the well-being of displaced populations.

3.4. The Environmental Impacts

3.4.1. Climate impacts

Because continued production of fossil fuels, and combustion of their refined products, release greenhouse gases that pose an existential threat to human civilization, a complete and accurate assessment of the climate impact of a proposed oil and gas project is perhaps the most essential material an EIA for a project may contain. Several principal international organizations have warned that any new oil and gas projects are not compatible with a hospitable future climate.

Defects in the Environmental Impacts chapter of EIAs for oil and gas projects occur when the following questions cannot be answered affirmatively:

*Does the EIA accurately <u>estimate **all** potential emissions of greenhouse gases</u> from the proposed oil and gas project?*

There are three categories of GHG associated with proposed oil and gas emissions:

Scope 1 emissions refer to direct GHG emissions that occur from sources that are owned or controlled by the oil and gas company itself. This includes emissions from onsite combustion of fuels, such as flaring of associated gas or operating machinery and vehicles. It also includes emissions from fugitive sources, such as leaks from wells, equipment, and pipelines. It is important that Scope 1 emissions be based on the most recent evidence from satellite-based sensors of super-emitters of methane from wells in oil & gas fields.

Scope 2 emissions refer to indirect GHG emissions associated with the consumption of purchased electricity, heat, or steam by the oil and gas company. These emissions occur from the generation of the purchased energy used in their operations. The oil and gas company may not directly control the generation of this energy but can influence it through choices in purchasing renewable or non-renewable electricity.

Scope 3 emissions encompass all other indirect GHG emissions that occur in the value chain of the oil and gas company but are not classified as Scope 2. Scope 3 emissions include emissions that occur as a result of the combustion of products derived from oil and gas projects, such as the use of diesel and gasoline as transportation fuels and natural gas in power plants.

Guidance developed by the United States Council on Environmental Quality is considered best practice for including direct and indirect greenhouse gas emissions from proposed oil and gas projects.[99] This guidance states:

> "NEPA requires agencies to consider the reasonably foreseeable direct and indirect effects of their proposed actions and reasonable alternatives (as well as the no-action alternative). The term "direct effects" refers to reasonably foreseeable effects that are caused by the action and occur at the same time and place. The term 'indirect effects' refers to effects that are caused by the action and are later in time or farther removed in distance, but are still reasonably foreseeable. Indirect effects generally include reasonably foreseeable emissions related to a proposed action that are upstream or downstream of the activity resulting from the proposed action. For example, where the proposed action involves fossil fuel extraction, direct emissions typically include GHGs emitted during the process of exploring for and extracting the fossil fuel. *The reasonably foreseeable indirect effects of such an action likely would include effects associated with the processing, refining, transporting, and end-use of the fossil fuel being extracted, including combustion of the resource to produce energy. Indirect emissions are often reasonably foreseeable since quantifiable connections frequently exist between a proposed activity that involves use or conveyance of a commodity or resource, and changes relating to the production or consumption of that resource.*
>
> "… *Agencies can provide an upper bound for effects analysis by treating the resource provided or enabled by the actions they take as new or additional. In the example of fossil fuel extraction or transportation, this is sometimes referred to as a 'full burn' assumption, as the agency can provide an upper bound estimate of GHG emissions by assuming that all of the available resources will be produced and combusted to create energy.*"

It is extremely expensive and impractical to reduce direct emissions of greenhouse gases. See: [Can we reduce greenhouse emissions from fossil fuels?]

[99] U.S. Council on Environmental Quality. (09 January 2023). *National Environmental Policy Act Guidance on Consideration of Greenhouse Gas Emissions and Climate Change*. https://www.regulations.gov/docket/CEQ-2022-0005

Does the EIA accurately describe the human significance of the project's greenhouse gas (GHG) emissions?

Assessing the human significance of expected GHG emissions from a proposed energy project involves considering factors such as the social cost of carbon (SCC) and the project's consistency with GHG reduction pathways aligned with the long-term temperature goals of the Paris Agreement. The SCC represents the economic cost associated with each ton of GHG emissions, taking into account the damages caused by climate change, such as impacts on human health, agriculture, infrastructure, and ecosystems. It provides a monetary value to quantify the societal impact of emissions. Assessing the human significance involves estimating the projected emissions of the proposed project and calculating the associated SCC to understand the potential costs to society.

The Paris Agreement aims to limit global warming well below 2 degrees Celsius above pre-industrial levels and pursue efforts to limit it to 1.5 degrees Celsius. Assessing the human significance of GHG emissions involves evaluating whether the proposed project's emissions trajectory aligns with these long-term temperature goals. This assessment may involve comparing projected emissions to various GHG reduction scenarios and pathways outlined in scientific literature or recognized by international bodies, such as the Intergovernmental Panel on Climate Change (IPCC). If the project's emissions exceed the recommended reduction pathways, it may indicate a significant misalignment with climate goals and raise concerns about its sustainability.

Guidance developed by the United States Council on Environmental Quality is considered best practice for providing context within an EIA of the significance of GHG emissions and climate effects of proposed oil and gas projects.[100] This guidance states:

> "In addition to quantifying emissions as described in Section IV(A), agencies should disclose and provide context for GHG emissions and climate effects to help decision makers and the public understand proposed actions' potential GHG emissions and climate change effects. To disclose effects and provide additional context for proposed actions' emissions once GHG emissions have been estimated, agencies should use the following best practices, as relevant:
>
> (1) *In most circumstances, once agencies have quantified GHG emissions, they should apply the best available estimates of the [Social Cost of Greenhouse Gas Emissions] SC–GHG to the incremental metric tons of each individual type of GHG emissions expected from a proposed action and its alternatives*. SC–GHG estimates allow monetization (presented in U.S. dollars) of the climate change effects from the marginal or incremental emission of GHG emissions, including carbon dioxide, methane, and nitrous oxide. These 3 GHGs represent more than 97 percent of U.S. GHG emissions. The SC–GHG provides an appropriate and

[100] U.S. Council on Environmental Quality. (9 January 2023). *National Environmental Policy Act Guidance on Consideration of Greenhouse Gas Emissions and Climate Change*. https://www.regulations.gov/docket/CEQ-2022-0005

valuable metric that gives decision makers and the public useful information and context about a proposed action's climate effects even if no other costs or benefits are monetized, because metric tons of GHGs can be difficult to understand and assess the significance of in the abstract. The SC–GHG translates metric tons of emissions into the familiar unit of dollars, allows for comparisons to other monetized values, and estimates the damages associated with GHG emissions over time and associated with different GHG pollutants. The SC–GHG also can assist agencies and the public in assessing the significance of climate impacts. *This is a simple and straightforward calculation that should not require additional time or resources*. ...

"(2) Where helpful to provide context, such as for proposed actions with relatively large GHG emissions or reductions or that will expand or perpetuate reliance on GHG-emitting energy sources, *agencies should explain how the proposed action and alternatives would help meet or detract from achieving relevant climate action goals and commitments, including Federal goals, international agreements, state or regional goals, Tribal goals, agency-specific goals, or others as appropriate. However, as explained above, NEPA requires more than a statement that emissions from a proposed Federal action or its alternatives represent only a small fraction of global or domestic emissions.* ***Such comparisons and fractions are not an appropriate method for characterizing the extent of a proposed action's and its alternatives' contributions to climate change.*** Agencies also should discuss whether and to what extent the proposal's reasonably foreseeable GHG emissions ***are consistent with GHG reduction goals, such as those reflected in the U.S. nationally determined contribution under the Paris Agreement***."

With respect to the *Social Cost of Greenhouse Gas Emissions*, the following monetary values in the *Report on the Social Cost of Greenhouse Gases: Estimates Incorporating Recent Scientific Advances* [101] (last updated in September of 2022) should be used unless supplanted by more recent analysis:

Table ES.1: Estimates of the Social Cost of Greenhouse Gases (SC-GHG), 2020-2080 (2020 dollars)

	SC-GHG and Near-term Ramsey Discount Rate								
	SC-CO_2 *(2020 dollars per metric ton of CO_2)*			SC-CH_4 *(2020 dollars per metric ton of CH_4)*			SC-N_2O *(2020 dollars per metric ton of N_2O)*		
Emission Year	2.5%	2.0%	1.5%	2.5%	2.0%	1.5%	2.5%	2.0%	1.5%
2020	120	190	340	1,300	1,600	2,300	35,000	54,000	87,000
2030	140	230	380	1,900	2,400	3,200	45,000	66,000	100,000
2040	170	270	430	2,700	3,300	4,200	55,000	79,000	120,000
2050	200	310	480	3,500	4,200	5,300	66,000	93,000	140,000
2060	230	350	530	4,300	5,100	6,300	76,000	110,000	150,000
2070	260	380	570	5,000	5,900	7,200	85,000	120,000	170,000
2080	280	410	600	5,800	6,800	8,200	95,000	130,000	180,000

Values of SC-CO_2, SC-CH_4, and SC-N_2O are rounded to two significant figures. The annual unrounded estimates are available in Appendix A.4 and at: www.epa.gov/environmental-economics/scghg.

101 https://www.epa.gov/system/files/documents/2022-11/epa_scghg_report_draft_0.pdf

3.4.2. Air quality impacts

Does the EIA accurately assess how pollutant emissions from the proposed oil and gas project would impact local air quality?

As discussed in Chapter 2, oil and gas projects can emit substantial quantities of harmful air pollutants, including volatile organic compounds (VOCs), particulate matter (PM), nitrogen oxides (NO_x), and hydrogen sulfide (H_2S).

It is an internationally accepted best practice that EIAs for oil and gas projects with the potential to emit significant quantities of harmful air pollutants ***quantify*** predicted impacts to air quality (starting with baseline levels of air pollutant concentrations) using **an approved air pollutant dispersion model,** usually the AERMOD Modeling System.[102] This modeling should predict the ***total*** amounts of air pollution, using the baseline air quality data and adding the emissions from the new facility. An EIA that models air pollution due to the new facility, but does not incorporate existing air quality pollutants, is incomplete. Outputs from these models may then be compared with national ambient air quality standards, where these exist, or with the stricter health-based guidelines of the World Health Organization.[103]

3.4.3. Water quantity and quality impacts

Does the EIA accurately assess how water requirements and pollutant discharges from the proposed oil and gas project would impact local water availability?

The need for water and the discharge of pollutants will occur at-surface (e.g., spills, pipeline leaks), and at-depth (see Loss of Well Integrity – LOWI, induced seismicity, etc.). Therefore, EIAs must describe the reliance of local populations on water, providing inventories of drinking, livestock, and irrigation water sources and the risks of having these sources impacted. Oil and gas projects will need water from surface water and/or groundwater sources. How these will interfere or compete with existing needs in water supply must be described. Long-term effects (decades) related to spills, the operation of disposal wells, and LOWI will affect aquifers potentially used for drinking water and/or connected to surface water used for a water source. This requires adequate conceptual models (and, ideally, numerical models) describing both the shallow and deep groundwater regimes, the interaction between surface water and groundwater, and illustrating these long-term scenarios.

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[102] USEPA Preferred and Recommended Air Quality Dispersion Models are available at the following page: https://www.epa.gov/scram/air-quality-dispersion-modeling-preferred-and-recommended-models
[103] World Health Organization. (22 September 2021). *What are the WHO Air quality guidelines?* https://www.who.int/news-room/feature-stories/detail/what-are-the-who-air-quality-guidelines

Supporting documents (e.g., maps describing aquifers and piezometric conditions, anticipated drawdowns and geometry of cones of depressions, representative cross-sections, and areas and depth of surface water and groundwater interaction) must be provided.

With climate change affecting the water cycle, the EIA must describe the compounding effects of the proposed project on the potential stress on water resources due to the existing and projected water needs of the local population.

Does the EIA comprehensively assess the proposed oil and gas project's impacts on wildlife?

The EIA should include a full assessment, relevant to the local context of a particular proposal, of the impacts described in sections 2.1.1.1, 2.2.2.3, 2.2.2.4, and 2.2.2.5.

Does the EIA comprehensively assess the proposed oil and gas project's impacts on communities?

The EIA should include a full assessment, relevant to the local context of a particular proposal, of the impacts described in section 2.2.4.1.

3.4.4. Offshore projects

Does the EIA comprehensively assess the proposed oil and gas project's impacts on marine resources?

The EIA should include a full assessment, relevant to the local context of a particular proposal, of the impacts described in sections 2.1.2.1, 2.2.3.1, and 2.2.3.2.

3.4.4.1. Impacts Of Oil Spills

Does the EIA accurately assess how an oil spill would impact the environment?

As discussed in Chapter 2, both onshore and offshore oil and gas projects have the potential to leak substantial quantities of oil. Well blowouts and pipeline breaks have the potential to release up to several million barrels (several hundred million liters) of oil into terrestrial and marine environments.

It is internationally accepted best practice that EIAs for oil and gas projects ***quantify*** the impacts of potential oil spills using state-of-the art modeling tools that predict the trajectory, fate, and impact of spilled oil. Oil spill modeling ***must take into account worst-case scenarios***, including reasonably foreseeable quantities of oil spilled under conditions (e.g. water currents and wind speeds) that have the potential to cause maximum injuries to resources. For offshore oil and gas projects, best practice defines the size of a worst-case oil spill as:

“For an offshore oil production platform facility, the size of the worst-case discharge scenario is the sum of:

- The maximum capacity of all oil storage tanks and flow lines on the facility. Flow line volume may be estimated;
- The volume of oil calculated to leak from a break in any pipelines connected to the facility considering shutdown time, the effect of hydrostatic pressure, gravity, frictional wall forces and other factors; and
- The ***daily production volume from an uncontrolled blowout of the highest capacity well associated with the facility.*** In determining the daily discharge rate, [the operator] must consider reservoir characteristics, casing/production tubing sizes, and historical production and reservoir pressure data. [The] ***scenario must discuss how to respond to this well flowing for 30 days***.”[104]

3.4.5. Cumulative impacts

Cumulative impacts must consider past and future phases of oil and gas projects as well as related disturbances of the marine environment or lands due to deforestation, roads, pipelines and related infrastructure, power lines, etc. Completing this assessment involves determining the necessary spatial and temporal scale, identifying important ecological and human values before development takes place, and making the integration among potential ecological, economic, community, recreational, and health considerations and consequences.[105]

3.5. Environmental Management and Monitoring

There are numerous measures for mitigating and monitoring the potential impacts of oil and gas projects. Some of these apply to both onshore and offshore wells, and some apply either to onshore or offshore wells. The key commitments to mitigation and monitoring that oil and gas companies must make in EIAs for proposed projects are discussed in detail below.

For onshore wells, does the Environmental Management and Monitoring chapter commit the project proponent to follow internationally accepted best practices for well completions?

In the United States, the Environmental Protection Agency (EPA) has established regulations requiring green completions for newly drilled wells that should be considered international best practice. Specifically, the EPA's New Source Performance Standards (NSPS) require that all new, modified, or reconstructed wells be completed with green

[104] The Bureau of Safety and Environmental Enforcement (BSEE). (09 February 2016). *Worst Case Discharge Analysis (Volume I).* https://www.bsee.gov/sites/bsee.gov/files/volume-i-wcd-discharge-analysis-report-13january2017.pdf

[105] Case Brief: Yahey v. British Columbia, 2021 BCSC 1287 https://www.dgwlaw.ca/case-brief-yahey-v-british-columbia-2021-bcca-1287/

completions equipment unless an exemption applies.[106] Green completions, also known as reduced emissions completions (RECs), are a process used in the oil and gas industry to reduce emissions of volatile organic compounds (VOCs) and other pollutants during the completion of oil and gas wells. It involves *capturing the gas that flows back to the surface during the completion process and processing it* so that it can be sold or used as fuel, thereby reducing emissions of greenhouse gases and other pollutants. The core text of the regulation states:

> "40 CFR § 60.5375a What VOC standards apply to well affected facilities. ...
>
> "(1) For each stage of the well completion operation, as defined in § 60.5430a, follow the requirements specified in paragraphs (a)(1)(i) through (iii) of this section. ...
>
> "(ii) During the separation flowback stage, route all recovered liquids from the separator to one or more well completion vessels or storage vessels, re-inject the recovered liquids into the well or another well, or route the recovered liquids to a collection system. Route the recovered gas from the separator into a gas flow line or collection system, re-inject the recovered gas into the well or another well, use the recovered gas as an onsite fuel source, or use the recovered gas for another useful purpose that a purchased fuel or raw material would serve. If it is technically infeasible to route the recovered gas as required above, follow the requirements in paragraph (a)(3) of this section. If, at any time during the separation flowback stage, it is technically infeasible for a separator to function, you must comply with paragraph (a)(1)(i) of this section."

In simple terms, this means that any liquids and gases from a required separator at an onshore oil and gas facility must either be: 1) **for liquids (like oil and water)**, sent to a storage vessel or a vessel used in well completion, re-injected into the well or another well to continue the extraction process, or directed to a collection system for further processing or disposal; and 2) **for gases (like natural gas**), sent into a pipeline or collection system for transportation or further use, re-injected back into the well or another well to maintain pressure and enhance production, recovered on-site as a fuel source for powering equipment or heating, or put to another useful purpose such as use as a fuel or a raw material in operations.

The environmental management plan for all EIAs for proposed onshore oil and gas projects should similarly commit to the use of green completions for all new wells.

For onshore wells, does the Environmental Management and Monitoring chapter commit the project proponent to allow third parties to detect methane leaks requiring corrective action?

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[106] 40 CFR Part 60, Subpart OOOOa—Standards of Performance for Crude Oil and Natural Gas Facilities for which Construction, Modification or Reconstruction Commenced After September 18, 2015 and On or Before December 6, 2022 https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-60/subpart-OOOOa

In the United States, the Environmental Protection Agency (EPA) has established regulations aimed at reducing fugitive emissions from oil and gas operations that should be considered international best practice. Specifically, in 2023, the EPA issued a final rule, "Standards of Performance for New, Reconstructed, and Modified Sources and Emissions Guidelines for Existing Sources: Oil and Natural Gas Sector Climate Review", which contains requirements for leak monitoring and repair timelines, at both new and existing operations.[107] According to the EPA's factsheet for the rule, "under the final rule's super-emitter program, the EPA will certify third parties, will receive and evaluate the data the third parties provide, and send notifications to owners and operators. … Once notified, owners and operators must investigate to find the source of the super emitter event. The responsible owners or operators must report the results of that investigation to EPA and repair any leaks or releases. …"[108]

For onshore wells, does the Environmental Management and Monitoring chapter commit the project proponent to follow internationally accepted best practices for monitoring air quality?

Internationally accepted best practices for monitoring air quality affected by onshore oil and gas activities generally revolve around comprehensive and systematic monitoring strategies that address the specific emissions and potential pollutants associated with these operations. Some key components of such best practices include:

- Employing continuous air quality monitoring systems at and around oil and gas facilities to track emissions in real time. These systems can detect fluctuations and potential issues promptly;
- Measuring a range of air quality parameters, including criteria pollutants (such as particulate matter, sulfur dioxide, nitrogen oxides, and volatile organic compounds), hazardous air pollutants, and greenhouse gases like methane;
- Implementing fence line monitoring systems to assess emissions and potential exposures in nearby communities, as well as sensitive environments. These systems can provide real-time data to the public and regulators; and
- Utilizing remote sensing technologies, such as infrared cameras, drones, and satellites, to detect and quantify emissions from facilities like well pads, compressor stations, and pipelines.

For onshore wells, does the Environmental Management and Monitoring chapter commit the project proponent to follow internationally accepted best practices for monitoring of surface and groundwater quality?

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[107] 40 CFR Part 60, Subpart OOOOb—Standards of Performance for Crude Oil and Natural Gas Facilities for which Construction, Modification or Reconstruction Commenced After December 6, 2022 https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-60/subpart-OOOOb

[108] USEPA. (02 December 2023). "EPA Issues Final Rule to Reduce Methane and Other Pollution from Oil and Natural Gas Operations Fact Sheet." https://www.epa.gov/system/files/documents/2023-12/epas-final-rule-for-oil-and-gas-operations.-overview-fact-sheet.pdf

International best practices for monitoring surface water and groundwater sources are typically based on guidelines and standards established by organizations like the World Health Organization (WHO), the United Nations Environment Programme (UNEP), and national environmental agencies. They typically include:

- Develop a comprehensive monitoring network that covers both local and regional areas, water sources, and potential pollution sources. Monitoring sites should cover surface water and shallow and deep groundwater. The network must also include background locations.
- Regular and consistent sampling is essential. The frequency of sampling should be determined based on the characteristics of the water source and the potential risks. Seasonal variations and extreme weather events should also be considered (e.g., monsoon, freshet, etc.).
- Sample using standardized sampling methods to ensure accuracy and consistency, such as using clean and appropriate sampling equipment to collect water samples.
- Determine the parameters to be monitored based on local regulations, water quality objectives, and potential sources of contamination. Common parameters include pH, temperature, turbidity, dissolved oxygen, nutrients, metals, and a wide range of organic and inorganic contaminants.
- Develop standardized reporting formats and share monitoring results with stakeholders, including the public. The data must be easy to understand and interpret and clearly allow comparison to applicable standards.
- Assess regularly to identify potential risks to human health and the environment (i.e., identify non-compliance and trends).
- Evaluate the impacts of pollution and develop mitigation strategies.
- Involve local communities and stakeholders in the monitoring process. Their input and participation can provide valuable insights and improve the overall monitoring process.

For both onshore and offshore wells, does the Environmental Management and Monitoring chapter commit the project proponent to follow internationally accepted best practices for the selection of drilling muds and fluids?

The selection of drilling muds and fluids in the oil and gas industry involves several environmental considerations to minimize the impact of drilling operations on the environment. These considerations aim to protect ecosystems, water resources, and the overall environmental quality. Key environmental factors include:

Toxicity and Biodegradability: Choose drilling mud and fluid formulations with lower toxicity to reduce harm to aquatic life in the event of spills or discharges. Select biodegradable additives to facilitate the breakdown of drilling fluids in case of unintentional releases. Drilling mud and fluid formulations with lower toxicity, which can help reduce harm to aquatic life in the event of spills or discharges, typically fall into two main categories: water-based muds (WBM) and synthetic-based muds (SBM). These formulations have various environmental advantages:

Water-Based Muds (WBM): 1) Non-Aqueous Drilling Fluids (NAFs) are a type of WBM that contains minimal water content and is often considered less toxic to aquatic life compared to oil-based muds. They have low toxicity due to their reduced hydrocarbon content; 2) Invert Emulsion Muds are a subcategory of NAFs that use oil droplets dispersed in a water-based continuous phase. They can be formulated to have low toxicity while maintaining drilling efficiency; and 3) Polymer Muds, some polymer-based WBMs can be formulated to have lower toxicity and are biodegradable, which can reduce harm to aquatic life.

Synthetic-Based Muds (SBM): 1) Synthetic-Based Drilling Fluids – SBMs are often considered environmentally friendly due to their low toxicity and minimal impact on aquatic life. They are formulated with synthetic base oils, and some are biodegradable; 2) Esther-Based Muds – Some SBMs use ester-based fluids, which have lower toxicity compared to traditional oil-based muds; and 3) Silicone-Based Muds, a type of SBM, are generally less toxic and more environmentally benign compared to oil-based muds.

For both onshore and offshore wells, does the Environmental Management and Monitoring chapter commit the project proponent to follow internationally accepted best practices for establishing, maintaining, and monitoring well integrity?

In recent years, well integrity-related laws, standards, and specifications have developed rapidly, and some international industry associations and standardization organizations have issued standards, guidelines and recommended practices related to well integrity. Norway, the United Kingdom, the United States, and other countries have successively issued many supplementary standards related to well integrity, including the integrity design, construction, and maintenance of well barrier components, such as pipe strings, downhole tools, and wellhead devices. Standards, guidelines, and best practices are being revised and developed. At the same time, countries are continuously improving regulations related to well integrity. The International Organization Standardization (ISO) and other international standards organizations have also started to compile well integrity standards, and initially formed some internationally used well integrity management and specifications.[109]

Commitments of the proponents must include:

- The well operator shall define and document a barrier philosophy that includes barriers to formation fluids, injected fluids, lift gas, and power fluids; and
- The effects of temperature changes shall be considered, especially in subsea or arctic situations, since the wellbore, flow lines, manifolds, risers, etc., cool down quickly when remotely actuated valves are closed. Special considerations that

[109] ISO 16530:2017 Petroleum and natural gas industries – Well integrity (2022) provides a good reference.

shall be taken into account should include: 1) At the end of each phase in the well life cycle, requirements for documentation, certification and verification shall be met to ensure that management of well integrity is maintained; 2) The Well Operator shall apply a management of change (MOC) process to address and record changes to integrity assurance requirements for an individual well or to the well integrity management system; and 3) All selected materials and equipment that will be used to establish a well barrier shall be verified against the well program prior to installation in the well.

Typically, Environmental Management and Monitoring chapters in project proposals, regulatory frameworks, or EIA documents reference the importance of well integrity, but the level of detail and specific commitments can vary. In general, some of the following points must be considered:

- Environmental regulations and permit conditions can vary from one jurisdiction to another. In some cases, the regulatory framework may explicitly require project proponents to adhere to internationally accepted best practices for well integrity.
- The oil and gas industry, including onshore and offshore drilling operations, often follows industry standards and best practices established by organizations such as the American Petroleum Institute (API), International Association of Oil & Gas Producers (IOGP), and others. These standards cover various aspects of well integrity.
- The project proponent, in collaboration with regulatory authorities, may establish specific commitments and requirements for well integrity in the environmental management and monitoring chapter of the project proposal. These commitments may be informed by industry standards and best practices.
- Some projects may include provisions for third-party verification of well integrity, where independent experts assess and confirm that best practices are being followed.

For both onshore and offshore wells, does the Environmental Management and Monitoring chapter commit the project proponent to follow internationally accepted best practices for the disposal of produced water, drilling muds, drill cuttings, and produced sand?

Regulations of the Environmental Protection Agency[110] are an example of best international practice with respect to the disposal of produced water, drilling muds, drill cuttings, and produced sand generated by onshore oil & gas projects. This best practice **prohibits** the discharge of these wastes to any surface waters, even if treated.

[110] 40 CFR Part 435, sections 435.30-34 Effluent Limitation Guidelines for the Oil And Gas Extraction Point Source Category, Subpart C - Onshore Subcategory. https://www.ecfr.gov/current/title-40/chapter-I/subchapter-N/part-435#subpart-C

> "§ 435.32 Effluent limitations guidelines representing the degree of effluent reduction attainable by the application of the best practicable control technology currently available.
>
> [Onshore oil & gas facilities] shall achieve the following effluent limitations representing the degree of effluent reduction attainable by the application of the best practicable control technology currently available (BPT): ***there shall be no discharge of waste water pollutants*** into navigable waters from any source associated with production, field exploration, drilling, well completion, or well treatment (i.e., produced water, drilling muds, drill cuttings, and produced sand)."

Prohibition of the discharge of produced water, drilling muds, drill cuttings, and produced sand generated by onshore oil and gas projects is based on the availability and feasibility of using underground injection control (UIC) wells for the injection and disposal of wastes into geological formations that are isolated from underground sources of drinking water and are chosen based on their capacity to safely contain the injected fluids without contaminating drinking water aquifers.

The environmental management plan for all EIAs for proposed onshore oil and gas projects should similarly commit to the prohibition of the discharge of produced water, drilling muds, drill cuttings, and produced sand into any surface waters.

International best practice for the disposal of wastes (produced water, drilling muds, drill cuttings, and produced sand) into any surface waters from offshore oil and gas projects *within 12 nautical miles of the shoreline* (i.e. within a country's territorial sea) are identical as the best practice for the disposal of these wastes from onshore oil and gas projects: that is, ***there shall be no discharge*** of these wastes to any surface water, including the marine environment.[111] This prohibition is similarly based on the availability and feasibility of using UIC wells for the safe disposal of these wastes.

International best practice for the disposal of wastes (produced water, drilling muds, drill cuttings, and produced sand) into any surface waters from offshore oil and gas projects *beyond the territorial seas* are exemplified by regulations of the Environmental Protection Agency that require pretreatment of these wastes prior to their disposal.[112] Under this best practice, the disposal of produced water, well treatment, completion, and workover fluids is permitted only if these wastes are pretreated to reduce their oil and grease content to a maximum of 42 milligrams per liter (42 mg/L) on a daily basis, and an average of 29 mg/L on a monthly basis. Under this best practice, the discharge to any

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[111] 40 CFR Part 435, sections 435.40-47 Effluent Limitation Guidelines for the Oil And Gas Extraction Point Source Category, Subpart C - Coastal Subcategory.. https://www.ecfr.gov/current/title-40/chapter-I/subchapter-N/part-435#subpart-D

[112] 40 CFR Part 435 § 435.10-15, Effluent Limitation Guidelines for the Oil And Gas Extraction Point Source Category, Subpart A - Offshore Subcategory, https://www.ecfr.gov/current/title-40/chapter-I/subchapter-N/part-435#subpart-A

surface water, including the marine environment, of any free oil or diesel oil in drilling fluids and drill cuttings is prohibited.

The environmental management plan for all EIAs for proposed offshore oil and gas projects should similarly commit to the attainment of these waste disposal requirements.

For onshore and offshore wells, does the Environmental Management and Monitoring chapter commit the project proponent to follow internationally accepted best practices for plugging and well abandonment?

Internationally accepted best practices for plugging and well abandonment in the oil and gas industry are crucial for ensuring the safe and environmentally responsible decommissioning of wells. These practices help mitigate the potential risks associated with abandoned wells, such as groundwater contamination, surface hazards, and ecosystem impacts. While specific regulations and standards can vary by region, some common best practices include:

- Conducting a thorough assessment of well integrity before abandonment to identify potential issues that may need to be addressed during the plugging process;
- Removing debris, fluids, and any obstructions from the wellbore to ensure a clean environment for plugging;
- Using properly designed cement plugs to isolate different formations and prevent fluid migration within the wellbore (multiple cement plugs may be required at different depths);
- In addition to cement, using mechanical barriers such as bridge plugs or packers to further isolate specific zones in the wellbore;
- Performing pressure testing to verify the integrity of cement and mechanical barriers. This ensures that the well is effectively sealed and isolated; and
- In the case of offshore wells, cutting and capping wellheads to prevent the release of hydrocarbons and other fluids into the environment. This is particularly important for wellheads in deep water environments.

It is important to note that the oil and gas industry often relies on industry-specific guidelines and standards provided by organizations like the American Petroleum Institute (API) and the International Association of Oil & Gas Producers (IOGP).[113] These organizations offer detailed guidance on well plugging and abandonment best practices, and their standards are often recognized internationally.

For offshore wells, does the Environmental Management and Monitoring chapter commit the project proponent to follow internationally accepted best practices for the protection of marine mammals and sea turtles during seismic surveys?

[113] https://www.iogp.org/workstreams/safety/well-control/#1667487111994-5b6ca16b-d054

Regulations of the National Marine Fisheries Service (NMFS) and the National Oceanic and Atmospheric Administration (NOAA)*[114]* are examples of best international practice to prohibit use of acoustic equipment during offshore seismic surveys when there is the possibility that marine mammals are close by. These best practices have two foundations: 1) **monitoring** for the presence of marine mammals; and 2) the establishment of **exclusion zones** when the presence of marine mammals is detected.

Monitoring: Protected Species Observers (PSOs) - trained observers stationed on the seismic vessel with binoculars to detect the presence of marine mammals); and Passive Acoustic Monitors (PAM systems — technology used to detect and monitor underwater sound, particularly the vocalizations of marine mammals and other marine life) for ordering the immediate shut down of airguns when an observation of a marine mammal occurs are fundamental requirements for the conduct of seismic surveys. With respect to monitoring for the presence of marine mammals, best practice requires:[115]

> "(i) During survey operations (i.e., any day on which use of the acoustic source is planned to occur, and whenever the acoustic source is in the water, whether activated or not), a minimum of two PSOs must be on duty and conducting visual observations at all times during daylight hours (i.e., from 30 minutes prior to sunrise through 30 minutes following sunset).
>
> "(ii) Visual monitoring must begin not less than 30 minutes prior to ramp-up and must continue until one hour after use of the acoustic source ceases or until 30 minutes past sunset.
>
> "(iii) Visual PSOs must coordinate to ensure 360° visual coverage around the vessel from the most appropriate observation posts, and must conduct visual observations using binoculars and the naked eye while free from distractions and in a consistent, systematic, and diligent manner.
>
> "(iv) Visual PSOs must immediately communicate all observations of marine mammals to the on-duty acoustic PSO, including any determination by the PSO regarding species identification, distance, and bearing and the degree of confidence in the determination.
>
> "(v) Any observations of marine mammals by crew members aboard any vessel associated with the survey must be relayed to the PSO team."
>
> "(i) … All source vessels must use a towed PAM system at all times when operating in waters deeper than 100 m, which must be monitored by a minimum of one acoustic PSO beginning at least 30 minutes prior to ramp-up, at all times during use of the acoustic source, and until one hour after use of the acoustic source ceases. "PAM system" refers to calibrated hydrophone arrays with full system redundancy to detect, identify, and

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[114] 50 CFR Part 217, Subpart S - Taking Marine Mammals Incidental to Geophysical Survey Activities in the Gulf of Mexico.. https://www.ecfr.gov/current/title-50/chapter-II/subchapter-C/part-217/subpart-S
[115] Ibid. 50 CFR § 217.184

estimate distance and bearing to vocalizing cetaceans, coupled with appropriate software to aid monitoring and listening by a PAM operator skilled in bioacoustics analysis and computer system specifications capable of running appropriate software. The PAM system must have at least one calibrated hydrophone (per each deployed hydrophone type and/or set) sufficient for determining whether background noise levels on the towed PAM system are sufficiently low to meet performance expectations. Applicants must provide a PAM plan including description of the hardware and software proposed for use prior to proceeding with any survey where PAM is required.

> “(ii) Acoustic PSOs must immediately communicate all detections of marine mammals to visual PSOs (when visual PSOs are on duty), including any determination by the PSO regarding species identification, distance, and bearing, and the degree of confidence in the determination.
>
> “(iii) Acoustic PSOs may be on watch for a maximum of four consecutive hours followed by a break of at least two hours between watches, and may conduct a maximum of 12 hours of observation per 24-hour period. Combined observational duties (visual and acoustic but not at the same time) must not exceed 12 hours per 24-hour period for any individual PSO.”

An **exclusion zone** is the distance to an air gun within which the detection of a marine mammal requires the shutdown of the air gun and related seismic equipment. Concerning exclusion zones for when the presence of marine mammals is detected, best practice requires:

> “PSOs must establish and monitor applicable exclusion and buffer zones. These zones must be based upon the radial distance from the edges of the airgun array (rather than being based on the center of the array or around the vessel itself). During use of the acoustic source (i.e., anytime the acoustic source is active, including ramp-up), occurrence of marine mammals within the relevant buffer zone (but outside the exclusion zone) should be communicated to the operator to prepare for the potential shutdown of the acoustic source.
>
> “(i) …Two exclusion zones are defined, depending on the species and context. A standard exclusion zone encompassing the area at and below the sea surface out to a radius of 500 meters from the edges of the airgun array (0-500 m) is defined. For special circumstances (defined at § 217.184(b)(9)(v)), the exclusion zone encompasses an extended distance of 1,500 meters (0-1,500 m).”
>
> “(6) … Shutdowns must be implemented as specified in this paragraph (b)(6).”
>
> “(v) … The extended 1,500-m exclusion zone must be applied upon detection (visual or acoustic) of a baleen whale, sperm whale, beaked whale, or Kogia spp. [species] within the zone.”

The environmental management plan for all EIAs for proposed offshore seismic exploration projects should include commitments to protecting marine mammals as robust as those required by the NMFS and the NOAA for protecting marine mammals in the Gulf of Mexico.

For offshore wells, does the Environmental Management and Monitoring chapter commit the project proponent to follow internationally accepted best practices for well control?

The inability to ***activate or trigger the blowout preventer and regain well control*** was the key reason the 2010 Deepwater Horizon oil spill caused tremendous environmental damage.

In 2016, the U.S. Bureau of Safety and Environmental Enforcement (BSEE) finalized a rule intended to prevent another similar disaster by imposing design requirements for blowout preventers (BOPs) and related equipment for controlling a well in the event of a serious accident.[116] The preamble of the rule explains:

> "Ensuring the integrity of the wellbore and maintaining control over the pressure and fluids during well operations are critical aspects of protecting worker safety and the environment. The investigations that followed the Deepwater Horizon incident documented gaps or deficiencies in the OCS regulatory programs and made recommendations for improvements. The objective of this rulemaking is to address many of these recommendations, especially those related to BOP system design, performance, and reliability.
>
> "The BOP equipment and systems are critical components of many well operations. The BOP systems can be the last defense against a release of hydrocarbons into the environment, when all other forms of well control have failed (e.g., the drilling fluid program). The BOPs may be the last line of defense in preventing release of gas that is volatile and considered to be an extreme safety hazard to rig personnel (uncontrolled gas releases can lead to explosions). The primary purpose of BOP systems is to prevent the uncontrolled release of hydrocarbons in an emergency by mechanically closing valves or rams that block the flow of fluid from the well. In some situations, this may require shear rams on the BOP stack to sever the drill pipe before the well can be sealed.
>
> "The BOP equipment and systems have increased in complexity as the industry moves into deeper water and develops reservoirs with pressures greater than 15,000 pounds per square inch (psi) or temperatures greater than 350 degrees Fahrenheit (F). Reservoirs with these conditions are considered high pressure high temperature (HPHT). Most of the BOPs that are used in deep water operations (400 to 10,000 feet) are located on the seabed, which presents technological and operational challenges. Additionally, HPHT operations create special metallurgical and design issues."[117]

[116] 30 CFR Part 250, Subpart G - Well Operations and Equipment. https://www.ecfr.gov/current/title-30/chapter-II/subchapter-B/part-250/subpart-G

[117] https://www.federalregister.gov/documents/2015/04/17/2015-08587/oil-and-gas-and-sulphur-operations-in-the-outer-continental-shelf-blowout-preventer-systems-and-well

The rule imposes 16 requirements for improving the performance and reliability of BOPs at new offshore oil and gas operations.[118] The environmental management plan for all EIAs for proposed offshore oil wells should include commitments to use BOP equipment and systems as robust as those required by the ***well control rule*** of the U.S. BSEE.

For offshore wells, does the Environmental Management and Monitoring chapter commit the project proponent to follow internationally accepted best practices for preventing routine flaring?

International best practice requires that companies operating offshore oil and gas projects minimize the flaring and venting of hydrocarbons to the extent practicable.[119] Flaring and venting must be limited to situations where it is necessary for safety or operational reasons.[120] Companies that fail to prevent routine flaring must pay substantial royalties for the loss of natural gas.[121] The environmental management plan for all EIAs for proposed offshore oil and gas projects should similarly commit to preventing routine flaring.

For offshore wells, does the Environmental Management and Monitoring chapter commit the project proponent to follow internationally accepted best practices for oil spill response and preparedness?

International best practice for the development of oil spill response and preparedness plans for proposed offshore oil and gas projects is exemplified by the requirements of Title 30 Part 254 (Subpart B - Oil-Spill Response Plans for Outer Continental Shelf Facilities) of the U.S. Code of Federal Regulations, enacted by the U.S. Bureau of Safety and Environmental Enforcement in 2011.[122] Under this best practice, oil spill response plans (OSRPs) must include detailed information about the facility and its operations, including the type and quantity of oil stored and handled, location, and response capabilities. Specifically, OSPRs must:

- Designate a qualified individual and an Oil Spill Response Organization (OSRO) responsible for coordinating and executing spill response activities. These entities must be available 24/7;

[118] 30 CFR § 250.734 - What are the requirements for a subsea BOP system? https://www.ecfr.gov/current/title-30/chapter-II/subchapter-B/part-250/subpart-G/subject-group-ECFR045ffcd99ad03d3/section-250.734

[119] 30 CFR Part 250, Subpart K—Oil and Gas Production Requirements, https://www.ecfr.gov/current/title-30/chapter-II/subchapter-B/part-250/subpart-K

[120] 30 CFR § 250.1160 - When may I flare or vent gas? https://www.ecfr.gov/current/title-30/chapter-II/subchapter-B/part-250/subpart-K/subject-group-ECFR4195e6d98546dbf/section-250.1160

[121] 30 CFR Part 1202 – Royalties, https://www.ecfr.gov/current/title-30/chapter-XII/subchapter-A/part-1202

[122] 30 CFR Part 254, Subpart B - Oil-Spill Response Plans for Outer Continental Shelf Facilities. https://www.ecfr.gov/current/title-30/chapter-II/subchapter-B/part-254/subpart-B

- Describe the available response resources, including equipment, personnel, and response times. It should also detail arrangements for contracting with OSROs and outline the specific procedures for responding to spills, including containment, recovery, and cleanup. This includes strategies for protecting sensitive environments and wildlife;
- Provide training for personnel involved in spill response and conduct regular drills to ensure the effectiveness of response actions;
- Establish procedures for notifying appropriate authorities, including the National Response Center (NRC), and for reporting spill incidents promptly;
- Address coordination with local, state, and federal authorities to ensure a coordinated response effort;
- Maintain response equipment in a state of readiness and provide documentation of maintenance and inspections; and
- Maintain records of drills, exercises, equipment testing, and other compliance-related activities.

The identification of response resources that can arrive at the scene of a spill promptly and have equipment that can ***effectively contain a worst-case*** oil spill are critical aspects of OSRP.

Additional information that must be included in OSRPs regarding response resources includes:

Photo 17 An offshore vessel performing oil spill response exercise in the middle of the sea. Oil spill response comprises of mother boat and a tow boat to carry oil spill boom. Mark_vyz on Shutterstock.com

- Equipment Inventory: The plan must provide a comprehensive inventory of response equipment available for spill response. This includes a detailed list of all response tools and resources, such as booms, skimmers, dispersants, containment systems, and personal protective equipment.

- Response Personnel: The plan should outline the roles and responsibilities of response personnel, including their training, qualifications, and specific duties in the event of a spill. This may include spill management teams, cleanup crews, and other relevant personnel.

- Response Timeframes: The response plan must specify ***the expected response times for each type of equipment and personnel.*** This information helps assess the readiness and effectiveness of the response team.

- Response Vessels: If vessels are part of the response resources, the plan should detail their specifications, capacities, locations, and deployment procedures. This information is critical for managing and mobilizing response vessels.

- Response Contractors (OSROs): Plans should identify and provide contact information for the OSRO that the facility has contracted with. The OSRO is responsible for providing response resources and personnel when needed.

- Resource Availability: Plans should specify the geographical areas where response resources are available and how they can be mobilized to the facility or spill site.

- Alternative Response Strategies: In some cases, the plan may need to outline alternative strategies if the primary resources are unavailable, or the spill exceeds the capacity of the initial response equipment.

- Waste Disposal Plan: Detail how recovered oil, waste materials, and contaminated equipment will be managed, stored, and disposed of in compliance with environmental regulations.

- Resource Deployment Plan: Provide a plan for how response resources will be deployed during a spill, including the deployment order, staging areas, and communication protocols.

This information is crucial for ensuring a rapid, effective, and well-coordinated response to oil spills from Outer Continental Shelf (OCS) facilities, as it outlines the available resources and the procedures for deploying them in the event of an oil spill.

Photo 18 Capping stack image from NOAA at https://response.restoration.noaa.gov/scientific-support-coordinators-tour-deepwater-well-containment-facility

A capping stack, defined as a mechanical device, including one pre-positioned that can be installed on top of a subsea or surface wellhead or blowout preventer to stop the uncontrolled flow of fluids into the environment, is a critical response resource. It is international best practice to require offshore oil and gas projects to have **a collocated capping stack**, as detailed in the following section of Title 30, Part 250 of the Code of Federal Regulations (Oil And Gas And Sulphur Operations In The Outer Continental Shelf):

"§ 250.462 What are the source control, containment, and collocated equipment requirements?"

The environmental management plan for all EIAs for proposed offshore oil wells should include an oil spill response plan with all the information required by the U.S. Bureau of Safety and Environmental Enforcement regulation applicable to Outer Continental Shelf oil and gas projects.

For offshore oil and gas projects, does the Environmental Management and Monitoring chapter commit the project proponent to follow internationally accepted best practices for <u>protecting biologically sensitive underwater features and deep-sea benthic communities</u>?

Photo 19 Fish, coral, and sea lions in Baja Mexico. Photo by Karim Iliya on Kogia.

In the United States, there is an administrative order (NTL No. 2009-G39, Notice To Lessees and Operators of Federal Oil, Gas, and Sulphur Leases and Pipeline Right-Of-Way Holders Outer Continental Shelf, Gulf Of Mexico OCS Region - Biologically-Sensitive Underwater Features and Areas) requiring offshore oil and gas operations to abide by the following stipulations:

TOPOGRAPHIC FEATURES

> "… no bottom-disturbing activities, including the use of anchors, chains, cables, and wire ropes from a semisubmersible drilling rig or from a pipeline construction vessel ***may occur within 152 meters (500 feet) of the designated "No Activity Zone" of a topographic feature***."
>
> "…If more than two wells that are not from development operations are to be drilled from the same surface location and that surface location is within the 3-mile Zone of an identified topographic feature, **all drill cuttings and drilling fluids from the drilling operations are to be shunted to the sea bottom through a structurally sound downpipe that terminates an appropriate distance, but no more than 10 meters (33 feet), from the bottom**." (Emphasis added).

Under the administrative order, “topographic features” means “isolated areas of moderate to high relief that provide habitat for hard-bottom communities of high biomass and diversity and large numbers of plant and animal species, and support, either as shelter or food, large numbers of commercially and recreationally important fishes.”

LIVE BOTTOMS (PINNACLE TREND FEATURES)

> “… no bottom-disturbing activities, including those caused by anchors, chains, cables, or wire ropes from a semisubmersible drilling rig or from a pipeline construction vessel, **may occur within 30 meters (100 feet) of any hard bottoms/pinnacles that have vertical relief of 8 feet or more**.” (Emphasis added).
>
> “If you propose bottom-disturbing activities (including rig placement, rig or construction barge use of anchors, chains, cables, and wire ropes) **within 61 meters (200 feet) of pinnacles, include a map at a scale of 1 inch = 1,000 feet with DGPS accuracy depicting**:
>
> a. Bathymetric contours at 2-foot intervals;
> b. An outline of the pinnacles;
> c. An annotation of the height of individual pinnacles;
> d. The surface location of each proposed well or platform; and
> e. The position of anchors, chains, cables, and wire ropes relative to each proposed surface location.
>
> “You may use transparency overlays to other maps to display items d. and e. above, provided they are at a scale of 1 inch = 1,000 feet.
>
> “If you propose pipeline construction activities (including the use of anchors, chains, cables, and wire ropes) **within 61 meters (200 feet) of pinnacles, include a map at a scale of 1 inch = 1,000 feet with DGPS accuracy depicting:**
>
> a. Bathymetric contours at 2-foot intervals;
> b. An outline of the pinnacles;
> c. An annotation of the height of individual pinnacles;
> d. The proposed pipeline route; and
> e. The maximum area of disturbance potentially caused by the pipeline construction activities (including the use of anchors, chains, cables, and wire ropes.)”
>
> “You may use transparency overlays to other maps to display items d. and e. above, provided they are at a scale of 1 inch = 1,000 feet.”

Under the administrative order, “live bottoms (pinnacle trend features)” means “small, isolated, low to moderate relief carbonate reefal features or outcrops of unknown origin or hard substrates exposed by erosion that provide surface area for the growth of sessile invertebrates and attract large numbers of fish.”

LIVE BOTTOMS (LOW-RELIEF FEATURES)

> "No bottom-disturbing activities, including the use of anchors, chains, cables, or wire ropes from a semisubmersible drilling rig or from a pipeline construction vessel, **may cause impacts to live bottoms (low-relief features)**."
>
> "Before you conduct any drilling activities or construct or place any structure for exploration or development on any lease with the live-bottom (low relief) stipulation, including, but not limited to, well drilling and pipeline and platform placement, **prepare a live-bottom survey report containing a bathymetry map constructed from remote-sensing data and an interpretation of live-bottom areas using the results of a photodocumentation survey**. Use the guidelines in Attachment 7 to conduct the surveys and prepare the report. Make sure that the live-bottom survey report, including the attendant surveys, encompasses the entire area at least 1,000 meters (3,280 feet) from the proposed activity site. Conduct bathymetric and shallow hazards surveys using the guidelines of NTL No. 2008-G05, Shallow Hazards Requirements, effective May 1, 2008." (Emphasis added).

Under the administrative order, "live bottoms (low-relief features)" mean "seagrass communities, areas that contain biological assemblages consisting of sessile invertebrates living upon and attached to naturally occurring hard or rocky formations with rough, broken, or smooth topography; and areas where a hard substrate and vertical relief may favor the accumulation of turtles, fishes, or other fauna."

POTENTIALLY SENSITIVE BIOLOGICAL FEATURES

> "No bottom-disturbing activities, including the use of anchors, chains, cables, or wire ropes from a semisubmersible drilling rig or from a pipeline construction vessel, **may cause impacts to potentially sensitive biological features**. …
>
> "If you propose bottom-disturbing activities (including rig placement, rig or construction barge use of anchors, chains, cables, and wire ropes) **within 30 meters (100 feet) of potentially sensitive biological features, include a map at a scale of 1 inch = 1,000 feet with DGPS accuracy depicting:**
>
> > a. bathymetric contours at 2-foot intervals;
> > b. an outline of the potentially sensitive biological features;
> > c. an annotation of the height of individual potentially sensitive biological features;
> > d. the surface location of each proposed well or platform; and
> > e. the position of anchors, chains, cables, and wire ropes relative to each proposed surface location.
>
> "You may use transparency overlays to other maps to display items d. and e. above, provided they are at a scale of 1 inch = 1,000 feet.

"If you propose pipeline construction activities (including the use of anchors, chains, cables, and wire ropes) **within 30 meters (100 feet) of potentially sensitive biological features, include a map at a scale of 1 inch = 1,000 feet with DGPS accuracy depicting:**

a. bathymetric contours at 2-foot intervals;
b. an outline of the potentially sensitive biological features;
c. an annotation of the height of individual potentially sensitive biological features;
d. the proposed pipeline route; and
e. the maximum area of disturbance potentially caused by the pipeline construction activities (including the use of anchors, chains, cables, and wire ropes).

"You may use transparency overlays to other maps to display items d. and e. above, provided they are at a scale of 1 inch = 1,000 feet."

Under the administrative order, "potentially sensitive biological features" mean "those features not protected by a biological lease stipulation that are of moderate to high relief (about 8 feet or higher), provide surface area for the growth of sessile invertebrates, and attract large numbers of fish."

International best practice for the protection of deep-sea benthic communities includes the imposition of exclusion zones described below in a Notice To Lessees And Operators Of Federal Oil, Gas, And Sulphur Leases And Pipeline Right-Of-Way Holders, Outer Continental Shelf, Gulf Of Mexico OCS Region drafted by the United States Department of Interior:

"If you propose activities that could disturb seafloor areas in water depths 300 meters (984 feet) or greater, maintain the following separation distances from high-density deepwater benthic communities:

1. At least 2,000 feet from each proposed muds and cuttings discharge location; and

2. At least 250 feet from the location of all other proposed seafloor disturbances (including those caused by anchors, anchor chains, wire ropes, seafloor template installation, and pipeline construction). Seafloor disturbances include all "temporary" disturbances caused during mooring operations (e.g., anchor deployment, setting, and retrieval) as well as those caused by anchoring activities conducted prior to a [Mobile Offshore Drilling Unit] MODU arriving on location (e.g., pre-installation of suction piles and cables; where seafloor impacts are much greater while the cables are located on the seafloor prior to being pulled taut and attached to the MODU)."

This international best practice for protecting deepwater benthic communities requires proponents of offshore oil and gas projects to make detailed information available before project approval about geological features that might indicate the presence of deep-sea benthic communities to be protected by the exclusion zones described above.[123]

The environmental management plan for all EIAs for proposed offshore oil wells should include commitments to protect deep-sea benthic communities at least as robust as those contained in the Notice To Lessees of the United States Department of Interior described above.

For offshore wells, does the Environmental Management and Monitoring chapter commit the project proponent to follow internationally accepted best practices for treating and disposing Floating Production Storage and Offloading (FPSO) waste?

FPSO vessels are used in offshore oil and gas production and have waste management systems to handle various types of waste generated on board. Internationally accepted best practices for treating and disposing FPSO waste are focused on minimizing environmental impact and ensuring the safety and efficiency of operations. Best practices for managing FPSO waste include:

- Implementing waste minimization practices to reduce waste generation on the FPSO;
- Promoting source separation to segregate different types of waste (e.g., hazardous, non-hazardous, recyclable) at the point of generation;
- Providing proper waste storage facilities on the FPSO to prevent leaks or spills;
- Regularly collecting and transporting waste to onshore or offshore disposal facilities;
- Onboarding treatment and processing of specific waste streams, such as oily water, to reduce their environmental impact before discharge;
- Implementing safe and secure storage, handling, and disposal practices for hazardous chemicals and waste;
- Maintaining inventory records and safety data sheets for hazardous materials;
- Implementing ballast water management procedures to prevent the spread of invasive species between different regions; Install sewage and wastewater treatment systems to meet international standards for discharge or disposal;
- Effectively managing oil and hydrocarbon waste to prevent spills and discharges into the sea; and
- Operating oil-water separators to treat oily wastewater, especially bilge water.

For offshore wells, does the Environmental Management and Monitoring chapter commit the project proponent to follow internationally accepted best practices for preventing vessel strikes?

[123] Notice To Lessees And Operators Of Federal Oil, Gas, And Sulphur Leases And Pipeline Right-Of-Way Holders, Outer Continental Shelf, Gulf Of Mexico OCS Region drafted by the United States Department of Interior: Deepwater Benthic Communities. NTL No. 2009-G40 https://www.boem.gov/sites/default/files/regulations/Notices-To-Lessees/2009/09-G40.pdf

Internationally accepted best practices for preventing vessel strikes, particularly in maritime safety and environmental protection, focus on reducing the risk of vessels colliding with marine wildlife, such as whales, dolphins, and sea turtles. These best practices aim to protect both marine life and maritime operations and include:

- Mandating reduced vessel speeds in areas with known or potential marine wildlife populations.
- Establishing speed limits or "slow zones" in critical habitats or migration corridors;
- Designating safe shipping lanes and navigational routes that avoid critical marine wildlife habitats and migration paths (use updated navigational charts that include areas with high wildlife activity);
- Implementing Vessel Traffic Services (VTS) to provide vessel operators with real-time traffic information, including the presence of marine wildlife (use VTS to guide vessels around areas of concern);
- Employing trained marine mammal observers on board vessels transiting through wildlife-rich regions These observers can help identify the presence of marine life and recommend course alterations. They can also equip vessels with modern navigation and detection technologies, such as radar, sonar, and forward-looking infrared (FLIR) systems. Observers can use these technologies to detect and track marine wildlife and assess collision risks, like Whale Alert Systems, which provide real-time data on whale locations to inform vessel operators of nearby marine life and develop and implement operational procedures that guide vessel operators on how to respond when marine wildlife is spotted; and
- Establishing protocols for slowing down, changing course, or taking other avoidance measures.

For offshore wells, does the Environmental Management and Monitoring chapter commit the project proponent to follow internationally accepted best practices for light pollution prevention?

Preventing light pollution in offshore oil and gas activities is essential to minimize environmental impact, including marine ecosystems and surrounding communities. Internationally accepted best practices for preventing light pollution in offshore operations include:

- Using energy-efficient and shielded lighting fixtures to direct light where needed and prevent it from spreading unnecessarily, such as installing lighting fixtures with motion sensors and timers to reduce light levels when not required;
- Implementing low-impact lighting technologies, such as LED fixtures, that offer directional and controlled illumination. Consider selecting lighting with lower color temperature (warmer light) to minimize its impact on the natural environment, and use light curtains, shields, and hoods to direct light downward and reduce skyglow, glare, and light spill. Install barriers to block direct line-of-sight between light sources and sensitive areas;

- Implementing lighting curfew hours during which non-essential lights are dimmed or turned off; and
- Allowing essential lighting only during specific times and locations.

3.6. Financial Assurances

To address impacts to water and the climate caused by loss of well integrity at wells, often abandoned (discussed in section 2.2.2.2.), and to address the impacts of oil spills (discussed in sections 2.2.2.4 and 2.2.3.2.), it is vitally important that government regulators require oil companies to provide — before the commencement of drilling — financial assurances to ensure complete and timely plugging of the wells, reclamation of lease areas, and the restoration of lands or surface waters that might be adversely affected by lease operations after the abandonment or cessation of oil and gas operations.

Bonding requirements for new proposed onshore oil and gas projects

The following language in Title 43 of Subpart 3104 of the U.S. Code of Federal Regulations[124] that applies to proposed oil and gas activities on federal lands provides a good example of the type of bonding requirements that should be discussed in an EIA for a proposed oil and gas project:

> "§ 3104.1 Bond obligations.
>
> (a) Prior to the commencement of surface disturbing activities related to drilling operations, the lessee, operating rights owner (sublessee), or operator shall submit a surety or a personal bond, conditioned upon compliance with all of the terms and conditions of the entire leasehold(s) covered by the bond, as described in this subpart. The bond amounts shall be not less than the minimum amounts described in this subpart in order to ensure compliance with the act, including complete and timely plugging of the well(s), reclamation of the lease area(s), and the restoration of any lands or surface waters adversely affected by lease operations after the abandonment or cessation of oil and gas operations on the lease(s) in accordance with, but not limited to, the standards and requirements set forth in §§ 3162.3 and 3162.5 of this title and orders issued by the authorized officer.
>
> (b) Surety bonds shall be issued by qualified surety companies approved by the Department of the Treasury (see Department of the Treasury Circular No. 570).
>
> (c) Personal bonds shall be accompanied by:
>
> (1) Certificate of deposit issued by a financial institution, the deposits of which are Federally insured, explicitly granting the Secretary full authority to demand

[124] 43 CFR § 3104 - Bond obligations, https://www.ecfr.gov/current/title-43/subtitle-B/chapter-II/subchapter-C/part-3100/subpart-3104/section-3104.1

immediate payment in case of default in the performance of the terms and conditions of the lease. The certificate shall explicitly indicate on its face that Secretarial approval is required prior to redemption of the certificate of deposit by any party;

(2) Cashier's check;
(3) Certified check;
(4) Negotiable Treasury securities of the United States of a value equal to the amount specified in the bond. Negotiable Treasury securities shall be accompanied by a proper conveyance to the Secretary of full authority to sell such securities in case of default in the performance of the terms and conditions of a lease; or
(5) Irrevocable letter of credit issued by a financial institution, the deposits of which are Federally insured, for a specific term, identifying the Secretary as sole payee with full authority to demand immediate payment in the case of default in the performance of the terms and conditions of a lease."

The United States Bureau of Land Management has estimated that bond amounts adequate to cover the full plugging and reclamation costs of onshore operations are $994,000 for an oil and gas field with 14 wells and $4,686,000 for an oil and gas field with 66 wells.[125]

Bonding requirements for new proposed offshore oil and gas projects

The bonding requirements for new proposed offshore oil and gas projects, as outlined by the Bureau of Ocean Energy Management (BOEM), are designed to ensure that companies have sufficient financial resources to cover decommissioning and cleanup costs associated with their operations.[126] The bonding requirements are of $50,000 per lease or $300,000 for a group of leases within the same area.[127] Additional base and supplemental bonds are required for estimated decommissioning liabilities. These base and supplemental bonds ensure adequate funds to cover the total cost of decommissioning activities, including removing structures, plugging of wells, and site clearance. These supplemental amounts are typically for: 1) exploration activities – $200,000 for all leases within a specific outer-continental shelf area; and 2) production activities – $500,000 for all leases within a specific outer-continental shelf area.[128] The

[125] U.S. Bureau of Land Management. (July 2023). *Fluid Mineral Leases and Leasing Process* (Proposed Rule). https://www.blm.gov/sites/default/files/docs/2023-07/Final-Draft-Proposed-Onshore-Oil-and-Gas-Leasing-Rule-07-18-2023.pdf See also: U.S. Bureau of Land Management. (15 November 2018). IM 2019-014, Instruction Memorandum, *Oil and Gas Bond Adequacy Reviews*. https://www.blm.gov/policy/im-2019-014

[126] Bureau of Ocean Energy Management. (n.d.). *Financial Assurance Requirements for the Offshore Oil and Gas Industry Operating on the OCS*. https://www.boem.gov/oil-gas-energy/risk-management/financial-assurance-requirements-offshore-oil-and-gas-industry

[127] 30 CFR § 556.900 - Financial assurance requirements for an oil and gas or sulfur lease, https://www.ecfr.gov/current/title-30/section-556.900

[128] 30 CFR § 556.901 - Base and supplemental financial assurance. https://www.ecfr.gov/current/title-30/chapter-V/subchapter-B/part-556/subpart-I/section-556.901

BOEM may require further financial assurance beyond base and supplemental bonds if it determines a higher risk of non-compliance or if the lessee's financial condition warrants it. This could involve a combination of surety bonds, letters of credit, and other financial instruments. These bonding requirements protect the federal government and taxpayers from bearing the costs of decommissioning and environmental restoration if an offshore oil and gas operator cannot fulfill their obligations. The increased bond amounts reflect offshore operations' higher costs and risks.

The bonding requirements for new proposed offshore oil and gas projects to offset the costs of oil spills are primarily governed by the Bureau of Ocean Energy Management (BOEM) and the Bureau of Safety and Environmental Enforcement (BSEE). These requirements ensure that companies have sufficient financial resources to cover potential liabilities, including the costs associated with oil spills. The key components are:

1) Oil Spill Financial Responsibility (OSFR): Operators must demonstrate their ability to pay for cleanup and damages resulting from oil spills through OSFR requirements.

2) OSFR Coverage Amounts: These amounts are determined based on the worst-case discharge volume, with the following general tiers:

- Up to 35,000 barrels: $35 million
- 35,001 to 70,000 barrels: $70 million
- 70,001 to 105,000 barrels: $105 million
- More than 105,000 barrels: $150 million[129]

Operators must submit proof of financial capability to cover oil spill liabilities as part of their OSFR obligations. This proof can be provided through financial statements, credit ratings, or other evidence of financial strength. These bonding and financial assurance requirements are designed to mitigate the financial risk associated with oil spills, ensuring operators have the necessary resources to address spill-related costs and protect the environment and public health.

[129] 30 CFR § 553.13 - How much OSFR must I demonstrate? https://www.ecfr.gov/current/title-30/chapter-V/subchapter-B/part-553/subpart-B/section-553.13