WATER REUSE AND ENVIRONMENTAL CONSERVATION PROJECT

CONTRACT NO. EDH–I–00–08–00024–00 ORDER NO. 04

REGULATORY EVALUATION OF OIL SHALE DEVELOPMENT IN JORDAN:

MINISTRY OF ENVIRONMENT TRAINING REPORT

June 2015

IMPLEMENTED BY AECOM

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Submitted to:

USAID Jordan

Prepared by:

AECOM

DISCLAIMER:

The authors' views expressed in this document do not necessarily reflect the views of the United States Agency for International Development or the United States Government.

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LIST OF ACRONYMS

ASEZA	Aqaba Special Economic Zone Authority
EIA, EIS, EIR	Environmental Impact Assessment, Statement, Report
EPA	Environmental Protection Agency
FID	Financial Investment Decision
GOJ, GoJ	Government of Jordan
JOSCo	Jordanian Oil Shale Company
JOSE	Jordan Oil Shale Energy
KIO	Karak International Oil
MoEnv	Ministry of Environment
USEPA	United States Environmental Protection Agency
WAJ	Water Authority of Jordan

1 Introduction

The USAID Water Reuse and Environmental Conservation Project (WRECP, or the project) works throughout Jordan in institutional capacity building, pollution prevention for industries, solid waste and wastewater management, and water reuse. The project goal is to protect and conserve scarce resources through regulation, education, and coordination with industry, local communities and the private sector. The project is implemented by AECOM and a team of international and Jordanian partner firms. This five-year project has four primary tasks:

- Task 1 – Institutional and Regulatory Strengthening
- Task 2 – Pollution Prevention and Industrial Water Management
- Task 3 – Disposal sites Rehabilitation and Feasibility Studies
- Task 4 – Water Reuse for Community Livelihood Enhancement, including biosolids

As part of Task 1, providing Technical Support for the Ministry of Environment (MoEnv), the project conducted oil shale regulatory training for MoEnv staff and members of the Environmental Impact Assessment (EIA) Committee on May 13, 14 and 17, 2015. The training was provided by WRECP team members Don Shosky and Andrew Mathewson.

1.1 January and May 2015 Oil Shale Training Sessions

A previous training session in January 2015 in Amman had brought together MoEnv staff, environmental consultants, academics and representatives from local business associations. That session provided a brief explanation of what oil shale is; where it is generally located within the Kingdom of Jordan; why it is being mined and developed; and general methods for the exploration, excavation and production. The training also provided an overview of anticipated environmental and social effects, and their regulation. A copy of the presentation from the January workshop is provided in Attachment A.

The three days of training in May were requested by the MoEnv, to follow up on the January training. A list of participants and agenda for the May session are provided as Attachments B and C. A copy of the presentation from the May workshop is provided as Attachment D.

The training session in May, held prior to the International Energy Summit in Amman on 20-21 May 2015, provided additional and more detailed training to ministry staff regarding evaluation, monitoring and mitigation of environmental and social effects in relation to:

- Water impacts including usage, water quality, water reuse, and disposal
- Air emissions monitoring and mitigation
- Waste management considerations and options
- Socio-economic effects and Human Health and Ecological Risk Assessment
- Cumulative Effects of multiple concessions operating concurrently
- Life cycle assessment

This report provides a summary of information presented during the May training session on the status of oil shale development in the Kingdom, technologies being explored, insights during preparation of the training, and recommendations with respect to additional future institutional and other capacity-building efforts that could assist Jordan in the responsible and sustainable development of its oil shale resources.

1.2 Report Objectives

The purpose of this report is to:

- Provide an overview of the current state of oil shale development in Jordan
- Describe the Concession Development Process
- Identify the current oil shale concession holders and the technologies they are using
- Discuss the Environmental Impact Assessment (EIA) Committee
- Summarize key environmental issues associated with oil shale development
- Discuss the WRECP training programs as related to capacity building
- Present a path forward for continuing support to the Jordanian government

2 Overview of Oil Shale Development in Jordan

Oil shale in Jordan represents a significant resource. Oil shale deposits in Jordan underlie more than 70% of Jordanian territory. The total resource is estimated to be 31 billion tonnes of recoverable oil shale.

The deposits include a high quality marinite oil shale of Late Cretaceous to early Cenozoic age. The most important and investigated deposits are located in west-central Jordan, where they occur at the surface and close to developed infrastructure.

Although oil shale was utilized in northern Jordan prior to and during World War I, intensive exploration and studies of Jordan's oil shale resource potential started in the 1970s and 1980s, being motivated by higher oil prices, modern technology, better economic potential and reduced energy dependence on foreign sources of fossil fuels. Figure 2-1 shows known oil shale occurrences in Jordan.

Oil shale has a similar caloric value to thermal coal and could be an important energy and petroleum product source, helping to partially replace Jordanian imports of diesel for power generation and as a transportation fuel. When conducted in a sustainable and responsible manner, oil shale development can contribute to Government of Jordan revenues and provide employment opportunities in the Kingdom.

These potential benefits are balanced by the need to effectively evaluate and monitor the potential environmental and social impacts of oil shale development. Improving the capacity of Ministry of Environment and other responsible ministry staff to provide this critical regulatory oversight role was a primary impetus for WRECP environmental impact assessment training and the production of related guidance and technical protocol documentation.

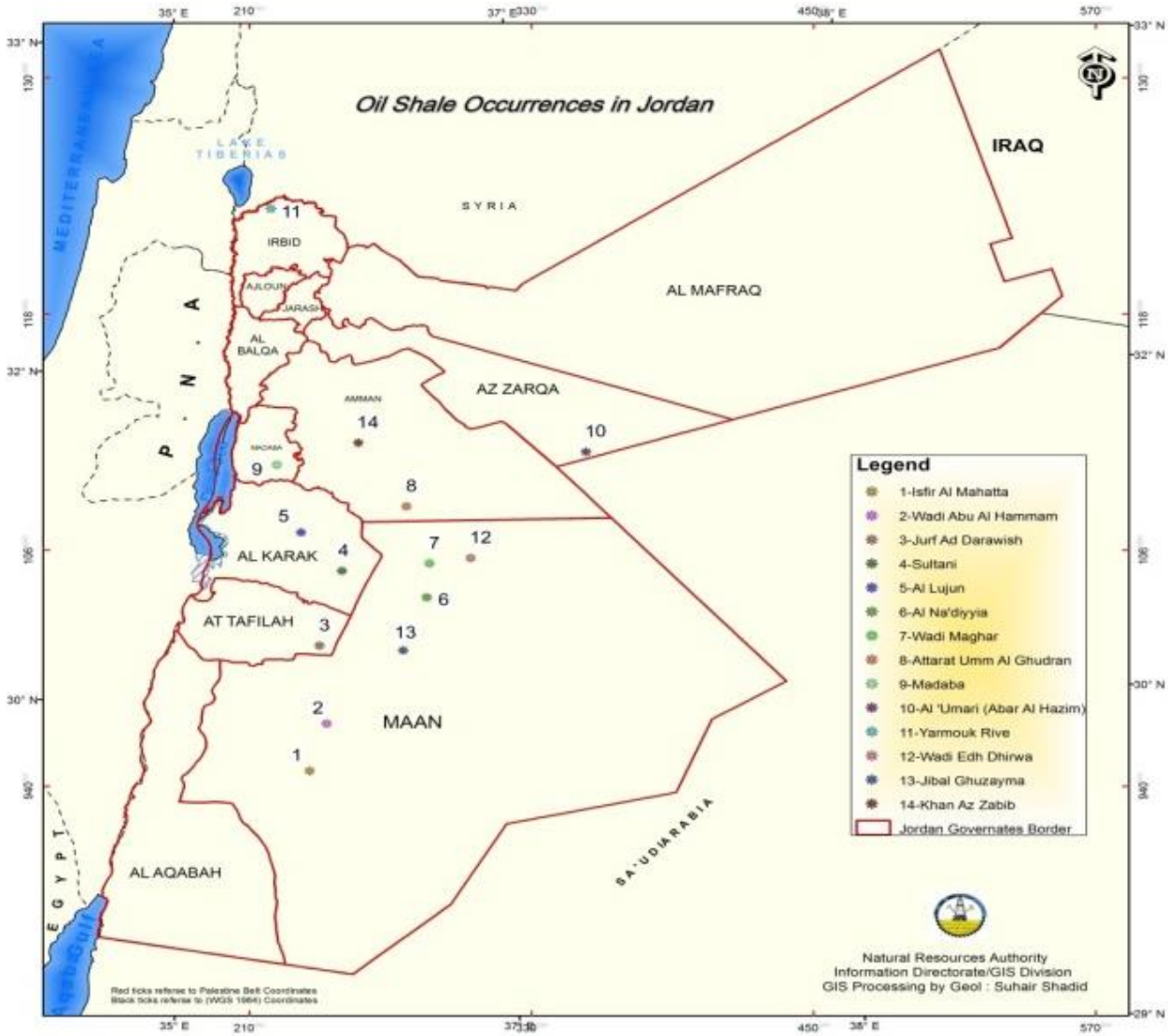

Figure 2-1 Oil Shale Occurrences and Concessions in Jordan
(Source: Natural Resources Authority, http://www.nra.gov.jo/)

3 Concession Development/Approval Process in Jordan

The Government of Jordan (GoJ) has designed four types of agreements for use in the development of the oil shale resource:

- Memoranda of Understanding (MoU)
- Concession Agreements (CA)
- Power Purchase Agreements (PPA)
- Head of Terms Agreements

The agreements are used during different phase of development and for different purposes. Figure 3-1 shows oil shale concession area approved by the Government of Jordan.

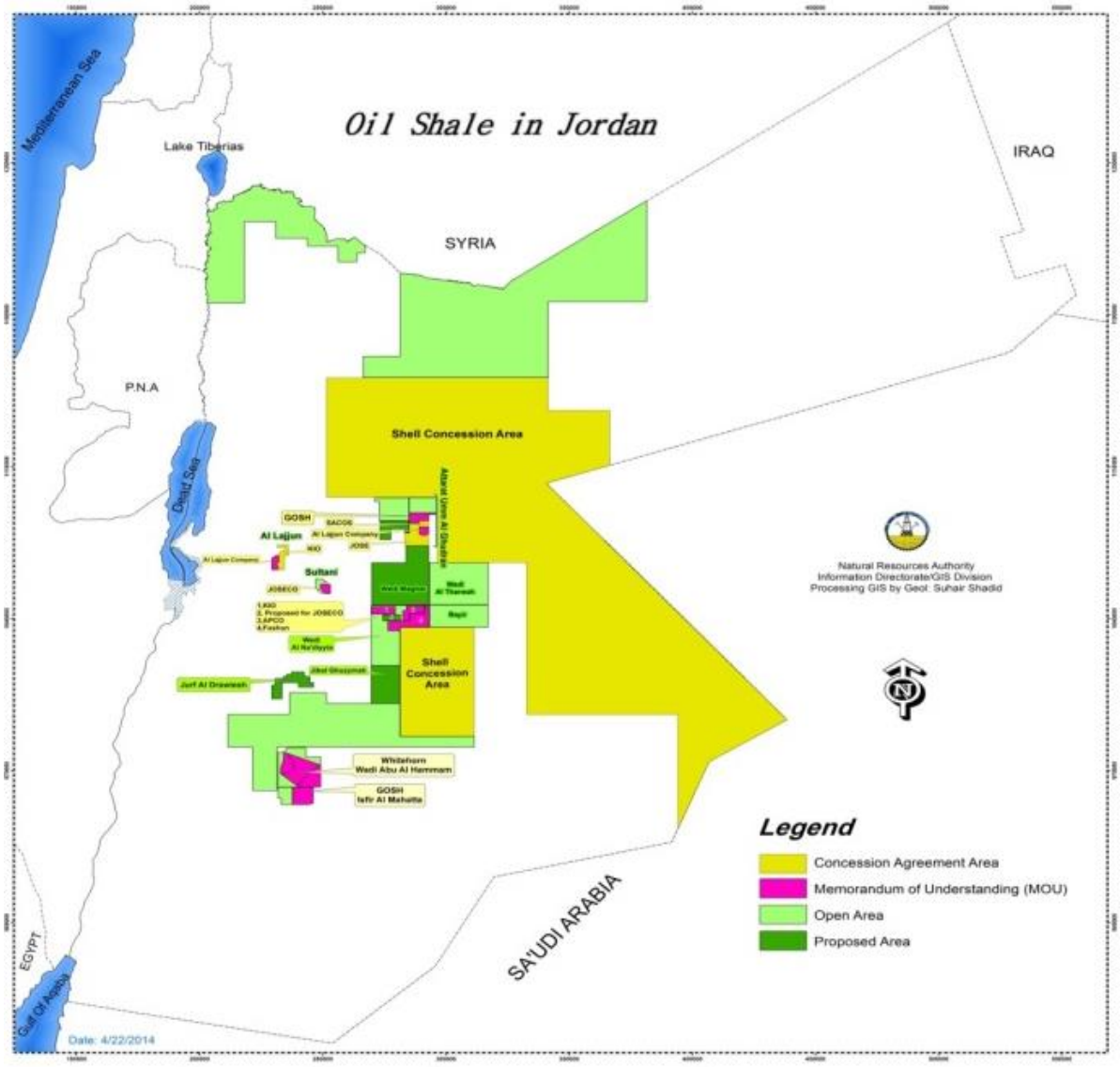

Figure 3.1 Oil shale concessions approved by the Government of Jordan (Source: Natural Resources Authority http://www.nra.gov.jo/).

3.1 Memorandum of Understanding (MoU)

During the initial exploration phase (typically 4-6 months), memoranda of understanding are signed, to give the government sufficient time to evaluate the companies and their financial capabilities, consider the technology being proposed, provide access to oil shale areas and needed ministerial approvals.

Over the next 24 months (with an option to extend this period) feasibility and technical studies are undertaken to assess the economics of the proposed project and consider the potential environmental and social impacts on preliminary basis. During these feasibility and technical studies there is an opportunity for public participation and comment on the project.

Once the project proponent and government are satisfied the project is viable based on this examination of project economics and potential impacts, a concession agreement is negotiated. See Figure 3-4.

The pre-development phase may continue for four years or longer, with activities and milestones including:

- Negotiation of a concession area and related Concession Agreement (CA)
- A detailed Environmental and Social Impact Assessment
- Collection of environmental and social baseline data
- Public participation and comment

Exploration phase: near surface soil shale deposit

Exploration phase: oil shale core samples

Exploration phase: drill rig

3.2 Concession Agreements

Concession agreements are the main vehicle used by the Ministry of Energy and Mineral Resources to negotiate terms with oil shale project proponents. The agreements establish the full terms for development, construction and operations of an oil shale project, including environmental impact assessment requirements.

Pre-development continues during regulatory review of the Environmental Impact Assessment by the MoEnv and other responsible ministries. Public comment can be made during “scoping sessions” held by the proponent.

Once environmental approvals and final investment decisions have been made the development phase of construction and operations begins () and may continue for thirty years (with an option to extend the operations period for an additional ten years or longer). During the development phase official procedures are ratified, there is

Operations phase: oil shale pre-mixing

parliamentary and Jordanian Council of Ministers review of the project, before issuance of a law in the Official Gazette, on the approval of His Majesty the King.

3.3 Power Purchase Agreement

A Power Purchase Agreement is used for negotiating production and rates for power generation and does not include environmental assessment requirements (See the Attarat Power Company Power Purchase Agreement below).

3.4 Head of Terms Agreement

Head of Terms agreements can be used in the feasibility stage as an interim step before a concession agreement is concluded (See the Al Lajjun Company Head of Terms Agreement below).

4 Oil Shale Development Companies and Technologies in Jordan

4.1 Concession Agreements

The following provides a brief summary of the concession agreements signed with oil shale project proponents, as well as a description of the proposed technology to be utilized. (Source: the Ministry of Energy and Mineral Resources, 2015. Note: timeframes and production capacities are based on Company estimates and plans and are subject to change). See Figure 3-1 above for a map of the companies in Jordan. **The information presented below is largely from sources provided on-line by the companies.**

4.2 JOSCo (Shell)

The Jordanian Oil Shale Company (JOSCo), a wholly-owned subsidiary of Royal Dutch Shell, was issued a concession agreement in 2009 to explore oil shale over an area of 22,270 km² throughout the Kingdom based on a proposed $20 billion investment. The exploration area will be narrowed down in three phases to finally reach 1000 km² for commercial purposes.

JOSCo will use Shell's *In-Situ Conversion Process* (ICP) electrically heating the reserve for three years while still underground. Typically the in situ conversion process includes provision for freezing out groundwater infiltration into the shale deposit. However, in Jordan JOSCo hopes to avoid the need for this production element by developing shale resources that lie above the groundwater table. See Figures 4-1 and 4-2.

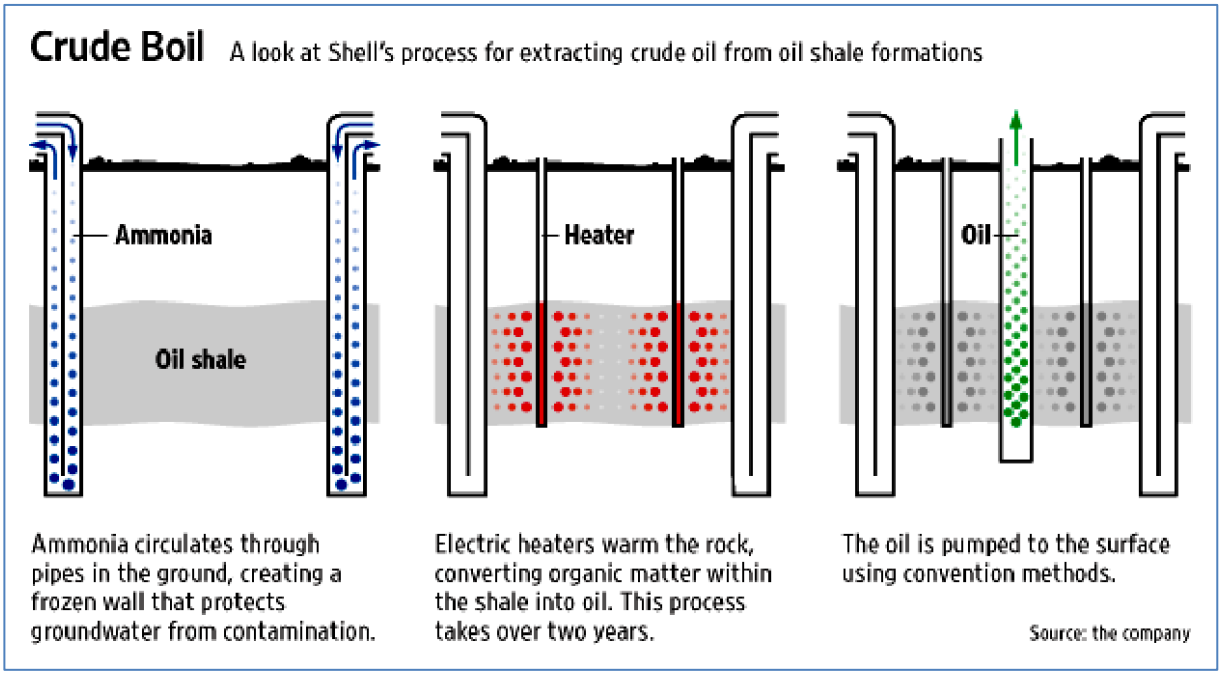

Figure 4-1. The Shell In situ Conversion Process (ICP) Source: Shell website, 2015)

A Final Investment Decision (FID) by JOSCo for implementing a project or projects in Jordan is expected to be made between 2020 and 2022. The Company plans to do an experimental pilot plant before reaching commercial full production of 100,000 barrels per day (bbl/d).

Figure 4-2. A Review of Shell's In Situ Conversion Process at a Pilot Facility in Colorado (Source: US Geological Survey, Department of the Interior, 2015)

4.3 Jordan Oil Shale Energy (JOSE)

An Estonian / Malaysian / Jordanian consortium, JOSE plans to develop two projects in Jordan to produce oil and electricity. The JOSE concession agreement was issued in 2010 to develop a surface retorting project to produce shale oil over an area of 72 km² in the Attarat Um Al Ghudran area using the Estonian Solid Heat Carrier Technology *Enefit 280* with an investment of $6 billion for both projects. JOSE is planning to produce 19,000 bbl/d by 2017 and will reach 38,000 bbl/d by 2019.

Estonia is one of the leading producers of oil shale and the Enefit 280 process used by Eesti Energia, the state-owned power producer, is considered one of the most sophisticated oil shale processing systems. See Figure 4-3. Enefit 280, an improvement on Russian UT3000 technology reduces water requirements, more thoroughly heats (pyrolysis) and retorts (extracts the oil) the crushed oil shale feedstock in a circulating fluidized bed, increasing yield, while better managing waste, dust and air emissions. (Source: Enefit website, 2015).

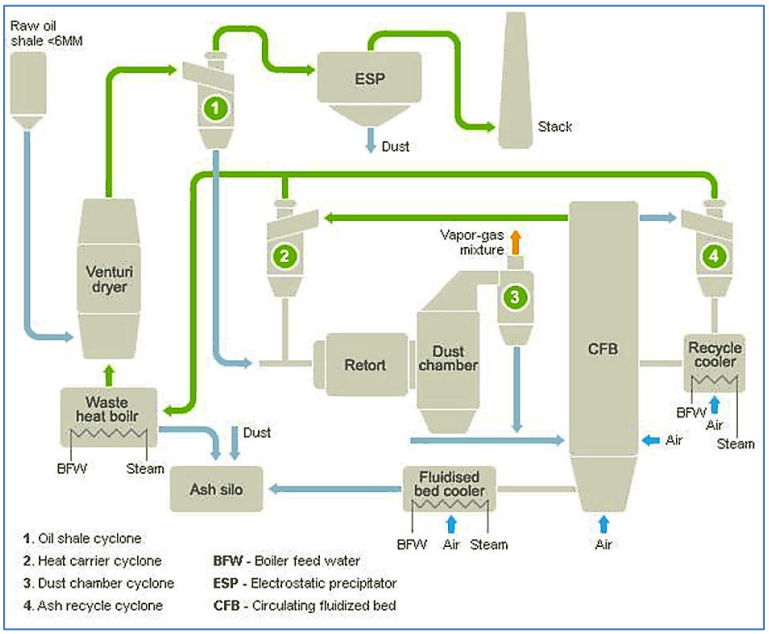

Figure 4-3. The Enefit 280 Process
Source: Outotec website, 2015)

4.4 Saudi Arabian Corporation for Oil Shale (SACOS)

The SACOS concession agreement was issued in 2014 to develop an oil shale surface retorting project over 11 km² in the Attarat Um Al-Ghudran area, using the Russian technology *UTT3000* with an investment of $1.8 billion. See Figure 4-4. UTT3000 uses a "Galoter process," an above-ground oil-shale retorting technology classified as a hot recycled solids technology (Source: Wikipedia.org, 2015). It is expected that SACOS will start producing 2,500 bbl/d of oil, to reach full capacity of 30,000 bbl/d.

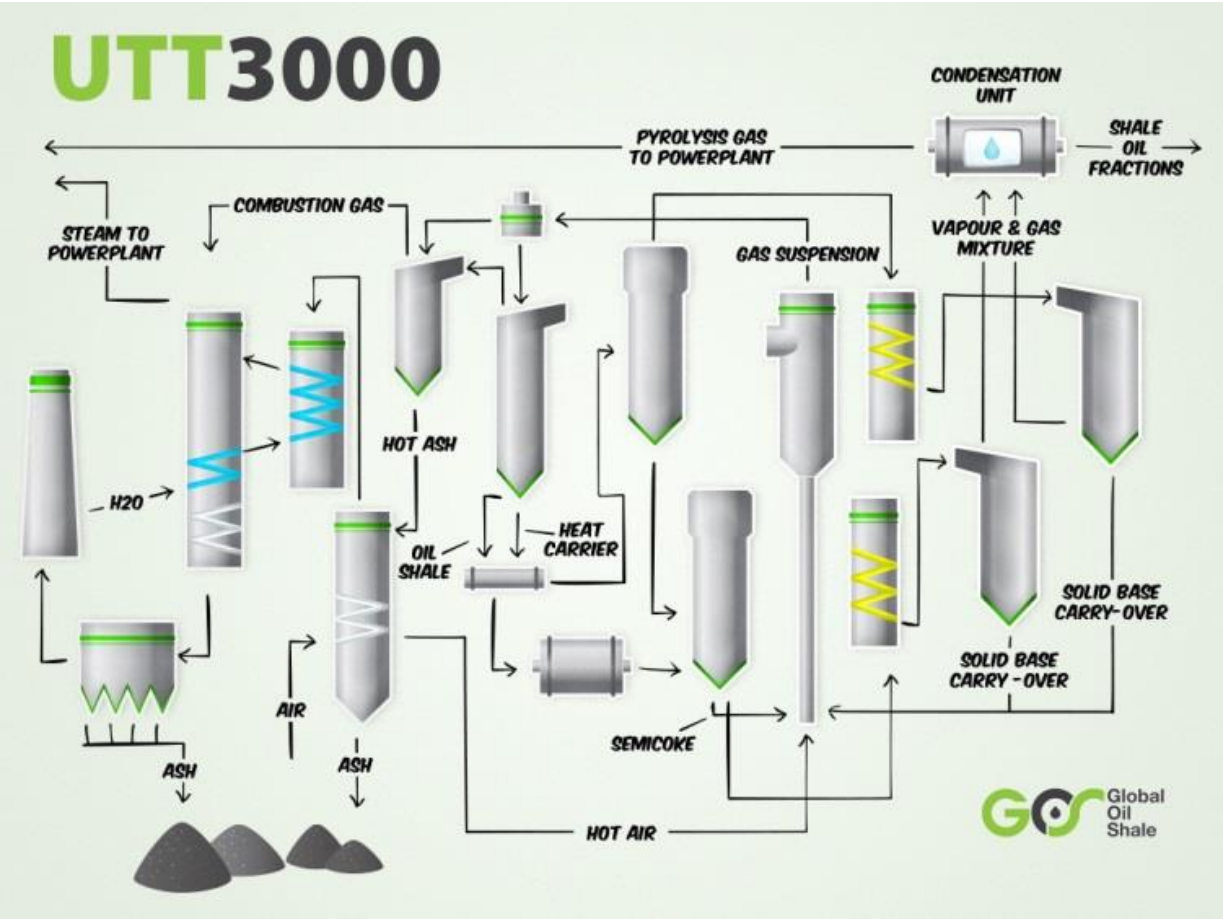

Figure 4-4. The UTT 3000 Process
(Source: GlobalOilShale.com website, 2015)

4.5 Karak International Oil (KIO)

Karak International Oil is a wholly-owned subsidiary of Jordan Energy and Mining Ltd. The KIO concession agreement was signed in 2011 to develop a surface retorting project to produce oil over an area of 33 km² in Al-Lajjun area with an investment of $1.9 billion. KIO is planning in Phase 1 to produce 4,000 bbl/d of oil, reaching full capacity of 50,000 bbl/d using the *Alberta Taciuk Process* (ATP). See Figure 4-5.

Two public participation "scoping sessions" were held by KIO in January 2015. KIO is currently updating environmental assessment information and installing air monitoring equipment in preparation for an anticipated construction phase.

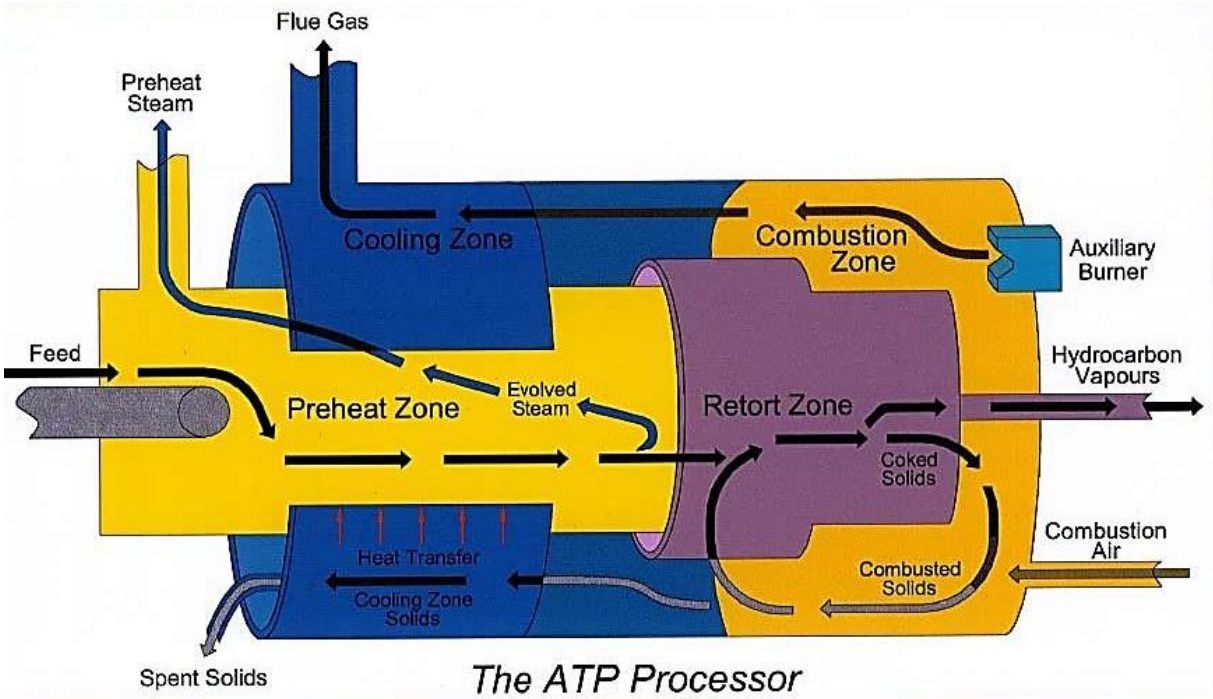

Figure 4-5. The Alberta Taciuk Process (ATP)
(Source: Jordan Energy and Mining Ltd. Website, 2015

The ATP is notable for its self-contained simplicity. First designed for processing of oil sands, pyrolysis and retorting occurs in a single large rotating cylinder. The process is energy self-sufficient. It can handle small particles, with minimal process water requirements and high yields. (Source: "Strategic Significance of America's Oil Shale Resource. Volume II Oil Shale Resources, Technology and Economics" (PDF). United States Department of Energy. 2004).

4.6 Oil Shale Memoranda of Understanding and Proposed Technologies

The following provides a brief summary of companies who have signed memoranda of understanding, as well as a description of the technologies to be utilized. Given these memoranda represent the earliest phase of development, prior to and during the study of feasibility and technical elements of the proposed projects, information is understandably limited. (Source: the Ministry of Energy and Mineral Resources).

4.6.1 National Company for the Production of Oil and Electric Power from Jordanian Oil Shale (ShaleEnergy)

The Government of Jordan has signed an MOU with ShaleEnergy for an area of 14.6 km² in the Sultani area to study the feasibility of developing an Oil Shale surface retorting project using Russian technology *UTT3000* to produce 30,000 bbl/ of oil.

4.6.2 Global Oil Shale Holdings (GOSH)

The Government of Jordan has signed an MOU with GOSH for an area of 33 km² in Attarat Um Al Ghudran area and 65 km² in Isfir Al Mahatta area to study the feasibility of developing a surface retorting project to produce 50,000 bbl/d of shale oil using a modified Brazilian Technology (PRIX). See Figure 4-6.

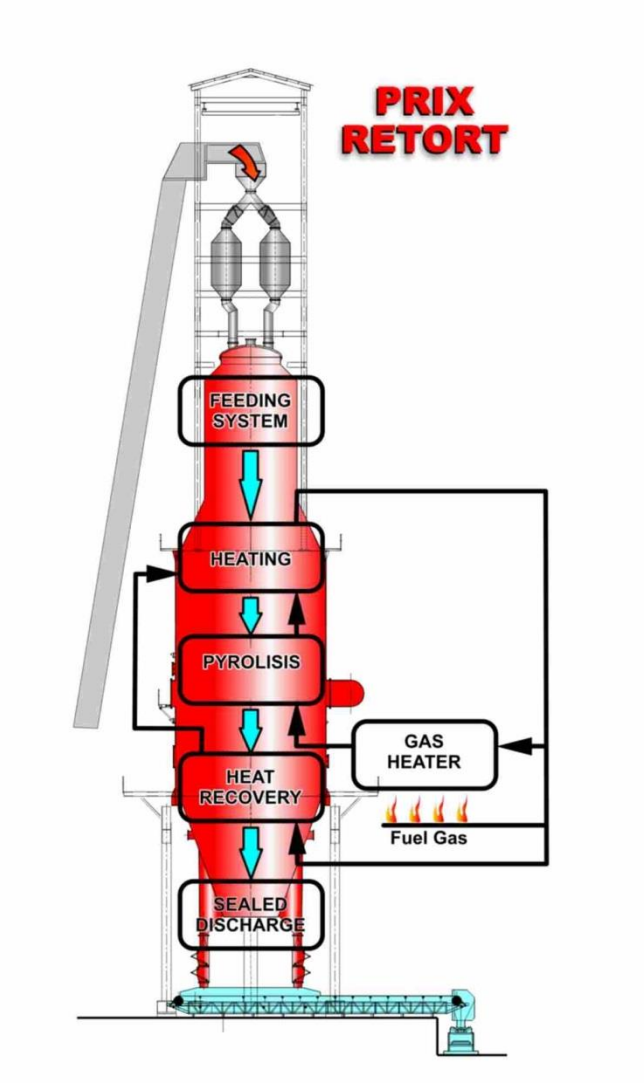

Figure 4-6. The PRIX Process
(Source: PRIXtechnology website, 2015)

PRIX is a refinement of the original vertical oil shale retorting process proposed by Alexander C. Kirk in the late 19th century. While the process requires a natural gas input as a heating source, improvements have been made to the grates that hold feedstock within the retort and seals have been added to increase efficiency and reduce emissions.

4.6.3 Whitehorn Resources Inc.

The Government of Jordan has signed an MOU with Whitehorn Resources over an area of 188 km² in the Wadi Abu Al Hamam area to study the feasibility of developing an Oil Shale project to produce 30,000 bbl/d of shale oil using Ecoshale™ *In Capsule* technology. See Figure 4-7.

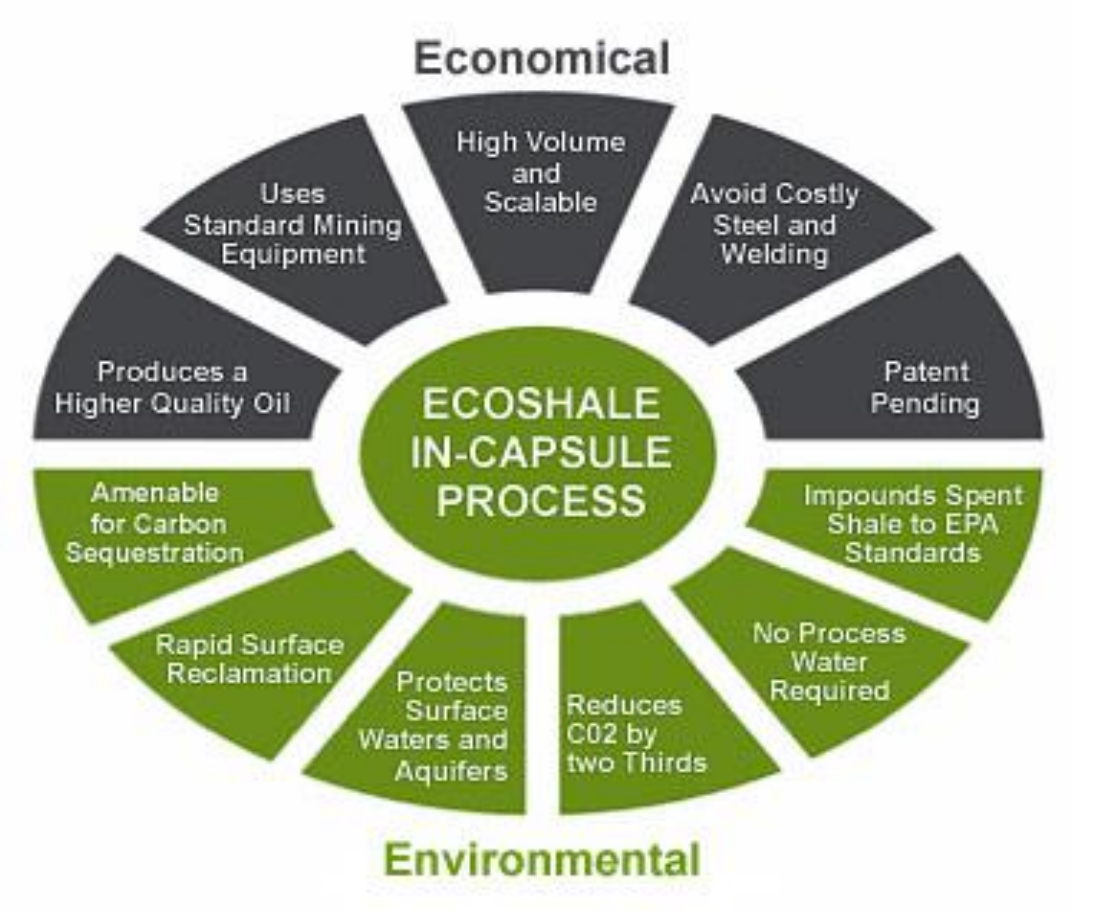

Figure 4-7 The Ecoshale™ model
(Source: Whitehorn Resources Inc.)

Based in Canada, Whitehorn Resources is proposing to surface mine oil shale and then place the resource into a lined "in capsule" containment area for heating and extraction of the oil resource. The advantage of this approach is that mining, processing and waste management are considered as part of a system, requiring minimal water resources for processing and reducing dust and air emissions. The feasibility of this process is still be explored, but results from a pilot project conducted by technology holder Red Leaf Resources Inc. are considered promising.

4.6.4 Aqaba Petroleum Company for Oil Shale (Al Janoub)

The Government of Jordan signed an MOU with the Aqaba Petroleum over an area of 35 km² in Wadi Al Na'adyeh area to study the feasibility of developing an Oil Shale project to produce up to 30,000 bbl/d of shale oil using the ENIN Russian technology.

4.6.5 Fushun Mining Group

The Government of Jordan signed an MOU with the Fushun Mining Group, a Chinese company, over an area of 87 km² in Wadi Al Na'adyeh area to study the feasibility of developing an Oil Shale project to produce up to 50,000 bbl/d of shale oil using the Chinese technology *Fushun*.

The Fushun technology was designed in the 1920's, comprising a vertical retort. Advantages of the process are its stability and lower investment costs. Disadvantages include the

introduction of air into the combustion process, nitrogen diluting the pyrolysis gas and oxygen burning some of the extracted oil, reducing yields.

4.6.6 Al Qamer for Energy and Infrastructure

The Government of Jordan signed a MOU with the Al Qamer over an area of 64 km² in the Attarat Um Al Ghudran area to study the feasibility of developing an Oil Shale project to produce up to 30,000 bbl/d of shale oil using the Russian technology *UTT3000*.

4.7 Oil Shale Direct Burning Power Plants – Power Purchase and Head of Terms Agreements

The following provides a brief summary of the projects and Power Purchase Agreements signed with oil shale proponents. (Source: Ministry of Energy and Mineral Resources, 2015).

Since oil shale has the same calorific value as various types of coal it is possible to mine the oil shale out of the ground and to burn it in a conventional power plant. The two companies below are proposing to generate electricity in this fashion. Potential environmental impacts from direct burning are significantly different from the various retorting processes described above, adding another dimension to the issue of cumulative effects management.

4.7.1 Attarat Power Company (APCO)

One of the two projects mentioned above is proposed by the Estonian/Malaysian/Jordanian consortium. The Government of Jordan signed a Power Purchase Agreement (PPA) (and other related agreements)with APCO in 2014 to develop an Oil Shale direct combustion power plant to produce 470 MW of electricity in the Al Attarat area. This power plant is expected to be operational in 2017.

4.7.2 Al-Lajjun Company

The Government of Jordan signed a Head of Terms Agreement with a Jordanian / Emirates / Chinese consortium (Al Lajjun/ Al-Hamed future/ HTG/ SEPCOIII) to study the feasibility of developing an Oil Shale direct burning power plant to produce 600-700 MW of electricity in Al Lajjun and Al Attarat areas.

5 Environmental Committee and Issues

To coordinate regulatory review and evaluation of oil shale development environmental assessment information and reports, the Government of Jordan has constituted an Environmental Impact Assessment (EIA) Technical Committee, made up of representatives from all ministries responsible for review of EIAs as well as participation from other groups such as the Federation of Jordanian Non-governmental Organizations (NGOs).

Participants in the January and May oil shale training sessions were selected from the Ministry of Environment staff, as the lead ministry responsible for review of environmental affairs and supplemented from ministries represented on the EIA Committee. The EIA Committee comprises representatives from:

- Ministry of Environment
- Ministry of Energy and Mineral Resources
- Ministry of Water and Irrigation
- Ministry of Health
- Ministry of Agriculture
- Ministry of Municipal Affairs
- Ministry of Labor
- Ministry of Tourism and Antiquities
- Royal Society for the Conservation of Nature
- Jordan Institute for Standards and Meteorology
- Civil Defense

Staff members from many of the ministries represented on the EIA Committee participated in and contributed to WRECP oil shale training in January and again in May. The president of the Federation of Jordanian NGOs actively participated during the May training session (See Attachment B for a list of May training participants).

During the training and capacity-building workshops held in January and May 2015 many environmental issues associated with oil shale development were discussed during workshop modules. Specific topics discussed in the May workshops included:

- Air
- Water
- Waste
- Social Economic
- Cumulative Effects
- Development Life Cycle Impacts

A copy of the presentation for the May 2015 workshop is contained in Attachment D.

This section is summarizes the issues of most interest to the participants. Recommendations for further training are provided following the summaries of issues.

5.1 Air

The participants seemed to understand well the issues surrounding air modeling, air monitoring and air pollution mitigation (scrubbers, dust control etc.). What appeared to be of greater concern was the issue of how the cumulative effects from a number of sites would be

dealt with. Jordanian law effectively regulates point source emissions. Of interest was how to fairly deal with multiple sources, while maintaining an established and acceptable level of air quality.

5.2 Ground and Surface Water

Ground and surface water is a finite resource in Jordan. Currently the country uses more than is available, based on recharge rates supplied by the Ministry of Water and Irrigation for Jordan's main aquifers (See May presentation slides in Attachment D for more information). Proposed oil shale development puts additional strain on an already stressed water supply and distribution system. The Kingdom has recognized that Jordan needs to develop oil shale resources to generate power, jobs, income and royalties. Cost savings and revenues from oil shale projects may finance new capital projects for the development of new water supply sources such as desalination facilities(either groundwater or sea water) or civil works programs to harvest surface water.

Both ground and surface water use was of significant interest to workshop participants and was discussed at length as a potentially limiting factor for oil shale development. The Kingdom has authorized a water allocation of 35 million cubic meters per year for oil shale development. This allocation may serve as a future constraint on how much of the resource can be developed. Almost every concession holder claims to minimize water usage – claiming that at full development water usage will not exceed 5 million cubic meters per year at their respective developments. However, this allocation of water likely does not account for socio-economic activity and the amount of water needed to service the new population that will grow up around these developments. The 35 million cubic meters per year is proposed to be moved from agricultural use to industrial use and will have an effect on the agricultural water users. Technical challenges, public/private stakeholder and governmental policy issues will have to be addressed in order for a workable coordinated plan to be reached. The resolution of these issues likely goes beyond the mandate of the MoEnv and the EIA Committee.

5.3 Waste

A significant amount of time was spent discussing waste issues but the most prevalent revolved around the following topics:

- Cover materials using natural materials
- Evapotranspiration cover systems
- Using the natural geology which has low permeability as a containment system
- Depth of ground water (very deep so impact unlikely)
- Control of surface run-off collection and reuse or treatment if necessary
- Reclamation of waste areas

While more workshops would be of benefit in this area the site specific nature of the questions raised would require technical assistance on a site-by-site basis.

5.4 Social/Economic Impacts

The social economic impacts of these developments appeared to be the least clear topic for the workshop attendees to understand. Once the concepts were further developed discussions on the following topics came out of that discussion:

- Acknowledgement that the development could have a 50 year life cycle and that a large number of people could be living and working in the area of the development was a reality
- New populations centers which grow up around oil shale projects could realistically expect many new job and technical / professional opportunities
- The new centers where people would live will need significant new infrastructure (water, sewer, electrical, roads, communication systems etc.).
- Resident populations who lived in the area before the oil shale development would need to be part of this change and should be engaged as interested stakeholders during on-going public participation processes
- Communities would need to be located in such a way as to minimize potential environmental and social impacts (for example, air emissions, water, noise/light effects) while maximizing quality of life elements.

The May training session included discussion of Human Health and Ecological Risk Assessment. Once understood, participants became engaged in the discussion as it was clear that this was an important aspect of the proposed oil shale developments. However, given the complex nature of this topic and the fact that a number of governmental agencies are involved additional efforts could go into workshops and intergovernmental coordination.

5.5 Project Life Cycle Impacts

The May 2015 workshop concluded with a discussion of project life cycle impacts. At the beginning of this session the question was asked of participants, “what is the most important output of this analysis?” Participants were in agreement that the human element was the most important output. The output for the human element should include a better standard of living for Jordanians in terms of environmental quality, economic gains and overall better community services (health care, municipal infrastructure and education facilities). This commonality between people and agencies can form the basis for working together for a common vision. The idea of working together and communicating between government agencies needs to be encouraged and this can be done through additional workshops or by embedding facilitators / specialists into organizations to encourage this behavior.

6 Conclusions, Recommendations and Path Forward

Historically, Jordan has been dependent on imported fossil fuels to feed their power generation and transportation requirements. Given the instability of the fossil fuel markets, both in terms of price and availability, Jordan has decided to develop other energy resources to supplement and eventually replace these imports. Jordan is aggressively looking at developing a number of different types of energy projects to assist them in gaining some independence from foreign energy sources. Given the significant financial losses experienced last year by the Jordan Electric Power Association the intent is to develop many of these projects as quickly as possible. All of these projects have an impact on human health and the environment which need to be managed in a way that helps to balance the needs of the country and potential environmental effects.

Jordan is encouraging the development of the following types of energy projects:

- Renewable energy sources like solar and wind farms
- Nuclear power plant
- Building an LNG terminal
- Oil shale for power generation, and
- Oil shale to heating oil, and eventually more refined transportation fuels

These energy projects are in various stages of development. Renewable energy sources are important but will not realistically be able to supply all of Jordan's electrical needs. A nuclear power plant is under consideration but in reality may be decades away from being realized. This leaves development of oil shale resources as a possible solution to fill some of the future energy requirements and as a hedge against potential shortages.

As part of this energy mix oil shale may provide both long and short term solutions to Jordan's energy requirements. Jordan has the fourth largest oil shale deposit in the world. This has attracted a number of investors who are interested in developing these resources. Two very different approaches to development exist and both have their place in the overall energy strategy. Oil shale deposits can be developed by in-situ and ex-situ technologies. The in-situ technologies take years to develop and bring up to full scale offering a more favorable approach to the environment and more diversity in how the extracted oil will be used. On the other hand the ex-situ technologies can potentially produce energy in relatively short order, but, due to the nature of the resource extraction process have a greater impact on the environment.

Based on the comments of ministry staff regarding expected water usage, it appears that up to 5 projects could potentially be developed simultaneously. Participants at the workshops discussed the life cycle analysis and determined that the most important portion of the analysis was the human factor and the ability of the project or development to be done in a way which balances human well-being and the environment. The group also recognized that the cumulative effects of these developments will have a lasting effect on population and infrastructure development. Based on information taken from Ministry of Water and Irrigation sources, water would need to be reallocated from agricultural / public to industrial uses. How to do this in a coordinated fashion is a major topic for further consideration.
In several lively exchanges, participants clearly expressed their appreciation for the content and focus of the oil shale impact assessment evaluation training provided. However, their feedback and recommendations also indicated interest in a more substantial program for both short-and long-term capacity building, technical training, institutional development and coordination. Major areas where support is needed include:

- Capacity-building support (on-going regulatory review and evaluation training)

- Technical systems support (air and water monitoring and related data management)
- Inspection / monitoring program enhancements (inspection and monitoring techniques and support)
- MoEnv human resources (additional technical / professional resources)
- Testing and monitoring equipment (mobile, field and stationary systems)

Providing the necessary resources and activities to provide the requested information and training will require an on-going, phased approach. The approach summarized below is intended to provide a foundation for next steps in capacity-building, technical support and institutional development.

6.1 Capacity-building

To help cope with this emerging industry and mitigate the potential effects of oil shale development (environmental, social, health impact assessment, monitoring and regulation), various actions and activities need to be taken which include building capacity for Ministry of Environment and other responsible ministry staff in multiple disciplines through:

- On-going training programs on specific topics for ministry personnel overseeing monitoring, remediation and rehabilitation planning (including MoEnv, MEMR, Water and Irrigation, Labor, Agriculture, Health as key responsible ministries)
- Field trip(s) to in-development or operating projects for key ministry staff involved in environmental aspects of oil shale projects
- Additional and enhanced study of the main aquifers and collection of baseline data for water and environment within oil shale development project areas
- Study of the cumulative effects of other existing industrial projects, together with planned oil shale development in project areas

6.2 Technical Support

The capacity of key responsible ministries with responsibilities for regulatory oversight of the oil shale industry could be supported by:

- Preparing for human environmental / social infrastructure impacts and opportunities, including:
    - Life cycle analysis of proposed projects and the industry as a whole
    - Providing guidance in the design of training, employment, contracting and procurement to maximize local participation and benefits
- Building an environmental baseline of data and critical data requirements and data management / coordination systems (i.e. water/aquifer; emissions) in proposed oil shale project areas in order to improve evaluation, on-going monitoring and regulatory compliance activities
- Focused design of systems for monitoring aquifer and subsurface impacts in relation to in situ oil shale development
- Effective and sustainable management systems for oil shale waste products including remediation, rehabilitation and reclamation planning

6.3 Equipment

In order to facilitate the on-going inspection and monitoring work of MoEnv staff, a number of equipment needs were identified:

- Portable instruments for quick tests for some air pollutants emitted from different activities (SO_2, NO_2, NO_x, VOCs, PM, heavy metals, etc.)

- Portable instruments for quick tests for some water parameters (pH, EC, turbidity, SO_4, Cl_2, NH_4, DO, heavy metals, etc.)
- Portable instruments for quick tests of noise levels

6.4 Human Resources

To achieve lasting results for recommended capacity-building and technical support may require a combined approach including:

- Future training opportunities for ministry staff, and
- Embedding of technical specialists in the MoEnv and other key responsible ministries for a period of time

Increasing staff capacity in the MoEnv to evaluate environmental assessment-related technical reports from oil shale developers (environmental impact assessment reports and related concession agreements and memoranda of understanding) will take time to develop and likely will require "embedding" of experienced staff for an agreed term. The creation of an *Oil Shale Environmental Impact Assessment Regulatory Team* is recommended. The core members of this multi-disciplinary team would include experienced professionals, seconded from qualified environmental consultancies, to assist in training MoEnv staff and in developing departmental systems. Additional resources could be positioned on an on-call basis. The proposed Oil Shale EIA Regulatory Team would include:

- (4) Professionals to review Environmental Impact Assessments, including the following disciplines:
    - 2 Civil engineering/geologist/hydrogeologist, surface water hydrologist, chemist or another engineering discipline
    - 1 Biologist/reclamation specialist
    - 1 Socioeconomic specialist
- (4) Inspectors and monitoring persons with science or engineering backgrounds
    - 2 Chemists to follow-up the monitoring activities
    - 2 Civil engineers to follow-up on remediation plans

  (1) Senior Program Manager to manage the overall work effort (should have a science or engineering background)
- (1) Administrator

The Oil Shale Environmental Impact Assessment Team would also play an important role in providing technical support to the inter-departmental EIA Committee mentioned earlier – helping to build needed institutional coordination and discussion of cross-departmental issues such as cumulative effects management or public / workforce health and safety.

To address immediate capacity-building requirements the needs identified fall into three categories:

- Coaching in the Evaluation of Cumulative Effects of Oil Shale Developments through the MoEnv
- Developing cooperatively Policy Guidance for Oil Shale Developments through the MoEnv
- Providing training and workshop to enhance capacity building capabilities in the MoEnv and other responsible ministries.

While the training and workshops have been well-attended and received, the next step in capacity building would be to provide some immediate and on-going support to MoEnv. This assistance would need to be embedded into the MoEnv (i.e. a person working within the

MoEnv organization) for a period of time. The position should be senior enough person who can work well with others within the MOE and other governmental organizations. Some technical skills related to environmental impacts would be of benefit but the position would focus on EIA, master planning and cumulative effects of multiple sites. The embedded personnel would also provide support in the establishment of the recommended Oil Shale EIA Regulatory Team. In order to have a lasting result, a 3-6 month term is recommended. In summary, the WRECP has provided an important foundation in the creation of a Guidance for Preparing Environmental Impact Assessments (July 2014) and related Technical Protocols (October 2014). Implementation and use of these documents by MoEnv and other responsible ministry staff have been supported by the oil shale EIA evaluation training. The guidance and structure provided by these documents are a basis for undertaking the recommendations outlined above to support the sustainable development of the oil shale industry in Jordan.

List of Attachments

A. Presentations from January 2015 Oil Shale Workshop
B. List of Participants in USAID WRECP Evaluation of Oil Shale Development Training May 2015
C. Agenda from USAID WRECP Evaluation of Oil Shale Development Training May 2015
D. Presentations from USAID WRECP Evaluation of Oil Shale Development Training May 2015

Attachment A

Presentations from January 2015 Oil Shale Workshop

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USAID Water Reuse and Environmental Conservation Project

Oil Shale Development in Jordan

Presentation to USAID staff

Don Shosky
Andrew Mathewson

January 2015
Implemented by AECOM

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OIL SHALE – A ROCK THAT BURNS

A fine-grained sedimentary rock

Formed in lake beds and sea bottoms from silt and organic material

Contains kerogen, a solid, insoluble organic bituminous material

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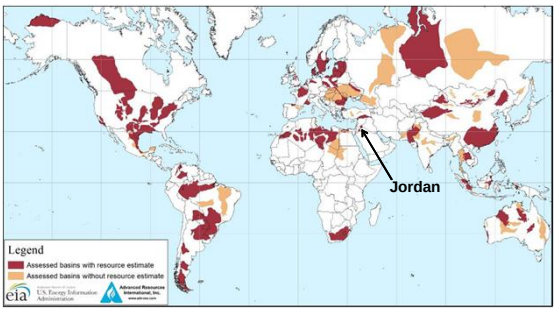
WORLDWIDE OIL SHALE RESOURCES



Data Source: US Department of Energy, Energy Information Administration. 2013. Technically Recoverable Shale Oil and Shale Gas Resources, June. http://www.eia.gov/analysis/studies/worldshalegas

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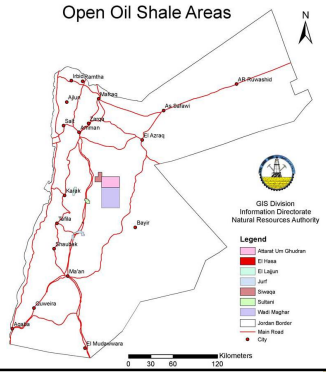
OIL SHALE RESOURCES IN JORDAN



Graphic Source: Alali, J. 2006. "Jordan Oil Shale, Availability, Distribution, and Investment Opportunities", Paper rtos-A117, International Conference on Oil Shale, 7-9 Nov 2006. Amman.

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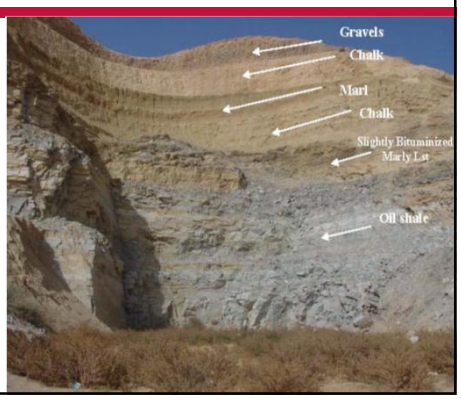
OIL SHALE OUTCROP IN AL-LAJJUN DEPOSIT



Source: Alali, J. 2006. Jordan Oil Shale, "Availability, Distribution, and Investment Opportunities", Paper rtos-A117, International Conference on Oil Shale, 7-9 Nov 2006. Amman.

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DEVELOPMENT OF THE OIL SHALE RESOURCE

Five activities associated with developing oil shale:

- Exploration
- Resource Extraction
- Oil Shale Processing
- Distribution of energy or refined petroleum products
- Decommissioning and Reclamation

OPEN CAST MINING

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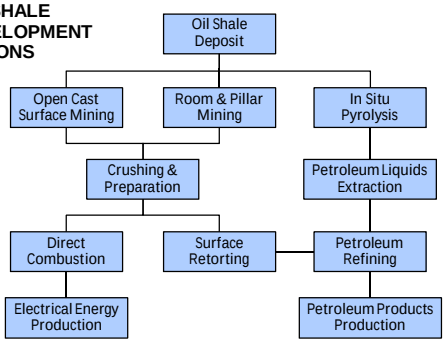
OIL SHALE DEVELOPMENT OPTIONS



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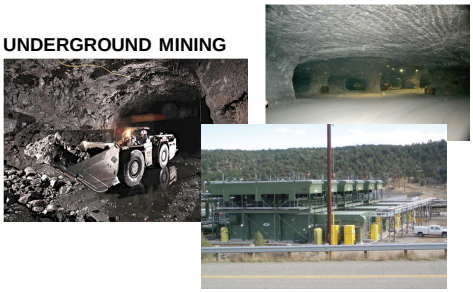
UNDERGROUND MINING



IN SITU SHALE OIL PROCESSING

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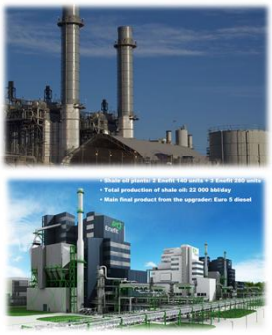
DEVELOPMENT OPTIONS:

- Direct combustion to generate electricity
- Refining of shale oil into petroleum products



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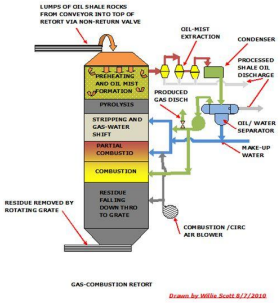
AN OIL SHALE RETORT



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ENVIRONMENTAL IMPACTS OF OIL SHALE DEVELOPMENT

- Major land use and reclamation management issues
- Major use of available water resources
  - Potential degradation of surface and groundwater sources
- Air emissions
- Vegetation & wildlife impacts
- Related issues:
  - Protection of antiquities
  - Dust control
  - Sustainable waste disposal
  - Reclamation

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SOCIOECONOMIC IMPACTS OF OIL SHALE DEVELOPMENT

- Visual changes
- Smell and dust
- Noise
- Human health

- Cumulative effects
- Residual effects

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SOCIOECONOMIC IMPACTS OF OIL SHALE DEVELOPMENT

- Competing land and water uses and values
- Employment and contracting opportunities
- Construction camps
- Re-settlement?
- Income-related impacts
- Cultural integration issues

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FUGITIVE DUST IS A PERVASIVE ISSUE

- Blasting
- Drilling
- Mining
- Loading material
- Hauling material
- Reclaiming wastes (overburden, ash, spent oil shale)

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WATER RESOURCE USE IS A PERVASIVE ISSUE

- Dust suppression
- Cooling
- Processing
- Operations

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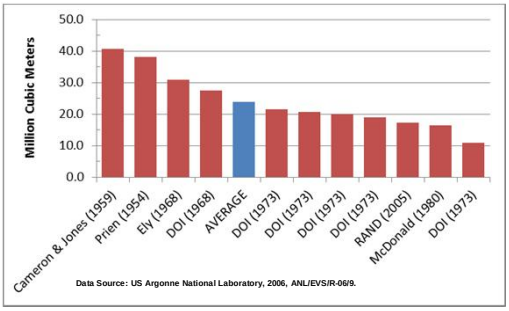
ESTIMATED WATER NEEDS PER 100,000 BARRELS OF SHALE OIL PRODUCED



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SOCIAL & ECONOMIC DISPLACEMENT OF COMMUNITIES IS A PERVASIVE ISSUE

- Competing and conflicting land uses
  - Impacts on agricultural cultivation or grazing lands
- Potential human health risks
- Socioeconomic issues during construction phase (camps)
- Strains on existing infrastructure and community services
- Necessary waste management and reclamation efforts

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COMMERCIAL AND REGULATORY REALITIES

- Oil shale development is a national priority for Jordan, from energy security - power generation and balance of payments perspectives
- Responsibility for the oil shale industry is spread over several Jordanian government departments
- Environmental impact assessment and compliance regulations are currently be developed and implemented
- Concession agreements give developers strong commercial and land rights that may supersede national and international environmental standards and laws if there is a conflict

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OPTIONS TO INFLUENCE PROTECTION OF ENVIRONMENTAL AND SOCIAL VALUES COMPONENTS

- Centralize oversight of the oil shale industry in one government department
- Implement robust environmental monitoring programs and publish the data collected, comparing results against commitments by developers
- Encourage environmental and public participation best practices in the development and implementation of environmental assessment and compliance regulations
  - Community Advisory Committees

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QUESTIONS?

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USAID Water Reuse and Environmental Conservation Project

Oil Shale Development in Jordan

Presentation to MoEnv

Don Shosky
Andrew Mathewson

January 2015
Implemented by AECOM

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AGENDA

- **Day 1**
  - Introduction and Overview
  - Oil Shale Development in Jordan
  - Environmental Impact Assessment and Compliance Part 1
- **Day 2**
  - Environmental Impact Assessment and Compliance Part 2
  - Social Impact Assessment and Engagement
- **Day 3**
  - Summary of Environmental Quality Impacts
  - Recommendations for Oversight and Compliance

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COURSE OBJECTIVES

- Provide overview of the various phases of oil shale exploration, excavation, development and decommissioning
- Outline key environmental quality and compliance concerns
- Discuss potential social impacts and engagement issues
- Provide recommendations for environmental oversight and regulatory compliance

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TRAINERS

- Don Shosky - Environmental Compliance Specialist, AECOM
- Andrew Mathewson - Social Risk and Engagement Specialist, AECOM

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OIL SHALE – A ROCK THAT BURNS

A fine-grained sedimentary rock

Formed in lake beds and sea bottoms from silt and organic material

Contains kerogen, a solid, insoluble organic bituminous material

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KEY TERMS / DEFINITIONS

Oil Shale	A fine-grained sedimentary rock formed in lake beds and sea bottoms from silt and organic material. It contains **KEROGEN**.
Kerogen	The solid, insoluble organic bituminous material in **OIL SHALE**
Shale Oil	A synthetic petroleum product produced from oil shale by heating (**PYROLYSIS**)
Pyrolysis	A chemical change brought about by the action of heat, typically in the absence of oxygen

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KEY TERMS / DEFINITIONS (CONTINUED)

Risk In Place Shale Oil	An adjusted estimate of the recoverable resource (**OIL SHALE)** considering field characteristics conducive to resource recovery and the capability of current technology to produce the resource.
Retort	The vessel used to convert **OIL SHALE KEROGEN** to hydrocarbons through heating (**PYROLYSIS**)
In Situ	A synonym for **IN PLACE** (i.e. underground)
Greenhouse Gas (GHG)	Gaseous pollutants in the atmosphere that contribute to climate change through the action of absorption of long wavelength radiation (heat)

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KEY TERMS / DEFINITIONS (CONTINUED)

Opencast mining	A surface mining technique in which adjacent linear rows of mineable resource (**OIL SHALE)** are sequentially stripped of overburden, the resource mined, and spoils from mining are deposited in a previously mined row to be eventually reclaimed.
Room and Pillar mining	An underground mining technique in which the resource (**OIL SHALE)** is mined in a chess board fashion leaving "pillars" of unmined resource to support the roof of mined "rooms".
Oil Shale In Situ Pyrolysis	A **SHALE OIL** recovery technique in which hot air (or other heat source) is transferred underground into a fractured seam of **OIL SHALE**, allowing **PYROLYSIS** to occur within the oil shale seam. The produced hydrocarbon is then recovered through conventional oil extraction methods.

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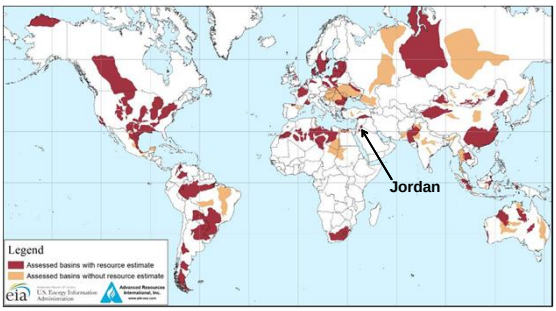
WORLDWIDE OIL SHALE RESOURCES



Data Source: US Department of Energy, Energy Information Administration. 2013. Technically Recoverable Shale Oil and Shale Gas Resources, June. http://www.eia.gov/analysis/studies/worldshalegas

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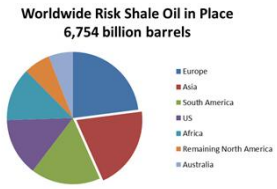
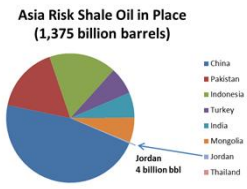
WORLD RISK OIL SHALE RESERVES (AS OF JUNE 2013)





Risk Oil In Place reflects the estimated volume of oil in place that is recoverable considering field characteristics conducive to resource recovery and the capability of current technology to produce the resource

Data Source: US Department of Energy, Energy Information Administration. 2013. Technically Recoverable Shale Oil and Shale Gas Resources. June. http://www.eia.gov/analysis/studies/worldshalegas/

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OIL SHALE OUTCROP IN AL-LAJJUN DEPOSIT

Source: Alali, J. 2006. Jordan Oil Shale, "Availability, Distribution, and Investment Opportunities", Paper rtos-A117, International Conference on Oil Shale, 7-9 Nov 2006. Amman.

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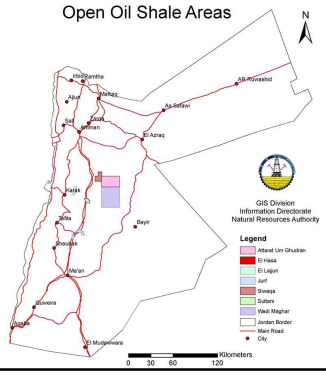
OIL SHALE RESOURCES IN JORDAN



Graphic Source: Alali, J. 2006. "Jordan Oil Shale, Availability, Distribution, and Investment Opportunities", Paper rtos-A117, International Conference on Oil Shale, 7-9 Nov 2006. Amman.

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DEVELOPMENT OF THE OIL SHALE RESOURCE

- Resource exploration and field development
- Mining and resource processing
- In Situ processing and extraction
- Combustion to generate electricity
- Retorting and refining to produce petroleum products
- Disposal of wastes
- Reclamation and restoration

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RESOURCE DEVELOPMENT

Is the oil shale resource development economically viable?

Detailed characterization of oil shale geologic and physical properties is required to answer the question

- Is the geology conducive to economical exploitation?
- Is the quantity of resources sufficient for production?
- What are the chemical and physical properties?
- What is the energy content of the oil shale?
- What is the physical composition of the oil shale?
- What is the final product: electricity or shale oil?
- What is the optimum production method?

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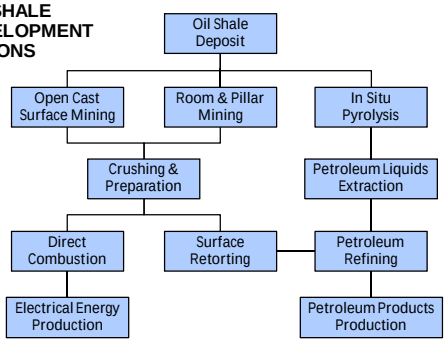
OIL SHALE DEVELOPMENT OPTIONS



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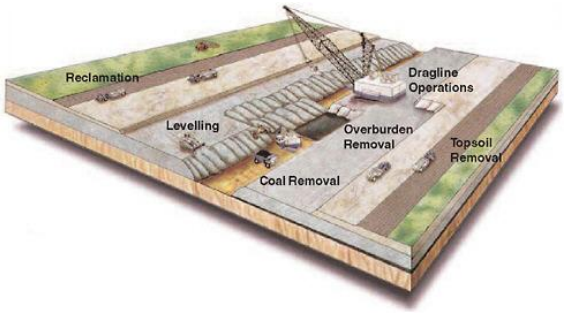
EXTRACTION OPTION 1—SURFACE MINING



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CONVENTIONAL SURFACE MINING TO EXTRACT OIL SHALE

- Used for shallow deposits (up to 150 meters deep)
- Mineral seams must be horizontal

ADVANTAGES OF SURFACE MINING

- Lower cost and higher productivity relative to other mining techniques
- Flexibility to adjust to formation geometry changes
- High resource recovery efficiencies
- Previously mined areas provide storage areas for overburden, spent shale, and ash
- Established mining technology

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DISADVANTAGES OF SURFACE MINING

- Substantial land areas disturbed and habitat lost
- Displacement of persons / communities by mining activities
- Substantial overburden and spent shale management issues
- Polluted ground / surface water and altered drainage patterns
- Air quality impacts from equipment exhaust and fugitive dust
- Exposes layers of phosphates with trace radionuclide emissions
- Noise impacts from equipment, vehicles, crushing operations, material movement, and explosives
- Large land reclamation programs extend well beyond cessation of mining operations

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EXTRACTION OPTION 2—UNDERGROUND MINING

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CONVENTIONAL UNDERGROUND MINING METHODS USED TO EXTRACT OIL SHALE

- Used for deep deposits (below 150 meters deep)
- Mineral seams must be horizontal
- Large pillars of the mineral remain as roof supports
- Limited surface disturbance footprint
- About 25% of resource cannot be extracted
- Requires continuous active ventilation to prevent methane explosions
- Lower production rates for same investment compared to surface mining

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ROOM AND PILLAR UNDERGROUND MINE

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OPENCAST MINING

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DRAGLINE

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BUCKET WHEEL EXCAVATOR

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EXCAVATOR / SPREADER MACHINES WITH MATERIAL PILES

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LOADER AND HAUL TRUCK

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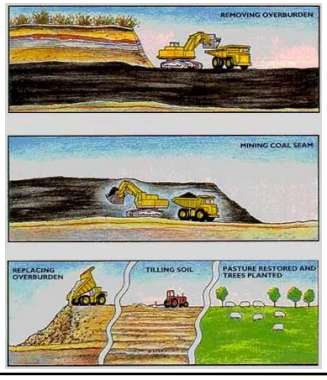
SURFACE MINING DOES NOT END WITH EXTRACTION



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EXTRACTION OPTION 3—IN SITU SHALE OIL PROCESSING

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IN SITU OIL SHALE PROCESSING

- Liquefies kerogen in place
- Produces shale oil precursor liquids
- Conventional production methods used to extract liquids
- Requires subsequent refining to produce desired products

Methods Used	Discussion
Electromagnetic heating	Requires at least 50 meter of overburden Demonstrated effectiveness for oil shale
Steam injection	Large water requirement
Water flooding	Large water requirement
CO_2 flooding	Large nearby CO_2 source requirement
Solvent flooding	Potential groundwater contamination Must recover/reuse solvent

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ADVANTAGES AND DISADVANTAGES OF IN SITU PROCESSING

Advantages

- Limited surface disturbance area
- Limited displacement of persons by processing activities compared to surface mining
- Requires conventional petroleum extraction methods

Disadvantages

- Large water demand
- Air pollutant emissions of SOx, NOx, PM10, PM2.5
  - vehicle and equipment operation
  - drilling and operation of production and injection wells
  - vehicles delivering chemicals for injection
- Potential ground water contamination

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IMPACTS FROM DEVELOPMENT AND PRODUCTION ACTIVITIES

- Air pollutant emissions
- Impacts on ground and surface water flow
- Use of water for oil shale processing and dust control
- Noise
- Traffic
- Potential local and Bedouin population displacement

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TWO ALTERNATIVES FOR DEVELOPMENT OF OIL SHALE ONCE MINED OR EXTRACTED

- Direct combustion for electrical generating
- Conversion of kerogen to shale oil through pyrolysis

Retorting and In Situ processing require subsequent refining to produce finished petroleum products

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DEVELOPMENT OPTION 1—DIRECT COMBUSTION OF OIL SHALE TO GENERATE ELECTRICITY

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IMPACTS FROM DIRECT OIL SHALE COMBUSTION

- Low heat content of oil shale results in large ash volume
- Large surface area required for ash disposal
- High water demand for power plant cooling and dust suppression
- Emissions of SOx, NOx, PM10, PM2.5
- Fugitive dust emissions from crushed oil shale and ash handling

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DEVELOPMENT OPTION 2—SHALE OIL DIRECT PRODUCTION

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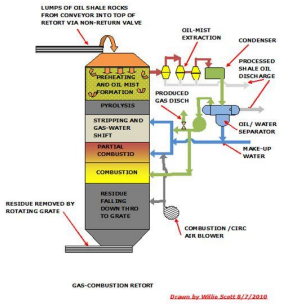
AN OIL SHALE RETORT



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IMPACTS FROM FIELD PRODUCTION?

- Drilling required to obtain oil shale for testing
- Limited development activities required to obtain bench scale quantities of oil shale for production test runs
- Impacts from exploration and field development
  - Drilling and blasting to remove overburden
  - Vehicle and equipment to extract oil shale for testing
  - Emissions of SOx, NOx, PM10, PM2.5
  - Fugitive dust emissions from extraction operations
- Construction activities for buildings and processing plants

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IMPACTS FROM SHALE OIL PRODUCTION

- Large process water use for hydrogenation of kerogen
- Large demand for electric power, heat, processing water, and reactants for use in upgrading reactions
- Pyrolysis in retorts produces significant emissions
  - Large fuel demand to fire the retort
  - Large quantities of SOx, NOx, CO, PM10, PM2.5 emitted
  - Fugitive dust generated in spent shale handling

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FUGITIVE DUST IS A PERVASIVE ISSUE

- Blasting
- Drilling
- Mining
- Loading material
- Hauling material
- Reclaiming wastes (overburden, ash, spent oil shale)

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VEHICLE MOVEMENT ROAD DUST

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HAUL ROAD FUGITIVE DUST

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MATERIAL TRANSFER FUGITIVE DUST

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DRILLING MACHINE WITH BLAST PATTERN MARKED OUT

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BLASTING FUGITIVE DUST AND NOISE

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WATER RESOURCE USE IS A PERVASIVE ISSUE

- Dust suppression
- Cooling
- Processing
- Operations

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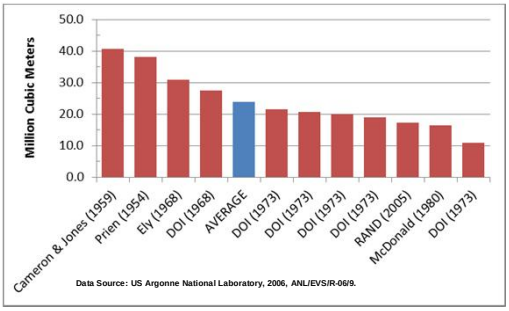
ESTIMATED WATER NEEDS PER 100,000 BARRELS OF SHALE OIL PRODUCED



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FUGITIVE DUST CONTROL VIA WATER SPRAY

- Availability issues may limit use of water for dust control

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STORM WATER AND WATER RUNOFF

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POTENTIAL SOCIAL & ECONOMIC DISPLACEMENT OF COMMUNITIES IS A PERVASIVE ISSUE

- Competing land uses
- Impacts on agricultural cultivation or grazing lands
- Human health risks
- Socioeconomic issues during construction phase (camps)

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QUESTIONS?

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USAID Water Reuse and Environmental Conservation Project

Oil Shale Development Social Impact Assessment and Engagement

Presentation to MoEnv

Andrew Mathewson
Social Risk & Engagement Specialist

January 2015
Implemented by AECOM

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Environmental and social impacts from
Jordanian oil shale and Canadian oil sands projects

Purpose:
…Asking the right questions in the regulatory review process...based on the ***Guidance for Preparing Environmental Impact Assessments, July 2014***

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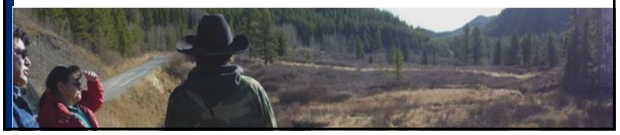
MY BACKGROUND

- 20+ years working with and for indigenous groups in Canada
- 3 years working in the Alberta oil sands for a leading global producer consulting with affected First Nations
- Engagement and Consultation Lead on major oil and gas, pipeline and mining project environmental impact assessments
- Masters in Conflict Analysis and Management
- Graduate-trained mediator
- Socioeconomics and Engagement Team member
- Lead, Integrated Aboriginal Services, Canada West



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ENVIRONMENTAL IMPACTS OF OIL SHALE DEVELOPMENT

- Major land use and reclamation management issues
- Major use of available water resources
  - Potential degradation of surface and groundwater sources
- Air emissions
- Vegetation & wildlife impacts
- Related issues:
  - Protection of antiquities
  - Dust control
  - Sustainable waste disposal
  - Reclamation

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SOCIOECONOMIC IMPACTS OF OIL SHALE DEVELOPMENT

- Competing land and water uses and values
- Employment and contracting opportunities
- Construction camps
- Re-settlement?
- Income-related impacts
- Cultural integration issues

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SOCIOECONOMIC IMPACTS OF OIL SHALE DEVELOPMENT

- Visual changes
- Smell and dust
- Noise
- Human health

- Residual effects
- Cumulative effects

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LESSONS LEARNED: ENVIRONMENTAL AND SOCIOECONOMIC IMPACTS IN THE ALBERTA OIL SANDS

- Loss of traditional indigenous lands to development
- Degradation of available water resources
- Emissions
- Major increase in roads, clearing of land for mining, housing
- Reported health effects

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SYNCRUDE MILDRED LAKE PROJECT

- Syncrude is one of the original oil sands producers
- The Mildred Lake Project has expanded through several phases since 2000—with major environmental and social impacts within the active mining area north of Fort McMurray

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SYNCRUDE MILDRED LAKE PROJECT

- Syncrude is actively reclaiming lands that were previously surface mined
- Major investments in local services and infrastructure
- Local / Aboriginal spend has surpassed $2 billion since 1990

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SYNCRUDE MILDRED LAKE PROJECT

- Regulatory review and oversight of oil sands projects has evolved since the first oil sands mines were approved
- Review processes now emphasize Aboriginal and public participation
- Mitigation of "residual" effects and reclamation planning have played an increasingly prominent role

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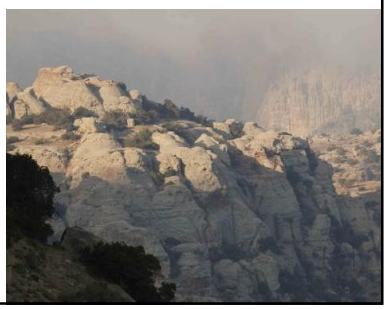
ASSESSMENT OF ENVIRONMENTAL AND SOCIO-ECONOMIC IMPACTS OF OIL SHALE DEVELOPMENT

- Jordan's legal framework and foundations for EIAs
- Outline for Comprehensive EIAs
- EIA Best Practice



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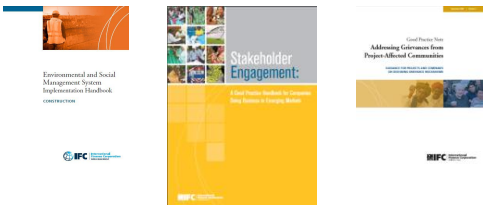
ASSESSMENT OF ENVIRONMENTAL AND SOCIO-ECONOMIC IMPACTS OF OIL SHALE DEVELOPMENT

IFC Performance Standards and Best Practice documents provide valuable guidance



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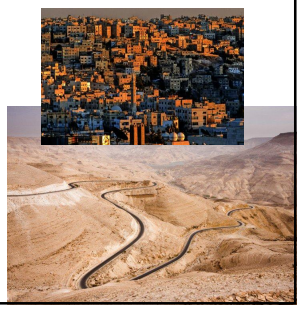
ASSESSMENT OF ENVIRONMENTAL AND SOCIO-ECONOMIC IMPACTS OF OIL SHALE DEVELOPMENT

Trade-offs: balancing impacts with benefits

- Energy resources
- Education / training
- Employment / contracting
- Community services and infrastructure
- Direct compensation



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ASSESSMENT OF ENVIRONMENTAL AND SOCIO-ECONOMIC IMPACTS OF OIL SHALE DEVELOPMENT

- Use or degradation of scarce water resources
- Loss of grazing areas and water resources used by Bedouin herders and tribes
- Potential health related effects due to dust, emissions, water, noise and light
- Construction camp and income-related socioeconomic effects

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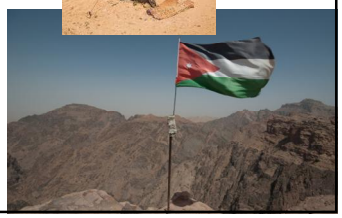
ASSESSMENT OF ENVIRONMENTAL AND SOCIO-ECONOMIC IMPACTS OF OIL SHALE DEVELOPMENT

- Training and employment / contracting opportunities
- Improvements in local infrastructure
- Resettlement / Compensation



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ASSESSMENT OF ENVIRONMENTAL AND SOCIO-ECONOMIC IMPACTS OF OIL SHALE DEVELOPMENT

Break-out session exercise:

- What information is needed in the Environmental Management Plan (EMP) to address the potential socioeconomic and human health impacts of an oil shale project?
- Identify the topics
- Identify the information you will be looking for in the EMP
- Identify the possible sources of information

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REGULATION OF THE ENVIRONMENTAL AND SOCIO-ECONOMIC IMPACTS OF OIL SHALE DEVELOPMENT

- Possible Topics?
  - Water management; Emissions; Engagement; Employment / Training; Community Investment; Health Indicators
- Information for the EMP?
  - Water usage and quality data; air emissions data; number of meetings held; number of complaints; employment data; local and legacy investments and criteria; respiratory disease data
- Information sources?
  - Periodic monitoring; annual reporting; independent auditing; compliance inspection; health sampling vs. baseline

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MANAGING THE ENVIRONMENTAL AND SOCIAL RISKS AND IMPACTS OF OIL SHALE DEVELOPMENT

- IFC Performance Standard 1
  - Environmental and Social Management Systems
- World Bank OP 4.01
  - Environmental Assessment requirements
- Equator Principle No.5
  - Consultation and Disclosure

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MANAGING THE ENVIRONMENTAL AND SOCIAL RISKS AND IMPACTS OF OIL SHALE DEVELOPMENT

- IFC Good Practice Guide Stakeholder Engagement Handbook
- Good planning — desired outcomes
- Keep the process simple and manageable
- Consider feedback from public participation workshops

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QUESTIONS?

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USAID Water Reuse and Environmental Conservation Project

Oil Shale Development Summary of Environmental Quality Impacts

Presentation to MoEnv

Don Shosky

January 2015
Implemented by AECOM

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ENVIRONMENTAL QUALITY IMPACTS BY PROCESS PHASE AND MEDIA

There are five activities associated with development of oil shale resources

- Exploration
- Resource Extraction
- Oil Shale Processing
- Distribution of Energy
- Decommissioning and Reclamation

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ENVIRONMENTAL QUALITY IMPACTS BY PROCESS PHASE AND MEDIA

Exploration Phase Activities

- Data collection and planning
- Land disturbance
- Waste generation
- Groundwater and surface water use and alteration

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ENVIRONMENTAL QUALITY IMPACTS BY PROCESS PHASE AND MEDIA

Resource Extraction Activities

- Overburden removal (large areas of disturbed land)
- Oil shale extraction (ex-situ operation)
- Oil extraction (in-situ operation)
- Waste replacement

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ENVIRONMENTAL QUALITY IMPACTS BY PROCESS PHASE AND MEDIA

Extraction Phase Impacts

- Land disturbance
- Increased water usage and drawdown
- Alterations in water quality (drainage and discharges)
- Increase in dust pollution
- Increase in noise pollution and light pollution
- Long-term waste disposal and possible isolation of wastes
- Infrastructure development

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ENVIRONMENTAL QUALITY IMPACTS BY PROCESS PHASE AND MEDIA

Oil Shale Processing Activities

- Infrastructure development (roads, pipelines, electrical transmission lines)
- Power plant construction and operation
- Processing plant construction and operation
- Wastewater plants (depending upon processes used)
- Resource consumption (fuel, raw materials)
- Growth in overall population from workers to service industry (both direct and indirect)
- 30-50 year planning cycle

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ENVIRONMENTAL QUALITY IMPACTS BY PROCESS PHASE AND MEDIA

Oil Shale Processing Impacts

- Air quality impacts (dust and odor)
- Surface water impacts (usage and water quality)
- Groundwater impacts (usage and water quality)
- More transportation related issues
- More social requirements to support population
- More opportunities for accidents that could have regional impacts (fires, leaks and explosions) and other health and safety concerns

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ENVIRONMENTAL QUALITY IMPACTS BY PROCESS PHASE AND MEDIA

Closure and Reclamation Activities

- Capping of waste areas
- Demolition of processing facilities
- Closure of pipelines and infrastructure
- Replanting of vegetation
- Restoration and continued protection of surface and groundwater resources

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ENVIRONMENTAL QUALITY IMPACTS BY PROCESS PHASE AND MEDIA

Reclamation/Closure Impacts

- Air quality should improve
- Water consumption would decrease
- Potential for water quality deterioration would decrease
- Decrease in population and required services
- Future plans for the area have been implemented

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ENVIRONMENTAL QUALITY IMPACTS BY PROCESS PHASE AND MEDIA

Lessons learned from past developments

- Ministry should identify areas appropriate for shale oil development and establish basic development guidelines
  - Require developer to provide comprehensive planning document that goes through the life cycle of the project
  - Require developer to maximize reuse and recycling (water and other natural resources)
  - Think ahead to the future and how to get there
  - Get buy-in from as many stakeholders as possible
  - Openly discuss both positive and negative aspects of the development
  - Be transparent in decision-making

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QUESTIONS?

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USAID Water Reuse and Environmental Conservation Project

Oil Shale Development in Jordan
Key Management Topics and Recommendations

Presentation to MoEnv
Don Shosky
Andrew Mathewson
January 2015
Implemented by AECOM

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WATER MANAGEMENT

- Surface Water
- Water Harvesting
- Water Treatment
- Water Use

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EMISSIONS MANAGEMENT

- Emissions sources:
  - Roads
  - Stockpiles
  - Excavation
- Air Modeling
- Monitoring

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WASTE MANAGEMENT

- Secure disposal
- Geologic segregation and stockpiling
- Landscaping / Reclamation

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HUMAN ENVIRONMENT

- Health and Safety
  - On-site
  - Affected communities
- Socio-economics
  - Employment, contracting and procurement
  - Training and education
  - Local and cultural impacts

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THE "COMMON" OR "CRITERIA" AIR POLLUTANTS

- Six common air pollutants are found everywhere and cause harmful health effects and property damage
- Called "criteria" pollutants because there are defined regulatory concentration standards (criteria) against which they are compared
- These pollutants are:
  - Particulate matter (PM10 and PM2.5)
  - Sulfur dioxide (SO2)
  - Nitrogen dioxide (NO2)
  - Carbon monoxide (CO)
  - Lead (Pb)
  - Ozone (O3)

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OTHER AIR POLLUTANTS

- Other Air Pollutants Can Also Be Harmful
- Heavy Metals
  - Includes Cadmium, Mercury, Hexavalent Chromium, Arsenic
- Combustion Products
  - Dioxins and Furans
  - Polycyclic Aromatic Hydrocarbons (PAHs)
  - HCl
- Radionuclides
  - Uranium and Thorium
  - Daughter (decay) products
  - Radon – special case as it is a gas

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QUESTIONS

Attachment B

List of Participants

USAID WRECP Evaluation of Oil Shale Development Training

May 2015

Attachment B. List of Participants in USAID WRECP Evaluation of Oil Shale Development Training

Participants in Oil Shale Training Workshop 13, 14, and 17 May 2015

Name	Organization
Dr. Mahmoud Aqaileh	Ministry of Labor
Eng. Abdel Kareem Shalabi	Ministry of Environment
Eng. Izzat Abu Humra	Ministry of Environment
Wafa Daibes	Ministry of Environment
Dr. Amani Khudeir	Ministry of Agriculture
Ghussanina Hilu	Ministry of Energy and Mineral Resources
Hanadi Saadeh	Ministry of Energy and Mineral Resources
Abbas Kalbouneh	Water Authority of Jordan
Ayman Jaber	Ministry of Water
Ali Khawaldah	Ministry of Energy and Mineral Resources
Muna Al Habahbeh	Ministry of Industry
Deemah Attyiat	Ministry of Energy And Mineral Resources
Asma'a Al-Ghzawi	Ministry of Municipal Affairs
Eng. Emad M.S	Ministry of Environment
Isra' Al-Turk	Federation of Environmental NGOS
Maha Al-Ma'ayta	Ministry of Environment
Medhat Anagreh	Ministry of Environment
Amjad Ghbari	Ministry of Environment
Ahlam Bader	Ministry of Environment
Laith Abu Affar	Ministry of Energy And Mineral Resources
Faraj Al-Talib	Ministry of Environment
Yaser Al- Sharif	Jordon Environment Society
Eng. Nasser Al-Juneidi	Ministry of Environment
Sahar Hammouri	WRECP
Charles Darnell	WRECP
Sathish Kumar	WRECP
Maggie Bartouli	WRECP

Attachment C

Agenda

USAID WRECP Evaluation of Oil Shale Development Training

May 2015

Evaluation of the Environmental and Social impacts
of Oil Shale Development in Jordan
13th, 14th, and 17th May 2015
Grand Hyatt Hotel
Amman – Jordan

Day One
Wednesday - May 13th

9:00	Registration
9: 30 - 10:00	Opening Remarks Eng. Charles Darnell – WRECP Chief of Party USAID Reprehensive Eng. Ahmed Qatarneh – MoEnv Secretary General
10:00 - 10:15	Training Overview and Objectives
10:15- 11:00	Review of Oil Shale Concession Agreements / MOUs / Project Technologies
11:00-11:30	Coffee Break
11:30- 14:00	Evaluating the Environmental and Social Impacts of a) Open cast - power generation b) Oil shale processing c) In situ processing, in relation to: • Water use and re-use • Air emissions • Waste management • Social / Health impacts / benefits
14:00 - 15:00	Lunch Break
15:30 - 16:00	Review of Technical Protocols and Government of Jordan regulatory requirements

Day Two
Thursday – May 14

9:00-9:30	Virtual Site Visits: KIO Project Site

9:30 – 10:30	Water: Evaluating Potential Impacts
	• Surface Water Hydrology and Quality Analysis
	• Groundwater Flow and Quality Analysis
	• Assessment tools
	  ○ Models, methods and equipment requirements
	• Monitoring methods
	  ○ Key indicators for the oil shale industry
	• Mitigating impacts
	  ○ Key parameters for oil shale industry
	  ○ Remedial measures

10:30-11:30	Air: Evaluating Potential Impacts • Purpose, Standards and Assessment Information Requirements

	• Qualification and Significance Criteria for the oil shale industry • Modeling and Monitoring Methods • Dust control mitigation measures • Cumulative Analysis • Climate Change Mitigation Analysis
11:30-12:00	Coffee Break
12:00 - 13:00	Waste Management and Site Decommissioning: Managing oil shale waste • Characterization of waste materials • Examination of data • Steps in evaluation • Managing stockpiles • Cover composition procedure • Drainage evaluation procedure • Restoration options
13:00-14:00	Lunch Break

14:00 - 15:00	Social / Health: Evaluating Potential Impacts
	• Human Health and Ecological Risk Assessment
	  ○ Data collection procedures
	  ○ Conceptual Site Model
	  ○ Tools, process and method
	• Water use / re-use / security
	• Dust / Noise / Visual
	• Waste / Contaminants / Restoration
	• Cumulative / residual effects
	• Land Use / Infrastructure demands / Traffic
	• Training and employment opportunities

15:00-16:00	Wrap-up: Conclusions / Recommendations for future capacity-building requirements • Support • Human resources • Equipment • Regulation

Day Three
Sunday – May 17th

9:00 - 10:30	Working sessions Creating Monitoring Systems • Water quality • Air emissions / Noise limits • Human and ecological health
10:30 - 11:30	Maximizing Local Benefits (Training and Employment) • Anticipating required skill sets and training needs • Collaboration: building on existing programs
11:30 - 11:45	Coffee Break
11:45 - 12:40	Restoration and Remediation options • Potential use of biosolids
	Closing Comments, followed by Lunch

Attachment D

Presentations from USAID WRECP Evaluation of Oil Shale Development Training

May 2015

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USAID Water Reuse and Environmental Conservation Project

Regulatory Evaluation of Oil Shale Development in Jordan

Don Shosky
Andrew Mathewson
May 2015

Implemented by AECOM

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AGENDA

DAY 1 – Evaluating Potential Environmental and Social Impacts: Part I

- Overview and Objectives
- Review of Oil Shale Concession Agreement and MOUs and Project Technologies
- Evaluating Environmental and Social Impacts of:
  - Open cast mining
  - Oil shale retorting / processing
  - In situ retorting / processing
- Review of the Technical Protocols and Government of Jordan regulatory requirements

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AGENDA

DAY 2 – Evaluating Potential Environmental and Social Impacts: Part II

- Virtual Site Visit – Karak International Oil
- Evaluating Potential Environmental and Social Impacts:
  - Air emissions
  - Water
  - Waste Management and Site De-commissioning
  - Social / Human Health / Ecology
- Conclusions / Working Sessions / Recommended Follow-up
  - Support
  - Human Resources
  - Equipment
  - Regulation

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AGENDA

DAY 3 – Evaluating Potential Environmental and Social Impacts:

- WORKING SESSIONS

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AGENDA

DAY 1 – Evaluating Potential Environmental and Social Impacts: Part I

- Overview and Objectives
- **Review of Oil Shale Concession Agreement and MOUs and Project Technologies**
- Evaluating Environmental and Social Impacts of:
  - Open cast mining
  - Oil shale retorting / processing
  - In situ retorting / processing
- Review of the Technical Protocols and Government of Jordan regulatory requirements

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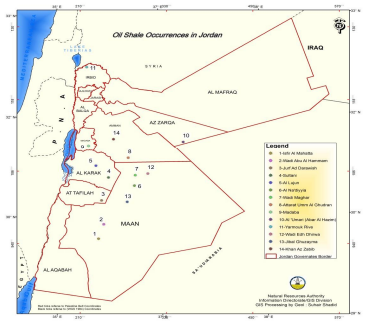
OIL SHALE OCCURRENCES



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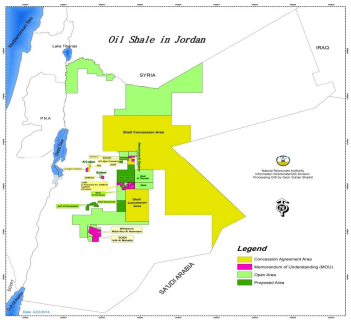
OIL SHALE CONCESSIONS



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OIL SHALE INVESTMENT TRACKS

Government of Jordan has adopted a three-track approach to Oil Shale resource exploitation*

1. Surface Retorting for the mined Oil Shale to produce oil

2. In Situ for the deep Oil Shale to produce oil

3. Direct Burning of Oil Shale for Electricity Generation

** The Government is also currently negotiating with the local Cement Industry for the use of oil shale waste and ash in cement manufacture. Similarly, the Government plans to discuss and study future options, other uses and new outcomes for oil shale.*

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TYPES OF AGREEMENTS FOR OIL SHALE DEVELOPMENT

1. Exploration Phase: Memorandum of Understanding (MoU)

2. Development Phase: Concession Agreement (CA)

3. Power Purchase Agreement (PPA)

4. Head of Terms Agreement

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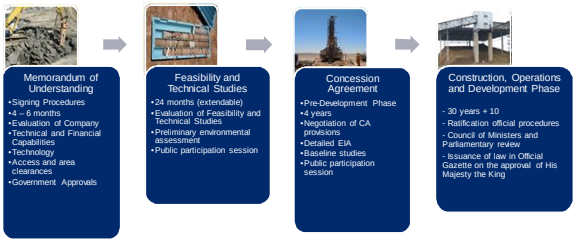
OIL SHALE AGREEMENTS AND APPROVAL



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OIL SHALE CONCESSION AGREEMENTS

1. JOSCo (Shell)

- The Concession Agreement was issued in 2009 to explore oil shale over an area of 22,270 km² throughout the Kingdom based on a proposed $20 billion investment. The exploration area will be narrowed down in three phases to finally reach 1000 km² for commercial purposes.
- JOSCo will use Shell's *In-Situ Conversion Process* (ICP) electrically heating the reserve for three years while still underground.
- A Final Investment Decision (FID) for implementing the Project in Jordan will be made between 2020-2022
- The Company plans to do an experimental pilot plant before reaching the commercial full production of 100,000 bbl/d.

** Timeframes and production capacities are based on Company estimates and plans.*

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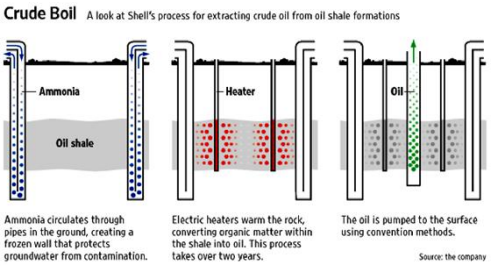
SHELL IN SITU CONVERSION PROCESS (ICP)



Source: Institute for Energy Research website

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SHELL IN SITU CONVERSION PROCESS (ICP)

Source: US Geological Survey Department of the Interior

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OIL SHALE CONCESSION AGREEMENTS

2. Jordan Oil Shale Energy (JOSE)

- Estonian / Malaysian / Jordanian consortium to develop two projects in Jordan to produce oil and electricity.
- The Concession Agreement was issued in 2010 to develop a surface retorting project to produce shale oil over an area of 72 km² in Attarat Um Al Ghudran area using the Estonian Solid Heat Carrier Technology *Enefit 280* with an investment of $6 billion for both projects.
- JOSE is planning to produce 19,000 bbl/d by 2017 and will reach 38,000 bbl/d by 2019.

** Timeframes and production capacities are based on Company estimates and plans.*

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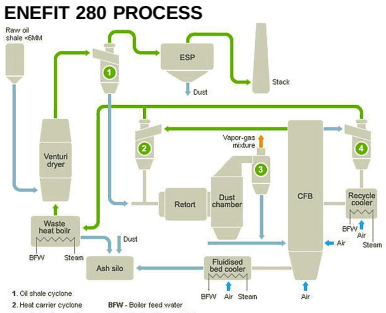
ENEFIT 280 PROCESS



Source: Outotec website

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ENEFIT OIL PROCESSING PLANT

Source: Enefit website

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OIL SHALE CONCESSION AGREEMENTS

3. Karak International Oil (KIO)

•The Concession Agreement was issued in 2011 to develop a surface retorting project to produce oil over an area of 33 km² in Al-Lajjun area with an investment of $1.9 billion.

•KIO is planning in Phase 1 to produce 4,000 bbl/d of oil, reaching full capacity of 50,000 bbl/d using the *Alberta Taciuk Process* (ATP).

4. Saudi Arabian Corporation for Oil Shale (SACOS)

•The concession agreement was issued in 2014 to develop an Oil Shale surface retorting project over 11 km² in Attarat Um Al-Ghudran area, using the Russian technology *UTT3000* with an investment of $1.8 billion.

•It is expected that SACOS will start producing 2,500 bbl/d of oil, to reach full capacity of 30,000 bbl/d.

** Timeframes and production capacities are based on Company estimates and plans.*

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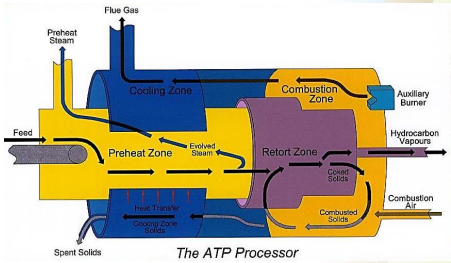
ALBERTA TACIUK PROCESS



Source: Jordan Energy and Mining website

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ALBERTA TACIUK PROCESS PLANT (FUSHUN CHINA)

Source: www.oilshale.co.uk

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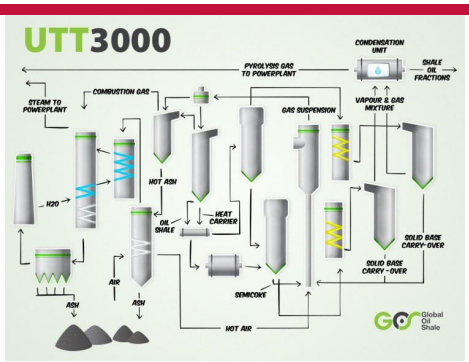

Source: GlobalOilShale.com website

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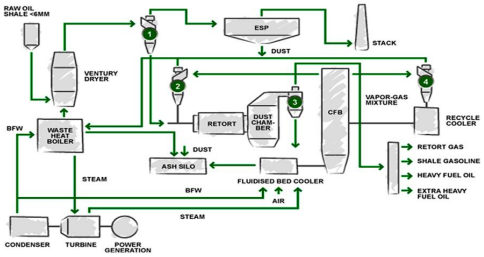
ENEFIT 280 PROCESS



Source: www.enefit.com

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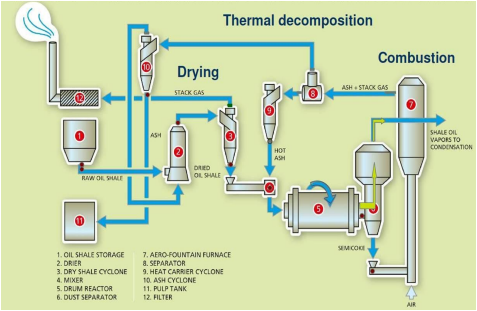
SURFACE RETORTING PROCESS



Source: MEMR

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OIL SHALE MEMORANDA OF UNDERSTANDING

1. National Company for the Production of Oil and Electric Power from Jordanian Oil Shale (ShaleEnergy)

- The Government of Jordan has signed an MOU with the company over an area of 14.6 km² in Sultani to study the feasibility of developing an Oil Shale surface retorting project using Russian technology *UTT3000* to produce 30,000 bbl/ of oil.

2. Global Oil Shale Holdings (GOSH)

- The Government of Jordan has signed an MOU with the company over an area of 33km² in Attarat Um Al Ghudran area and 65km² in Isfir Al Mahatta area to study the feasibility of developing a surface retorting project to produce 50,000 bbl/d of shale oil using a modified Brazilian Technology (PRIX).

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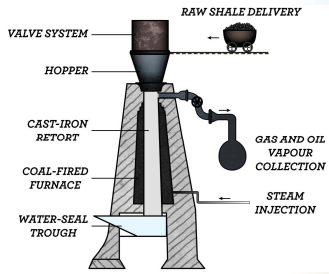
ALEXANDER C. KIRK'S RETORT (CIRCA 19TH CENTURY)



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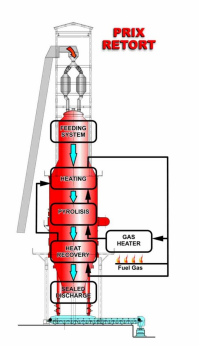
PRIX PROCESS



Source: PRIXtechnology website

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OIL SHALE MEMORANDA OF UNDERSTANDING

3. Whitehorn Resources Inc.

- The Government of Jordan has signed an MOU with the company over an area of 188 km² in Wadi Abu Al Hamam area to study the feasibility of developing an Oil Shale project to produce 30,000 bbl/d of shale oil using Ecoshale™ *In Capsule* technology.

4. Aqaba Petroleum Company for Oil Shale (Al Janoub)

- The Government of Jordan has signed an MOU with the company over an area of 35 km² in Wadi Al Na'adyeh area to study the feasibility of developing an Oil Shale project to produce up to 30,000 bbl/d of shale oil using the ENIN Russian technology.

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ECOSHALE™ PROCESS

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OIL SHALE MEMORANDA OF UNDERSTANDING

5. Fushun Mining Group

The GoJ has signed an MOU with the company over an area of 87 km² in Wadi Al Na'adyeh area to study the feasibility of developing an Oil Shale project to produce up to 50,000 bbl/d of shale oil using the Chinese technology *Fushun*.

6. Al Qamer for Energy and Infrastructure

The GoJ has signed a MOU with the company over an area of 64 km² in Attarat Um Al Ghudran area to study the feasibility of developing an Oil Shale project to produce up to 30,000 bbl/d of shale oil using the Russian technology *UTT3000*.

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OIL SHALE DIRECT BURNING POWER PLANTS

1. Attarat Power Company (APCO)

- Estonian/Malaysian/Jordanian consortium
- The Government of Jordan signed a Power Purchase Agreement (PPA) with APCO in 2014 (and other related agreements) to develop an Oil Shale direct combustion power plant to produce 470 MW of electricity in Al Attarat area. This power plant will be operational in 2017.

2. Al-Lajjun Company

- The Government of Jordan has signed a Head of Terms Agreement with a Jordanian / Emirates / Chinese consortium (Al Lajjun/ Al-Hamed future/ HTG/ SEPCOIII) to study the feasibility of developing an Oil Shale direct burning power plant to produce 600-700 MW of electricity in Al Lajjun and Al Attarat areas.

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AGENDA

DAY 1 – Evaluating Potential Environmental and Social Impacts: Part I

- Overview and Objectives
- Review of Oil Shale Concession Agreement and MOUs and Project Technologies
- **Evaluating Environmental and Social Impacts of:**
  - **Open cast mining**
  - **Oil shale retorting / processing**
  - **In situ retorting / processing**
- Review of the Technical Protocols and Government of Jordan regulatory requirements

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DEFINING THE QUALITY OF THE ENVIRONMENT JORDAN EXPECTS:

- Pre-industrial age conditions?
- Protection of wildlife and environment?
- Breathable air and drinkable water?
- Food security?
- Better health?
- Jobs which provide income and security?
- Better infrastructure and services such as roads, schools, hospitals, recreational facilities?

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POTENTIAL PROBLEM AREAS - WATER

Surface Water

- Excavation areas
- Surface drainage
- Erosion features
- Stockpiles
- Chemistry of water and various geological materials
- Water treatment—natural vs. mechanical
- Water retention management

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POTENTIAL PROBLEM AREAS - WATER

Groundwater

- Excavation activities
- In situ processing
- Potential groundwater users
- Potential groundwater recharge area
- Groundwater quality for various uses
- Water treatment / reinjection schemes

General
pH, TSS, TDS,TP,TN
Metals
As. HG, Ag, Ba, B, Br, Co, Cr, Cu, Fe, Mn, Mo, Ni, Pb, Zn, V, Th, U, St
Inorganics
Ammonia, Chloride, Fluoride Cyanide, Sulfide, Sulfate
Organics
BOD, COD, DOC, TOC, Oil, Phenols, PAHs

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COMPLIANCE POINTS

Surface Water

- Discharge point
- Source point
- Receptors
- Ground water
- Boundary conditions

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COMMON CRITERIA FOR COMPLIANT MONITORING FOR SURFACE AND GROUNDWATER

Surface and Ground Waters

- pH, conductivity, TDS
- Heavy metals
- PAH's
- Volatile organics
- Heavy organics

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POTENTIAL PROBLEM AREAS - AIR

Air Sources

- Overburden removal
- Oil Shale extraction
- Overburden and waste replacement
- Power generation by direct combustion
- Shale oil processing
- Dirt roads
- Stockpiles

Metals
Zn, Cr, As, Cd, Pb
Particulates
PM10, PM2.5
Organics
Phenols, VOCs, PAHs, Dioxins, Furans, Mercaptans
Inorganic Gases
NO2,SO2,NH3, H2S,CO2,CO

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COMPLIANCE POINTS

Air

- Boundary conditions
- Point source
- Modeling
- Technology

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THE "COMMON" OR "CRITERIA" AIR POLLUTANTS

- Six common air pollutants are found everywhere and harm health and property
- Called "criteria" pollutants because there are defined regulatory concentration standards (criteria) against which they are compared
- These pollutants are:
  - Particulate matter (PM10 and PM2.5)
  - Sulfur dioxide (SO_2)
  - Nitrogen dioxide (NO_2)
  - Carbon monoxide (CO)
  - Lead (Pb)
  - Ozone (O_3)

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OTHER POTENTIALLY HARMFUL AIR POLLUTANTS

- Heavy metals
  - Includes Cadmium, Mercury, Hexavalent Chromium, Arsenic
- Combustion products
  - Dioxins and Furans
  - Polycyclic Aromatic Hydrocarbons (PAHs)
  - HCl
- Radionuclides
  - Uranium and Thorium
  - Daughter (decay) products
  - Radon

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POTENTIAL PROBLEM AREAS - WASTE

Waste Management

- Segregation of domestic / industrial / hazardous
- Isolated final disposal area
- Leak detection technology
- Response to problems

Ash (PP)
Spent Shale (SRP)
Over Burden (Mining + remediation)
Fly Ash

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COMMON CRITERIA FOR WASTE MANAGEMENT

- Physical inspection
- Segregation
- Chemical analysis
- Detection point
- Plans and methods of management

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Break-out Session

1. *Choose an oil shale development phase and technology:*
   a. Open cast mining
   b. Power generation
   c. Ex situ processing
   d. In situ processing
2. *Consider the impacts of phase / chosen technology on:*
   a) Water
   b) Air
   c) Waste
   d) Social / health / ecology
3. *As the regulator, what should you require of oil shale producers to mitigate the impacts you have identified?*

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  - In situ retorting / processing
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ENVIRONMENTAL FRAMEWORK FOR OIL SHALE DEVELOPMENT IN JORDAN

- Baseline Pollution Levels (Air, Water and Soil)
- Water Effluent and Discharge Pollutants (Soil, S. Water & G. Water)
- Air Emissions Ambient, End of Stack and CO2
- Mining, SRP, PP, Upgrading, Remediation and Mitigation
- Solid Waste and Remediation (Air, Water and Soil)

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MINISTRIES INVOLVED IN ENVIRONMENTAL PROTECTION

- Ministry of Environment
- Ministry of Energy & Mineral Resources
- Jordan Institution for Standards & Meteorology
- Royal Society for The Conservation of Nature
- Ministry of Agriculture
- Ministry of Health
- Ministry of Labor
- Ministry of Tourism and Antiquities
- Civil Defense
- Ministry of Water & Irrigation
- Ministry of Municipal Affairs

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APPLICABLE JORDANIAN REGULATIONS

1. Ministry of Environment:

- The Environment Law No (52) of the year 2006
- Regulations for:
  - Nature Protection
  - Emergency Incidents No. (26) of 2005
  - Water Protection of 2005
  - Air Protection No. (28) of 2005
  - Marine and Coastal Protection No. (51) of 1999
  - Natural Reserves No. (29) of 2005
  - Hazardous Material No. (24) of 2005
  - Solid Waste No. (27) of 2005
  - Environmental Impact Assessment (EIA) No. (37) of 2005
  - Soil Protection No. (25) of 2005
  - Fees & Fines
  - Regulation of Hazardous Waste Management and Handling. No. (43) of 1999
  - Inspection and Environmental Monitoring of 2008.

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APPICABLE JORDANIAN REGULATIONS

2. Jordan Institution for Standards and Meteorology (JISM):

- Standards & Metrology Law No. (22) of Year 2000
- Standards and Guidelines:
  - Ambient Air Quality Standards
  - Maximum Limits for Air Pollutants
  - Industrial Reclaimed Wastewater
  - Drinking Water
  - Working Environment Standards
  - Noise Levels
  - Storage of Hazardous Materials
  - Ozone Depleting Agents
  - Motor Vehicles-Emissions- Diesel Engines

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APPLICABLE JORDANIAN REGULATIONS

3. Ministry of Water and Irrigation:

- Jordan Valley Authority (JVA) Law (30) of 2001 - Jordan Valley Development Law.
- Underground Water By-Law (85) of 2002.
- Regulations for the Protection of Water .
- Environmental Health Legislation, Law (12) of 1995.
- Guidelines for Drinking Water Resources Protection, 2006

4. Ministry of Health:

- The public health law (47) of 2008.
- The public health law (54) of 2002.
- Trade, industry and occupational safety laws.

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ENVIRONMENTAL PROTECTION DELIVERABLES

- A detailed work plan for each project phase:
  - Pre-development
  - Pilot
  - Development
- Environmental Impact Assessment
  - Feasibility (MOU)
  - Detailed (Concession)
- Health, Safety and Environmental Plan
- Remediation Plan

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REMEDIATION FUND

- Concession Agreements commit companies to the establishment of a cash fund, to be annually accumulated and held in a reputable Bank in order to guarantee the completion of the Remediation Activities

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TECHNICAL GUIDANCE PROTOCOLS

- Annex to Guidance for Preparing Environmental Impact Assessments (2014):
  - Surface Water Hydrology and Quality Analysis
  - Groundwater Flow and Quality Analysis
  - Air Quality Analysis
  - Noise Assessment
  - Traffic Impact Assessment
  - Life Cycle Analysis
  - Human Health Risk Assessment
  - Ecological Risk Assessment

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TECHNICAL GUIDANCE PROTOCOLS

- The protocols discuss:
  - Purpose
  - Terms and Acronyms
  - Information needed to conduct the analysis
  - Assessment tools
  - Recommended methods
  - Interpretation of results
  - Presentation of analysis methodology, findings and results
  - Example projects

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USAID Water Reuse and Environmental Conservation Project

Evaluating Environmental and Social Impacts of Oil Shale Development in Jordan

Air Quality Impacts

Don Shosky
Andrew Mathewson

May 2015
Implemented by AECOM

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AGENDA

- **Purposes and standards**
- Activities, factors and sources
- Principal pollutants
- Significance criteria
- Greenhouse gases
- Modeling and monitoring methods
- Cumulative analysis
- Mitigation
- Analysis review
- Modeling references

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PURPOSE OF AIR QUALITY ASSESSMENT

…Evaluate the potential air quality impacts posed by an oil shale development project and the methods for limiting those impacts…

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REGULATIONS AND STANDARDS

Regulatory review should address applicable Jordan, local, and international stationary source emission limits and ambient air quality standards

Type	Applicable Regulation
Ambient air quality	Jordan Standard 1140/2006 establishes air quality limits that are not to be exceeded at ground level anywhere outside the facility property line.
Stationary source smoke stack emission limits	Jordan Standard 1189/2006 establishes stationary source emission limits that apply at the point of release from an emission stack.
Mobil source	There are no separate Jordan standards for mobile sources.
Greenhouse gases	There are no separate Jordan standards for greenhouse gases or climate change.

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AGENDA

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ACTIVITIES THAT CAN AFFECT AIR QUALITY

Direct

- Land disturbance
- Mining and drilling operations
- Processing methods
- Quantity of oil produced

Indirect

- Additional electrical energy generation required by project
- Secondary population growth resulting from project

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IMPACTS OCCUR AT ALL STAGES AND OPTIONS

- Stages
  - Resource exploration and field development
  - Extraction and processing
- Options
  - Disposal, reclamation, and restoration
  - Surface or underground mining
  - In situ pyrolysis
  - Direct combustion
  - Surface retorting
  - Petroleum refining

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EXPLORATION AND FIELD ACTIVITIES

- Qualitative analyses for temporary, short-term activities
- Quantitative analyses for long-term operations
- Both depend on project scale and sensitivity, duration of activities

Activity	Surface Mining	Underground Mining	In Situ Retorting
Resource exploration	√	√	√
Construction of buildings and processing facilities	√	√	√
Construction of roads and other infrastructure (e.g., pipelines, electricity transmission lines, railroads)	√	√	√

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EXTRACTION AND PROCESSING

Activity	Surface Mining	Underground Mining	In Situ Retorting
Oil shale mining	√	√	
Well drilling and pumping			√
Crushing, sizing, and sorting	√	√	
Direct oil shale combustion	√	√	
Surface retorting	√	√	
In situ pyrolysis and extraction			√
Shale oil refining	√	√	√
Material conveyance, loading, and unloading	√	√	√
Material storage	√	√	√

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DISPOSAL, RECLAMATION, RESTORATION

Activity	Surface Mining	Underground Mining	In Situ Retorting
Overburden disposal	√	√	
Waste disposal	√	√	√
Facility demolition and decommissioning	√	√	√
Site reclamation and restoration	√	√	√

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POTENTIAL AIR EMISSION SOURCES

- Diesel equipment, vehicles
- Gasoline vehicles
- Diesel generators
- Diesel storage tanks
- Shale oil storage tanks
- Storage piles
- Shale stockpiles
- Spent material disposal area
- Blasting
- Mine opening
- Wells
- Unpaved roads
- Start-up burner
- Hydrogen plant reformer
- Above-ground retort
- Flaring flue gas
- Direct combustion facilities
- Shale crushing/screening
- Upgrading facilities
- Refining facilities
- Cryogenic (freeze wall) plants
- Pipelines
- Compressor stations

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PRINCIPAL AIR POLLUTANT EMISSIONS FROM OIL SHALE DEVELOPMENT

Pollutant	Discussion
Sulfur oxides (SO_X)	Refers to the mixture of sulfur oxide gases in the atmosphere and released from combustion processes. SO_X is composed primarily of sulfur dioxide (SO_2).
Carbon monoxide (CO)	An air pollutant that is a product of incomplete combustion.
Nitrogen oxides (NO_X)	Refers to the mixture of nitrogen oxide gases in the atmosphere and released from combustion processes. NO_X is composed primarily of nitrous oxide (NO) and nitrogen dioxide (NO_2).
Respirable particle matter (PM_{10})	Particle matter less than 10 micrometers in aerodynamic diameter. PM_{10} includes $PM_{2.5}$.
Fine particle matter ($PM_{2.5}$)	Particle matter less than 2.5 micrometers in aerodynamic diameter.

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PRINCIPAL AIR EMISSIONS FROM OIL SHALE DEVELOPMENT (CONTINUED)

Pollutant	Discussion
Fugitive Dust	Particulate matter that is released to the atmosphere from locations other than a process vent or stack.
Volatile organic compound (VOC)	An air pollutant composed of organic compounds that have a high vapor pressure at ordinary room temperature. Most organic compounds with a carbon number of 2 or greater are considered to be VOCs.
Phosphate	Phosphate typically is present as carbonate flourapatite in oil shale deposits in Jordan, with higher concentrations of phosphates within the lower part of oil shale. Phosphates in oil shale are present as pellets, intraclasts, bone, teeth, and coprolites.[1]

1. Source: Abed, A.M., K. Arouri, B.S. Amireh, and Z. Al-Hawari. (2009). Characterization and genesis of some Jordanian oil shales. *Dirasat*, Pure Sciences. 36(1):7-17.

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AGENDA

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JORDAN AIR QUALITY STANDARDS JS 1140/2006

Pollutant	Averaging Time	Jordan Air Quality Standard		
		Parts per Million	Micrograms per Normal Cubic Meter	Permissible Exceedances per Year
Sulphur Dioxide (SO_2)	1-Hour	0.3		3
	24-Hour	0.14		1
	Annual	0.04		None
Carbon Monoxide (CO)	1-Hour	26		3
	8-Hour	9	10,000	3
Nitrogen Dioxide (NO_2)	1-Hour	0.21	395	3
	24-Hour	0.08		3
	Annual	0.05	94	None

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JORDAN AIR QUALITY STANDARDS JS 1140/2006 (CONTINUED)

Pollutant	Averaging Time	Jordan Air Quality Standard		
		Parts per Million	Micrograms per Normal Cubic Meter	Permissible Exceedances per Year
Respirable particle matter (PM_{10})	24-Hour		120	3
	Annual		70	None
Fine particle matter ($PM_{2.5}$)	24-Hour		65	3
	Annual		15	None
Phosphate (P_2O_5)	24-Hour		100	None
	Annual		40	None

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JORDAN STATIONARY SOURCE EXHAUST STANDARDS (JS 1189/2006)

- Applicable to structures, buildings, and stationery operations which emit air pollutants from their smoke stacks
- Requires measuring stack exit pollutant concentrations for particulate and many other pollutants

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AGENDA

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PRINCIPAL GREENHOUSE GASES FROM OIL SHALE DEVELOPMENT

Greenhouse Gas	Discussion
Carbon dioxide (CO_2)	CO_2 is the most commonly emitted GHG as it is the end product of complete combustion of fossil fuels. It results from the combination of carbon with oxygen during combustion and other oxidation processes.
Methane (CH_4)	CH_4 is formed during chemical and biological processes that occur in oxygen-poor environments in landfills, agricultural activities, and the geologic processes that produced oil and gas deposits. Smaller amounts of CH_4 emissions occur as a byproduct of fuel combustion from both stationary and mobile sources.

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PRINCIPAL GREENHOUSE GASES FROM OIL SHALE DEVELOPMENT (CONTINUED)

Greenhouse Gas	Discussion
Nitrous oxide (N_2O)	N_2O is emitted during agricultural and industrial activities, as well as during combustion of fossil fuels and solid waste. Smaller amounts of N_2O emissions occur as a byproduct of fuel combustion from both stationary and mobile sources and from agricultural activities.

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AGENDA

- Purposes and standards
- Activities and sources
- Principal pollutants
- Significance criteria
- Greenhouse gases
- **Modeling and monitoring**
- Cumulative analysis
- Mitigation
- Analysis review
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AQ MONITORING DATA LIMITATIONS

- Pollutants sampled
  - Ambient standards have been established for many critical pollutants
  - Large monitoring network would need to be developed
- Duration of sampling
  - Continuing year-round monitoring would be required since many pollutants have annual standards
- Long-term monitoring system
  - At each site, complex system (routinely maintained year after year), and data validation and reduction process
- Geographical extent
  - Selecting representative sites for ambient monitoring is challenging
  - Need to encompass urbanized land uses

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ACTIONS TO ADDRESS DATA LIMITATIONS

- Request that applicant collect new data
- Request that monitoring start in the early planning stage
  - To meet year-round monitoring requirement o establish background levels around the site.
- Identify comparable background levels from available sites around the country or from neighboring countries
  - Less desirable alternative

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AQ MODELING OF OIL SHALE DEVELOPMENT

- Use dispersion model to estimate the impact of emissions from proposed project
- Computer program simulates transport and dispersion of air pollutants upon release from emission source
- 3 general types of models for oil shale EIA

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AQ DISPERSION MODELS FOR OIL SHALE

Type	Application	Capability	Tools
Screening	Where necessary meteorological and elevation data are not available	Computation of impacts of single source, using a standardized array of meteorological conditions	AERSCREEN SCREEN3
Refined	Where extensive meteorological data from surface and aloft, and detailed characterization of aerodynamic boundary layer and ground surface elevations are available	Computation of impacts of multiple sources	AERMOD OML ADMS-5
Mobile Source	Model emissions from vehicles on roads, including vehicles and heavy equipment during construction and operations	Simulate emissions and dispersion along line source such as roadway, at a point, or within an area	CAL3QHC CAL3QHCR AERMOD

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AGENDA

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CUMULATIVE ANALYSIS

- Air quality impacts are cumulative
- Use screening approach, assuming no monitoring background levels or meteorological data are available
- Determine project impacts
  - Combine emissions from various sources within the site
    - Combustion from various stationary or mobile sources
    - Earth disturbance
    - Process releases
  - Simulate these emissions evenly over the project site working areas as a combined area or volume source
  - Conduct dispersion modeling using screening model

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CUMULATIVE ANALYSIS (CONTINUED)

- Determine other background neighboring source contributions
  - Identify site neighboring major emitting sources within a 10-kilometer radius of the project site
  - If relevant emission points and facility configurations are available, repeat the same screening approach to predict neighboring major sources ambient background contributions
  - If no source data is available, use typical background levels from similar urban or rural areas from neighboring or other countries

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CUMULATIVE ANALYSIS (CONTINUED)

- Combine
  - Project impacts
  - Background levels contributed from neighboring major facilities or from representative, similar areas
- Compare total, combined levels with Jordan ambient standards
- Apply above procedures using a refined model, rather than a screening model
  - When representative meteorological data are available,
- Require proponent to install meteorological monitoring tower, enabling more accurate and refined dispersion modeling
  - As required for baseline air quality monitoring
  - If project is large-scale and highly controversial

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AGENDA

- Purposes and standards
- Activities and sources
- Principal pollutants
- Significance criteria
- Greenhouse gases
- Modeling and monitoring
- Cumulative analysis
- **Mitigation**
- Analysis review
- Modeling references

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AQ IMPACT MITIGATION

- Optimize stack heights, diameters, and location designs
- Optimize flare tip height and flaring efficiency
- Specify emission control devices on production equipment – e.g., scrubbers, cyclones, and bag filters
- Capture and destroy or recover vapors from hydrocarbon storage tanks
- Use newer equipment with improved fuel-burning efficiency
- Use natural gas fuel rather than diesel fuel for stationary source engines
- Require low-sulfur-content fuels
- Decrease vehicle idling times
- Monitor exhaust gas emissions from major smoke stacks
- Monitor ambient air quality to ensure compliance with standards

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AQ IMPACT MITIGATION (CONTINUED)

- Minimize and capture dust at source
- Apply water or dust suppressants to unpaved roads, construction sites, stockpiles, and disposal areas
- Restrict vehicle speeds on unpaved roads
- Cover vehicles carrying dry spoil and other dust-generating cargo
- Provide wheel-cleaning facilities
- Pave heavily-used roads

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GREENHOUSE GAS MITIGATION

- Capture and destroy or beneficially use methane from underground mine and wells
- Use natural gas fuel rather than diesel fuel for stationary source engines
- Capture and destroy or recover vapors from hydrocarbon storage tanks
- Use renewable energy for electricity generation
- Use newer equipment with improved fuel-burning efficiency
- Decrease vehicle idling times

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AGENDA

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ANALYSIS REVIEW PROCESS: SITE PLAN AND EMISSION SOURCE IDENTIFICATION

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SITE PLAN AND EMISSION SOURCE IDENTIFICATION

- Understand relevant emissions inventory tools or models
- Review site plot plan
- Identify all emission points and areas within the project site
- Check emissions rate calculation worksheet and/or emission factor modeling results, and corresponding operational scenarios
  - Source inventory (type, size, fuel use, and location on site)
  - Operational capacity (hours of operation on daily and annual basis)
  - Stack parameters (exit velocity, temperature, diameter, elevation, etc.) for combustion stacks
  - Mobile source emission factor modeling output files
- Check references used for emissions rate calculations for each source category

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DISPERSION MODELING INPUTS

- Understand relevant screening and/or dispersion models and request all relevant model inputs and outputs
- Check neighborhood receptor location map to ensure sensitive receptors in the areas around the project site are modeled
- Verify that buildings affects on dispersion are considered
  - Check 3-D building dimensions shown in model input for one random wind direction
- Check if emissions points and/or areas identified previously are modeled correctly with respect to
  - geometric setup
  - source-specific emission rates predicted previously

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DISPERSION MODELING OUTPUTS

- Confirm that model outputs are consistent with EIA-reported concentration levels for each applicable pollutant
- Compare the model-predicted results with the corresponding ambient standards that vary in terms of averaging time; i.e.:
  - Hourly
  - Daily
  - Annual
- Repeat above review process with mitigation in place

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METEOROLOGICAL DATA AND MONITORING BACKGROUND

- Refined dispersion modeling
- Check validity of meteorological station data used for the project based on comparability of weather patterns
- Minimum 1 year of data if collected on site
- 5 years of data if obtained from other site
- Check validity of background levels used based on comparability of land use types, population density, urban or rural land characteristics, etc.

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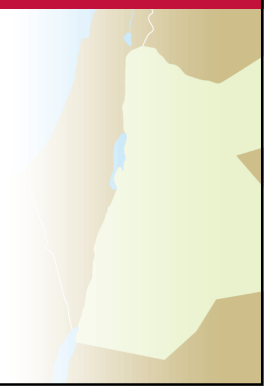
- Mitigation
- Analysis review
- **Modeling references**



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DISPERSION MODELING TOOLS

- http://www.epa.gov/ttn/scram/dispersion_prefrec.htm#aermod
- **For stationary, area and volume sources**
  - AERSCREEN User's Guide, USEPA, March 2011
  - SCREEN3 Model User's Guide, USEPA, September 1995
  - User's Guide for the AERMOD Meteorological Preprocessor (AERMET), USEPA, 2004
- **For mobile line sources**
  - User's Guide To CAL3QHC/CAL3QHCR Version 2: A Modeling Pollutant Concentrations Near Roadway Intersections, USEPA, September 1995

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EMISSIONS FACTOR PREDICTION TOOLS

- **For stationary sources**
  - AP 42, Fifth Edition, Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources, USEPA, January 1995
  - http://www.epa.gov/ttn/chief/ap42/index.html
- **For roadway vehicles**
  - Motor Vehicle Emission Simulator (MOVES) User's Guide for MOVES2014, USEPA, July 2014
  - http://www.epa.gov/otaq/models/moves/index.htm
- **For nonroad equipment**
  - User's Guide for the Final NONROAD 2005 Model, USEPA, December 2005
  - http://www.epa.gov/otaq/nonrdmdl.htm

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USAID Water Reuse and Environmental Conservation Project

Regulatory Evaluation of Oil Shale Development in Jordan

Socio-Economic Effects / Health and Ecological Risks

Don Shosky
Andrew Mathewson
May 2015

Implemented by AECOM

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AGENDA

- **Definitions**
- Evaluation of socio-economic effects
- Evaluation of human health & ecological risks

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EVALUATION OF SOCIO-ECONOMIC EFFECTS

Collection of data on current (baseline) and anticipated future conditions

- Land use
- Cultural resources
- Noise
- Infrastructure
- Transportation
- Solid and hazardous waste management
- Demographic conditions
- Aesthetics

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EVALUATION OF HUMAN HEALTH & ECOLOGICAL RISKS

…the process for evaluating the nature and the probability of adverse health effects in human exposed to chemicals or radiation in contaminated environmental media now or in the future… (USEPA, 2014)

In other words:

… a process that uses scientific data to analyze exposure pathways to humans and the environment…

(WRECP Guidance for Preparing Environmental Impact Assessments, 2014)

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AGENDA

- Definitions
- **Evaluation of socio-economic effects**
- Evaluation of human health & ecological risks

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DEMOGRAPHIC CONDITIONS

- Population characteristics
- Cultural characteristics
- Economic activities
- Crime rates
- Literacy rates
- Public services
- Community organizations
- Public health and safety

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LAND USE

EIAs must describe and consider planning schemes and requirements prepared by:

- Ministry of Municipal Affairs (MoMA)
- Jordan Valley Authority (JVA)
- Development and Free Zones Commission (DFZC)
- Aqaba Special Economic Zone Authority (ASEZA)

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OTHER SOCIO-ECONOMIC CONSIDERATIONS

- Open space, parks, areas of special protection
- Wildlife and hunting areas
- Agricultural land (farmland/cropland)
- Grazing land/pasture
- Wetlands/wadis
- Recreation tourist areas
- Utility corridors
- Roads
- Mining areas
- Industrial facilities
- Residential areas
- Public / institutional (schools, cemeteries, religious buildings

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CULTURAL RESOURCES

- Archaeological structures / sites / artifacts
- Architectural resources
- Historic buildings
- Ancients monuments
- Burial grounds
- Sacred or ceremonial sites

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INFRASTRUCTURE

- Water supply
- Wastewater systems
- Communications and energy
- Emergency services

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TRANSPORTATION

- Roads
- Parking
- Transit
- Pedestrian and bicycle transportation
- Airports and air strips

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AGENDA

- Definitions
- Evaluation of socio-economic effects
- **Evaluation of human health and ecological risks**

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HUMAN HEALTH & ECOLOGICAL RISK ASSESSMENT

- Separate from EIA
- Integrates data collected during EIA
- Often is basis for monitoring, mitigation and contingency planning
  - Quantitative
  - Qualitative
  - Site specific data
  - Area use data
  - Chemical toxicity data
  - Conceptual site modeling

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EVALUATION OF HUMAN AND ECOLOGICAL RISK

- Historic data, sampled data and conceptual modeling
- Describes risks and creates limits for exposure
- Helps in development of mitigation plans for:
  - Water use / re-use / security
  - Dust / noise / visual
  - Waste management
  - Cumulative / residual effects
  - Land use / infrastructure / traffic
  - Health and safety standards / training / employment

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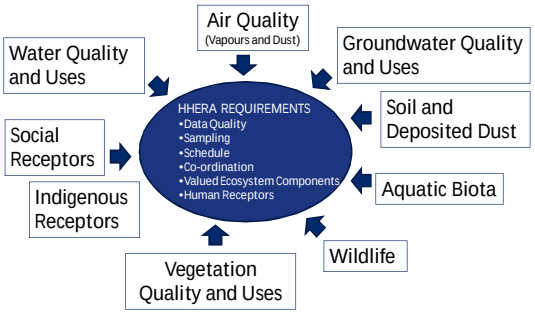

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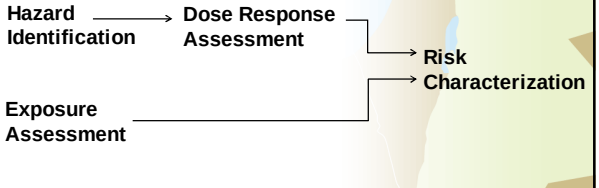
STEPS IN HUMAN HEALTH RISK EVALUATION



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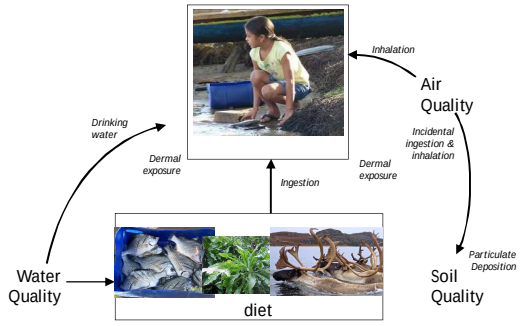
GENERALIZED MODEL FOR HUMAN EXPOSURE



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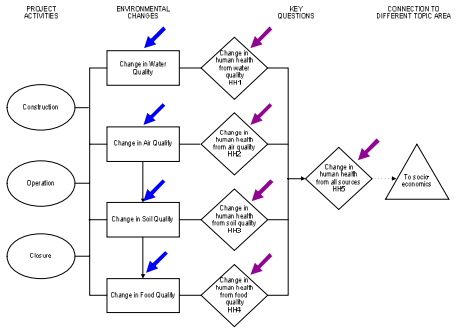
EIA LINKAGE DIAGRAM – HUMAN HEALTH



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EVALUATION OF ECOLOGICAL RISK

- Evaluates potential impacts on plants, animals or ecological communities as a result of exposure to "environmental stressors" such as chemicals
- May be used to establish environmental protection requirements, limits and clean-up standards of control
- Site specific data
- Ecological communities in the Project area
- Ecotoxicity data
- Conceptual modeling

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STEPS IN EVALUATION OF ECOLOGICAL RISK

Problem Formulation

↓

Analysis
- **Characterization of Exposure**
- **Characterization of Ecological Effects**

↓

Risk Characterization

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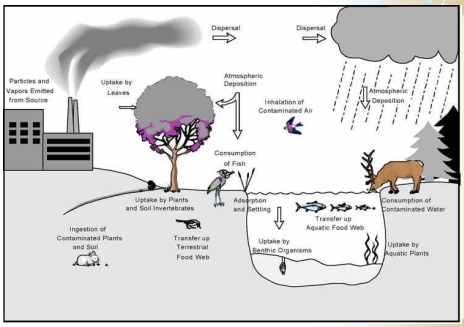
ECOLOGICAL RISK CONCEPTUAL MODEL



Source: USEPA, 2014d

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HHERA KEY QUESTIONS

HH1: What effect will project releases have on water quality and subsequently human health?	**ER1**: What effect will project releases have on water quality and subsequently ecological health?
HH2: What effect will project releases have on air quality and subsequently human health?	**ER2**: What effect will project air releases have on ecological health?
HH3: What effect will project releases have on soil quality and subsequently human health?	**ER3**: What effect will project releases have on soil quality and subsequently ecological health?
HH4: What effect will project releases have on food quality and subsequently human health?	**ER4**: What effect will project releases have on food resource quality and ecological health?
HH5: What will be the collective effect of changes to water, air, soil and food on human health?	**ER5**: What will be the collective effect of changes to water, air, soil and food on ecological health?

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WHAT ABOUT UNACCEPTABLE RISK?

- An EIS with unacceptable risk reduces likelihood of approval
  - First refine conservatism in the risk estimate (resolved by risk assessor?)
  - Also - consider baseline conditions (i.e., naturally elevated substances?)
  - Further mitigate the Project design or risk scenario

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QUESTIONS?

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USAID Water Reuse and Environmental Conservation Project

Regulatory Evaluation of Oil Shale Development in Jordan

Waste Cover Systems

Don Shosky
Andrew Mathewson

May 2015
Implemented by AECOM

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PROCEDURES OF EVALUATION

- Examine:
  - soil test data
  - topography
  - climate data
- Evaluate
  - composition
  - thickness
  - placement
  - configuration
  - drainage
  - vegetation
  - post-closure maintenance
  - contingencies plan

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CHARACTERIZATION OF WASTE

Cover system design and waste composition:

- Water content
- Thickness of waste
- Compaction
- Gas-forming potential
- Hazardous components

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1: REVIEW FIELD SAMPLING OF COVER SOILS

- Physical characteristics
- Volume available
- Potential borrow areas
- Gradation analysis
- Organic content
- Compaction
- Water content
- More as needed

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2: CHECK ADEQUACY OF SOIL TESTING PROGRAM

- Qualifications of testing personnel
- Adequacy of testing facilities
- Testing parameters
  - Grain-size distribution
  - Percent fines
  - Atterberg limits
  - Soil classification
  - Water content

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3: CHECK SOIL VOLUMES AVAILABLE

- Validate soil volume calculations
- Bulking factors

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4: EXAMINE COVER CONFIGURATION AND TOPOGRAPHY

- Accurate topographic maps
- Geologic and cover cross sections
- Access roads
- Drainage patterns

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5 TO 7: CLIMATOLOGICAL DATA REVIEW

- Examine:
  - precipitation records
  - evapotranspiration estimates
  - design storms and control features

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8: COVER COMPOSITION EVALUATION PROCEDURE

- Evaluate cover composition
- Thickness evaluation procedure:
  - coverage
  - infiltration
  - gas migration
  - trafficability
  - freeze/thaw or dry/soak effects

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9 TO 13

- Evaluate:
  - coverage
  - thickness for infiltration
  - thickness for gas migration
  - support requirements
- Consider freeze/thaw and dry soak effects

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14 TO 18: PLACEMENT EVALUATION PROCEDURE

- Evaluate:
  - cover compaction
  - internal layering
  - topsoil & use of topsoil enhancements like biosolids
  - time of construction
- Review proposed construction techniques

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19 & 20: CONFIGURATION EVALUATION PROCEDURE

- Evaluate:
  - erosion potential
  - surface slope inclination

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21 TO 24: DRAINAGE EVALUATION PROCEDURE

- Check overall surface drainage system
- Evaluate:
  - ditch design
  - culvert design
- Check gas drainage

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25 TO 32: VEGETATION EVALUATION PROCEDURE

- Evaluate:
  - soil suitability for vegetation
  - pH level
  - nitrogen and organic matter
  - other nutrients
  - species selection
  - shrubs and trees
  - time of seeding
  - seed and surface protection

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33 TO 35: MAINTENANCE EVALUATION PROCEDURE

- Evaluate:
  - design/maintenance balance
  - maintenance of vegetation
  - provisions for condition surveys

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36 TO 39: CONTINGENCY PLAN EVALUATION PROCEDURE

- Evaluate:
  - plan for erosion damage repair
  - plan for vegetation repair
  - plan for drainage renovation
  - provisions for other cover deterioration

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SUMMARY

- Cradle to Grave Approach

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QUESTIONS?

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USAID Water Reuse and Environmental Conservation Project

Evaluating Environmental and Social Impacts of Oil Shale Development in Jordan

Water Quality Impacts

Don Shosky
Andrew Mathewson

May 2015
Implemented by AECOM

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AGENDA

- Water Use
  - Background and overview
  - Projected water needs for oil shale development
  - Regulatory compliance
- Anticipated water use and water quality impacts
  - Key considerations
  - Potential surface water and groundwater impacts
- Technical assessments
  - Evaluating surface water impacts
  - Evaluating groundwater impacts
  - Mitigating impacts

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WATER SCARCITY IN JORDAN

- Jordan is world's 4th most water-deprived country
- >80% of Jordan is desert and receives <100 mm/year of rainfall
- 92.5% of water is lost by evaporation
- Low groundwater recharge

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WATER DEMAND

- Up, due to increasing population (including refugees), but less water is available per person
- 2014 population of Jordan: 9.9 million
- Annual per capita share of water
  - 1946: approx.3,600 m^3
  - 2015 (current): approx.143 m^3
  - 2025 (projected): 90 m^3
    - 37% reduction over current

Source: UNESCO slideshow

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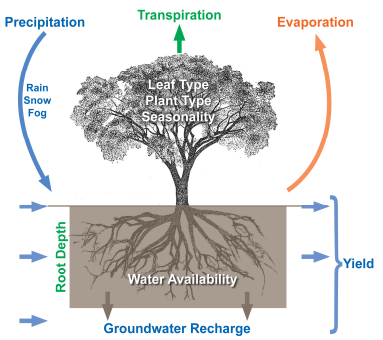
IMPORTANCE OF MAINTAINING WATER BALANCE



Source: The Natural Capital Project, 2014, Stanford.edu

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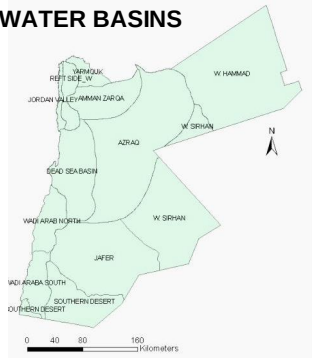
GROUNDWATER BASINS



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AQUIFERS SAFE YIELD AND OVER-PUMPING IN MCM/YEAR (MWI 2010)

Basin Name	Save Yield	Pumped water	Over Pumping
Yarmouk	40	50	10
Side Wadis	15	28	13
Jordan Valey	21	27	6
Amman/Zarqa	87	159	72
Dead Sea	57	82	25
North Wadi Araba	3	4	1
SouthWadi Araba	6	7	1
Jafer	9	32	23
Azraq	24	53	29
Sarhan	5	2	--
Hamad	8	1	--
Disi	125	63	--

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JORDAN'S NET DEFICIT OF WATER SUPPLY

Historic and Predicted Water Shortage is Significant*

Year	Rainfall (MCM)	Demand (MCM)	Supply (MCM)	Deficit (MCM)
2004	8,500	1,300	866	500
2007	8,500	1,500	866	630
2020	8,500	1,600	1,000	734

*Source: 3rd GEF IW Learn-UNESCO Integration Dialogue, Managing Groundwater in Coastal Areas, Jordan Groundwater, May 2014

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SOURCES

Renewable

- Surface Water: 505 MCM/year
- Groundwater: 275 MCM/year
- Treated Wastewater: 110 MCM/year (2012)
- Peace Treaty Water: 25 – 50 MCM/year

Non-Renewable

- Fossil Water: 140 MCM/year
- Brackish Water: 50 MCM/year

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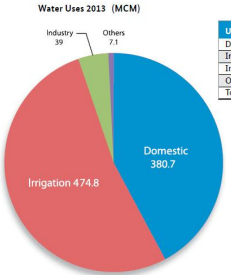
WATER USE BY SECTOR (2013)*



Uses	Surface Water	Groundwater	Total Volume (MCM)
Domestic	123	257	381
Irrigation	225	250	475
Industry	7	32	39
Others	7	0	7
Total	362	540	902

*Source: Jordan Ministry of Water and Irrigation 2013)

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CURRENT OR PLANNED WATER IMPORTS

- Disi-Amman water conveyance project
  - Temporary solution to larger water supply issue
  - 10% of Disi Aquifer located in Jordan; 90% of aquifer located in Saudi Arabia
  - 20 to 30 year lifespan of aquifer water available to Jordan (@ 100-120 MCM/yr. abstraction rate)

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  - Evaluating groundwater impacts
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PROJECTED WATER CONSUMPTION

- Estimated 1 to 3 barrels to produce 1 barrel of oil
- Industry Average: 1.7 B water:1 B oil*

Shale Oil Production	Shale Oil Production	Water Required (1.7B water: 1B oil)	Water Required (1.7B water: 1 B oil)	Water Required (1.7B water: 1B oil)	Water Required (1.7B water: 1B oil)
Barrels/day	*Barrels/year*	*Barrels/day*	*Barrels/year*	*acre-ft/day*	*acre-ft/year*
5,000	1,800,000	8,500	3,060,000	1.1	400
50,000	18,000,000	85,000	30,600,000	11	4,000
500,000	180,000,000	850,000	306,000,000	110	40,000

*Source: National Oil Shale Association , 2012

- Additional 0%-10% usage to support associated business and local population
- Water produced by retorting can help offset small portion of water demand

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WATER USE BY TECHNOLOGY

- Varies according to
  - In situ
  - Ex situ
  - Modified In situ

US Estimates (Colorado, Utah, and Wyoming) for Shale Oil Production and Water Usage by Technology*

Technology Type	Shale Oil Production (Barrels/day)	Gross (Barrels water/ Barrels oil)	Net (Barrels water/ Barrels oil)	Net Acre-Ft/year
In situ	225,000	0.6 - 1.3	0.3 – 1.0	3,180 - 10,600
Ex situ	200,000	2.4 - 2.6	1.4 – 1.6	13,200 – 15,100
Modified In situ	75,000	0.5 - 1.1	0.0 – 0.9	0 – 3,180
	Total =500,000		*0.7 - 1.2*	*16,400 – 28,900*

*Source: National Oil Shale Association, 2014

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PROJECTS WITH CONCESSION AGREEMENTS

Project	Proposed Technology	Production
JOSCo (Shell)	In-situ conversion	100,000 bl/d
JOSE	Surface retorting (Enefit 280)	19,000bbl/d (2017); 38,000bbl/d (2019)
KIO (Karak International Oil)	Surface retorting (ATP)	4,000bbl/d (Phase 1) to 50,000 bbl/d (full development)
SACOS (Saudi Arabian Corp)	Surface retorting (UTT3000)	2,500 bbl/d (initially) to 30,000 (full capacity)

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MOU AND CONCESSION TOTAL WATER USE

- 6 Oil Shale Memoranda of Understanding
  - Potential development of up to 220,000 bbl/d
- Total potential water use to support Concession Agreements and MOA

Concession:	218,000 bbl/d
MOA	220,000 bbl/d
Total	438,000 bbl/d

- **At average water demand of 1.7 B water:1 B oil, total additional water demand to support proposed projects could be up to 744,600 bbl/d**
- While in situ projects appear to provide greatest chance to reduce water use, careful assessment of individual and cumulative effects is needed

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  - Mitigating impacts

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REGULATORY COMPLIANCE

- **Groundwater Management Policy of 1998**
  - Emphasizes need to protect groundwater resources from over-abstraction and associated quality degradation
  - Gives use priority to municipal and industrial uses
  - Kingdom established several measures to protect aquifers including development of vulnerability maps, and creation of groundwater monitoring directorate within Ministry of Water and Irrigation
- **Underground Water Control Bylaw (85) of 2002**
  - Regulates groundwater well licensing, drilling and water abstraction.
  - Jordanian Standard for Drinking Water Quality No. 248 of 2008

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REGULATORY COMPLIANCE (CONTINUED)

- **Jordanian Standard for Industrial Reclaimed Wastewater No. 202 of 2007**
- **Jordanian Standard for Drinking Water Quality No. 248 of 2008**

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AGENDA

- Water Use
  - Background and overview
  - Projected water needs for oil shale development
  - Regulatory compliance
- **Anticipated water use and water quality impacts**
  - **Key considerations**
  - Potential surface water and groundwater impacts
- Technical assessments
  - Evaluating surface water impacts
  - Evaluating groundwater impacts
  - Mitigating impacts

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KEY CONSIDERATIONS

- Direct and indirect impacts
- Impacts occur throughout all phases of oil shale development
  - This presentation focuses on extraction / processing phase
- Impacts depend on
  - Technical approach
  - Location
  - Scale of the operation

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KEY CONSIDERATIONS (CONTINUED)

- Impacts may be associated with different oil shale development options
  - Surface mining with surface retorting
  - Underground mining with surface retorting
  - In situ retorting

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ANTICIPATED SURFACE WATER QUALITY IMPACTS

Impact	Surface Mining	Under-ground Mining	In Situ Retorting
Surface piles of spent shale could leach remaining hydrocarbons, salts, trace minerals, etc. into surface water	✓	✓	
Disturbance of soils and ground surfaces, resulting in increased erosion and amount of sediment and contaminants transported to waterways	✓	✓	✓
Withdrawal of water from surface waters could decrease flows downstream and degrade water quality by deposition of sediments as flows decrease, greater risk of temperature changes, and decrease in dissolved oxygen	✓	✓	✓

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ANTICIPATED SURFACE WATER QUALITY IMPACTS (2)

Impact	Surface Mining	Under-ground Mining	In Situ Retorting
Discharges of wastewater from operations could decrease the quality of downstream water is the discharged water is of lower quality, has a higher temperature, or contains less oxygen	✓	✓	✓
Increased flows resulting from discharged wastewater could cause downstream erosion	✓	✓	✓
Contaminants in groundwater, including those at in situ retort zones and backfilled mines, have the potential to travel to surface water bodies	✓	✓	✓

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ANTICIPATED SURFACE WATER QUALITY IMPACTS (3)

Impact	Surface Mining	Under-ground Mining	In Situ Retorting
Accidental chemical spills or product spills or leaks could contaminate surface water	✓	✓	✓
Contaminants contained in air emissions from retort facilities and power plants	✓	✓	
Contaminants from fly ash and boiler bottom ash resulting from surface retorting, if not properly disposed of	✓	✓	

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ANTICIPATED GROUNDWATER QUALITY IMPACTS (4)

Impact	Surface Mining	Under-ground Mining	In Situ Retorting
Flows through abandoned / backfilled mines could decrease groundwater quality by increasing concentrations of salts, metals, and hydrocarbons within the groundwater	✓	✓	
Fracturing of oil shale could connect the oil shale to an adjacent aquifer, possibly contaminating the aquifer with hydrocarbons			✓

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ANTICIPATED GROUNDWATER QUALITY IMPACTS (5)

Impact	Surface Mining	Under-ground Mining	In Situ Retorting
Chemical changes may occur to removed overburden rock due to exposure to precipitation and atmospheric oxygen; resulting leachate can affect groundwater	✓		
Increased leaching of residual hydrocarbons, salt, or metals due to increased permeability and surface area in the retorted zone			✓
Accidental chemical spills or product spills or leaks could contaminate groundwater	✓	✓	✓
Cross-connection between aquifers of varying water quality resulting from mining and drilling activities	✓	✓	✓

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TECHNICAL ASSESSMENT CONSIDERATIONS

- Local hydrologic conditions must be characterized and considered in selecting development sites
- Adopt requirements for baseline water quality measurements and report baseline conditions in advance of oil shale development
- Spent shale management program should be required for surface retorting projects
- Assessment of potential wastewater disposal effects on aquatic environment should be part of receiving water quality criteria

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TECHNICAL ASSESSMENT CONSIDERATIONS (2)

- Establish water quality monitoring programs
- Long term effects of groundwater flowing through retorted zones are unknown
- Magnitude of impacts on quality of surface and groundwater is unknown
  - Some technologies have yet to be commercially proven (primarily in situ)

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EVALUATING SURFACE WATER IMPACTS

Hydrology Issues

- Increase in runoff due to changes to site conditions
- Bridge and other construction in floodways
- Water diversion impacts

Water Quality Concerns

- Contaminated storm water discharges, wastewater or landfill leachate discharge
- Increases or decreases in temperature of surface water discharges
- Impairment due to higher stream flows and resulting higher sediment loads

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INFORMATION AND DATA NEEDS

- Topography and site plan
- Soils data
- Rainfall characteristics
- Runoff flows and WQ data for existing conditions
- Wadi flow records
- Wadi water quality data (temperature, TSS, total dissolved solids, pH, DO, TN, nitrite and nitrate, TP, orthophosphate)
- Aerial or satellite photos

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ASSESSMENT TOOLS

- Various computer models available
  - Rainfall / runoff, erosion, flooding, stream water quality, and coastal water quality
- Model options vary in degree of complexity
- Models in public domain can be obtained at no cost, while others are proprietary
- Use of any model requires an understanding of basic principles underlying it

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MODELS APPLICABLE TO SURFACE WATER ASSESSMENT

Application	Model	Originator	Public Domain	Degree of Complexity
Rainfall / Runoff	HEC HMS	USACOE	Yes	Medium
	HydroCAD	HydroCAD Software Solutions	No	Low
	SWMM	USEPA	Yes	Low to High
	HSPF	USGS	Yes	High
	WinTR20	USDA – NRCS	Yes	Low
Erosion	Universal Soil Loss Equation	USDA	Yes	Low
	FLO-2D	Flo-2D Software Inc.	No	High
	CREAMS	USDA	Yes	Medium

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MODELS APPLICABLE TO SURFACE WATER ASSESSMENT (2)

Application	Model	Originator	Public Domain	Degree of Complexity
Flooding	HEC-RAS	USACOE	Yes	Medium
	SWMM	USEPA	Yes	Low to High
	Mike Flood	DHI	No	Medium to High
Stream Water Quality	Qual2K	USEPA	Yes	Low to Medium
	CE-QUAL-RIV1	USACOE	Yes	High
	HSPF	USGS	Yes	High
	MIKE 11	DHI	No	High
	WinnSLAM	USEPA	Yes	Medium

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MODELS APPLICABLE TO SURFACE WATER ASSESSMENT (3)

Application	Model	Originator	Public Domain	Degree of Complexity
Coastal Water Quality	CORMIX	USEPA	No	Low
	Delft3D	Deltares	No	High
	EFDC	USEPA	Yes	High
	Mike 21	DHI	No	High
	RMA2 / 4	USACOE	Yes	High

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METHODS OF ANALYSIS FOR SURFACE WATER ASSESSMENT

- Data acquisition
  - Review existing data sources
  - Conduct project-specific investigations or measurements
    - Runoff flow measurements during storm, runoff sampling and analysis, water quality sampling and analytical testing
- Model development: enter site data and assumptions
- Model calibration: adjust parameters to match measurements or observations
- Model application
  - Pre- and post-development simulations
  - Use design storms to assess impacts of runoff and associated erosion
  - For stream water quality impacts, analyses are typically conducted for low stream flows

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INTERPRETATION OF RESULTS

- Compare predicted pre- and post-development conditions
- Compare predicted pre- and post-development conditions with existing standards or criteria (determine whether violations are currently occurring)

Parameter	Typical Performance Standard
Runoff flow	Peak post-development flow for selected design storm(s) does not exceed peak pre-development flow or does not exceed by more than set percentage
Runoff volume	Total runoff volume for selected design storms(s) does not exceed predevelopment volume, or does not exceed by more than set percentage.
Sediment transport	Post-development erosion and deposition does not exceed predevelopment conditions by more than set percentage.
Water quality	Post-development conditions do not exceed ambient water quality criteria outside of specified mixing zone (if applicable).

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EVALUATING POTENTIAL IMPACTS TO GROUNDWATER

- Hydrology issues
  - Groundwater lowering due to increased withdrawal or mining
  - Aquifer depletion due to excessive withdrawal
  - Recharge reduction due to increased imperviousness and runoff
  - Groundwater rise due to development activities
- Contamination of groundwater can result from
  - Seepage of contaminated fluids from pipe leaks, landfill leachate, or spills
  - Mining due to contaminated drainage from a mine flowing to down-gradient groundwater and minerals from excavated materials seeping into aquifer

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EVALUATING POTENTIAL IMPACTS TO GROUNDWATER

- Information and data needs
  - Geology (stratigraphy, presence of aquifers)
  - Groundwater flow regime
  - Piezometric head distribution (should be no fewer than three points)
  - Soil characteristics
  - Aquifer parameters (thickness, transmissivity, storage coefficient, and leakage coefficients with other aquifers)
  - Groundwater quality (basic parameters include salinity and nitrate)
- Assessment tools
  - Use of a groundwater model is typically necessary; several computer models are available (see table on following slide)
  - Model both groundwater flow and water quality

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MODELS APPLICABLE TO GROUNDWATER ASSESSMENT

Application	Model	Originator	Public Domain	Degree of Complexity
Groundwater Hydrology	MODFLOW	USGS	Yes	Medium
	GMS (GUI for MODFLOW and MT3D)	Aquaveo	No	Medium to High
	Visual MODFLOW (GUI for MODFLOW and MT3D)	Schlumberger Water Services	No	Medium to High
	FEFLOW	DHI / WASY	No	Medium to High
Groundwater Quality	MT3D	USEPA	Yes	Low
	FEFLOW	DHI / WASY	No	Medium to High

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METHODS OF ANALYSIS

- Data acquisition
  - Review existing data sources
  - Conduct project-specific investigations or measurements (e.g. additional monitoring wells, hydraulic conductivity tests, pumping tests, sampling of groundwater from monitoring wells and analytical testing)
- Model development: data and assumptions describing the site entered into the model
- Model calibration: parameters are adjusted to match measurements or observations
- Model application
  - Pre- and post-development simulations
  - Since groundwater conditions vary slowly, the model is often used to simulate a multi-year period

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INTERPRETATION OF RESULTS

- Changes in piezometric head are basic metric for assessing groundwater flow impacts
- Future groundwater levels relative to existing wells
- Predicted groundwater levels relative to ground surface or elevation of basements or utilities
- Small reductions in discharge to streams may be allowable depending on conditions and regulatory requirements, but significant reductions should be mitigated
- Predicted contaminant concentrations at existing wells are an impact metric
- Measures should be included in the project to reduce potential that toxic chemicals will be introduced underground

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GENERAL – APPLICABLE TO ALL OPTIONS

- Treat and recycle water as much as possible
- Avoid or limit diversions from small streams
- Minimize area of disturbed land and reclaim disturbed areas as quickly as possible
- Apply erosion controls that comply with local standards and regulations
- Maintain vegetated buffers near streams and wetlands
- Avoid creating excessive slopes during excavation and blasting operations
- Avoid alteration of existing drainage systems
- Apply runoff controls to disconnect new pollutant sources from surface water and groundwater
- Divert runoff from spent shale piles into retention ponds where it can be treated prior to disposal
- Intercept site runoff and provide treatment prior to disposal

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SPECIFIC TO IN SITU DEVELOPMENT OPTION

- Provide treatment to groundwater extracted to dewater oil shale zone prior to on-site reuse
- Reclaim subsurface in situ heating zone
  - Methods such as repeated rinsing with water to remove residual hydrocarbons (effectiveness uncertain)
- Line the surface below piles of spent shale and overburden rock with impervious materials
  - Prevent water from transporting pollutants into shallow groundwater

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SPECIFIC TO SURFACE AND UNDERGROUND MINING

- Line surface below piles of spent shale and overburden rock with impervious materials
  - Prevent water from transporting pollutants into shallow groundwater