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# enviro news

Environmental Protection Department



Photo Source: Saudi Aramco

# A Message from Omar S. Abdulhamid, EPD Manager



Saudi Aramco is working hard to excel in environmental and community health fields, leaving no stone unturned in its quest to produce hydrocarbons in a sustainable manner. Issue 27 of Enviro News provides clear evidence of this sweeping commitment to environmental and operational excellence. Flip through the pages and get a taste of the projects, campaigns, and best practices evolving across the company. There are many.

In this issue, find out how Saudi Aramco monitors the effectiveness of its Manifa Causeway to ensure marine habitats remain healthy and vibrant, thanks to this remarkable engineering success story. And speaking of ecosystems, Saudi Aramco's work in the Red Sea not only protects marine life, it uncovers it as well. Ongoing collaboration efforts between Saudi Aramco and King Abdullah University of Science and Technology have unearthed a previously unknown species of marine worm. Today, *inermonephtys aramco* is known to science and proudly bears the Company's name. Also in the issue, we will revisit the launch of the "Field Guide to the Biodiversity of Dhahran," a must-have for all in our community. Likewise, learn more about the sharks that call the Arabian Gulf home and methods used to conserve water in our operations.

Separately, this issue will also address Saudi Aramco's many efforts to protect the community and workers' health—in your home especially. Rest assured that your drinking water is safe, and before tossing unused food into the garbage, learn what those dates on the packaging really mean. Speaking of managing refuse, considerations to develop an Integrated Solid Waste Management Facility in the Eastern Province are under study. Back in your kitchen, learn more about the additives that go into your favorite dishes and look for tips to cut down on food waste—the environment will thank you.

The Environmental Protection Department (EPD) invites you to enjoy this lengthy edition of Enviro News. As always, we look forward to hearing from you and your ongoing efforts to keep diminishing our environmental footprint while contributing to the Kingdom's sustainable growth and prosperity.

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**Manager,** Omar S. Abdulhamid

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# Bridging the divide

## Monitoring the success of the Manifa Causeway

### Alaa Abu Arafah, MPD

Operational since 2013, the massive offshore Manifa field has a capacity to produce 900,000 barrels per day of Arabian heavy crude, allowing the Kingdom to maintain its leading position as a global energy supplier. The most striking aspect about this mega- project is the massive causeway built to allow for oil production in an environmentally sustainable manner. A company landmark, the Manifa Causeway is an engineering success story that illustrated how collaboration among Saudi Aramco departments and local universities allowed for environmentally friendly oil production that spared expense to marine ecosystems.

Manifa Bay is an area of the Arabian Gulf marked by high primary productivity from a marine ecology perspective. Beneath the surface of the waters lie delicate habitats supporting marine ecosystems and local economies that depend on them, so its vitality could not be overlooked during the planning stages.

With that in mind, building a causeway and man-made islands was the only way to develop the Manifa oil field. Doing so would allow for the responsible production of oil

while simultaneously allowing for a natural flow of water needed to sustain marine life, easier said than done. This balance between the environmental and operational needs posed a challenge for all involved, which included Project Management Team (PMT), Manifa Producing Department (MPD), Environmental Protection Department (EPD), King Fahd University of Petroleum and Minerals (KFUPM), and Drilling & Workover. Today, the causeway, which comprises of 27 drilling islands connected by a 42-kilometer causeway and 14 bridges, allows for environmentally stable oil production, thanks in part to the design, as well as the monitoring program.

An effective and specifically tailored monitoring program involving several entities helped solidify the project's success, most notably the 10-year partnership between Saudi Aramco's Environmental Protection Department and King Fahd University of Petroleum and Minerals.

The results of this careful collaboration is already paying off. In multiple reports, KFUPM scientists have concluded the causeway, thanks to its design, has maintained, and in fact enhanced, the natural circulation of tidal waters into and out of Manifa Bay.

Dissolved oxygen rates are higher than they were before construction, making those shallow waters a healthier environment for fish and shrimp larvae. Coral has grown in size and seem to be spreading onto the rocks of the Manifa Causeway itself. Seagrass meadows have also increased, covering more area than before construction.

Far from destroying the fragile ecosystem at Manifa Bay, the Manifa Causeway is now a habitat for the shrimp and fish populations that call Manifa their home, which is affirming Saudi Aramco's determination toward environmental protection.



(Photo Source: Saudi Aramco)

# A life of its own

## Dhahran's rich biodiversity detailed in new field guide

Chris Boland, EPD

Have you ever wondered what that quirky crested bird hopping around Dhahran is called? Or have you ever wanted to know how many native flowers grow wild around the jebels in Saudi Aramco's largest residential community? Have you ever seen a small hedgehog in Dhahran Hills and wondered if you simply imagined it? Well, ponder no

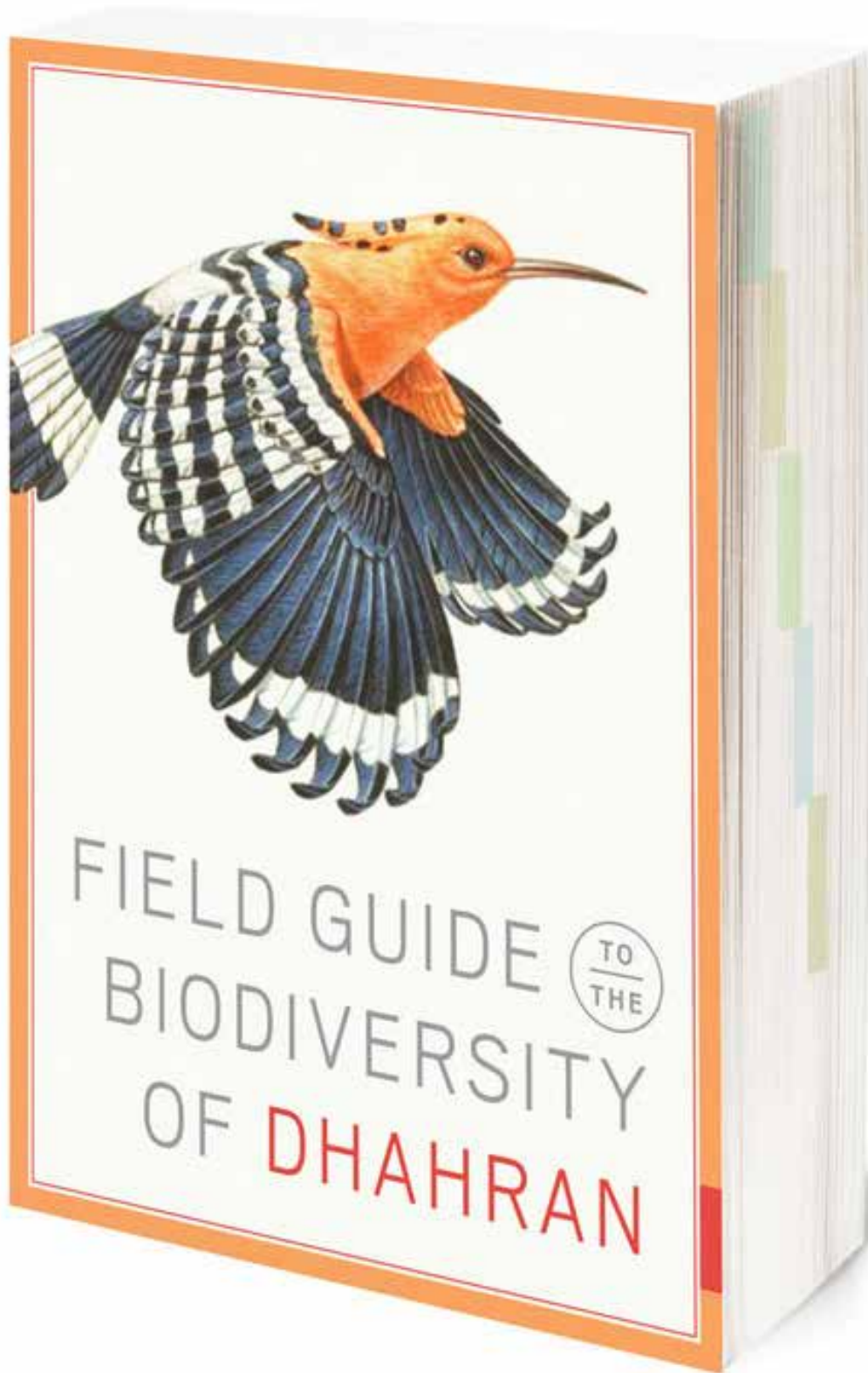
more. The Environmental Protection Department's (EPD) new Field Guide to the Biodiversity of Dhahran can help you identify everything that grows, flies, scurries, and swims in and around the Company's headquarters.

The Field Guide to the Biodiversity of Dhahran contains more than 350

professional quality photographs taken by Dhahran residents, along with helpful descriptions of the native plants and animals recorded within the Dhahran community. Most readers are astonished to discover that 265 species of birds have been recorded in Dhahran, along with more than 100 species of native plants, 12 species of reptiles, at



The Field Guide contains photographs and descriptions of over 350 plants and animals recorded in Dhahran, such as the Arabian Toad-headed Agama on page 126.





least seven species of mammals, one species of frog, and countless species of invertebrates.

EPD has produced 10,000 copies of the field guide, which the department is giving to interested residents and employees of Dhahran to help raise biodiversity awareness. The major contributors to the field guide were Chris Boland from EPD, Jem Babbington from EXPEC Advanced Research Center, Phil Roberts from Projects Procurement Department, and the late Irene Linning (a wonderful former resident of Dhahran).

### Dhahran's conservation value

A key message to emerge from the field guide is that Dhahran is one of the most important sites for biodiversity in the Kingdom. The Company's headquarters supports at

least seven species that are formally listed as internationally threatened with extinction, including four species that are listed as vulnerable (Dhub, European Turtle-dove, Greater Spotted Eagle, and Eastern Imperial Eagle [pictured]) and three species that are listed as endangered (Steppe Eagle, Saker Falcon, and Basra Reed-warbler). Fourteen more species are listed as near threatened and decreasing, which means they are likely to become vulnerable in the next few years.

In addition, at least 15 species found in Dhahran are listed as species of national high conservation priority, according to the Saudi Wildlife Authority, which means these species have been identified as being of national conservation concern and/or important for maintaining Saudi cultural heritage. These include seven birds (such as falcons and eagles),

two plants (Arta and Harm), one fungus (Desert Truffle – a traditional delicacy), one reptile (Dhub), one mammal (Arabian Red Fox [pictured]), and all dragonflies.

Furthermore, Dhahran contains at least three reptile species that occur only in Arabia and nowhere else on earth (Yellow-spotted Agama [pictured], Arabian Short-fingered Gecko, and Haas's Fringe-toed Lizard) and three plant species also largely restricted to the region (Cakile [pictured], Ghurayra', and Shuhayba). In addition, two species of reptile were first discovered to science from specimens collected in Dhahran (Schmidt's Fringe-toed Lizard, and Haas's Fringe-toed Lizard).

The field guide highlights the fact that Dhahran is a key site for birds within the region. A staggering 265 species have been recorded



*The Eastern Imperial Eagle is one of seven species found in Dhahran that are globally threatened with extinction (Photo: Phil Roberts)*

in Dhahran, comprising more than half of the bird species recorded throughout all of Saudi Arabia. These range from the tiny Graceful Prinia (weighing only 6 – 8 grams and standing only 10 centimeters tall) to the majestic Eastern Imperial Eagle (weighing 4,500 grams with a wingspan of 215 centimeters). This magnificent diversity is a result of Dhahran's mixture of habitat types, including jebels, semi-arid scrub, wetlands, spray fields, evaporation ponds, ornamental ponds, sports fields, parks, and gardens with each supporting different types of birds.

A large percentage of birds recorded in Dhahran are migrating between their breeding grounds (usually in northern Eurasia) and their wintering grounds (often in Africa or Southern Asia). As a result of the high number of migrants passing through Dhahran, the diversity of birds increases in spring and autumn. Many others are winter visitors; that is, they breed elsewhere (typically Eurasia) and spend the winter in Dhahran (Figure 1).

Consider for a moment how extraordinary it is that these birds—some only 11 centimeters tall and weighing less than a tablespoon of water—fly such vast distances every year to breed. How fortunate for them that the Dhahran community contains a diversity of habitats that provide food, water, and safety. Likewise, how fortunate for Dhahran's residents to have the opportunity to catch glimpses of such special birds from places as far as South Africa, Sri Lanka, Norway, Siberia, and Alaska as they pass by our home on their epic annual voyages.

In addition to migratory species, many birds live in Dhahran year-round. Indeed, at least 15 species nest within the community each year. Another eight species have been recorded nesting here occasionally, while nine others possibly nest in Dhahran sporadically.

At least seven native mammal species occur in Dhahran. Most are nocturnal or crepuscular (i.e., active in the early

morning or late afternoon), meaning that people rarely get more than a quick glimpse of these shy but special animals. Indeed, other small mammal species probably occur in Dhahran, but they have not yet been formally recorded.

Dhahran's mammals can be divided into aerial and terrestrial species. The aerial species include at least three species of bats, which were surveyed by EPD in 2015 using ultrasonic detectors. The most common bat species detected was Kuhl's Pipistrelle, which is often seen flying around street lights during the warmer months, capturing tens of thousands of insects every night.

At least four terrestrial mammal species occur in Dhahran, including the incredibly lovable Desert Hedgehog, which occasionally wanders into people's gardens in Dhahran Hills. Another endearing little mammal is Sundevall's Jird, which nests around the jebels northwest of Peninsula Boulevard and can forage several kilometers



*The Yellow-spotted Agama is one of six species found in Dhahran that occur only in Arabia (Photo Source: Jem Babbington)*



# Birds

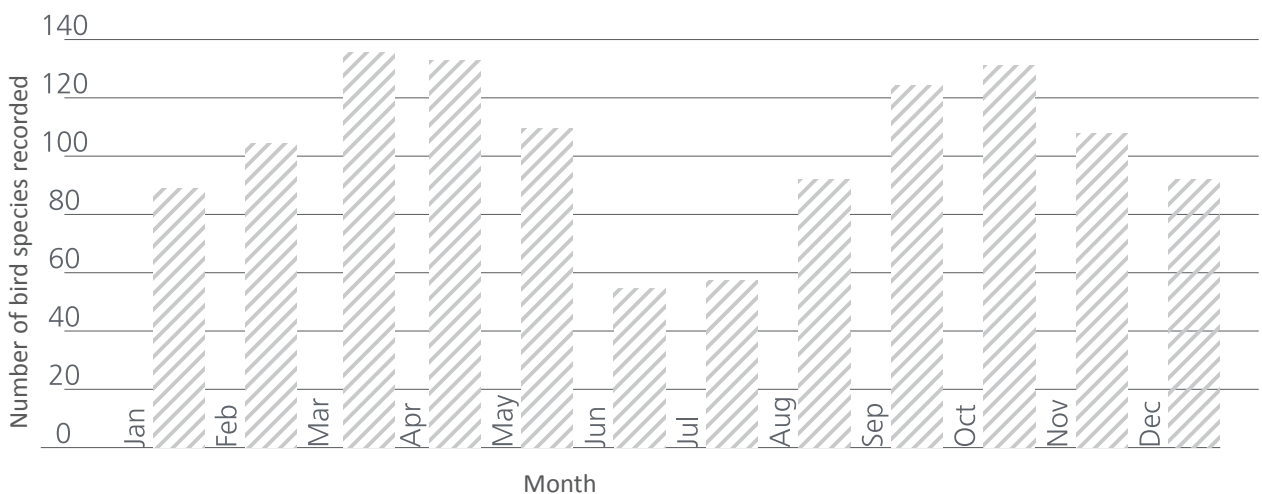
*The exquisite Common Kingfisher is one of 265 species of bird recorded in Dhahran (Photo Source: Jem Babbington)*

from its burrow each night. We are also fortunate to share the community with the Arabian Red Fox. While the red fox occurs across much of Eurasia, the subspecies that lives in Dhahran is confined to Arabia and is especially beautiful.

At least 12 reptile species have been recorded within the community, representing 12 percent of all of Saudi Arabia’s reptiles. These range in size from the tiny Yellow-bellied House Geckos that often occur around our porch lights at night up

to the iconic Dhub (or Spiny-tailed Lizard). While many people may have eaten the Dhub as a traditional delicacy, few people realize that this fine creature takes six years to reach maturity and may live for 33 years. As a result of over-hunting, the Dhub is formally listed internationally as vulnerable and decreasing, meaning that at the current rate of exploitation it is heading toward global extinction. the number of Dhubs in Dhahran has dropped in recent years, and so we need to help protect this impressive animal.

The field guide shows that over a hundred species of native plants grow wild in Dhahran, which represent about 64 percent of the plants recorded in the Central Coastal Lowlands, the area of the Eastern Province in which Dhahran occurs. This remarkable concentration of plants is due partly to the varied topography of Dhahran, including limestone outcrops (the jebels), firm silt, rock covered with thin layers of sand, pockets of shallow sand, and rare areas of deep sand.



*Figure 1: The number of bird species observed in Dhahran increases during the spring and autumn migration periods, and over winter when some species fly south to escape the Northern winter (Data: Jem Babbington)*



# Mammals

*The Arabian Red Fox is one of 15 species found in Dhahran that are formally listed as being of High Conservation Priority to the Kingdom (Photo Source: Jem Babbington)*

The plants of Dhahran have been used traditionally as sources of food, animal fodder, cosmetics, and medicine. For instance, Dhahran's plants were used to treat kidney disease, cholera, malaria, toothache, and jaundice. Other species were used for making soap or rope and flavoring milk.

The late Irene Linning conducted hundreds of hours of research studying the native plants and invertebrates of Dhahran, particularly

around the jebel habitat northwest of Peninsula Boulevard. Irene's research demonstrated that these jebels are the most floristically diverse site in the Eastern Province. Her data show that the best time to see wildflowers in Dhahran is from February to April (Figure 2).

### How to get a copy

The Field Guide to the Biodiversity of Dhahran is free to interested residents and employees. Free copies

are available from the Dhahran Recreational Library, Dhahran Heritage Gallery, Dhahran Garden Group Shop, Dhahran Saudi Aramco Employees Association office, or the Dhahran Community Services Help Desk in Al Mujamma. Employees can also request a copy from the EPD secretary (login ID: campbede).



# Reptiles

*Schmidt's Fringe-toed Lizard is one of two species that were first discovered by scientists in Dhahran (Photo Source: Jem Babbington)*



The delicate flower of the Cakile plant, a species that is unique to the region (Photo Source: Irene Linning)

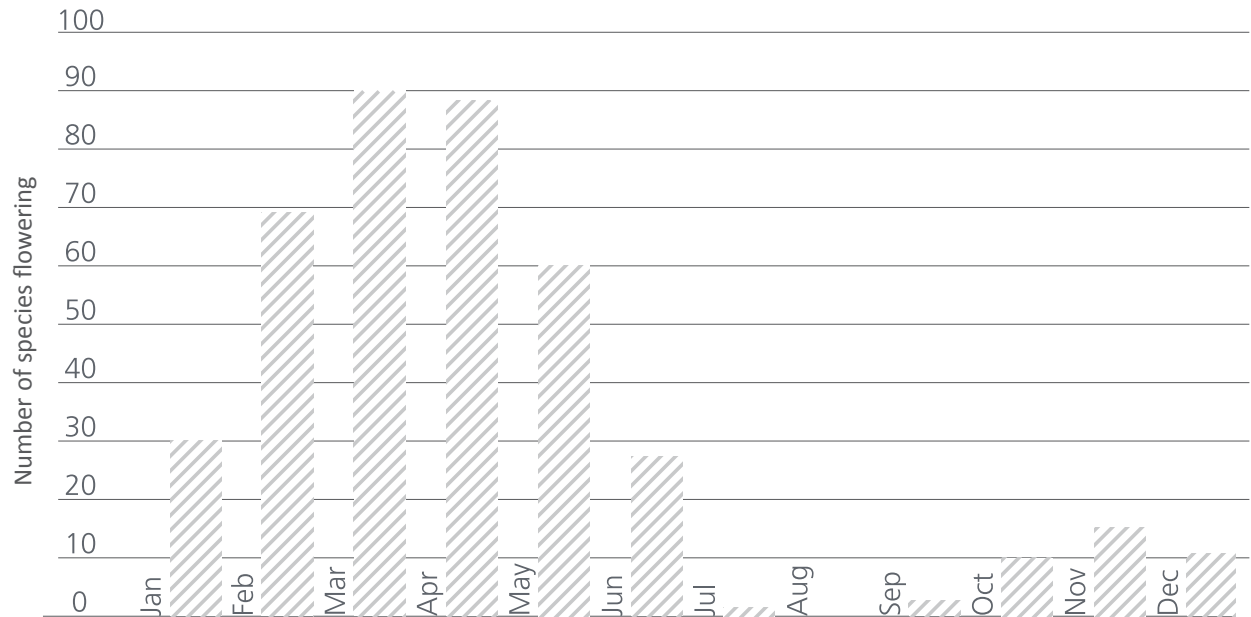


Figure 2: The number of species flowering in Dhahran peaks in spring (Data: Irene Linning)



Numerous butterflies and moths have been recorded in Dhahran, such as this Painted Lady (Photo Source: Jem Babbington)



The field guide contains over 350 stunning photographs, such as this image of a Striped Hawkmoth pollinating a Silene villosa flower with its long proboscis (Photo Source: Irene Linning)

# Duly dubbed

## a new marine species in the Red Sea named after Saudi Aramco

Diego Lozano-Cortes and Yasser Kattan, EPD



Meet *Inermonephtys aramco*, a previously undiscovered marine worm introduced to the world by Saudi Aramco/SAKMEO researchers. (Photo Source: Ascensao Ravara)

There are countless species of life on earth and to date, science has identified more than 2 million of them. Many more species are waiting to be discovered, and today many are brought to light and with great frequency, thanks to the advanced

technology allowing scientists to explore in untouched places. As it turns out, one of those untouched places is right here in Saudi Arabia beneath the waters of the Red Sea, home to *inermonephtys aramco*, a previously unknown species of

marine worm. Saudi Aramco research with King Abdullah University of Science and Technology (KAUST) helped welcome this new species and Company namesake to the scientific world.



The RV-Thuwal, a KAUST research boat used during work that led to the discovery of *inermonephtys aramco*. (Photo Source: Saudi Aramco)

In November of 2013, Saudi Aramco opened the Center for Marine Environmental Observations (SAKMEO) at KAUST to gain a scientific understanding of the Red Sea and its ecosystems. This region has largely gone understudied, and knowledge about it would benefit the Kingdom.

Since its inception, SAKMEO, in collaboration with EPD, has been conducting research cruises to assess the current status of the Red Sea to study its changes over time due to natural and anthropogenic processes. As part of these scientific expeditions, researchers collected sediment samples extending down 150 meters in depth to characterize

the biodiversity patterns of soft-bottomed habitats. During analysis of these sediment samples, SAKMEO scientists found four species of marine worms that they had never encountered before. After months of working in the laboratory and with the help of a taxonomist (a specialist in the classification of organisms), it was discovered that three of these species were seen in the Red Sea for the first time ever, and remarkably, the fourth one was a totally new species for science.

As this fourth species was previously undiscovered, scientists gladly accepted the task to give to it a name and officially introduce it to

the world. In 2016, *inermonephtys aramco* was the chosen name to present this species in an article published in August of 2017 in the Journal of the Marine Biological Association of the United Kingdom. This particular marine worm and Company namesake was collected in sands in the Southern region of the Red Sea at depths of between 60 and 83 meters. In the article, the authors stated that the name of the species refers to Saudi Aramco that has been providing support for an extensive baseline characterization of the physico-chemical and biological patterns of the Red Sea where this species has been found.<sup>1</sup>

Ongoing collaboration efforts between Saudi Aramco and KAUST have not only discovered this new species. They continue to provide knowledge that will help to implement regulations to better protect and manage biodiversity and ecosystems in Saudi Arabia.

SAKMEO projects have tracked marine vulnerabilities, determined impacts linked to industrial urban/coastal development and non-anthropogenic sources, and have identified areas in need of protection based on their ecological resilience and ability to support recovery of disturbed areas in the Red Sea. Today, SAKMEO scientists have conducted seven major research expeditions, 40 reef surveys, and have deployed 72 Autonomous Reef Monitoring Structures on top of analyzing over 500 water and sediment samples.

<sup>1</sup> *Nephtyidae (Polychaeta, Phyllodocida) from the Red Sea, with record of a new species by Ascensao Ravara and Susana Carvalho*

# Safe in every drop

## EPD rolls out water safety plans beginning with Dhahran community

David Corry, EPD

Water is our most precious resource, and access to safe water supply is essential for life everywhere. A Water Safety Plan (WSP) is widely considered to be the most effective means of consistently ensuring this safe access. It follows comprehensive risk assessment and risk management

approaches that encompass all distribution steps from source to consumer, and it is a valuable tool to help suppliers effectively operate and manage the water supply system.

All Saudi Aramco potable water producers with a daily production

exceeding 10m<sup>3</sup> must have a WSP in place by the end of 2018. The Company's Environmental Protection Department management is committed to supporting departments in this endeavor and has unveiled the WSP toolkit to do just that.

The toolkit includes a guide book, a Water Safety Plan template, and a risk assessment matrix. EPD developed the toolkit during a two-year collaboration with Dhahran Utilities Department's Utilities and Technical Services Division (U&TSD), which recently launched Saudi Aramco's first Water Safety Plan for drinking water supplied to Dhahran.

EPD released the toolkit in 2017 during the department's Water Safety Plan workshops, which were delivered to Saudi Aramco drinking water producers to provide them with the knowledge and skills they will need to adhere to new requirements. EPD's Saleh Al-Qahtani, Head of the Workplace Environment Division, introduced the workshops by welcoming attendees and encouraging them to participate fully to gain the most from the venues.



EPD Manager Omar Abdulhamid (left) and U&TSD Manager Abdulaziz Misfir (right) at a ceremony hosted by the latter to mark Saudi Aramco's first approved Water Safety Plan. (Photo Source: Arabian Sun)





*(Photo Source: Shutterstock)*

Attendees obtained a thorough introduction to WSPs, which were first conceived in the International Water Association's Bonn Charter back in 2004. Today, they have become the best practice endorsed by the World Health Organization and form a critical part of WHO Guidelines for Drinking Water Quality. Many countries today have made it mandatory to develop and implement WSPs, and Saudi Arabia will do likewise in 2019.

Workshop attendees were then advised to form teams of experts from within their organizations in charge of understanding the risks within their networks and be capable of implementing all necessary controls and monitoring. These teams will include utilities engineers, persons responsible for supply networks, environmental coordinators, and management. Key responsibilities will include data collection and analysis, site visits, as well as identifying and documenting risks, controls and emergency procedures into the WSPs.

The workshops then took attendees through the comprehensive risk assessment approach that must be followed at each stage of the water supply. The primary objectives here include the minimization of contamination of source waters, the reduction or removal of contamination through treatment processes and the prevention of contamination during storage, distribution, and handling of drinking water. The plans are intended to identify potential sources of hazards at all points on the supply chain and implement control measures to minimize the risk of contamination. A system of routine monitoring of the control measures and a remedial action plan when a control measure is not within the target will also be developed as part of the plan.

Each workshop element saw support from practical team exercises, giving the attendees an opportunity to learn from each other. Finally, attendees were presented with milestones to assist them in the development and implementation of their own WSPs.

Once the WSPs are developed, EPD will assess and approve each one to ensure all steps have been followed and that the WSP will effectively ensure safe and wholesome drinking water supply. In addition, EPD will continue to support proponents through provision of advice and guidance and by conducting periodic WSP compliance audits.

"The WSPs program will be critical in identifying potential quality and quantity risks for drinking water in Saudi Aramco facilities," EPD Manager Omar Abdulhamid said at U&TSD's launch of Saudi Aramco's first Water Safety Plan in 2017.

"EPD has a strong commitment to ensuring safe drinking water and welcomes this opportunity to collaborate with proponents on creating their WSPs throughout Saudi Aramco. EPD expects to have all plans completed before the government deadline of 2019."

# Save the dates

## Familiarity with food expiration labels saves money, energy, and our planet

Fatimah A. Turki, EPD

As the old saying goes when it comes to food, “when in doubt, toss it out.” That’s good advice, right? Certainly, but should doubt arise when things still look and smell fresh? Read the label carefully and wisely, and you will have a better idea.

Every year around the globe, people throw away 1.3 billion tonnes of food. Roughly a third of food waste created at the household level can be linked to consumer misunderstanding of the meaning of expiry dates (end of shelf life). While it’s true that many food items are discarded because they have passed the point deemed

safe for consumption, a worryingly large amount is still perfectly edible, even if a little past its prime.

The GCC Standardization Organization (GSO) has determined four statements must be used for expressing the end of shelf life:

- Best until.....from production date
- Best before date
- Consume until date
- The expiration date (EXP)

All have very different meanings, so let’s take a look at the ingredients.

### Best until ... from production date and Best before date

These are typically the dates by which the manufacturer recommends that consumers use their products for peak quality of the food. These dates indicate when an unopened product will have the best flavor or quality. It is not a date to indicate spoilage, nor does it necessarily signal that the food is no longer safe to eat. After these dates have passed (and even



(Photo Source: Shutterstock)

some time before), you may start to notice gradual changes in the unopened product's texture, color or flavor. But as long as you've been storing the unopened item properly, you can generally consume it beyond these dates, though it likely is not going to be at peak quality.

Examples: These statements are often found on products that can be preserved for a long time, such as spices, rice, cereals, sugar, and others.

### Consume until date and the Expiration Date (EXP)

Some foods such as meat, cheese, fish, and milk must carry an expiration date. These dates are the dates up to which the food maintains its microbiological and physical stability as well as the nutrient content declared on the label. Expiration dates (EXP) and consume until dates are about food safety. Foods with these dates should not be consumed after the date on the label has passed.

### Opened products

The above dates only apply to unopened products stored under normal conditions. Once opened, these dates are no longer valid. Handling or transporting food can also affect shelf life. For opened packages, manufacturers are required to provide storage instructions on the label when they differ from normal room temperature. Some examples are "refrigerate after opening" or "keep refrigerated," which are important to follow.

### Different countries, different rules of the game

Some foodstuffs in local shops are imported, so you may find products from outside Saudi Arabia. Be aware that different countries have different guides for expiring dates. For example: The use by date can be found in foodstuffs produced in the U.K. and the U.S. In the U.K., you will see use by dates on foods that go off quickly, such as fresh and chilled foods (yogurt, milk, etc.).

Environmental Protection Department Accordingly, the U.K. Food Standard Agency points out that the use by date concerns itself with safety, so therefore food cannot be eaten after the use by date.

In contrast, in the U.S., use by dates can be found on shelf-stable products such as mustard, mayonnaise and peanut butter. Consequently, the U.S. Department of Agriculture's Food Safety and Inspection Service points out that the use by date concerns itself with quality and not safety. The food will be safe to eat after this date, though it may not be at its best.

So be safe and be smart. Wasting food means wasting money, labor, and resources such as energy, land, and water that all go into producing breakfast, lunch, dinner, and all the snacks and goodies in between. Wasting food also increases greenhouse gas emissions, and thus contributes to climate change and global warming. When in doubt, toss it out, but think carefully before throwing away precious food.

## save the dates, know your food expiry labels



1.3

billion tonnes of food are wasted every year around the globe.



1/3

of food waste created at the household level can be linked to consumers misunderstanding the meaning of expiry dates (end of shelf life).




Stop

We need to stop wasting food, because wasting food means wasting money, labor, and resources such as energy, land, and water.

NOTE: A version of this story previously ran in *The Arabian Sun* under EPD's regular column, *Green Matters*.

## understand dates in your food

	<b>Best Before Best Until</b>	<b>(CB) Consume Before (Exp) Expiration</b>
	<b>Food quality</b> You can generally consume unopened products beyond these dates, but they likely are not going to be at peak quality. e.g., cereals and grains	<b>Food quality</b> Foods with these dates should not be consumed after the date on the label has passed. e.g., meat and dairy products

The above dates only apply to unopened products stored per manufacturer recommendations

## Opened products

For opened packages, manufacturers are required to provide storage instructions on the label when they differ from normal room temperature. Some examples are “refrigerate after opening” or “keep refrigerated.” When in doubt, toss it out, but think carefully before throwing away precious food.



For more information on food safety, please visit the Environmental Health Community of Practice page on <https://sharek.aramco.com.sa/cop/ih>

# Add them up

## A look at food additives from a regulatory perspective

Saad Qahtani, EPD

With an ever-increasing urban population demanding more and more food that is high in quality, longer lasting, and aesthetically pleasing, food additives have become a necessity. However, many believe that the long-term consumption of these substances may have undesirable effects on our health. What exactly goes into our food, and

how much of a health risk does the chemical content in food pose to us?

This edition of Enviro News will answer some questions that are often raised about food additives.

### What are food additives?

Food additives are substances that preserve food or enhance their

flavor. The addition of chemicals to food is not new; in fact, many have been around for a long time. Salt, for example, has been used to preserve meat and fish for centuries. Without food additives, many foods would spoil very quickly and may become unsafe due to bacterial contamination. Additives are needed



(Photo Source: Shutterstock)

to produce the kinds of foods we have come to expect. Whereas some additives are extracted from natural sources, others are manmade and therefore artificial.

## Commonly used food additives and their uses

Food additives that appear on food labels include preservatives, sweeteners, colors, nutrients, and texture improvers. Preserving agents are used to prevent food spoilage from bacteria, molds, fungi, or yeast (antimicrobials). They also slow or prevent changes in color, flavor, or texture, delay rancidity (antioxidants) and maintain freshness. Acetic acid and Benzoic acid are commonly used preservatives in this area. Additives such as aspartame are used to ensure that food stays sweet. Color additives offset color loss due to exposure to light, air, temperature extremes, moisture, and storage conditions. They also correct and enhance variations in colors that occur naturally, and you may recognize their names on packages—examples include Blue No. 1 and Yellow No. 5. Nutrients replace vitamins and minerals lost in processing (enrichment), and add nutritive value that may be lacking in the diet (fortification). Vitamins added to milk formulas belong to this category. Texture improvers include emulsifiers, stabilizers, thickeners, and binders. These allow for a smooth mixing of ingredients, prevent separation, keep emulsified products stable, reduce stickiness, control crystallization, keep ingredients dispersed, and help products dissolve more easily. Lecithin and sodium silicate are examples of

emulsifiers used in various products. A comprehensive list of commonly used additives, their functions and types of foods used in can be accessed at [www.fda.com](http://www.fda.com).

## What do “E” numbers mean?

They refer to an internationally recognized reference system for listing additives that have been tested and approved for use in food. For example, E260 is used to designate acetic acid.

## Are food additives safe?

Food additives are carefully regulated by international public health organizations such as Food Chemicals Codex (FCC) or by the Joint FAO/WHO Expert Committee on Food Additives (JECFA) to ensure that foods are safe to eat and are accurately labeled. Most additives have been in existence for many years, and their safety has been well established. Studies are frequently undertaken to reassess the safety and use of food additives when research shows that a particular substance imposes a health risk to consumers. Immediate steps are usually taken to withdraw its approval.

Several criteria may be considered when health effects of food additives are evaluated. These factors include but are not limited to (1) the composition of the substance, (2) the typical consumption per day, as well as (3) effects from short- and long-term exposure. The level of use in food includes a built-in safety margin that accounts for uncertainty inherent to research methods. Therefore, the

approved levels of use are much lower than those at which adverse effects are expected to arise. Good Manufacturing Practices (GMPs) add another layer of safety, whereby the amount of food ingredients added to food is limited to the amount necessary to achieve the desired effect.

## Concerned? Read the label

In spite of assurance provided by regulatory bodies, many consumers remain wary about food additives. In fact, numerous publications by independent research suggest that some food additives may have adverse health effects ranging from allergic reactions to children hyperactivity and even cancer risk, which has created controversy about several additives such as nitrites and some food colors. Additionally, international regulators maintain that approval criteria for a certain substance are based on “best available science” and “reasonable certainty.” In other words, the absence of risk from the use of any substance is never absolute. Fortunately, labelling standards require that prepackaged food labels declare all used ingredients including food additives. Where consumers have concerns about a particular substance, consulting product labels may be the recommended approach to ensure they are not consuming controversial food additives. More information can be found at regulatory websites.

*References: The United States Food and Drug Administration (FDA). [www.fda.com](http://www.fda.com)*

# Fish finders

## Saudi Aramco offshore facilities attract whale sharks, open doors to potential tourism venue

Hua Hsun Hsu, KFUPM, and Khaled Al-Abdulkader, EPD

### Gentle giant of the sea

Sharks are circling on the horizon off Saudi Aramco facilities. Big sharks, and that's a good thing. A KFUPM shark study team, part of the broader Saudi Aramco-KFUPM Marine Sustaining Research Program, spotted whale shark aggregations around several of Saudi Aramco's offshore facilities about 100 km off

Jubail in 2017. The world's biggest fish, the whale shark is a harmless animal and friendly when interacting with humans, thus its nickname "the gentle giant of the sea." Because of its temperate character that complements its beautiful white stripes and spots cascading alongside its huge body that entice divers, many countries have developed whale shark ecotourism, where tourists

can swim alongside these majestic species and even catch a ride on their fins. This educational tourism venue has great potential for the Kingdom in the near future and aligns with broader tourism strategies outlined in the broader Saudi Vision 2030 economic diversification program.

Huge as whales, hence their name, whale sharks (*Rhincodon typus*) are



Saudi Arabian "whale shark ecotourism" may develop in the future. (Photo Source: Shutterstock)



*A diver swims alongside a whale shark, demonstrating what could be a big tourism draw. (Photo Source: KFUPM)*

born at around 65 cm in total length and grow as large as 18 meters as adults. At present, there are 23 shark species in the Arabian Gulf alone, and unlike other predatory sharks off Saudi coasts, the whale shark has no sharp teeth — it is one of three filter-feeding shark species, which swallow hundreds of tons of seawater to filter tiny planktonic prey every day. There population structure and gathering period in Saudi waters are still under investigation, and further research and continuous monitoring are underway.

### Shark stories

Many people still conjure up images of sharks from the 1975 thriller movie “Jaws,” with a ferocious image of a bloodthirsty shark terrorizing resort towns deeply implanted in their minds. However, the main character in that movie, the great

white shark (*Carcharodon carcharias*), is just one species of shark—one of many. Actually, there are more than 500 living species of shark in the world today. Sharks have existed in the world’s oceans for more than 400 million years. Most of them are top predators in various marine ecosystems and are important regulators that help to manage healthy marine ecosystems. That is to say, the higher the shark biomass and diversity, the healthier the marine ecosystem.

### Sharks in the Arabian Gulf

Saudi Arabia is home to the longest coastline along the Arabian Gulf and with many diverse habitats, but reports of sharks in Saudi waters are rare. Therefore, Saudi Aramco supported the “Sustaining Project-Shark Study” launched by scientific researchers to study sharks beginning

in 2016. During the one-year investigation, exciting results revealed that there were at least 23 shark species observed and recorded, more than the team had expected, and the species richness (i.e., the number of species, with higher species richness meaning more species are identified and recorded) is still increasing by month.

The team recorded the small oviparous Arabian bamboo shark *Chiloscyllium arabicum* with a maximum length of 80 cm and the zebra shark *Stegostoma fasciatum*, which has zebra-like stripes in juvenile stages and a leopard-like spot pattern as an adult. Researchers also documented one of the most dangerous shark species, the bull shark *Carcharhinus leucas*, which can travel 4,000 km up freshwater rivers and has been attributed to many recorded attacks on human beings.



# Protect and conserve

## Manifa Producing Department unveils new groundwater protection programs to save water

Alaa Abu Arafah, MPD

As part of its commitment to advance environmental protection and in line with its water conservation roadmap to minimize water use—groundwater especially—the Manifa Producing Department (MPD) has launched two conservation initiatives to ensure sustainable use of precious water resources. First, MPD’s water conservation team recently unveiled wash water optimization efforts and second, the department commissioned Advanced Process Control (APC) technology

at Khursaniyah Producing Facility (KPF). Both initiatives have made noteworthy contributions to Saudi Aramco’s umbrella groundwater conservation programs and MPD specifically by reducing groundwater consumption by 2,022 m<sup>3</sup> per day.

### Wash water optimization efforts

Wash water is utilized in the Wet Crude Handling (WCH) unit in Khursaniyah Producing Facility’s Gas Oil Separation Plant (GOSP).

Here, wash water is used to extract the salt from raw crude and ensure that the processed crude meets company specifications. In 2016, an optimization team composed of an Environmental Coordinator and members from Engineering & Operation developed a plan to reduce wash water consumption in KPF’s GOSP without affecting operation and performance.

Historically, the average wash water flowrate for the two wet crude handling trains in the WCH unit was 530 U.S. gallons per minute (USGPM) (265 USGPM for each train). The team conducted an optimization exercise by reducing the wash water flowrate gradually while closely monitoring salt analysis, resulting in the stabilized crude. The team managed to decrease the wash water consumption to reach a total of 360 USGPM, which is the minimum flow into the WCH unit’s recycle pumps without causing noticeable negative impacts on the desalting process as illustrated in Figure 1.

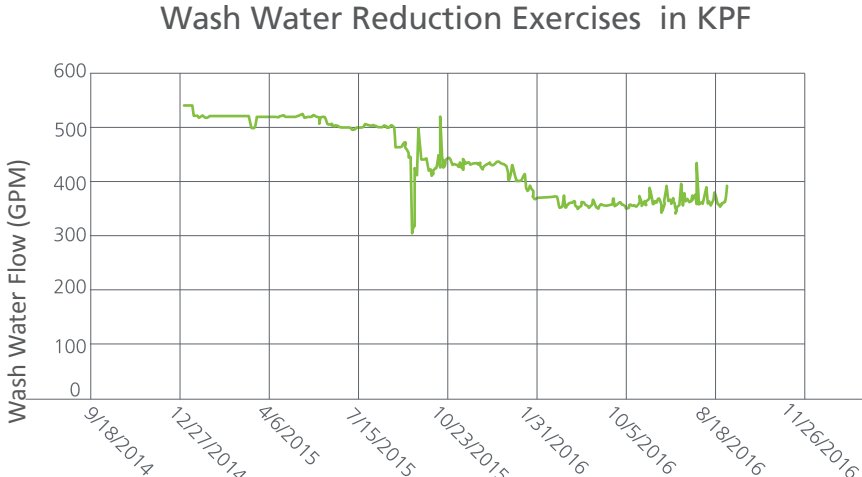


Figure 1: Wash water reduction in 2016

The team did not stop there. In 2017, the group convened anew to brainstorm and come up with another initiative to overcome pump minimum flowrate issues to further reduce wash water consumption.

After thoroughly reviewing the process, an initiative was brought to the table to benchmark with Manifa GOSP process and utilize a similar practice of recycling water through the normally closed recycle line of

the wash water pumps. This practice has helped to optimize further wash water consumption to 200 USGPM for both wet crude handling trains (100 USGPM per train) as illustrated in Figure 2.

### Wash Water Reduction Exercises in KPF



Figure 2: Wash water reduction in 2017

### Salt Results for Khurasaniyah Crude (PTB)

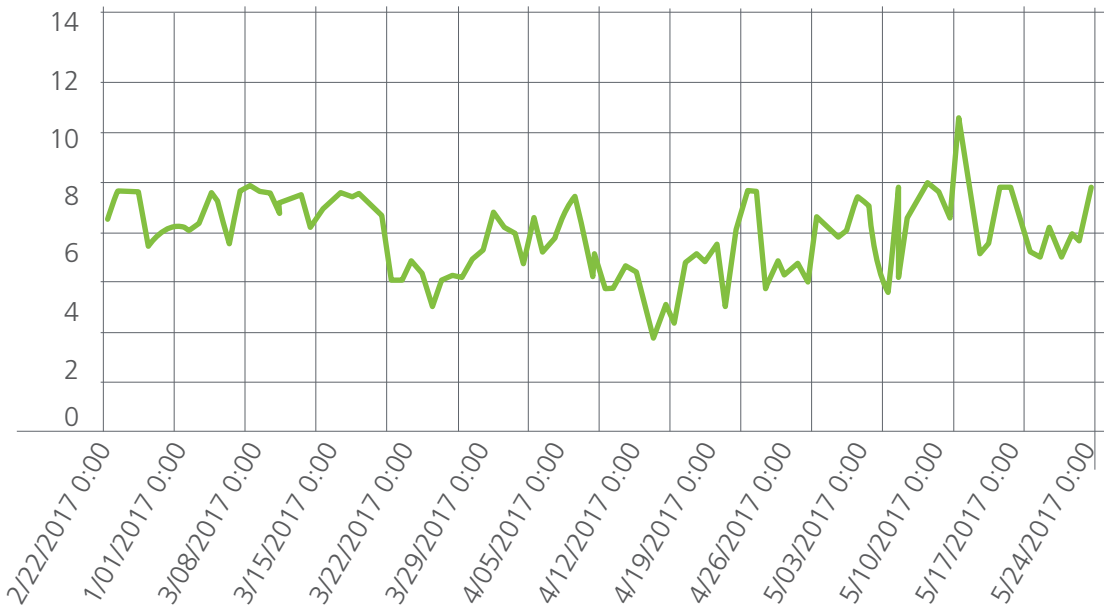
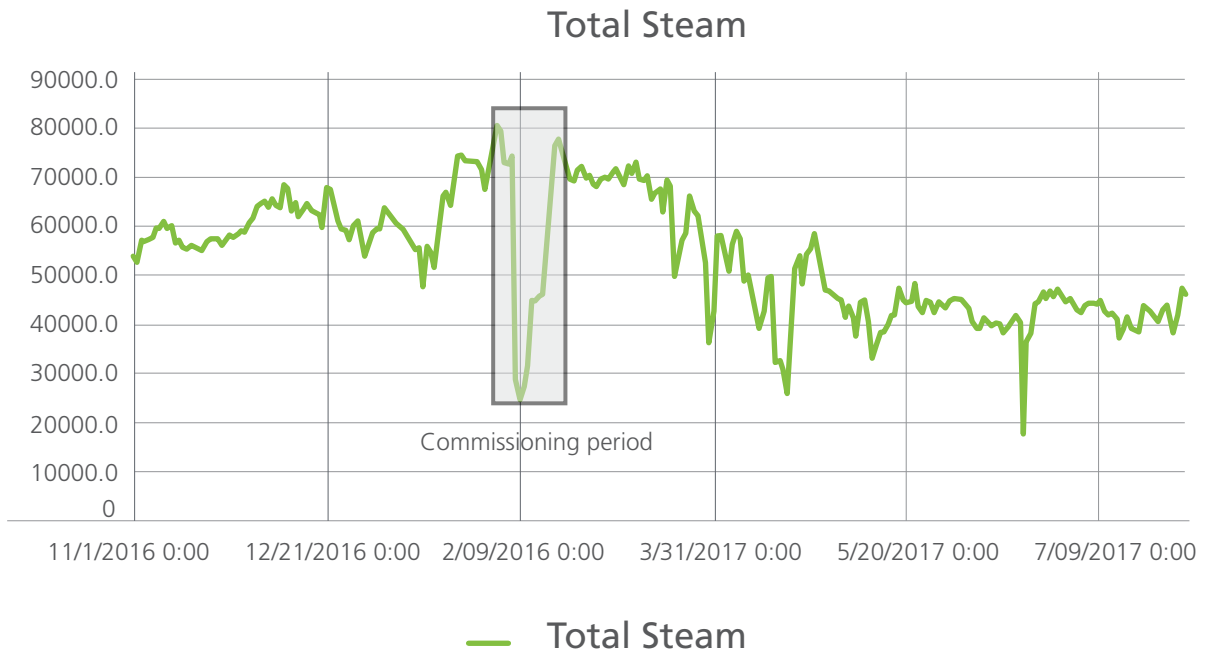


Figure 3: Salt results for Khurasaniyah crude



*Figure 4 Steam reduction*

Moreover, the team monitored the crude's salt result to ensure it met Saudi Aramco requirements to not exceed 10 pounds of salt per thousand barrels of crude oil (PTB). Figure 3 shows the salt result fluctuated between 8 and 10 PTB during this exercise.

### Implementing advanced process control (APC) technology

Separately, the implementation of APC technology further reduced the company's environmental footprint. MPD, in collaboration with the Process & Control Systems Department, carried out an APC feasibility study to gauge the benefits of implementing this technology. The study revealed that APC can deliver significant benefits to Khursaniyah Processing Facilities stabilization processes and thereby increase in crude recovery while reducing steam consumption. The study was

based on historical data collected for more than one year and then selected the optimum solution to gain more benefits for implementing this technology. The result of the study strongly indicated that APC is feasible on the two stabilization trains at KPF. It was recommended to deploy APC at KPF after developing a detailed development plan for APC deployment.

In early 2017, APC technology was installed and commissioned in KPF. After implementing this initiative, steam consumption fell from approximately 60,000 lb/hr to 42,142 lb/hr, which translates into savings around 17752.1 lb/hr of steam (222 m<sup>3</sup>/d), as illustrated in Figure 4.

### Conclusion

In line with the Saudi Aramco Water Conservation Policy (INT-11) and MPD water conservation roadmaps, both initiatives were carried out to reduce

groundwater consumption at MPD facilities. Wash water optimization initiative has cut down groundwater consumption by 62.3%, falling from 530 USGPM to 200 USGPM with no impact in oil specification results. Moreover, implementing APC technology has reduced steam consumption by 17752.1 lb/hr, which is equivalent to saving 222 m<sup>3</sup> per day of groundwater consumption. Applying both water conservation initiatives at MPD's facilities was part of continuous efforts of MPD's water conservation team for seeking any opportunities, initiatives, and technologies in order to achieve one of MPD's long-standing commitments to protect the environment.



in depth

# Under study

## Saudi Aramco assesses feasibility for developing an integrated solid waste management facility in the Eastern Province

Jihad Shina'a, EPD

In 2016, Saudi Aramco completed a study titled "Feasibility Study for an Integrated Solid Waste Management Facility in the Eastern Province." True to its name, the study's objective sought to develop an Integrated Solid Waste Management Facility (ISWMF) that minimizes environmental and health impacts while exploring opportunities to generate economic benefits, including recycling,

composting, and Waste to Energy (WtE). The study covered residential communities and commercial activities located in Dammam and four main neighboring cities (Al Khobar, Qatif, Ras Tanura, and Abqaiq), home to over 2.5 million people (See Figure 1).

The waste streams covered in the study included Municipal Solid Waste

(MSW), Construction & Demolition Waste (CDW) and Commercial & Industrial Waste (CIW). However, more emphasis was given to MSW since the environmental and health impacts associated with this stream are more significant. The study's scope involved desktop review, including: legal and institutional frameworks, waste projection, waste characterization, assessment of the current waste management practices, analysis of alternative solid waste management technologies, cost-benefit analysis, and proposing an ISWMF that fits the needs of the study area.

### Waste Projection

According to the Central Department of Statistics and Information (CDSI) the total population of the study area in 2015 was 2.47 million and expected to reach close to 3 million by 2045. Based on population and Gross Domestic Production (GDP) forecasts, in 2015 the total solid waste generation was estimated to be 2 million tons and projected to reach 3 million tons by 2045, of

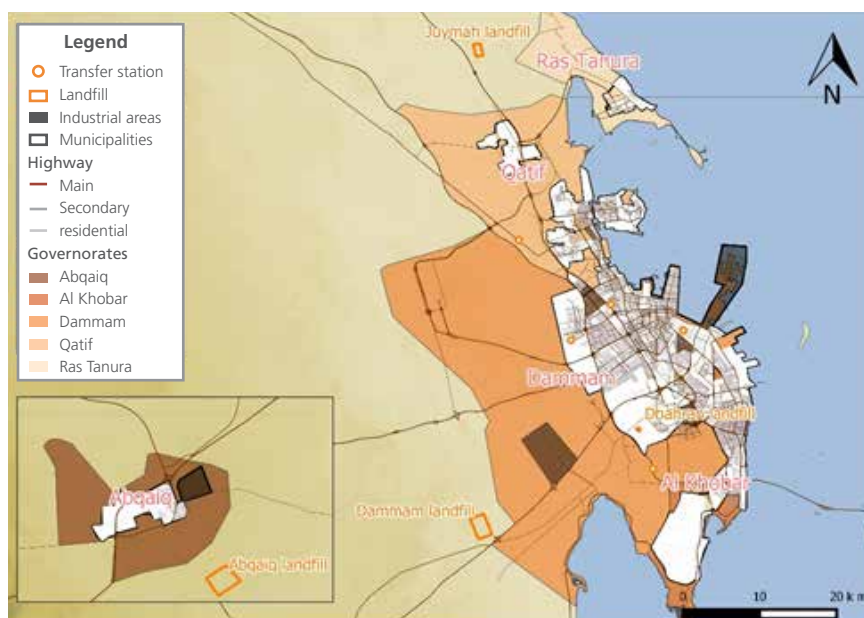


Figure 1: Cities within the study area (Source: from the report "Feasibility Study for Developing an Integrated Solid Waste Management Facility in the Eastern Province")

which 45% consist of MSW (Figures 2 and 3).

### Waste characterization

EPD carried out a characterization campaign in different communities to assess the MSW composition. Since the composition is influenced

#### Solid Waste Generation in the Study Area

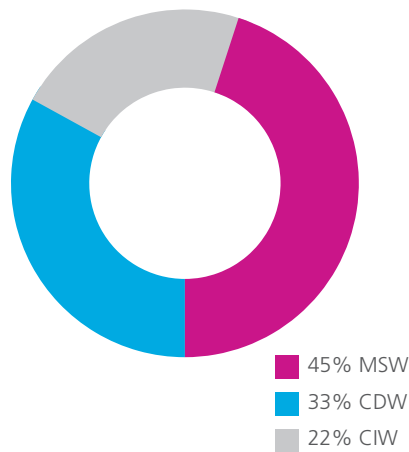


Figure 2: Distribution of solid waste in the study area (Source: Feasibility Study for Developing an Integrated Solid Waste Management Facility in the Eastern Province).

by socioeconomic factors, the campaign considered low income, medium income, and high income communities in Dammam. The impacts of informal sectors, collection of recyclables by waste collectors, and scavengers on MSW composition were also considered in the study. The campaign revealed that between 75-80% of the MSW is composed of Organic Matter (OM), paper, cardboard and plastic (Figure 4). Due to informal-sector interest of some recyclable waste, the composition of waste received at the landfill was determined to be different than the waste generated by inhabitants. CIW and CDW compositions were also determined from data recorded at the Dammam landfill.

### Assessment of current practices

About 90% of solid waste is collected and disposed of in an unsanitary landfill located along the Dhahran-Abqaiq highway, about 12 km south of Dammam Second

Industrial City. The landfill lacks an adequate synthetic liner that prevents groundwater contamination and a biogas collection system that minimizes impacts on ambient air quality and greenhouse gases (GHG). Landfill gas (LFG) is generated in the landfill by the decomposition and biodegradation of organic matter in the waste mass. The quantity of biogas depends on the volume and composition of the waste.

The Intergovernmental Panel for Climate Change in 2006 employed a SWANA (Solid Waste Association of North America) model to estimate and project methane generation rates over a 30-year period. The IPCC model estimated about 230,817 tCH<sub>4</sub> (total amount of methane) will be released from the Dammam landfill over a period of 30 years (Figure 5).

The impact of global warming from methane is 21 times higher than carbon dioxide, and the impact of global warming from methane not

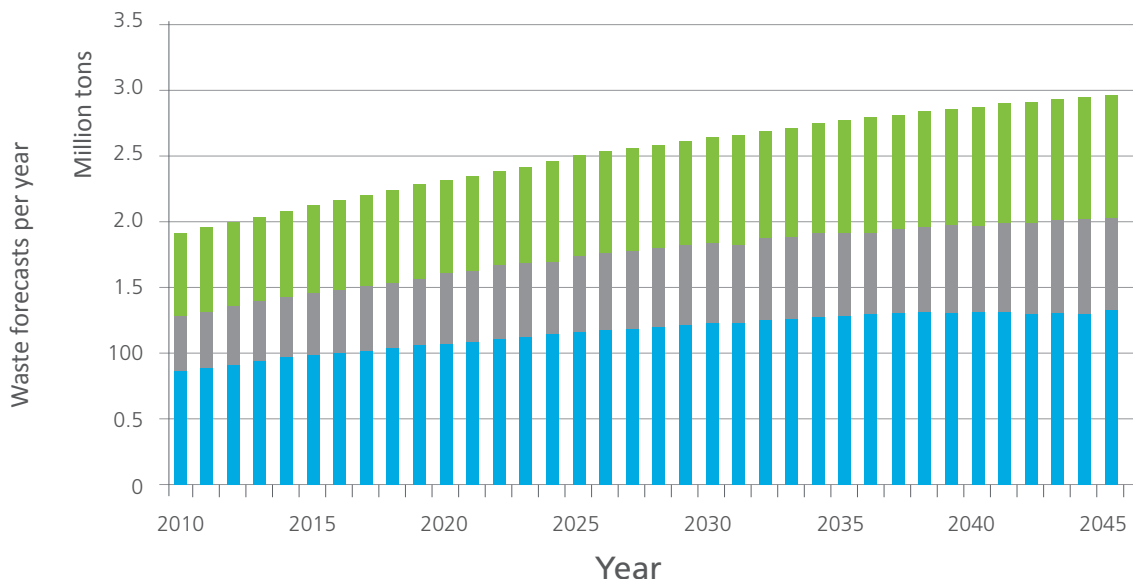
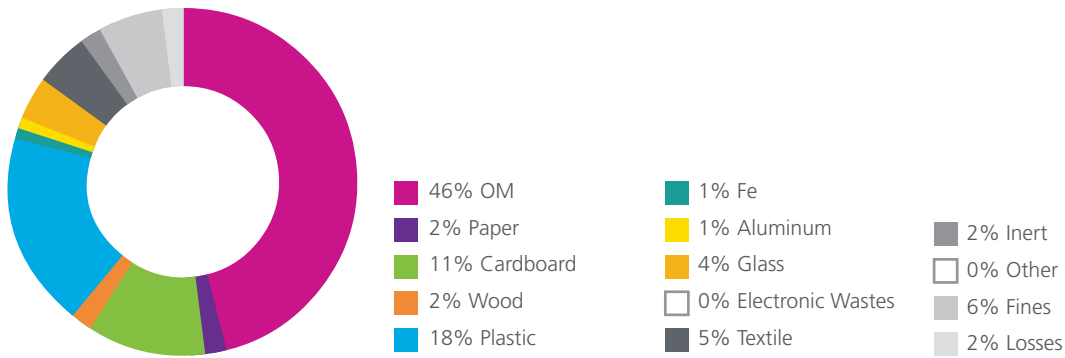
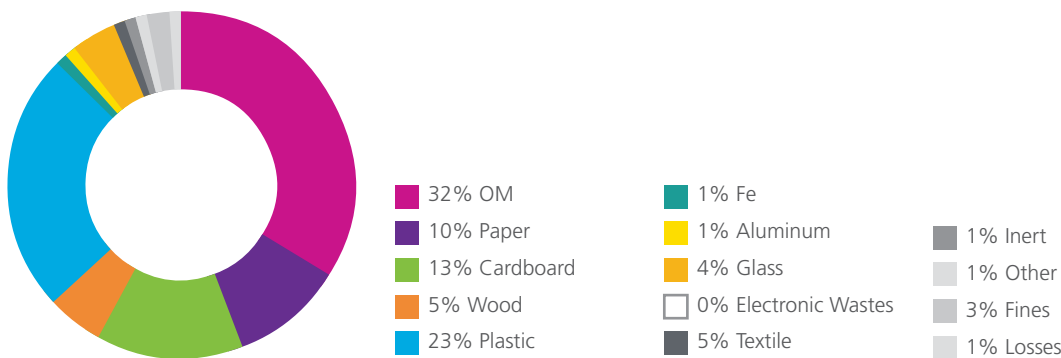


Figure 3: Solid Waste Projection in the Study Area (Source: Feasibility Study for Developing an Integrated Solid Waste Management Facility in the Eastern Province)

### Composition After Informal Sorting Low Income



### Composition After Informal Sorting Medium Income



### Composition After Informal Sorting High Income

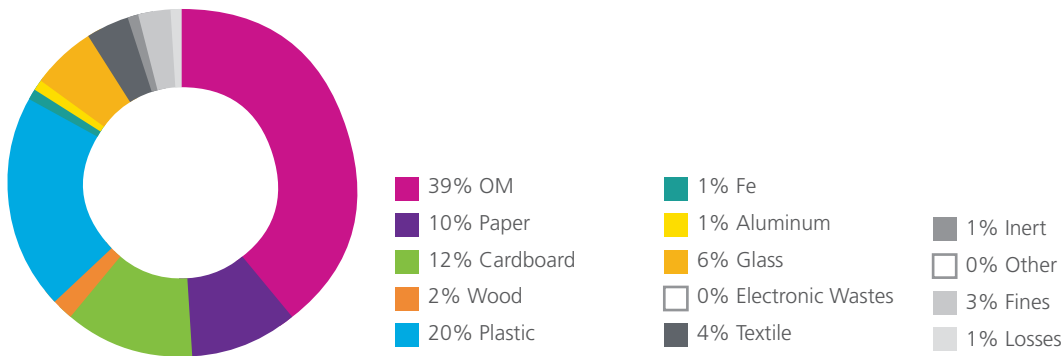


Figure 4: Waste composition from different communities in Dammam

captured in Dammam’s uncontrolled landfill site since 2004 translated to about 5.26 million Teq CO<sub>2</sub>. A modern car emits around 125 grams of carbon dioxide per kilometer. If we consider the average mileage of a motorist to be 25,000 km per year, the impact of global warming is equivalent to the annual pollution of 1,684,287 vehicles.

### Analysis of technologies

As mentioned earlier, the study aimed to identify technologies that maximize diversion of waste into landfills and recover recyclables. The waste management hierarchy concept was adopted for the selection of appropriate technologies that meet study objectives (Figure 6).

Each technology was assessed based on the following criteria:

- Technology robustness
- Composition and quantities of waste treated
- Potential outputs for process products and residues
- Financial/affordability restrictions



### Methane Generation Rates Over a 30-year Period

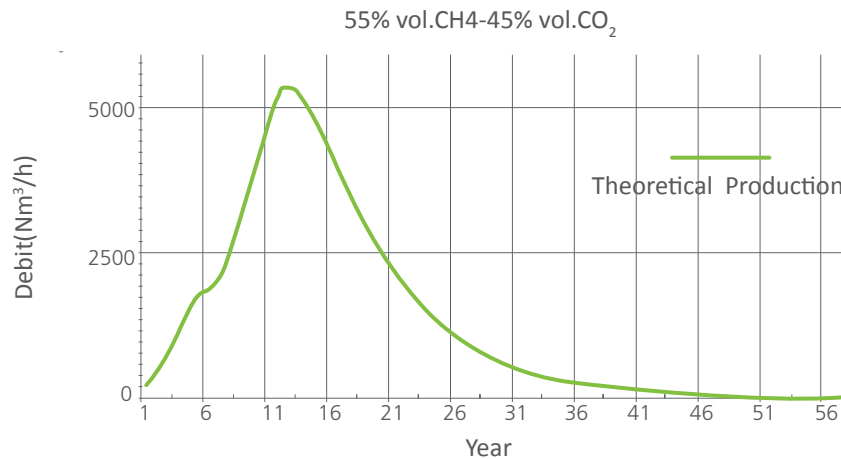


Figure: Theoretical biogas production

### The Waste Management Hierarchy

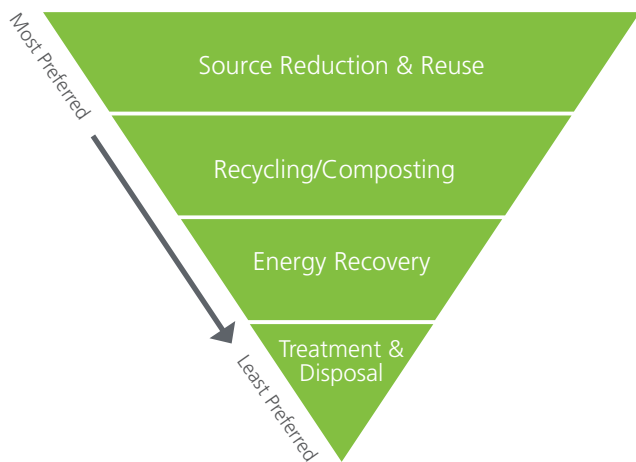


Figure 6: Waste management hierarchy

Various technologies were identified and screened. The following is a brief description and assessment of the most common solid waste management technologies:

#### Waste sorting and recycling

The recyclable components of waste include paper and cardboard, plastics, glass, metals, and organic or biodegradable materials. However, it must be kept in mind that it is not technically feasible or economically desirable to recycle all components of

waste.

The list of potentially recyclable materials continues to grow as technological developments enable more materials to be recycled. However, for the purpose of the study, the major types of materials found within waste that can be recycled are:

- Recyclable consumer product packaging
- PET plastics, colored, or colorless

- Tetra pack
- Steel
- Aluminum
- Newspapers and magazines
- Other paper
- Electronic waste

The sorting process involves the following steps:

- Waste reception and checking
- Feeding and preparation
- Waste separation (manual or mechanical)
- Storage
- Preparation and baling
- Final Storage and shipping

Materials Recovery Facilities (MRF) are centralized facilities designed to sort recyclable waste from MSW. There are two types of MRF, clean and dirty. Clean MRFs are used to segregate the different recyclables that have been collected together at the source. Table 1 demonstrates the assessment of clean MRF.

Dirty MRFs are used to segregate mixed recyclable and organic waste streams and can also be called Mechanical and Biological Treatment (MBT). Table 2 demonstrates the assessment of dirty MRF.

#### Biological treatment technology

About 45% of MSW is composed of organic matter or biodegradable material. A biological treatment facility aims to:

- Produce organic soil improvement
- Stabilize organic matter
- Produce biogas for energy production
- Reduce waste volume

The two different treatment technologies that can achieve these goals are:

- Composting: aerobic degradation or natural/forced aeration
- Methanization: anaerobic fermentation

### Waste to Energy Incineration

Incineration, also known as mass-burn, is an established method of treating waste and recovering energy. Incineration is a treatment process based on combustion with excess air. Prevention and recycling of waste can still be done in the context of an incineration scheme. Incineration

can therefore be considered as an alternative to landfill disposal. Table 5 presents the assessment of Waste to Energy incineration plant:

### Pyrolysis / Gasification

Pyrolysis and gasification are thermal processes used to address waste containing combustible fractions. These processes are characterized by treatments performed either in the absence of oxygen (pyrolysis case) or in the presence of a reduced amount of oxygen (gasification).

These two processes lead to the production of synthetic gas that is generally recovered (burned) on site. However, the generated emissions must comply with the same regulations as incineration.

Pyrolysis produces a solid by-product (or pyrolysis coke). It is made up of the incombustible fraction of the treated waste (minerals and metals) and a combustible fraction (rich in carbon). Table 6 presents the assessment of Pyrolysis/Gasification Plant:

### Landfilling

Landfill is the final disposal of the waste and is designed to isolate waste from the surrounding environment. There are three types of landfills:

- Class 1 Landfills - Hazardous Landfills, which may only accept hazardous waste that satisfies site-specific acceptance criteria.
- Class 2 Landfills - Nonhazardous Landfills, which may accept any waste considered to be non-hazardous, including municipal waste, commercial waste, stable non-reactive hazardous waste, inert waste, and others as demonstrated through appropriate investigation and risk assessment.
- Class 3 Landfills - Inert Landfills, which may only accept waste known to be inert (that is, physically, chemically, or biologically unreactive).

MRF for mixed recyclable waste

Technology Robustness	Composition and quantities of waste	Financial/affordability restrictions	Potential outputs for process products and residues
Depending on the processes used	Only mixed recyclables from selective collection	Medium to high operating costs	Need to identify a market for recyclables
High level of maintenance required for mechanized facilities	From 10,000t/year up to 150,000t/year	Medium to high investment costs	
		Require the implementation of a selective waste collection	

Table 1: Assessment of Clean MRF (Source: Feasibility Study for Developing an Integrated Solid Waste Management Facility in the Eastern Province)

## MRF for dirty recyclable waste

<b>Technology Robustness</b>	<b>Composition and quantities of waste</b>	<b>Financial/affordability restrictions</b>	<b>Potential outputs for process products and residues</b>
Depending on the processes used	Only mixed recyclables from selective collection	Medium to high operating costs	Need to identify a market for recyclables
High level of maintenance required for mechanized facilities	From 10,000t/year up to 150,000t/year	Medium to high investment costs	
		Require the implementation of a selective waste collection	

Table 2: Assessment of Dirty MRF (Source: Feasibility Study for Developing an Integrated Solid Waste Management Facility in the Eastern Province)

## Composting

<b>Technology Robustness</b>	<b>Composition and quantities of waste</b>	<b>Financial/affordability restrictions</b>	<b>Potential outputs for process products and residues</b>
Very robust technology	Only segregated organic matter	Low operating costs	Need to identify a market for the compost produced
	Flexible process	Low investment costs	

Table 3: Assessment of MSW Composting Plant (Source: Feasibility Study for Developing an Integrated Solid Waste Management Facility in the Eastern Province)

## Methanization

<b>Technology Robustness</b>	<b>Composition and quantities of waste</b>	<b>Financial/affordability restrictions</b>	<b>Potential outputs for process products and residues</b>
Robust technology but sensitive process	The amount of waste treated will be limited by the facility and the size of the reactors	Medium operating costs	Need to identify a market for the compost produced
	Only segregated organic matter	Medium investment costs	
			Need to determine the buyer for the energy produced

Table 4: Assessment of MSW Methanization Plant (Source: Feasibility Study for Developing an Integrated Solid Waste Management Facility in the Eastern Province)

### Proposed ISWMF

Based on these inputs, the study suggests mitigation measures that would enhance solid waste management practices taken into consideration to be the best economical, technical and environmentally sound alternatives

that fits the study area requirements (See Figure 7. The alternatives proposed developing an ISWMF consisting of:

1. Mechanical and Biological Treatment (MBT) facility, which includes a sorting plant and a composting plant. These plants

can process MSW and green waste with a total plant capacity of 400,000 tons/year.

2. Material Recovery Facility (MRF) for sorting recyclables from CIW and CDW. The plant carries a capacity of 230,000 tons/year.

### Waste-to-Energy Incineration

Technology Robustness	Composition and quantities of the waste feedstock	Financial/affordability restrictions	Potential outputs for process products and residues
<p>Reliable technology</p> <p>Proven process</p> <p>Appropriate maintenance of the facility</p>	<p>Incinerator can efficiently treat quantities of waste from 50,000 to around 500,000t/year</p> <p>The amount of waste must be estimated with caution to ensure nominal performance of the plant</p> <p>Can burn MSW, CIW and some hazardous waste</p>	<p>High investment costs</p>	<p>Metal recovery</p> <p>Fly ash needs to be treated as hazardous waste</p> <p>Around 20% of bottom ashes must be recovered or landfilled</p> <p>Electrical and/or thermal recovery</p>

Table 5: Distribution of solid waste in the study area (Source: Feasibility Study for Developing an Integrated Solid Waste Management Facility in the Eastern Province).

### Pyrolysis/Gasification

Technology Robustness	Composition and quantities of the waste feedstock	Financial/affordability restrictions	Potential outputs for process products and residues
<p>Not a world wide technology</p> <p>Complex technology to develop</p> <p>Appropriate maintenance of the facility</p>	<p>Pyrolysis not adapted to heterogeneous waste like MSW</p> <p>Can efficiently treat quantities of waste from 50,000 to around 500,000t/year</p>	<p>High investment costs, higher than WtE incineration</p>	<p>Metal recovery</p> <p>Market for syngas</p> <p>Pyrolysis coke still contains waste pollutants and is not considered as a secondary fuel in Europe</p>

Table 6: Distribution of solid waste in the study area (Source: Feasibility Study for Developing an Integrated Solid Waste Management Facility in the Eastern Province).

Advantages and Disadvantages of Landfills

Technology Robustness	Composition and quantities of waste	Financial/affordability restrictions	Potential outputs for process products and residues
Robust technology	Can treat large quantities of waste from 10,000t/year to 1Mt/year  Flexible facility capacity	Low operating costs  Low to medium investment costs	Need to treat the leachate  Potential energy recovery from the landfill gas

Table 7: Distribution of solid waste in the study area (Source: Feasibility Study for Developing an Integrated Solid Waste Management Facility in the Eastern Province).

- Sanitary landfill (Class II) of 7.3 million tons capacity. Wastes disposed are MSW, CIW, non-inert CDW and MBT/MRF residues.
- A class III inert materials landfill for the CDW.

**Phase I:** Upon completion of the construction activities and commencement of operations, 20% of the waste will be diverted to the MBT facility and the remaining 80% will be disposed of at engineered landfills meeting international environmental specifications.

**Phase II:** Expanding the ISWMF capacity to double after five years of

operations.

A financial appraisal of the proposed solution was carried out over 20 years to visualize the required budget of the project. The revenues will be generated by selling recyclables and collecting gate fees per ton of waste treated and/or disposed of at the facility (See Figure 7).

The facility will be developed in two phases:

ISWMF mass flow

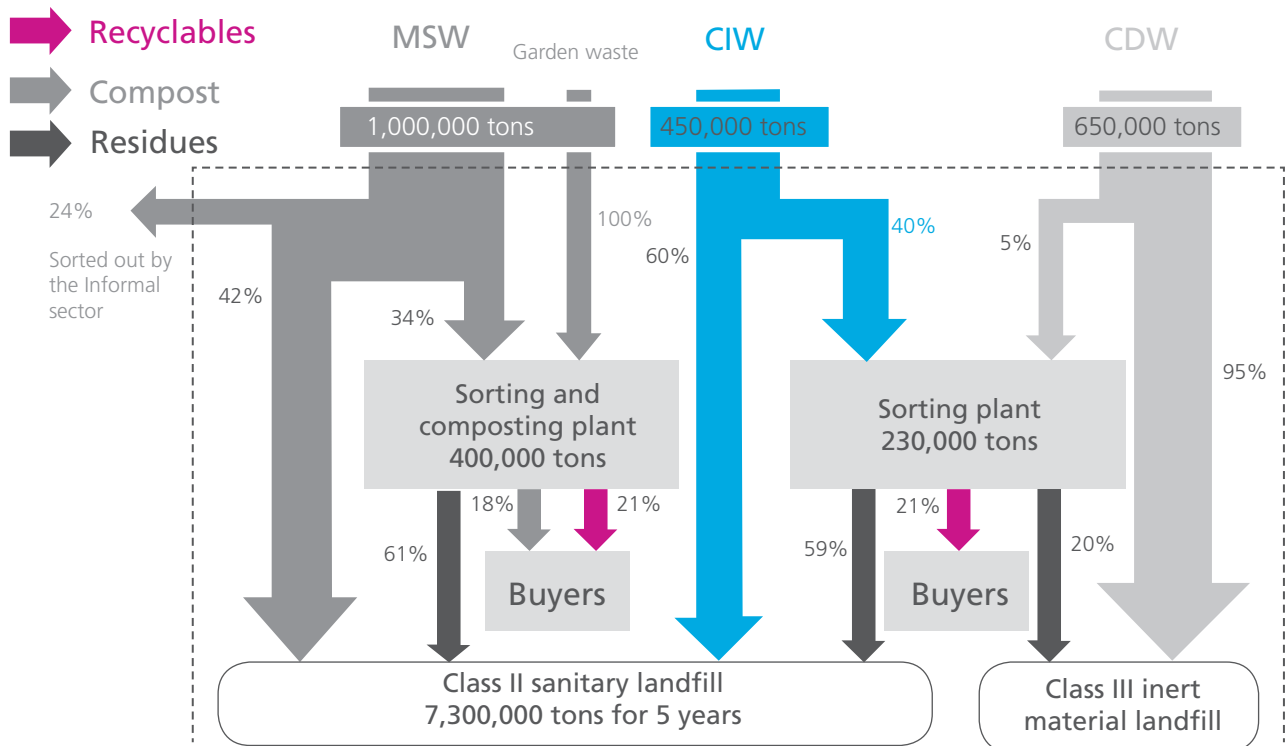


Figure 7: ISWMF mass flow

# Sustainable future

## Initiative saves water at company facilities

Nidal Samad, EPD

Saudi Aramco is on the forefront of employing water savings technology as one of the important enablers to implement its Water Conservation Strategy (WCS). Optimizing water demand and minimizing irresponsible water waste—which are the main WCS objectives—can save a significant amount of water and bring the Company closer to achieving these goals. Leveraging the latest technologies and striving for efficient and optimum water use are WCS pillars that support the Company’s ultimate environmental objectives. At Saudi Aramco communities and industrial facilities, during the process of producing potable/high-quality water, most often a significant amount of water is discharged into the sewer, which greatly hampers the overall efficiency of the treatment process. This Enviro

News article presents a water saving initiative using ceramic membrane filtration (CMF) technology. This technology will enhance the optimization of the water treatment system and increase its water recovery by recycling a portion of the discharge water back to mix with the withdrawn groundwater feeding the water treatment system. As a result, the amount of groundwater withdrawal is reduced.

### The current water treatment process

Potable and high-quality water are typically generated by treating groundwater through a Reverse Osmosis (RO) plant. Pretreatment of groundwater sources is required to increase the efficiency of the RO system and reduce the fouling

of the membrane. Pretreatment relies on the use of a multimedia filter (MMF) followed by a 5-micron cartridge filter. The multimedia filtration removes most of the total suspended solids (TSS), while the finer solids are removed by the 5 micron cartridge. The fine-filtered water is fed to the RO membranes to produce potable and high-quality water. Figure 1 illustrates the current treatment process. Capturing the MMF backwash stream generally disposed into the sewer followed by treating and recycling it back to be mixed with the groundwater feed stream will result in water savings. This process has no impact on the RO system operations, because the quality of the MMF backwash is similar to groundwater with the exception of the Total Suspended Solids. The technical challenge in

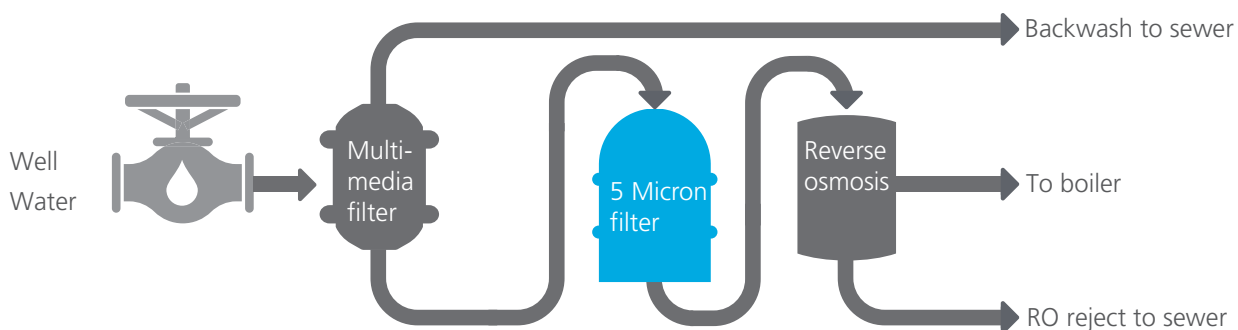


Figure 1: Current water treatment system

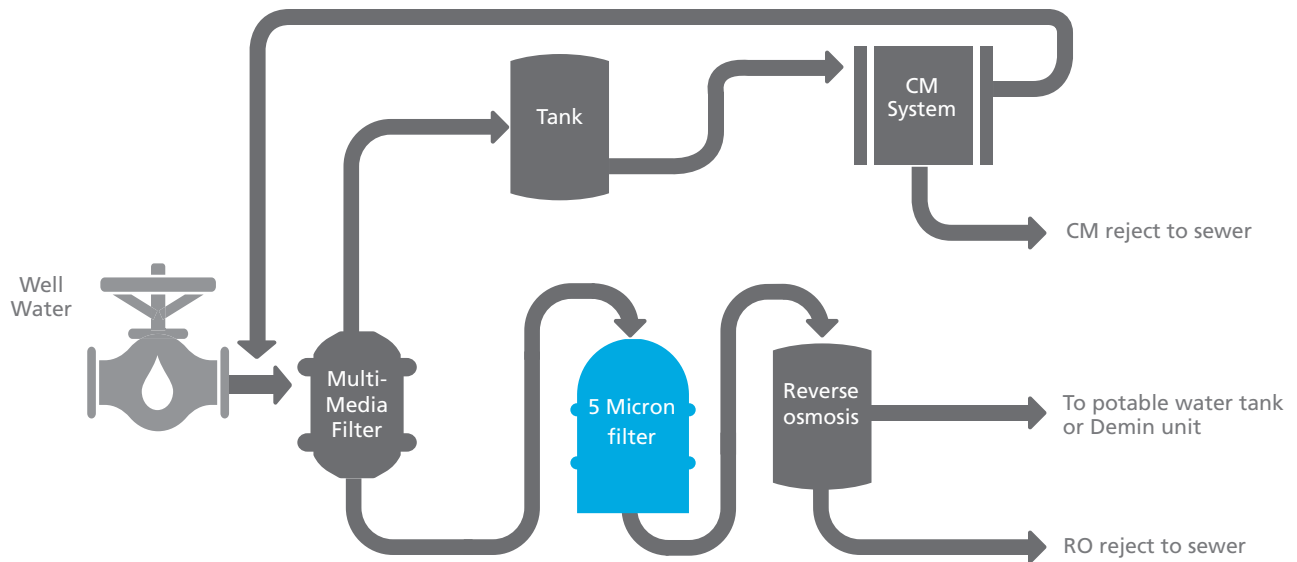


Figure 2: Retrofitted water treatment system

reaching that objective consists of two parts. One is the recovery treatment system has to be high (over 90%) and, secondly, the quality of the treated water should not cause great variation in the solid loading to the filter, which will affect its operation and thus its production capabilities. A promising ceramic membrane filtration (CMF) technology presented to EPD addresses both challenges and is also easy to implement and to retrofit existing water treatment systems.

### Retrofitting the current water treatment process

Retrofitting the current system is a manageable task. The backwash stream is rerouted to a collection tank and prevented from going to the sewer. The tank is equipped with an overflow that is connected to the sewer in case the CMF pilot system has to be stopped. The CMF system is fed at a constant rate from the collection tank, which also serves as a settling step for solids with high

density.

The CMF system is equipped with pressure gauges, flow meters, and water sampling valves. The treated water is routed back to the inlet of the MMF, and the CMF system reject was discharged into the sewer as depicted in the schematic below. The CMF system is backwashed periodically resulting with the only water discharge from the system. (See Figure 2 for an illustration)

### How does the CMF system work?

The CMF system employs 1-micron ceramic membrane modules, a control panel, scour air sparger, permeate and feed pumps and related instrumentations and valves. The ceramic membrane is durable, inert, and it tolerates harsh chemicals and high temperatures. The innovation of continuous air scouring with an automatic reject line and backwash gives the CMF system the edge for easy operations

and flexibility. The unique operation of the CMF is part of the design that allows the MMF backwash to be continuously fed into the CMF modules while being treated (Refer to Figure 3).

MMF backwash water is pumped to the CMF unit into a collection feed tank. When the tank is full, the backwash water fills the CMF module and exits through a so-called reject line. The CMF module is a flat sheet configuration.

The reject line has dual functions. One is to maintain a constant operating pressure on the CMF module. The second function is to allow the carryover of the concentrated particles (solids) through a flow of about 10 - 15% of the feed flow to be filtered through a typically 25-micron cartridge filter and return back the collection feed tank for continuous operation. The combination of filtered reject with the air sparging provides a unique flexibility in setting the operating

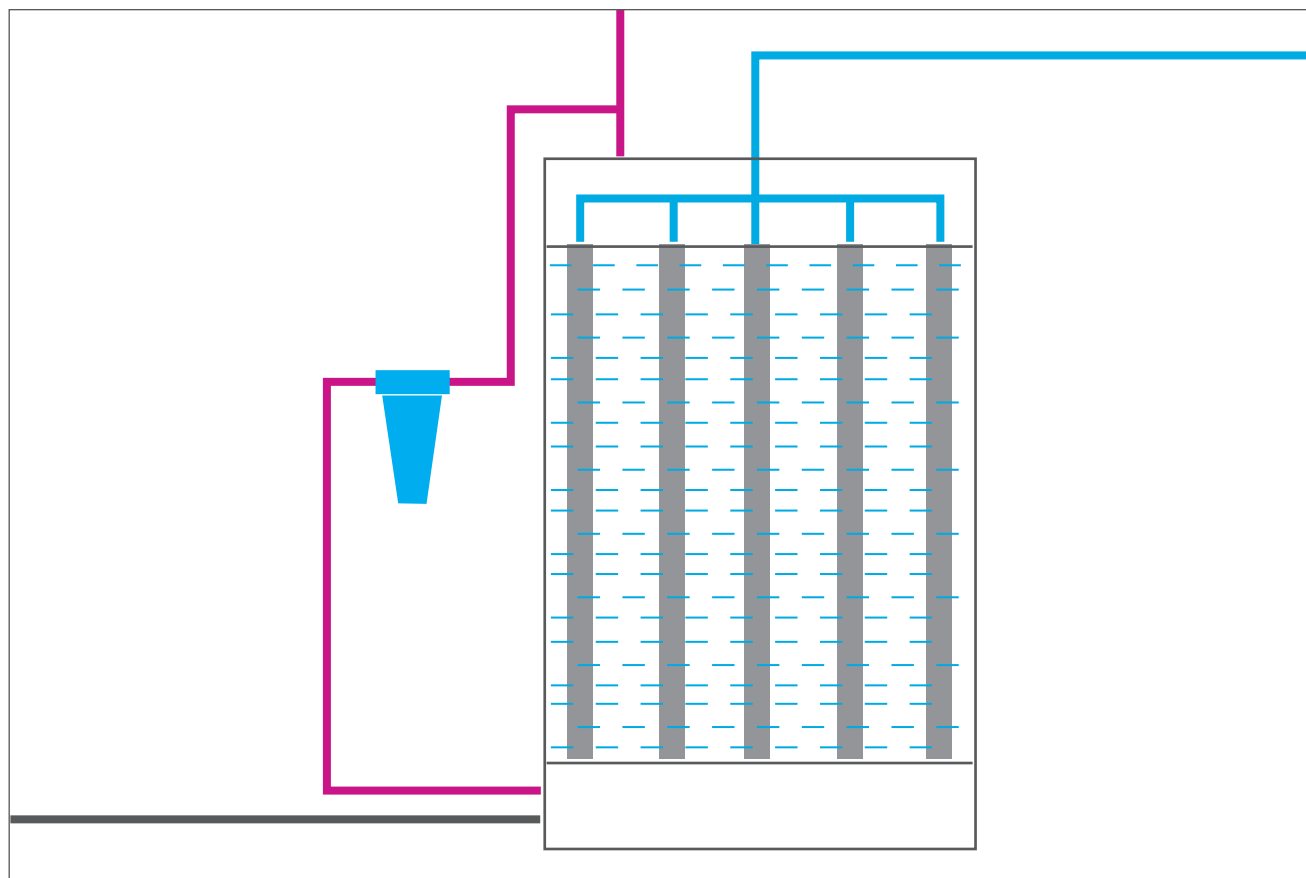


Figure 3: CMF module schematic

conditions of the unit in order to meet the desired quality of the treated water.

The CMF unit is equipped with a backwashing option to periodically clean the ceramic membrane. Depending on the pressure differential readings, the frequency of backwashing is set by the operator and the PLC control system will automatically conduct this function.

Although the operation of the CMF system is fully automatic, the operator must still conduct minor activities such as recording flow rates and feed pressures and taking samples and determining

the performance of the system by analyzing for the desired parameters including the particle size distribution. The typical removal efficiency of the CMF per particle size is presented in Table 1.

Table 1

Particle Size, Microns	Removal Efficiency, %
> 20	99
> 10	99
> 5	97
> 2	96

### Conclusion

Saving water a drop at a time is a valid approach as long as the economics justify it. Although the volume of groundwater that would be saved from modifying single-filtration backwash water per year is relatively small, this number can grow by a significant amount when implemented companywide. Technology is one of the identified enablers that EPD utilizes to bring Saudi Aramco closer to sustainable water operations. Currently, EPD is in the process of piloting this technology to evaluate its technical and economic feasibility.



# Leftovers

## Dealing with food waste disposal in Saudi Arabia

**Abdulrahman Al Jaafari, EPD**

The population of the world has crossed the 7 billion mark, of which 1 billion are facing starvation, which is a tragedy in itself. To add insult to injury, every year a significant 30% of total food production is wasted. That's enough to feed 3 billion people in the world, according to the World Hunger Education Service. Economic impacts of this waste are estimated to run as high as \$750 billion per year, and at the same time, food waste affects climate, ground water, and land in a negative way, underlined by the fact that 14% of the world's CO<sub>2</sub> equivalent emissions stem from food wastage in the form of landfill gases. Those working in or living close to uncontrolled or poorly

operated landfills are exposed to a wide range of air pollutants not to mention communicable diseases that can be transmitted by pests.

In the Kingdom of Saudi Arabia (KSA), rapid population growth has led to an increase of solid waste in recent years. Since 2007, Municipal Solid Waste (MSW) rose from 12.1 million tons/year to 15.2 million tons/year in 2012. At the same time, average daily production of MSW per capita has increased from 1.4 kg/day to 1.75 kg/day. Recent studies also show that food waste is the largest waste component that goes into the Saudi MSW, representing 43% of total MSW. As of 2012 6.6

million tons of food was going to waste, causing major economic losses and putting a heavy burden on the environment. All of this waste is disposed in KSA's landfills or dumpsites, which are expected to reach capacity within the next 10 years. These facts underline the seriousness of the food waste problem facing KSA.

Food wastes originate from three major sources, which are household, religious occasions, and the food industry. It requires the combined efforts of all stakeholders to reduce food wastes by considering varying solutions, which would result in environmental, health, economic, and social benefits.



(Photo Source: Shutterstock)



(Photo Source: Shutterstock)



(Photo Source: Shutterstock)

The diagram below illustrates major sources of waste disposal in the Kingdom, possible causes and the effective solutions that can help reduce the amount of food wastage.

### Household



- lack of awareness of the importance of waste reduction
- Absence of waste separation
- Culture and lifestyle
- Bad purchasing habits

### Solutions

- Use home composter
- An effective public awareness through different media such as the television, newspapers, and school programs
- Establish more food banks

### Religious occasions



- In July and November every year, millions of Muslims visit KSA for religious pilgrimage. This causes significant increases in food wastage and generates about 600,000 kg of 4,400 cubic meters food wastage per day

### Solutions

- Use home Composter
- An effective public awareness through different media such as the television, newspapers, and school programs
- Establish more food banks

### Food industries



- Food waste comes from poor handling or packaging and up to 25% of food is wasted
- Lack of waste collection and recycling systems
- KSA produces approximately 670 food products

### Solutions

- Food waste audits
- Regular training class for food handlers
- Rotating older food items to the front of shelves

Households play an important role to conserve food and protect the environment. Simple changes to daily behaviors can make a difference and help cut food wastes at home:

- 1. Plan your meals and then stick to your plan:** Plan your meals for the week before you go shopping and use a shopping list. Don't buy food items or even ingredients you know you won't use and discard, exacerbating food waste problems.
- 2. Conduct a food waste check:** Keeping track of everything that goes into the trash can help you figure out where opportunities lie to change your routine. Watch the "expiry date" and "best before" dates to avoid letting food go bad.
- 3. Optimize your refrigerator and store all items properly:** Write a detailed list of exactly how and where to store foods so they last as long as possible.
- 4. Use leftovers:** Plan a "leftovers" night, or use leftovers as ingredients to prepare your next meals. Freeze leftovers after use, or use them to feed your pets (whatever they can safely eat). For more information on safe handling of leftovers please refer to United States Department of Agriculture (USDA) website at [www.fsis.usda.gov](http://www.fsis.usda.gov).
- 5. Compost:** Composting is one resort that can help to convert waste to fertilizer. Search for the best home composter for you.

"We just need to value our food. Just imagine operating under the belief that food is a really important, valuable asset that takes huge amounts of resources to produce and is in fact critical to our survival," says Dana Gunders in her book: *WasteFree Kitchen Handbook: A Guide to Eating Well and Saving Money by Wasting Less Food*.

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# Testing ground

## In situ chemical oxidation in remediation of groundwater technology

Mansor Kashir, EPD

In situ chemical oxidation (ISCO) is a groundwater treatment approach that uses chemical oxidants such as persulfate, percarbonate, hydrogen peroxide, and permanganate to chemically oxidize and destroy a wide range of contaminants in the ground. Contaminants include benzene, toluene, ethylbenzene, xylenes (BTEX), naphthalene, trimethylbenzenes (TMBs) and MTBE, among others, some of which come from refining crude oil. (MTBE is an additive to gasoline products to aid in car-combustion processes).

Traditionally, contaminated groundwater had to be pumped from the ground to be treated above ground using water treatment equipment such as particle filters, air strippers, settlement tanks, activated carbon, etc. These traditional methods were only partially successful and resulted in large expenditures of capital resources. They also took years or even decades to succeed, though in situ chemical oxidation allowed for more efficient and cost-effective results.

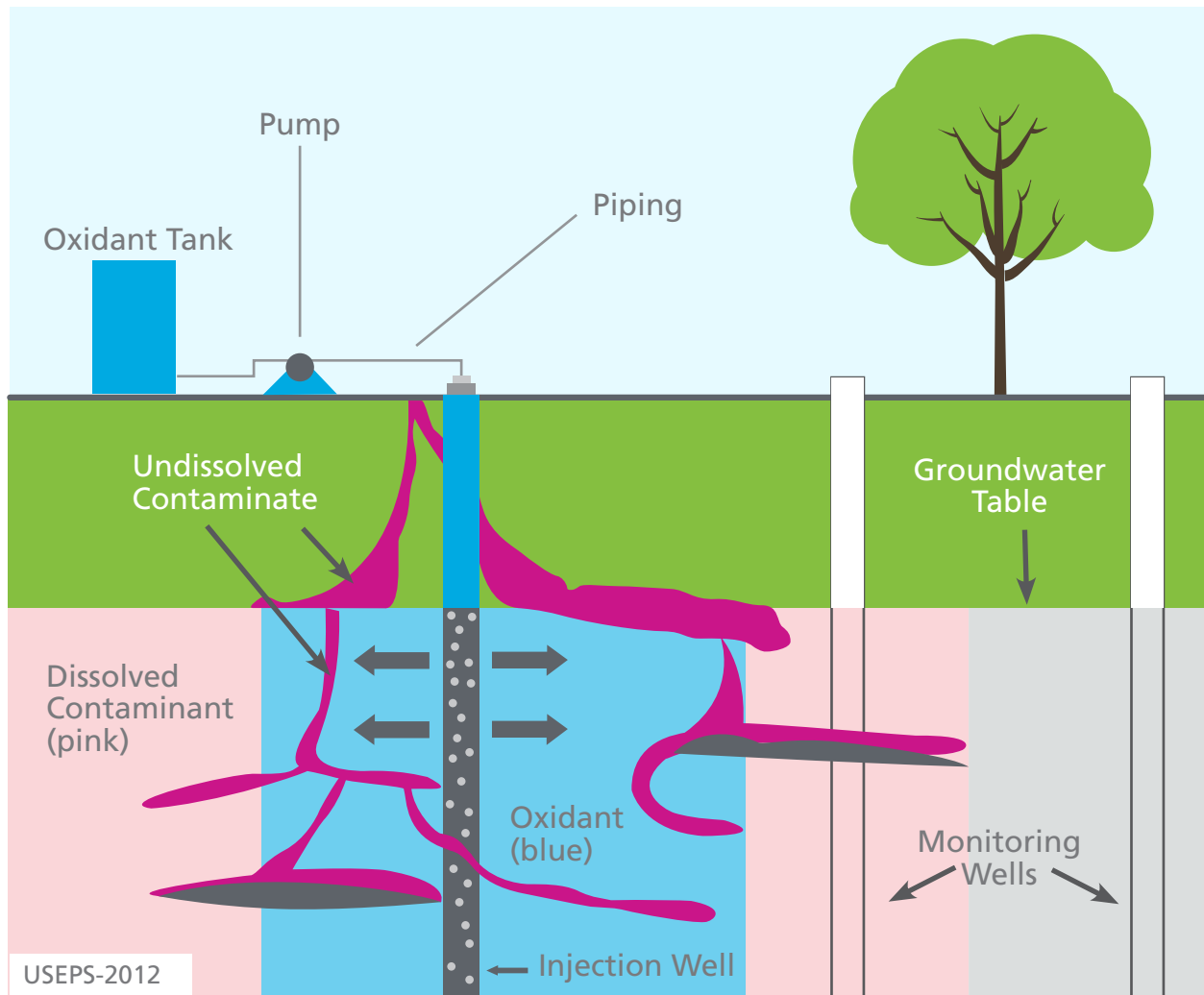
### Chemical oxidation. What is it?

Chemical oxidation relies on the transfer of electrons from the contaminant to the oxidant, which results in the destruction of both the contaminant and the oxidant into harmless, inert compounds. The oxidant is usually injected into injection wells or via direct push technology using a portable injection unit. Use of this technology results in a very small and temporary footprint that has little to no impact on operational facilities as well as requiring no power hookups or transfer infrastructure.

In order to determine if ISCO was applicable to the unique geologic and geochemical environments in which Saudi Aramco sites are situated, a series of laboratory and pilot tests were completed at various company facilities. Laboratory tests were conducted at the University of Waterloo Canada, while four pilot tests were conducted at three company bulk plants.

### Pilot test description

Based on a series of bench scale laboratory tests, the pilot tests conducted at certain company facilities aimed to evaluate the effectiveness of in situ chemical oxidation in various geologies and compounds including BTEX, TMBs, naphthalene, MTBE, and TBA. The pilot tests consisted of injecting one of three oxidants (sodium persulfate, hydrogen peroxide or stabilized hydrogen peroxide) over multiple events (three to eight events) and monitoring the groundwater quality. The oxidant solutions were injected using mobile injection units that could be deployed at facilities with little cost and time required. Each injection event typically lasted one to three days and required a small temporary footprint that had minimal effects on facility operations. The advantages of using in situ chemical oxidation include the ease and quickness of the technology as well as the minimal need for infrastructure such as pipes, tanks and treatment



units, etc. The technology can be applied within most geologic units and is applicable for the treatment of almost all organic-based contaminants. Any facility having dissolved phase groundwater contamination could serve as a potential deployment site.

## Results

Saudi Aramco's pilot and laboratory tests revealed that chemical oxidation can provide an effective treatment option for groundwater contaminated by organic compounds such as

petroleum hydrocarbons. Specifically, the results have shown that:

- Chemical oxidants such as unactivated persulfate, hydrogen peroxide and stabilized hydrogen peroxide can effectively destroy high concentrations of petroleum hydrocarbons, including BTEX, naphthalene, TMBs and effectively reduce all contaminants to below risk-based concentrations.
- The oxidants can be applied

within a wide range of geologies and geochemical conditions using temporary, easily deployed equipment that leaves a small footprint and minimizes the impact to facility operations.

- The cost to treat a kilogram of dissolved-phase hydrocarbons using in situ chemical oxidation is approximately one tenth of that to treat the same contaminant using technologies such as pump & treat procedures.



in focus

## Yanbu' Refinery Dept. wins International Green Apple Award

Yazeed Janbi, (YRD)

In line with Yanbu' Refinery Department's efforts to achieve environmental excellence, the facility participated and won a 2017 International Green Apple Environment Award for its best

practice through "Flare Optimization Study." The study's main intention was to reduce the total purge gas rate from 340 million scf per year down to 192 million scf per year, which represents a 57% reduction. The awards are organized by The Green Organization, an international, independent, non-political and non-profit environment group dedicated to recognizing, rewarding and promoting environmental best practices around the world. The Green Apple Awards are supported by the Environment Agency, the U.K. Chartered Institute of Environmental Health, and the Chartered Institution

for Waste Management.

## Ras Tanura kicks the habit

Rehman Khalilur (RTPD)

There's an old saying that quitters never win, but just the opposite was true at Ras Tanura recently. In 2017, the Abu Ali Producing Division in coordination with Abu Ali Clinic & Population Health – Managed Care Department of Johns Hopkins Aramco Healthcare (JAHA), organized a "Smoke Free Campaign" during



Hossam A. Bargawi, an engineer in the Yanbu' Refinery Department's (YRD) Operations Engineering Unit, and Esam M. Hawsah, a field maintenance projects coordinator in YRD, accept a Green Apple award from Michael Cook, former chief executive of the Chartered Institute of Environmental Health in the U.K. and longtime presenter for The Green Organization. YRD was recognized for its significant efforts to reduce flaring. (Photo and Caption Source: The Arabian Sun).



## Team up to clean up: children value their own backyard in 'Udhailiyah

Lizette J. Yap (GDD)

It was a sunny breezy day in the heart of Ghawar Field in 'Udhailiyah earlier in 2017. Young Saudi students, teachers, engineers, administration staff and Company management held plastic bags in one hand and scooped up trash from the ground with the other, all donning t-shirts with the duly emblazoned "Team Up to Clean Up" campaign moniker across their backs. Drilling & Workover Admin Area embodied the Company's social responsibility efforts by holding the first of its kind environmental trash cleanup campaign in the area.

As part of D&WO's organizational efforts to promote our Company's social responsibility and operational excellence, led by its Vice President, Mr. AbdulHameed A. Al-Rushaid, Chief Drilling Engineer, Mr. Khalid A. Al-Abdulgader, and D&WO General Manager Operations, Mr. Omar S. Al-Husaini, the Gas Drilling Team in 'Udhailiyah began promoting environmental awareness in their very own backyard via "Team Up to Clean Up."

"The Saudi Aramco logo, is not just a random logo, it represents the blue in the sky, the stars, and the green in the ground," Gas Drilling Department



*A hands-on approach to quitting smoking. (Photo Source: Saudi Aramco)*

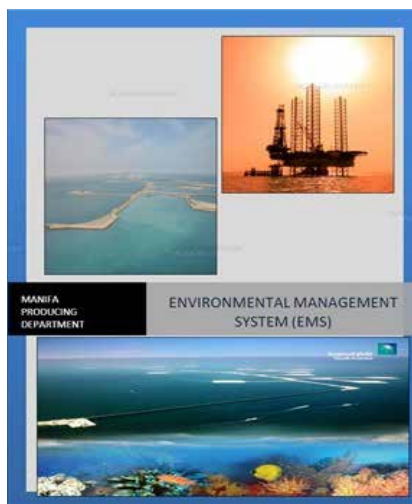
the Holy Month of Ramadan. During this campaign, JAHA representatives used tools such as healthcare presentations, informational sessions, visual aids and even physical examinations and medications to help smokers to kick the habit. Moreover, a "Quit & Win Competition" also took place during this campaign, with quitters receiving due rewards for stopping smoking. The campaign ran from May 24 through July 3, 2017 at Abu Ali Clinic.

## Manifa Producing Department's environmental messaging goes online

Alaa Abu Arafah (MPD)

As part of Manifa Producing Department's environmental awareness program, an e-learning course now provides an overview of the department's environmental

system, outlining responsibilities that empower everyone to safeguard the environment. This course will help spread environmental awareness among MPD's personnel as well as an understanding of requirements and importance of environmental programs. Moreover, this initiative will help MPD continue exerting all efforts towards reaching environmental excellence to adhere to its mission to produce oil and generate power in reliable, safe, cost-effective and environmentally friendly manner while applying the highest standards of business conduct.





Volunteers at the “Team Up to Clean Up” campaign. (Photo Source: Saudi Aramco)



Clean up participants celebrate a successful “Team Up to Clean Up” campaign. (Photo Source: Saudi Aramco).

Manager, Saeed A. Al-Khathami told campaign participants, highlighting the importance of the environment to Saudi Aramco.

Over 50 students from the local government school and more than 120 employees from the three D&WO gas drilling departments attended the campaign in 'Udhailiyah. The necessity of waste reduction and the concept of recycling (reuse, reduce, and recycle) were highlighted followed by the cleanup campaign in the 'Udhailiyah Village. “Through these great organizing efforts to gather the future leaders of Saudi at this honorable campaign, we

have highlighted the importance of conserving our environment, taking responsibility for its future and leading by example,” said Gas Drilling & Workover Department Manager Hussain M. Al-Haleimi.

Abdulrahman A. Al-Sanea, Supervisor Environment & Occupational Health, Drilling Operational Excellence & Compliance Division (DOE&CD), delivered the campaign’s opening remarks, emphasizing the importance of waste reduction and caring for the environment in general. The campaign was well received by employees and the public, and many participants described it as an excellent opportunity to reflect,

appreciate and protect our precious environment.

One local observer commented that the cleanup activity underscored the need to address waste currently deteriorating nearby surroundings. The awareness generated through this campaign served as a starting point towards a cultural change in the community.

Other event participants included DOE&CD, Community Services Recycling Group, 'Udhailiyah Gardening/Sanitation Unit, 'Udhailiyah Security Operations, and 'Udhailiyah Emergency Medical Services. Southern Area Oil Drilling Department Manager, Mr. Fahad A. Al-Mulaik, and DOE&CD General Supervisor, Mohammad M. Al-Qahtani, also attended to show their endorsement of this powerful message. This environmental awareness campaign concluded with the recognition of the presenter, organizers, and all participating departments that supported and with the delivery of the key message “The environment is everybody’s responsibility.”

## EPD conducts second environmental coordinators workshop of 2017

### Hussain Aseeri (EPD)

EPD hosted its second Environmental Coordinators (EC) Workshop for 2017 on November 1. An EC is responsible for all environmental

matters at the facility level. This biannual workshop forms part of EPD's ongoing efforts to enhance EC environmental capacity-building and share their experiences, exchange information on new technologies and find solutions to concerns and challenges. EPD manager attended the entire event and conducted a two-hour open discussion session in which participants voiced opinions regarding communication with EPD as well as training, technology issues and other topics. The manager-led open forum, the first of its kind, revealed EC concerns involving environmental protection in regards to operational excellence as well as new challenges facing Saudi Aramco such as IPO-related issues. More than 180 participants viewed presentations from EPD SMEs as well as environmental coordinators on a variety of environmental and occupational health topics.

## EPD launches environmental discussion workshop for managers

**Hussain Aseeri, EPD**

On December 12, 2017, EPD launched its first ever Environmental Discussion Workshop for Managers in Dhahran. Around 45 participants, including 30 managers, attended. The workshop carried the objective of sharing with the management the essential elements of the Company's environmental protection programs, gather feedback on environmental

and health management issues as well as address organizational challenges. Six EPD subject matter experts (SMEs) delivered presentations, while the EPD manager led an open discussion giving attendees the chance to express concerns, share success stories and even converse among each other on issues regarding environmental protection and community health.

## EPD attends third UN environment assembly of the UN Environmental Programme

**Abdullah Tawlah (EPD)**

EPD representatives attended the 3rd United Nations Environment Assembly of the United Nations Environment Programme (UNEA-3) from December 4-6, 2017, in Nairobi, Kenya, grouping over 4,500 delegates, including 120 ministerial-level participants from 170 countries. UNEA-3 adopted 11 resolutions calling for accelerated action and strengthened partnerships on combatting the spread of marine plastic litter and micro-plastics, the environment and health, improving air quality and controlling pollution by mainstreaming biodiversity into key sectors. Others addressed protecting water-related ecosystems, managing soil pollution to achieve sustainable development and pollution prevention and control in areas of conflict. EPD's participation forms part of the Company's strategy



*Abdullah Tawlah, Environmental Protection Department, represents the Kingdom at UNEA3. (Photo Source: IISD)*

to support the Kingdom in technical and negotiating capacities to ensure Saudi Arabia's interests remain protected in multilateral arenas. The team has successfully prevented the adoption of a Ministerial Declaration requesting to reduce pollutants through decreasing investments in fossil fuels, while supporting the adoption of a technology approach.

## EPD supports Kingdom at International Maritime Organization (IMO)

EPD representatives participated in the IMO's GHG Strategy Working Group 2nd session aimed at drafting an initial strategy text on addressing emissions to be adopted in April of 2018. Specifically, EPD sought to ward off strategies proposed by developed countries involving

market-based measures and carbon pricing elements. The IMO GHG Strategy is expected to impact global oil demand, as maritime fuel oil represents 9% of global consumption. Furthermore, IMO requirements could impact other oil markets needing to adopt new technologies to work with the shipping sector, such as heavy road transport and power stations. EPD representatives will continue working with other member states to minimize impacts from IMO strategies.

## Saudi Aramco achieves goal of planting two million mangroves

### Ron Loughland (EPD)

On November 23, 2017, EPD/PMT, representatives from the Ministry of Environment, Water and Agriculture (MEWA) conducted a site visit to Al Fura'ah north of Jubail to inspect the mangrove development site. Ministry officials were extremely impressed with the progress of the work, meeting all time lines and exceeding their expectations with the additional plantation of 300,000 mangrove seedlings initiated by EPD and implemented under the PMT Scope. The planting of these additional mangroves enabled Saudi Aramco to achieve its two million mangrove corporate target. Mangroves benefit the environment by shoring up coastlines, nurturing biodiversity and absorbing CO2 from the atmosphere.



*EPD's Raed Al Basseet speaks at a stock take session at COP23 in Bonn, Germany. (Photo Source: IISD).*

## Bonn climate change conference – COP23 outcome

### Abdullah Tawlah (EPD)

Under the leadership and guidance of H.E. Khalid Al-Falih, Minister of Energy, Industry and Mineral Resources, Saudi Aramco provided technical support to the Saudi Arabian climate change negotiations team, which successfully concluded preliminary negotiations on the implementation work program to operationalize the Paris Agreement. This program consists of a number of mandates to develop modalities and procedures to implement the Paris Agreement to be adopted by Conference of the Parties (COP 24) in December 2018. The Bonn Climate Change Conference commenced on November 6 and concluded on November 18, 2017. Under the Presidency of Fiji, the conference comprised of the 23rd Conference of the Parties (COP 23) to the United Nations Framework Convention on Climate Change (UNFCCC), the

13th Conference of the Parties to the Kyoto Protocol (CMP 13), and the Conference of the Parties to the Paris Agreement (CMA 1-2). The 47th sessions of the Subsidiary Body for Implementation (SBI 47) and Subsidiary Body for Scientific and Technological Advice (SBSTA 47), as well as the 4th Ad Hoc Working Group on the Paris Agreement (APA 1-4).

## EPD leads Kingdom marine and coastal zone management session at COP23 summit

### Umar Zahrani (EPD)

EPD, in collaboration with the Ministry of Energy, Industry and Mineral Resources (MEIM), arranged a presentation session addressing Marine & Coastal Zone Management topics at the UNFCCC COP23 climate change conference in Bonn, Germany in November 8, 2017. The venue addressed adaptation actions through marine biodiversity stewardship and environmental protection programs, including mangrove forest development and carbon sink projects and their mitigation co-benefits. Two professors from KAUST, one from Saudi Aramco and three from PERSGA led the sessions, while EPD provided coordination, technical and logistical support for the event.





enviro  
snaps

# Heat of the moment

## The Lesser Crested Tern overcomes high temperatures to successfully breed in Saudi island sands

**Abdullah Alsuhaibany, EPD**

The Lesser Crested Tern is one of four species of terns that breeds in summer months on Saudi Arabia's offshore islands in the Arabian Gulf. The terns arrive in May and begin breeding in early June every year. The terns breed in dense colonies, reaching about 14,000 pairs in some years, incubating eggs for 22-25 days. The young leave the nest shortly after hatching, and they can fly within 32-35 days.

Amazingly, the birds successfully breed during the hottest month of the year. So how do they do it, especially when sand temperatures in June along the offshore islands approach 60 degrees Celsius? At this

temperature, the egg will be cooked!

The birds manage to reduce the heat of the egg by flying to the gulf, dipping their chests into the water, and then they bring some water back to the nest in the chest feathers.

There, they shake their bodies and sprinkle the cooling waters over their nests. Within a few seconds, nests and eggs cool, and the birds repeat this activity throughout the day to keep temperatures down. The terns can gauge egg temperatures with the skin of their chests, thus maintaining temperatures between 37 and 42 C. In the end, the egg stays healthy and a new generation takes flight!





*Photo Source: Saudi Aramco*



*Photo Source: Saudi Aramco*



*Photo Source: Saudi Aramco*

