Kuwait Environmental Remediation Program (KERP): EQUIS (Environmental Quality Information System) Software Implementation

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Abstract: *In 1991, the world witnessed one of the worst environmental catastrophes in recorded history when approximately 700 Kuwaiti oil wells were destroyed and set ablaze during the conclusion of the Gulf War with Iraq. The environmental consequences were colossal. Millions of liters of liquid crude oil were released into the waters of the Arabian Gulf. The surrounding desert habitat was devastated, resulting in the destruction of native ecosystems and consequently impacting fauna and flora life in the affected areas.*

When the last of the fires were finally extinguished, Kuwait faced a dire environmental remediation challenge. Over 26 million cubic meters of soil was heavily contaminated within the oil field areas. The contamination came in several forms, including wet oil lakes, dry oil lakes, oil contaminated piles, tarcrete, wellhead pits. Moreover, in North West Kuwait along the coast line, coastal trenches were dug and filled with crude oil as well as explosive ordinance.

The necessity to restore the environment back to its pre-war state lead to the establishment of the Kuwait Environmental Remediation Program (KERP), one of the largest environmental rehabilitation programs in the world funded through the United Nations Compensation Commission (UNCC). Headed by the Kuwait National Focal Point (KNFP) in coordination with Kuwait Oil Company (KOC).

Over its lifetime, through numerous projects, KERP will identify and remediate millions of cubic meters of contaminated soils necessitating excavation and remediation works on an unprecedented scale. In order to demonstrate the successful identification and verification of the remediation works, tens of thousands of environmental samples with multiple determinants will be collected and analyzed.

Considering the vastness of the program's scope and the enormous amounts of data collection required, KOC began searching for an environmental database system that would ensure consistently high quality environmental data in a standardized format across all projects that could be appropriately stored and readily interrogated, to validate KERP meeting the United Nations requirements. After significant research and selection process of the industry leaders, Earthsoft's EQUIS was selected for this purpose.

EQUIS stands for Environmental Quality Information System and is the industry leader in advanced environmental data management and decision support systems. EQUIS, will enable KERP to track, monitor and visualize laboratory results across a wide range of matrices including soil, groundwater, air and ecological function. As referenced above, KERP will collect tens of thousands of environmental samples from the contaminated areas as part of remediation projects in the Raudhatain, Sabriyah and Greater Burgan oilfields, thus EQUIs is crucial for the way forward in KERP.EQUIS software contains three components, EQUIS Enterprise, EQUIS Professional, and EQUIS collect. EQUIS enterprises utilize the overall review purpose, which manage the data within the system. EQUIS Professional serves the purpose of data loading, editing and integrating other applications. Moreover, EQUIS collect is used on collecting all relevant data within the fields. EQUIS is utilized by managing the remediation data of existing projects within KOC. This paper mainly demonstrates EQUIS implementation process, determines the analytical tools which will allow remediation staff, contractors and risk assessors to rapidly identify the best remedial approaches. Moreover, this software will be integrated with Arc GIS software. This implementation will lead to provide better report quality for future analysis and reference.

*Keywords: Contaminated Features, EQUIS, and Environmental data.*

I. Introduction

The State of Kuwait is located in the northeast corner of the Arabian Peninsula. Kuwait is one of the smallest countries in the world in terms of land area. On 2nd August 1990, Iraqi troops invaded the State of

Kuwait. The country was liberated on 26 February 1991. After the Gulf War, over than 798 oil wells in Kuwait were ignited, causing the largest environmental and ecological disaster in its history. Approximately 20-25 million barrels of ignited crude oil were extinguished using 12 billion gallons of seawater collected in artificial pounds to control the fire. The damaged oil wells spilled crude oil across the land surface and created "Oil lakes" in low-lying land. The crude oil released had negative short-term and long-term impacts on physical characteristics of the soil, vegetation, and wildlife and threatening precious groundwater resources. These oil lakes are mostly dry oil materials, but some features still containing semi-liquid, oil/sludgy material are referred to as wet oil lakes. Today, over than 26 years, these contaminated features (~26 million cubic meters of heavily oil contaminated soils) still exist in KOC oil field areas. KOC conducted site soil sampling exercise carried out in area of the South-East Burgan and North Kuwait oil fields in different decades to define the range of the oil impacts and developed the total remediation solution under KERP.As part of environmental data management, KOC intends to implement EQUIS (Environmental Quality Information System) software to manage and maintain the environmental data for the KERP projects.The implementation of this software is to assist in data collection and verify the contamination level in the various locations in the oil contaminated areas in the oil fields. Further, this software used as a full-scale historical data migration, meaning that all data related to KERP transferred and uploaded into the EQUIS data management system and it will be utilized as under the KERP projects

II. Overview of EQUIS Software

EQUIS stands for Environmental Quality Information Systems and is a database schema for environmental data management. The platform runs on Microsoft SQL server or Microsoft Azure. Each database within EQUIS may contain one to thousands of projects. The two major components of the software's are EQUIS Enterprise and EQUIS Professional.
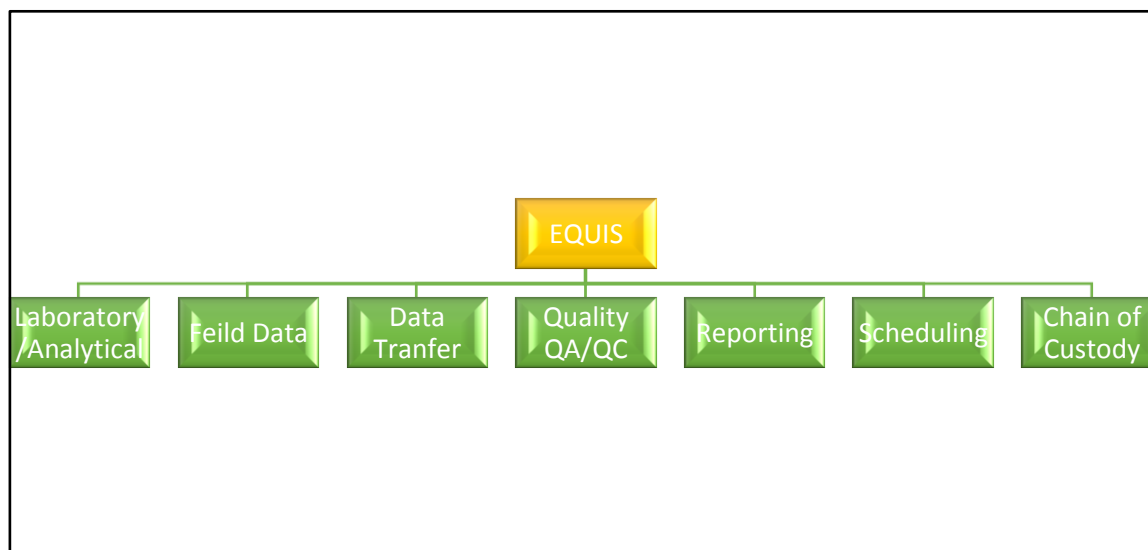
Fig.1: Environmental Quality Information System (EQUIS)

The benefits of using EQUIS on a project include the following:
❖ Management of environmental liabilities
❖ Improves data integrity and reduces costs
❖ Has the potential for workflow automation supported via Outlook, Excel and other tools
❖ Improves retention of data
❖ Improves project transitions for large workforces and new internal and external staff
❖ Lowers costs and reduces the hours to input, create and distribute information
❖ Promotes standards and consistency in data collection and reporting
❖ Allows easy monitoring of project progress and data from a central location
❖ Allows sharing of documents and data through web portals
❖ Allows potential integration of data with variety of other applications

2.1 EQUIS Enterprise

EQUIS Enterprise is a web application that is typically used by managers, auditors, executives and laboratories. EQUIS Enterprise connects to the same EQUIS database as EQUIS Professional, but provides simple, easy to use tools to view and analyse data and automate workflow. EQUIS Enterprise enables one to gain an overview of projects in highly configurable web dashboards, download and visualize data instantly and in real-time. A key benefit of the EQUIS Professional is its ability to generate reports including the creation of graphs, tabular and crosstab reports in addition to advanced, formatted and pint-ready reports.

Terminology within Enterprise;
* Facilities – The physical (site) or logical (project) extent of data made available for reporting or modelling.
* Dashboards – Dashboards are pages within an EQUIS Enterprise site that serve as containers for one or more widgets.
* Widgets – Widgets are the individual elements added to dashboards that perform
* Specific functions, such as the display of data or other system information.
* EQUIS Enterprise EDP – Performs all the same checks as either EQUIS Data Processor (EDP) Standalone or Professional EDP, but the entire process may be automated.
* EIAs – EQUIS Information Agents (EIAs) can automatically email alerts and are triggered by one of the following:
* Each time new data is submitted;
* By calendar frequency (e.g., daily, weekly, monthly) or scheduled event; and
* Action level exceedances.
* Permissions – EQUIS Enterprise includes a flexible and powerful permissions infrastructure to assign and manage user privileges for accessing tools and data within the application.

Benefits of using EQUIS Enterprise
* Web Application
* Minimize the limitation for data management
* Ease of submission
* Submit EDDs (Electronic Data Deliverable) via email, web upload, or locally on server.
* Hands-off processing
* Automated process notifies of success or errors at each key step.
(a) If appropriate, log file describing all determinable errors, listing row and column number.
(b) If no errors are found in the EDD, data is automatically imported into the database for immediate use.
* Triggered/scheduled reports
* EIA (EQUIS Information Agent) watches incoming data and automatically sends reports (new data, exceedances, etc.) via email, or ftp. Schedulenew reports as desired.

2.2   EQUIS Professional

EQUIS Professional is an application designed for power-users and data managers. It is used for data importing and editing. Furthermore, it has tools for advanced data analysis and modelling, and provides ultimate power and flexibility.

EQUIS Professional Key Terminology;

* EDDs (Electronic Data Deliverable) are electronic tabular formats for sharing manipulating and using data. Access databases, Excel spreadsheets, and tab delimited text files are all examples of EDDs.

* Sample Type – Refers to the classification of samples based on the sampling purpose and procedure

* Matrices – Describes the media from which samples are collected

* Tables – Tables contain varied of information, how data has been stored in a database.

* Analyse – The substance being analysed for or quantified by an analytical procedure. Many different names can be used to mean the same thing: Analyse, chemical, compound, constituent, contaminant, determinant, and parameter.

* CAS RN (Chemical Abstracts Service Registry Number) – The CAS RN, often referred to as the "CAS number", is a unique identifier assigned by the Chemical Abstracts Service to chemical substances. There is only one identifier per substance. The registry designation serves as a link to a wealth of information about a specific chemical substance. Data cannot be loaded without a CAS RN.

Benefits of EQUIS Professional:
❖ Easy to Deploy and Update the Application
a. Smart client application automatically checks local server for any updates, making it virtually self-deploying.
❖ Error Reduction
b. Labs and consultants can check data prior to submission using EDP (EQUIS Data Processor) Standalone.
❖ Data Quality
c. EDP checks data format, business rules, valid values. Errors are displayed in either html or text format, indicating both row and column number, along with a description of each error.

2.3 EQUIS Collect

EQUIS Collect is a mobile field application for collecting any type of data on a phone, tablet, or laptop. Forms to collect data can be created and published with EQUIS Collect. Collect software manages field data workflow through the Enterprise dashboards in addition to verifying and enforcing data quality in real time. Moreover, before any field data loading can occur, a field data form needs to be created in the system. Field data includes any water levels, well depths, TPH, pH values, temperatures, etc. these parameters were collected in the field. Typically, field forms are generated with the most recent sampling date/data from the facility.

III. EQUIS Implementation

As part of environmental data management, KOC intends to implement EQUIS (Environmental Quality Information System) software to manage and maintain the environmental data for the KERP projects [3].The main activities of KERP EQUIS implementation covered the set-up, installation andconfiguration of the KERP database, the migration of existing historical data into the database, development of projectdata management documentation, and the provision of training to KOC and KERP - Project Management Consultant (PMC) staff.The following scope of works executed simultaneously as part of implementation.
• EQUIS Implementation Kick-off Meeting
• Historical Migration
• Project Data Management Plan(PDMP)
• EQUIS Workflow Documentation
• EQUIS Configuration and Installation
• Training

3.1. Kickoff Meeting
High level conversations with PMC and KOC that outlined the overall goals and timelines of the project.

3.2 Historical Migration
EQUIS implementation began with a complete migration of all KERP historic site soil characterization data from multiple and diverse sources into a consolidated single KERP EQUIS database. Analysis was then performed on the historical data to create reference tables, mapping and loading of data.

All historical data(Limited Site Soil Characterization (LSSC-235 samples), North Kuwait Excavation and Transportation (NKET- 3040 samples), Consortium of International Consultants(CIC- 8090 samples) and South Kuwait Excavation and Transportation (SKET- 2030 samples) migrated and available in KERP EQUIS Database.

3.3 Project Data Management Plan (PDMP)
Project Data Management Plan and associated workflow diagrams were developed, which set forth the standard operating procedures for the following: sample planning, field data collection, characterization preparation and submission of data to the laboratories.

3.4 EQUISWorkflow Diagram
EQUISworkflow diagrams created to provide a visual representation of the PDMP and relates to KERP. The workflow diagrams highlight that key roles and deterministic gates for data flow to ensure the successful operating performance of EQUIS. A set of visual workflow diagrams that provideinformation for the KERP project in the sectors of planning, historical data, location, well, and surveydata, water levels and field parameters, laboratory data sample receipt confirmation, and laboratorydate certificate of analysis.
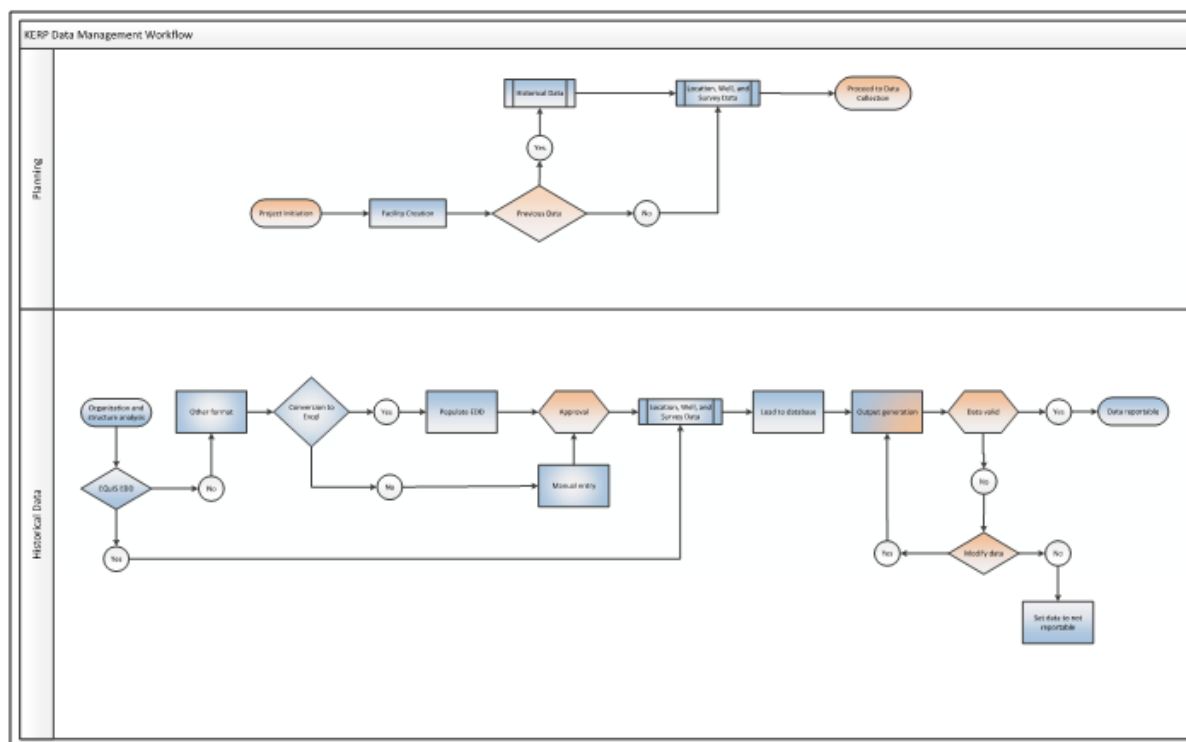
Fig.2: Data Management Workflow

3.5 EQUIS Configuration and Installation
EQUIS Configuration is the stage that applies the definitions, requirements, and procedures defined in the Project Data Management Plan (PDMP). Specifically:
- EQUIS KERP Database created and deployed to production data center
- EQUIS Enterprise instance created and deployed to Azure
- Structured Query Language (SQL) Access Roles created
- EQUIS Enterprise Roles created and connected with SQL Roles
- Reference values for matrix, location type, analytical method, fraction, and test type loaded
- Combined values from historical data and laboratory provided information
- Method Analysis Groups (MAGs) created as defined in PDMP
- Action Levels will be reviewed and loaded
- Other reference value sets, as required and appropriate, loaded
- Groups (analysis, location, facility, and others as needed) created as defined in PDMP
- Locations and coordinates will be reviewed and loaded
- Historical data loaded
- EQUIS Professional software deployed as required
- System reports configured
- EQUIS Enterprise dashboards created as prescribed within the scope

The order of focus this activity that the elements required for operation of the software and loading of data will be executed initially and then followed by data analysis and visualization. Furthermore, deployment and set up of KERP EQUIS, including set up/review of locations, coordinates, methods of analytic groups, action levels and reference values as well as configuration of reports anddashboards.

3.6 EQUIS Implementation Training
As part of the implementation of EQUIS for KERP [3], there aretraining sessions on the overall EQUIS system. The training program consisted four sessions of hands-on training for EQUIS Enterprise, two information sessionson EQUIS Professional, and finally a single session refresher on EQUIS Enterprise. These training sessions wereprovided tokey personnel with both KOC and Project Management Consultants (PMC-KERP) stafffor the proper and efficient use of the EQUIS required for the project. This training was conducted

via video conference in two-hour sessions with various sessions and training certificates were delivered to trained personnel.

IV. Conclusion

The EQUISimplementation was successfully implemented as part of Environmental data management under the KERP projects through the installation and configuration of the system, and the upload of available historical data into the database and operational system. Further, successful completion of training sessions withutilizing EQUIS Enterprises under the KERP projects.Additionally, this software implementation very useful to KERP projects and the relevant contractors to manage the environmental data, which includes soil characterisation, ground water analysis, NORM analysis etc.With all tasks of the KERP EQUIS Implementation scope of work complete, KOC is looking to the future of KERP which is scheduled to run from the summer of 2020 to the end of 2024. During this phase of KERP, KOC plans to utilize EQUIS to manage 1,200 FEED Data samples in addition to approximately 12,000 samples of contaminated soil for North Kuwait Excavation and Transportation (NKETR) project, 28,000 samples from South Kuwait Excavation and Transportation (SKETR) as well as a further 15,000 samples for the second phase of the KERP project.Finally, this software will be integrated with Arc GIS software to determine the sample locations with analysis report for the easy reference to identify the contamination level.

Acknowledgement

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