Hussein TPS Power Generation Project

Zarqa, Jordan

Environmental and Social Impact Assessment

Volume 4 – Appendices

Prepared for:

ACWA Power

April 2016

5 Capitals Environmental and Management Consulting
PO Box 119899, Sheikh Zayed Road, Dubai, UAE
Tel: +971 4 343 5955 Fax: +971 4 343 9366

Document Information

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Client	ACWA Power
Project Manager	Max Borrow
Project Director	Ken Wade

Document Control

Issue	Issue Date	Description	Author	Reviewed	Approved
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Appendices

Contents

Appendix A

Project Registration Letter and Response from MoE (Screening)

شركة محطة الزرقاء لتوليد الطاقة الكهربائية م.خ.م.

Date : 05.01.2016

Reference : Z/MoE/001

Ministry of Environment,
EIA Directorate,
Building No: 83
King Faisal bin Abdul Aziz Street
Postal Code: 11941
PO Box: 1408
Amman, Jordan

Tel: +962 556 1136

F.A.O. Mr Izzat Ahmad Salman Abu Humra, (Director, Licensing and Guidance, EIA Directorate)

SUBJECT: HUSSEIN THERMAL POWER STATION: EXPANSION PROJECT

His Excellency Minister of Environment

ACWA Power is proposing to expand the existing Hussein Thermal Power Station located in the industrial sector of Zarqa, Zarqa Governorate, Jordan, through their 100% owned "Al Zarqa Electric Power Generation PSC".

The project will be located within the current Hussein Thermal Power Station (TPS) site boundary, on land belonging to the plant. The existing plant was built in 4 stages between 1973 & 1984 and currently has a net capacity of 321 MW, operating on Heavy Fuel Oil (HFO).

The proposed combined cycle gas turbine expansion will increase operational capacity to approximately 485 MW at a higher generating efficiency. The operational fuel will be natural gas.

This letter has been prepared to notify the Ministry of Environment's EIA Directorate of the proposed expansion project and to request that the project is registered in the applicable Ministry systems.

Al Zarka would like to outline its commitment to fully undertake an EIA in line with the Jordanian EIA requirements, in order to obtain the necessary project environmental clearances.

For and on behalf of
Zarka Power Generation Co.

Yours sincerely,

Mr. Sanjiv Iyer
Authorized Signatory

نهضة

وزارة البيئة

الرقم ٤/٧/٤٦٤

التاريخ

الموافق ١٩/١/٢٠١٦

السادة شركة محطة الزرقاء لتوليد الطاقة الكهربائية م.خ.م.

الموضوع: توسعة محطة الحسين الحرارية

تحية طيبة وبعد،،

إشارة لكتابكم رقم Z/MoE/001 تاريخ 2016/1/5 بخصوص المتطلبات البيئية لمشروع توسعة محطة طاقة الحسين الحرارية الحالية في محافظة الزرقاء.

أرجو التكرم بالعلم بأن المشروع أعلاه يتطلب إجراء دراسة تقييم أثر بيئي شامل قبل البدء بأي نشاط يتعلق بالمشروع وذلك استناداً لنظام تقييم الأثر البيئي رقم 37 لسنة 2005 ،علماً بأن قائمة الجهات الاستشارية المعتمدة لاجراء دراسات تقييم الاثر البيئي مبينة على موقع الوزارة الإلكتروني: (www.moenv.gov.jo)

وتفضلوا بقبول فائق الاحترام،،،

الدكتـــــور طاهر راضي الشخشير

وزيـــــــــر البيئـــــــــة

المهندس أحمد القطارنه
الأمـين العـام

ENGLISH TRANSLATION

Date: 19/1/2016

Attn: Al Zarqa power station Company

Subject: Hussein Thermal power station expansion

Greetings,,,

Reference to your letter number Z/MoE/001 dated 5/1/2016 regarding the environmental requirements of the expansion project of Hussein existing thermal station in Al ZARQA .

Kindly be informed that the above project requires a comprehensive environmental study before taking any action related to the project based on the system of environmental impact assessment of No. 37 for the year 2005 noting that the official qualified consultant parties list to conduct environmental impact assessment studies are indicated on the ministry's website.

Dr. Taher Radi Al Shakhsheer

Environment Ministry

الجهات الاستشارية المؤهلة لعام 2015

الرقم المتسلسل	رقم التاهيل	اسم المستشار	المجال	الفئة	هاتف	فاكس	صندوق البريد
1	1	دار العمران ودار العمران للبنية التحتية والبيئة (تاهيل مشترك)	البيئة	1	5604200	5606606	
2	9	شركة بيطار مهندسون مستشارون	البيئة	1	4641884-4613198	4655390	962070/ 11196عمان
3	20	الدار العربية للهندسة	البيئة	1	5668188-5659991	5660188	8049 / 11121عمان
4	29	شركة سيجما مهندسون مستشارون	البيئة	1	5661031-5662612	5678320	1118 الرمز/20076
5	38	شركة ارابتك جردانه مهندسون ومعماريون	البيئة	1	5857167	5824532	9532 /11191
6	39	شركة المستشار للهندسة	البيئة	1	4602120	4602130	926963/ 11190
7	42	شركة اتحاد المستشارين للهندسة والبيئة	البيئة	1	4612377	4612380	11183 الرمز/830746
8	129	مكتب الشامل للهندسة	البيئة	1	5347516	5333585	1075 /11941الجبيهة
9	147	الاتجاهات الجديدة للاستشارات (ECO Consult)	البيئة	1	0797681010 5699769	5697264	941400/ 11194
10	157	الروابي لاستشارات البيئة والطاقة	البيئة	1	5347332-0777425839	5347332	11814/140011
11	162	شركة دار العمران للبنية التحتية والبيئة - مهندسون مستشارون	البيئة	1	5681000	5690057	942365-11194

الجهات الاستشارية المؤهلة لعام 2015

الرقم المتسلسل	رقم التاهيل	اسم المستشار	المجال	الفئة	هاتف	فاكس	صندوق البريد
12	170	المستدامه لحلول البيئة والطاقة	البيئة	1	5339446-0797718090	5339776	830690-11183
13	175	شركة المستقبل للاستشارات الهندسية والبيئية	البيئة	1	065662783-5663611	065923601	2084-11821
14	140	شركة سبيل الهندسه	البيئة	2	5371019-5371018	5371022	143182/ 11814
15	174	حمى لاستشارات البيئة والإدارة	البيئة	2	0799901061-4721230	4721230	140011-11814
16	-	الجمعية العلمية الملكية	اعتماد الوزارة	-	5344701	5344806	
17	-	جامعة البلقاء التطبيقية	اعتماد الوزارة	-	05-3491111	05-3532312	
18	-	مركز الملكة رانيا العبدالله – جامعة العلوم والتكنولوجيا الاردنية	اعتماد الوزارة	-	02 - 7201000	02-7201076	
19	-	مركز الدراسات البيئية – الجامعة الهاشمية	اعتماد الوزارة	-	053903333 فرعي /4163 فرعي /41912	053826870 5344806	
20	-	مركز المياه والطاقة والبيئة – الجامعة الاردنية	اعتماد الوزارة	-	5355000 فرعي 21120	5355511 فرعي 21035 5300803	الجامعة الاردنية 11942

Appendix B

Environmental Scoping Study – MoE Approval Letter

وزارة البيئة

نهضة

الرقم ٢/٢٢٤/ECS

التاريخ

الموافق ٢٠١٥/٣/٢٤

السادة مكتب الاتجاهات الجديدة للإستشارات

تحية طيبة وبعد ،،

إشارة لكتابكم رقم ECS-06-16/ وزارة البيئة/2/224 تاريخ 2015/3/14 ومرفقه تقرير الأسس المرجعية لدراسة تقييم الأثر البيئي لمشروع توسعة محطة الحسين الحرارية الحالية في محافظة الزرقاء.

أوافق على الأسس المرجعية لدراسة المشروع أعلاه شريطة أن يتم اجراء القياسات المرجعية للضجيج لمدة ساعة خلال فترة النهار وساعة خلال فترة الليل ولمدة ثلاثة أيام متواصلة مع الأخذ بعين الإعتبار عدم وجود مصادر ضجيج خارجية بالقرب من مواقع المراقبة المحددة في التقرير وذلك استناداً إلى توصية اللجنة الفنية لمراجعة دراسات تقييم الأثر البيئي للمشاريع.

وتفضلوا بقبول فائق الإحترام ،،،

الدكتور طاهر راضي الشخشير

وزيـــــــر البيئـــــــة

المهندس أحمد القطارنة

الأمين العام

ENGLISH TRANSLATION

Ministry of the Environment

No. 4/7/208
Date: ….....
Corresponding to: …….

To: New Directions Consulting Co.

After greetings,

With reference to your letter no ECS-06-16/Ministry of the Environment/224/2, on 14/3/2015, to which the terms of reference report of the environmental impact study for the exiting thermal plant extension project in Zarqa Governorate is attach,

I declare approving the terms of reference for the above project study, provided that noise reference measurements are taken for one-hour during the day and one-hour at night, for three consecutive days, while taking into consideration that no external nose sources are existing nearby the monitoring locations defined in the report. This is based upon the recommendation of the technical committee that projects' environmental impact studies must be revised.

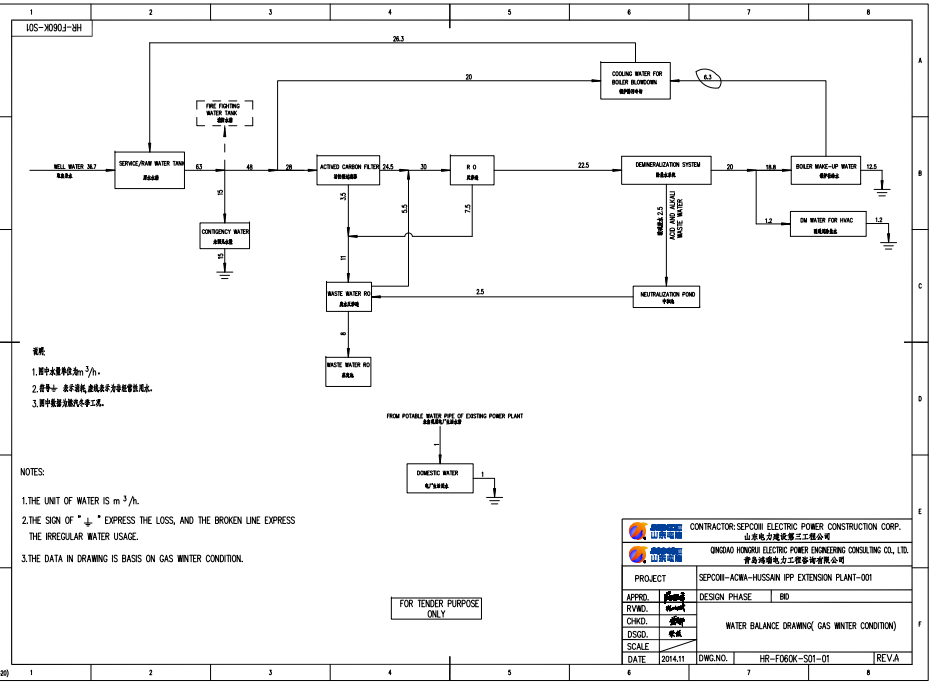
Best regards,

Dr. Tahir Radi Shakhshir
(Signature)
Minister of the Environment

(Seal [Eng. Ahmed Qatarneh - Secretary-General])

Appendix C

Water Balance Diagrams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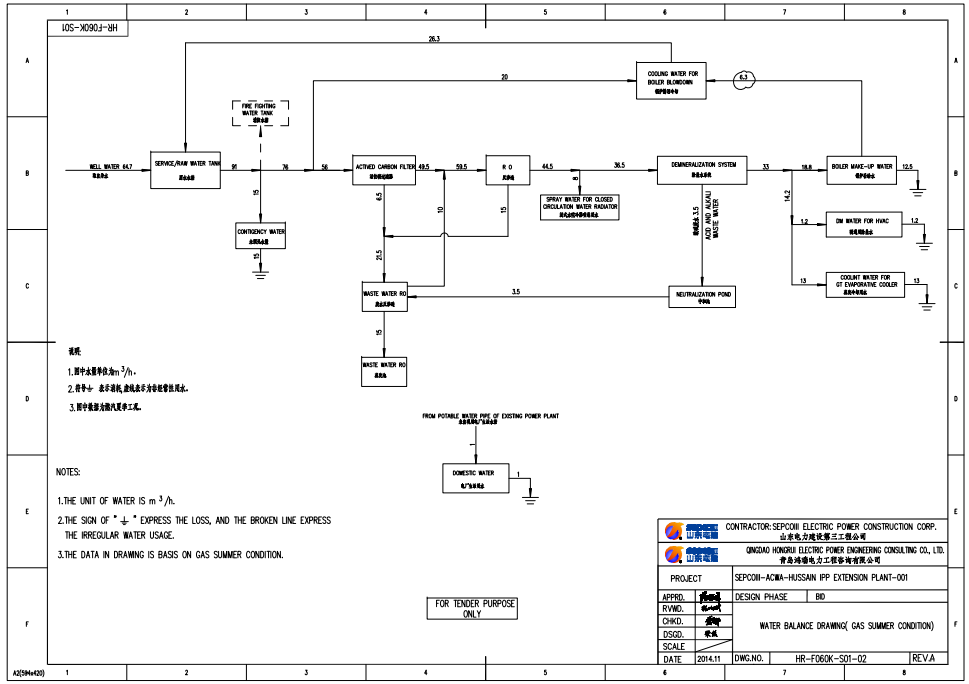
20
COOLING WATER FOR BOILER BLOWDOWN
6.3
FIRE FIGHTING WATER TANK
WELL WATER 36.7
SERVICE/RAW WATER TANK
63
48
28
ACTIVED CARBON FILTER
24.5
30
R O
22.5
DEMINERALIZATION SYSTEM
20
18.8
BOILER MAKE-UP WATER
12.5
CONTIGENCY WATER
15
3.5
6.5
7.5
11
DM WATER FOR HVAC
1.2
1.2
ACID AND ALKALI WASTE WATER
2.5
WASTE WATER RO
2.5
NEUTRALIZATION POND
8
WASTE WATER RO
FROM POTABLE WATER PIPE OF EXISTING POWER PLANT
DOMESTIC WATER
1
说明:
1.图中水量单位为m³/h.
2.符号 表示损耗,虚线表示为非经常性用水.
3.图中数据为燃汽轮单工况.
NOTES:
1.THE UNIT OF WATER IS m ³/h.
2.THE SIGN OF " " EXPRESS THE LOSS, AND THE BROKEN LINE EXPRESS THE IRREGULAR WATER USAGE.
3.THE DATA IN DRAWING IS BASIS ON GAS WINTER CONDITION.
FOR TENDER PURPOSE ONLY
CONTRACTOR:SEPCOIII ELECTRIC POWER CONSTRUCTION CORP.
山东电力建设第三工程公司
QINGDAO HONGRUI ELECTRIC POWER ENGINEERING CONSULTING CO., LTD.
青岛鸿瑞电力工程咨询有限公司
PROJECT
SEPCOIII-ACWA-HUSSAIN IPP EXTENSION PLANT-001
APPRD.
RVWD.
CHKD.
DSGD.
SCALE
DESIGN PHASE
BID
WATER BALANCE DRAWING(GAS WINTER CONDITION)
DATE
2014.11
DWG.NO.
HR-F060K-S01-01
REV.A
A2(594x420)


HR-F060K-S01
26.3
20
COOLING WATER FOR BOILER BLOWDOWN
6.3
FIRE FIGHTING WATER TANK
WELL WATER 64.7
SERVICE/RAW WATER TANK
91
76
56
ACTIVED CARBON FILTER
49.5
59.5
R O
44.5
36.5
DEMINERALIZATION SYSTEM
33
18.8
BOILER MAKE-UP WATER
12.5
SPRAY WATER FOR CLOSED CIRCULATION WATER RADIATOR
40
CONTIGENCY WATER
15
4.5
10
15
14.2
DM WATER FOR HVAC
1.2
1.2
ACID AND ALKALI WASTE WATER
3.5
24.5
COOLANT WATER FOR GT EVAPORATIVE COOLER
13
13
WASTE WATER RO
3.5
NEUTRALIZATION POND
15
WASTE WATER RO
FROM POTABLE WATER PIPE OF EXISTING POWER PLANT
DOMESTIC WATER
1
说明:
1.图中水量单位为m³/h.
2.符号 表示损耗,虚线表示为非经常性用水.
3.图中数据为燃汽夏季工况.
NOTES:
1.THE UNIT OF WATER IS m ³/h.
2.THE SIGN OF " " EXPRESS THE LOSS, AND THE BROKEN LINE EXPRESS THE IRREGULAR WATER USAGE.
3.THE DATA IN DRAWING IS BASIS ON GAS SUMMER CONDITION.
FOR TENDER PURPOSE ONLY
CONTRACTOR:SEPCOIII ELECTRIC POWER CONSTRUCTION CORP.
山东电力建设第三工程公司
QINGDAO HONGRUI ELECTRIC POWER ENGINEERING CONSULTING CO., LTD.
青岛鸿瑞电力工程咨询有限公司
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SEPCOIII-ACWA-HUSSAIN IPP EXTENSION PLANT-001
APPRD.
RVWD.
CHKD.
DSGD.
SCALE
DESIGN PHASE
BID
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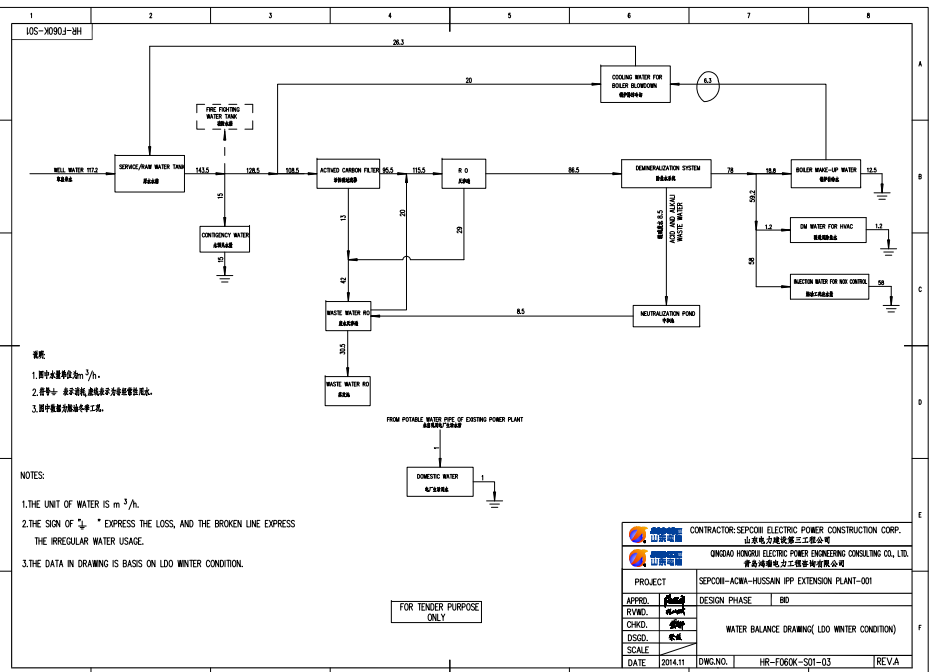
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26.3
20
COOLING WATER FOR BOILER BLOWDOWN
6.3
FIRE FIGHTING WATER TANK
WELL WATER 117.2
SERVICE/RAW WATER TANK
143.5
128.5
108.5
ACTIVED CARBON FILTER
95.5
115.5
R O
86.5
DEMINERALIZATION SYSTEM
78
18.8
BOILER MAKE-UP WATER
12.5
CONTIGENCY WATER
15
13
20
29
39.2
DM WATER FOR HVAC
1.2
1.2
ACID AND ALKALI WASTE WATER
8.5
42
56
INJECTION WATER FOR NOX CONTROL
58
WASTE WATER RO
8.5
NEUTRALIZATION POND
30.5
WASTE WATER RO
FROM POTABLE WATER PIPE OF EXISTING POWER PLANT
DOMESTIC WATER
1
说明:
1.图中水量单位为m³/h.
2.符号 表示损耗,虚线表示为非经常性用水.
3.图中数据为燃油冬季工况.
NOTES:
1.THE UNIT OF WATER IS m ³/h.
2.THE SIGN OF " " EXPRESS THE LOSS, AND THE BROKEN LINE EXPRESS THE IRREGULAR WATER USAGE.
3.THE DATA IN DRAWING IS BASIS ON LDO WINTER CONDITION.
FOR TENDER PURPOSE ONLY
CONTRACTOR:SEPCOIII ELECTRIC POWER CONSTRUCTION CORP.
山东电力建设第三工程公司
QINGDAO HONGRUI ELECTRIC POWER ENGINEERING CONSULTING CO., LTD.
青岛鸿瑞电力工程咨询有限公司
PROJECT
SEPCOIII-ACWA-HUSSAIN IPP EXTENSION PLANT-001
APPRD.
RVWD.
CHKD.
DSGD.
SCALE
DESIGN PHASE
BID
WATER BALANCE DRAWING(LDO WINTER CONDITION)
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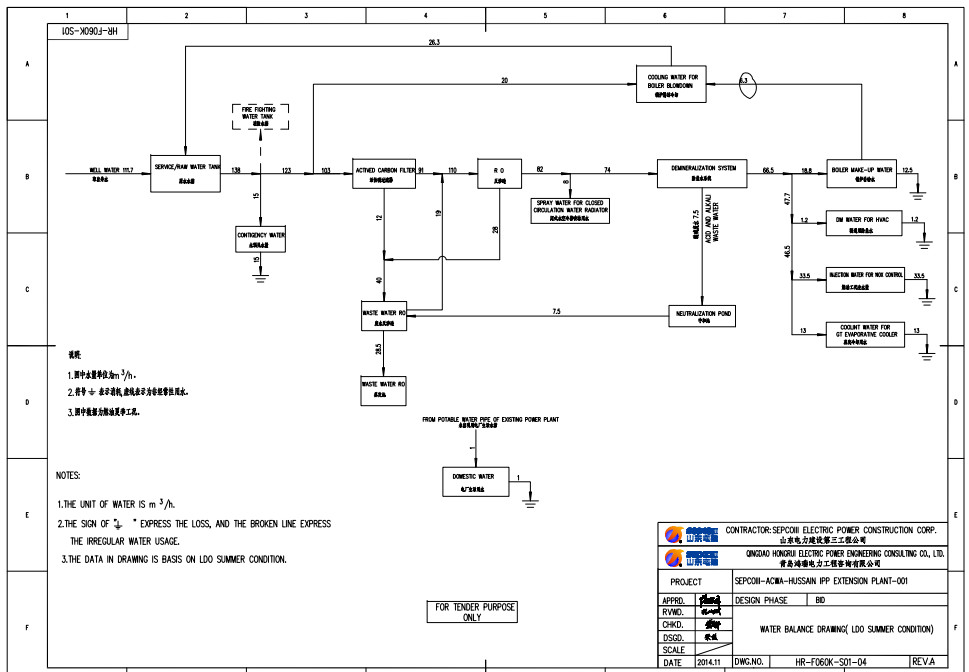
HR-F060K-S01
26.3
20
COOLING WATER FOR BOILER BLOWDOWN
6.3
FIRE FIGHTING WATER TANK
WELL WATER 111.7
SERVICE/RAW WATER TANK
138
123
103
ACTIVED CARBON FILTER
91
110
R O
82
74
DEMINERALIZATION SYSTEM
66.5
18.8
BOILER MAKE-UP WATER
12.5
SPRAY WATER FOR CLOSED CIRCULATION WATER RADIATOR
40
CONTIGENCY WATER
15
12
19
28
47.7
DM WATER FOR HVAC
1.2
1.2
ACID AND ALKALI WASTE WATER
7.5
40
46.5
INJECTION WATER FOR NOX CONTROL
33.5
33.5
WASTE WATER RO
7.5
NEUTRALIZATION POND
30.5
WASTE WATER RO
13
COOLANT WATER FOR GT EVAPORATIVE COOLER
13
FROM POTABLE WATER PIPE OF EXISTING POWER PLANT
DOMESTIC WATER
1
说明:
1.图中水量单位为m³/h.
2.符号 表示损耗,虚线表示为非经常性用水.
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SEPCOIII-ACWA-HUSSAIN IPP EXTENSION PLANT-001
APPRD.
RVWD.
CHKD.
DSGD.
SCALE
DESIGN PHASE
BID
WATER BALANCE DRAWING(LDO SUMMER CONDITION)
DATE
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REV.A
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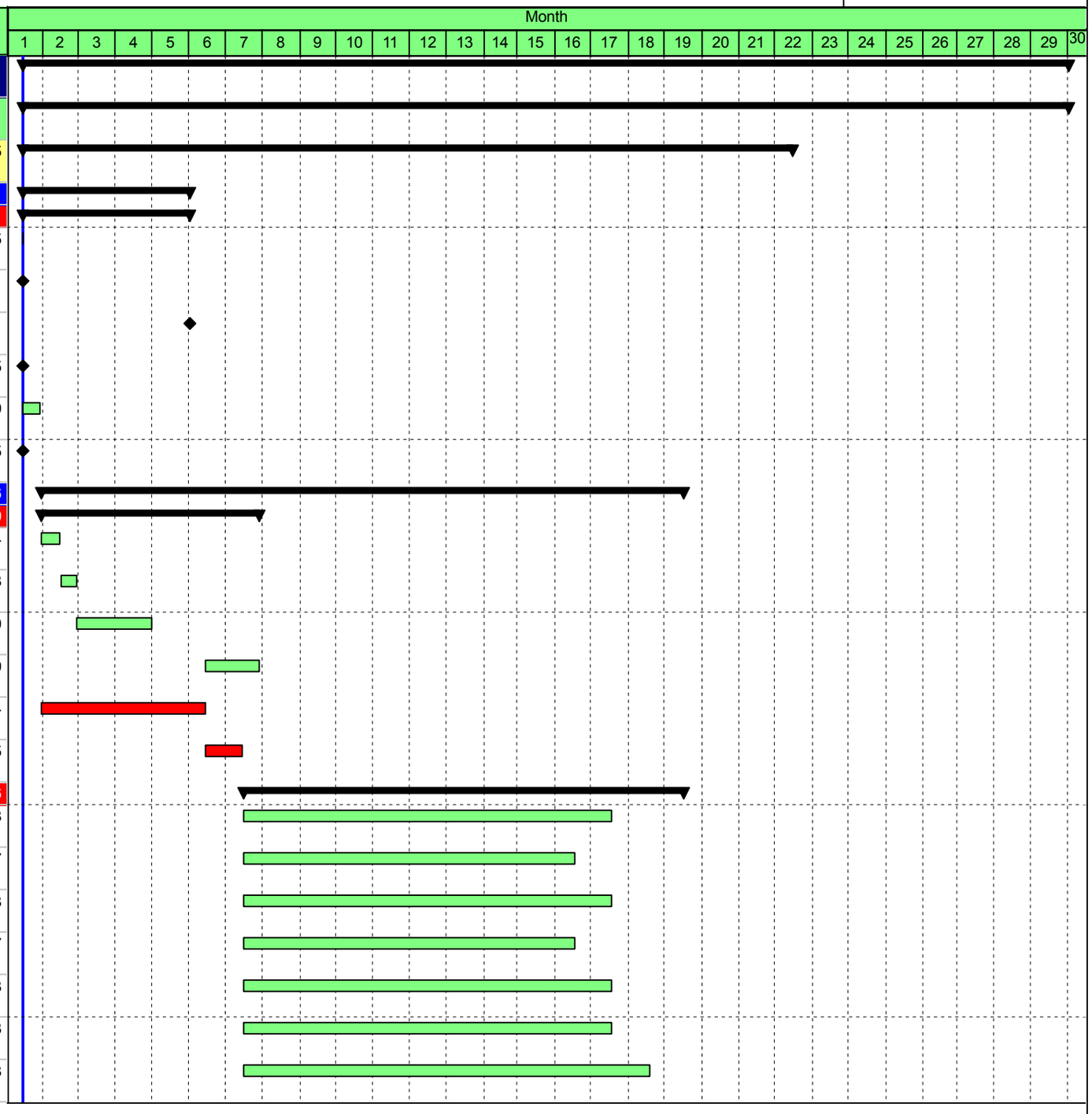
Appendix D

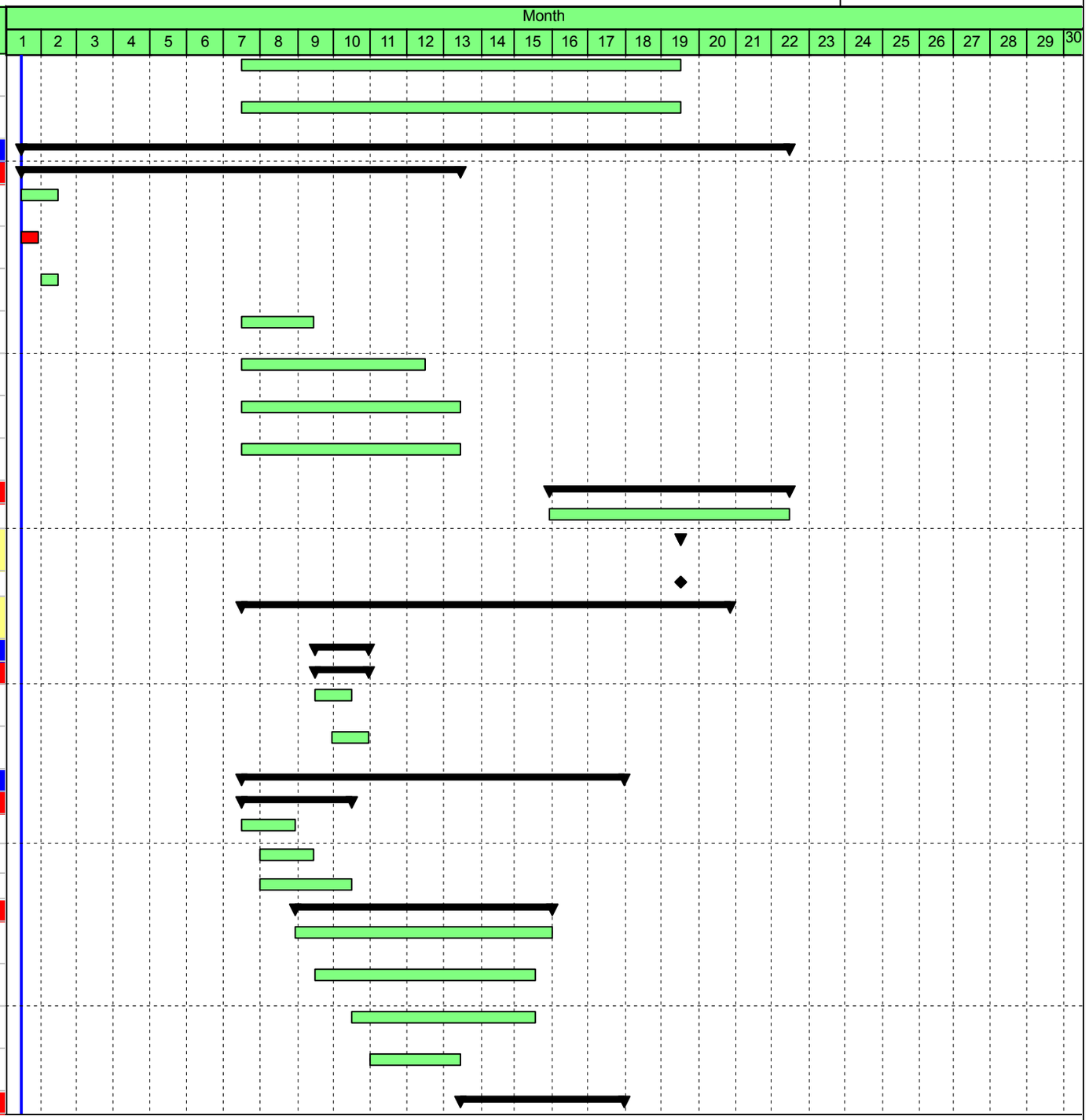
Construction Programme

Activity ID	Activity Name	Start	Finish
Milestone schedule for Hussain Project		2016-01-15	2018-06-01
Block 10		2016-01-15	2018-06-01
General		2016-01-15	2017-10-15
General		2016-01-15	2016-06-01
General		2016-01-15	2016-06-01
10GEGE1000	EPC contract signed	2016-01-15	2016-01-15
10GEGE1020	LNTP issued	2016-01-15	
10GEGE1025	Notice To Proceed issued	2016-06-01	
10GEGE1030	All land released for construction handed-over		2016-01-15
10GEGE1040	Personnel mobilization to site	2016-01-15	2016-01-29
10GEGE1050	Construction water and power interface provided		2016-01-15
Engineering		2016-01-30	2017-07-16
Basic design		2016-01-30	2016-07-29
10GEEB1000	The Proposal of Geo-techtial investigation	2016-01-30	2016-02-14
10GEEB1010	Geo-technical investigation preparation	2016-02-15	2016-02-28
10GEEB1020	GT building preliminery geo-technical investigation and report	2016-02-29	2016-04-30
10GEEB1040	Detailed geo-technical investigation report	2016-06-15	2016-07-29
10GEEB1070	Basic design	2016-01-30	2016-06-14
10GEEB1080	Basic design reviewed by Owner	2016-06-15	2016-07-15
Detailed design		2016-07-16	2017-07-16
10GEED1000	Detailed design of general plan drawings	2016-07-16	2017-05-18
10GEED1010	Detailed design of civil structure drawings	2016-07-16	2017-04-17
10GEED1020	Detailed design of architecture drawings	2016-07-16	2017-05-18
10GEED1030	Detailed design of hydraulic structure drawings	2016-07-16	2017-04-17
10GEED1040	Detailed design of water supply drawings	2016-07-16	2017-05-18
10GEED1050	Detailed design of chemical drawings	2016-07-16	2017-05-18
10GEED1060	Detailed design of mechanical drawings	2016-07-16	2017-06-18



Remaining Level of Effort · Actual Work · Critical Remaining Work · Summary · WBS Summary Progress
Actual Level of Effort · Remaining Work · Milestone · WBS Summary Activity

Activity ID	Activity Name	Start	Finish
10GEED1070	Detailed design of electric drawings	2016-07-16	2017-07-16
10GEED1080	Detailed design of I&C drawings	2016-07-16	2017-07-16
Procurement		2016-01-15	2017-10-15
Purchase		2016-01-15	2017-01-14
10GEPP1000	Bidding work of HRSG & Turbine & Generator	2016-01-15	2016-02-14
10GEPP1010	Bidding work of Designing Institute	2016-01-15	2016-01-29
10GEPP1020	Bidding work of Geo-techtial investigation sub-contractor	2016-01-31	2016-02-14
10GEPP1030	Bidding work of BTG auxiliary equipment	2016-07-16	2016-09-14
10GEPP1050	Bidding work of chemical system	2016-07-16	2016-12-16
10GEPP1060	Bidding work of electric system	2016-07-16	2017-01-14
10GEPP1070	Bidding work of I&C system	2016-07-16	2017-01-14
Delivery		2017-03-30	2017-10-15
10GEPD1000	Delivery of main equipments on site	2017-03-30	2017-10-15
Switch yard		2017-07-16	2017-07-16
YA0101	Switch yard and transmission line available（Owner scope）		2017-07-16
Auxiliary power system		2016-07-16	2017-08-27
Engineering		2016-09-15	2016-10-30
Detailed design		2016-09-15	2016-10-30
10BAED1010	Engineering / Approval of The foundation drawings of Switchgear Building	2016-09-15	2016-10-15
10BAED1020	Engineering / Approval of The structure drawings of Switchgear Building	2016-09-30	2016-10-30
Procurement		2016-07-16	2017-05-30
Purchase		2016-07-16	2016-10-15
10BAPP1000	Bidding of GTT/UT	2016-07-16	2016-08-29
10BAPP1010	Bidding of HV switchgear	2016-07-31	2016-09-14
10BAPP1020	Bidding of LV switchgear	2016-07-31	2016-10-15
Manufacture		2016-08-30	2017-03-31
10BAPM1000	Manufacture of GTT/UT	2016-08-30	2017-03-31
10BAPM1010	Manufacture of HV switchgear	2016-09-15	2017-03-17
10BAPM1020	Manufacture of LV switchgear	2016-10-16	2017-03-17
10BAPM1030	Manufacture of steel structure for Switchgear Building	2016-10-31	2017-01-14
Delivery		2017-01-15	2017-05-30



Remaining Level of Effort | Actual Work | Critical Remaining Work | Summary | WBS Summary Progress
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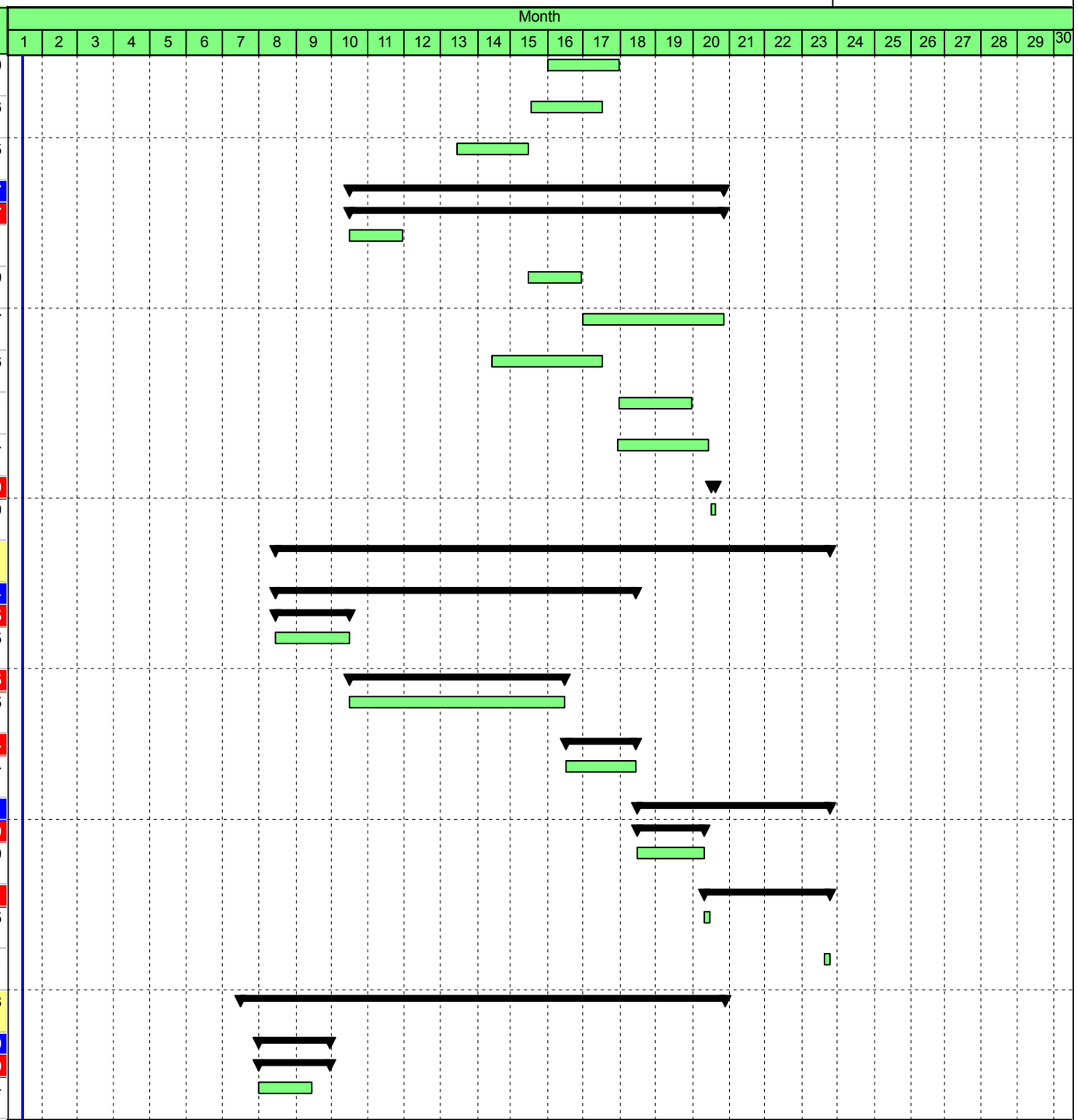
Activity ID	Activity Name	Start	Finish
10BAPD1000	Delivery of GT/UT	2017-04-01	2017-05-30
10BAPD1010	Delivery of HV/LV switchgear	2017-03-18	2017-05-16
10BAPD1020	Delivery of steel structure for Switchgear Building	2017-01-15	2017-03-15
Construction & Commissioning		2016-10-16	2017-08-27
Construction		2016-10-16	2017-08-27
10BACS1010	Foundation works of Switchgear Building	2016-10-16	2016-11-29
10BACS1020	Structur works of Switchgear Building	2017-03-16	2017-04-29
10BACS1030	Architecture works of Switchgear Building	2017-04-30	2017-08-27
10BACS1040	Foundation works of GT/UT	2017-02-13	2017-05-16
10BACS1060	Installation works of GT/UT	2017-05-31	2017-07-31
10BACS1070	Installation works of Switchgear Building（for SC part）	2017-05-30	2017-08-14
Commissioning		2017-08-16	2017-08-20
10BACM1000	Back energizing to GT11 HV/LV switchgear	2017-08-16	2017-08-20
I&C system		2016-08-15	2017-11-24
Procurement		2016-08-15	2017-06-14
Purchase		2016-08-15	2016-10-15
10CAPP1000	Bidding of DCS equipment	2016-08-15	2016-10-15
Manufacture		2016-10-16	2017-04-15
10CAPM1010	Manufacture of DCS equipment	2016-10-16	2017-04-15
Delivery		2017-04-16	2017-06-14
10CAPD1010	Delivery of DCS equipment	2017-04-16	2017-06-14
Construction & Commissioning		2017-06-15	2017-11-24
Construction		2017-06-15	2017-08-10
10CACS1040	DCS equipment (for SC part) installation	2017-06-15	2017-08-10
Commissioning		2017-08-11	2017-11-24
10CACM1000	DCS (for SC part) energized	2017-08-11	2017-08-15
10CACM1010	DCS (for CC part) energized	2017-11-20	2017-11-24
LDO system		2016-07-16	2017-08-28
Engineering		2016-07-31	2016-09-29
Detailed design		2016-07-31	2016-09-29
10EGED1010	Engineering / Approval of The foundation drawings of Fuel oil tank	2016-07-31	2016-09-14



Remaining Level of Effort | Actual Work | Critical Remaining Work | Summary | WBS Summary Progress
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Activity ID	Activity Name	Start	Finish
10EGED1020	Engineering / Approval of The structure drawings of Fuel oil pump house	2016-07-31	2016-09-29
Procurement		2016-07-16	2017-04-15
Purchase		2016-07-16	2016-07-30
10EGPP1000	Bidding of Fuel oil pump house	2016-07-16	2016-07-30
Manufacture		2016-09-30	2017-02-14
10EGPM1010	Manufacture of Fuel oil pump house equipment	2016-09-30	2017-02-14
Delivery		2017-02-15	2017-04-15
10EGPD1010	Delivery of Fuel oil pump house equipment	2017-02-15	2017-04-15
Construction & Commissioning		2016-09-15	2017-08-28
Construction		2016-09-15	2017-08-13
10EGCS1010	Foundation works of Fuel oil pump house	2016-09-30	2016-11-13
10EGCS1020	Structure works of Fuel oil pump house	2016-11-14	2017-02-14
10EGCS1030	Architecture works of Fuel oil pump house	2017-02-15	2017-05-31
10EGCS1040	Foundation works of LDO tank	2016-09-15	2017-01-12
10EGCS1050	Installation of LDO tank	2017-01-13	2017-07-16
10EGCS1060	Installation works of Fuel oil pump house equipment	2017-04-16	2017-08-13
Commissioning		2017-07-28	2017-08-28
10EGCM1010	LDO available（Owner scope）		2017-07-28
10EGCM1020	Commissioning of Fuel oil pump house	2017-08-14	2017-08-28
Fuel Gas treatment station		2016-07-16	2017-08-27
Engineering		2016-08-15	2016-10-15
Detailed design		2016-08-15	2016-10-15
10EKED1010	Engineering / Approval of The foundation drawings of Fuel Gas treatment station	2016-08-15	2016-09-29
10EKED1020	Engineering / Approval of The structure drawings of Fuel Gas treatment station	2016-08-15	2016-10-15
Procurement		2016-07-16	2017-03-17
Purchase		2016-07-16	2016-08-14
10EKPP1000	Bidding of Fuel Gas treatment station	2016-07-16	2016-08-14
Manufacture		2016-10-14	2017-01-14

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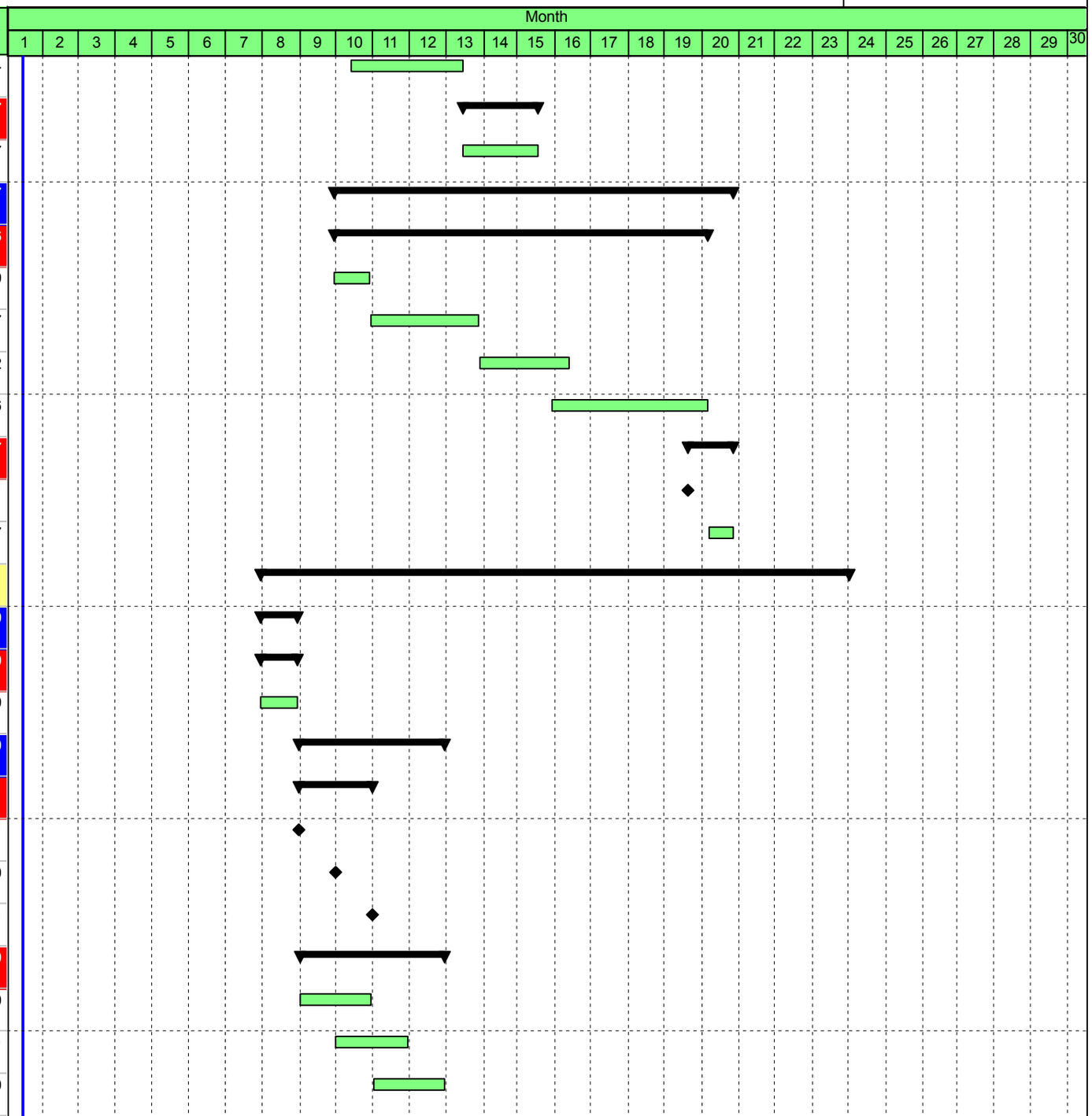
Activity ID	Activity Name	Start	Finish
10EKPM1010	Manufacture of Fuel Gas treatment station equipment	2016-10-14	2017-01-14
Delivery		2017-01-15	2017-03-17
10EKPD1010	Delivery of Fuel Gas treatment station equipment	2017-01-15	2017-03-17
Construction & Commissioning		2016-09-30	2017-08-27
Construction		2016-09-30	2017-08-06
10EKCS1010	Foundation works of Fuel Gas treatment station plant	2016-09-30	2016-10-29
10EKCS1020	Structure works of Fuel Gas treatment station plant	2016-10-30	2017-01-27
10EKCS1030	Architecture works of Fuel Gas treatment station plant	2017-01-28	2017-04-12
10EKCS1040	Installation works of Fuel Gas treatment station	2017-03-29	2017-08-06
Commissioning		2017-07-21	2017-08-27
10EKCM1000	Gas available （Owner scope）		2017-07-21
10EKCM1010	Commissioning of Fuel Gas treatment station	2017-08-07	2017-08-27
GT11 / 12 /13		2016-07-30	2017-12-01
Engineering		2016-07-30	2016-08-29
Detailed design		2016-07-30	2016-08-29
10MBED1010	Engineering / Approval of The foundation drawings of GT	2016-07-30	2016-08-29
Procurement		2016-08-31	2016-12-30
Manufacture		2016-08-31	2016-10-31
11MBPM1000	GT11 Ex-work		2016-08-31
12MBPM1000	GT12 Ex-work		2016-09-30
13MBPM1000	GT13 Ex-work		2016-10-31
Delivery		2016-09-01	2016-12-30
11MBPD1000	Delivery of GT11	2016-09-01	2016-10-30
12MBPD1000	Delivery of GT12	2016-10-01	2016-11-29
13MBPD1000	Delivery of GT13	2016-11-01	2016-12-30



Remaining Level of Effort | Actual Work | Critical Remaining Work | Summary | WBS Summary Progress
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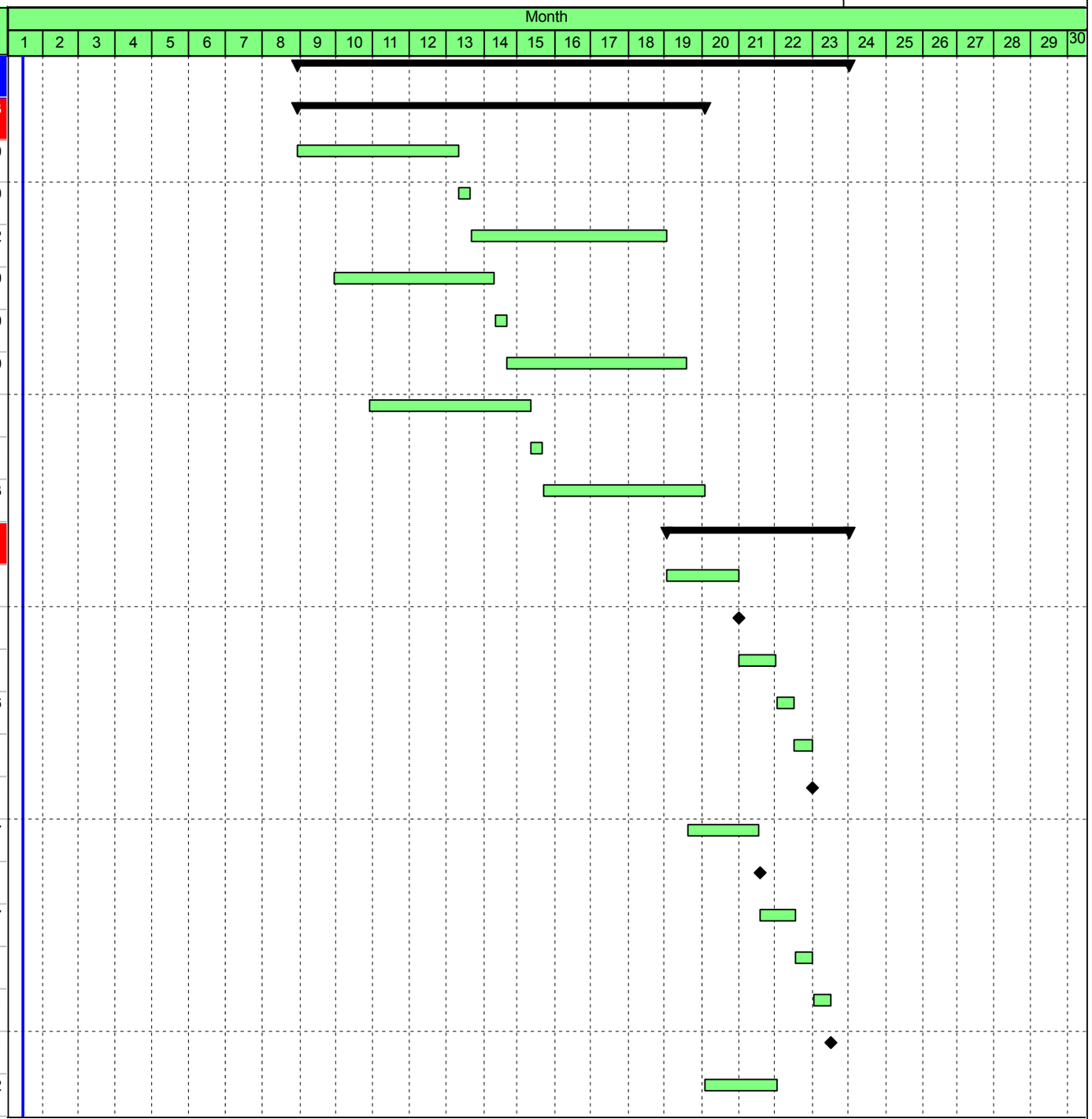
Activity ID	Activity Name	Start	Finish
Construction & Commissioning		2016-08-30	2017-12-01
Construction		2016-08-30	2017-08-03
11MBCS1010	Foundation works of GT11	2016-08-30	2017-01-10
11MBCS1020	Placing of GT11	2017-01-11	2017-01-20
11MBCS1030	Erection works of GT11	2017-01-21	2017-07-02
12MBCS1010	Foundation works of GT12	2016-09-29	2017-02-09
12MBCS1020	Placing of GT12	2017-02-10	2017-02-19
12MBCS1030	Erection works of GT12	2017-02-20	2017-07-19
13MBCS1010	Foundation works of GT13	2016-10-29	2017-03-11
13MBCS1020	Placing of GT13	2017-03-12	2017-03-21
13MBCS1030	Erection works of GT13	2017-03-22	2017-08-03
Commissioning		2017-07-03	2017-12-01
11MBCM1000	Oil flushing & Cold Commissionning of GT11	2017-07-03	2017-08-31
11MBCM1010	First Fire of GT11	2017-09-01	
11MBCM1020	Hot Commissionning of GT11	2017-09-01	2017-10-01
11MBCM1030	Reliability Run of GT11	2017-10-02	2017-10-16
11MBCM1040	Performance Test of GT11	2017-10-17	2017-10-31
11MBCM1050	Put into commercial operationof GT11		2017-10-31
12MBCM1000	Oil flushing & Cold Commissionning of GT12	2017-07-20	2017-09-17
12MBCM1010	First Fire of GT12	2017-09-18	
12MBCM1020	Hot Commissionning of GT12	2017-09-18	2017-10-17
12MBCM1030	Reliability Run of GT12	2017-10-18	2017-11-01
12MBCM1040	Performance Test of GT12	2017-11-02	2017-11-16
12MBCM1050	Put into commercial operationof GT12		2017-11-16
13MBCM1000	Oil flushing & Cold Commissionning of GT13	2017-08-04	2017-10-02



Remaining Level of Effort | Actual Work | Critical Remaining Work | Summary | WBS Summary Progress
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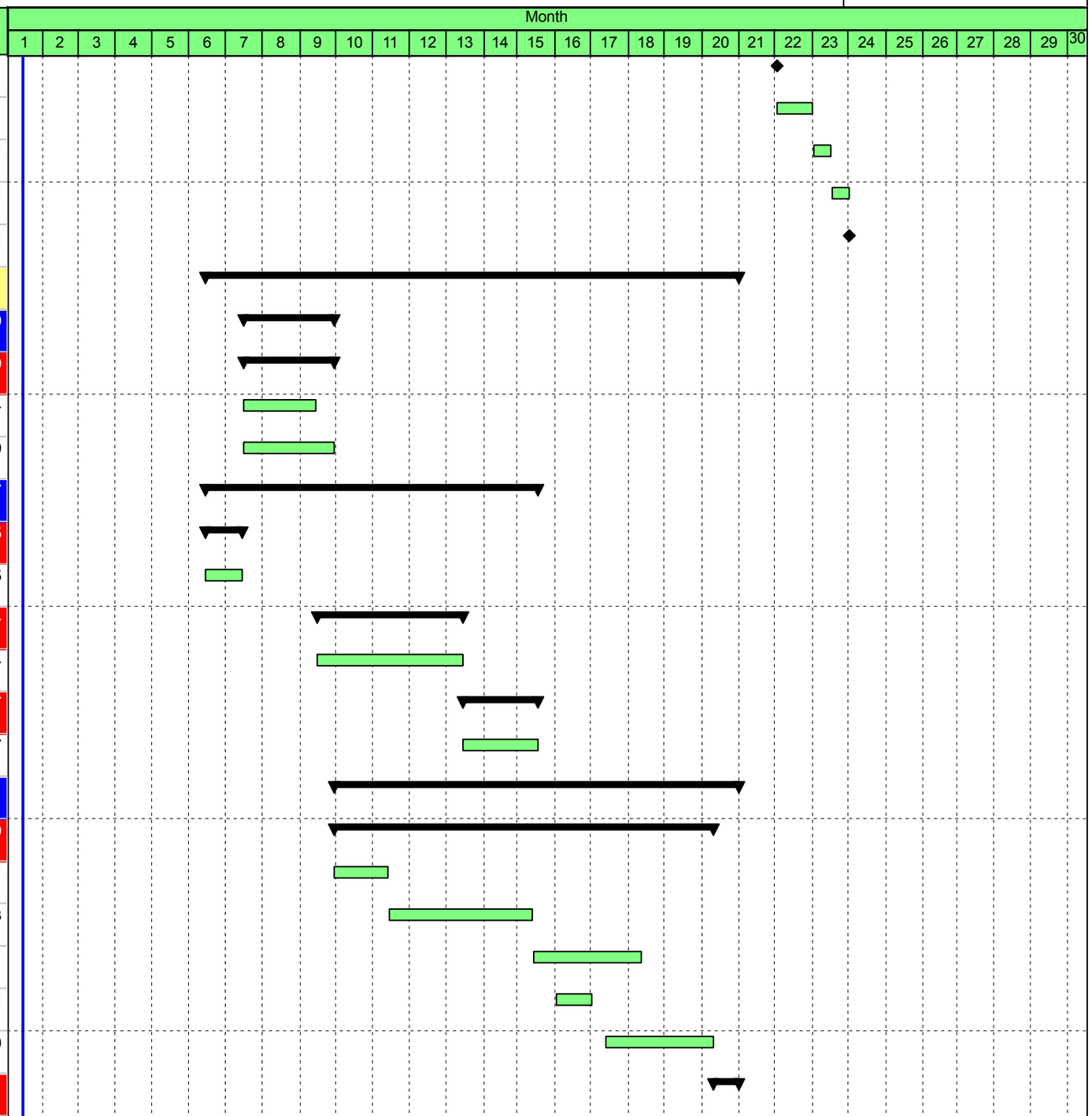
Activity ID	Activity Name	Start	Finish
13MBCM1010	First Fire of GT13	2017-10-03	
13MBCM1020	Hot Commissionning of GT13	2017-10-03	2017-11-01
13MBCM1030	Reliability Run of GT13	2017-11-02	2017-11-16
13MBCM1040	Performance Test of GT13	2017-11-17	2017-12-01
13MBCM1050	Put into commercial operationof GT13		2017-12-01
Demineralized water system		2016-06-15	2017-08-31
Engineering		2016-07-16	2016-09-29
Detailed design		2016-07-16	2016-09-29
10GCED1010	Engineering / Approval of The foundation drawings of Demineralized water plant	2016-07-16	2016-09-14
10GCED1020	Engineering / Approval of The structure drawings of Demineralized water plant	2016-07-16	2016-09-29
Procurement		2016-06-15	2017-03-17
Purchase		2016-06-15	2016-07-15
10GCPP1000	Bidding of Demineralized water plant	2016-06-15	2016-07-15
Manufacture		2016-09-15	2017-01-14
10GCPM1010	Manufacture of Demineralized water plant equipment	2016-09-15	2017-01-14
Delivery		2017-01-15	2017-03-17
10GCPD1010	Delivery of Demineralized water plant equipment	2017-01-15	2017-03-17
Construction & Commissioning		2016-09-30	2017-08-31
Construction		2016-09-30	2017-08-10
10GCCS1010	Foundation works of Demineralized water plant	2016-09-30	2016-11-13
10GCCS1020	Structure works of Demineralized water plant	2016-11-14	2017-03-13
10GCCS1030	Architecture works of Demineralized water plant	2017-03-14	2017-06-11
10GCCS1040	Placing of Demineralized water equipments	2017-04-02	2017-05-01
10GCCS1050	Installation works of Demineralized water plant equipment & piping	2017-05-13	2017-08-10
Commissioning		2017-08-11	2017-08-31



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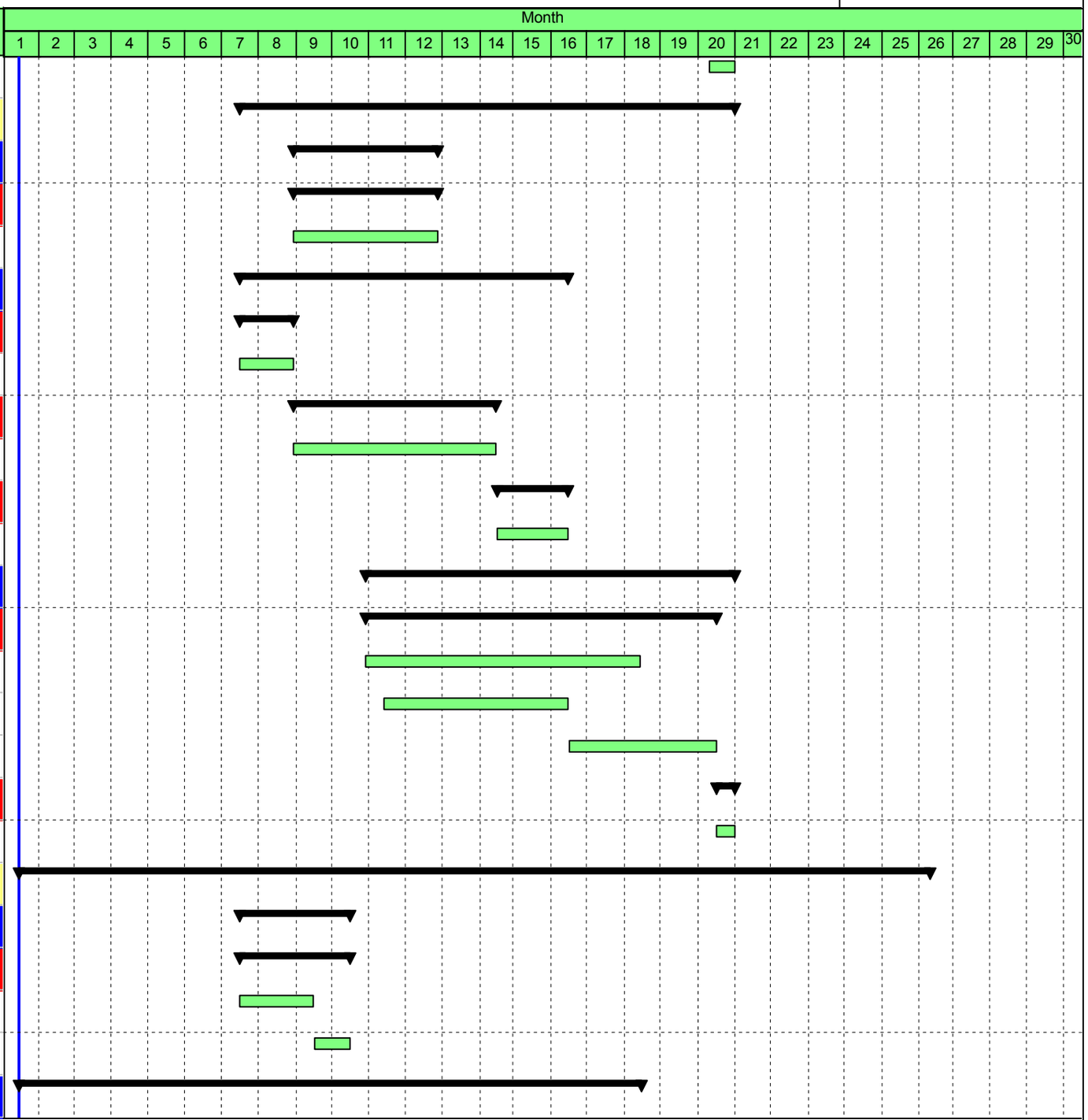
Activity ID	Activity Name	Start	Finish
10GCCM1000	Commissioning of Demineralized water plant	2017-08-11	2017-08-31
Waste water treatment system		2016-07-16	2017-08-31
Engineering		2016-08-30	2016-12-27
Detailed design		2016-08-30	2016-12-27
10GNED1000	Detailed foundation drawing of Waste water treatment plant	2016-08-30	2016-12-27
Procurement		2016-07-16	2017-04-15
Purchase		2016-07-16	2016-08-29
10GNPP1000	Bidding of Waste water treatment system equipment	2016-07-16	2016-08-29
Manufacture		2016-08-30	2017-02-14
10GNPM1000	Manufacture of Waste water treatment system equipment	2016-08-30	2017-02-14
Delivery		2017-02-15	2017-04-15
10GNPD1000	Delivery of Waste water treatment system equipment	2017-02-15	2017-04-15
Construction & Commissioning		2016-10-29	2017-08-31
Construction		2016-10-29	2017-08-16
10GNCS1000	Civil works of Waste water pool	2016-10-29	2017-06-14
10GNCS1010	Civil works of Waste water treatment pump house	2016-11-13	2017-04-15
10GNCS1020	Installation works of Waste water treatment equipment & piping	2017-04-16	2017-08-16
Commissioning		2017-08-17	2017-08-31
10GNCM1000	Commissioning of Waste water treatment system	2017-08-17	2017-08-31
HRSG11 & HRSG12 & HRSG13		2016-01-15	2018-02-10
Engineering		2016-07-16	2016-10-15
Detailed design		2016-07-16	2016-10-15
10HBED1010	Engineering of The foundation drawings of HRSG	2016-07-16	2016-09-15
10HBED1020	Approval of The foundation drawings of HRSG	2016-09-16	2016-10-15
Procurement		2016-01-15	2017-06-15



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Activity ID	Activity Name	Start	Finish
Purchase		2016-01-15	2016-02-14
10HBPP1000	HRSG contract signed	2016-01-15	2016-02-14
Manufacture		2016-06-15	2017-04-16
10HBPM0000	Manufacture of HRSG11-13 anchor bolts	2016-06-15	2016-09-14
11HBPM1000	Manufacture of HRSG11 steel structure	2016-06-15	2016-12-05
11HBPM1010	Manufacture of HRSG 11heating surface module	2016-07-15	2017-02-14
12HBPM1000	Manufacture of HRSG12 steel structure	2016-07-15	2017-01-04
12HBPM1010	Manufacture of HRSG12 heating surface module	2016-08-14	2017-03-16
13HBPM1000	Manufacture of HRSG13 steel structure	2016-07-15	2017-02-04
13HBPM1010	Manufacture of HRSG13 heating surface module	2016-08-14	2017-04-16
Delivery		2016-09-15	2017-06-15
10HBPD0000	Delivery of HRSG 11-13 anchor bolts	2016-09-15	2016-11-13
11HBPD1000	Delivery of HRSG11 steel structure	2016-12-06	2017-02-03
11HBPD1010	Delivery of HRSG11 heating surface module	2017-02-15	2017-04-15
12HBPD1000	Delivery of HRSG12 steel structure	2017-01-05	2017-03-05
12HBPD1010	Delivery of HRSG12 heating surface module	2017-03-17	2017-05-15
13HBPD1000	Delivery of HRSG13 steel structure	2017-02-05	2017-04-05
13HBPD1010	Delivery of HRSG13 heating surface module	2017-04-17	2017-06-15
Construction & Commissioning		2016-10-16	2018-02-10
Construction		2016-10-16	2017-11-12
11HBCS1010	Excavation works of HRSG11	2016-10-16	2016-11-05
11HBCS1020	Foundation works of HRSG11	2016-11-06	2017-02-04
11HBCS1030	Erection of HRSG11 steel structure	2017-02-14	2017-04-15
11HBCS1040	Erection of HRSG11 heating surface and pipe	2017-04-16	2017-10-12
12HBCS1010	Excavation works of HRSG12	2016-11-15	2016-12-05

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Activity ID	Activity Name	Start	Finish
12HBCS1020	Foundation of HRSG12	2016-12-06	2017-03-06
12HBCS1030	Erection of HRSG12 steel structure	2017-03-16	2017-05-14
12HBCS1040	Erection of HRSG12 heating surface and pipe	2017-05-16	2017-11-11
13HBCS1010	Excavation works of HRSG13	2016-11-15	2016-12-05
13HBCS1020	Foundation of HRSG13	2016-12-06	2017-03-06
13HBCS1030	Erection of HRSG13 steel structure	2017-04-16	2017-06-15
13HBCS1040	Erection of HRSG13 heating surface and pipe	2017-06-16	2017-11-12
Commissioning		2017-10-13	2018-02-10
11HBCM1000	Hydro test of HRSG11	2017-10-13	2017-10-22
11HBCM1010	Chemical cleaning of HRSG11	2018-01-07	2018-01-21
12HBCM1000	Hydro test of HRSG12	2017-11-12	2017-11-21
12HBCM1010	Chemical cleaning of HRSG12	2018-01-24	2018-01-31
13HBCM1000	Hydro test of HRSG13	2017-11-13	2017-11-22
13HBCM1010	Chemical cleaning of HRSG13	2018-02-04	2018-02-10
Steam turbine and Generator		2016-01-15	2018-01-24
Engineering		2016-07-16	2016-10-29
Detailed design		2016-07-16	2016-10-29
10MAED1010	Engineering / Approval of The foundation drawings of Steam turbine Buildiing	2016-07-16	2016-09-14
10MAED1020	Engineering / Approval of The structure drawings of Steam turbine Buildiing	2016-08-15	2016-10-29
10MAED1030	Engineering / Approval of The underplate drawings of Steam turbine	2016-07-31	2016-10-14
Procurement		2016-01-15	2017-10-14
Purchase		2016-01-15	2016-02-14
10MAPP1000	Steam turbine contract signed	2016-01-15	2016-02-14
10MAPP1010	Steam turbine generator contract signed	2016-01-15	2016-02-14
Manufacture		2016-09-15	2017-07-15

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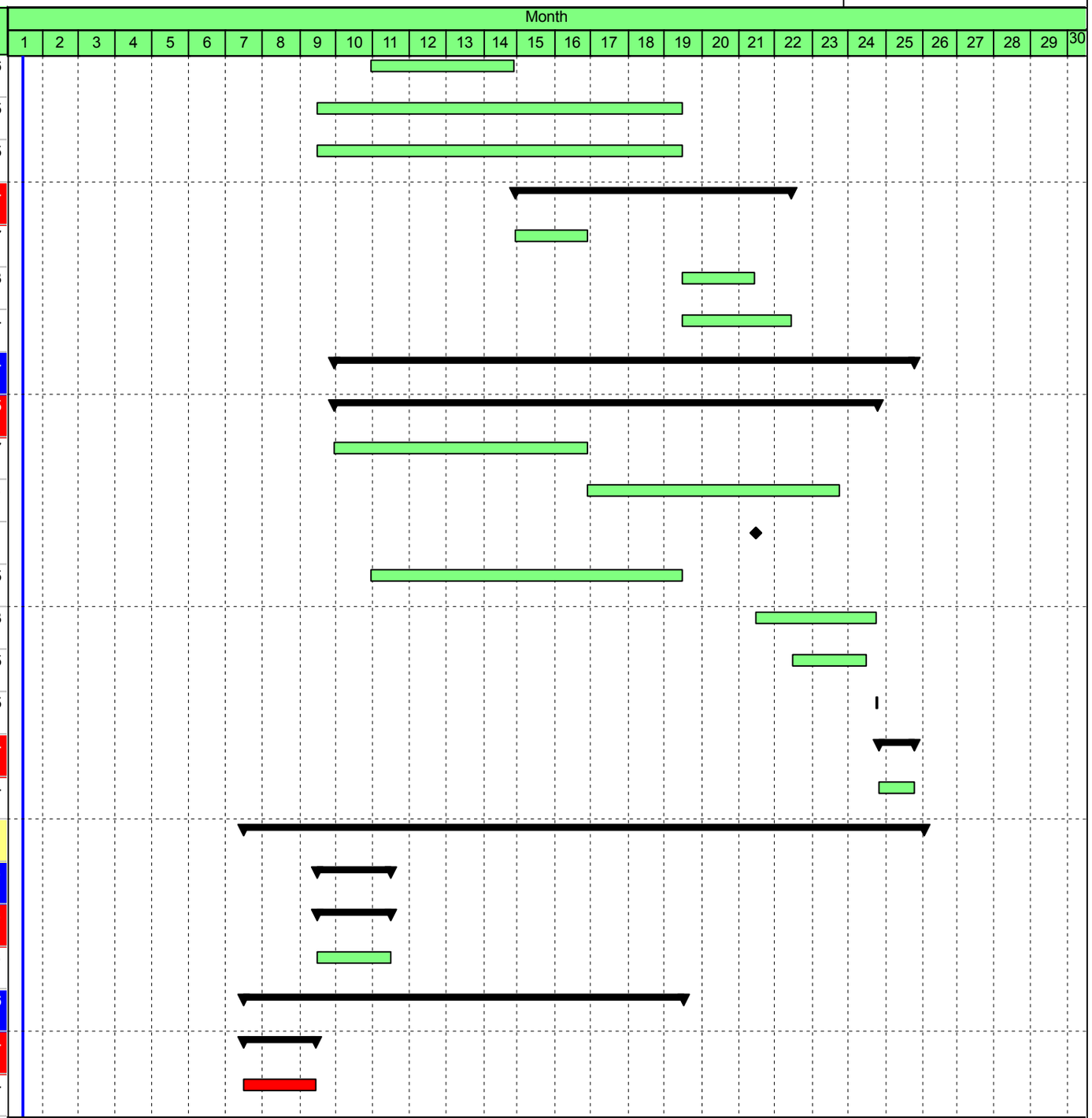
Activity ID	Activity Name	Start	Finish
10MAPM1000	Manufacture of ST10 Steam Turbine building steel structure	2016-10-30	2017-02-26
10MAPM1020	Manufacture of ST10 Steam Turbine	2016-09-15	2017-07-15
10MAPM1030	Manufacture of ST10 Steam Turbine generator	2016-09-15	2017-07-15
Delivery		2017-02-27	2017-10-14
10MAPD1000	Delivery of ST10 Steam Turbine building steel structure	2017-02-27	2017-04-27
10MAPD1020	Delivery of ST10 Steam Turbine	2017-07-16	2017-09-13
10MAPD1030	Delivery of ST10 Steam Turbin egenerator	2017-07-16	2017-10-14
Construction & Commissioning		2016-09-30	2018-01-24
Construction		2016-09-30	2017-12-25
10MACS1010	Foundation works of Steam turbine building	2016-09-30	2017-04-27
10MACS1020	Erection of SS structure and architecture of ST10 building	2017-04-28	2017-11-23
10MACS1030	ST10 building available for installation	2017-09-15	
10MACS1040	Foundation of ST10 Steam Turbine	2016-10-30	2017-07-15
10MACS1060	Erection of ST10 Steam Turbine	2017-09-15	2017-12-23
10MACS1070	Erection of ST10 Steam Turbine generator	2017-10-15	2017-12-15
10MACS1080	ST10 Steam Turbine casing close up	2017-12-24	2017-12-25
Commissioning		2017-12-26	2018-01-24
10MACM1000	Oil flushing of ST10 Steam Turbine	2017-12-26	2018-01-24
Air cooling system		2016-07-16	2018-02-01
Engineering		2016-09-15	2016-11-15
Detailed design		2016-09-15	2016-11-15
10QAED1010	Engineering / Approval of The foundation drawings of Air cooling system	2016-09-15	2016-11-15
Procurement		2016-07-16	2017-07-16
Purchase		2016-07-16	2016-09-14
10QAPP1000	Bidding of Air cooling system	2016-07-16	2016-09-14



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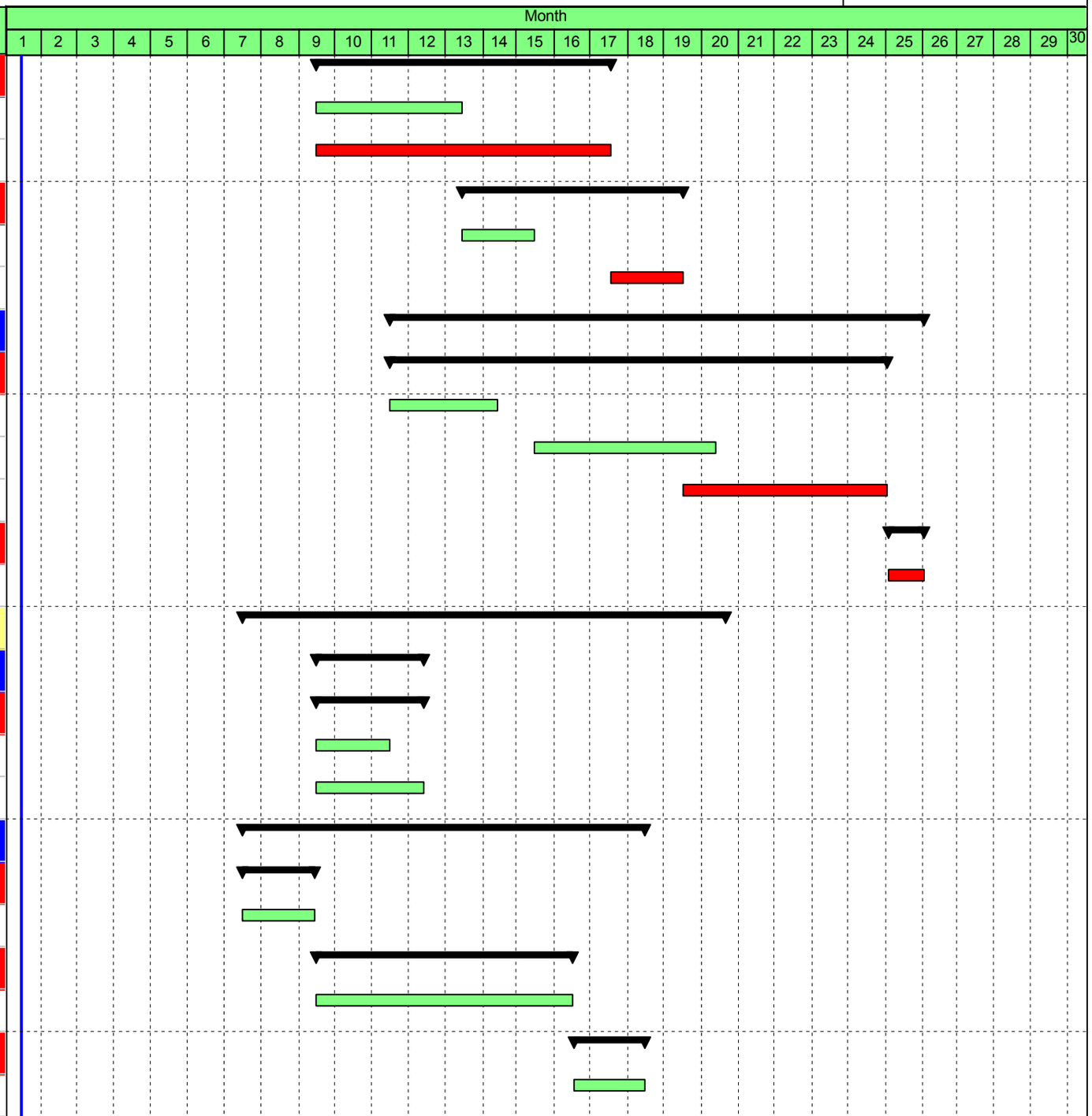
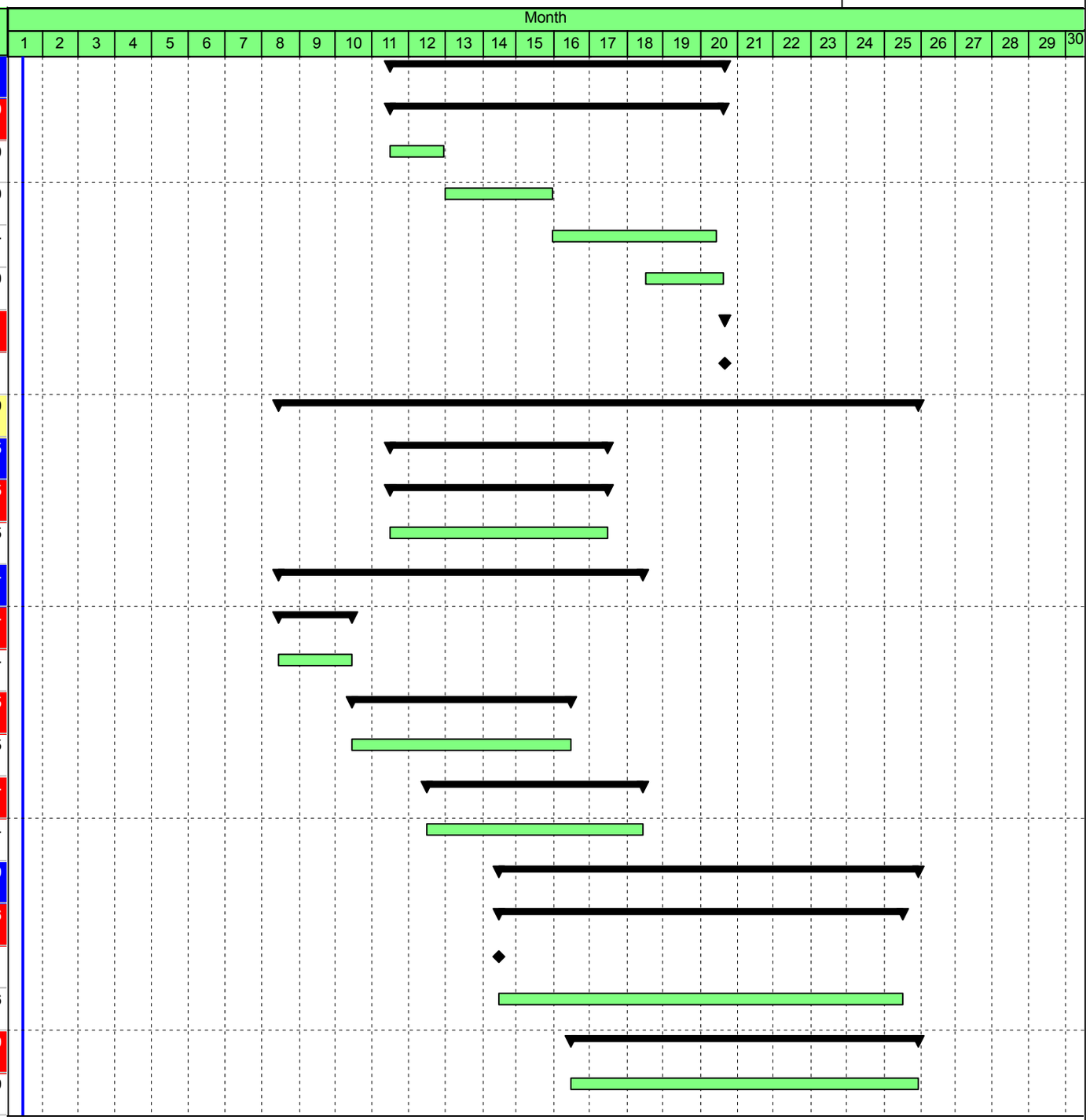
Activity ID	Activity Name	Start	Finish
Manufacture		2016-09-15	2017-05-17
10QAPM1000	Manufacture of steel structure of Air cooling system	2016-09-15	2017-01-14
10QAPM1010	Manufacture of Air cooling system equipment	2016-09-15	2017-05-17
Delivery		2017-01-15	2017-07-16
10QAPD1000	Delivery of steel structure of Air cooling system	2017-01-15	2017-03-15
10QAPD1010	Delivery of Air cooling system equipment	2017-05-18	2017-07-16
Construction & Commissioning		2016-11-16	2018-02-01
Construction		2016-11-16	2018-01-02
10QACS1010	Foundation works of Air cooling system	2016-11-16	2017-02-13
10QACS1020	Structure works of Air cooling system	2017-03-16	2017-08-12
10QACS1030	Installation works of Air cooling system equipment	2017-07-17	2018-01-02
Commissioning		2018-01-03	2018-02-01
10QACM1000	Commissioning of Air cooling system system	2018-01-03	2018-02-01
Compressed air system		2016-07-16	2017-08-21
Engineering		2016-09-15	2016-12-13
Detailed design		2016-09-15	2016-12-13
10QEED1010	Engineering / Approval of The foundation drawings of Compressed air house	2016-09-15	2016-11-15
10QEED1020	Engineering / Approval of The structure drawings of Compressed air house	2016-09-15	2016-12-13
Procurement		2016-07-16	2017-06-15
Purchase		2016-07-16	2016-09-14
10QEPP1000	Bidding of Compressed air house equipment	2016-07-16	2016-09-14
Manufacture		2016-09-15	2017-04-16
10QEPM1010	Manufacture of Compressed air house equipment	2016-09-15	2017-04-16
Delivery		2017-04-17	2017-06-15
10QEPD1010	Delivery of Compressed air house equipment	2017-04-17	2017-06-15



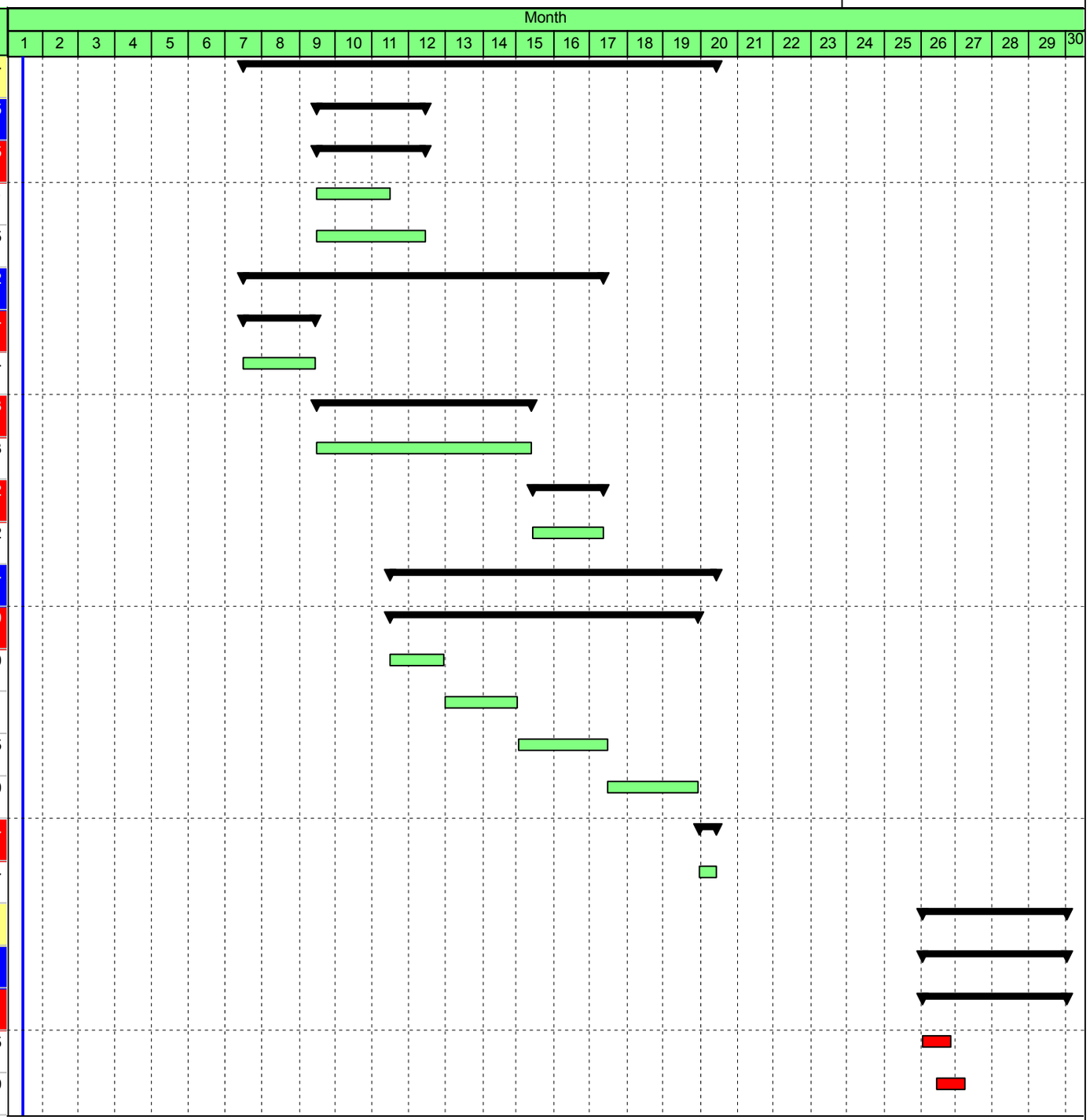
Remaining Level of Effort | Actual Work | Critical Remaining Work | Summary | WBS Summary Progress
Actual Level of Effort | Remaining Work | Milestone | WBS Summary Activity

Activity ID	Activity Name	Start	Finish
Construction & Commissioning		2016-11-16	2017-08-21
Construction		2016-11-16	2017-08-20
10QECS1010	Foundation works of Compressed air house	2016-11-16	2016-12-30
10QECS1020	Structure works of Compressed air house	2016-12-31	2017-03-30
10QECS1030	Architecture works of Compressed air house	2017-03-31	2017-08-14
10QECS1040	Installation works of Compressed air system equipment	2017-06-16	2017-08-20
Commissioning		2017-08-21	2017-08-21
10QECM1000	Start of Commissioning of I&C Compressed air system	2017-08-21	
Fire fighting system		2016-08-15	2018-01-29
Engineering		2016-11-15	2017-05-15
Detailed design		2016-11-15	2017-05-15
10SGED1000	Detailed design of fire fighting system	2016-11-15	2017-05-15
Procurement		2016-08-15	2017-06-14
Purchase		2016-08-15	2016-10-14
10SGPP1000	Bidding of fire fighting sytem equipment	2016-08-15	2016-10-14
Manufacture		2016-10-15	2017-04-15
10SGPM1000	Manufacture of fire fighting system equipment	2016-10-15	2017-04-15
Delivery		2016-12-16	2017-06-14
10SGPD1000	Delivery of fire fighting system equipment	2016-12-16	2017-06-14
Construction & Commissioning		2017-02-14	2018-01-29
Construction		2017-02-14	2018-01-16
10SGCS1000	Inlet from the pipe main connections of the Phase I Facility	2017-02-14	
10SGCS1020	Installation works of fire fighting piping	2017-02-14	2018-01-16
Commissioning		2017-04-15	2018-01-29
10SGCM1000	Commissioning of Fire fighting system	2017-04-15	2018-01-29



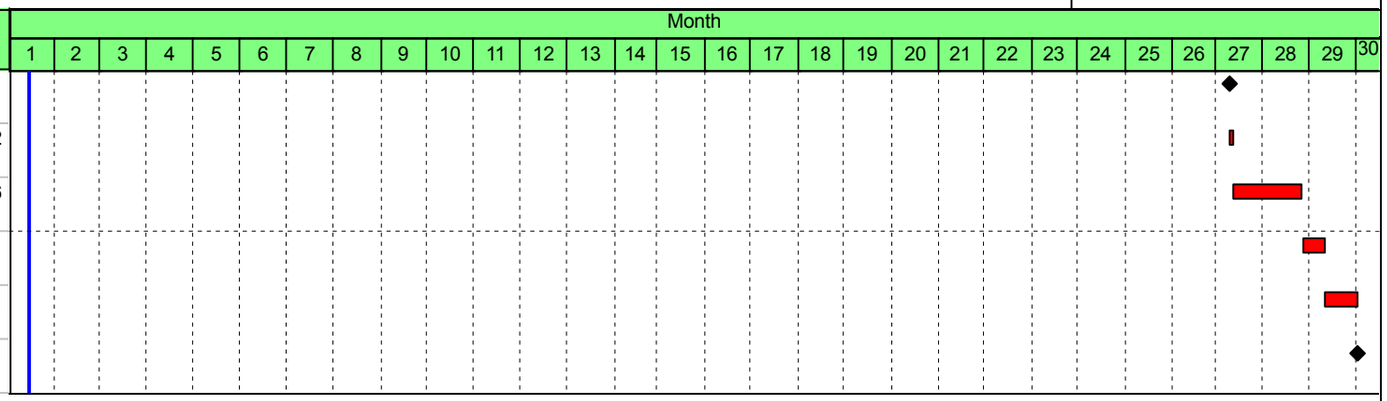
Remaining Level of Effort | Actual Work | Critical Remaining Work | Summary | WBS Summary Progress
Actual Level of Effort | Remaining Work | Milestone | WBS Summary Activity

Activity ID	Activity Name	Start	Finish
Diesel engine generator		2016-07-16	2017-08-14
Engineering		2016-09-15	2016-12-15
Detailed design		2016-09-15	2016-12-15
10XJED1010	Engineering / Approval of The foundation drawings of Diesel engine generator plant	2016-09-15	2016-11-15
10XJED1020	Engineering / Approval of The structure drawings of Diesel engine generator plant	2016-09-15	2016-12-15
Procurement		2016-07-16	2017-05-12
Purchase		2016-07-16	2016-09-14
10XJPP1000	Bidding of Diesel engine generator equipment	2016-07-16	2016-09-14
Manufacture		2016-09-15	2017-03-13
10XJPM1010	Manufacture of Diesel engine generator equipment	2016-09-15	2017-03-13
Delivery		2017-03-14	2017-05-12
10XJPD1010	Delivery of Diesel engine generator equipment	2017-03-14	2017-05-12
Construction & Commissioning		2016-11-16	2017-08-14
Construction		2016-11-16	2017-07-30
10XJCS1010	Foundation works of Diesel engine generator plant	2016-11-16	2016-12-30
10XJCS1020	Structure works of Diesel engine generator plant	2016-12-31	2017-03-01
10XJCS1030	Architecture works of Diesel engine generator plant	2017-03-02	2017-05-15
10XJCS1040	Installation works of Diesel engine generator equipment	2017-05-16	2017-07-30
Commissioning		2017-07-31	2017-08-14
10XJCM1000	Commissioning of Diesel engine generator	2017-07-31	2017-08-14
Unit commissioning		2018-02-02	2018-06-01
Construction & Commissioning		2018-02-02	2018-06-01
Commissioning		2018-02-02	2018-06-01
10GECM1000	HRSG11/12/13 steam blowing	2018-02-02	2018-02-25
10GECM1005	HRSG11/12/13 steam blowing recovery	2018-02-14	2018-03-09



Remaining Level of Effort | Actual Work | Critical Remaining Work | Summary | WBS Summary Progress
Actual Level of Effort | Remaining Work | Milestone | WBS Summary Activity

Activity ID	Activity Name	Start	Finish
10GECM1010	CCU1 Start-up Test	2018-03-10	
10GECM1020	CCU1 First Synchronization	2018-03-10	2018-03-12
10GECM1030	CCU1 load test and trial operation	2018-03-13	2018-04-26
10GECM1040	CCU1 Reliability Run	2018-04-27	2018-05-11
10GECM1050	CCU1 Performance Test	2018-05-12	2018-06-01
10GECM1060	CCU1 Put into commercial operation		2018-06-01



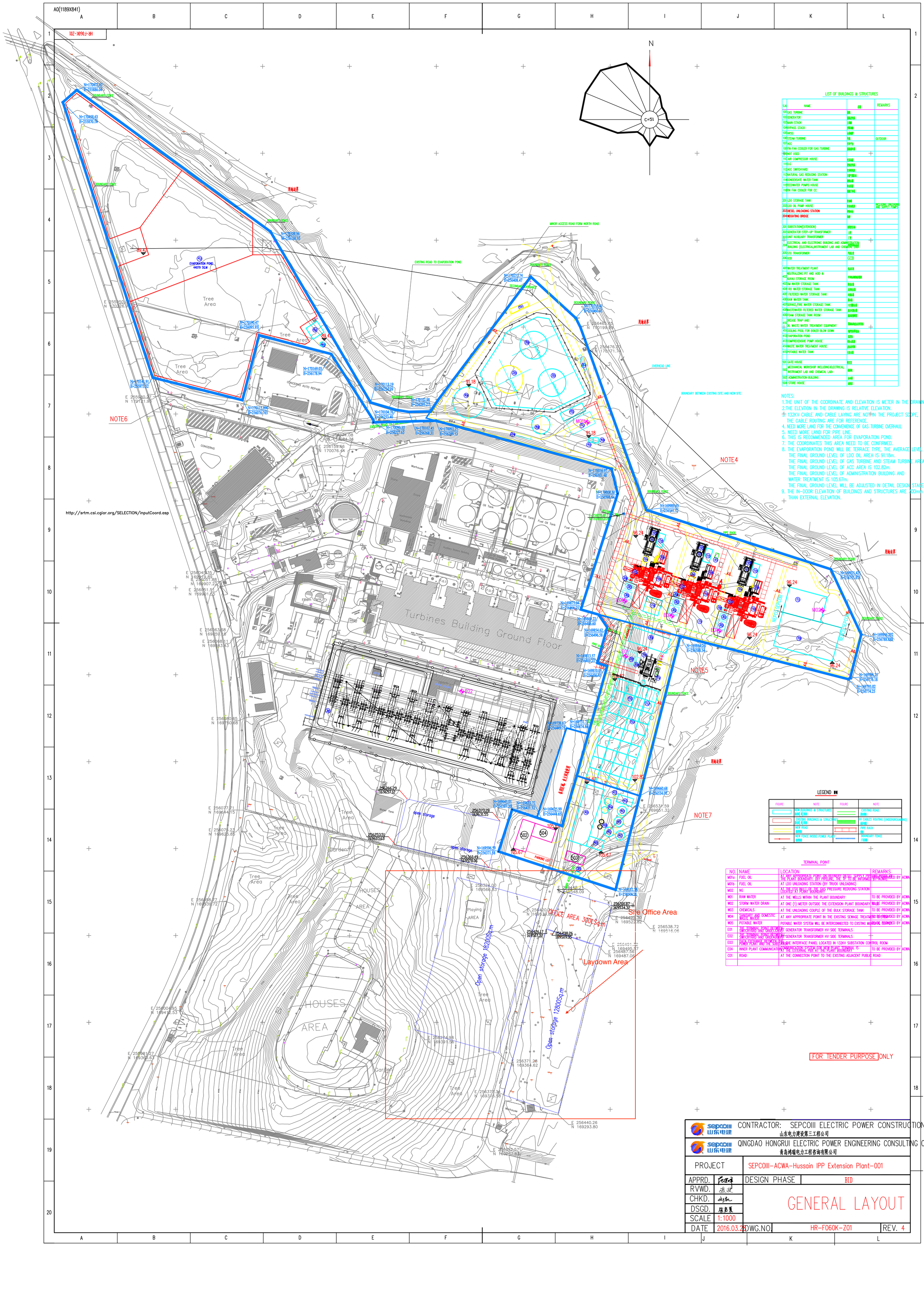
Remaining Level of Effort | Actual Work | Critical Remaining Work | Summary | WBS Summary Progress
Actual Level of Effort | Remaining Work | Milestone | WBS Summary Activity

Appendix E

Project Plan (and plans for construction laydown areas)

A0(1189X841)

HR-F060K-Z01



LIST OF BUILDINGS & STRUCTURES

S.N	NAME	名称	REMARKS
101	GAS TURBINE	燃机	
102	GENERATOR	燃机发电机	
103	MAIN STACK	主烟囱	
104	BYPASS STACK	旁路烟囱	
105	HRSG	余热锅炉	
106	STEAM TURBINE	汽机	OUTDOOR
107	ACC	空冷岛	
108	FIN FAN COOLER FOR GAS TURBINE	燃机翅片冷却器	
109	NOT USED		
110	AIR COMPRESSOR HOUSE	空压机房	
111	D.G	柴油发电机房	
112	ACC SWITCHYARD	空冷岛开关站	
113	NATURAL GAS REDUCING STATION	天然气调压站	
114	CONDENSATE WATER TANK	凝结水箱	
115	FEEDWATER PUMPS HOUSE	给水泵房	
116	FIN FAN COOLER FOR CC	联合循环翅片冷却器	
201	LDO STORAGE TANK	轻油罐	
202	LDO OIL PUMP HOUSE	轻油泵房	INCLUDING UNLOADING AND SUPPLY PUMPS
203	DIESEL UNLOADING STATION	柴油卸油站	
204	WEIGHTING BRIDGE	地磅	
301	SUBSTATION(EXTENSION)	新增升压站	
302	GENERATOR STEP-UP TRANSFORMER	主变	
303	UNIT AUXILIARY TRANSFORMER	厂变	
304	ELECTRICAL AND ELECTRONIC BUILDING AND ADMINISTRATION BUILDING (ELECTRICAL,INSTRUMENT LAB AND CHEMICAL LAB)	电气电子楼及综合楼（电气、仪表、化验）	
305	STG TRANSFORMER	汽机主变	
306	GCB	GCB	
401	WATER TREATMENT PLANT	水处理	
402	NEUTRALIZING PIT AND ACID & ALKALI STORAGE ROOM	中和池及酸碱储存间	
403	DM WATER STORAGE TANK	除盐水箱	
404	RO WATER STORAGE TANK	反渗透水箱	
405	FILTERED WATER STORAGE TANK	过滤水箱	
406	RAW WATER TANK	原水箱	
407	SERVICE/FIRE WATER STORAGE TANK	工业水/消防水箱	
408	WASTEWATER FILTERED WATER STORAGE TANK	废水回用水箱	
409	FOAM STORAGE TANK ROOM	泡沫罐间	
410	GREASE TRAP AND OIL WASTE WATER TREATMENT EQUIPMENT	隔油池及污油处理设备	
411	COOLING POOL FOR BOILER BLOW DOWN	锅炉排污冷却池	
412	EVAPORATION POND	蒸发池	
413	COMPREHENSIVE PUMP HOUSE	综合泵房	
414	WASTE WATER TREATMENT HOUSE	废水处理间	
415	POTABLE WATER TANK	生活水箱	
501	GATE HOUSE	门卫	
502	MECHANICAL WORKSHOP INCLUDING ELECTRICAL, INSTRUMENT LAB AND CHEMICAL LAB	检修间	
503	ADMINISTRATION BUILDING	办公楼	
504	STORE HOUSE	仓储楼	

NOTES:
1. THE UNIT OF THE COORDINATE AND ELEVATION IS METER IN THE DRAWING.
2. THE ELEVTION IN THE DRAWING IS RELATIVE ELEVATION.
3. 132KV CABLE AND CABLE LAYING ARE NOT IN THE PROJECT SCOPE, THE CABLE ROUTING ARE FOR REFERENCE.
4. NEED MORE LAND FOR THE CONVENIENCE OF GAS TURBINE OVERHAUL
5. NEED MORE LAND FOR PIPE LINE.
6. THIS IS RECOMMENDED AREA FOR EVAPORATION POND.
7. THE COORDINATES THIS AREA NEED TO BE CONFIRMED.
8. THE EVAPORATION POND WILL BE TERRACE TYPE, THE AVERAGE LEVEL IS 89.42M.
   THE FINAL GROUND LEVEL OF LDO OIL AREA IS 91.18m.
   THE FINAL GROUND LEVEL OF GAS TURBINE AND STEAM TURBINE AREA IS 96.24m.
   THE FINAL GROUND LEVEL OF ACC AREA IS 102.82m.
   THE FINAL GROUND LEVEL OF ADMINISTRATION BUILDING AND WATER TREATMENT IS 105.67m.
   THE FINAL GROUND LEVEL WILL BE ADJUSTED IN DETAIL DESIGN STAGE.
9. THE IN-DOOR ELEVATION OF BUILDINGS AND STRUCTURES ARE 300mm HIGHER THAN EXTERNAL ELEVATION.

LEGEND

FIGURE	NOTE	FIGURE	NOTE
	NEW BUILDINGS & STRUCTURES 新建(拟)构筑物		EXISTING ROAD 现有道路
	EXISTING BUILDINGS & STRUCTURES 现有(拟)构筑物		HV CABLES ROUTING (UNDERGROUNDING) 电缆敷设
	NEW ROAD 新建道路		PIPE RACK 管架
	NEW FENCE INSIDE POWER PLANT 新建围墙		BOUNDARY FENCE 厂区围墙

TERMINAL POINT

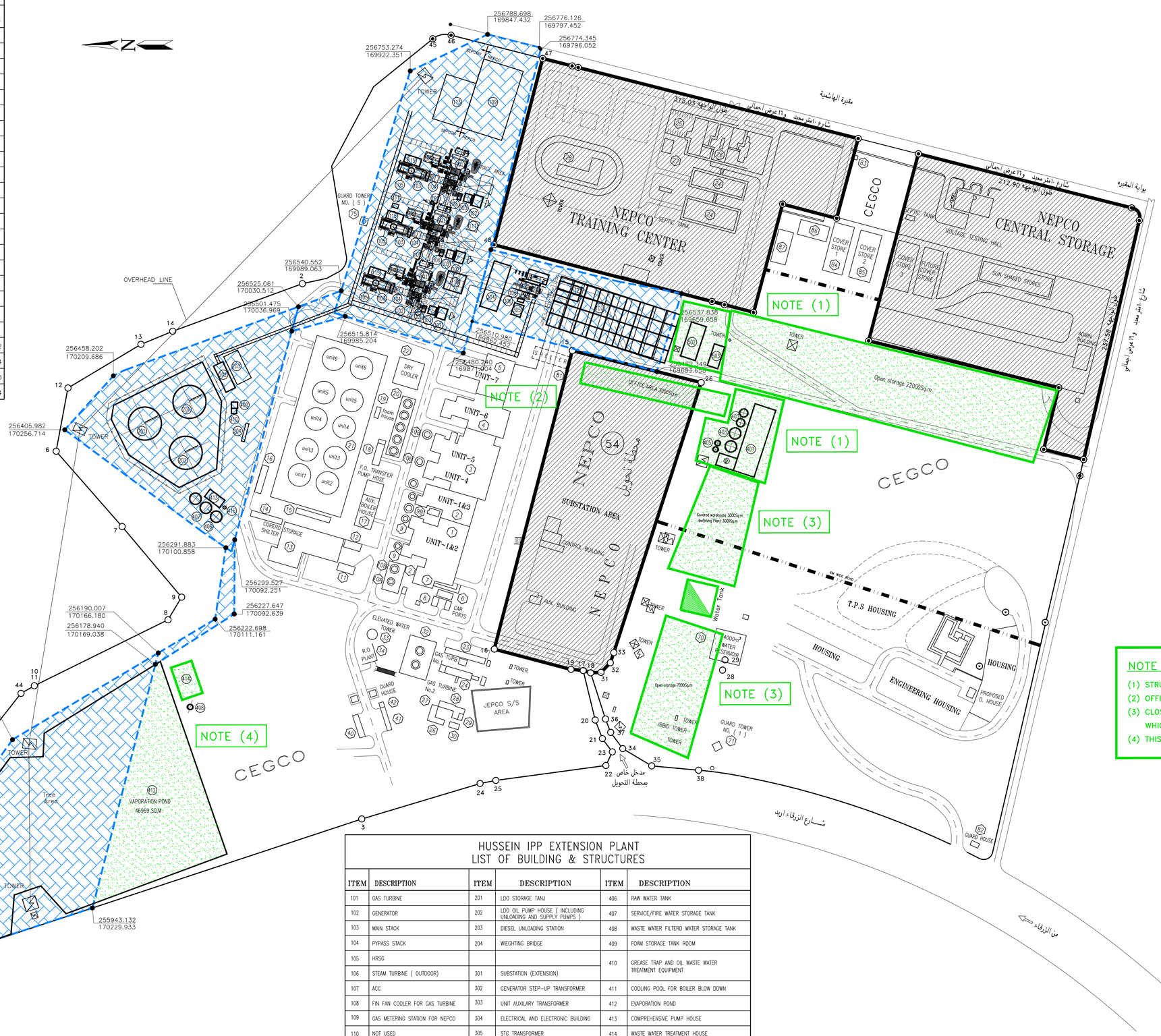
NO.	NAME	LOCATION	REMARKS
M01a	FUEL OIL	AT ANY APPROPRIATE POINT ON REFINERY OR OIL SUPPLY PIPELINE WITHIN THE PLANT BOUNDARY. (BY PIPELINE, THE TIP TO BE INFORMED BY ACWA)	TO BE PROVIDED BY ACWA
M01b	FUEL OIL	AT LDO UNLOADING STATION (BY TRUCK UNLOADING)	
M02	NG	AT THE TIE-IN POINT OF THE GAS PRESSURE REDUCING STATION LOCATED AT PLANT BOUNDARY	
W01	RAW WATER	AT THE WELLS WITHIN THE PLANT BOUNDARY	TO BE PROVIDED BY ACWA
W02	STORM WATER DRAIN	AT ONE (1) METER OUTSIDE THE EXTENSION PLANT BOUNDARY	TO BE PROVIDED BY ACWA
W03	CHEMICALS	AT THE UNLOADING COUPLE OF THE BULK STORAGE TANK	TO BE PROVIDED BY ACWA
W04	SANITARY AND DOMESTIC WASTE WATER	AT ANY APPROPRIATE POINT IN THE EXISTING SEWAGE TREATMENT SYSTEM	TO BE PROVIDED BY ACWA
W05	POTABLE WATER	POTABLE WATER SYSTEM WILL BE INTERCONNECTED TO EXISTING MUNICIPAL SYSTEM	TO BE PROVIDED BY ACWA
E01	THE TERMINAL POINT BETWEEN SWITCHYARD AND GRID CODE OF GENERATOR TRANSFORMER HV SIDE TERMINALS		
E02	THE TERMINAL POINT BETWEEN SWITCHYARD AND GRID CODE OF GENERATOR TRANSFORMER HV SIDE TERMINALS		
E03	DATA INTERFACE BETWEEN THE POWER PLANT AND THE SUBSTATION	ONE INTERFACE PANEL LOCATED IN 132KV SUBSTATION CONTROL ROOM	
E04	INNER PLANT COMMUNICATION	COMMUNICATION SYSTEM FOR NEW PLANT, TERMINAL IS AT THE EXTERNAL PBX AT THE PLANT BOUNDARY	TO BE PROVIDED BY ACWA
C01	ROAD	AT THE CONNECTION POINT TO THE EXISTING ADJACENT PUBLIC ROAD	

FOR TENDER PURPOSE ONLY

CONTRACTOR:	SEPCOIII ELECTRIC POWER CONSTRUCTION CORP. 山东电力建设第三工程公司	
QINGDAO HONGRUI ELECTRIC POWER ENGINEERING CONSULTING CO., LTD. 青岛鸿瑞电力工程咨询有限公司		
PROJECT	SEPCOIII-ACWA-Hussain IPP Extension Plant-001	
APPRD.	DESIGN PHASE	BID
RVWD.	GENERAL LAYOUT	
CHKD.		
DSGD.		
SCALE	1:1000	
DATE	2016.03.28	DWG.NO. HR-F060K-Z01 REV. 4

COORDINATES SCHEDULE

POINT	EASTING	NORTHING	POINT	EASTING	NORTHING
1	256519.690	169914.870	25	256066.610	169839.540
2	256547.420	170026.700	26	256451.700	169640.720
3	256029.210	169969.350	27	256431.290	169558.370
4	255922.080	170388.780	28	256173.380	169620.100
5	255900.570	170358.780	29	256183.250	169617.740
6	256385.160	170265.070	30	256173.380	169620.100
7	256312.170	170201.250	31	256171.160	169737.730
8	256222.070	170156.810	32	256180.460	169728.720
9	256243.980	170143.680	33	256190.260	169725.340
10	256158.180	170286.240	34	256097.330	169716.660
11	256158.180	170286.240	35	256080.670	169688.690
12	256446.370	170253.660	36	256126.000	169733.360
13	256488.650	170183.030	37	256113.030	169728.350
14	256501.330	170152.320	38	256076.440	169643.310
15	256482.630	169765.430	39	255851.710	170511.360
16	256193.650	169841.030	40	255883.190	170501.830
17	256172.880	169754.930	41	255890.850	170495.680
18	256170.750	169747.740	42	256027.150	170384.710
19	256174.010	169766.820	43	256103.930	170336.110
20	256125.030	169743.310	44	256150.840	170299.080
21	256107.060	169736.380	45	256784.380	1169900.562
22	256081.040	169732.980	46	256787.920	1169882.864
23	256094.170	169726.780	47	256765.386	1169792.105
24	256063.580	169854.740	48	256585.089	1169841.294



ITEM	DESCRIPTION	ITEM	DESCRIPTION	ITEM	DESCRIPTION
1	TURBINE BUILDING UNIT 1&2	32	DIESEL TANK	63	OIL VEHICLE STORE
2	TURBINE BUILDING UNIT 3	33	ELEVATOR WATER TOWER	64	UNUSED BUILDING
3	TURBINE BUILDING UNIT 4x5	33a	GROUND WATER TANK	65	STORE
4	TURBINE BUILDING UNIT 6	34	REVERES ASSMOZIE	66	DRIVERS BUILDING
5	TURBINE BUILDING UNIT 7	35	ACID TANK	67	VEHICLE WORKSHOP
6	LIBRARY BUILDING	36	CONTROL GATE HOUSE	68	UNUSED BUILDING
7	EXCHANGE BUILDING	37	SHELTER	69	OIL WATER SEPARATOR
8	FIRE PUMP BUILDING	38	DRIVES OFFICE	70	GROUND WATER RESERVOIR
9	CHIMNEY	39	DRIVES STORE	71	GUARD TOWER No. 1
10A	FUEL TANKS	40	PARKING AREA	72	GUARD TOWER No. 2
10B	FUEL TANKS	41	PARKING AREA	73	GUARD TOWER No. 3
11	MAINTENANCE BUILDING	42	PARKING AREA	74	GUARD TOWER No. 4
12	STORE	43	SECURITY BUILDING	75	GUARD TOWER No. 5
13	MAINTENANCE STORE & WRORKSHOP	44	GUARD HOUSE	76	WATER WELL No. 1
14	SHELTER	45	MAINTENANCE OFFICE	77	WATER WELL No. 2
15	STORE	46	OFFICES & MILITARY RESIDENT	78	WATER WELL No. 3
16	WELDING WORKSHOP	47	CONCRETE WATER TANK	79	WATER WELL No. 4
17	AUXILIARY BOILER BUILDING	48	UNUSED BUILDING	80	WATER WELL No. 5
18	FUEL PUMP BUILDING	49	UNUSED BUILDING	81	SHELTER
19	FOAM BUILDING	50	UNUSED BUILDING	82	GUARD HOUSE
20	DAILY FUEL TANKS	51	UNUSED BUILDING	83	GUARD HOUSE
21	MAIN FUEL TANKS AREA	52	UNUSED BUILDING	84	STORE
22	DRY COOLER	53	STORE FOR WORKSHOP	85	STORE
23	GAS TURBINE	54	WORKSHOP	86	SHELTER
24	GAS TURBINE	55	DIESEL GENERATOR	87	RUBBISH STORE
25	ELECTRICAL MAINTENANCE BUILDING	56	CARPENTER WORKSHOP		
26	STATISTICS BUILDING	57	PAINTING & AC WORKSHOP		
27	MECHANICAL MAINTENANCE & STORE	58	OLD WORKSHOP		
28	PAINT STORE	59	STORE FOR WORKSHOP		
29	AIR CONDITION MAINTENANCE	60	ELECTRICAL WORKSHOP		
30	OFFICE AIR CONDITION MAINTENANCE	61	COMBINED CYCLE AREA		
31	WORKSHOP	62	VECHLE PAINTING WORKSHOP		

الاراضي التي تخص شركة الكهرباء الوطنية

الاراضي التي تخص شركة توليد الكهرباء المركزية

الاراضي المؤجرة لمشروع اعادة تأهيل المحطة

NOTE :-

(1) STRUCTURES AND BUILDING LOCATED OUT OF LAND LEASE AREA.
(2) OFFICE AREA OF 3000m2 LOCATED IN NEPCO AREAS.
(3) CLOSED WAREHOUSE AND OPEN STORAGE LOCATED WITHIN CEGCO LANDS WHICH NOT INCLUDED IN THE LAND LEASE,
(4) THIS PART OF EVAPORATION POND OUT OF LAND LEASE.

HUSSEIN IPP EXTENSION PLANT
LIST OF BUILDING & STRUCTURES

ITEM	DESCRIPTION	ITEM	DESCRIPTION	ITEM	DESCRIPTION
101	GAS TURBINE	201	LDO STORAGE TANJ	406	RAW WATER TANK
102	GENERATOR	202	LDO OIL PUMP HOUSE (INCLUDING UNLOADING AND SUPPLY PUMPS)	407	SERVICE/FIRE WATER STORAGE TANK
103	MAIN STACK	203	DIESEL UNLOADING STATION	408	WASTE WATER FILTERD WATER STORAGE TANK
104	PYPASS STACK	204	WIEGHTING BRIDGE	409	FOAM STORAGE TANK ROOM
105	HRSG			410	GREASE TRAP AND OIL WASTE WATER TREATMENT EQUIPMENT
106	STEAM TURBINE (OUTDOOR)	301	SUBSTATION (EXTENSION)		
107	ACC	302	GENERATOR STEP-UP TRANSFORMER	411	COOLING POOL FOR BOILER BLOW DOWN
108	FIN FAN COOLER FOR GAS TURBINE	303	UNIT AUXILARY TRANSFORMER	412	EVAPORATION POND
109	GAS METERING STATION FOR NEPCO	304	ELECTRICAL AND ELECTRONIC BUILDING	413	COMPREHENSIVE PUMP HOUSE
110	NOT USED	305	STG TRANSFORMER	414	WASTE WATER TREATMENT HOUSE
111	D.G.	306	GCB	415	POTABLE WATER TANK
112	ACC SWITCHYARD				
113	NATURAL GAS STATION	401	WATER TREATMENT PLANT		
114	CONDENSATE WATER TANK AND AIR COMPRESSOR HOUSE	402	NEUTRALIZING PIT AND ACID & ALKLI STORAGE ROOM	501	GATE HOUSE
115	FEEDWATER PUMPS HOUSE	403	DM WATER STORAGE TANK	502	MECHANICAL WORKSHOP INCLUDING (ELECTRICAL, INSTRUMENT LAB AND CHEMICAL LAB)
116	FIN FAN COOLER FOR CC	404	RO WATER STORAGE TANK		
		405	FILERED WATER STORAGE TANK	503	ADMINSTRATION BUILDING

Rev.	Date	Description	Drawn by	checked by	Approved By
A	17/1/2016	FIRST ISSUE	A.DEL	T.A.JALIL	T.A.JALIL

بسم الله الرحمن الرحيم

شركة توليد الكهربا. المركزية م.ع
Central Electricity Generating Co.
(CEGCO)

Project: ZERQA DISTRICT
HUSSEIN THERMAL POWER STATION SITE
HUSSEIN IPP EXTENSION PLANT

حجم المخطط Drawing size: A1	Tender NO.
مقياس الرسم Scale: 1 : 2000	Title: LAND LAYOUT BOUNDARY AND COORDINATES
رقم اللوحة sheet No.: 1 From 1	
Drawing No.: 2-1-21-C1-0002	
Cad File	

Appendix F

Scoping Consultation Exercise – Report and Handouts

SCOPING SESSION

In accordance with MoEnv's "EIA Regulation No. (37) of the year 2005", a scoping session must be held for those projects which require a comprehensive EIA study; as the case with this Project. Public participation is one of the most important aspects in the Scoping/EIA process as it directly involves the stakeholders whom are expected to be affected by the Project development. In general, the objectives of the scoping session include the following:

- Introduce the Project and its various components to the stakeholders and provide them with all available information at this stage;
- Allow stakeholders to participate in the process of scoping environmental and social impacts of the Project;
- Early consideration of stakeholders concerns and fears regarding the nature and scale of anticipated impacts from the Project; and
- Allow stakeholders to comment on the scope of work and methodology that will be adopted for the EIA study.

In accordance with the above and in coordination with MoEnv, the scoping session for the Project was held on 24 February 2016 at the Le Meridian Hotel in Amman. The list of invitees was identified jointly by the MoEnv and the 'EIA team' taking into account all stakeholder groups which are likely to be affected by the Project directly or indirectly. The list of invitees, list of attendees, and the agenda of the session is presented in Annex I.

Throughout the scoping session, the following presentations were given:

- A welcome speech by **Mr. Imad Daraawi, EIA Engineer from the Ministry of Environment**. Mr. Daraawi started by welcoming the attendees to the scoping session, after which he briefly explained the purpose of the scoping session and stressed on its importance as it aims to take into account the concerns and comments of stakeholders throughout the EIA study.

- A presentation on the Project by **Mr. Maher Tubeishat, Asset Management Executive Manager at CEGCO.** Mr. Tubeishat started by briefly discussing the history of the Hussein Thermal Power Plant, and then he presented in details the Project to include the following: (i) Project's agreements and contractual structure, (ii) Project technology, (iii) Project location and layout, (iv) Project components, (v) Project schedule and duration, and (vi) anticipated job opportunities during the Project's various phases and other social responsibility programs to be implemented.

- A presentation by **Mr. Ibrahim Masri, Consultant from ECO Consult.** Mr. Masri reiterated the objectives of the scoping session and discussed briefly the Project details (location, components and phases) and then moved on to discuss the environmental clearance process for the Project as required by the MoEnv. More specifically, Mr. Masri presented in details the anticipated negative and positive environmental and social impacts during the various Project phases and the methodology that will be adopted throughout the EIA study – this included mainly the methodology for baseline assessment of the various environmental and social receptors as well as the methodology for assessing the various impacts.

  There was time for questions and answers following this presentation as well as a facilitated discussion, moderated by Mr. Masri.

Attendees raised and discussed a number of issues and concerns, which are summarized below. Selected photos from the session are shown in Figure 1 below.

Figure 1: Selected Photos from the Scoping Session

SYNTHESIS OF COMMENTS

The 'EIA Team' documented all records of the scoping session to include transcripts, minutes of meetings, list of participants and attendees, comments and so on. In addition, throughout the scoping session a form was distributed to stakeholders to allow them to document any comments or concerns they might have in writing.

The following table presents the main issues raised by the stakeholders throughout the scoping session. The table also highlights how those comments will be incorporated throughout the EIA study. The detailed minutes of meeting and the filled stakeholder forms are presented in Annex I.

Table 1: Main Issues Raised by Stakeholders during the Scoping Session

No.	Parameter	Comment	Response
1.	Air Quality	A stakeholder stated that additional air quality monitoring points should be considered at areas located at a distance from the project site in order to improve the accuracy of the modelling results and pollutant concentrations in such areas (given that all air quality monitoring points are currently located within the Project site and adjacent nearby areas only). In addition, several stakeholders suggested that such data could be available from the Ministry of Environment's continuous air quality monitoring program in the area.	The consultants will coordinate with the Ministry of Environment with the intention of obtaining recorded data of the continuous air quality monitoring being undertaken in the local area. Upon review of such data, and subject to its suitability, the results will be included to the ESIA baseline and used to outline existing background concentrations for the cumulative assessment of the air emissions in the air dispersion model.
2.		A stakeholder stated that there must be a continuous air quality monitoring program during the operation phase of the project to measures stack emissions and which should be coordinated with the Environmental Monitoring Department at the Ministry of Environment.	Continuous Emissions Monitoring Systems (CEMS) will be included on each stack for monitoring during operation. The requirement for this will further be detailed in the ESIA and outline Environmental & Social Management and Monitoring Plan (ESMMP); which will be developed as part of the ESIA. The outline ESMMP will include the monitoring measures to be identified to ensure emissions are within allowable limits.
3.	Noise	A comment was raised on the noise baseline monitoring duration stating that 1 hour of monitoring during daytime and 1 hour of monitoring during night-time is not considered sufficient.	Given that the Project site is not located within or close to any significant sources of variable noise disturbances (such as airports, railways, or variable industrial processes), the actual noise levels within the area is relatively stable. During monitoring the average nose level (Leq(A)) stabilises quickly (e.g. within a minute) and therefore a short term monitoring period can provide representative baseline noise conditions in the project area.
4.	Soil and Groundwater	Some stakeholders inquired about the water requirements of the Project and how will it be supplied and also required that the potential impacts on	The ESIA will include projections of all water requirements in relation to the project, whilst outlining the sources of supply. Water will be supplied via a new pipeline to be constructed by the Water Authority of Jordan. The developer has already

		water resources in the area be studied as part of the ESIA.	signed a water supply agreement with the Water Authority of Jordan, who have guaranteed the supply of 2,450m^3 of water per week. In addition, a back up water supply of 3 deep groundwater wells will be drilled within the site area to a depth of approximately 450m. The ESIA will study and assess the impacts of water supply to the Project, including any expected impacts on water resources and associated infrastructure.
5.		Several comments were raised requiring that the ESIA identify all the waste streams that will be generated from the project (including hazardous waste) and identify the appropriate handling and disposal measures to be implemented.	The ESIA will include an assessment of waste and hazardous waste streams expected to be generated during construction and operation. The outline ESMMP will include a requirement to develop a waste management plan to manage solid waste and hazardous fractions. Wastewater assessment will be included in a separate chapter of the ESIA. The assessment of solid waste will outline the expected type, quantity, and management. This will include appropriate mitigation measures for storage onsite and expected management off-site. Such measures will take into account all the requirements from the Ministry of Environment as stipulated within the various regulations and instruction on management of waste streams.
6.	Community Health, Safety and Security	A stakeholder suggested that the ESIA should identify appropriate measures to prevent urbanisation in areas close to the thermal power plant. This could include for example the acquisition of land areas adjacent to the power plant.	Impacts on community health, safety and security will be discussed and assessed as part of the ESIA, with inclusion of appropriate mitigation measures and monitoring requirements. Specific impacts upon local urbanisation will also be discussed in the ESIA.
7.	Worker Conditions and Occupational Health and Safety	A stakeholder inquired how employees of the existing Hussein TPS will be managed/retained etc. It was suggested that existing employees be included to the ESIA.	The employees of the old HTPS will not be dismissed but will retain their jobs either at the new power plant or other projects of CEGCO. This will be outlined in the ESIA.
8.	Other	A stakeholder indicated that the ESIA should include the associated facilities of the Project such as the gas pipeline	As per the lender requirements an assessment of associated facilities will be included to the ESIA. NEPCO is the responsible entity for developing the detailed design and construction of the gas pipeline connection with the thermal power plant. Water Authority of Jordan

			is responsible for the water pipeline. The ESIA will outline the process to be undertaken by NEPCO and WAJ to ensure compliance of associated facilities with national and lender requirements.
9.		The ESIA should include an Environmental Emergency Response Plan to detail procedures for dealing and handling of any environmental emergency which might occur at the Project site	The requirement for a site specific Emergency Preparedness and Response Plan will be included in Volume 3 of the ESIA (Outline ESMMP) for development by the EPC Contactor during construction and the O&M Company during operation.

APPENDIX I – SCOPING SESSION INVITEES, ATTENDEES, AGENDA AND MINUTES OF MEETING

LIST OF INVITEES

No.	Key Stakeholders
National Governmental Agencies	
1	Ministry of Environment (MoEnv)
2	Ministry of Water and Irrigation (MWI)
3	Ministry of Agriculture (MoA)
4	Ministry of Labour (MoL)
5	Ministry of Tourism and Antiquities (MoTA)
6	Ministry of Industry and Trade (MoIT)
7	Jordan Institute for Standards and Metrology (JISM)
8	Department of Lands and Survey (DLS)
9	Energy and Minerals Regulatory Commission (EMRC)
10	Public Security Directorate (PSD)
11	Civil Defense Directorate (CDD)
12	Traffic Department
13	Royal Department for Environment Protection (Rangers)
14	Jordan Atomic Energy Commission (JAEC)
15	Jordan Industrial Estates Company (JIEC)
16	Jordan Engineers Association (JEA)
17	Greater Amman Municipality (GAM)
Local Governmental Agencies	
18	Al Zarqa Governorate
19	Al Zarqa Municipality
20	Al Hashimeyeh Municipality
21	Zarqa Environmental Directorate
Research and Academic Institutions	
22	Hashemite University
Non-Governmental Organizations	
23	Jordanian Hashemite Fund for Human Development (JOHUD)
24	Environmental Societies Association – the society represents all environmental NGO's in Jordan – RSCN, JES, NEWS, etc. An invitation is issued by the MoEnv to the Association who in turn invites all environmental NGO's to the scoping session.
Local Community Representatives	
25	This mainly includes members of the Municipal Council which are elected as representatives of the local community (and includes both males and females). This includes the following: Ms. Fatima Jammal; Ms. Buthayna Al-Hindawi; Ms. Jamilah Al-Mashaqbeh; Mr. Khaled Zyoud; and Mr. Abdelraheem Al-Omoush.
Private Sector	
26	Jordan Petroleum Refinery Co.
27	Samra Wastewater Treatment Plant Co

LIST OF ATTENDEES

No.	Entity	Name	Position
National Governmental Agencies			
1	Ministry of Environment	Ali Almashni	Head of Environmental Monitoring Department
2		Noura Alshraa	Chemical Researcher
3		Hussein AlSharabati	Agricultural Engineer
4		Ahlam AlDumour	Legal Expert
5		Emad Al-Darawi	EIA Engineer
6		Aseel Jaloudi	Intern
7	Ministry of Water and Irrigation	Saleh AlOran	Head of Environment and Climate Department
8		Wafa'a Shehadeh	Head of Energy Efficiency Department
9		Ayman Jaber	Head of Service Department
10	Ministry of Agriculture	Lama Abu Hassan	Agricultural Engineer
11	Ministry of Energy and Natural Resources	Ali Khawaldeh	Engineer
12		Sama'an Makhamreh	Head of Electricity Generation Department
13	Greater Amman Municipality	Manal Mohamad	Agricultural Engineer
14		Rasha Abu Hamour	Environmental Engineer
15	Traffic Department	Hana Nsour	Planning Engineer
16	Energy and Minerals Regulatory Commission	Ayman Quraan	Engineer
17		Khaled Moumani	Geological Expert
18	Royal Department for Environment Protection (Rangers)	Ra'afat Walid	Officer
19	Civil Defense Directorate	Mohammed Basheer	Department Head
20	Department of Lands and Survey	Ghaleb Mahmoud	General Director Advisor
21	Ministry of Municipal Affairs	Asmaa Ghzawi	Head of Environmental Department
Local Governmental Agencies			
22	Al Zarqa Governorate	Ghazi Shbeilat	Assistant to the Mayor of Zarqa Governorate
23	Zarqa Environmental Directorate	Inam Joude	Head of Directorate
Research and Academic Institutions			
24	Hashemite University	Ali Alnaqa	Hydrology Professor
Non-Governmental Organizations			
25	RSCN	Rasha Haymour	Conservation Planner
26	National Environment and Wildlife Society	Naser AlJuneidi	N/A
Private Sector			
27	Jordan Petroleum Refinery Co.	Khaled Alqasem	Process Engineer
28		Khaled Noubani	Safety Engineer
Other			
29	CEGCO	Maher Tubaishat	Director
30		Faisal Hamed	Head of Environment and Safety Department
31	5 Capitals	Ken Wade	Director
32	ECO Consult	Ibrahim Masri	Consultant
33		Lamees Hayary	Analyst

AGENDA

Hussein Thermal Power Station Repowering Project
Environmental Impact Assessment

Scoping Session Agenda
24 February 2016 – Le Meridian Hotel, Amman

10:00 – 10:15	**Registration**
10:15 – 10:20	**Welcoming Speech** *Ministry of Environment*
10:20 – 11:00	**Project Concept and Components** *Central Electricity Generating Company (CEGCO)*
11:00 – 11:30	**Discussion on Project Concept and Components** *Facilitated by Central Electricity Generating Company (CEGCO)*
11:30 – 12:00	**Coffee Break**
12:00 – 12:45	**EIA and Potential Environmental Impacts of the Project** *ECO Consult*
12:45 – 13:30	**Discussion on EIA and Potential Environmental Impacts** *Facilitated by ECO Consult*
13:30 – 14:30	**Lunch Break**

مشروع إعادة تأهيل محطة الحسين الحرارية لتوليد الكهرباء
دراسة تقييم الأثر البيئي

برنامج الحلقة التشاورية
24 شباط 2016 - فندق المريديان عمّان

10:15 - 10:00	**تسجيل المشاركين**
10:20 - 10:15	**كلمة ترحيبية** *وزارة البيئة*
11:00 - 10:20	**شرح مفهوم ومكونات المشروع** *شركة توليد الكهرباء المركزية (CEGCO)*
11:30 - 11:00	**نقاشات وأسئلة المشاركين حول مفهوم ومكونات المشروع** *ادارة الجلسة من قبل شركة توليد الكهرباء المركزية(CEGCO)*
12:00 - 11:30	**استراحة قهوة**
12:45 - 12:00	**عرض دراسة تقييم الأثر البيئي والتأثيرات المحتملة للمشروع** *ECO Consult*
13:30 - 12:45	**نقاشات وأسئلة المشاركين حول دراسة تقييم الأثر البيئي** *ادارة الجلسة من قبل ECO Consult*
14:30 - 13:30	**استراحة غداء**

DETAILED MINUTES OF MEETING OF THE SCOPING SESSION

1. Welcoming Speech – Mr. Imad Daraawi, EIA Engineer, Ministry of Environment

Mr. Daraawi started by welcoming the attendees to the scoping session, after which he briefly explained the purpose of the scoping session and stressed on its importance as it aims to take into account the concerns and comments of stakeholders throughout the EIA study.

2. Project Concept and Components – Mr. Maher Tubeishat, CEGCO Director

Mr. Tubeishat started by briefly discussing the history of the Hussein Thermal Power Plant, and then he presented in details the Project to include the following: (i) Project's agreements and contractual structure, (ii) Project technology, (iii) Project location and layout, (iv) Project components, (v) Project schedule and duration, and (vi) anticipated job opportunities during the Project's various phases and other social responsibility programs to be implemented.

After the presentation there was time for questions regarding the project. The main questions are summarized in the table below.

A. Project Description

1	***Mr. Saleh Oran – Ministry of Water and Irrigation*** Why weren't other alternatives considered for generating electricity instead of a thermal power plant such as renewable energy? ***Mr. Maher Tubeishat – CEGCO*** An important decisive factor in relation to this is the land area available for generating electricity at a capacity of 485MW. Renewable energy such as solar PV or wind in general requires large land areas, especially if we take into account the production capacity required. For example, a solar PV project requires around 18-25 Dunums for the generation of 1MW. The land area available at the project site is definitely not sufficient for the development of 485MW of electricity through renewable energy sources. In addition, the Ministry of Energy and Mineral Resources has defined optimal areas in Jordan for the development of solar and wind energy projects, and the project site is not located within such areas. ***Mr. Ibrahim Masri – ECO Consult*** I would also like to add that the Master Strategy of Energy Sector prepared by the Ministry of Energy discusses the need to diversify energy resources and increase the share of renewable energy to 7% in 2015 and 10% in 2020. The Master Strategy of Energy Sector understands the importance of inclusion of renewable energy within the energy mix but also understands its limitation. Not all the electricity needs of Jordan can be met by renewable energy sources and therefore there has to be a combination of electricity generation sources which also includes thermal power plants which is considered crucial for meeting base load demands in Jordan. Renewable energy sources such as solar and wind are not available all the time throughout the day as opposed to thermal power plants which can consistently generate electrical power needed to meet base load demands.
2	***Mr. Emad Al-Darawi – Ministry of Environment*** It is understood that the old thermal power plant will be decommissioned. How will you handle the decommissioned parts and will you be benefit from such decommissioned materials for the new thermal power station? ***Mr. Maher Tubeishat – CEGCO*** Due to the old age of the thermal power plant, the decommissioned parts cannot and will not be used for the new project. Decommissioned parts will be sold as scrap through a tendering process to be issued at a later stage.
3	***Mr. Khaled Moumani - Energy and Minerals Regulatory Commission*** What is the duration of the operation phase of the Project? ***Mr. Maher Tubeishat – CEGCO*** As discussed throughout the presentation, based on the PPA signed between NEPCO and the developer the project will be operational for 25 years.
4	***Mr. Khaled Noubani – Jordan Petroleum Refinery Co.*** Within the design of the power plant, did you consider the utilization of air preheaters?

	Mr. Maher Tubeishat – CEGCO The combined cycle technology incorporates air preheating. This technology has been chosen as it ensures the lowest heat rate and minimal combustion. This has been studied based on a heat mass balance diagram.

3. Environmental and Social Impact Assessment - Mr. Ibrahim Masri, Consultant at ECO Consult

Mr. Masri reiterated the objectives of the scoping session and discussed briefly the Project details (location, components and phases) and then moved on to discuss the environmental clearance process for the Project as required by the MoEnv. More specifically, Mr. Masri presented in details the anticipated negative and positive environmental and social impacts during the various Project phases and the methodology that will be adopted throughout the EIA study – this included mainly the methodology for baseline assessment of the various environmental and social receptors as well as the methodology for assessing the various impacts.

There was time for questions and answers following this presentation as well as a facilitated discussion moderated by Mr. Masri. The main issues raised during the session are summarized below according to the environmental/social attribute they relate to.

A. Air Quality

1	***Mr. Khaled Noubani – Jordan Petroleum Refinery Co.*** With regards to the selection of the 6 air quality monitoring points, were certain standards, regulations or guidelines followed in the selection process? ***Mr. Ibrahim Masri – ECO Consult*** There are no specific guidelines, standards or regulations that detail the number of monitoring points that should be selected for a baseline study or where they should be selected. Monitoring points are selected based on the detailed understanding of the site and which is usually determined on a case by case basis. Many factors should be taken into account when selecting the number of monitoring points and their location to include location of nearby receptors (such as community settlements such as Al Hashimeyeh in the case of the project), nearby polluting sources (such as the refinery in the case of the project), topography of the site, meteorological conditions in the area such as wind direction, expected impacts from the project, etc. All such factors were taken into account for the selection of the 6 monitoring points as part of the air quality monitoring program.
2	**Mr. Ali Naqah – Hashemite University** I believe that the 6 monitoring points selected for baseline measurements will be insufficient for the statistical analysis that will be undertaken as part of the air emission dispersion model that will determine the emissions concentration and dispersion in the area. This is especially true in other areas located at a distance from the power plant where no baseline monitoring points have been selected. How will the model be able to determine concentrations in such areas where there are no baseline measurements? This will lead to lower accuracy and estimations of pollutants. For improved accuracy, additional monitoring points must be considered at a distance from the project site. ***Ms. Inam Joudeh – Zarqa Environmental Directorate*** The Ministry of Environment along with the Royal Scientific Society (RSS) have set a continuous air quality monitoring program at several locations in the area which takes into account emissions from the old HTPS, the refinery and As-Samra WWTP. The results of such a monitoring program could be taken into account as part of the model to improve the accuracy of the modeling results. ***Mr. Ibrahim Masri – ECO Consult*** As stated earlier, the selection of the monitoring points has been based on several factors and focused on those areas where the greatest impacts on air quality are expected. At further distances from the project site (5-10km) the impact is expected to decrease significantly but nevertheless the modeling program will assess the impact in such areas based on estimations on baseline conditions. However, your comment will be taken into account and we will coordinate with the MoEnv to obtain the results of the continuous air quality monitoring program undertaken in the area to improve the accuracy of the modelling results.

3	***Mr. Emad Al-Darawi – Ministry of Environment*** There must be a continuous air quality monitoring program during the operation phase of the project to measure stack emissions. It is recommended that this program be coordinated with the Environmental Monitoring Department at the Ministry of Environment. ***Mr. Ibrahim Masri – ECO Consult*** As part of the EIA an Environmental Management Plan (EMP) is developed which identifies the mitigation and monitoring requirements that must be implemented during the construction and operation phase. Such an air quality monitoring program will be considered and taken into account, but this will be determined at a later stage during the EIA study and will depend on the results of the impact assessment.

B. Noise

1	***Mr. Emad Al-Darawi – Ministry of Environment*** You stated in the presentation that there will be 6 monitoring points for noise within the Project area and its surroundings which will measure noise levels during day and night. What will be the monitoring duration at each location? ***Mr. Ibrahim Masri – ECO Consult*** The monitoring will be undertaken for 1 hour during daytime and 1 hour during night-time at each monitoring point. Based on previous experiences, such duration is considered to be sufficient and representative of baseline conditions given that there are no significant sources of noise disturbances in the area which could significantly affect baseline measurements. ***Mr. Emad Al-Darawi – Ministry of Environment*** I believe noise monitoring should be conducted for a longer duration so that the results provide a more accurate representation of noise levels in the area. 1 hour of monitoring during daytime and 1 hour during night-time is not considered sufficient. ***Mr. Ken Wade – 5Capitals*** This issue has been studied and from our previous experiences in undertaking noise baseline measurements, 1 hour of monitoring during daytime and 1 hour of monitoring during night-time is considered sufficient to reflect noise levels within the area, especially that project site is not located close to airports or a busy highway or any other disturbing sources of noise. Taking that into account the actual noise levels would usually stabilize quickly, after the first ten minutes of monitoring. ***Mr. Ibrahim Masri – ECO Consult*** In addition, within the scoping report that will be submitted to the Ministry of Environment a detailed justification will be provided on why such a monitoring duration has been decided. As you know such a scoping report will be submitted to the Ministry of Environment for review, and should the Ministry still conclude that such duration is not representative of the actual conditions and require a longer monitoring period then this will be taken into account.

C. Soil and Groundwater

1	***Mr. Khaled Noubani – Jordan Petroleum Refinery Co.*** It is known that the Zarqa area has scarce water resources while on the other hand the Project is expected to require significant amounts of water. How will water be supplied for the project? And what are the expected impacts from such water requirements on the water supply in the area? ***Mr. Maher Tubeishat – CEGCO*** There are two options for water supply to the project. This will include a dedicated pipeline network from the Water Authority of Jordan (WAJ) whom the developer has already signed a water supply agreement with which it will provide 2,450m^3/week (350m^3/day) – while the project requirements are estimated at this stage at 100m^3/day (this will be confirmed at a later stage) AND/OR the second alternative will include 3 deep groundwater wells within the

	site. It is important to note that within the existing HTPS are currently 9 water wells but those will not be utilized given that the water quality is not suitable as the Total Dissolved Solid (TDS) is too high. ***Mr. Ibrahim Masri – ECO Consult*** I would also like to bring to your attention that the EIA will also study the potential impacts from the water requirements of the project on the local water resources in the area. The results of this study will be included within the EIA that will be submitted to the Ministry of Environment. ***Mr. Ali Almashani - Ministry of Environment*** Which is the better alternative, for water to be supplied through a pipeline from WAJ or through the 3 new deep water wells? ***Mr. Maher Tubeishat – CEGCO*** This has been thoroughly studied with WAJ, and it was found that the supply through a pipeline form WAJ is the best alternative, and hence an agreement has been signed. The 3 new water wells will be utilized in cases of emergency and during situations where WAJ cannot supply the required amount of water. In addition, the study concluded that the existing old wells within the HTPS cannot be used given that the water quality is not suitable as the Total Dissolved Solid (TDS) is too high and that is why 3 new water wells will be utilized for abstraction, which run deeper than the existing ones and have a lower TDS value. ***Mr. Khaled Moumani – Hashemite University*** The old wells lie within the Amman-Wadi Sir basin that is 50 – 60 meters deep with a TDS value of more than 3,000 mg/l. The newer well will run deeper and reach the A4 layer with a TDS value between 1000 – 1400 mg/l. ***Mr. Khaled Noubani – Jordan Petroleum Refinery Co.*** Will a Reverse Osmosis Unit be required if the water will be extracted from the deep wells? ***Mr. Maher Tubeishat – CEGCO*** Since salinity levels in these new well are much lower especially when compared to the existing wells, a Reverse Osmosis will not be required.
2	***Mr. Hussein Sharbati – Ministry of Environment*** The EIA must identify all waste streams that will be generated from the project and their estimated quantities. In addition, the EIA must also explain whether the evaporation ponds will be lined or not. Finally, the EIA must also ensure that the storage tanks for the fuels are bunded taking into account 110% of their storage capacity. ***Ms. Noura Alsharei – Ministry of Environment*** The EIA must detail how hazardous waste will be managed and disposed in a safe way with appropriate coordination with the Ministry of Environment. ***Mr. Ibrahim Masri – ECO Consult*** All those comments will be taken into account. The EIA will develop a detailed waste management plan which will identify the types of wastes expected, nature, quantities and the appropriate measures for their storage onsite and their final disposal. The plan will take into account all the requirements form the Ministry of Environment as stipulated within the various regulations and instruction on management of waste streams.

D. Community Health, Safety and Security

1	***Mr. Ghaleb Ahmad – Department of Land and Survey*** Will the Developer adopt any compensation measures to the local community for any environmental pollution incidents, such as air pollution? ***Mr. Ibrahim Masri – ECO Consult*** The EIA will identify and study all potential impacts from the Project on the local community and assign the appropriate mitigation and monitoring measures to be implemented throughout the project's construction and operation phase to ensure that such impacts are eliminated or reduced to acceptable levels. Nevertheless, taking the above into account, in the highly unlikely event that the Developer is responsible on his own for any unacceptable environmental pollution, then the developer will be committed to compensation towards the local communities which in any case is required as part of the laws and regulations of Jordan. ***Mr. Faisal Hamed – CEGCO***

	It should be noted that in comparison to the old thermal power plant the air quality will to some extent be improved given that emissions will be severely reduced as the new power plant will run on natural gas as opposed to the old plant which ran on heavy fuel oil. Moreover, the company will follow an integrated and strict environmental, health and safety management system to ensure compliance with all environmental requirements.
2	***Mr. Khaled Moumani - Energy and Minerals Regulatory Commission (EMRC)*** Since the project will be operational for 25 years, the concept of urbanization of Al-Hashimeyeh and Al-Zarqa should be taken into account and appropriate measures should be set to prevent urbanization in areas close to the thermal power plant. This could include for example the acquisition of land areas adjacent to the power plant to prevent any new community settlements close to the Project.

E. Worker Conditions and Occupational Health and Safety

1	***Mr. Sama'an Makhamreh – Ministry of Energy*** What will happen to the old employees of the HTPS? Will they be dismissed? This issue must be investigated as part of the EIA. ***Mr. Maher Tubeishat – CEGCO*** The employees of the old HTPS will not be dismissed but will retain their jobs either at the new power plant or other projects of CEGCO. There has been a clause defined with the Ministry of Energy that addresses this issue and states that arbitrary dismissal is forbidden. A work package will be offered to the employees, whom have the right to either accept or refuse the offered package. This will all be coordinated with the Ministry at a later stage. For example, at this stage 12 of the employees at the old HTPS have been transferred to work in the Aqaba Thermal Power Plant. In addition, the new power plant is expected to provide 100 new job opportunities.

F. Other

1	***Mr. Emad Al-Darawi – Ministry of Environment*** Will the EIA study cover the associated facilities of the project such as the pipeline route from the main gas pipeline to the project site? ***Mr. Maher Tubeishat – CEGCO*** The main pipeline with which this project will connect is located 900 -1000 meters east of the station and will be included in the EIA study. ***Mr. Ghaleb Ahmad – Department of Land and Survey*** With regards to the pipeline, will any land acquisition occur? ***Mr. Ibrahim Masri – ECO Consult*** At this point, the final detailed design of the pipeline has not been developed. At a later stage, when the design is finalized, the exact uses of these lands and their ownership (private or public) will be determined and should any acquisition be required it is expected that it will be undertaken in accordance with the laws and regulations of Jordan – mainly the Land Acquisition Law No. (12) of the year 1987 which sets in details the land acquisition process in relation to advertisements, compensation, grievances, etc. Anyways, as stated earlier this issue will be investigated as part of the EIA study as well. ***Mr. Maher Tubeishat – CEGCO*** It is important to note that the design and construction of the pipeline is the responsibility of NEPCO. Similarly, any land acquisition and compensation requirements will be undertaken by NEPCO and the relevant governmental entities such as the Ministry of Energy and the Department of Lands and Survey.
2	***Mr. Hussein Sharbati – Ministry of Environment*** The EIA must include an Environmental Emergency Response Plan which details procedures for dealing and handling of any environmental emergency which might occur at the Project site.

وزارة البيئة

نهضة

الرقم ع/ا/١٢٨٩١

التاريخ

الموافق ٢٠١٦/١/١٧

السادة .....

الموضوع : الحلقة التشاورية الخاصة بدراسة تقييم الأثر البيئي لمشروع توسعة محطة الحسين الحرارية الحالية في محافظة الزرقاء

تحية طيبة وبعد ،،

أرجو التكرم بالإيعاز لأحد مندوبيكم بحضور الحلقة التشاورية الخاصة بالمشروع المقترح أعلاه والتي ستعقد في تمام الساعة العاشرة من صباح يوم الاربعاء الموافق 2016/2/24 في فندق المريديان/عمان.

وتفضلوا بقبول فائق الإحترام ،،،

الدكتور طاهر راضي الشخشير

وزير البيئة

المهندس أحمد القطارنه

الأمين العام

دراسة تقييم الأثر البيئي
مشروع محطة الحسين الحرارية

- **المشروع:** مشروع محطة الحسين الحرارية
- **المطوّر:** شركة ACWA Power
- **المالك:** شركة محطة الزرقاء لتوليد الطاقة الكهربائية PSC
- **المقاول للهندسة والتوريد والإنشاء:** SEPCO III
- **التشغيل والصيانة:** شركة توليد الكهرباء المركزية CEGCO
- **المستشار البيئي:** شركة 5 Capitals و ECO Consult

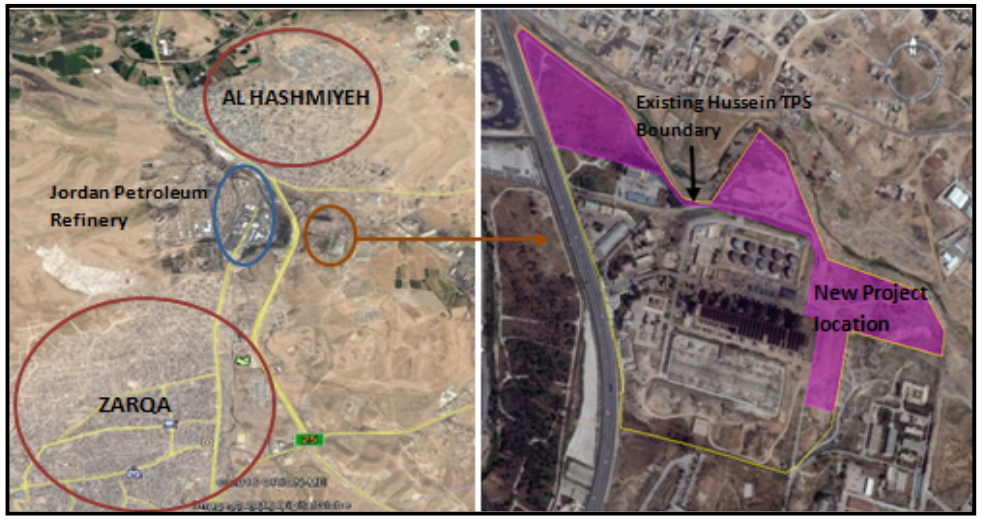
1. المقدمة

تقدمت شركة ACWA Power باقتراح لإنشاء محطة حرارية جديدة تعمل على الغاز الطبيعي بقدرة 485 ميغا واط في موقع محطة الحسين الحرارية في محافظة الزرقاء. وسيتم تزويد شركة الكهرباء الوطنية بالطاقة المولدة من المحطة الجديدة بموجب اتفاقية لشراء الطاقة لمدة 25 عام.

تأتي أهمية هذا المشروع نتيجة إغلاق محطة الحسين الحرارية الحالية في كانون الأول من عام 2015، بالإضافة إلى التزايد المستمر في الطلب على الطاقة الكهربائية في الأردن. وسيقوم المشروع المقترح بتوفير مصدر نظيف نسبياً للطاقة بكفاءة تشغيلية عالية مقارنة بمحطة الحسين الحرارية التي تم إغلاقها.

2. موقع المشروع

يقع المشروع في محافظة الزرقاء شمال الأردن، على بعد حوالي 25 كم من العاصمة عمان. ويقع بالتحديد ضمن المنطقة الصناعية التي تبعد مسافة 4 كم إلى الشمال الشرقي من مدينة الزرقاء (التي تعتبر مركز المحافظة)، وإلى الشمال من الموقع تقع مدينة الهاشمية. كما تقع شركة مصفاة البترول الأردنية غرب الموقع. وسيتم إنشاء المشروع المقترح بالكامل في الموقع الحالي لمحطة الحسين الحرارية كما هو مبين في الشكل 1 أدناه.



الشكل 1: موقع المشروع

3. مكونات المشروع

فيما يلي وصف لمكونات المشروع الرئيسية:

- 3 توربينات مولدة للطاقة الكهربائية تقوم بتوليد توليد الكهرباء مباشرة عن طريق حرق الغاز الطبيعي؛
- 3 مولدات بخار تقوم باسترداد الحرارة، حيث يتم استخدام الحرارة الناتجة من التوربينات المولدة للكهرباء في تحويل المياه إلى بخار؛
- توربين بخاري واحد، يتم من خلاله استخدام البخار الناتج من مولدات البخار لتوليد طاقة كهربائية إضافية في دورة التشغيل المركبة؛
- مكثفات تبريد بالهواء لغايات تبريد البخار الناتج من التوربين البخاري؛
- خزانات لوقود الديزل؛ ويعتبر الغاز الطبيعي هو الوقود الأساسي المستخدم لتوليد الطاقة، بينما يستخدم الديزل كوقود احتياطي في الحالات الطارئة؛
- محطة استقبال الغاز التي تقوم بنقل الغاز الطبيعي من خط الغاز الرئيسي (الذي يقع خارج موقع المشروع الى شرق) الى المحطة؛

- بئر عميق للمياه ومحطة ضخ داخل حدود موقع المشروع لتلبية احتياجاته من المياه، حيث سيتم ضخ المياه من البئر عند الحاجة؛
- مرافق تابعة وتشمل مكاتب إدارية وغرفة تحكم مركزية، وبركة تبخير للمياه، إلخ..

4. عرض عام لنشاطات المشروع

يُبين هذا الجزء النشاطات المحتملة والمتوقع حصولها خلال مراحل تنفيذ المشروع، والتي تشتمل على ثلاث مراحل منفصلة هي: (1) مرحلة التخطيط والإنشاء، (2) مرحلة التشغيل، و(3) مرحلة التفكيك

مرحلة التخطيط والإنشاء

من المتوقع أن تبدأ الأنشطة المتعلقة بمرحلة التخطيط والإنشاء بعد الحصول على كافة الموافقات اللازمة، والتي يتوقع الحصول عليها في الربع الثاني من عام 2016، ومن المتوقع أن تستمر المرحلة الإنشائية لمدة سنتين قبل بدء فترة التشغيل التجاري للمشروع المتوقعة في شهر حزيران من عام 2018. و فيما يلي قائمة بالأنشطة النموذجية لمرحلة التخطيط والإنشاء لهذا النوع من المشاريع:

- التخطيط والتصميم التفصيلي للمشروع ومكوناته؛
- تنفيذ أعمال تجهيز الموقع والتي تشتمل على: الحفريات وتنظيف الموقع وإزالة الطمم وغيرها؛
- تركيب الأساسات والأعمال المدنية للمنشآت والمعدات؛
- تركيب الأجهزة والمعدات.

مرحلة التشغيل

من المتوقع أن يتم التشغيل على مرحلتين، يجري في المرحلة الأولى تشغيل الدورة البسيطة (التي تشمل تشغيل توربينات الغاز لوحدها)، ويتلوها تشغيل الدورة المركبة في المرحلة الثانية (والتي تشمل تشغيل توربينات توليد الطاقة الكهربائية، ومولدات البخار، والتوربين البخاري). من المتوقع أن يبدأ تشغيل الدورة البسيطة في 1 كانون الأول من عام 2017 ، وتشغيل الدورة المركبة في 1 حزيران من عام 2018.

يتوقع استمرار مرحلة التشغيل لمدة 25 عام حسب اتفاقية شراء الطاقة. وستعتمد مرحلة التشغيل على الغاز الطبيعي مما يضمن كفاءة انتاجية أعلى وانبعاثات غازيّة أقل مقارنة بالمحطة السابقة.

مرحلة التفكيك

يجري في هذه المرحلة التخلّص من مكونات المشروع بعد انتهاء المرحلة التشغيلية، أي بعد مرور 25 عام. ولا تتوفر معلومات عن الأنشطة المتوقعة في هذه المرحلة.

5. التأثيرات البيئية المتوقعة للمشروع

سيؤدّي تنفيذ هذا المشروع إلى حصول جملة من التأثيرات الإيجابية والسلبية على البيئة المحيطة، والتي ستتم مناقشتها في الحلقة التشاورية.

من المهم تسليط الضوء على الآثار الإيجابية المتوقعة على الخصائص البيئية الناتجة عن إنشاء وتشغيل المشروع، وفيما يلي ملخص لأبرز هذه الآثار:

- توفير مصدر موثوق لتوليد الطاقة الكهربائية، والتي سوف تساعد على تلبية الزيادة في الطلب على الطاقة الكهربائية في الاردن.
- توفير مصدر نظيف للطاقة مقارنة بالمحطة الحرارية السابقة التي كانت تستخدم الوقود الثقيل، والتي كانت تعمل بقدرة إنتاجية منخفضة مقارنة بالمشروع المقترح.
- تخفيض كبير في انبعاثات غازات الدفيئة وانبعاثات التلوث مقارنة بالمحطة السابقة.
- توفير فرص عمل للمجتمع المحلي مما سيؤدي إلى تحسين الوضع الإقتصادي للمجتمع المحلي.

من المتوقع أن تكون هنالك آثار سلبية للمشروع، ولكن من المهم الإشارة إلى أن هذه الآثار السلبية ستكون أقل بكثير مما كانت عليه في المحطة السابقة ، وسيتم وضع إجراءات احترازية لرصد وتخفيف هذه الآثار.

وفيما يلي ملخص للآثار المتوقعة الناجمة عن المشروع في مراحله المختلفة:

ملخص للآثار المتوقعة الناجمة عن المشروع خلال مرحلة التخطيط والإنشاء

المجال	الآثار المحتملة للمشروع
التربة والمياه الجوفية	مخاطر طفيفة لتلوث التربة والمياه الجوفية بسبب الأنشطة الإنشائية والتي قد تشمل الإجراءات غير السليمة لتنظيف وترتيب الموقع، مثل الطرح العشوائي للمخلفات والمياه العادمة.
التنوع الحيوي (النباتي والحيواني)	مخاطر طفيفة نتيجة الأنشطة التحضيرية وتنظيف الموقع. حيث يُحتمل لهذه الأنشطة أن تخلّ بالموائل الطبيعية المتواجدة في منطقة المشروع.
المواقع الأثرية	من غير المحتمل حدوث أي تأثير بهذا الخصوص، غير أن الأعمال الإنشائية قد تتسبّب في إحداث أضرار لبقايا مواقع أثرية إن وجدت في منطقة المشروع.
نوعية الهواء/ الضجيج	تتضمن الأنشطة الإنشائية عمليات الحفر وتنظيف الموقع بالإضافة لحركة المركبات والآليات ونقل المعدات، والتي من المحتمل أن ينتج عنها زيادة في مستويات الغبار والملوثات ، والتي بدورها قد تؤثر على نوعية الهواء المحيط.
	من المتوقع حصول زيادة في مستويات الضجيج في البيئة المحيطة بالمشروع بسبب النشاطات الإنشائية، والتي من المحتمل أن تشتمل على استخدام الآليات والمعدات، إلا أن هذه النشاطات ستقتصر على الفترة النهارية فقط.
النقل والمواصلات	من المتوقع حصول زيادة في عدد المركبات التي تنتظر على طريق الخدمات المجاور لمدخل المحطة، إلا أنه لا يتوقع إغلاق الطرق أو تحويل السير.
الصحة والسلامة المهنية	هنالك بعض المخاطر التي قد تؤثر على صحة وسلامة العمال في الموقع خلال مرحلة الإنشاء.

ملخص للآثار المتوقعة الناجمة عن المشروع خلال المرحلة التشغيلية

المجال	الآثار المحتملة للمشروع
نوعية الهواء/ الضجيج	سينتج عن العمليات التشغيلية للمحطة الحرارية باستخدام الغاز الطبيعي انبعاثات للغازات الملوثة (كثاني أكسيد النيتروجين وأكسيد الكربون) بالإضافة لغازات الدفيئة في البيئة المحيطة. إلا أن هذه الانبعاثات أقل بكثير مقارنة بالمحطة السابقة.
	من المحتمل الزيادة في مستويات الضجيج في البيئة المحيطة بسبب النشاطات التشغيلية للمحطة.
التربة والمياه الجوفية	يحتاج المشروع خلال التشغيل إلى مياه والتي سيتم تزويدها من خلال استخدام المياه الجوفية من بئر في منطقة المشروع بشكل رئيسي، وقد يؤثرذلك على إحتياجات المنطقة من المياه مثل المجتمعات المحلية.
	قد ينتج عن المشروع تلوث التربة والمياه الجوفية خلال نشاطات التشغيل المختلفة والتي قد

المجال	الآثار المحتملة للمشروع
	تشمل الإجراءات غير السليمة لتنظيف وترتيب الموقع، مثل الطرح العشوائي للمخلفات والمياه العادمة والخزّانات وغيرها.
الصحة والسلامة المهنية	سوف يكون هناك بعض المخاطر على صحة العمال وسلامتهم خلال مرحلة تشغيل المشروع.

6. معلومات الاتصال

لمزيد من الاستفسارات أو التعليقات، يمكن الاتصال بـ:

ابراهيم المصري – مدير المشروع ، أو مكتب ECO Consult
بريد الكتروني: Ibrahim.masri@ecoconsult.jo
هاتف: 9769 569 6 962+
فاكس: 7264 569 6 962 +

Environmental Impact Assessment

Hussein Thermal Power Station Project

- **Project:** Hussein Thermal Power Station Project
- **Developer:** ACWA Power
- **Project Company (Owner):** Al Zarqa Electric Power Generation PSC
- **EPC Contractor:** SEPCO III
- **O&M Company:** Central Electricity Generating Company (CEGCO)
- **Environmental Consultant:** 5 Capitals and ECO Consult

1. INTRODUCTION

ACWA Power is to proposing to develop a new 485MW natural gas fired power plant within the existing landholding of the Hussein Thermal Power Station (Hussein TPS) located in Zarqa Governorate. The output from the power plant will be supplied to the National Electricity Power Company of Jordan (NEPCO) under a 25-year Power Purchase Agreement (PPA).

The requirement for the Project is due to the closure of the original Hussein TPS in December 2015 and the continued growth of electrical demand in Jordan. The proposed project will provide a cleaner energy source at a much improved operational efficiency compared to the original Hussein TPS plant.

2. PROJECT LOCATION

The Project site is located within Zarqa Governorate in the north of Jordan, around 25km northeast of the capital city of Amman. More specifically, the Project site is located within the Industrial Area located around 4km northeast of Zarqa City (the capital city of the Governorate) while to the north is located Al-Hashmiyeh city. To the west is also the existing Jordan Petroleum Refinery. The new proposed Project site is located within the existing boundaries of the Hussein TPS.

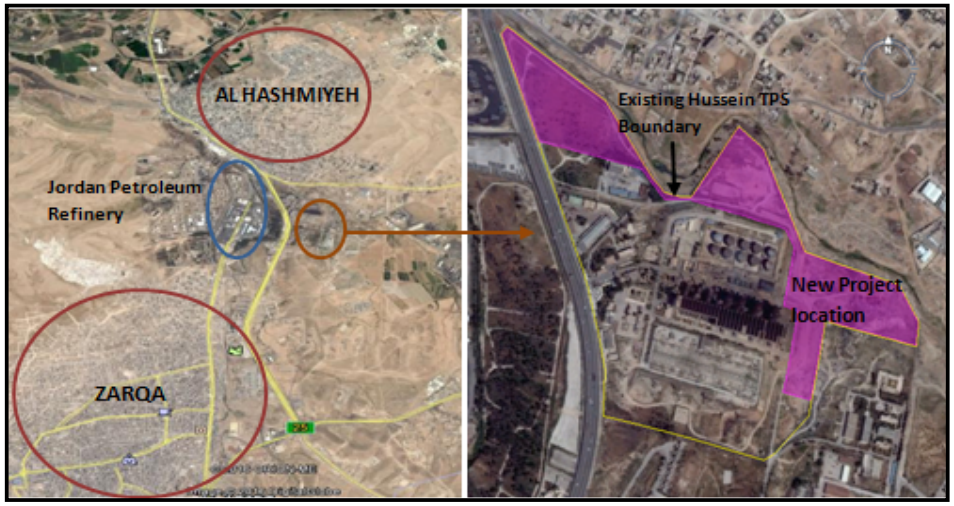


Figure 1: Project Location

3. PROJECT COMPONENTS

The following present the key components of the Project and which include the following:

- 3 Gas Turbine Generators which generate electricity directly from the combustion of fuel;
- 3 Heat Recovery Steam Generators (HRSG) which uses exhaust heat generated from gas turbines to convert water to steam;
- 1 Steam Turbine Generator that uses steam generated by the HRSG's to generate additional electricity under combined cycle operation;
- Air Cooled Condensers for dry cooling of steam turbine steam;
- Fuel Storage Tanks; Natural gas is the main fuel used, while Diesel fuel is a backup fuel used in emergency situations only;
- Gas Receiving Station to transfer incoming natural gas for the pipeline;

- Deepwater well and pumping station within the site boundary for process water will only be used to top up process water as required; and
- Ancillary facilities including administration building, central control room, evaporation ponds, etc.

4. OVERVIEW OF PROJECT ACTIVITIES

This section presents the likely activities to take place during the Project development and which will include: (i) planning and construction, (ii) operation and (iii) decommissioning each of which is summarized below.

Planning and Construction Phase

Typical activities during the planning and construction phase for the Project are summarized below. Construction activities for the project are expected to commence once all necessary project approvals are obtained and which is expected in the 2nd Quarter of 2016. Construction duration is anticipated to last for approximately 2 years.

- Detailed and final planning and design for the project and its components;
- Site preparation activities which include excavations, clearing and levelling;
- Installation of foundation and civil works for structures and equipment;
- Installation of equipment.

Operation Phase

Operation is expected to commence in two separate phases for simple cycle operation (Gas Turbines operation alone) and combined cycle operation (Gas Turbines and HRSG & Steam Turbines in combination). Simple cycle operation is expected to commence on 1st December 2017, while combined cycle operation is due for 1st June 2018.

The operational phase will continue for 25 years in accordance with the PPA.

The operational phase will predominantly generate power in combined cycle operation fuelled by natural gas. This will ensure high efficiency power generation, with low air emissions.

Decommissioning Phase

Decommissioning of the proposed repowering project will be as a minimum after 25 years of operations. Information regarding decommissioning activities is not available at this stage.

5. ANTICIPATED ENVIRONMENTAL IMPACTS FROM THE PROJECT

Implementation of the Project will give rise to several potential positive and negative impacts on certain environmental attributes all of which will be discussed throughout the project scoping session.

It is important to highlight the positive environmental impacts that are anticipated from the development of the project. These impacts are summarised below:

- Provision of a reliable source of electrical generation which will help to meet the increasing electricity demands in Jordan;
- The project will generate a much cleaner form of energy compared with the previous Hussein TPS which operated on Heavy Fuel Oil with a low efficiency;
- A substantial reduction in GHG and pollution emissions compared to the previous Hussein TPS;
- The project is expected to generate local employment, particularly during the construction and operation phase and subsequently enhance socio-economic conditions of local communities.

Several negative impacts are anticipated from the Project, however it should be noted that these will be vastly reduced compared to the previous Hussein TPS plant and will be subject to mitigation measures and monitoring. Such impacts are summarised in the tables below for each phase of the Project development.

Summary of Anticipated Impacts during the Planning and Construction Phase

Attribute	Likely Project Impact
Soil, Geology and Groundwater	Minor risk of soil and groundwater contamination during the various construction activities from improper housekeeping activities, spillage of hazardous material, waste and wastewater, etc.
Biodiversity (Flora/Fauna)	Minor impacts to ecology due to the largely cleared nature of the enclosed project site. Various construction activities could potentially disturb existing habitats within the site.
Archaeology	Considered unlikely, however various earthworks have the potential to disturb/damage sub-surface archaeological

	remains if present within the site.
Air Quality/Noise	Various construction activities could result in an increased level of dust from excavations and unpaved vehicle movements. Vehicles and construction plant may also lead to gaseous pollutant emissions.
	Various construction activities will likely result in noise emissions to the environment. Any noisy construction works will however be limited to daylight periods.
Traffic and Transportation	Potential for waiting vehicles on the service road adjacent to the entrance of the existing Hussein TPS. No road closures or diversions are expected.
Occupational Health and Safety	Generic occupational health and safety risks from working on construction sites.

Summary of Anticipated Impacts during the Operation Phase

Attribute	Likely Project Impact
Air Quality and Noise	Operation of the thermal power plant on natural gas will result in air pollutant emissions (e.g. NO_2 and CO) as well as greenhouse gas emissions to the surrounding environment. Impacts are significantly reduced compared to the original Hussein TPS.
	Operation of the thermal power plant will likely result in noise emissions to the surrounding environment.
Soil, Geology and Groundwater	Depending on water availability and supply, water requirements for the Project could affect local water resources and uses of local communities.
	Risk of soil and groundwater contamination during the various operation activities from improper housekeeping activities, spillage of hazardous material, waste and wastewater, storage tanks, etc.
Occupational Health and Safety	Generic occupational health and safety risks during operation.

6. CONTACT INFORMATION

For further questions and comments please contact:

Ibrahim Masri – Project Manager, or ECO Consult office

E-mail: Ibrahim.masri@ecoconsult.jo

Phone: +962 6 569 9769

Fax: +962 6 569 7264

Appendix G

Diffusion Tube Laboratory Results (2016)

gradko environmental
(A division of Gradko International Ltd.)
St. Martins House, 77 Wales Street Winchester, Hampshire SO23 0RH
tel.: 01962 860331 fax: 01962 841339 e-mail:diffusion@gradko.co.uk

ilac-MRA UKAS TESTING 2187

LABORATORY ANALYSIS REPORT

DETERMINATION OF ACID GASES IN DIFFUSION TUBES BY ION CHROMATOGRAPHY

REPORT NUMBER X5449R

BOOKING IN REFERENCE No X5449

DESPATCH NOTE No SOR27562

CUSTOMER 5 Capitals Environmental & Management Consulting
PO Box 119899
Sheikh Zayed Road, Dubai
UAE

DATE SAMPLES RECEIVED 26/02/2016

GRADKO LAB REF GIN 18301-18312
JOB REFERENCE Hussein TPS

				NITROGEN DIOXIDE			
Tube Identification	Date On	Date Off	Exposure (hrs)	µg NO_2 Total	µgNO_2 - Blank	NO_2 µg/m^3*	NO_2 ppb*
669880 A-1(A)	27/01/16	23/02/16	649.50	0.81	0.81	16.70	8.69
669881 A-1(B)	27/01/16	23/02/16	649.50	0.78	0.77	16.06	8.35
669883 A-2(A)	27/01/16	23/02/16	648.75	0.76	0.76	15.70	8.17
669882 A-2(B)	27/01/16	23/02/16	648.75	0.73	0.73	15.16	7.89
669884 A-3(A)	27/01/16	23/02/16	648.75	1.18	1.18	24.53	12.76
669885 A-3(B)	27/01/16	23/02/16	648.75	1.17	1.17	24.22	12.59
669886 A-4(A)	27/01/16	23/02/16	649.00	0.79	0.79	16.42	8.54
669887 A-4(B)	27/01/16	23/02/16	649.00	0.88	0.87	18.15	9.44
669888 A-5(A)	27/01/16	23/02/16	648.25	0.88	0.88	18.34	9.53
669889 A-5(B)	27/01/16	23/02/16	648.25	0.80	0.80	16.53	8.59
669892 A-6(A)	27/01/16	23/02/16	647.75	0.75	0.75	15.60	8.11
669893 A-6(B)	27/01/16	23/02/16	647.75	0.78	0.78	16.19	8.42
Lab Blank				0.002			

(RESULTS ARE BLANK CORRECTED)

OVERALL M.U. ±14.9% **REPORTING LIMIT** 0.05µg NO_2^-

Analysed on Dionex ICS1100 ICU10 **ANALYST NAME** B. Gregory

DATE OF ANALYSIS 10/03/2016 **DATE OF REPORT** 11/03/2016

ANALYSIS HAS BEEN CARRIED OUT IN ACCORDANCE WITH IN-HOUSE METHOD GLM3

REPORT OFFICIALLY CHECKED

Gradko International Ltd
This signature confirms the authenticity of these results
Signed.....
L. Gates, Laboratory Manager

gradko environmental
(A division of Gradko International Ltd.)
St. Martins House, 77 Wales Street Winchester, Hampshire SO23 0RH
tel.: 01962 860331 fax: 01962 841339 e-mail:diffusion@gradko.co.uk

ilac-MRA UKAS TESTING 2187

LABORATORY ANALYSIS REPORT

DETERMINATION OF ACID GASES IN DIFFUSION TUBES BY ION CHROMATOGRAPHY

Tube Identification	Date On	Date Off	Exposure (hrs)	SULPHUR DIOXIDE µg S Total	µgS - Blank	SO_2 µg/m^3*	SO_2 ppb*
669880 A-1(A)	27/01/16	23/02/16	649.50	0.39	0.39	21.96	8.23
669881 A-1(B)	27/01/16	23/02/16	649.50	0.37	0.36	20.49	7.69
669883 A-2(A)	27/01/16	23/02/16	648.75	0.26	0.26	14.57	5.46
669882 A-2(B)	27/01/16	23/02/16	648.75	0.32	0.32	17.85	6.69
669884 A-3(A)	27/01/16	23/02/16	648.75	0.74	0.74	41.65	15.62
669885 A-3(B)	27/01/16	23/02/16	648.75	0.68	0.68	38.13	14.30
669886 A-4(A)	27/01/16	23/02/16	649.00	0.18	0.17	9.63	3.61
669887 A-4(B)	27/01/16	23/02/16	649.00	0.23	0.23	12.91	4.84
669888 A-5(A)	27/01/16	23/02/16	648.25	0.32	0.31	17.60	6.60
669889 A-5(B)	27/01/16	23/02/16	648.25	0.19	0.19	10.60	3.97
669892 A-6(A)	27/01/16	23/02/16	647.75	0.34	0.33	18.69	7.01
669893 A-6(B)	27/01/16	23/02/16	647.75	0.36	0.35	19.93	7.47
Lab Blank				0.004			

(RESULTS ARE BLANK CORRECTED)

OVERALL M.U. ±14.9% **REPORTING LIMIT** 0.03µg S

Analysed on Dionex ICS1100 ICU10 **ANALYST NAME** B. Gregory

DATE OF ANALYSIS 10/03/2016 **DATE OF REPORT** 11/03/2016

ANALYSIS HAS BEEN CARRIED OUT IN ACCORDANCE WITH IN-HOUSE METHOD GLM3

REPORT OFFICIALLY CHECKED

Gradko International Ltd
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Signed.....
L. Gates, Laboratory Manager

gradko environmental
(A division of Gradko International Ltd.)
St. Martins House, 77 Wales Street Winchester, Hampshire SO23 0RH
tel.: 01962 860331 fax: 01962 841339 e-mail:diffusion@gradko.co.uk

2187

LABORATORY ANALYSIS REPORT

DETERMINATION OF OZONE IN DIFFUSION TUBES BY ION CHROMATOGRAPHY

REPORT NUMBER K01316R
BOOKING IN REFERENCE No K01316
DESPATCH NOTE No 27562
CUSTOMER 5 Capitals Environmental & Management Consulting Attn: Max Burrow
Sheikha Sana Bldg, Svite 203
Sheikh Zayed Road,
Dubai
United Arab Emirates
DATE SAMPLES RECEIVED 26/02/2016
JOB NUMBER Hussein TPS

Location	Sample Number	Date Exposed	Date Finished	Exposure Hours	µg on Tube Total	µg - Blank	O_3 µg/m^3*	O_3 ppb*
A-1 (A)	669894	27/01/2016	23/02/2016	649.50	0.56	0.55	48.89	24.45
A-1 (B)	669895	27/01/2016	23/02/2016	649.50	0.77	0.76	67.47	33.74
A-2 (A)	669896	27/01/2016	23/02/2016	648.75	0.64	0.62	55.48	27.74
A-2 (B)	669897	27/01/2016	23/02/2016	648.75	0.63	0.62	55.11	27.55
A-3 (A)	669898	27/01/2016	23/02/2016	648.75	0.62	0.61	54.05	27.02
A-3 (B)	669899	27/01/2016	23/02/2016	648.75	0.52	0.50	44.95	22.47
A-4 (A)	669900	27/01/2016	23/02/2016	649.00	0.90	0.89	79.29	39.64
A-4 (B)	669901	27/01/2016	23/02/2016	649.00	0.78	0.77	68.23	34.11
A-5 (A)	669902	27/01/2016	23/02/2016	648.25	0.70	0.69	61.57	30.79
A-5 (B)	669903	27/01/2016	23/02/2016	648.25	0.71	0.70	62.47	31.24
A-6 (A)	669906	27/01/2016	23/02/2016	647.75	0.68	0.66	59.17	29.58
A-6 (B)	669907	27/01/2016	23/02/2016	647.75	0.60	0.59	52.56	26.28
Laboratory Blank					0.01			

Comment: Results are blank subtracted

Overall M.U. ±10.0%
Analysed on Dionex ICS3000 ICU5

Reporting Limit 0.096µg O_3

Analyst Name Katya Paldamova

Date of Analysis 09/03/2016

Date of Report 10/03/2016

Analysis has been carried out in accordance with in-house method GLM 2

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L. Gates, Laboratory Manager

(A division of Gradko International Ltd.)
St. Martins House, 77 Wales Street Winchester, Hampshire SO23 0RH
tel.: 01962 860331 fax: 01962 841339 e-mail:diffusion@gradko.co.uk

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LABORATORY ANALYSIS REPORT

REPORT NUMBER	**K01348R**
CUSTOMER	**5 Capitals Environmental & Management Consulting**
	P.O.Box 119899
	Sheikh Zayed Rd
	Dubai, UAE
GRADKO LAB REFERENCE	**03K0231-0238**
DATE SAMPLES RECEIVED	**26.02.2016**
DESPATCH REF.NUMBER	**27562**
JOB NUMBER	**Hussein TPS**
BOOKING IN REF.	**X5450**

QUANTITATIVE ANALYSIS FOR BTEX ON CG1TD DIFFUSION TUBES BY GCMS
IDENTIFICATION AND ESTIMATION (SEMI-QUANTITATIVE ANALYSIS) FOR TOP 5 VOC ON CG1TD DIFFUSION TUBES BY GC/MS
Analysis has been carried out in accordance with in-house method GLM 13

Index to UKAS Accreditation Status	
U	Analysis is UKAS accredited under our Fixed Scope
F	Analysis is UKAS accredited under our Flexible Scope
N	Analysis is not UKAS accredited

Tube Number	**GRA 10939**			
Tube Location	**A-1 (A)**			
Exposure Time (mins)	**38970**			
	Accreditation			
BTEX	**Status**	**ng on tube**	**ppb in air***	**µgm^{-3}***
Benzene	**U**	26.09	0.36	1.13
Toluene	**U**	93.53	1.16	4.27
Ethylbenzene	**U**	23.08	0.31	1.29
m/p-Xylene	**U**	74.25	0.98	4.16
o-Xylene	**U**	28.88	0.38	1.62
TOP 5 VOC		**ng on tube**	**ppb in air***	**µgm^{-3}***
Butane, 2-methyl-	**N**	61.53	0.79	2.27
Pentane	**F**	51.45	0.66	1.90
Pentane, 2-methyl-	**N**	48.28	0.62	2.13
Hexane	**F**	36.67	0.47	1.62
Heptane	**F**	24.60	0.32	1.26

Tube Number	**GRA 11183**			
Tube Location	**A-1 (B)**			
Exposure Time (mins)	**38970**			
	Accreditation			
BTEX	**Status**	**ng on tube**	**ppb in air***	**µgm^{-3}***
Benzene	**U**	29.58	0.41	1.28
Toluene	**U**	107.23	1.33	4.89
Ethylbenzene	**U**	24.99	0.33	1.40
m/p-Xylene	**U**	79.46	1.05	4.46
o-Xylene	**U**	30.59	0.40	1.72

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L. Gates, Laboratory Manager

gradko environmental
(A division of Gradko International Ltd.)
St. Martins House, 77 Wales Street Winchester, Hampshire SO23 0RH
tel.: 01962 860331 fax: 01962 841339 e-mail:diffusion@gradko.co.uk

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LABORATORY ANALYSIS REPORT

TOP 5 VOC		ng on tube	ppb in air*	µgm^{-3}*
Butane, 2-methyl-	N	59.43	0.76	2.20
Pentane, 2-methyl-	N	54.00	0.69	2.38
Pentane	F	51.20	0.66	1.89
Hexane	F	41.42	0.53	1.83
Heptane	F	26.89	0.34	1.38

Tube Number	**GRA 11011**
Tube Location	**A-4 (B)**
Exposure Time (mins)	**38940**

BTEX	Accreditation Status	ng on tube	ppb in air*	µgm^{-3}*
Benzene	U	31.41	0.44	1.36
Toluene	U	109.36	1.36	4.99
Ethylbenzene	U	19.05	0.25	1.07
m/p-Xylene	U	54.54	0.72	3.06
o-Xylene	U	20.97	0.28	1.18

TOP 5 VOC		ng on tube	ppb in air*	µgm^{-3}*
Butane, 2-methyl-	N	75.52	0.97	2.79
Pentane	F	65.11	0.84	2.41
Pentane, 2-methyl-	N	60.63	0.78	2.68
Hexane	F	36.03	0.46	1.59
Pentane, 3-methyl-	N	22.47	0.29	0.99

Tube Number	**GRA 11153**
Tube Location	**A-2 (B)**
Exposure Time (mins)	**38880**

BTEX	Accreditation Status	ng on tube	ppb in air*	µgm^{-3}*
Benzene	U	34.51	0.48	1.50
Toluene	U	98.76	1.23	4.52
Ethylbenzene	U	24.55	0.33	1.38
m/p-Xylene	U	73.22	0.97	4.12
o-Xylene	U	27.98	0.37	1.57

TOP 5 VOC		ng on tube	ppb in air*	µgm^{-3}*
Butane, 2-methyl-	N	66.32	0.85	2.46
Pentane	F	61.96	0.80	2.29
Pentane, 2-methyl-	N	53.37	0.69	2.36
Hexane	F	38.03	0.49	1.68
Pentane, 3-methyl-	N	25.25	0.32	1.12

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gradko environmental
(A division of Gradko International Ltd.)
St. Martins House, 77 Wales Street Winchester, Hampshire SO23 0RH
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LABORATORY ANALYSIS REPORT

Tube Number	**GRA 11683**			
Tube Location	**A-3 (A)**			
Exposure Time (mins)	**38940**			
	Accreditation			
BTEX	**Status**	**ng on tube**	**ppb in air***	**µgm^{-3}***
Benzene	**U**	60.55	0.84	2.62
Toluene	**U**	204.82	2.75	10.13
Ethylbenzene	**U**	50.21	0.62	2.62
m/p-Xylene	**U**	142.70	1.75	7.43
o-Xylene	**U**	56.70	0.70	2.95
TOP 5 VOC		**ng on tube**	**ppb in air***	**µgm^{-3}***
Pentane	**F**	204.57	2.63	7.56
Butane, 2-methyl-	**N**	198.18	2.54	7.33
Pentane, 2-methyl-	**N**	163.94	2.11	7.24
Hexane	**F**	145.83	1.87	6.44
Heptane	**F**	99.15	1.27	5.09

Tube Number	**GRA 11128**			
Tube Location	**A-3 (B)**			
Exposure Time (mins)	**38940**			
	Accreditation			
BTEX	**Status**	**ng on tube**	**ppb in air***	**µgm^{-3}***
Benzene	**U**	60.25	0.84	2.61
Toluene	**U**	199.61	2.48	9.11
Ethylbenzene	**U**	48.22	0.64	2.71
m/p-Xylene	**U**	139.80	1.85	7.85
o-Xylene	**U**	55.09	0.73	3.09
TOP 5 VOC		**ng on tube**	**ppb in air***	**µgm^{-3}***
Pentane	**F**	202.24	2.60	7.48
Butane, 2-methyl-	**N**	198.60	2.55	7.34
Pentane, 2-methyl-	**N**	171.30	2.20	7.57
Hexane	**F**	142.66	1.83	6.30
Heptane	**F**	92.99	1.19	4.78

Tube Number	**GRA 10225**			
Tube Location	**A-4 (A)**			
Exposure Time (mins)	**38940**			
	Accreditation			
BTEX	**Status**	**ng on tube**	**ppb in air***	**µgm^{-3}***
Benzene	**U**	37.40	0.52	1.62
Toluene	**U**	124.77	1.55	5.70
Ethylbenzene	**U**	21.24	0.28	1.19
m/p-Xylene	**U**	61.44	0.81	3.45
o-Xylene	**U**	23.19	0.31	1.30

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gradko environmental
(A division of Gradko International Ltd.)
St. Martins House, 77 Wales Street Winchester, Hampshire SO23 0RH
tel.: 01962 860331 fax: 01962 841339 e-mail:diffusion@gradko.co.uk

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LABORATORY ANALYSIS REPORT

TOP 5 VOC		ng on tube	ppb in air*	µgm^{-3}*
Butane, 2-methyl-	N	91.50	1.17	3.38
Pentane	F	77.51	1.00	2.87
Pentane, 2-methyl-	N	64.70	0.83	2.86
Hexane	F	46.40	0.60	2.05
Pentane, 3-methyl-	N	25.64	0.33	1.13

Tube Number	**GRA 11061**
Tube Location	**A-2 (A)**
Exposure Time (mins)	**38940**

BTEX	Accreditation Status	ng on tube	ppb in air*	µgm^{-3}*
Benzene	U	36.58	0.51	1.58
Toluene	U	105.56	1.31	4.82
Ethylbenzene	U	26.30	0.35	1.48
m/p-Xylene	U	79.95	1.06	4.49
o-Xylene	U	30.58	0.40	1.72

TOP 5 VOC		ng on tube	ppb in air*	µgm^{-3}*
Butane, 2-methyl-	N	81.25	1.04	3.00
Pentane	F	70.47	0.90	2.61
Pentane, 2-methyl-	N	61.03	0.78	2.70
Heptane	F	24.44	0.31	1.26
Pentane, 3-methyl-	N	23.26	0.30	1.03

UPTAKE RATES
Benzene 1.85ng.ppm^{-1}.min^{-1}
Toluene 2.07ng.ppm^{-1}.min^{-1}
Ethylbenzene 1.94ng.ppm^{-1}.min^{-1}
Xylenes 1.94ng.ppm^{-1}.min^{-1}
All other compounds: 2.00 ng.ppm^{-1}.min^{-1}.

Identification and estimation results for ng on tube are calculated using toluene standards.
Overall MU 13.7% for quantitative analysis of BTEX compounds.

		Date of Analysis	**01.03.2016**
Analysts Name	**G. Aikman**	**Date of Report**	**10.03.2016**

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Appendix H

Continuous Air Quality Monitoring Results (2016)

الاكاديمية الوطنية للبيئة
National Academy for Environment

Data Collection Methods

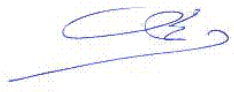
The methods in bellow are used for data collection:

Parameter(s)	Method
NO, NO2, NOx	Direct-reading - Chemiluminescence method
CO	Direct-reading- electrochemical cell
PM10 and PM2.5	Continuous direct mass method using a tapered element oscillating microbalance analyzer.
SO2	Direct-reading -electrochemical cell.
Wind Speed, Wind Direction, Ambient Temperature, and Relative Humidity	Meteorological Monitoring Guidance + our thermal Environment Monitor (EQUEST Brand) and wind sensor (Vaisala Brand)

- **All equipment's used for monitoring equipped with data logging meter stores all of reading up to 250 logs.**

- **Data was download from the devices and placed in the Excel- tables**
- **The geographical location of measuring site is specified by ECO Consult.**

Occupational and Environmental Health Specialist



"Muhamed Fuad" Khalefeh Banny Awwad

هاتف: 962-6-5350650+ فاكس 962-6-5330434+
بريد الكتروني: abja958@orange.jo ص

الاكاديمية الوطنية للبيئة
National Academy for Environment

Results of Ambient Air Quality Monitoring

At

Al-Husain Thermal Power Station – Zarqa

During 22– 29 March 2016

For

Eco-Consult

Prepared by

Occupational and Environmental Health Specialist

Muhamed Fuad" Khalefeh Banny Awwad

1st April 2016

هاتف: 962-6-5350650+ فاكس 962-6-5330434+ خلوي 962-79-5758689+ 962-777-296305+
بريد الكتروني: abja958@orange.jo ص.ب. 2358 الجبيهة 11941 عمان- الاردن

الاكاديمية الوطنية للبيئة
National Academy for Environment

Ambient Air Quality Data Report

Date : 22.03.2016

Geographical Position: **32.11923 N and 036.12859** E

Duration (24 Hours)

Weather Condition: **(**Cloudy, Wind direction: West North, Wind speed = 16 km/hr. Humidity: 46% and Temperature: 19Ċ)

Table 1.1

Average Air Quality Levels (in µg/m3) with respect to 24-hourly average Standard

S.N	Parameters	Unit	Concentrations (Readings)			Maximum Allowable Concentration ($\mu g/m^3$)
			Average	Min	Max	
1	PM_{10}	$\mu g/m^3$/24 Hrs.	39.2	20.2	59.9	120
2	$PM_{2.5}$	$\mu g/m^3$/24 Hrs.	23.0	17.6	29.4	65
3	SO_2	$\mu g/m^3$/24 Hrs.	1.42	0.3	4.20	20*
4	NO	$\mu g/m^3$/24 Hrs.	15.0	8.8	27.0	
5	NO_2	$\mu g/m^3$/24 Hrs.	7.0	3.6	13.0	200*
6	NO_x	$\mu g/m^3$/24 Hrs.	17.5	10.6	26.0	
7	CO	$\mu g/m^3$/8 Hrs.	251.7	190.0	330.0	15000*

*** WHO Ambient Air Quality Standard**

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بريد الكتروني: abja958@orange.jo ص.ب. 2358 الجبيهة 11941 عمان- الاردن

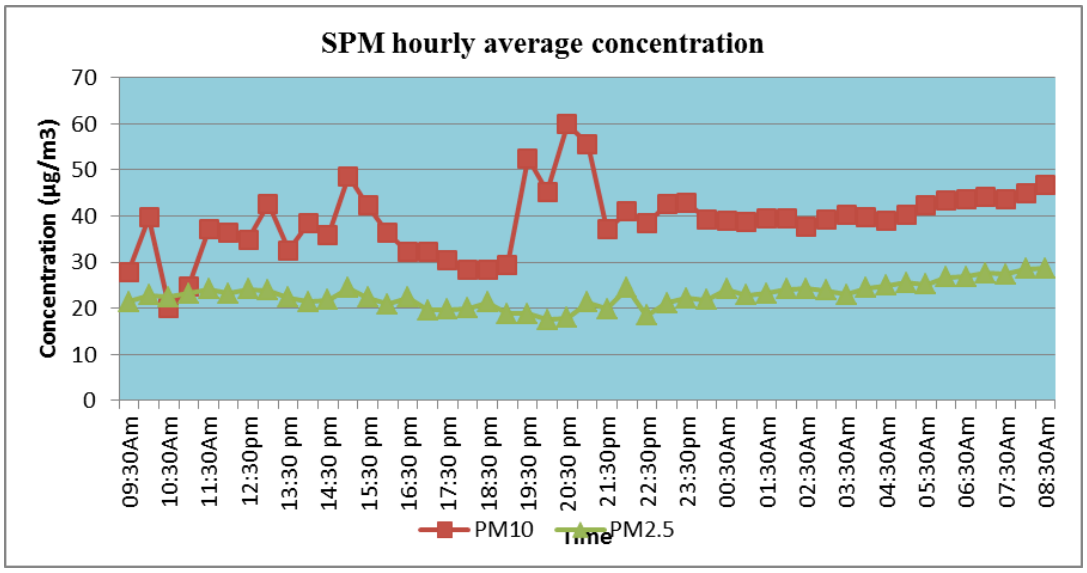

Figure1: PM $_{10}$ and PM 2.5concentrations (24- hour average) 22.3.2016

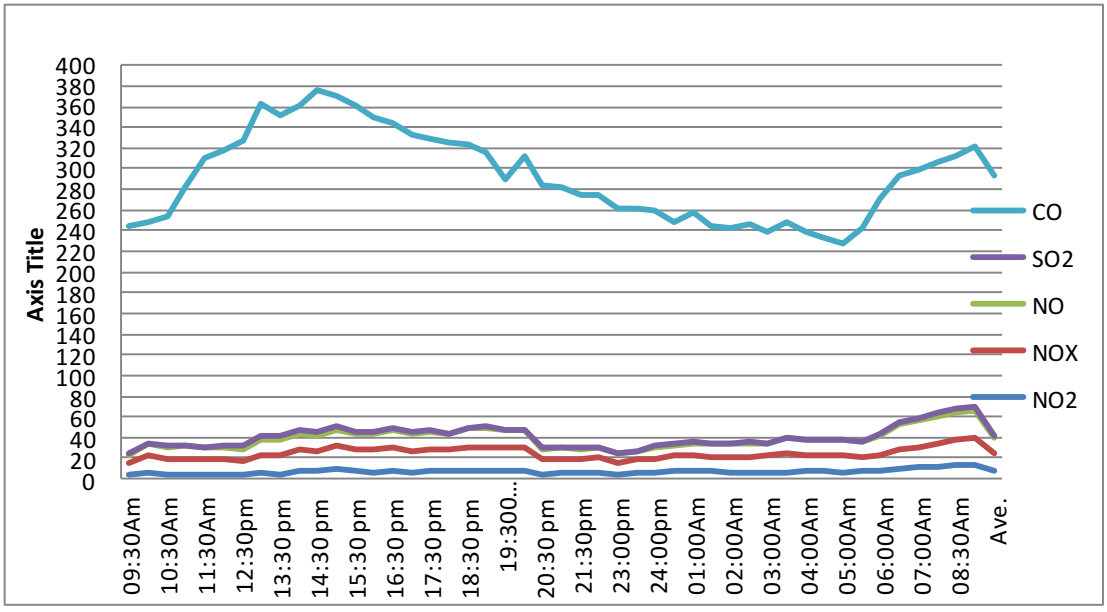

Figure 2: CO, SO2, NO, NO2, NOx, Concentrations (24-hour average) 22.3.2016

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بريد الكتروني: abja958@orange.jo ص.ب. 2358 الجبيهة 11941 عمان- الاردن

الاكاديمية الوطنية للبيئة
National Academy for Environment

Ambient Air Quality Data Report

Date : 23.03.2016

Geographical Position: **32.11923 N and 036.12859** E

Duration (24 Hours)

Weather Condition: **(**partially Cloudy, Wind direction: South East, Wind speed = 21 km/hr. Humidity: 15% and Temperature: 26Ċ)

Table 1.1

Average Air Quality Levels (in µg/m3) with respect to 24-hourly average Standard

S.N	Parameters	Unit	Concentrations (Readings)			Maximum Allowable Concentration ($\mu g/m^3$)
			Average	Min	Max	
1	PM_{10}	$\mu g/m^3$/24 Hrs.	42.6	30.3	55.6	120
2	$PM_{2.5}$	$\mu g/m^3$/24 Hrs.	24.8	18.3	34.2	65
3	SO_2	$\mu g/m^3$/24 Hrs.	1.54	0.4	4.6	20*
4	NO	$\mu g/m^3$/24 Hrs.	15.7	9.7	28.5	
5	NO_2	$\mu g/m^3$/24 Hrs.	7.7	4.6	13.9	200*
6	NO_x	$\mu g/m^3$/24 Hrs.	17.5	8.2	27.0	
7	CO	$\mu g/m^3$/24 Hrs.	256.9	192.0	330.0	15000*

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هاتف: 962-6-5350650+ فاكس 962-6-5330434+ خلوي 962-79-5758689+ 962-777-296305+
بريد الكتروني: abja958@orange.jo ص.ب. 2358 الجبيهة 11941 عمان- الاردن

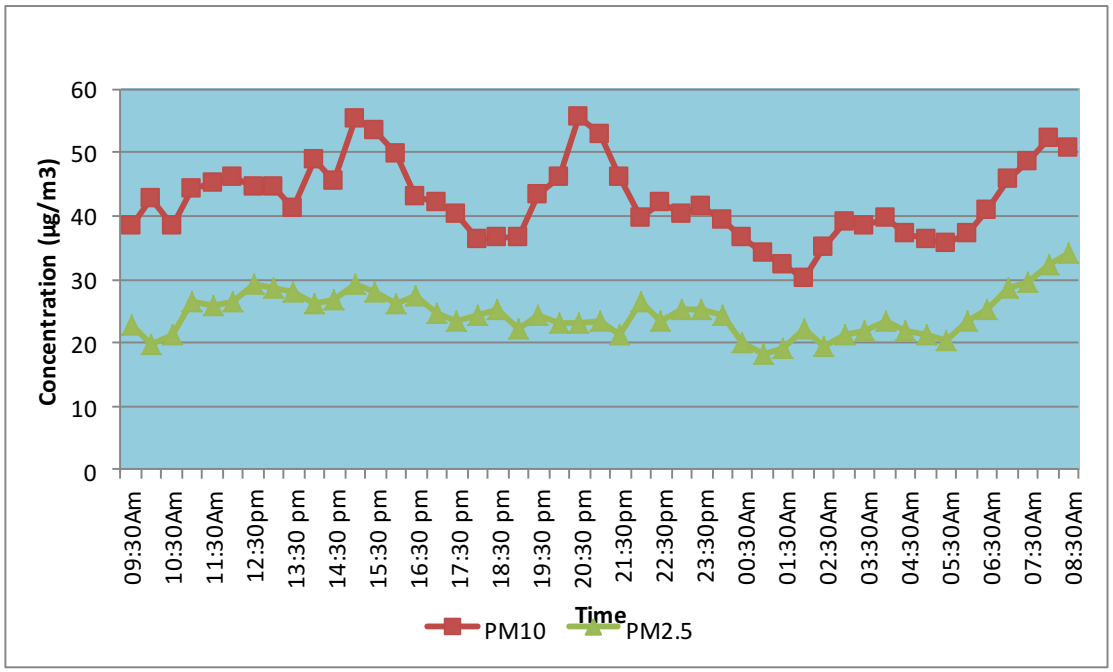

Figure1: PM $_{10}$ and PM 2.5concentrations (24- hour average) 23.3.2016

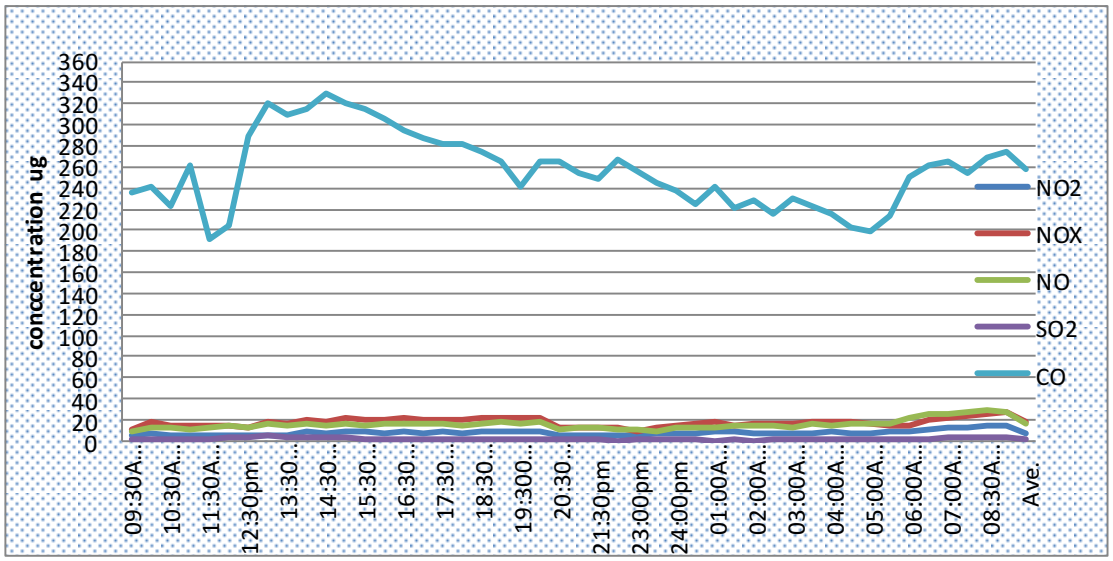

Figure 2: CO, SO2, NO, NO2, NOx, Concentrations (24-hour average) 23.3.2016

هاتف: 5350650-6-962+ فاكس 5330434-6-962+ خلوي 5758689-79-962+ 296305-777-962+
بريد الكتروني: abja958@orange.jo ص.ب. 2358 الجبيهة 11941 عمان- الاردن

الاكاديمية الوطنية للبيئة
National Academy for Environment

Ambient Air Quality Data Report

Date : 24.03.2016

Geographical Position: **32.11923 N and 036.12859** E

Duration (24 Hours)

Weather Condition: **(**partially Cloudy, Wind direction: South East, Wind speed = 18 km/hr. Humidity: 34% and Temperature: 22Ċ)

Table 1.1

Average Air Quality Levels (in µg/m3) with respect to 24-hourly average Standard

S.N	Parameters	Unit	Concentrations (Readings)			Maximum Allowable Concentration ($\mu g/m^3$)
			Average	Min	Max	
1	PM_{10}	$\mu g/m^3$/24 Hrs.	43.0	32.2	57.5	120
2	$PM_{2.5}$	$\mu g/m^3$/24 Hrs.	29.1	20.2	39.5	65
3	SO_2	$\mu g/m^3$/24 Hrs.	1.53	0.40	3.60	20*
4	NO	$\mu g/m^3$/24 Hrs.	15.4	10.2	25.4	
5	NO_2	$\mu g/m^3$/24 Hrs.	8.1	4.6	13.2	200*
6	NO_x	$\mu g/m^3$/24 Hrs.	19.5	13.8	28.2	
7	CO	$\mu g/m^3$/24 Hrs.	268.2	195.5	345.0	15000*

*** WHO Ambient Air Quality Standard**

هاتف: 5350650-6-962+ فاكس 5330434-6-962+ خلوي 5758689-79-962+ 296305-777-962+
بريد الكتروني: abja958@orange.jo ص.ب. 2358 الجبيهة 11941 عمان- الاردن

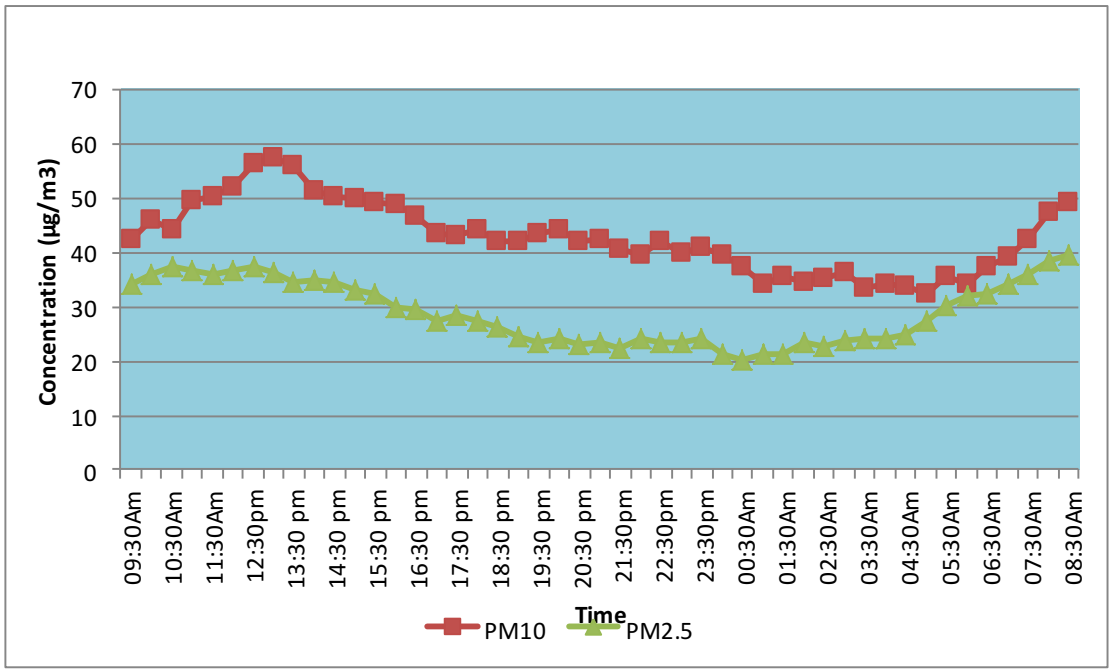

Figure1: PM $_{10}$ and PM 2.5concentrations (24- hour average) 24.3.2016

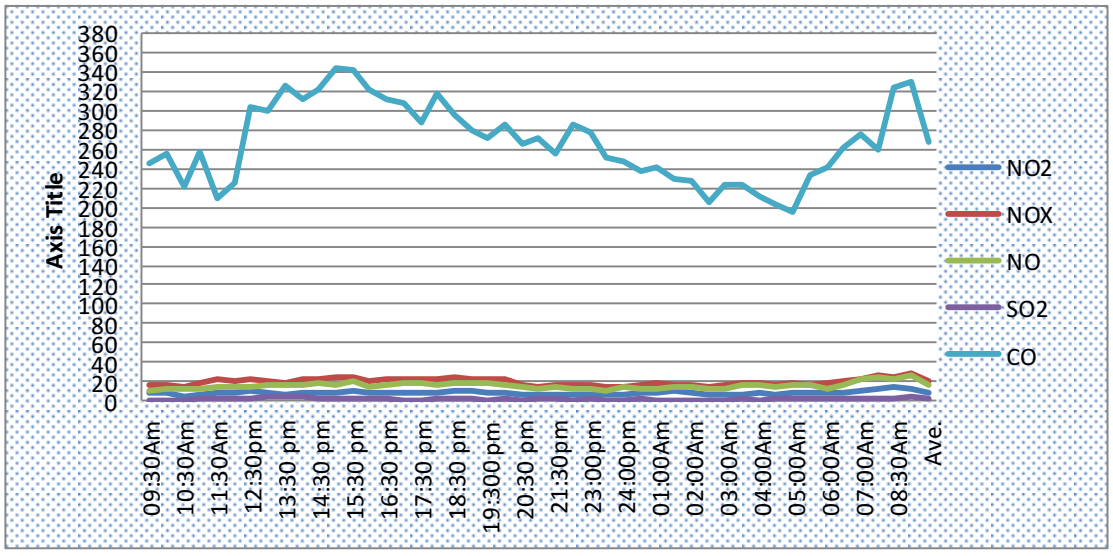

Figure 2: CO, SO2, NO, NO2, NOx, Concentrations (24-hour average) 24.3.2016

هاتف: 962-6-5350650+ فاكس 962-6-5330434+ خلوي 962-79-5758689+ 962-777-296305+
بريد الكتروني: abja958@orange.jo ص.ب. 2358 الجبيهة 11941 عمان- الاردن

الاكاديمية الوطنية للبيئة
National Academy for Environment

Ambient Air Quality Data Report

Date : 25.03.2016

Geographical Position: **32.11923 N and 036.12859** E

Duration (24 Hours)

Weather Condition: **(**partially Cloudy, Wind direction: East, Wind speed = 26 km/hr. Humidity: 43% and Temperature: 25Ċ)

اجواء خماسينية

Table 1.1

Average Air Quality Levels (in µg/m3) with respect to 24-hourly average Standard

S.N	Parameters	Unit	Concentrations (Readings)			Maximum Allowable Concentration ($\mu g/m^3$)
			Average	Min	Max	
1	PM_{10}	$\mu g/m^3$/24 Hrs.	53.9	31.0	72.3	120
2	$PM_{2.5}$	$\mu g/m^3$/24 Hrs.	36.1	24.6	47.2	65
3	SO_2	$\mu g/m^3$/24 Hrs.	1.86	0.50	3.90	20*
4	NO	$\mu g/m^3$/24 Hrs.	16.10	11.20	22.30	
5	NO_2	$\mu g/m^3$/24 Hrs.	9.10	5.90	14.0	200*
6	NO_x	$\mu g/m^3$/24 Hrs.	21.70	15.50	30.20	
7	CO	$\mu g/m^3$/8 Hrs.	276.8	188.9	366.9	15000*

*** WHO Ambient Air Quality Standard**

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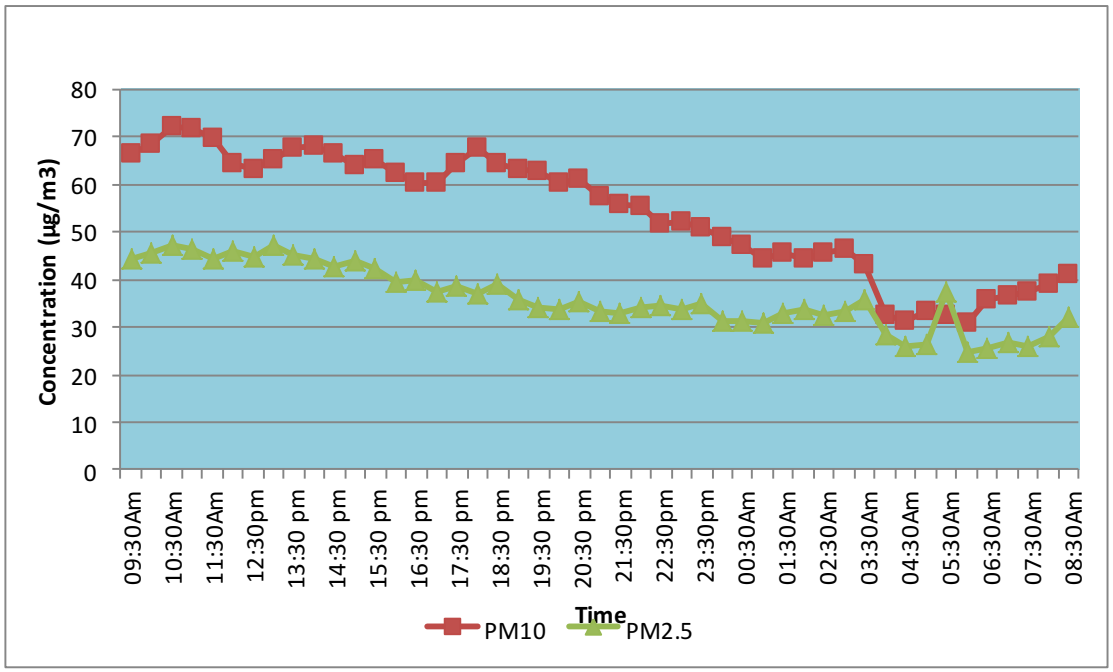

Figure1: PM $_{10}$ and PM 2.5concentrations (24- hour average) 25.3.2016

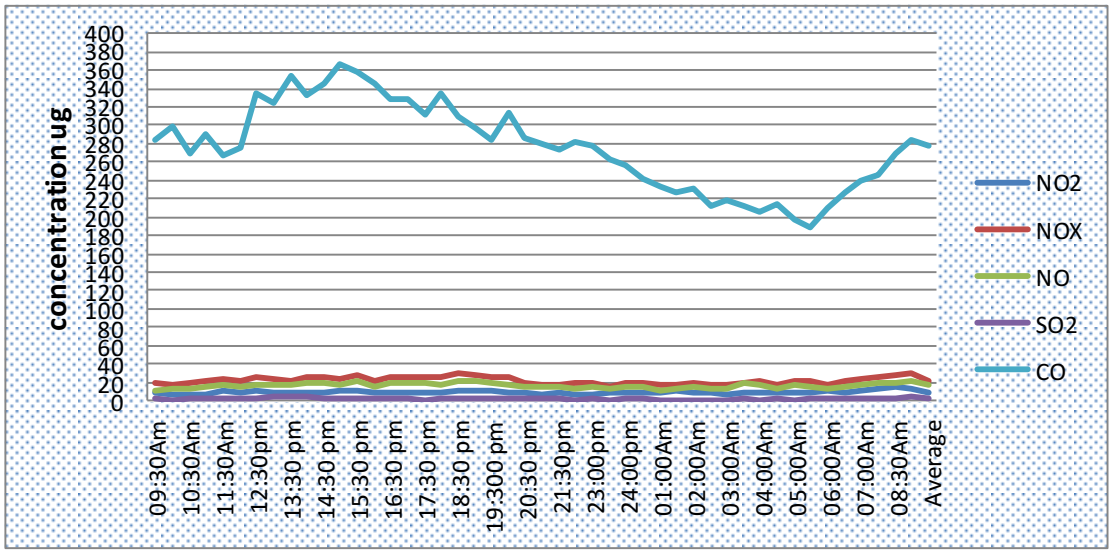

Figure 2: CO, SO2, NO, NO2, NOx, Concentrations (24-hour average) 25.3.2016

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National Academy for Environment

Ambient Air Quality Data

Date : 26.03.2016

Geographical Position: **32.11923 N and 036.12859** E

Duration (24 Hours)

Weather Condition: **(**Cloudy with scattered rain, Wind direction: West, Wind speed = 18 km/hr. Humidity: 60% and Temperature: 21Ċ)

Table 1.1

Average Air Quality Levels (in µg/m3) with respect to 24-hourly average Standard

S.N	Parameters	Unit	Concentrations (Readings)			Maximum Allowable Concentration ($\mu g/m^3$)
			Average	Min	Max	
1	PM_{10}	$\mu g/m^3$/24 Hrs.	37.70	28.70	48.50	120
2	$PM_{2.5}$	$\mu g/m^3$/24 Hrs.	27.50	21.00	36.30	65
3	SO_2	$\mu g/m^3$/24 Hrs.	1.54	0.60	2.80	20*
4	NO	$\mu g/m^3$/24 Hrs.	11.8	10.4	15.3	
5	NO_2	$\mu g/m^3$/24 Hrs.	8.00	6.60	11.20	200*
6	NO_x	$\mu g/m^3$/24 Hrs.	17.70	15.30	21.60	
7	CO	$\mu g/m^3$/24 Hrs.	248.40	178.90	315.30	15000*

*** WHO Ambient Air Quality Standard**

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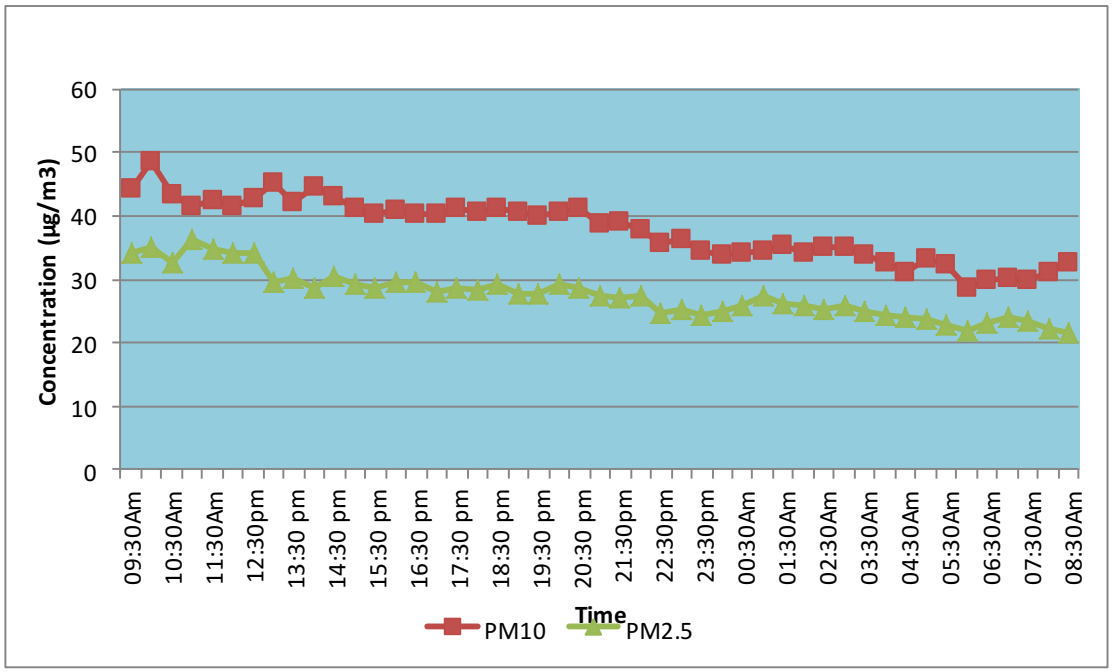

Figure1: PM $_{10}$ and PM 2.5concentrations (24- hour average) 26.3.2016

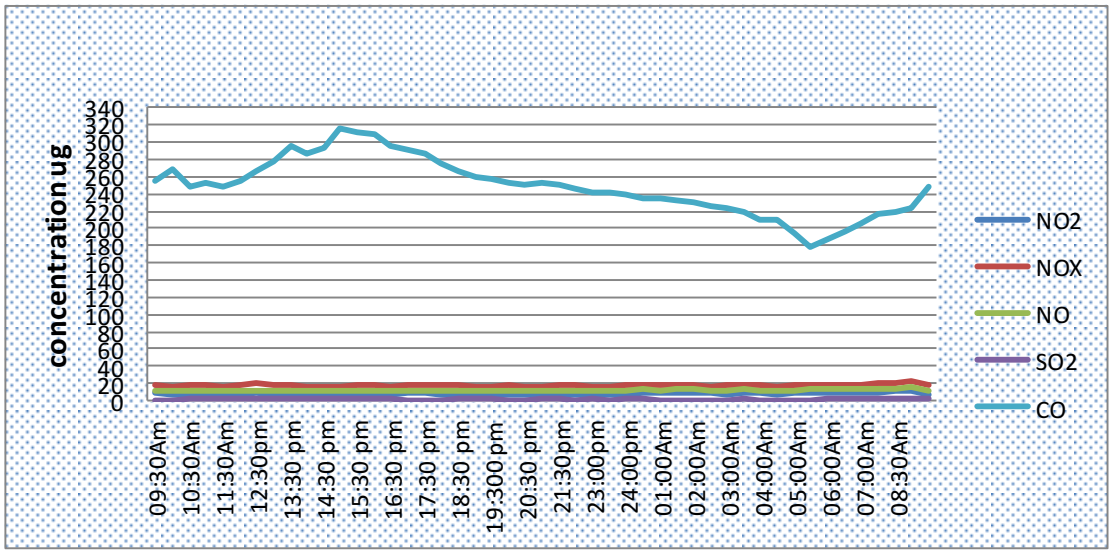

Figure 2: CO, SO2, NO, NO2, NOx, Concentrations (24-hour average) 26.3.2016

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بريد الكتروني: abja958@orange.jo ص.ب. 2358 الجبيهة 11941 عمان- الاردن

الاكاديمية الوطنية للبيئة
National Academy for Environment

Ambient Air Quality Data Report

Date : 27.03.2016

Geographical Position: **32.11923 N and 036.12859** E

Duration (24 Hours)

Weather Condition: **(**Cloudy with scattered rain, Wind direction: West, Wind speed = 18 km/hr. Humidity: 60% and Temperature: 21Ċ)

Table 1.1
Average Air Quality Levels (in µg/m3) with respect to 24-hourly average Standard

S.N	Parameters	Unit	Concentrations (Readings)			Maximum Allowable Concentration ($\mu g/m^3$)
			Average	Min	Max	
1	PM_{10}	$\mu g/m^3$/24 Hrs.	34.3	25.0	43.3	120
2	$PM_{2.5}$	$\mu g/m^3$/24 Hrs.	22.4	16.5	31.2	65
3	SO_2	$\mu g/m^3$/24 Hrs.	1.36	0.6	2.40	20*
4	NO	$\mu g/m^3$/24 Hrs.	8.10	6.40	10.60	
5	NO_2	$\mu g/m^3$/24 Hrs.	7.40	5.80	8.90	200*
6	NO_x	$\mu g/m^3$/24 Hrs.	15.50	13.50	18.20	
7	CO	$\mu g/m^3$/24 Hrs.	222.6	188.6	263.5	15000*

*** WHO Ambient Air Quality Standard**

هاتف: 5350650-6-962+ فاكس 5330434-6-962+ خلوي 5758689-79-962+ 296305-777-962+
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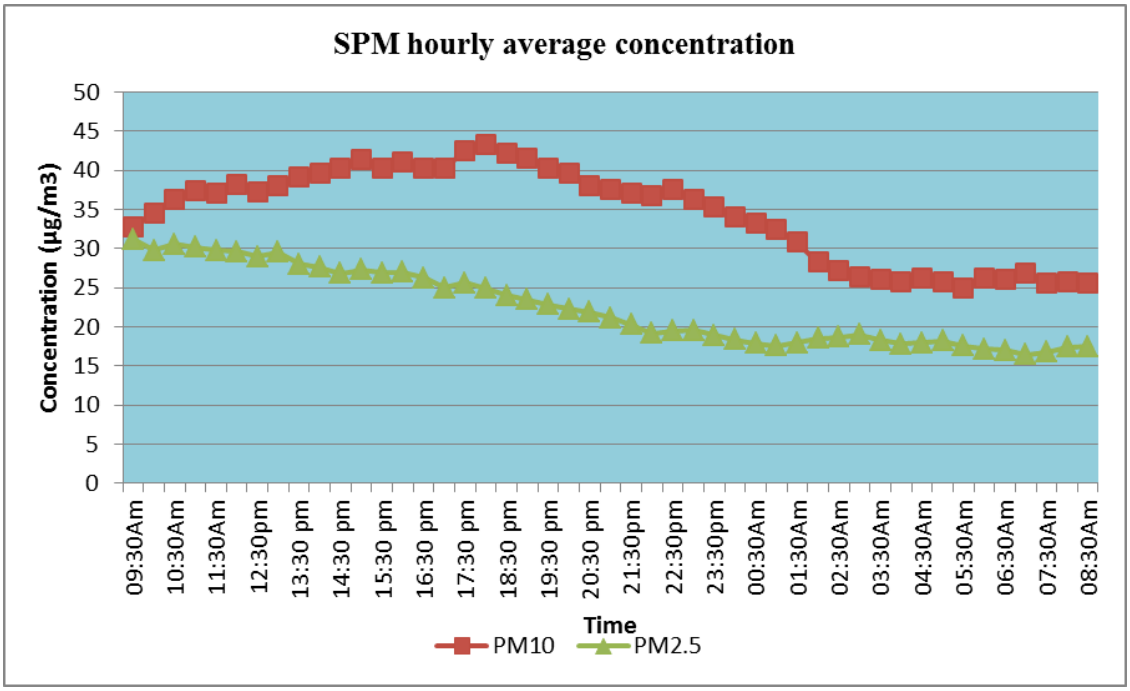

Figure1: PM $_{10}$ and PM 2.5concentrations (24- hour average) 27.3.2016

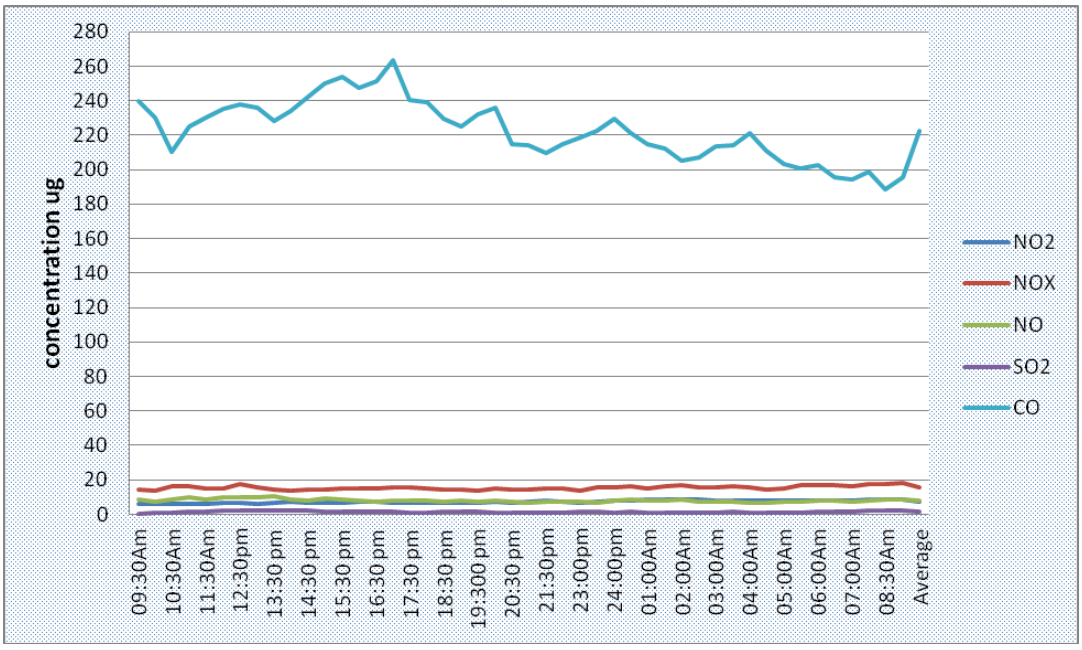

Figure 2: CO, SO2, NO, NO2, NOx, Concentrations (24-hour average) 27.3.2016

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بريد الكتروني: abja958@orange.jo ص.ب. 2358 الجبيهة 11941 عمان- الاردن

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Ambient Air Quality Data

Date : 28.03.2016

Geographical Position: **32.11923 N and 036.12859** E

Duration (24 Hours)

Weather Condition: **(**Rainy, Wind direction: West, Wind speed = 18 km/hr. Humidity: 87% and Temperature: 14Ċ)

Table 1.1
Average Air Quality Levels (in µg/m3) with respect to 24-hourly average Standard

S.N	Parameters	Unit	Concentrations (Readings)			Maximum Allowable Concentration ($\mu g/m^3$)
			Average	Min	Max	
1	PM_{10}	$\mu g/m^3$/24 Hrs.	31.5	26.8	33.8	120
2	$PM_{2.5}$	$\mu g/m^3$/24 Hrs.	18.3	16.0	21.3	65
3	SO_2	$\mu g/m^3$/24 Hrs.	1.01	0.20	1.80	20*
4	NO	$\mu g/m^3$/24 Hrs.	6.70	0.00	7.60	
5	NO_2	$\mu g/m^3$/24 Hrs.	5.80	5.2	6.70	200*
6	NO_x	$\mu g/m^3$/24 Hrs.	13.40	11.30	14.60	
7	CO	$\mu g/m^3$/24 Hrs.	208.60	187.90	238.80	15000*

*** WHO Ambient Air Quality Standard**

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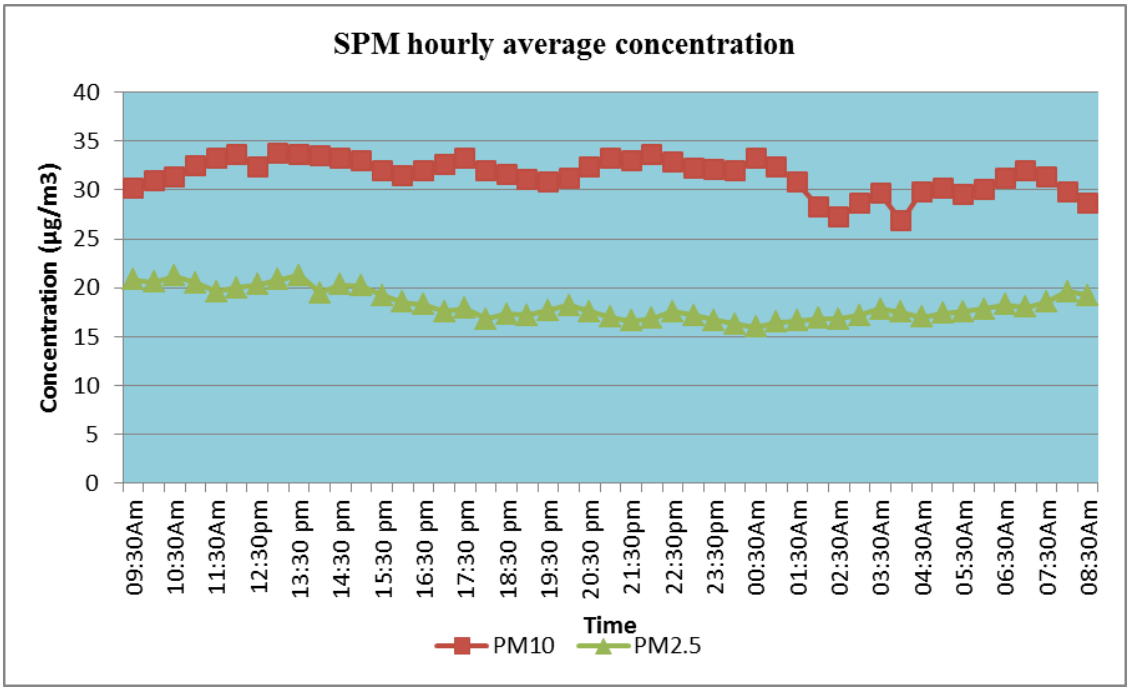

Figure1: PM $_{10}$ and PM 2.5concentrations (24- hour average) 28.3.2016

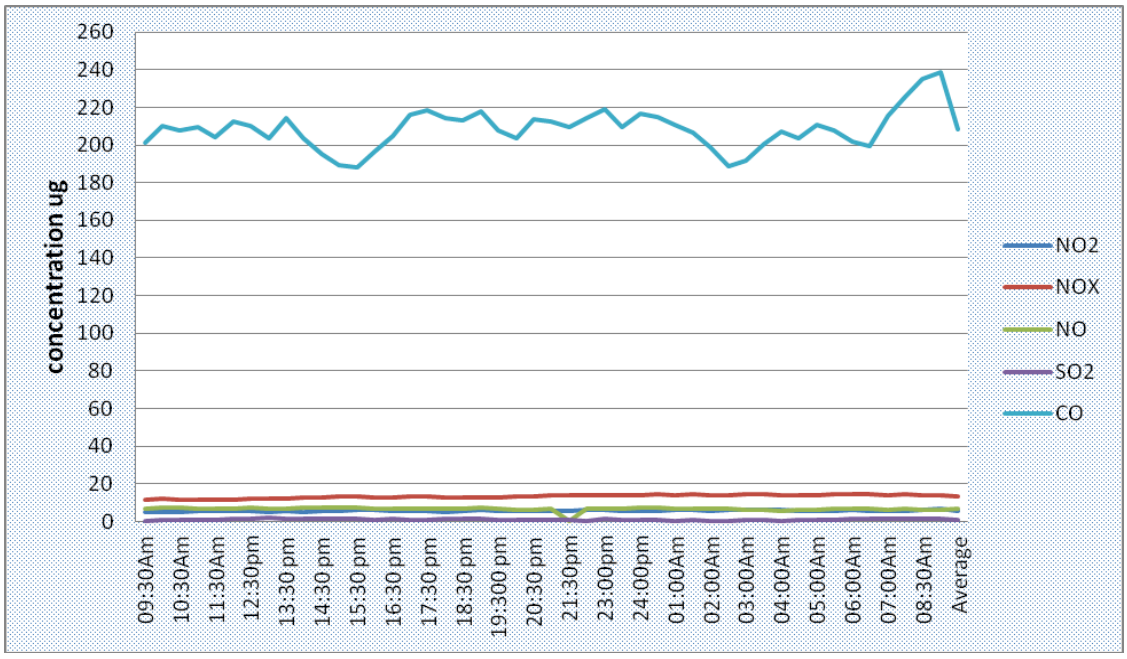

Figure 2: CO, SO2, NO, NO2, NOx, Concentrations (24-hour average) 28.3.2016

هاتف: 5350650-6-962+ فاكس 5330434-6-962+ خلوي 5758689-79-962+ 296305-777-962+
بريد الكتروني: abja958@orange.jo ص.ب. 2358 الجبيهة 11941 عمان- الاردن

Ambient Air Analysis

- The concentration of PM_{10} and $PM_{2.5}$ at monitoring site was found below the Maximum Allowable Concentration limits.

- The concentration of CO, SO2, and NO_2 at monitoring site was found below the Maximum Allowable Concentration limits.

Note: All measurements were performed at 1.5 meter above ground level.
No Exceedences noted during monitoring period for all measurements.

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بريد الكتروني: abja958@orange.jo ص.ب. 2358 الجبيهة 11941 عمان- الاردن

Appendix I

Predictive Emissions Dispersion Modelling Report

Hussein TPS Power Generation Project, Zarqa, Jordan

Air Quality Impact Assessment

Hussein TPS Power Generation Project, Zarqa, Jordan

Air Quality Impact Assessment

Revision	Date	Notes	Author	Checked	Approved
1	11/04/16	E1766	SD	ND	Dr N Davey

Entran Limited
12 Greenway Farm
Bath Road
Wick
Bristol
BS30 5RL

T: 0117 937 4077
www.entranltd.co.uk

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CONTENTS **PAGE**

1 INTRODUCTION

1.1 Entran Ltd has been commissioned to undertake an assessment of the predicted local air quality impacts arising from the operation of the proposed Hussein Thermal Power Station (HTPS) Power Generation Project at Zarqa, Jordan.

1.2 The HTPS location is presented in Figure 1; the Site boundary is shown in yellow and the Project area in purple). The Site is located in an industrial area, approximately 25 km northeast of Amman and 4km northeast of the centre of Zarqa. The nearest sensitive residential receptor (Hashmiyeh) is approximately 250m north of the Site.

Figure 1: Location of the Hussein TPS Project

1.3 The proposed power block will comprise three gas turbines, three heat recovery steam generators (HRSG) and one steam turbine. The typical operational regime of the plant will be combined cycle, whereby the gas turbines operate in parallel with the HRSGs and steam turbine. Emissions to air would be via a 60 m main stack (4.8 m in diameter).

1.4 In simple cycle mode, emissions from the gas turbines would vent directly to air via a 45 m (5.4 m diameter) bypass stack.

1.1 The primary fuel for the HTPS will be natural gas, with low sulphur (< 0.2%wt) light diesel oil (LDO) as a back-up fuel.

1.2 The impact on air quality of the new turbines in both combined and simple cycle mode, using both natural gas and LDO has been assessed.

1.3 A detailed air quality dispersion modelling assessment has been undertaken to determine impacts associated with the proposed. Dispersion modelling has been carried out using the United States (US) Environmental Protection Agency (EPA) AERMOD dispersion model and three years of meteorological data from Amman Airport (2013 to 2015). This is the most recent data available for the area that is suitable for dispersion modelling.

1.4 The key pollutants considered in this assessment are: oxides of nitrogen (NOx as NO_2), particles (as PM_{10}), sulphur dioxide (SO_2) and carbon monoxide (CO). Predicted ground-level concentrations are compared with relevant air quality standards and guidelines.

1.5 A background monitoring study has been undertaken around the proposed HTPS to establish current air quality conditions to determine potential cumulative impacts at receptor locations.

1.6 A glossary of common air quality terminology is provided in **Appendix A.**

2 LEGISLATION, POLICY AND ASSESSMENT CRITERIA

The Hashemite Kingdom of Jordan Ministry of Environment

2.1 Emissions of NOx and SO_2 from the HTPS will be compliant with the Jordanian emission standards[1], as detailed in Table 2.1.

Table 2.1: Jordanian Maximum Permissible Emission Rates

Pollutant	Averaging Period	Guideline Value ($\mu g/m^3$)
Nitrogen Dioxide	1-hour	1,500
Sulphur Dioxide	1-hour	6,500

2.2 Ambient air quality standards for Jordan are specified in JS 1140/2006. The standards for NO_2, CO, SO_2 and PM_{10} are presented in Table 2.2.

Table 2.2: Jordanian Air Quality Standards for Ambient Air Quality

Pollutant	Averaging Period	ppm	$\mu g/m^3$
Carbon Monoxide	8-hour	9	9,920 (a)
	1-hour	26	28,708 (a)
Nitrogen Dioxide	1-hour	-	400
	24-hour	0.08	145 (a)
	Annual	0.05	91 (a)
Sulphur Dioxide	1-hour	-	786
	24-hour	0.14	353
	Annual	-	114
Particulate Matter (as PM_{10})	24-hour	-	120
	Annual	-	70
(a) Conversion from ppm to $\mu g/m^3$ assumes an ambient temperature of 36°C and atmospheric pressure of 101.3 kPa			

International Finance Corporation World Bank Group

2.3 The IFC Guidelines[2] recommend the use of national legislated standards, or in their absence, the current World Health Organisation (WHO) Air Quality Guidelines.

2.4 A summary of the IFC guideline values for NO_2, SO_2 and PM_{10} is provided in Table 2.3. In addition to the guideline values the IFC also specifies interim targets for SO_2 and PM_{10} in recognition of the need for a staged approach to achieving the guideline value.

Table 2.3: IFC Guideline Values

Pollutant	Averaging Period	Guideline Value ($\mu g/m^3$)
Nitrogen Dioxide	1-year	40
	1-hour	200
Sulphur Dioxide	24-hour	125 (Interim target 1)
		50 (Interim target 2)
		20
	10-minute	500
Particulate Matter (as PM_{10})	1-year	70 (Interim target 1)
		50 (Interim target 2)
		30 (Interim target 3)
		20
	24-hour	150 (Interim target 1)
		100 (Interim target 2)
		75 (Interim target 3)
		50

The Equator Principles

2.5 The Equator Principles provides a set of standards for financial investors to assess the social and environmental risk of a project. In air quality terms, a proposed facility satisfies the Equator Principles if compliance with the IFC air quality guideline values is demonstrated.

Degraded Airsheds

2.6 The term 'Airshed' refers to the local area around a facility or complex of facilities that is directly affected by emissions from the facility or complex. There are a number of factors that can potentially affect the size of a relevant airshed, including plant characteristics, stack height, meteorological conditions and topography.

[1] JS 1189/2006

[2] International Finance Corporation World Bank Group, General EHS Guidelines: Environmental. Air Emissions and Ambient Air Quality, April 2007.

2.7 For new power plants in degraded airsheds, the IFC[3] states that new facilities should minimise incremental impacts by achieving the emission values set out in Table 2.4. The IFC also state that where these emission values result in excessive ambient impacts relative to local regulatory standards, the project should explore and implement site-specific off-sets that result in no net increase in the total emissions of those pollutants. Off-set provisions should be implemented before the power plant comes fully on stream.

2.8 Suitable offset measures could include reductions in emissions of particulate matter, sulphur dioxide or nitrogen dioxide, as necessary through:

(a) *the installation of new or more effective controls at other units within the same power plant or at other power plants in the same airshed,*

(a) the installation of new or more effective controls at other large sources, such as district heating plants or industrial plants, in the same airshed, or

(b) investments in gas distribution or district heating systems designed to substitute for the use of coal for residential heating and other small boilers.

2.9 In addition, the IFC guidance states that:

> *emissions from a single project should not contribute more than 25% of the applicable ambient air quality standards to allow additional, future sustainable development in the same airshed.*

[3] International Finance Corporation World Bank Group (December 2008), Environmental, Health and Safety Guidelines for Thermal Power Plants.

Table 2.4: World Bank Emission Guidelines for Combustion Turbines (mg/Nm^3)

Note:
- Guidelines are applicable for new facilities
- EA may justify more stringent or less stringent limits due to ambient environment, technical and economic considerations provided there is compliance with applicable ambient air quality standards and incremental impacts are minimised.
- For projects to rehabilitate existing facilities, case-by-case emission requirements should be established by the EA considering (i) the existing emission levels and impacts on the environment and community health, and (ii) cost and technical feasibility of bringing the existing emission levels to meet these new facilities limits.
- EA should demonstrate that emissions do not contribute a significant portion to the attainment of relevant ambient air quality guidelines or standards, and more stringent limits may be required.

Combustion Technology/ Fuel	**Particulate Matter (PM)**		**Sulphur dioxide (SO_2)**		**Nitrogen oxides (NOx)**		**Dry Gas, Excess O_2 Content (%)**
Boiler	**NDA**	**DA**	**NDA**	**DA**	**NDA**	**DA**	
Natural Gas (all turbine types of Unit >50MWth)	N/A	N/A	N/A	N/A	51	51	15%
Other Fuels (Unit > 50MWth)	50	30	Use of 1% or less S fuel	Use of 0.5% or less S fuel	152 (a)	152 (a)	15%

General Notes:

- MWth = Megawatt thermal input on HHV basis; N/A/ = Not applicable; NDA = Non-degraded airshed; DA = Degraded airshed (poor air quality); Airshed should be considered as being degraded if nationally legislated air quality standards are exceeded or, in their absence, if WHO Air Quality Guidelines are exceeded significantly; S = sulphur content (expressed a percent by mass); Nm^3 is at one atmosphere pressure, 0 degrees Celsius, MWth category is to apply to the entire facility consisting of multiple units that are reasonably considered to be emitted from a common stack. Guideline limits to apply to facilities operating more than 500 hrs per year. Emission levels should be evaluated on a one hour average basis and be achieved 95% of annual operating hours.
- If supplemental firing is used in a combined cycle gas turbine mode, the relevant guideline limits for combustion turbines should be achieved including emissions from those supplemental firing units (e.g., duct burners).
- (a) Technological differences (for example the use of Aeroderivatives) may require different emissions values which should be evaluated on a cases-by-case basis through the EA process but which should not exceed 200 mg/Nm3.

Comparison of the Guideline limits with standards of selected countries / region (as of August 2008):

- Natural Gas-fired Combustion Turbine – NOx
  - o Guideline limits: 51 (25 ppm)
  - o EU: 50 (24 ppm), 75 (37 ppm) (if combined cycle efficiency > 55%), 50*η / 35 (where η = simple cycle efficiency)
  - o US: 25 ppm (> 50 MMBtu/h (≈ 14.6 MWth) and ≤ 850 MMBtu/h (≈ 249MWth)), 15 ppm (> 850 MMBtu/h (≈ 249 MWth))
  - o (Note: further reduced NOx ppm in the range of 2 to 9 ppm is typically required through air permit)
- Liquid Fuel-fired Combustion Turbine – NOx
  - o Guideline limits: 152 (74 ppm) – Heavy Duty Frame Turbines & LFO/HFO, 300 (146 ppm) – Aeroderivatives & HFO, 200 (97 ppm) – Aeroderivatives & LFO
  - o EU: 120 (58 ppm), US: 74 ppm (> 50 MMBtu/h (≈ 14.6 MWth) and ≤ 850 MMBtu/h (≈ 249MWth)), 42 ppm (> 850 MMBtu/h (≈ 249 MWth))
- Liquid Fuel-fired Combustion Turbine – SOx
  - o Guideline limits: Use of 1% or less S fuel
  - o EU: S content of light fuel oil used in gas turbines below 0.1% / US: S content of about 0.05% (continental area) and 0.4% (non-continental area)

Source: EU (LCP Directive 2001/80/EC October 23 2001), EU (Liquid Fuel Quality Directive 1999/32/EC, 2005/33/EC), US (NSPS for Stationary Combustion Turbines, Final Rule – July 6, 2006)

European Standards

2.10 The project is seeking funding from the European Bank for Reconstruction and Development (EBRD) and will therefore require compliance with European environmental standards. On this basis it is proposed that emissions from the Project will be compliant with the Industrial Emissions Directive[4] standards, which are extremely stringent compared with those specified by JS 1189/2006. The NOx and CO emission limit values for new gas turbines using both natural gas and light/ middle distillates are 50 mg/Nm^3 and 100 mg/Nm^3 respectively (referenced to 15% O_2), however the emission limits are not applicable to operations occurring for less than 500 hours per year (e.g. back-up operation).

2.11 European Directive 2008/50/EC of the European Parliament and of the Council of 21st May 2008, sets legally-binding limit values for the protection of public health and sensitive habitats. The EU limit values for NO_2, SO_2, CO and PM_{10} are presented in Table 2.5.

Table 2.5: EU Limit Values

Pollutant	Averaging Period	AQS (μg/m^3)	Comments
Nitrogen Dioxide (NO_2)	annual	40	-
	1-hour	200	Not to be exceeded more than 18 times per annum, equivalent to the 99.8th percentile of 1-hour means
Sulphur Dioxide (SO_2)	24-hour	125	Not to be exceeded more than 3 times per annum, equivalent to the 99.2nd percentile of 24-hour means
	1-hour	350	Not to be exceeded more than 24 times per annum, equivalent to the 99.7th percentile of 1-hour means
Carbon Monoxide (CO)	8-hour	10,000	-
Particulate Matter (as PM_{10})	annual	40	-
	24-hour	50	UK AQO, not to be exceeded more than 35 times per annum, equivalent to the 90.4th percentile of 24-hour means

Assessment Ambient Air Quality Standards

2.12 For the purposes of this assessment, the air quality standards (AQS) that have been applied are provided in Table 2.6. The standards referenced in the table below relate to the most

[4] The Industrial Emissions Directive, 2010/75/EU

stringent standards when considering the Jordanian, IFC and EU standards/guideline for each parameter, per averaging period.

Table 2.6: Air Quality Standards Adopted for the Air Quality Assessment

Pollutant	Averaging Period	Air Quality Standard ($\mu g/m^3$)
Nitrogen Dioxide	Annual	40
	24-hour	145
	1-hour	200
Sulphur Dioxide	Annual	114
	24-hour	125
	1-hour	350
	10 minute	500
Particulate Matter (as PM_{10})	Annual	40
	24-hour	50
Carbon Monoxide	8-hour	9,920
	1-hour	28,708

3 ASSESSMENT METHODOLOGY

Dispersion Modelling Parameters

3.1 The potential impact of the HTPS on local air quality has been assessed using Breeze AERMOD7, a new generation dispersion model that incorporates the latest understanding of the atmospheric boundary layer.

3.2 The primary emission sources at the site are as follows:

- In combined cycle mode - three main stacks associated with the HRSG; or
- In simple cycle mode - three bypass stacks.

3.3 For normal project operations, the key pollutants arising from natural gas combustion and emitted via the HRSG/ bypass stacks will be nitrogen dioxide (NOx as NO_2) and CO.

3.4 In the event of a natural gas supply failure or routine maintenance, it is proposed that ultra-low-sulphur diesel oil is used as a back-up fuel, which will result in emissions of sulphur dioxide (SO_2) and particulate matter (PM_{10}) in addition to NO_x and CO.

3.5 The source emission parameters used in the dispersion modelling are presented in **Appendix B**. These data have been provided by the equipment manufacturer in line with the proposed fuel specifications. All stacks will include flue gas sampling ports and regular monitoring will be undertaken using Continuous Emissions Monitoring Systems.

3.6 Dispersion modelling has been carried out for the following operational scenarios:

- Scenario 1 (normal operation) – operation of all three gas turbines using natural gas and in combined cycle mode with emissions via the 60 m tall main stacks.
- Scenario 2 (natural gas and simple cycle mode) – operation of all three gas turbines using natural gas and in the simple cycle mode with emissions via the 45 m tall bypass stacks.
- Scenario 3 (LDO and combined cycle) – operation of all three gas turbines using low sulphur LDO and in combined cycle mode with emissions via the 60 m tall main stacks.
- Scenario 4 (LDO and simple cycle mode) – operation of all three gas turbines using low sulphur LDO and in the simple cycle mode with emissions via the 45 m tall bypass

stacks.

3.7 A summary of the scenarios assessed is presented in Table 3.1.

Table 3.1 – Summary of Scenarios Assessed for the Air Quality Assessment

Scenario	Fuel	Pollutants	Operational Mode	Emissions Via
Scenario 1	Natural gas	NO_x, CO	Combined	Main stacks
Scenario 2	Natural gas	NO_x, CO	Simple	Bypass stacks
Scenario 3	LDO	NO_x, CO, SO_2, PM_{10}	Combined	Main stacks
Scenario 4	LDO	NO_x, CO, SO_2, PM_{10}	Simple	Bypass stacks

3.8 For each scenario, the assessment represents worst-case conditions as it is assumed that the all three gas turbines operate continuously.

Nitric Oxide to NO_2 Conversion

3.9 Oxides of nitrogen (NO_x) emitted to atmosphere as a result of combustion will consist largely (around 90%) of nitric oxide (NO), a relatively innocuous substance. Once released into the atmosphere, NO is oxidised to NO_2. The proportion of NO converted to NO_2 depends on a number of factors including wind speed, distance from the source, solar irradiation and the availability of oxidants, such as ozone (O_3). At locations close to the source where highest concentrations are predicted, the rate of oxidation will be relatively small.

3.10 Typical NO:NO_2 conversion ratios of 70% for long term predictions and 35% for short term predictions have been assumed for comparison with the air quality standards for NO_2.

Local Meteorological Data

3.11 The modelling has been carried out using three years (2013-2015) of hourly sequential meteorological data in order to take account of inter-annual variability and reduce the effect of any atypical conditions. A meteorological station in Amman has been used for the assessment, which is the most representative data currently available for the area. This is located approximately 25 km to the northeast of the HTPS site.

3.12 Wind roses for each of the three years are presented in Figures 3.1 to 3.3 below. These generally show that the prevailing wind direction is from the west; therefore sensitive receptors to

the east of the TPS are likely to be worst-affected by emissions from the site.

Figure 3.1: Wind Rose for Amman 2013

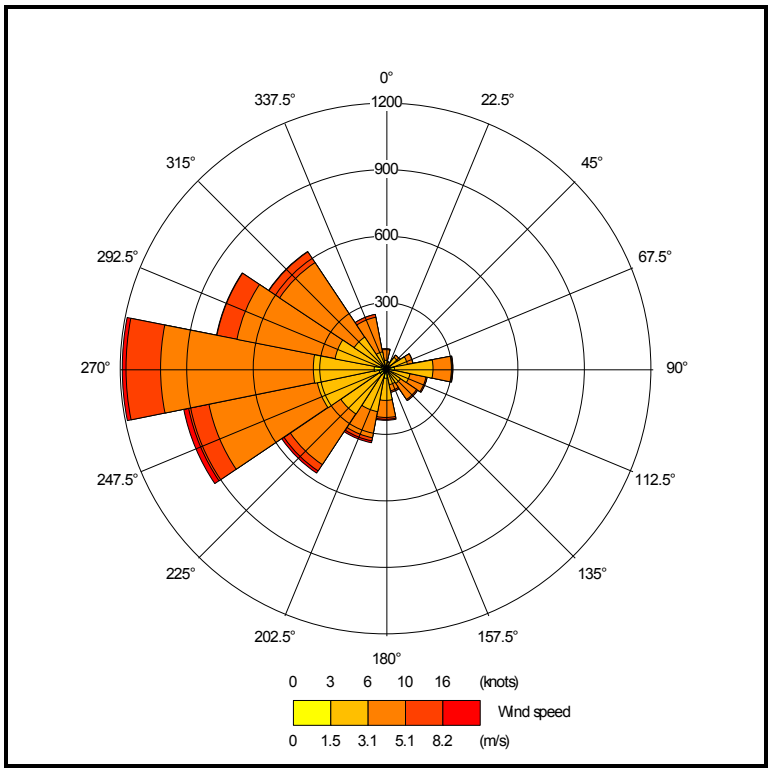


Figure 3.2: Wind Rose for Amman 2014

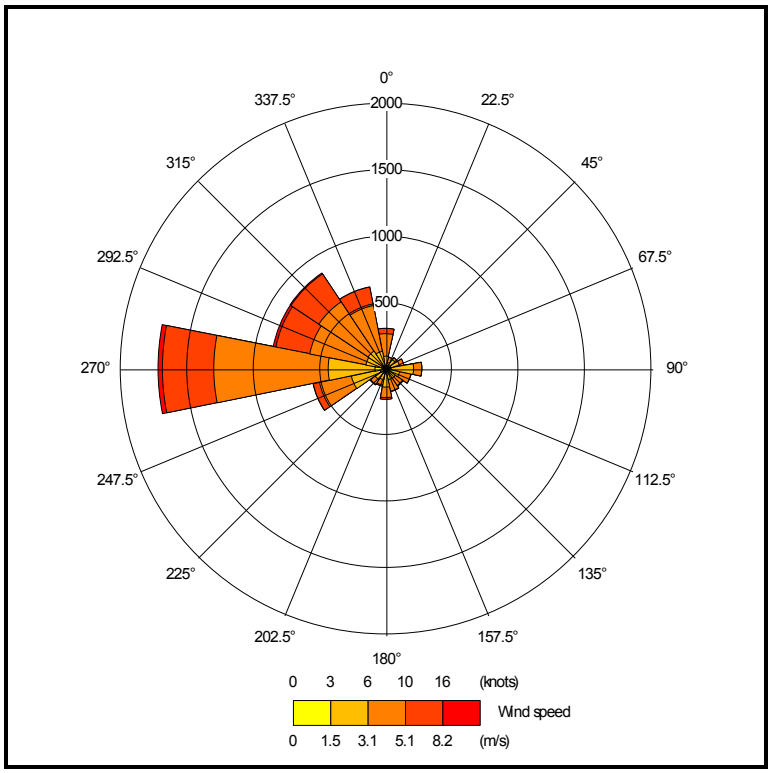
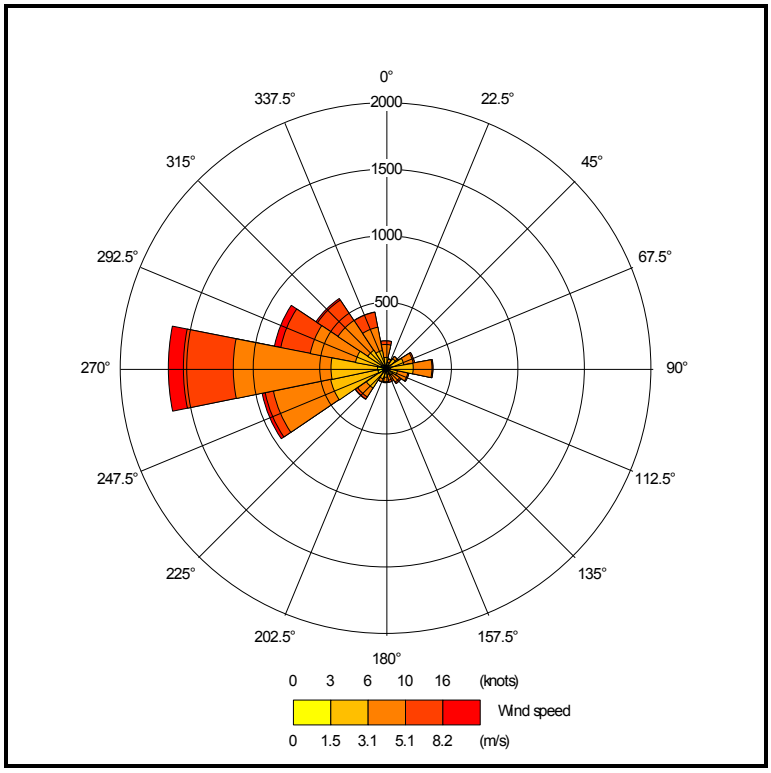


Figure 3.3: Wind Rose for Amman 2015



Buildings

3.13 The presence of buildings close to emission sources can significantly affect the dispersion of pollutants by leading to a phenomenon called building downwash. This occurs when a building distorts the wind flow, creating zones of increased turbulence. Increased turbulence causes the plume to come to ground earlier than otherwise would be the case and results in higher ground level concentrations closer to the stack.

3.14 Downwash effects are only significant where building heights are greater than 30 to 40% of the emission release height. The downwash structures also need to be sufficiently close for their influence to be significant.

3.15 The HTPS will include a number of buildings (e.g. HRSGs, electric building, ACC) that have the potential to affect the wind field and these have been included in the dispersion model as downwash structures, along with the old TPS building.

Terrain

3.16 The area in the immediate vicinity of the site is relatively flat, however there is hilly terrain to the west beyond Zarqa. Topographical data has therefore been included in the model to account

for any terrain related effects.

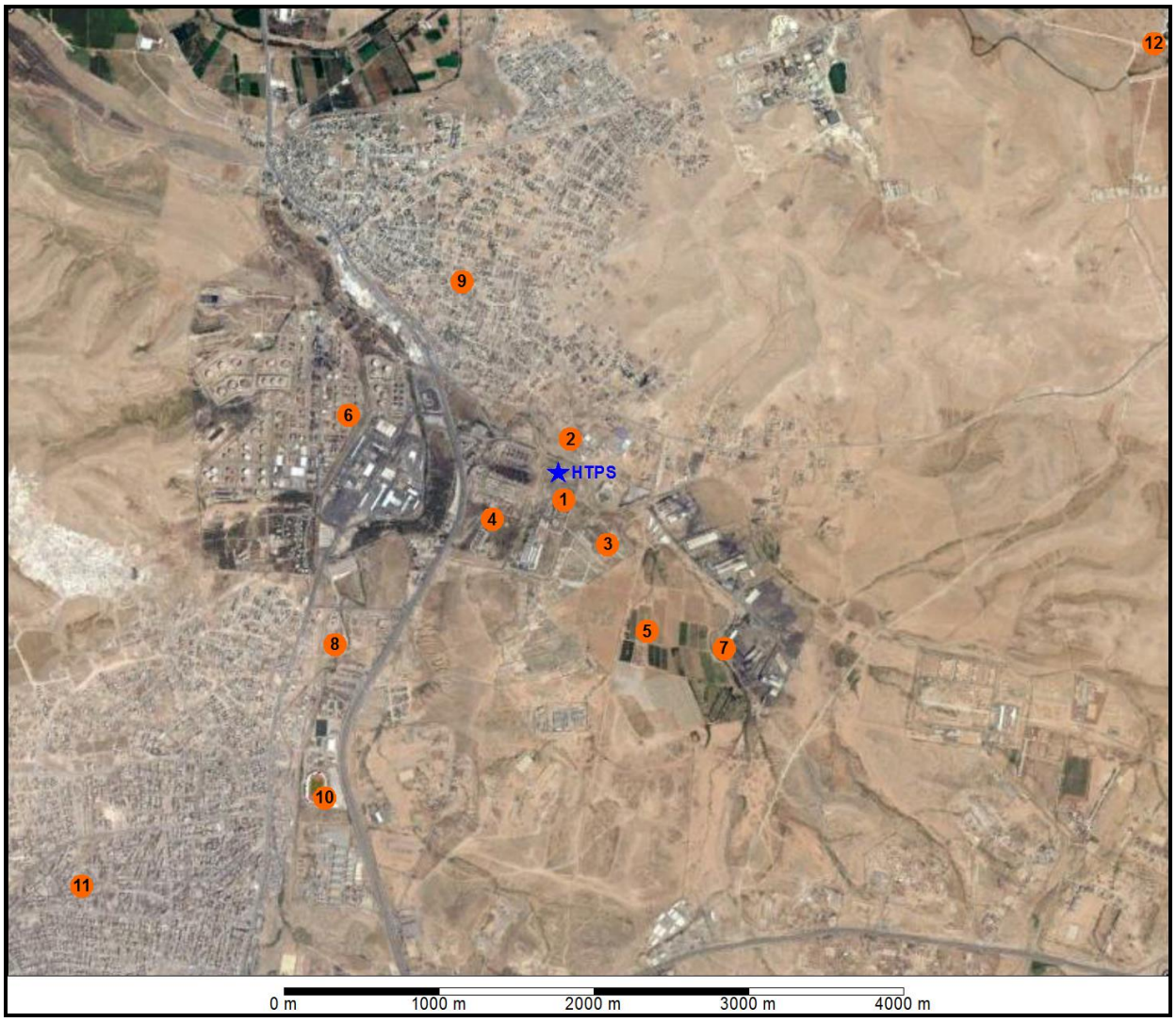
Sensitive Receptors

3.17 Specific receptors have been identified where people are likely to be regularly exposed for prolonged periods of time (e.g. residential areas). The location of the discrete sensitive receptors is presented in Table 3.2 and Figure 3.4.

Table 3.2: Location of Sensitive Receptors

ID	Receptor	Type	Location Relative to Proposed Power Block Area
1	NEPCO Training Centre	Commercial	0.2km south
2	Nearest Residential Receptor to the Proposed Site (Hashmiyeh)	Residential	0.25km north
3	Zarqa Cemetery	Cultural	0.5km south-southeast
4	CEGCO Engineers Accommodation	Residential	0.65km southwest
5	Agricultural Land	Agriculture	1km southeast
6	Petrochemical Refinery	Industrial	1.5km west
7	Steelworks	Industrial	1.7m southeast
8	Education Centre	Educational	1.75km southwest
9	Residential Cluster (Hashmiyeh)	Residential	1.7km northwest
10	Sports Stadium	Recreational	2.5km southwest
11	North Zarqa (Residential)	Residential	4.1km southwest
12	Wastewater Treatment Facility	Industrial	5km northeast

Figure 3.4: Sensitive Receptor Locations



3.18 Pollutant concentrations have been predicted at both discrete receptor locations and over a 8km by 6 km Cartesian grid of 100m resolution.

Significance Criteria

3.19 There are no local planning policies that provide limits for acceptable impacts from proposed facilities in Jordan. The UK Environment Agency has developed criteria for assessing the significance of an impact compared with relevant air quality standards and background air quality. A process contribution (PC) is considered significant if:

- The long-term PC > 1% of the long-term air quality standard
- The short-term PC > 10% of the short-term air quality standard

3.20 At 1% of the long-term air quality standard, the impact of a development is unlikely to be significant compared with background air quality. Both the short-and long term criteria are also designed to ensure that there is a substantial safety margin to protect public health and the environment.

3.21 If the above criteria are not met, the PC should be considered in combination with relevant ambient background pollutant concentrations. The air quality standards are likely to be met if:

- The long-term PC + background concentration < 70% of the air quality standard
- The short-term PC < 20% (air quality standard – short-term background concentration), where the short-term background concentration is assumed to be twice the long-term background concentration

4 BASELINE CONDITIONS

Diffusion Tube Monitoring

4.1 Ambient concentrations of SO_2 and NO_2 were measured by passive diffusion tube at six locations (A-1 to A-6) in support of this Project. The location of the tubes is presented in Figure 4.1.

4.2 Two tubes were exposed at each location for a period of 27 days (27th January 2016 to 23rd February 2016). The measured data are considered to provide an indication of long-term background concentrations at the site.

Figure 4.1: Diffusion Tube Locations

4.3 The measured 27-day mean SO_2 and NO_2 concentrations are presented in Table 4.1.

Table 4.1: 27-Day Mean Concentrations of NO_2 and SO_2 Measured by Diffusion Tube ($\mu g/m^3$)

ID	NO_2		SO_2	
	Tube A	Tube B	Tube A	Tube B
A-1	16.7	16.1	22.0	20.5
A-2	15.7	15.2	14.6	17.9
A-3	24.5	24.2	41.7	38.1
A-4	16.4	18.2	9.6	12.9
A-5	18.3	16.5	17.6	10.6
A-6	15.6	16.2	18.7	19.9
Airshed Average	17.8		20.3	
Long-Term Air Quality Standard	**40**		**114**	

4.4 The data indicate that existing long term NO_2 and SO_2 concentrations in the area are likely to be within the relevant air quality standards. The highest concentrations were measured by tube A-3, which is located on the western site boundary adjacent to the highway, and is likely to be strongly affected by both traffic and emissions from the petrochemical refinery to the east.

Automatic Monitoring

4.5 Continuous monitoring of NO_2, PM_{10}, CO and SO_2 has been undertaken at the Project site (32.11923 N, 036.12859 E) to provide an indication of existing short-term concentrations in the area. The monitoring was carried out between the 22nd and 29th March 2016 and reported as the average concentration measured over each 24-hour period for NO_2, PM_{10} and SO_2. For CO, the data is reported as the 8-hour mean.

4.6 A summary of the 24-hour mean concentrations measured over the five day period is presented in Table 4.2.

Table 4.2: Concentrations of NO_2, SO_2, PM_{10} and CO Measured by Continuous Monitor at the Project Site ($\mu g/m^3$)

Day	24-Hour Mean			8-Hour Mean
	NO_2	SO_2	PM_{10}	CO
1	7.0	1.4	39.2	252
2	7.7	1.5	42.6	257
3	8.1	1.5	43.0	268
4	9.1	1.9	53.9	277
5	8.0	1.5	37.7	248
Air Quality Standard	**145**	**125**	**50**	**9920**

4.7 The monitoring data indicate that existing 24-hour mean NO_2, SO_2 and CO concentrations are well within the relevant air quality standards. The measured NO_2 and SO_2 concentrations are somewhat lower than the 27-day mean concentrations measured diffusion tube, possibly indicating that conditions over the five day monitoring period were atypical.

4.8 The 24-hour mean PM_{10} concentration exceeded the EU limit value on one day. The air quality standard permits 35 exceedences of the limit value per year, however a considerably longer monitoring period would be required to determine whether a significant number of exceedences are likely to occur. It should be noted that the 24-hour mean PM_{10} concentrations are well within the Jordanian air quality standard of 70 $\mu g/m^3$.

Summary of Baseline Monitoring Data

4.9 A review of the local monitoring data indicates that existing NO_2, SO_2 and CO concentrations in the immediate vicinity of the HTPS are likely to be well within the relevant air quality standards. The airshed is therefore not considered to be degraded with respect to these pollutants.

4.10 The data indicate that there is the potential for short-term exceedences of the EU limit value for PM_{10}, however this would not be considered unusual in areas characterised by a dry, windy climate.

5 PREDICTED IMPACT (NORMAL GAS-FIRED OPERATION)

Introduction

5.1 Concentrations of NO_2, PM_{10}, SO_2 and CO due to emissions from the proposed HTPS are presented as the maximum predicted over the three years of meteorological data. The concentrations are compared with the relevant air quality standards to determine the significance of the impact.

Scenario 1 (Natural Gas, Combined Cycle)

Nitrogen Dioxide (NO_2)

5.2 The maximum predicted NO_2 concentration at identified sensitive receptor locations is presented in Table 5.1 for Scenario 1 (natural gas, combined cycle). This represents the normal operational scenario.

Table 5.1: Maximum Predicted NO_2 Concentrations – Natural Gas, Combined Cycle ($\mu g/m^3$)

Receptor	Annual Mean	24-Hour Mean	1-Hour Mean
NEPCO Training Centre	0.26	0.83	4.3
Nearest Residential Receptor to the Proposed Site (Hashmiyeh)	0.27	0.71	3.8
Zarqa Cemetery	0.65	1.6	6.0
CEGCO Engineers Accommodation	0.32	1.0	5.6
Agricultural Land	0.41	1.0	3.5
Petrochemical Refinery	0.17	0.70	3.0
Steelworks	0.37	0.87	4.6
Education Centre	0.10	0.35	2.1
Residential Cluster (Hashmiyeh)	0.14	0.77	3.2
Sports Stadium	0.051	0.19	2.2
North Zarqa (Residential)	0.041	0.15	1.8
Wastewater Treatment Facility	0.13	0.39	1.9
Maximum PC	0.65	1.6	6.0
Air Quality Standard	40	145	200
PC as a %age of AQS	1.6%	1.1%	3.0%

5.3 The maximum predicted annual mean NO_2 concentrations are considered to be potentially significant since they exceed 1% of the IFC and EU guideline/ limit value of 40 µg/m^3. However, the local monitoring data indicates that existing NO_2 concentrations in the area are well within the standard and therefore the risk of an exceedence during normal, gas-fired, combined cycle operation at the HTPS is considered to be *negligible*.

5.4 The predicted short-term NO_2 impacts are less than 10% of the relevant air quality standards and are therefore considered to be of *negligible* significance.

5.5 The predicted NO_2 concentrations are also presented as contour plots in Figures 5.1, 5.2 and 5.3 for the year in which maximum impacts occur (2014).

5.6 Maximum annual mean impacts occur to the east of the HTPS, which is primarily occupied by industrial and commercial sites, where there will be no relevant long-term exposure.

5.7 The influence of the local topography is evident in the short-term concentrations with maximum impacts occurring over the higher ground, approximately 1km north-northeast of the proposed power blocks.

Figure 5.1: Predicted Annual Mean NO_2 Concentrations (µg/m^3) – Natural Gas, Combined Cycle

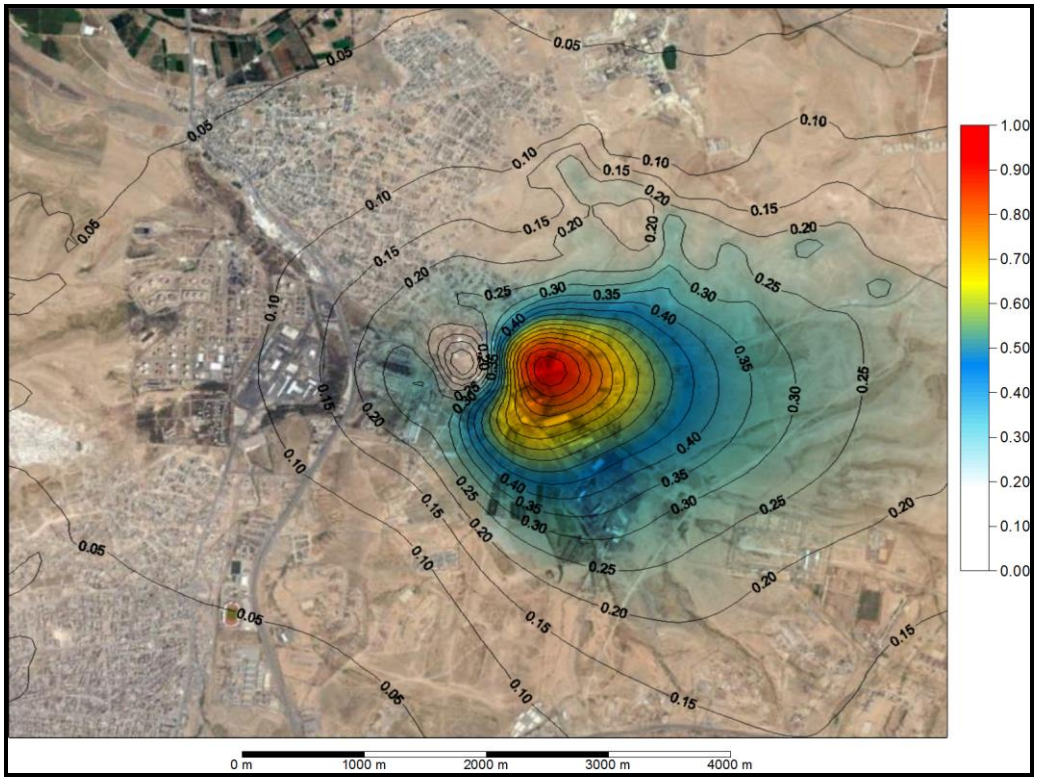


Figure 5.2: Predicted Maximum 24-Hour Mean NO_2 Concentrations ($\mu g/m^3$) – Natural Gas, Combined Cycle

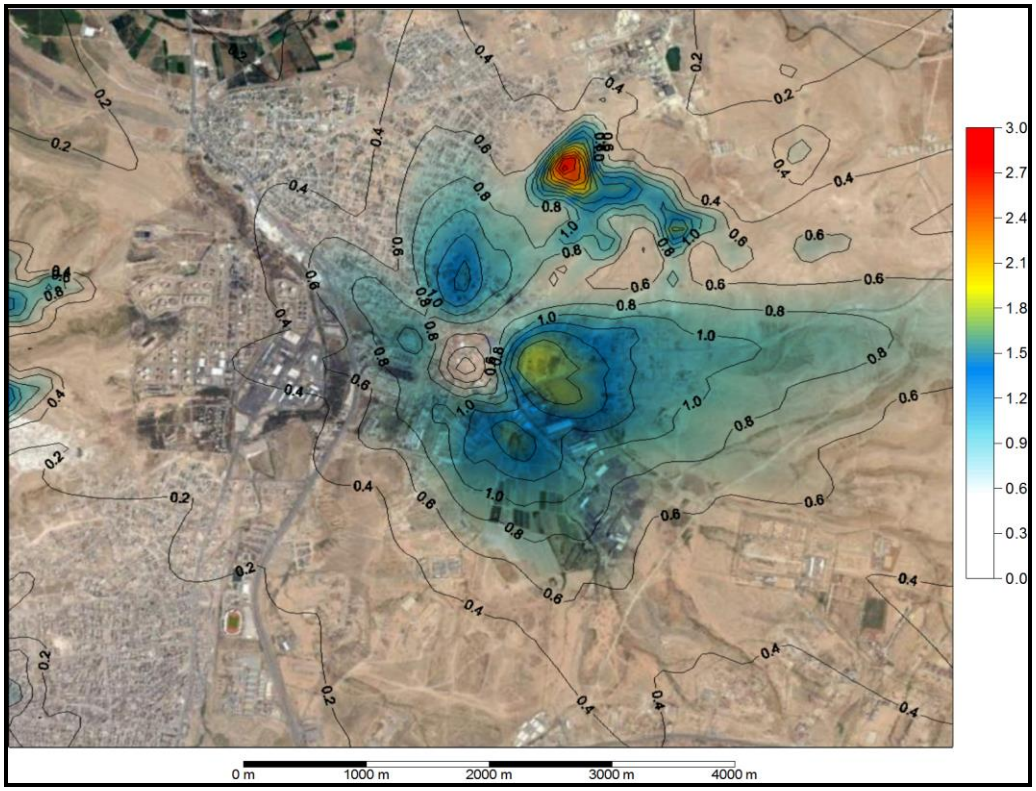
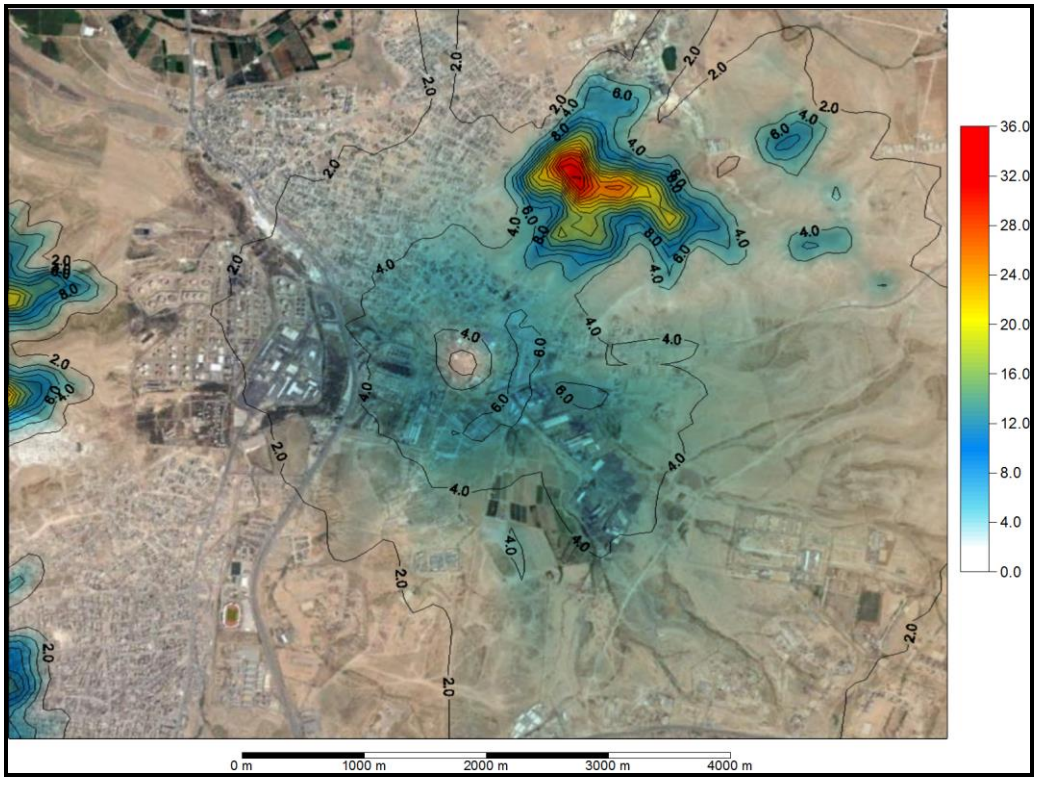


Figure 5.3: Predicted Maximum 1-Hour Mean NO_2 Concentrations ($\mu g/m^3$) – Natural Gas, Combined Cycle



Carbon Monoxide (CO)

5.8 Predicted maximum ground-level mean CO concentrations as 8-hour and 1-hour means are presented in Table 5.2.

Table 5.2: Maximum Predicted CO Concentrations – Natural Gas, Combined Cycle (μg/m^3)

Receptor	8-Hour Mean	1-Hour Mean
NEPCO Training Centre	5.8	11.7
Nearest Residential Receptor to the Proposed Site (Hashmiyeh)	4.0	10.4
Zarqa Cemetery	7.2	16.3
CEGCO Engineers Accommodation	6.9	15.2
Agricultural Land	5.6	9.5
Petrochemical Refinery	3.6	8.1
Steelworks	5.1	12.7
Education Centre	2.4	5.7
Residential Cluster (Hashmiyeh)	5.2	8.7
Sports Stadium	1.3	5.9
North Zarqa (Residential)	1.1	4.9
Wastewater Treatment Facility	1.7	5.1
Maximum PC	7.2	16.3
Air Quality Standard	9,920	28,708
PC as a %age of AQS	0.073%	0.057%

5.9 The impact of the proposed HTPS under normal operation is less than 10% of the relevant air quality standard at all receptor locations and is therefore considered to be of *negligible* significance.

Scenario 2 (Natural Gas, Simple Cycle)

Nitrogen Dioxide (NO_2)

5.10 The maximum predicted NO_2 concentration at identified sensitive receptor locations is presented in Table 5.3 for Scenario 2 (natural gas, simple cycle).

Table 5.3: Maximum Predicted NO_2 Concentrations – Natural Gas, Simple Cycle ($\mu g/m^3$)

Receptor	Annual Mean	24-Hour Mean	1-Hour Mean
NEPCO Training Centre	0.087	0.27	1.2
Nearest Residential Receptor to the Proposed Site (Hashmiyeh)	0.11	0.28	1.3
Zarqa Cemetery	0.22	0.55	2.3
CEGCO Engineers Accommodation	0.081	0.31	1.9
Agricultural Land	0.16	0.45	1.8
Petrochemical Refinery	0.054	0.26	1.4
Steelworks	0.15	0.40	1.4
Education Centre	0.034	0.13	1.0
Residential Cluster (Hashmiyeh)	0.045	0.32	1.4
Sports Stadium	0.021	0.073	0.75
North Zarqa (Residential)	0.020	0.062	0.57
Wastewater Treatment Facility	0.060	0.16	0.85
Maximum PC	0.22	0.55	2.3
Air Quality Standard	40	145	200
PC as a %age of AQS	0.54%	0.38%	1.1%

5.11 The maximum predicted NO_2 concentrations due to gas-fired simple-cycle operation at the TPS are less than 1% and 10% of the relevant AQSs, therefore the significance of the impact is considered to be *negligible*.

Carbon Monoxide (CO)

5.12 Predicted maximum ground-level mean CO concentrations as 8-hour and 1-hour means are presented in Table 5.4.

Table 5.4: Maximum Predicted CO Concentrations – Natural Gas, Simple Cycle (μg/m³)

Receptor	8-Hour Mean	1-Hour Mean
NEPCO Training Centre	1.9	3.4
Nearest Residential Receptor to the Proposed Site (Hashmiyeh)	1.7	3.6
Zarqa Cemetery	2.9	6.3
CEGCO Engineers Accommodation	2.1	5.1
Agricultural Land	2.7	4.9
Petrochemical Refinery	1.6	3.7
Steelworks	2.7	3.8
Education Centre	1.1	2.8
Residential Cluster (Hashmiyeh)	2.2	3.9
Sports Stadium	0.51	2.1
North Zarqa (Residential)	0.41	1.6
Wastewater Treatment Facility	0.60	2.3
Maximum PC	2.9	6.3
Air Quality Standard	9,920	28,708
PC as a %age of AQS	0.029%	0.039%

5.13 The impact of the proposed HTPS is less than 10% of the AQS at all receptor locations and is therefore considered to be of *negligible* significance.

6 PREDICTED IMPACT (LIGHT DIESEL OIL)

Scenario 3 (LDO, Combined Cycle)

Nitrogen Dioxide (NO_2)

6.1 The maximum predicted NO_2 concentration at identified sensitive receptor locations is presented in Table 6.1 for Scenario 3 (LDO, combined cycle).

Table 6.1: Maximum Predicted NO_2 Concentrations – LDO, Combined Cycle ($\mu g/m^3$)

Receptor	Annual Mean	24-Hour Mean	1-Hour Mean
NEPCO Training Centre	1.1	3.4	17.9
Nearest Residential Receptor to the Proposed Site (Hashmiyeh)	1.1	2.8	15.6
Zarqa Cemetery	2.8	6.9	26.3
CEGCO Engineers Accommodation	1.3	4.2	24.6
Agricultural Land	1.84	4.7	16.2
Petrochemical Refinery	0.73	3.2	14.1
Steelworks	1.6	3.8	20.9
Education Centre	0.43	1.6	8.9
Residential Cluster (Hashmiyeh)	0.61	3.5	15.1
Sports Stadium	0.24	0.87	7.1
North Zarqa (Residential)	0.19	0.66	8.1
Wastewater Treatment Facility	0.60	1.9	8.8
Maximum PC	2.8	6.9	26.3
Air Quality Standard	40	145	200
PC as a %age of AQS	6.9%	4.8%	13.2%

6.2 The maximum predicted annual mean and 1-hour mean NO_2 concentrations are considered to be potentially significant since they exceed 1% and 10% of the air quality standards respectively. However, since existing NO_2 concentrations in the area are relatively low, the risk of an exceedence of any of the air quality standards for NO_2 during back-up, LDO-fired, combined cycle operation at the TPS is considered to be *negligible*.

6.3 The predicted NO_2 concentrations are also presented as contour plots in Figures 6.1, 6.2

and 6.3 for the year in which maximum impacts occur (2014).

Figure 6.1: Predicted Annual Mean NO_2 Concentrations ($\mu g/m^3$) – LDO, Combined Cycle

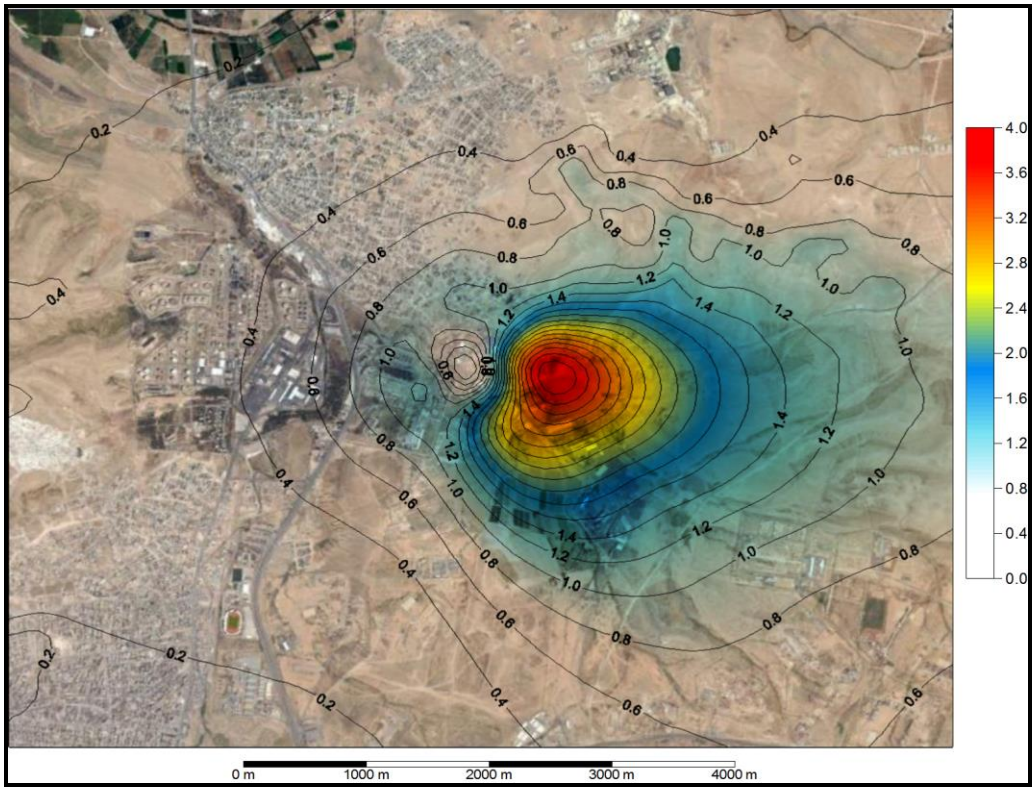


Figure 6.2: Predicted Maximum 24-Hour Mean NO_2 Concentrations ($\mu g/m^3$) – LDO, Combined Cycle

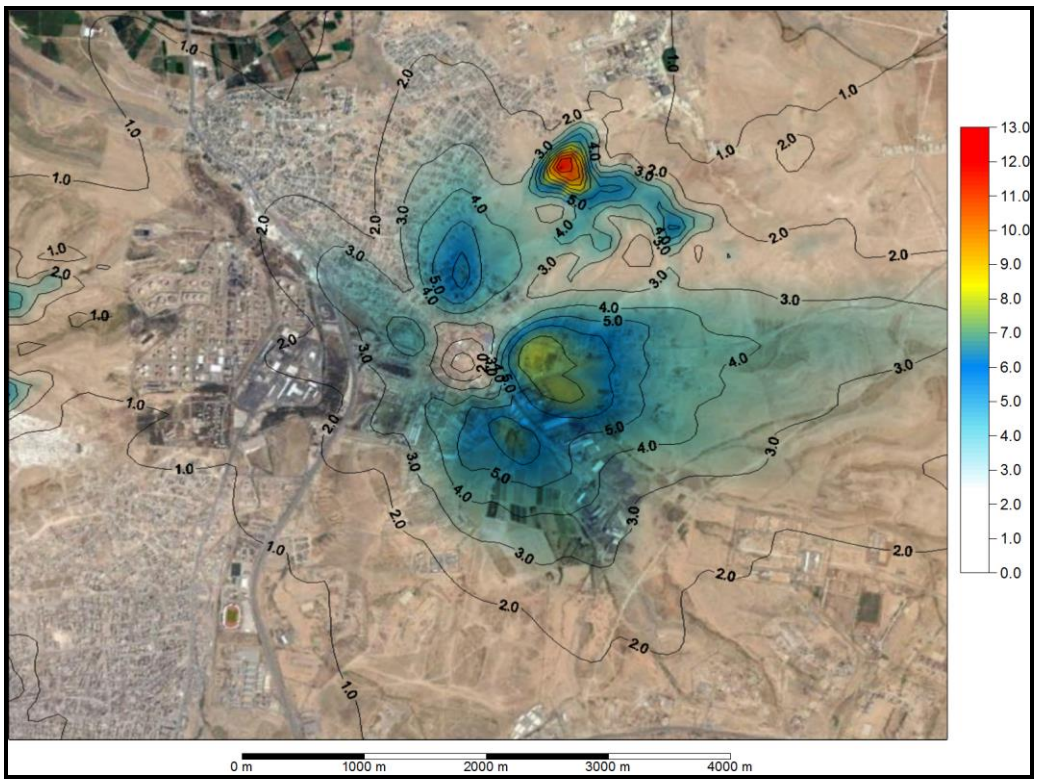
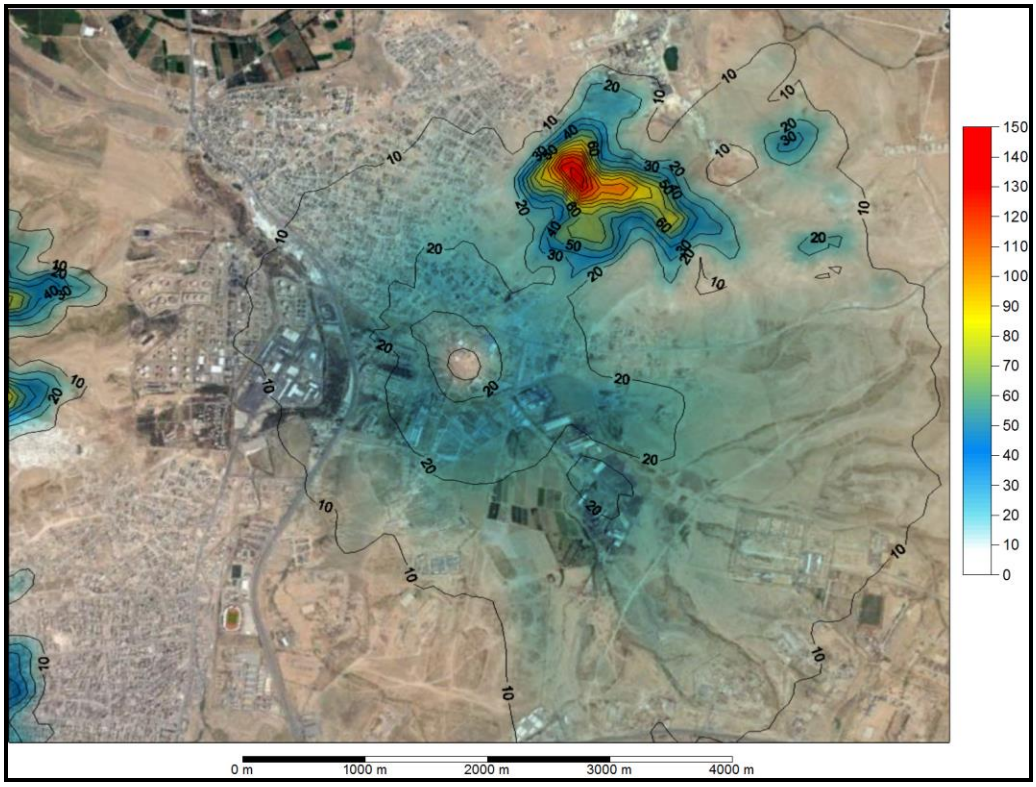


Figure 6.3: Predicted Maximum 1-Hour Mean NO_2 Concentrations ($\mu g/m^3$) – LDO, Combined Cycle



Carbon Monoxide (CO)

6.4 Predicted maximum ground-level mean CO concentrations as 8-hour and 1-hour means are presented in Table 6.2.

Table 6.2: Maximum Predicted CO Concentrations – LDO, Combined Cycle (μg/m³)

Receptor	8-Hour Mean	1-Hour Mean
NEPCO Training Centre	3.7	7.5
Nearest Residential Receptor to the Proposed Site (Hashmiyeh)	2.6	6.6
Zarqa Cemetery	4.9	11.1
CEGCO Engineers Accommodation	4.5	10.4
Agricultural Land	4.0	6.8
Petrochemical Refinery	2.6	5.9
Steelworks	3.7	8.8
Education Centre	1.7	3.7
Residential Cluster (Hashmiyeh)	3.7	6.3
Sports Stadium	0.90	3.0
North Zarqa (Residential)	0.73	3.4
Wastewater Treatment Facility	1.2	3.7
Maximum PC	4.9	11.1
Air Quality Standard	9,920	28,708
PC as a %age of AQS	0.049%	0.039%

6.5 The impact of the proposed HTPS under back-up, combined cycle operation is less than 10% of the relevant AQS at all receptor locations and is therefore considered to be of *negligible* significance.

Sulphur Dioxide (SO_2)

6.6 Predicted maximum ground-level mean SO_2 concentrations are presented in Table 6.3.

Table 6.3: Maximum Predicted SO_2 Concentrations – LDO, Combined Cycle (μg/m³)

Receptor	Annual Mean	24-Hour Mean	1-Hour Mean	10-Minute Mean (a)
NEPCO Training Centre	6.6	41.8	219	293
Nearest Residential Receptor to the Proposed Site (Hashmiyeh)	6.8	34.0	191	256
Zarqa Cemetery	16.9	84.9	322	431
CEGCO Engineers Accommodation	8.2	51.4	301	404
Agricultural Land	11.2	57.9	198	266
Petrochemical Refinery	4.5	38.8	173	231
Steelworks	10.0	46.9	256	342
Education Centre	2.6	19.8	109	146
Residential Cluster (Hashmiyeh)	3.7	43.0	184	247
Sports Stadium	1.4	10.7	86.3	116
North Zarqa (Residential)	1.2	8.1	98.6	132
Wastewater Treatment Facility	3.7	23.3	108	145
Maximum PC	16.9	84.9	322	431
Air Quality Standard	114	125	350	500
PC as a %age of AQS	14.8%	67.9%	92.0%	86.3%

(a) 10-minute mean estimated by multiplying the 1-hour mean by 1.34 as recommended by UK Environment Agency Guidance.

6.7 The impact of SO_2 emissions from the proposed HTPS under back-up, combined cycle operation is potentially significant over all averaging periods. However, the predicted process concentrations are within the relevant air quality standards at all receptor locations.

6.8 The 24-hour and 1-hour mean EU limit values for SO_2 permit 3 and 7 exceedences per annum respectively (see Table 2.5). The 99.2nd percentile of 24-hour means at the Zarqa Cemetery (where maximum receptor impacts are predicted) is 61.4 μg/m^3, 49.1% of the limit value. The 99.7th percentile of 1-hour means at Zarqa Cemetery is 253 μg/m^3, 72% of the limit value.

6.9 Based on the limited existing SO_2 monitoring data for the local area, it is considered unlikely that the air quality standards will be exceeded at any of the identified receptor locations.

6.10 The predicted SO_2 concentrations are also presented as contour plots in Figures 6.4, 6.5, 6.6 and 6.7 for the year in which maximum impacts occur (2014).

Figure 6.4: Predicted Annual Mean SO_2 Concentrations ($\mu g/m^3$) – LDO, Combined Cycle

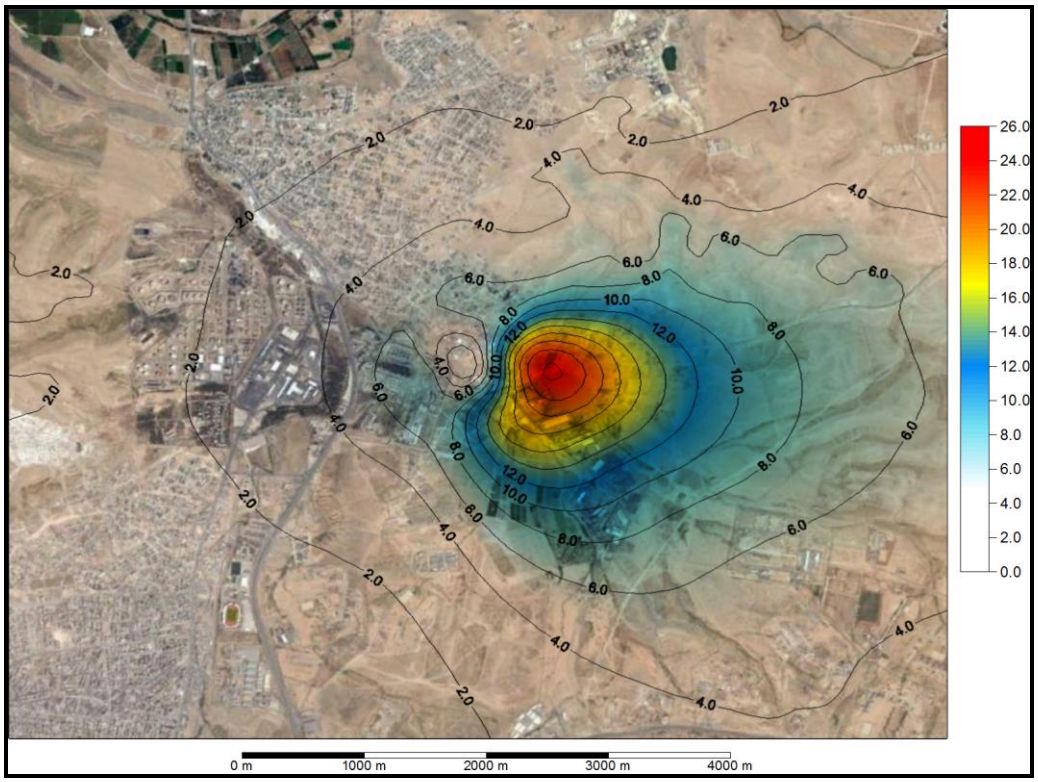


Figure 6.5: Predicted Maximum 24-Hour Mean SO_2 Concentrations ($\mu g/m^3$) – LDO, Combined Cycle

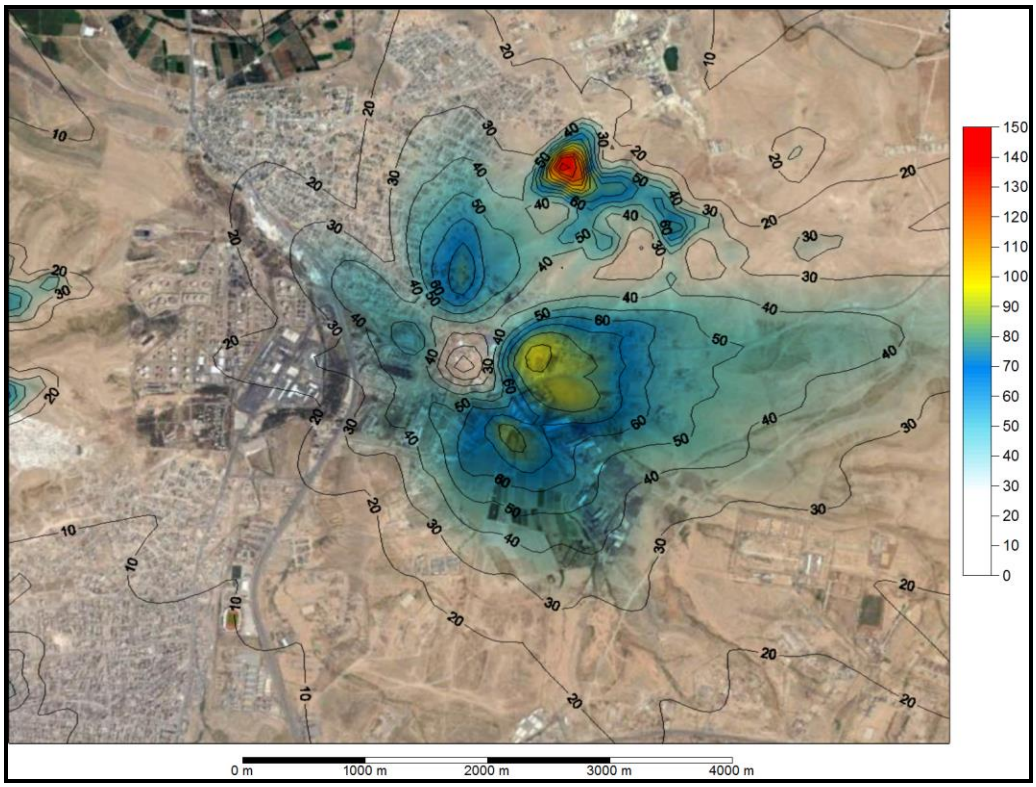


Figure 6.6: Predicted Maximum 1-Hour Mean SO_2 Concentrations ($\mu g/m^3$) – LDO, Combined Cycle

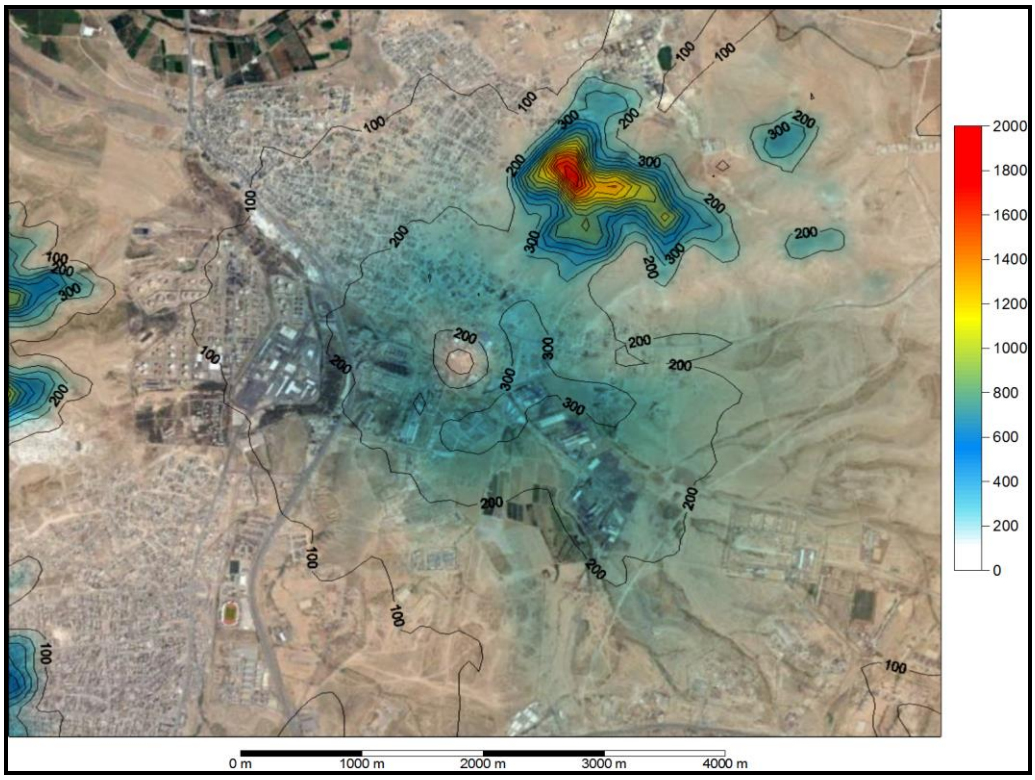
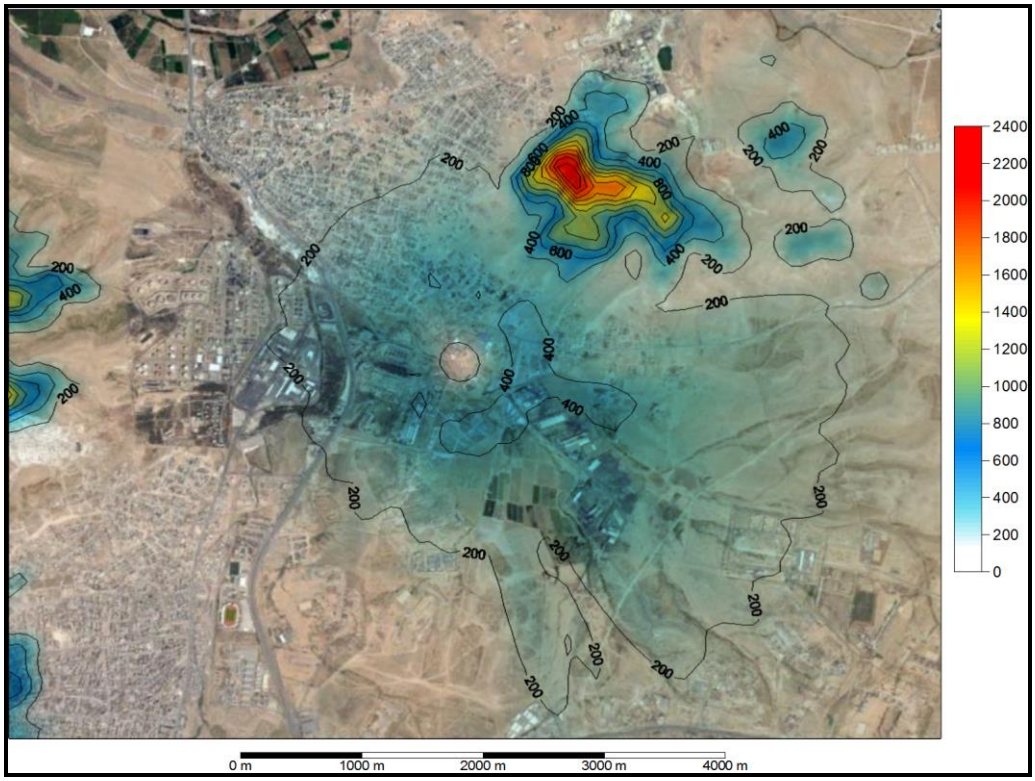


Figure 6.7: Predicted Maximum 10-Minute Mean SO_2 Concentrations ($\mu g/m^3$) – LDO, Combined Cycle



Particulate Matter (PM_{10})

6.11 Predicted maximum annual and 24-hour mean ground-level mean PM_{10} concentrations are presented in Table 6.4.

Table 6.4: Maximum Predicted PM_{10} Concentrations – LDO, Combined Cycle ($\mu g/m^3$)

Receptor	Annual Mean	24-Hour Mean
NEPCO Training Centre	0.061	0.38
Nearest Residential Receptor to the Proposed Site (Hashmiyeh)	0.063	0.31
Zarqa Cemetery	0.16	0.78
CEGCO Engineers Accommodation	0.076	0.47
Agricultural Land	0.10	0.53
Petrochemical Refinery	0.041	0.36
Steelworks	0.092	0.43
Education Centre	0.024	0.18
Residential Cluster (Hashmiyeh)	0.034	0.39
Sports Stadium	0.013	0.10
North Zarqa (Residential)	0.011	0.074
Wastewater Treatment Facility	0.034	0.21
Maximum PC	0.16	0.78
Air Quality Standard	40	50
PC as a %age of AQS	0.39%	1.6%

6.12 The maximum predicted PM_{10} concentrations due to LDO-fired, combined-cycle operation at the HTPS are less than 1% and 10% of the relevant AQSs, therefore the significance of the impact is considered to be *negligible*.

Scenario 4 (LDO, Simple Cycle)

Nitrogen Dioxide (NO_2)

6.13 The maximum predicted NO_2 concentration at identified sensitive receptor locations is presented in Table 6.5 for Scenario 4 (LDO, simple cycle).

Table 6.5: Maximum Predicted NO_2 Concentrations – LDO, Simple Cycle ($\mu g/m^3$)

Receptor	Annual Mean	24-Hour Mean	1-Hour Mean
NEPCO Training Centre	0.45	1.4	6.4
Nearest Residential Receptor to the Proposed Site (Hashmiyeh)	0.56	1.4	6.9
Zarqa Cemetery	1.1	2.9	11.9
CEGCO Engineers Accommodation	0.42	1.6	9.7
Agricultural Land	0.82	2.4	9.4
Petrochemical Refinery	0.28	1.3	7.1
Steelworks	0.77	2.1	7.2
Education Centre	0.18	0.67	5.4
Residential Cluster (Hashmiyeh)	0.23	1.7	7.4
Sports Stadium	0.11	0.4	3.9
North Zarqa (Residential)	0.10	0.32	2.9
Wastewater Treatment Facility	0.31	0.82	4.4
Maximum PC	1.1	2.9	11.9
Air Quality Standard	40	145	200
PC as a %age of AQS	2.8%	2.0%	5.9%

6.14 The maximum predicted annual mean NO_2 concentration is over 1% of the AQS and therefore potentially significant. However, since the local monitoring data indicates that existing long-term concentrations are well within the standard, the risk of an exceedence is considered to be *negligible*.

6.15 The predicted short-term NO_2 concentrations are less than 10% of the relevant AQSs and are therefore of *negligible* significance.

Carbon Monoxide (CO)

6.16 Predicted maximum ground-level mean CO concentrations as the 8-hour mean are presented in Table 6.6.

Table 6.6: Maximum Predicted CO Concentrations – LDO, Simple Cycle (μg/m³)

Receptor	8-Hour Mean	1-Hour Mean
NEPCO Training Centre	1.5	2.7
Nearest Residential Receptor to the Proposed Site (Hashmiyeh)	1.3	2.9
Zarqa Cemetery	2.3	5.0
CEGCO Engineers Accommodation	1.7	4.1
Agricultural Land	2.2	4.0
Petrochemical Refinery	1.3	3.0
Steelworks	2.1	3.0
Education Centre	0.85	2.3
Residential Cluster (Hashmiyeh)	1.8	3.1
Sports Stadium	0.41	1.7
North Zarqa (Residential)	0.33	1.2
Wastewater Treatment Facility	0.48	1.8
Maximum PC	2.3	5.0
Air Quality Standard	9,920	28,708
PC as a %age of AQS	0.024%	0.017%

6.17 The impact of the proposed HTPS under back-up, simple cycle operation is less than 10% of the relevant AQS at all receptor locations and is therefore considered to be of *negligible* significance.

Sulphur Dioxide (SO_2)

6.18 Predicted maximum 24-hour mean ground-level mean SO_2 concentrations are presented in Table 6.7.

Table 6.7: Maximum Predicted SO_2 Concentrations – LDO, Simple Cycle ($\mu g/m^3$)

Receptor	Annual Mean	24-Hour Mean	1-Hour Mean	10-Minute Mean (a)
NEPCO Training Centre	2.8	17.1	78.0	105
Nearest Residential Receptor to the Proposed Site (Hashmiyeh)	3.4	17.7	83.9	112
Zarqa Cemetery	6.8	35.0	145	195
CEGCO Engineers Accommodation	2.6	19.5	119	160
Agricultural Land	5.0	28.8	115	155
Petrochemical Refinery	1.7	16.5	86.2	116
Steelworks	4.7	25.5	88.4	118
Education Centre	1.1	8.2	65.8	88.2
Residential Cluster (Hashmiyeh)	1.4	20.3	90.4	121
Sports Stadium	0.68	4.6	48.1	64.4
North Zarqa (Residential)	0.63	3.9	35.9	48.1
Wastewater Treatment Facility	1.9	10.0	53.7	72.0
Maximum PC	6.8	35.0	145	195
Air Quality Standard	114	125	350	500
PC as a %age of AQS	6.0%	28.0%	41.5%	38.9%

(a) 10-minute mean estimated by multiplying the 1-hour mean by 1.34 as recommended by UK Environment Agency Guidance.

6.19 The impact of SO_2 emissions from the proposed HTPS under back-up, simple cycle operation is potentially significant over all averaging periods. However, the predicted process concentrations are within the relevant air quality standards at all receptor locations. However, based on the limited existing SO_2 monitoring data for the local area, it is considered unlikely that the air quality standards will be exceeded at any of the identified receptor locations.

Particulate Matter (PM_{10})

6.20 Predicted maximum annual and 24-hour mean ground-level mean PM_{10} concentrations are presented in Table 6.8.

Table 6.8: Maximum Predicted PM_{10} Concentrations – LDO, Simple Cycle ($\mu g/m^3$)

Receptor	Annual Mean	24-Hour Mean
NEPCO Training Centre	0.025	0.16
Nearest Residential Receptor to the Proposed Site (Hashmiyeh)	0.031	0.16
Zarqa Cemetery	0.063	0.32
CEGCO Engineers Accommodation	0.024	0.18
Agricultural Land	0.046	0.26
Petrochemical Refinery	0.016	0.15
Steelworks	0.043	0.23
Education Centre	0.010	0.075
Residential Cluster (Hashmiyeh)	0.013	0.19
Sports Stadium	0.006	0.043
North Zarqa (Residential)	0.006	0.036
Wastewater Treatment Facility	0.018	0.092
Maximum PC	0.063	0.32
Air Quality Standard	40	50
PC as a %age of AQS	0.16%	0.64%

6.21 The maximum predicted PM_{10} concentrations due to LDO-fired, simple-cycle operation at the TPS are less than 1% and 10% of the relevant AQSs, therefore the significance of the impact is considered to be *negligible*.

7 MITIGATION MEASURES

7.1 All mitigation measures detailed in the ESIA mitigation section for Air Quality shall be employed at the project.

7.2 The proposed facility will employ best available technology (BAT) in order to minimise emissions. Regular maintenance of plant at the proposed facility will also be carried out in order to optimise performance.

8 SUMMARY AND CONCLUSIONS

8.1 An assessment has been carried out to determine the potential air quality impacts associated with the proposed Hussein Thermal Power Station (HTPS).

8.2 The key pollutants considered in the assessment were NOx (as NO_2), CO, particles (as PM_{10}), and SO_2. A background monitoring study has been undertaken around the proposed site to establish current air quality conditions. The data indicate that existing NO_2, SO_2 and PM_{10} concentrations are within the relevant air quality standards and the airshed is not considered to be degraded.

8.3 Detailed dispersion modelling of potential emissions from the proposed facility has been carried out using AERMOD for combined and simple cycle operation for both the primary fuel (natural gas) and back-up fuel (light diesel oil). The assessment has considered the impact of the HTPS for all operational modes at sensitive receptor locations.

8.4 For normal operation utilising natural gas as a fuel and in combined cycle mode, the model predicts that ground-level pollutant concentrations of NO_2 and CO at sensitive receptors will be well within the relevant air quality standards and the risk of an exceedence is considered to be negligible. For natural-gas fired, single cycle operation, the predicted impacts are also of negligible significance.

8.5 Operation of the TPS using low sulphur light diesel oil would only occur during failure of the natural gas supply or routine maintenance activities. For both combined cycle and simple cycle operation using light diesel oil, the predicted NO_2, CO and PM_{10} concentrations at receptor locations are well within the relevant air quality standards and the risk of an exceedence is considered to be negligible. However, maximum predicted concentrations of SO_2 are potentially significant, particularly in terms of short-term impacts. The local monitoring data indicates that existing SO_2 concentrations are relatively low and therefore an exceedence of the relevant air quality standards at sensitive receptor locations is considered unlikely. However, the use of light diesel oil for prolonged periods should be avoided in order to minimise the impact of emissions on short-term SO_2 concentrations.

APPENDIX A - AIR QUALITY TERMINOLOGY

Term	Definition
Accuracy	A measure of how well a set of data fits the true value.
Air quality objective	Policy target generally expressed as a maximum ambient concentration to be achieved, either without exception or with a permitted number of exceedences within a specific timescale (see also air quality standard).
Air quality standard	The concentrations of pollutants in the atmosphere which can broadly be taken to achieve a certain level of environmental quality. The standards are based on the assessment of the effects of each pollutant on human health including the effects on sensitive sub groups (see also air quality objective).
Ambient air	Outdoor air in the troposphere, excluding workplace air.
Annual mean	The average (mean) of the concentrations measured for each pollutant for one year. Usually this is for a calendar year, but some species are reported for the period April to March, known as a pollution year. This period avoids splitting winter season between 2 years, which is useful for pollutants that have higher concentrations during the winter months.
Exceedence	A period of time where the concentrations of a pollutant is greater than, or equal to, the appropriate air quality standard.
Fugitive emissions	Emissions arising from the passage of vehicles that do not arise from the exhaust system.
LDO	Light diesel oil
NO	Nitrogen monoxide, a.k.a. nitric oxide.
NO_2	Nitrogen dioxide.
NO_x	Nitrogen oxides.
O_3	Ozone.
Percentile	The percentage of results below a given value.
PM_{10}	Particulate matter with an aerodynamic diameter of less than 10 micrometres.
ppmw	Parts per million by mass (weight)
Ratification (Monitoring)	Involves a critical review of all information relating to a data set, in order to amend or reject the data. When the data have been ratified they represent the final data to be used (see also validation).
$\mu g/m^3$ micrograms per cubic metre	A measure of concentration in terms of mass per unit volume. A concentration of 1µg/m^3 means that one cubic metre of air contains one microgram (millionth of a gram) of pollutant.
Uncertainty	A measure, associated with the result of a measurement, which characterizes the range of values within which the true value is expected to lie. Uncertainty is usually expressed as the range within which the true value is expected to lie with a 95% probability, where standard statistical and other procedures have been used to evaluate this figure. Uncertainty is more clearly defined than the closely related parameter 'accuracy', and has replaced it on recent European legislation.

APPENDIX B - STACK EMISSION PARAMETERS

Table B1: Emission Parameters (Main HRSG Stacks)

Parameter / Fuel	Natural Gas	LDO
Stack Height (m)	60.0	
Stack Diameter (m)	4.8	
Temperature (K)	392	427
Actual Flow Rate (Am^3/s)	572	567
Exit Velocity (m/s)	24.7	27.2
Emission Rate (g/s)		
NOx	15.5	45.2
PM_{10}	-	1.8
CO	31.1	6.7
SO_2	-	193

Table B2: Emission Parameters (Bypass Stacks)

Parameter / Fuel	Natural Gas	LDO
Stack Height (m)	35.0	
Stack Diameter (m)	6.8	
Temperature (K)	919	880
Actual Flow Rate (Am^3/s)	1451	1281
Exit Velocity (m/s)	39.9	35.3
Emission Rate (g/s)		
NOx	8.6	45.2
PM_{10}	-	1.8
CO	8.3	6.7
SO_2	-	193

Appendix J

Noise Modelling Report

Hussein Thermal Power Station – Power Generation Project
Zarqa, Hashemite Kingdom of Jordon

Hussein Thermal Power Station – Power Generation Project
Zarqa, Hashemite Kingdom of Jordon

Noise Assessment

Revision	Date	Notes	Author	Checked	Approved
Ver 1.2	08-04-16	Noise Assessment	SP	ND	ND

Entran Limited
12 Greenway Farm
Bath Road
Wick
Bristol
BS30 5RL

T: 0117 937 4077
www.entranltd.co.uk

CONTENTS **PAGE**

1 INTRODUCTION

1.1 Entran Ltd have been commissioned to undertake a noise assessment for the Al-Hussein Power Plant located at Zarqa, Jordon. Specifically the noise modelling assessment is in regard to the proposed combined cycle power plant project to be developed within the existing landholding of the Hussein TPS.

1.2 The Project site is located within Zarqa Governorate in the north of Jordan, around 25km northeast of the capital city of Amman. The proposed project will be located entirely within existing land belonging to the Central Electricity Generating Company (CEGCO) at the Hussein Thermal Power Station. The Hussein TPS is located in the north of Zarqa city, in an area with several industrial and commercial facilities, including a large petrochemical refinery and steelworks facility. The proposed project site is approximately 4 Km north east of the centre of Zarqa city (the capital city of Zarqa Governorate) while to the north is located Al-Hashmiyeh city.

1.3 The Hussein TPS Repowering Project will involve the design, construction, ownership financing, operation and maintenance of the expanded thermal power generating facility, under its new operational configuration. The proposed expansion configuration will comprise the following:

a) **3 Gas Turbine Generators (GTG)**

Gas Turbines directly combust fuel to generate electricity via the in built turbine and generator (Operates in a similar method to a turbofan engine on an aeroplane).

- Equipped with Low NO_x burners;
- Each Gas Turbine will have a bypass stack for emissions during simple cycle operation (when required);
- Equipped with Continuous Emissions Monitoring System (CEMS) monitoring systems.

b) **3 Heat Recovery Steam Generators (HRSG);**

HRSG's use the hot exhaust gases from the gas turbine to heat water to steam for transfer to the steam turbine.

- Each HRSG will have a main stack for emissions during combined cycle operations;
- Equipped with main stack and CEMS systems for air emissions monitoring;

c) **Steam Turbine Generator**.

The steam turbine uses the steam from the HRSG to turn generate electricity in combined cycle, additional to the GTG, thereby increasing plant efficiency.

- Natural gas (main fuel):
    - Delivered via a new gas pipeline connection to Jordan's main gas pipeline (approximately 900m to the east);
- Natural Gas receiving station equipped with:
    - Gas forwarding systems;
    - Metering devices;
    - Gas compressors (if required, but not expected to be required);
    - All related auxiliaries.

d) **Diesel fuel (back up):**
- To be delivered by the existing pipeline from the adjacent petrochemical refinery;
- 14 days of operational on site storage capacity provide on-site.

e) **Wastewater treatment facilities** for:
- Process/Chemical wastewater;
- Oily waste water streams;
- Sanitary wastewater.

f) **Air Cooled Condensers** (for dry cooling of ST steam);

g) **Deepwater well and pumping station within site boundary**:
- Filter, Reverse Osmosis (RO) and Ion Exchanger for water treatment;
- Storage for water on site;

h) **Ancillary Facilities** (including administration building, Central Control Room etc.)

i) **Evaporation pond**

1.4 The project site is effectively spilt into four main sections based on the proposed operational uses of these areas. These sections are shown in Figure 1. Some of the receptors adjacent to the project site are shown in Figure 2.

1.5 The purpose of this assessment is to establish the potential noise levels at nearby receptors and, if necessary, formulate mitigation measures to protect existing noise sensitive receptors. Relevant national/local guidance on noise sources is presented in Section 2. The assessment of noise is considered in Section 3 together with our recommendations for mitigation. Our conclusions are summarised in Section 4.

1.6 This Report is necessarily technical in nature and contains terminology relating to acoustics and noise. Therefore, a glossary together with a brief introduction to the subject of noise has been provided in Appendix A.

Figure 1 Project Site

Figure 2 Adjacent Receptors

2 NOISE ASSESSMENT CRITERIA

Jordanian Legislative Policy

2.1 The Environmental Protection Law no. 52/2006 sets the definitions and outlines the main responsibilities and functions of the ministry of environment. As per the law, the ministry is responsible for setting Jordan's environmental protection policy, monitoring activities, coordinating national efforts for environmental protection, and preparing environmental contingency plans. Article 7 of the law assigns the ministry of environment with the environmental monitoring and inspection responsibilities, and grants its employees the right to enter any facility for inspection needs. Articles 8, 9, 10 relate to marine environment. Article 13 sets the requirements for conducting environmental impact assessment for projects.

2.2 The law also calls for the establishment of environmental protection fund (articles 16 and 17); and sets fees for violation of its provision, terms for delegation of authority, and the operation of environmental nongovernmental organizations in Jordan. Finally, it lists the regulations that should be issued in accordance to the law. Of the required 12 regulations set by law; the following regulations have already been issued: marine and coastal environment; environment protection from pollution in emergency cases; air protection; nature reserves and national parks; management, transport and handling of harmful and hazardous substances; management of solid wastes; environmental impact assessment; and soil protection.

2.3 The Jordanian Guidelines for the Prevention of Noise (2003) sets the noise limits for the ambient noise climate for various situations:

Table 2.1 Jordanian Guidelines for the Prevention of Noise (2003)

Area	Highest Permissible Limits of Equivalent Sound Level (dB(A))	
	Day	Night
Residential in Urban	60	50
Residential in Sub-Urban	55	45
Residential in Rural	50	40
Residential having Small industries, Offices and Public Buildings	65	55
Industrial	75	65
Schools, hospitals, mosques and Churches	45	35

Table 2.2 IFC EHS Guidelines, 2007 - Noise

Receptor	One Hour LAeq (dBA)	
	Daytime 07:00 – 22:00	Night time 22:00 – 07:00
Residential, Institutional, Educational	55	45
Industrial, Commercial	70	70

2.4 Under the Jordanian regulations the noise sensitive residential receptors (NSRs) in the vicinity of the plant have been classified as 'Residential having Small industries, Offices and Public Buildings'. This is due to the presence of the commercial and industrial activity locally. Therefore, the relevant noise limits for the residential NSRs are 65 dB(A) during the day and 55 dB(A) at night. These limits are 10dB(A) above the guidance of the IFC EHS General Guidelines for noise.

2.5 For receptors such as the NEPCO training centre (located immediately adjacent to the proposed power block, the noise limit has been taken to reflect the industrial criteria, due to the industrial nature of training activities that are undertaken at this facility. In relation to the Jordanian standards the industrial limits reflect 75 dB(A) in the daytime and 65 dB(A) at night. For the IFC EHS Guidelines, this value is considered to be 70 dB(A) for either day or night.

3 NOISE ASSESSMENT

3.1 The projects equipment suppliers have provided the major noise generators both internally (e.g. within the acoustic enclosures) as well as other externally located plant (e.g. air cooled condensers, water pumps the outlet stack, and ancillary equipment). The noise source data of all major plant is presented in Table 3.1.

Table 3.1 Plant Sound Power Noise Levels dB

Freq	31.5 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz
Gt air inlet filter	111	111	103	99	94	91	88	88	86
Gt inlet duct	103	103	95	91	97	95	97	97	89
Gt inlet duct transition	97	99	94	93	92	91	90	90	87
Generator	121	118	115	112	107	103	108	97	87
Generator coupling	121	114	111	109	104	96	92	83	77
Gt acoustical enclosure	117	118	113	107	106	103	102	108	99
DLN gas acoustical enclosure	104	99	94	88	88	89	93	90	84
Water injection acoustical enclosure	109	104	101	91	84	89	88	84	73
Fin fan coolers	-	109	108	108	107	104	100	96	90
Exhaust If silencer and transition	119	114	107	98	92	89	84	87	83
ACC	-	78	83	83	80	80	78	75	73
Boiler Inlet ducting						93			
Boiler casing						93			
Boiler outlet ducting and stack						93			
boiler stack exit						93			
Equipment						93			
Safety valve Silencers						138			

3.2 By taking into account the source noise levels, the area of acoustic or non-acoustic enclosures (where available) and the intervening distance to the receptor, a noise model was constructed using proprietary software IMMI2016 using the methodology outlined in ISO9613 (ISO 9613-2 “Acoustics – Attenuation of sound during propagation outdoors – Part 2: General method of calculation” describes a detailed procedure to calculate sound levels from point sources. Area and line sound sources are divided into component point sound sources).

3.3 ISO 9613-2 computes long-term average sound levels in octave bands with nominal mid-band frequencies from 63 to 8000 Hz. ISO 9613-2 makes a difference between calculation of short-term and long-term levels. If the first are calculated in downwind conditions (favourable propagation of sound with significant positive wind from source to receiver), the latter are calculated using the same formulas but corrected by means of the meteorological correction term $\mathbf{C_{met}}$.

3.4 The guidance given by ISO 9613-2 on how to determine the meteorological correction term C0 is rather unsatisfactory and therefore the following global parameters are included in the noise model:

- Temperature 10^{o}C; relative Humidity 70%;
- Light downwind propagation towards the receptor;
- No soft ground attenuation

3.5 In terms of noise attenuation from buildings off-site, information on these were not available and therefore a worst-case free propagation model was constructed. The results of the noise modelling at representative receptors (NSRs) are presented below (other NSRs are too distant for an accurate calculation of noise levels). Noise contours based on the above methodology have been computed and are presented in Figure 3.

Figure 3 Computed Noise Contours (Free Propagation Model)

Al-Hussein Power Plant

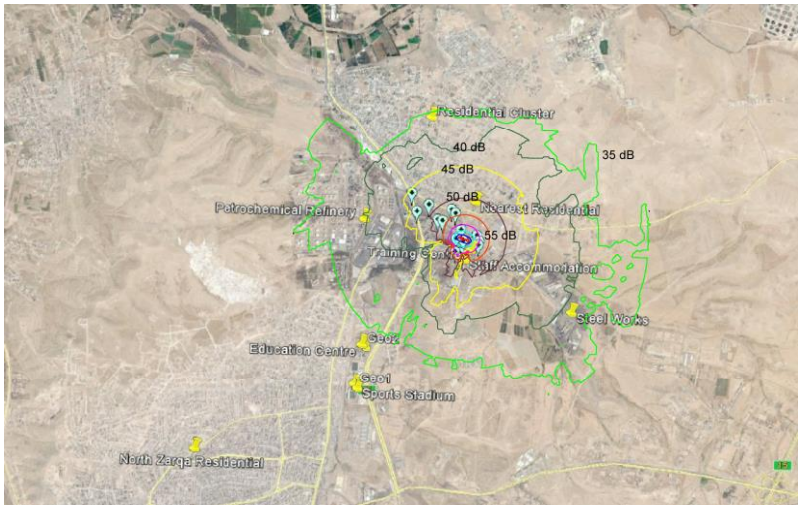
entran

12 Greenway Farm, Bath Road,
Wick,
BRISTOL, BS30 5RL
TEL: 0117 937 4077

PROJECT TITLE	Al-Hussien Power Plant		
DRAWING TITLE	Noise Contours		
DATE #	SCALE n/a	STATUS Final	
DRAWN SP	CHECKED ND	APPROVED ND	
Drg SIZE A3	DRAWING No. Figure 3	REV 1	

Figure 4 Computed Noise Contours (with Terrain Input)

Al-Hussein Power Plant



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PROJECT TITLE	Al-Hussien Power Plant		
DRAWING TITLE	Noise Contours		
DATE #	SCALE n/a	STATUS Final	
DRAWN SP	CHECKED ND	APPROVED ND	
Drg SIZE A3	DRAWING No. Figure 3	REV 2	

Table 3.3 Receptor Noise Levels, dB(A) (Base Load, without mitigation)

	Representative NSRs		Noise Standards per Receptor	
First Floor (4.5m)	**Receptor Type**	**Noise Level, dB $L_{Aeq,T}$ Day/Night**	**Jordanian**	**IFC**
Residential Cluster, Al Hashmiyeh	Residential having Small industries, Offices and Public Buildings	39.1	65 – Day 55 - Night	55 – Day 45 - Night
Nearest Residential Receptor, in Al Hashmiyeh		51.9	65 – Day 55 - Night	55 – Day 45 - Night
Training Centre, NEPCO	Industrial	63.4	75 – Day 65 - Night	70 Day/Night
CEGCO Staff Accommodation	Residential having Small industries, Offices and Public Buildings	54.0	65 – Day 55 - Night	55 – Day 45 - Night
Jordon Petroleum Refinery Al Zarqaa	Industrial	41.1	75 – Day 65 - Night	70 Day/Night
Education Centre	Schools, hospitals, mosques and Churches	37.1	45 – Day 35 - Night	55 – Day 45 - Night
Prince Mohammed Sports Stadium	Recreational (Institutional)	34.6	65 – Day 55 - Night	55 – Day 45 - Night
Steel Works	Industrial	39.1	75 – Day 65 - Night	70 Day/Night

3.6 As can be seen from the above, noise levels are within the adopted criteria for the daytime at all modelled receptors.

3.7 At night, there is compliance to all Jordanian standards, however the off-site nearest residential receptor and CEGCO accommodation area may be exposed to noise levels in excess of the IFC nigh time noise guidelines.

3.8 The only other receptor that may be exposed to exceeding limits at night is the Education centre in Zarqa, however, this is not considered to be open at night and therefore not applicable for consideration of exceedances.

Mitigation Measures

3.9 All mitigation measures detailed in the operational mitigation section of the ESIA shall be considered and implemented.

3.10 As appropriate, the following suggestions may also be taken into considered in order to reduce noise impacts at local receptors (where not already considered in the projects design):

- appropriate acoustic enclosures around the gas turbines, steam turbines and generators;
- baffle mufflers and filters on the gas turbine inlets;
- attenuation of the noise from the gas turbine exhausts by the HRSGs;
- inlet and exhaust mufflers on the cooling fans;
- silencers on all steam reject pipes; and
- all unnecessary equipment to be either switched off or throttled down at night.

3.11 The above measures are likely to give an additional benefit of approximately 10 dB and will therefore ensure that noise at **all modelled receptor locations is compliant with the adopted criteria**.

4 SUMMARY

4.1 Noise levels have been assessed at the proposed Hussein TPS Power Generation Project in Zarqa, Jordan.

4.2 This assessment has considered the noise effects of the proposed project on noise levels at local receptors, during the operational phase. The assessment has been based on a series of environmental noise predictions using ISO9613 methodology, with input data from the equipment manufacturers of the proposed plant.

4.3 During the operational phase of the development, it is predicted that the proposed project will meet the required Jordanian noise standards at all modelled receptors (in regard to the specific receptor classification).

4.4 Receptor noise levels are modelled to exceed the IFC noise guidelines at night at a couple of residential receptors.

4.5 However, it is considered that with appropriate mitigation the noise level generated can likely be reduced by 10dB(A), to ensure that the required standards are met.

APPENDIX A – INTRODUCTION TO NOISE

In order to assist the understanding of acoustic terminology and the relative change in noise, the following background information is provided.

The human ear can detect a very wide range of pressure fluctuations, which are perceived as sound. In order to express these fluctuations in a manageable way, a logarithmic scale called the decibel, or dB scale is used. The decibel scale typically ranges from 0 dB (the threshold of hearing) to over 120 dB.

The ear is less sensitive to some frequencies than to others. The A-weighting scale is used to approximate the frequency response of the ear. Levels weighted using this scale are commonly identified by the notation dB(A).

A noise impact on a community is deemed to occur when a new noise is introduced that is out of character with the area, or when a significant increase above the pre-existing ambient noise level occurs. For levels of noise that vary with time, it is necessary to employ a statistical index that allows for this variation. These statistical indices are expressed as the sound level that is exceeded for a percentage of the time period of interest.

In the UK, traffic noise is measured as the L_{A10}, the noise level exceeded for 10% of the measurement period. The L_{A90} is the level exceeded for 90% of the time and has been adopted to represent the background noise level in the absence of discrete events. An alternative way of assessing the time varying noise levels is to use the equivalent continuous sound level, L_{Aeq}. This is a notional steady level that would, over a given period of time, deliver the same sound energy as the actual fluctuating sound.

To put these quantities into context, where a receiver is predominantly affected by continuous flows of road traffic, a doubling or halving of the flows would result in a just perceptible change of 3dB, while an increase of more than 25%, or a decrease of more than 20%, in traffic flows represent changes of 1dB in traffic noise levels (assuming no alteration in the mix of traffic or flow speeds).

Note that the time constant and the period of the noise measurement should be specified. For example, BS 4142 specifies background noise measurement periods of 1 hour during the day and 5 minutes during the night. The noise levels are commonly symbolised as $_{A90(1hour)}$ and

$L_{A90(5mins)}$. The noise measurement should be recorded using a 'FAST' time response equivalent to 0.125 ms.

Table A1: Glossary of Terms

Term	Definition
Decibel (dB)	A scale for comparing the ratios of two quantities, including sound pressure and sound power. The difference in level between two sounds s1 and s2 is given by 20 log10 (s1/s2). The decibel can also be used to measure absolute quantities by specifying a reference value that fixes one point on the scale. For sound pressure, the reference value is 20μPa.
A-weighting, dB(A)	The unit of sound level, weighted according to the A-scale, which takes into account the increased sensitivity of the human ear at some frequencies.
Noise Level Indices	Noise levels usually fluctuate over time, so it is often necessary to consider an average or statistical noise level. This can be done in several ways, so a number of different noise indices have been defined, according to how the averaging or statistics are carried out.
$L_{eq,T}$	A noise level index called the equivalent continuous noise level over the time period T. This is the level of a notional steady sound that would contain the same amount of sound energy as the actual, possibly fluctuating, sound that was recorded.
$L_{max,T}$	A noise level index defined as the maximum noise level during the period T. L_{max} is sometimes used for the assessment of occasional loud noises, which may have little effect on the overall L_{eq} noise level but will still affect the noise environment. Unless described otherwise, it is measured using the 'fast' sound level meter response.
$L_{90,T}$	A noise level index. The noise level exceeded for 90% of the time over the period T. L_{90} can be considered to be the "average minimum" noise level and is often used to describe the background noise.
Free-Field	Far from the presence of sound reflecting objects (except the ground), usually taken to mean at least 3.5m
Ambient Noise Level	The totally encompassing sound in a given situation at a given time, usually composed of a sound from many sources both distant and near ($L_{Aeq,T}$).
Residual Noise Level	The ambient noise remaining at a given position in a given situation when specified sources are suppressed to a degree such that they do not contribute to the ambient noise level ($L_{Aeq,T}$)
Specific Noise Level	The equivalent continuous A-weighted sound pressure level at the assessment position produced by the specific noise source (the noise source under investigation) over a given time interval ($L_{Aeq,T}$)
Rating Noise Level	The specific noise level plus any adjustment for the characteristic features of the noise ($L_{Ar,Tr}$).

Appendix K

Soil Quality Laboratory Results (2016)

الجمعية العلمية الملكية
Royal Scientific Society
مختبرات التحليل الكيميائي الآلي

رقم الكتاب :(١٧٠١٠١) ١/٥٥/١٦٤ /٨٠١٧
تاريخ : ١٧/ ٤ /٢٠١٦

رقم المعاملة الجمركية : تاريخ :
رقم العينة التميزي: ٢٠١٦/٠١/١٧/٥٢٦٨(١-٥)
رقم التقرير: ٨٧٢-٨٧٦
عدد صفحات التقرير بما فيها الغلاف: (٧)

السادة: شركة توليد الكهرباء المركزية م.ع / CEGCO المحترمين.
العنوان : عمان

تحية طيبة وبعد

إشارة لكتابكم رقم (HSED 2016-02) تاريخ (٢٠١٦/٠٤/٠٣) ، تجدون مرفقاً تقرير نتائج الفحص/المعايرة/ الخدمة المطلوبة من قبلكم ، وقد بلغت تكاليف العمل المطلوب مبلغا و قـدره (١٤٢٥,٠٠٠) ألفا و أربعمائة وخمسة وعشرون دينارا أردنيا.

أرجو اتخاذ الإجراء المحدد أدناه بالإشارة ☒ :-

☐ لا حاجة لاتخاذ أي إجراء بخصوص هذه المطالبة و ذلك للأسباب التالية:-

☐ القيمة دفعت نقداً ☐ بموجب اتفاقية رقم (/) ☐ أخرى .....

☐ دفع قيمة المطالبة عند استلامكم الفاتورة الصادرة عن الدائرة المالية في الجمعية العلمية الملكية.

و اقبلوا الاحترام،،،

مدير المختبرات

د. عدنان صقر الخصاونة
Adnan.elkhasawneh@rss.jo
رقم الهاتف :٥٣٤٤٧٠١

ملاحظات: يرجى إصدار الشيكات باسم الجمعية العلمية الملكية

- لا يجوز استعمال نتائج فحوصات الجمعية العلمية الملكية لأغراض دعائية إلا بموافقة الجمعية خطيا على النص المراد نشره.
- تقارير الفحص غير صالحة بدون التوقيع والختم.
- *يرجى إرسال مندوبكم لاستلام العينات خلال فترة أسبوعين من تاريخ اصدار التقرير.*
- *يحق للجمعية التصرف التام بالعينات بعد الفحص إذا لم يتم استلامها من قبل صاحب العلاقة او من ينوبه خلال أسبوعين.*

هاتف ٥٣٤٤٧٠١ ٦ ٩٦٢+ فاكس ٥٣٤٤٨٠٦ ٦ ٩٦٢+
صندوق بريد ١٤٣٨ عمان ١١٩٤١ الأردن
Tel +962 6 5344701 Fax +962 6 5344806
P.O.Box 1438 Amman 11941 Jordan www.rss.jo

الجمعية العلمية الملكية
Royal Scientific Society

Test Report

Sector: Technical/Labs.

Division: Automated Chemical Analysis labs **Sample Designation No.:17/01/16/5268/1**

Laboratory: Spectroscopy **Lab Report No.:872**

تقرير الفحص غير رسمي مالم يحمل التوقيع المعتمد وختم القسم

Client Address	**Central Electricity Generating Co.(CEGCO)**
	Amman Tel:/56997769

Our Reference No.: (170101) 164/55/1/ 8c/ 7 Type of sample: Soil

Date: 17 /4/2016 Method of sampling: collected and delivered by your representative

Your Reference No.: HSED 2016-02 Date of Receipt: 03/04/20016

Date: 03/4/2016 Date of end of testing: 17/04/2016

لا ينسخ التقرير بشكل مجزأ إلا بأخذ موافقة خطية من الجهة المصدرة للشهادة

نتائج الفحص تمثل العينة المفحوصة فقط

أي كشط او تعديل يلغي هذا التقرير

Parameter	Unit	Results/ Sample Code HUSSEIN 4A 15/3/2016	Testing method
As	mg/kg	<7.5	SOP17/01/01/02/1
Ba	mg/kg	150	SOP17/01/01/02/1
Cd	mg/kg	<1.0	SOP17/01/01/02/1
Cr	mg/kg	54.8	SOP17/01/01/02/1
Co	mg/kg	6.47	SOP17/01/01/02/1
Cu	mg/kg	18.0	SOP17/01/01/02/1
Pb	mg/kg	13.2	SOP17/01/01/02/1
Ni	mg/kg	36.3	SOP17/01/01/02/1
Hg	mg/kg	<1.0	SOP17/01/01/02/1
Zn	mg/kg	87.1	SOP17/01/01/02/1

Notes:
- Samples were received in a good condition.
-Samples were labeled by your representative.
- Attached is TPH result.

Test report is only valid with devision-stamp and signature

Test report shall not be reproduced other than in full, except with the written approval of the issuing party

The test results relate only to the items tested

Any erasure or attrition in the report will invalid it

Lab Supervisor: Eman Ta'an

Division Head: Eng.Haitham Naser

هاتف ٥٣٤٤٧٠١ ٦ ٩٦٢+ فاكس ٥٣٤٤٨٠٦ ٦ ٩٦٢+ ص.ب ١٤٣٨ عمان ١١٩٤١ الأردن
Tel: +962 6 5344701 Fax: +962 6 5344806 P.O.Box 1438 Amman 11941 Jordan

الجمعية العلمية الملكية
Royal Scientific Society

Test Report

Sector: Technical/Labs.

Division: Automated Chemical Analysis labs **Sample Designation No.:17/01/16/5268/2**

Laboratory: Spectroscopy **Lab Report No.:873**

تقرير الفحص غير رسمي مالم يحمل التوقيع المعتمد وختم القسم

Client	**Central Electricity Generating Co.(CEGCO)**
Address	**Amman**

Our Reference No.: (170101) 164/55/1/ 8017
Date: 17/4/2016

Your Reference No.: HSED 2016-02

Date: 03/4/2016

Type of sample: Soil

Method of sampling: collected and delivered by your representative

Date of Receipt: 03/04/20016

Date of end of testing: 17/04/2016

لا ينسخ التقرير بشكل مجزأ إلا بأخذ موافقة خطية من الجهة المصدرة للشهادة

Parameter	Unit	Results/ Sample Code HUSSEIN 1B 15/3/2016	Testing method
As	mg/kg	<7.5	SOP17/01/01/02/1
Ba	mg/kg	183	SOP17/01/01/02/1
Cd	mg/kg	3.97	SOP17/01/01/02/1
Cr	mg/kg	98.7	SOP17/01/01/02/1
Co	mg/kg	<5.0	SOP17/01/01/02/1
Cu	mg/kg	27.2	SOP17/01/01/02/1
Pb	mg/kg	10.4	SOP17/01/01/02/1
Ni	mg/kg	62.6	SOP17/01/01/02/1
Hg	mg/kg	<1.0	SOP17/01/01/02/1
Zn	mg/kg	164	SOP17/01/01/02/1

نتائج الفحص تمثل العينة المفحوصة فقط

أي كشط او تعديل يلغي هذا التقرير

Test report is only valid with devision-stamp and signature

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The test results relate only to the items tested

Any erasure or attrition in the report will invalid it

Notes:
- Samples were received in a good condition.
-Samples were labeled by your representative.
- Attached is TPH result.

Lab Supervisor: Eman Ta'an

Division Head: Eng.Haitham Naser

هاتف ٥٣٤٤٧٠١ ٦ ٩٦٢+ فاكس ٥٣٤٤٨٠٦ ٦ ٩٦٢+ ص.ب ١٤٣٨ عمان ١١٩٤١ الأردن
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الجمعية العلمية الملكية
Royal Scientific Society

Test Report

Sector: Technical/Labs.

Division: Automated Chemical Analysis labs **Sample Designation No.:17/01/16/5268/3**

Laboratory: Spectroscopy **Lab Report No.:874**

تقرير الفحص غير رسمي مالم يحمل التوقيع المعتمد وختم القسم

Client	**Central Electricity Generating Co.(CEGCO)**
Address	**Amman**

Our Reference No.: (170101) 164/55/1/ 807

Date: 17 /4/2016

Your Reference No.: HSED 2016-02

Date: 03/4/2016

Type of sample: Soil

Method of sampling: collected and delivered by your representative

Date of Receipt: 03/04/20016

Date of end of testing: 17/04/2016

لا ينسخ التقرير بشكل مجزأ إلا بأخذ موافقة خطية من الجهة المصدرة للشهادة

نتائج الفحص تمثل العينة المفحوصة فقط

أي كشط او تعديل يلغي هذا التقرير

Parameter	Unit	Results/ Sample Code HUSSEIN 3A 15/3/2016	Testing method
As	mg/kg	<7.5	SOP17/01/01/02/1
Ba	mg/kg	114	SOP17/01/01/02/1
Cd	mg/kg	<1.0	SOP17/01/01/02/1
Cr	mg/kg	42.9	SOP17/01/01/02/1
Co	mg/kg	<5.0	SOP17/01/01/02/1
Cu	mg/kg	13.1	SOP17/01/01/02/1
Pb	mg/kg	19.3	SOP17/01/01/02/1
Ni	mg/kg	212	SOP17/01/01/02/1
Hg	mg/kg	<1.0	SOP17/01/01/02/1
Zn	mg/kg	78.0	SOP17/01/01/02/1

Notes:
- Samples were received in a good condition.
-Samples were labeled by your representative.
- Attached is TPH result.

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Any erasure or attrition in the report will invalid it

Lab Supervisor: Eman Ta'an

Division Head: Eng.Haitham Naser

هاتف ٥٣٤٤٧٠١ ٦ ٩٦٢+ فاكس ٥٣٤٤٨٠٦ ٦ ٩٦٢+ ص.ب ١٤٣٨ عمان ١١٩٤١ الأردن
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الجمعية العلمية الملكية
Royal Scientific Society

Test Report

Sector: Technical/Labs.

Division: Automated Chemical Analysis labs **Sample Designation No.:17/01/16/5268/4**

Laboratory: Spectroscopy **Lab Report No.:875**

Client	**Central Electricity Generating Co.(CEGCO)**
Address	**Amman**

Our Reference No.: (170101) 164/55/1/ &cl).
Date: 17 /4/2016

Your Reference No.: HSED 2016-02

Date: 03/4/2016

Type of sample: Soil

Method of sampling: collected and delivered by your representative

Date of Receipt: 03/04/20016

Date of end of testing: 17/04/2016

Parameter	Unit	Results/ Sample Code HUSSEIN 2ACC 15/3/2016	Testing method
As	mg/kg	<7.5	SOP17/01/01/02/1
Ba	mg/kg	224	SOP17/01/01/02/1
Cd	mg/kg	4.98	SOP17/01/01/02/1
Cr	mg/kg	45.4	SOP17/01/01/02/1
Co	mg/kg	<5.0	SOP17/01/01/02/1
Cu	mg/kg	11.4	SOP17/01/01/02/1
Pb	mg/kg	<5.0	SOP17/01/01/02/1
Ni	mg/kg	25.9	SOP17/01/01/02/1
Hg	mg/kg	<1.0	SOP17/01/01/02/1
Zn	mg/kg	40.3	SOP17/01/01/02/1

Notes:
- Samples were received in a good condition.
-Samples were labeled by your representative.
- Attached is TPH result.

Lab Supervisor: Eman Ta'an

Division Head: Eng.Haitham Naser

Page (1) of (1)

هاتف ٥٣٤٤٧٠١ ٦ ٩٦٢+ فاكس ٥٣٤٤٨٠٦ ٦ ٩٦٢+ ص.ب ١٤٣٨ عمان ١١٩٤١ الأردن
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الجمعية العلمية الملكية
Royal Scientific Society

Test Report

Sector: Technical/Labs.

Division: Automated Chemical Analysis labs **Sample Designation No.:17/01/16/5268/5**

Laboratory: Spectroscopy **Lab Report No.:876**

تقرير الفحص غير رسمي مالم يحمل التوقيع المعتمد وختم القسم

Client	**Central Electricity Generating Co.(CEGCO)**
Address	**Amman**

لا ينسخ التقرير بشكل مجزأ إلا بأخذ موافقة خطية من الجهة المصدرة للشهادة

Our Reference No.: (170101) 164/55/1/8612 Type of sample: Soil

Date: 17/4/2016 Method of sampling: collected and delivered by your representative

Your Reference No.: HSED 2016-02 Date of Receipt: 03/04/20016

Date: 03/4/2016 Date of end of testing: 17/04/2016

نتائج الفحص تمثل العينة المفحوصة فقط

أي كشط او تعديل يلغي هذا التقرير

Parameter	Unit	Results/ Sample Code HUSSEIN 1A 15/3/2016	Testing method
As	mg/kg	<7.5	SOP17/01/01/02/1
Ba	mg/kg	301	SOP17/01/01/02/1
Cd	mg/kg	6.02	SOP17/01/01/02/1
Cr	mg/kg	678	SOP17/01/01/02/1
Co	mg/kg	5.66	SOP17/01/01/02/1
Cu	mg/kg	1772	SOP17/01/01/02/1
Pb	mg/kg	157	SOP17/01/01/02/1
Ni	mg/kg	508	SOP17/01/01/02/1
Hg	mg/kg	<1.0	SOP17/01/01/02/1
Zn	mg/kg	1040	SOP17/01/01/02/1

Notes:
- Samples were received in a good condition.
-Samples were labeled by your representative.
- Attached is TPH result.

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Lab Supervisor: Eman Ta'an **Division Head: Eng.Haitham Naser**

هاتف ٥٣٤٤٧٠١ ٦ ٩٦٢+ فاكس ٥٣٤٤٨٠٦ ٦ ٩٦٢+ ص.ب ١٤٣٨ عمان ١١٩٤١ الأردن
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الجمعية العلمية الملكية
Royal Scientific Society

تقرير فحص

القطاع:الشؤون الفنية/ المختبرات

القسم:المختبرات البيئة والغذاء

المختبر: مختبر المياه

الرقم التميزي للعينة:٥٢٦٨/١٦/٠١/١٧

رقم التقرير: ٤٩٣ – ٤٩٧

السادة: شركة توليد الكهرباء المركزية / CEGCO المحترمين

العنوان: عمـان

اشارتنا رقم: (١٧٠١٠٢)١/٥٥/٣٣٠/ ٨٦٢ ل

تاريخ: ١٤/ ٢٠١٦/٠٤

اشارتكم رقم: HSED 2016-02

تاريخ: ٢٠١٦/٠٤/٠٣

نوع العينة: تربة

طريقة اخذ العينة: تم جمعها وإحضارها من قبلكم

تاريخ الاستلام: ٢٠١٦/٠٤/٠٣

تاريخ انتهاء الفحص: ٢٠١٦/٠٤/١٣

الفحص	النتيجة / رمز العينة					الوحدة	طريقة الفحص
	1 A	3 A	1B	2 ACC	4 A		
TPH	< 400	< 400	< 400	< 400	< 400	mg/ kg	Water Air Soil Pollutant Journal, 2008

ملاحظات:

- حالة العينة عند الاستلام : جيدة .
- تم ترميز العينة من قبلكم

مسؤول المختبر: عبدالله عبيدات

رئيس القسم : صامد القطارنة

صفحة (١) من (١)

FORM NO. RSSPMP1302 REV.(1)

تقرير الفحص غير رسمي مالم يحمل التوقيع المعتمد وختم القسم

لا ينسخ التقرير بشكل مجزأ إلا بأخذ موافقة خطية من الجهة المصدرة للشهادة

نتائج الفحص تمثل العينة المفحوصة فقط

أي كشط او تعديل يلغي هذا التقرير

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The test results relate only to the items tested

Any erasure or attrition in the report will invalid it

هاتف ٥٣٤٤٧٠١ ٦ ٩٦٢+ فاكس ٥٣٤٤٨٠٦ ٦ ٩٦٢+ ص.ب ١٤٣٨ عمان ١١٩٤١ الأردن
Tel: +962 6 5344701 Fax: +962 6 5344806 P.O.Box 1438 Amman 11941 Jordan

Appendix L

Groundwater Quality Laboratory Results (2016)

مختبرات البيئة والغذاء

رقم الكتاب : (١٧٠١٠٢) ٣٣٠/٥٥/١/٥٥٦٤
تاريخ : ٢٠١٦/٠٣/١٥

رقم العينة التسلسلي: ٣٤٤١/٢٠١٦/٠١/١٧
رقم التقرير: ٣٣٦-٣٣٨ + ١١٨٧-١١٨٩
عدد صفحات التقرير بما فيها الغلاف: (٧)

السادة : شركة توليد الكهرباء المركزية المحترمين

العنوان : عمان

تحية طيبة وبعد،،،

إشارة لكتابكم رقم: HSED 2016-01 تاريخ ٢٠١٦/٠٣/٠١، تجدون مرفقاً تقرير نتائج الفحص/المعايرة/ الخدمة المطلوبة من قبلكم، وقد بلغت تكاليف العمل المطلوب مبلغاً و قدره (٥٥٥) خمسمائة و خمسة و خمسون ديناراً اردنياً فقط لا غير.

أرجو اتخاذ الإجراء المحدد أدناه بالإشارة ☒ :-

☐ لا حاجة لاتخاذ أي إجراء بخصوص هذه المطالبة و ذلك للأسباب التالية:-
☐ القيمة دفعت نقداً ☐ بموجب اتفاقية رقم (/ /) ☐ أخرى

☐ دفع قيمة المطالبة عند استلامكم الفاتورة الصادرة عن الدائرة المالية في الجمعية العلمية الملكية.

و اقبلوا الاحترام،،،

مدير مختبرات

د. عدنان صقر الخصاونة
Adnan.elkhasawnch@rss.jo
رقم الهاتف :٥٣٤٤٧٠١

ملاحظات: يرجى إصدار الشيكات باسم الجمعية العلمية الملكية

- لا يجوز استعمال نتائج فحوصات الجمعية العلمية الملكية لأغراض دعائية إلا بموافقة الجمعية خطياً على النص المراد نشره.
- تقارير الفحص غير صالحة بدون التواقيع والختم.
- يرجى إرسال مندوبكم لاستلام العينات خلال فترة اسبوعين من تاريخ إصدار التقرير .
- يحق للجمعية التصرف التام بالعينات بعد الفحص إذا لم يتم استلامها من قبل صاحب العلاقة أو من ينوبه خلال اسبوعين.

هاتف ٥٣٤٤٧٠١ ٦ ٩٦٢+ فاكس ٥٣٤٤٨٠٦ ٦ ٩٦٢+
صندوق بريد ١٤٣٨ عمان ١١٩٤١ الأردن
Tel +962 6 5344701 Fax +962 6 5344806
P.O.Box 1438 Amman 11941 Jordan www.rss.jo

تقرير فحص

Test-053

القطاع: الشؤون الفنية/ المختبرات

القسم: المختبرات البيئة والغذاء

المختبر: مختبر المياه

الرقم التمييزي للعينة: ٣٤٤١/١٦/٠١/١٧

رقم التقرير: ٣٣٦

السادة: شركة توليد الكهرباء المركزية المحترمين

العنوان: عمان

اشارتنا رقم: (١٧٠١٠٢) ٥٥/٣٣٠/١/5561

تاريخ: ١٥/٠٣/٢٠١٦

اشارتكم رقم: HSED 2016-01

تاريخ: ٠١/٠٣/٢٠١٦

نوع العينة: مياه (No. 1)

طريقة اخذ العينة: تم جمعها واحضارها من قبلكم

تاريخ الاستلام: ٠١/٠٣/٢٠١٦

تاريخ انتهاء الفحص: ١٥/٠٣/٢٠١٦

الفحص	النتيجة	الوحدة	طريقة الفحص
PH	7.04	SU	4500 - H+ B*
EC at 25° C	4260	µs/cm	2510 B*
FOG**	<8	mg/ L	5520 – B*
TPH**	<8	mg/ L	Water Air Soil Solution, 2008

*: Standard Methods for the Examination of Water & Wastewater, Online, 2011
**: Test is not accredited by JAS & UKAS.

ملاحظات
- حالة العينة عند الاستلام: جيدة
- تم ترميز العينة من قبلكم
- معلومات العينة: Deep well No. 1 - Sampling @ 11:40 (03/03/2016)

مسؤول المختبر: عبدالله عبيدات

رئيس القسم: صامد القطارنة

صفحة (١) من (١)

FORM NO. RSSPMP1302 REV.(1)

تقرير الفحص غير رسمي مالم يحمل التوقيع المعتمد وختم القسم

لا يتسخ التقرير بشكل مجزأ إلا بأخذ موافقة خطية من الجهة المصدرة للشهادة

نتائج الفحص تمثل العينة المفحوصة فقط

أي كشط او تعديل يلغي هذا التقرير

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تقرير فحص

Test-053

القطاع:الشؤون الفنية/ المختبرات

القسم:المختبرات البيئة والغذاء

المختبر : مختبر المياه

الرقم التميزي للعينة:٣٤٤١/١٦/٠١/١٧

رقم التقرير: ٣٣٧

السادة: شركة توليد الكهرباء المركزية المحترمين

العنوان: عمـان

اشارتنا رقم: (١٧٠١٠٢)٣٣٠/١/٥٥/ ٥٥٦١

تاريخ: ١٥ /٢٠١٦/٠٣

اشارتكم رقم: HSED 2016-01

تاريخ: ٢٠١٦/٠٣/٠١

نوع العينة: مياه (No. 8)

طريقة اخذ العينة: تم جمعها واحضارها من قبلكم

تاريخ الاستلام: ٢٠١٦/٠٣/٠١

تاريخ انتهاء الفحص: ٢٠١٦/٠٣/١٥

الفحص	النتيجة	الوحدة	طريقة الفحص
PH	7.10	SU	4500 - H^+ B*
EC at 25° C	3650	µs/cm	2510 B*
FOG**	<8	mg/ L	5520 – B*
TPH**	<8	mg/ L	Water Air Soil Solution, 2008

* Standard Methods for the Examination of Water & Wastewater, Online, 2011
**: Test is not accredited by JAS & UKAS

ملاحظات:
- حالة العينة عند الاستلام : جيدة
- تم ترميز العينة من قبلكم
- معلومات العينة: Deep well No. 8 - Sampling at 14:45 (02/03/2016)

مسؤول المختبر: عبدالله عبيدات

رئيس القسم : صامد القطارنة

صفحة (١) من (١)

FORM NO. RSSPMP1302 REV.(1)

تقرير الفحص غير رسمي مالم يحمل التوقيع المعتمد وختم القسم

لا ينسخ التقرير بشكل مجزأ إلا بأخذ موافقة خطية من الجهة المصدرة للشهادة

نتائج الفحص تمثل العينة المفحوصة فقط

أي كشط او تعديل يلغي هذا التقرير

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Royal Scientific Society

JAS
Jordanian Accreditation System
نظام الاعتماد الأردني

UKAS TESTING
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تقرير فحص

Test-053

القطاع:الشؤون الفنية/ المختبرات

القسم:المختبرات البيئة والغذاء

المختبر: مختبر المياه

الرقم التمييزي للعينة:٣٤٤١/١٦/٠١/١٧

رقم التقرير: ٣٣٨

السادة

شركة توليد الكهرباء المركزية المحترمين

العنوان

عمـان

اشارتنا رقم: (١٧٠١٠٢)/٣٣٠/٥٥/١/٥٥٦١

تاريخ: ١٥/٠٣/٢٠١٦

اشارتكم رقم: HSED 2016-01

تاريخ: ٠١/٠٣/٢٠١٦

نوع العينة: مياه (No. 9)

طريقة اخذ العينة: تم جمعها واحضارها من قبلكم

تاريخ الاستلام: ٠١/٠٣/٢٠١٦

تاريخ انتهاء الفحص:١٥/٠٣/٢٠١٦

الفحص	النتيجة	الوحدة	طريقة الفحص
PH	7.14	SU	4500 - H^+ B*
EC at 25° C	3440	µs/cm	2510 B*
FOG**	<8	mg/ L	5520 – B*
TPH**	<8	mg/ L	Water Air Soil Solution, 2008

*: Standard Methods for the Examination of Water & Wastewater, Online, 2011
**: Test is not accredited by JAS & UKAS.

ملاحظات:
- حالة العينة عند الاستلام : جيدة
- تم ترميز العينة من قبلكم
- معلومات العينة: Deep well No. 9 - Sampling @ 14:20 (03/03/2016)

مسؤول المختبر: عبدالله عبيدات

رئيس القسم : صامد القطارنة

صفحة (١) من (١)

FORM NO. RSSPMP1302 REV.(1)

تقرير الفحص غير رسمي مالم يحمل التوقيع المعتمد وختم القسم

لا ينسخ التقرير بشكل مجزأ إلا بأخذ موافقة خطية من الجهة المصدرة للشهادة

نتائج الفحص تمثل العينة المفحوصة فقط

أي كشط او تعديل يلغي هذا التقرير

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الجمعية العلمية الملكية
Royal Scientific Society

تقرير فحص

القطاع: الشؤون الفنية/المختبرات
القسم: مختبرات التحليل الكيميائي الآلي
المختبر: الكروماتوغرافي

الرقم التمييزي للعينة: ١/٣٤٤١/١٦/٠١/١٧
رقم التقرير: ١١٨٧

تقرير الفحص غير رسمي مالم يحمل التوقيع المعتمد وختم القسم

السادة	شركة توليد الكهرباء المركزية المحترمين
العنوان	عمان

لا ينسخ التقرير بشكل مجزأ إلا بأخذ موافقة خطية من الجهة المصدرة للشهادة

اشارتنا رقم: (١٧٠١٠١) ١/٥٥/١٦٣ ٥٥٠٩
تاريخ: ١٥/ ٢ /٢٠١٦

إشارتكم رقم: HSED 2016-01
تاريخ: ٢٠١٦/٠٣/٠١

نوع العينة: مياه Deep well No.1
طريقة اخذ العينة: من صاحب العلاقة
تاريخ الاستلام: ٢٠١٦/٠٣/١٠
تاريخ الفحص: ٢٠١٦/٠٣/١٥

نتائج الفحص تمثل العينة المفحوصة فقط

أي كشط او تعديل يلغي هذا التقرير

الفحص	النتيجة	الوحدة	طريقة الفحص
Polyaromatic Hydrocarbons			
Acenaphtylene	<0.04	µg/L	6410-B*
Flourene	<0.07		
Phenanthrene	<0.07		
Anthracene	<0.06		
Pyrene	<0.2		
Benzo (a) anthracene	<0.3		
Chrycene	<0.3		
Benzo (b) flourene	<0.35		
Benzo (k) flourene	<0.35		
Benzo (a) pyrene	<0.6		
Indeno (1,2,3-cd) pyrene	<1.1		
Dibenzo (a,h) anthracene	<1.3		
Benzo (g,h,i) pyrene	<1.3		

ملاحظات:

- حالة العينة عند الاستلام: جيدة.

*: Standard Methods for the Examination of Water & Wastewater, Online, 2011.

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مسؤول المختبر: محمد ابو عفيفان

رئيس القسم : م. هيثم نصر

FORM NO. RSSPMP1302 REV. (1)

هاتف ٥٣٤٤٧٠١ ٦ ٩٦٢+ فاكس ٥٣٤٤٨٠٦ ٦ ٩٦٢+ ص.ب ١٤٣٨ عمان ١١٩٤١ الأردن
Tel: +962 6 5344701 Fax: +962 6 5344806 P.O.Box 1438 Amman 11941 Jordan

الجمعية العلمية الملكية
Royal Scientific Society

تقرير فحص

القطاع: الشؤون الفنية/المختبرات
القسم: مختبرات التحليل الكيميائي الآلي
المختبر: الكروماتوغرافي

الرقم التمييزي للعينة: ٢/٣٤٤١/١٦/٠١/١٧
رقم التقرير: ١١٨٨

تقرير الفحص غير رسمي مالم يحمل التوقيع المعتمد وختم القسم

السادة	شركة توليد الكهرباء المركزية المحترمين
العنوان	عمان

لا ينسخ التقرير بشكل مجزأ إلا بأخذ موافقة خطية من الجهة المصدرة للشهادة

اشارتنا رقم: (١٧٠١٠١) ١٦٣/٥٥/١ ٥٥٠٩
تاريخ: ١٥/٣/٢٠١٦
إشارتكم رقم: HSED 2016-01
تاريخ: ٢٠١٦/٠٣/٠١

نوع العينة: مياه Deep well No.8
طريقة اخذ العينة: من صاحب العلاقة
تاريخ الاستلام: ٢٠١٦/٠٣/١٠
تاريخ الفحص: ٢٠١٦/٠٣/١٥

نتائج الفحص تمثل العينة المفحوصة فقط

أي كشط او تعديل يلغي هذا التقرير

الفحص	النتيجة	الوحدة	طريقة الفحص
Polyaromatic Hydrocarbons			
Acenaphtylene	<0.04	µg/L	6410-B*
Flourene	<0.07		
Phenanthrene	<0.07		
Anthracene	<0.06		
Pyrene	<0.2		
Benzo (a) anthracene	<0.3		
Chrycene	<0.3		
Benzo (b) flourene	<0.35		
Benzo (k) flourene	<0.35		
Benzo (a) pyrene	<0.6		
Indeno (1,2,3-cd) pyrene	<1.1		
Dibenzo (a,h) anthracene	<1.3		
Benzo (g,h,i) pyrene	<1.3		

ملاحظات:
- حالة العينة عند الاستلام: جيدة.

*: Standard Methods for the Examination of Water & Wastewater, Online, 2011.

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مسؤول المختبر: محمد ابو عثمان

رئيس القسم: م. هيثم نصر

FORM NO. RSSPMP1302 REV. (1)

هاتف ٥٣٤٤٧٠١ ٦ ٩٦٢+ فاكس ٥٣٤٤٨٠٦ ٦ ٩٦٢+ ص.ب ١٤٣٨ عمان ١١٩٤١ الأردن
Tel: +962 6 5344701 Fax: +962 6 5344806 P.O.Box 1438 Amman 11941 Jordan

الجمعية العلمية الملكية
Royal Scientific Society

تقرير فحص

القطاع: الشؤون الفنية/المختبرات
القسم: مختبرات التحليل الكيميائي الآلي
المختبر: الكروماتوغرافي

الرقم التمييزي للعينة: ٣/٣٤٤١/١٦/٠١/١٧
رقم التقرير: ١١٨٩

تقرير الفحص غير رسمي مالم يحمل التوقيع المعتمد وختم القسم

السادة	شركة توليد الكهرباء المركزية المحترمين
العنوان	عمان

لا ينسخ التقرير بشكل مجزأ إلا بأخذ موافقة خطية من الجهة المصدرة للشهادة

اشارتنا رقم: (١٧٠١٠١) ١٦٣/٥٥/١ ٥٥٩
تاريخ: ١٥/ ٢٠١٦

إشارتكم رقم: HSED 2016-01
تاريخ: ٢٠١٦/٠٣/٠١

نوع العينة: مياه Deep well No.9
طريقة اخذ العينة: من صاحب العلاقة
تاريخ الاستلام: ٢٠١٦/٠٣/١٠
تاريخ الفحص: ٢٠١٦/٠٣/١٥

نتائج الفحص تمثل العينة المفحوصة فقط

أي كشط او تعديل يلغي هذا التقرير

الفحص	النتيجة	الوحدة	طريقة الفحص
Polyaromatic Hydrocarbons			
Acenaphtylene	<0.04	µg/L	6410-B*
Flourene	<0.07		
Phenanthrene	<0.07		
Anthracene	<0.06		
Pyrene	<0.2		
Benzo (a) anthracene	<0.3		
Chrycene	<0.3		
Benzo (b) flourene	<0.35		
Benzo (k) flourene	<0.35		
Benzo (a) pyrene	<0.6		
Indeno (1,2,3-cd) pyrene	<1.1		
Dibenzo (a,h) anthracene	<1.3		
Benzo (g,h,i) pyrene	<1.3		

ملاحظات:
- حالة العينة عند الاستلام: جيدة.

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مسؤول المختبر: محمد ابو عثمان

رئيس القسم : م. هيثم نصر

FORM NO. RSSPMP1302 REV. (1)

هاتف ٥٣٤٤٧٠١ ٦ ٩٦٢+ فاكس ٥٣٤٤٨٠٦ ٦ ٩٦٢+ ص.ب ١٤٣٨ عمان ١١٩٤١ الأردن
Tel: +962 6 5344701 Fax: +962 6 5344806 P.O.Box 1438 Amman 11941 Jordan

CENETRAL ELECTRICITY GENERATING COMPANY
HUSSEIN THEMRAL POWER STATION
CHEMICAL DEPATRMENT
LAB & CHEMICAL INJECTION SECTION

DEEP WELLS MONTHLY REPORT

SAMPLE TYPE: DEEP WELLS WATER LOCATION: HTPS – DEEP WELL	REPORTING DATE : 03/01/2016 SAMPLING MONTH: December

Deep №→ / Test ↓	1	2	3	7	8	9	10
pH @ 25 °C	7.38	-	7.35	-	-	-	7.48
X , µS/cm @ 25 °C	4500	-	4020	-	-	-	2500
TDS ppm	2880	-	2573	-	-	-	1600
SiO_2 ppm	16.6	-	16.8	-	-	-	17.2
Cl^- ppm	968	-	984	-	-	-	672
T.H as $CaCO_3$ ppm	983	-	1016	-	-	-	748
Ca^{++}ppm	236	-	225	-	-	-	163
Mg^{++}ppm	147	-	158	-	-	-	123
Na^+ppm	489	-	434	-	-	-	256
Total Fe ppm	0.059	-	0.062	-	-	-	0.046
SO_4^{-2} ppm	558	-	573	-	-	-	392
K^+ppm	13	-	12	-	-	-	8
Total alkalinity as $CaCO_3$ ppm	208	-	206	-	-	-	224

NOTES:

- Deep wells (2,7,8,9) are not available .

ANALYST	SUPERVISOR	SECTION HEAD
Raid Karajeh	Said Tobassi	Abdullah Alhasani

CENETRAL ELECTRICITY GENERATING COMPANY
HUSSIE THEMRAL POWER STATION
CHEMICAL DEPATRMENT
LAB & CHEMICAL INJECTION SECTION

WASTE WATER & NEUTRALIZATION PITS REPORT

SAMPLE TYPE: WASTE WATER LOCATION: HTPS – WASTE WATER SYSTEM	SAMPLING DATE : 29/11/2015 SAMPLING HOUR: @ 9:30 am

Test→ / Sample ↓	pH @ 25 °C	X , µS/cm @ 25 °C	TDS ppm	Oil ppm	Remarks
NEUTRALIZATION PIT .4&5	-	-	-	-	Empty
NEUTRALIZATION PIT 6	-	-	-	-	Empty
NEUTRALIZATION PIT R.O	-	-	-	-	Stop
AFTER OIL SEPARETOR	6.31	77	49	-	-
TOTAL WASTE WATER	7.36	569	364	11	-
RECOMMENDED VALUES	6.0 - 9.0	-	-	<100	-

NOTES:

.....

.....

.....

.....

.....

.....

ANALYST	SUPERVISOR	SECTION HEAD
Raed Karajeh	Said Tobassi	Abdullah Alhasani

CENTRAL ELECTRICITY GENERATING COMPANY

HTPS - DW # 8 Monitoring Report

	Date & Hour	07:00	08:00	09:00	11:30	14:00	19:00	Notes
HFO Concentration, v/v %	01/02/2016			Nil		Nil		* sample @ 9:00 is Turbid but @ 14:00 is clear
	02/02/2016			Nil		Nil		* sample @ 9:00 is Turbid but @ 14:00 is clear
	03/02/2016			Nil		Nil		* sample @ 9:00 is Turbid but @ 14:00 is clear
	04/02/2016			Nil				
	07/02/2016			Nil		Nil		* sample @ 9:00 is Turbid but @ 14:00 is clear
	08/02/2016			Nil		Nil		* sample @ 9:00 is Turbid but @ 14:00 is clear
	09/02/2016			Nil		Nil		* sample @ 9:00 is Turbid but @ 14:00 is clear
	10/02/2016			Nil		Nil		* sample @ 9:00 is Turbid but @ 14:00 is clear
	11/02/2016				Nil			sample is clear / conductivity : 4000 µS/cm , pH : 7.20

Appendix M

Hydrogeology Study

Groundwater Investigation in the Vicinity of the Hussein Thermal Power Plant

November 2012

Table of Contents

1) Introduction

Hussein power plant is located in the northern region of Jordan, approximately 30 km northeast of the capital Amman. The plant site is located within Zarqa Industrial area and is situated 560 m above sea level. Hussein power plant comprises 7 generating units, 3 of which are steam turbines, nominally rated at 33 MW gross, 4 are steam turbines rated at 66 MW gross (CEGCO).

Within the power plant the water demand is being satisfied through groundwater wells distributed mainly in the northern parts of the plant penetrating mainly the upper B2A7 limestone aquifer which outcrops in the area with partial penetrating of the A4 aquifer in some wells (Figure 1)

According to the records of the Ministry of Water and Irrigation the average depth of groundwater wells ranges from 86m to 280m with a static water level between 480 and 490m asl.

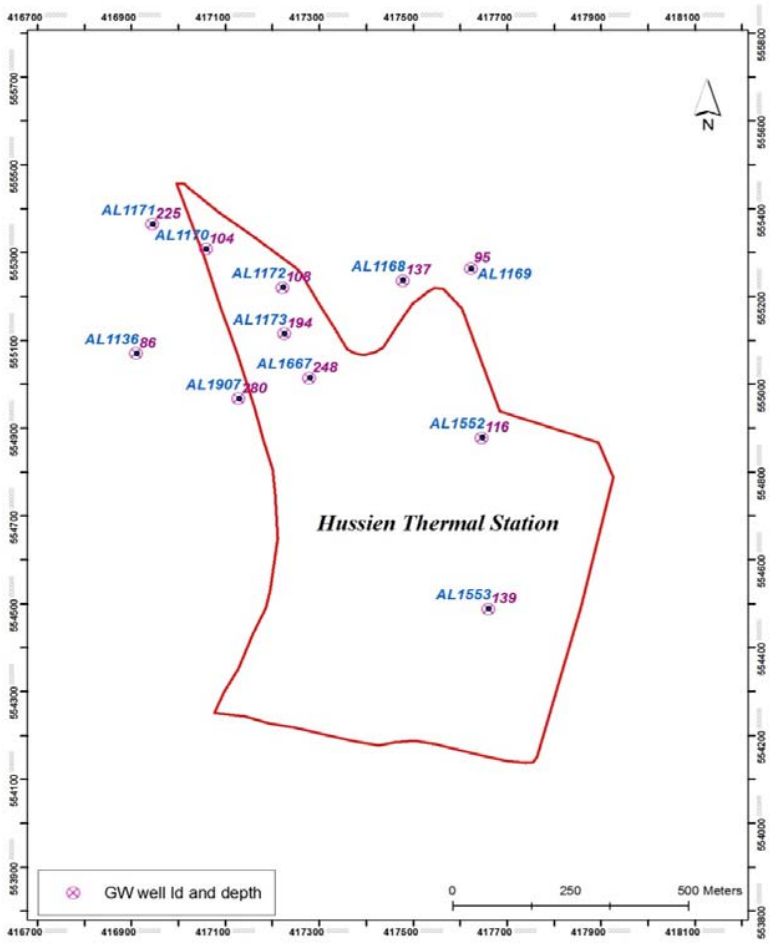

Figure 1: Groundwater wells location and depth within and in the surroundings of the thermal station.

2) Geologic Setting

The geologic outcrops in the study area are shown in figure 2. The dominant geologic units are of late Cretaceous age composed of limestone, marl and marly limestone belonging to Ajlun and Balqa groups. Inplaces they are covered by quaternary soil, alluvium and lacustrine gravels.

In the northern parts of the area a Tertiary basaltic flow crops out and extends from Samra treatment plant to the north along Zarqa River. The geologic succession is given in table 1.

Table 1: Geologic outcrops in the study area.

Formation	Symbol	Group	Period	Era	Stage
Soil over bedrock	S		Quaternary	Cenozoic	Holocene - Recent
Alluvium and Wadi Sediments	Al		Quaternary	Cenozoic	Holocene - Recent
Fluviatill and Lacustrine Gravels	Pl		Quaternary	Cenozoic	Pleistocene
Abed Olivine Phyric Basalt	AOB	Safawi	Tertiary	Cenozoic	Miocene
Amman Silicified Limestone	ASL	Belqa	Late Cretaceous	Mesozoic	Campanian
Wadi Umm Ghudran	WG	Belqa	Late Cretaceous	Mesozoic	Santonian
Wadi as Sir Limestone	WSL	Ajlun	Late Cretaceous	Mesozoic	Turonian
Fuhays/Hummar/Shu'ayb	FHS	Ajlun	Late Cretaceous	Mesozoic	Cenomanian

3) Topography

The station is located within Amman Zarqa ground and surface water basins with an elevation range within the station from 530 to 580 masl.

The vicinity of the station is modeled to form a medium relief area with elevations ranging from 475 masl 3 km northwest of the station to a maximum of 690masl 3 km south west of the station as shown in figure 3.

The power station site is located between two main drainage courses trending from south and east and pour in Zarqa River in the northern part of the study area as shown in figure 4.

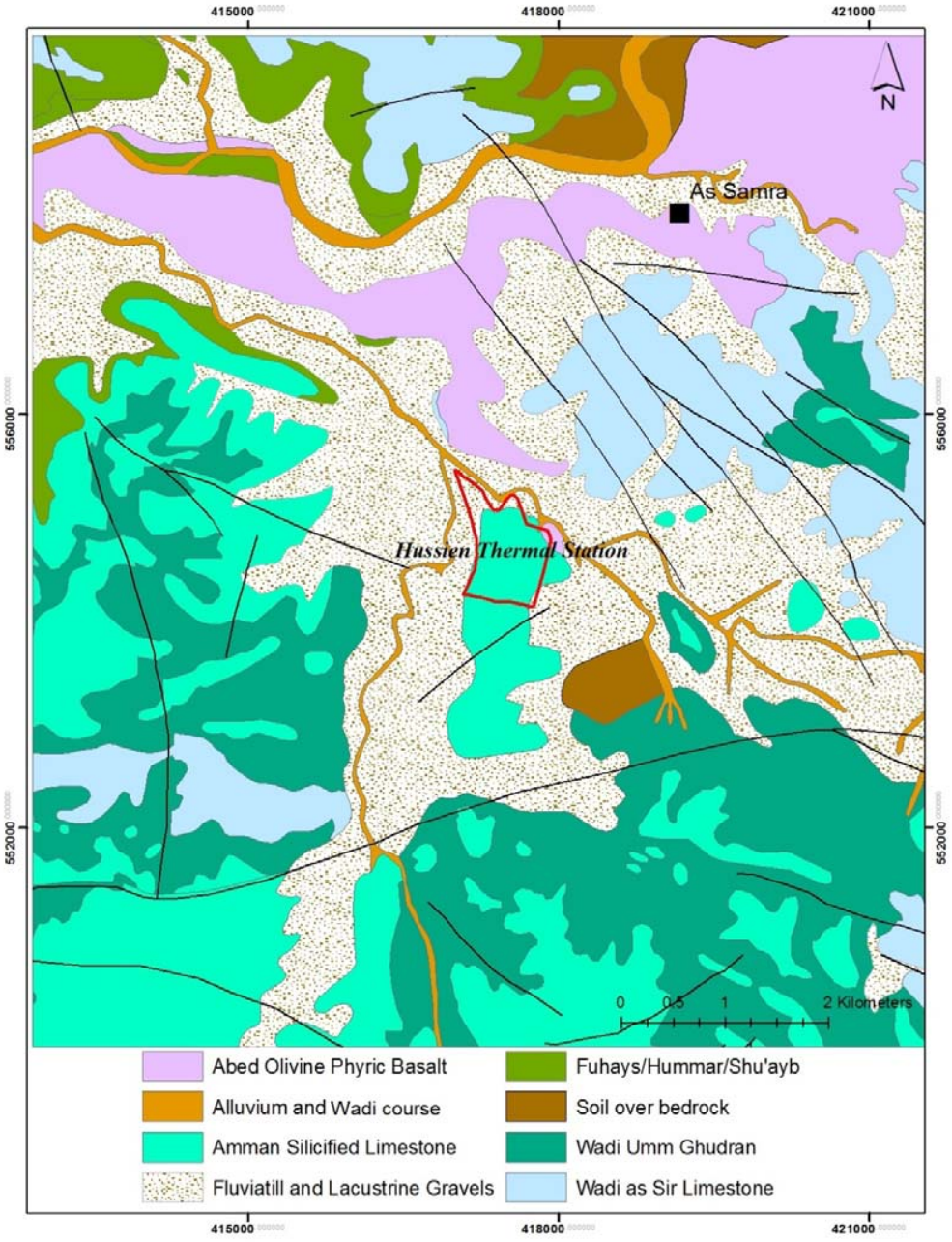

Figure 2: Geologic outcrops in the study area.

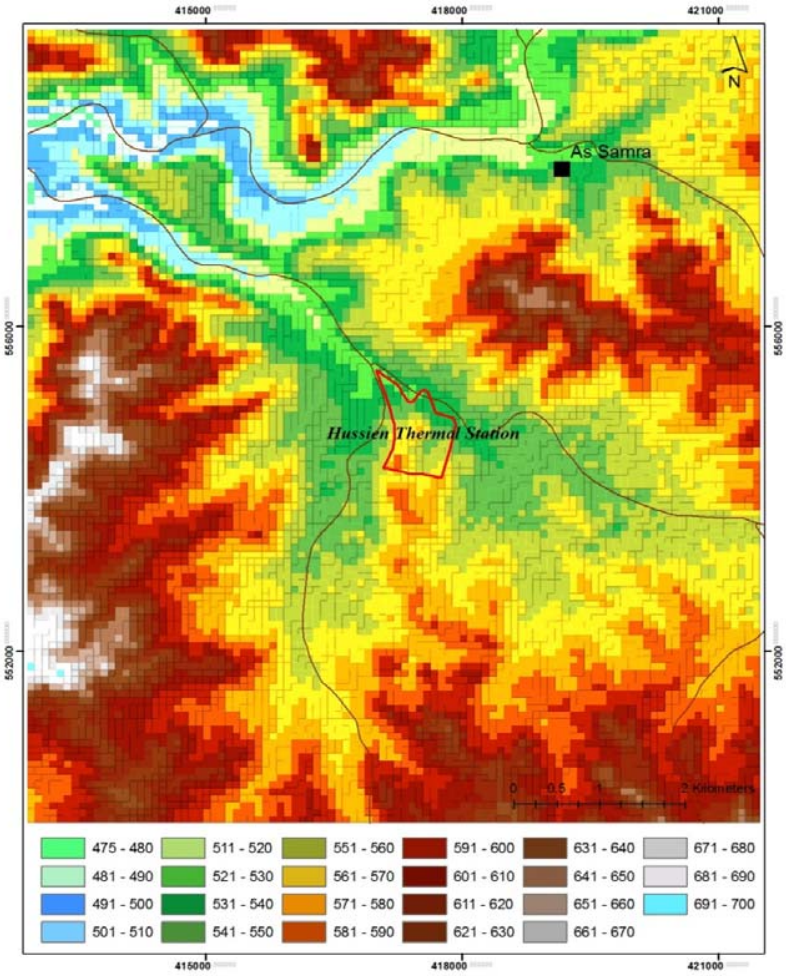

Figure 3: Digital Elevation model of the area.

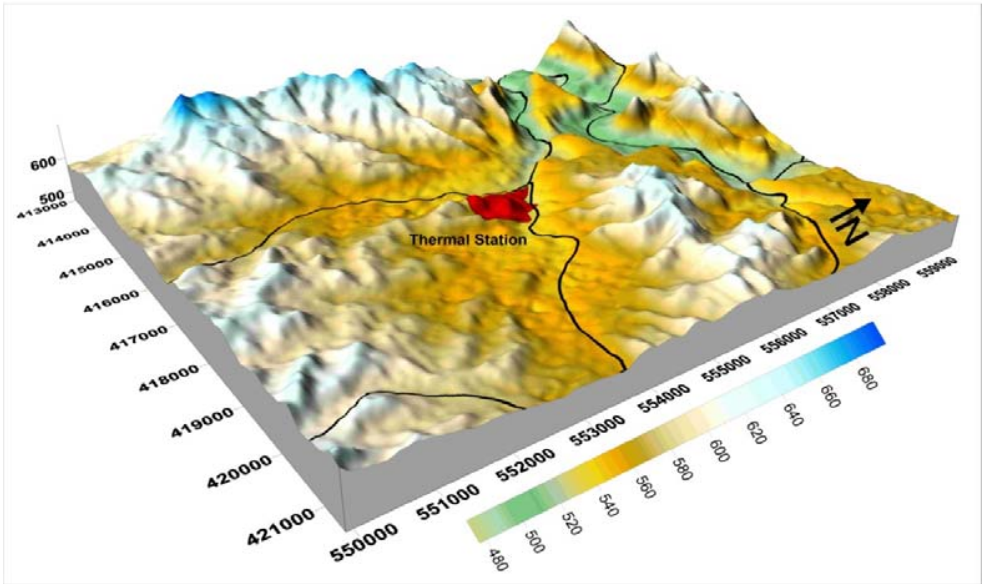

Figure 4: 3D model of the study area.

4) Hydrogeologic Settings

The power station is located in the center of Amman Zarqa groundwater basin which is one of the most important groundwater basins in Jordan.

The main hydrolgeologic unit is the composite aquifer of the A7 and B2 units, which are high productive units, composed of Wadi Sir Lime stone (A7) and Amman Silicified Limestone unit with an average thickness of 130m within the thermal station. Um Ghudran chalky Limestone unit (B1) between the B2 and A7 aquifers is a semi aquifer, but it hydraulically connects the overlying B2 with the underlying A7 aquifers, building the B2/A7 composite aquifer system.

The base of this productive composite aquifer system is located at a depth of 80 m in the north western parts of the area increasing gradually to reach a maximum of 240m in the southern parts of the area (Figure 5)

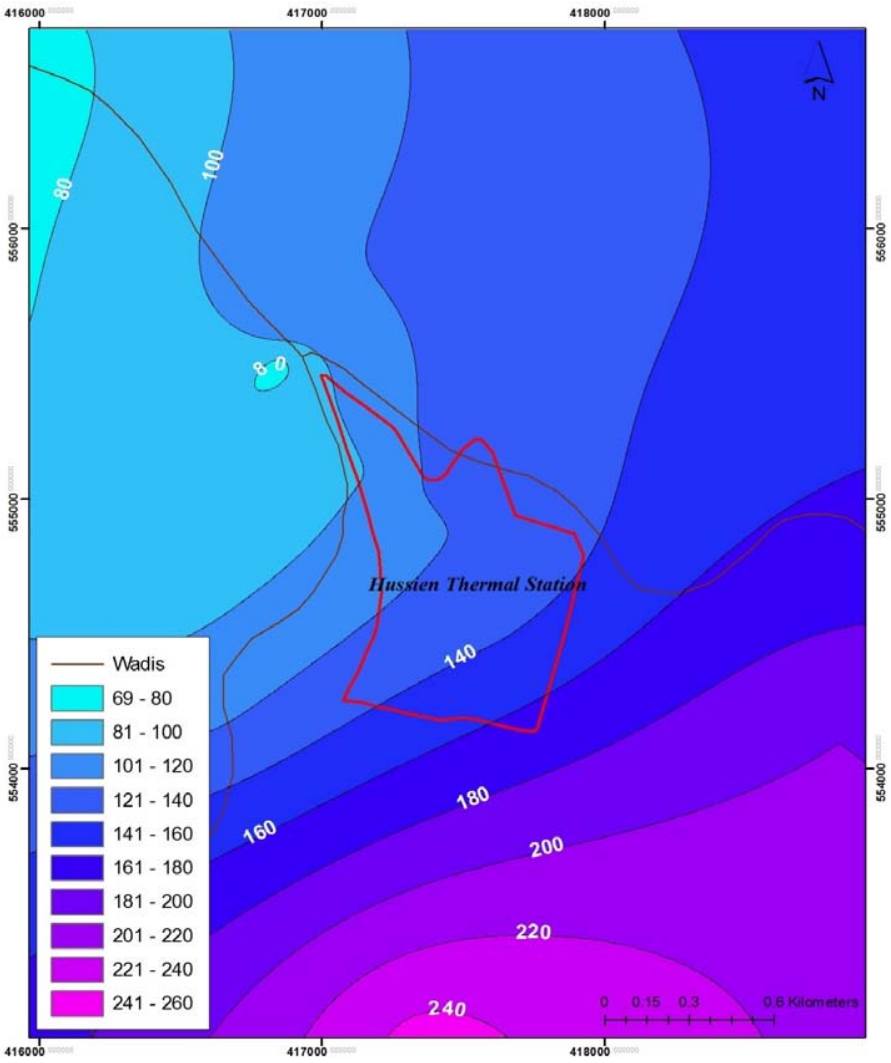

Figure 5: Depth to the base of B2A7 aquifer unit

Within the Thermal power station the base level of this unit is restricted between depths of 100m to 160m giving a maximum well depth of 160m in the southern parts of the power station.

The thickness of this unit or the base depth to the underlying aquiclude (not a water producing unit) represents the limiting factor for the depth of groundwater wells in the area.

Due to this distribution of the B2A7 units the groundwater wells in the area were drilled to depths ranging from 38 m in the low thickness zone reaching a maximum of 238m in the southern parts of the area where the thickness is relatively high (Figure 6).

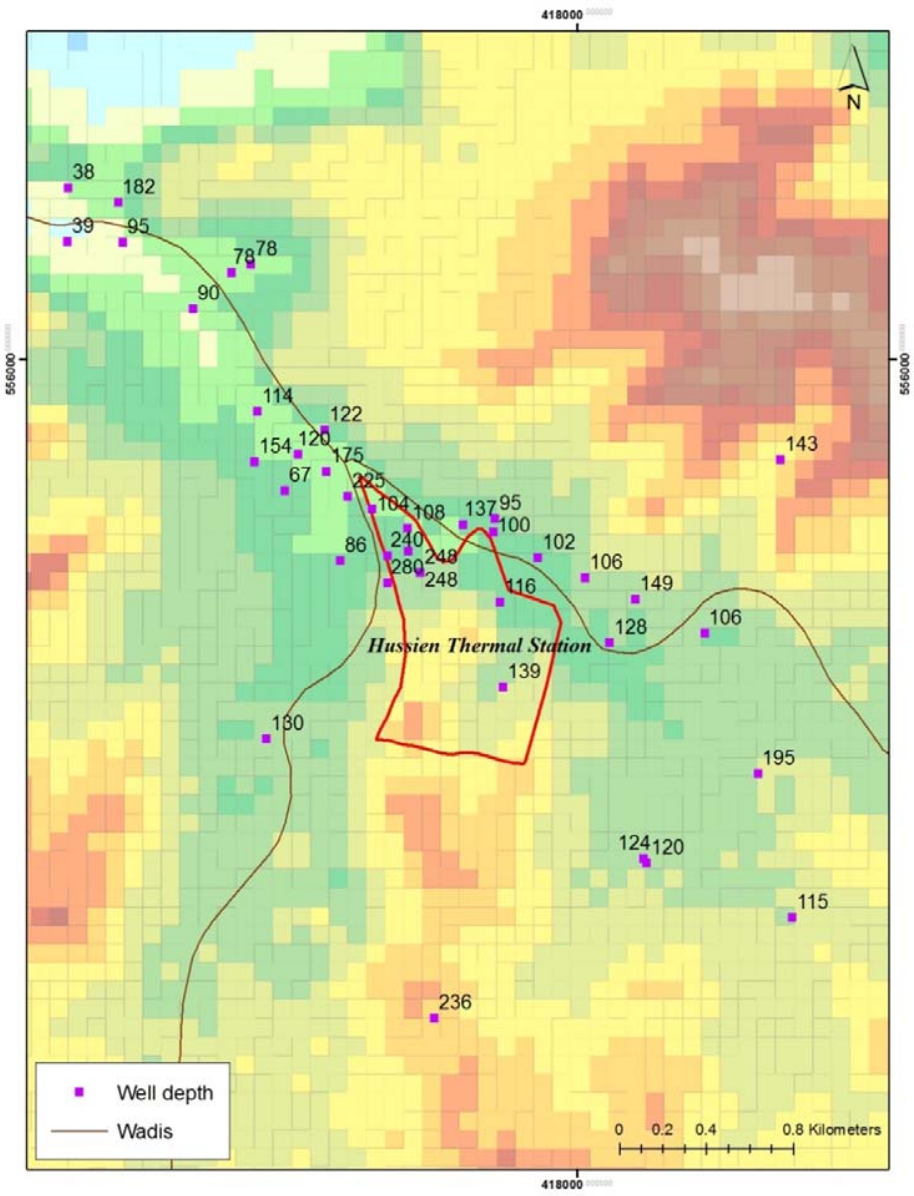

Figure 6: Groundwater wells distribution and depth within and in the vicinity of the thermal station.

In the central parts of the area few wells were drilled with a depth exceeding 200 m to invest the second productive groundwater aquifer, known as Hummar Formation (A4) in the middle Ajlun group.

The B2 A7 aquifer is underlain by the A5 A6 Aquitard unit which separates it from the A4 (middle aquifer) systems.

The Base depth of the A5,6 layer ranges from 200m in the North western parts of the area reaching a maximum of 340m below the surface in the southern parts of the area (Figure 7).

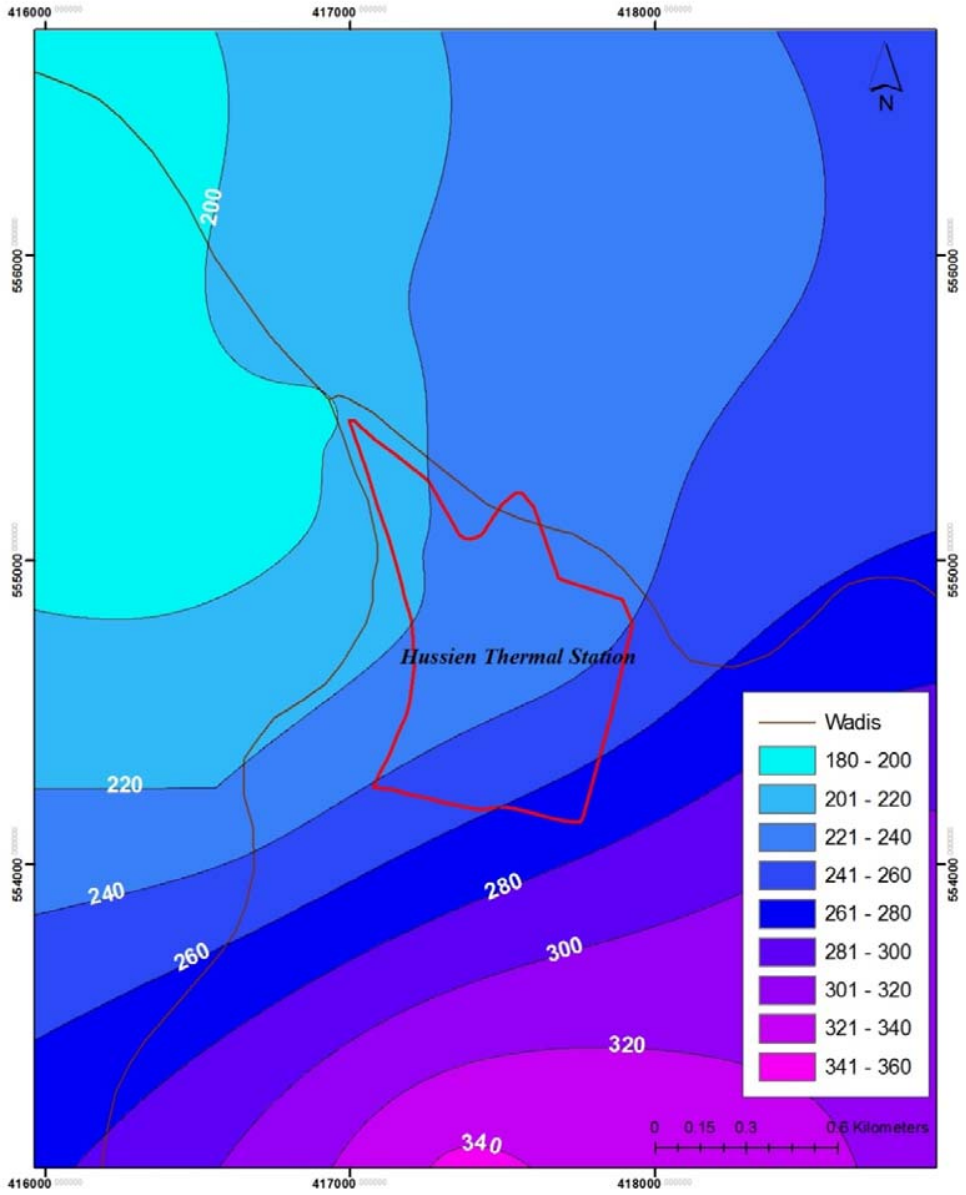

Figure 7: Depth to the base of A5-6 aquitard unit.

By modeling of the hydrogeological units base distribution the thickness of the A5 A6 Aquitard unit is calculated to be in a range of 100m to 108m separating the two aquifer system with a low permeability layer preventing hydraulic connection between these two aquifer systems (Figure 8).

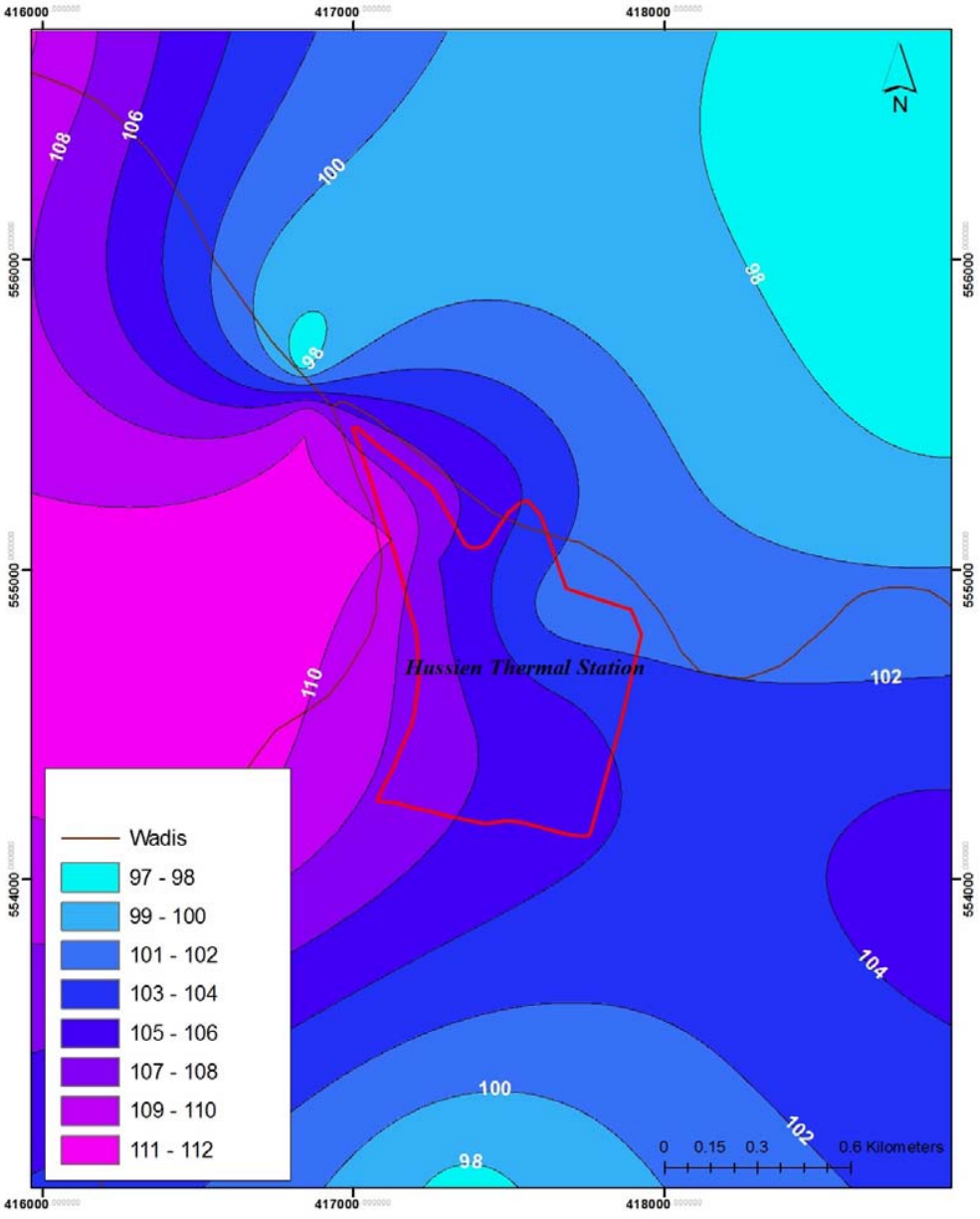

Figure 8: Thickness distribution of the A5-6 aquitard unit.

5) Groundwater Flow

The records of the Ministry of Water and Irrigation (MWI) updated in October 2012, show that the water levels of observation wells data were recently measured for wells within and around the power station.

A map of groundwater flow was created in the GIS environment based on static water level measurements. Information of the observation wells data allowed constructing groundwater table and groundwater flow lines (Fig. 9).

The obtained groundwater flow map of the area of the power station illustrate the severe with over pumping resulting from the high concentration of groundwater wells in the Hashimya area leading to a drop in the water level forming a sink for the groundwater and allowing water from all the surrounding areas to flow to this sink.

The water table within the power station was found to be in the range of 480 masl to 490m asl.

The surrounding water levels are relatively high in the southern parts of the area with a water table of 510m asl generating a groundwater flow towards the power station well field.

The presence of Samra waste water treatment plant produced a recharge mound created due to the infiltration of treated waste water into the upper aquifer system and giving a water table as high as 550m asl.

The presence of the recharge mound created a groundwater divide located 3 km north of the power station that enhanced the groundwater flow towards the power station with a high hydraulic gradient. It also generated another groundwater flow from that recharge mound to the north.

The presence of this high groundwater recharge and flow amount from the treatment plant to the power station may lead to NO3 enrichment in the groundwater.

A major flow line crosses the Oil Refinery and reaches the power station which may be considered as the source of the oil in the groundwater wells within the power station.

A cross section was constructed from the recharge mound downstream of Samra treatment plant to the south eastern parts of the study area (Figure 10).

The cross section shows a very high hydraulic gradient of 3% from the recharge mound to the thermal station compared with a relatively low gradient of 0.4% for the groundwater flow coming from the south east, while the hydraulic gradient for the groundwater flowing from the oil refinery to the thermal station is around 1.2%.

The high hydraulic gradient has formed due to two factors, the groundwater over drafting in the vicinity of the thermal plant and the recharge from Samra waste water treatment plant effluent creating a recharge mound raising the water table about 50 meter above the average groundwater table in the area as shown in the records of the observation wells (Figures 11, 12 and 13).

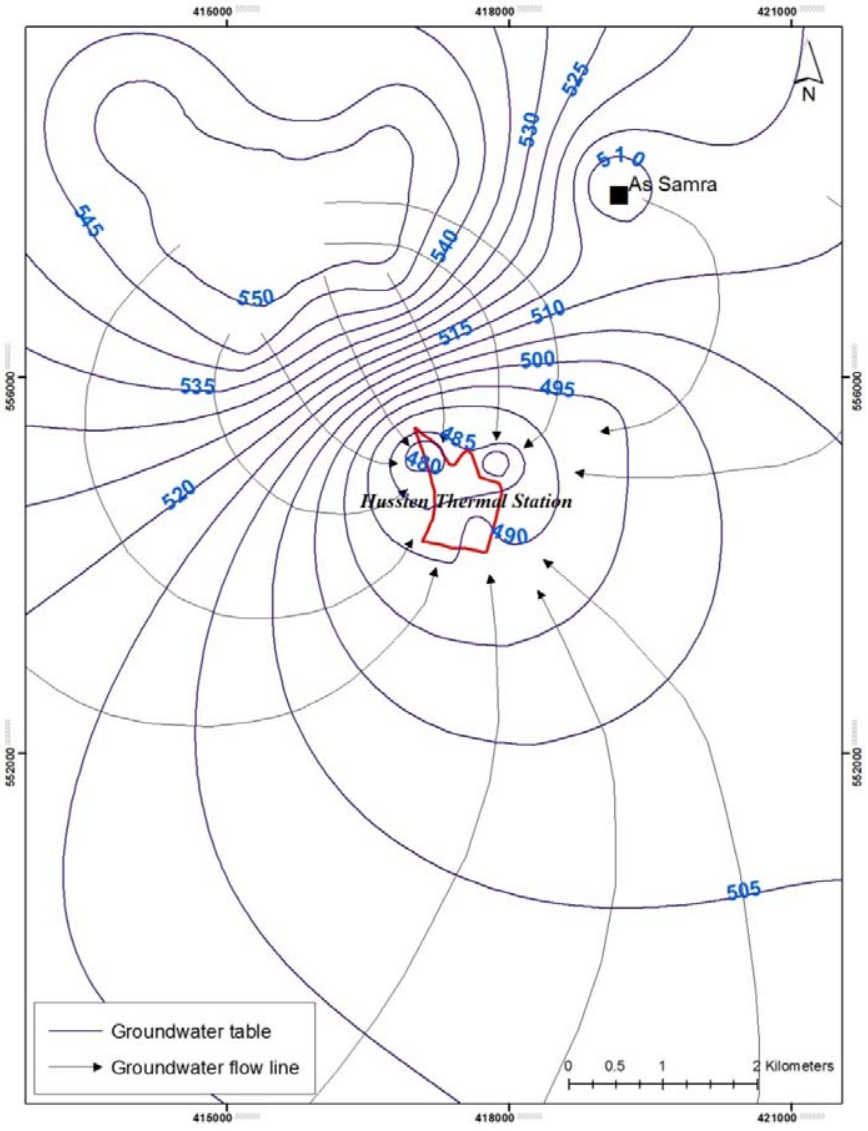

Figure 9: Groundwater flow pattern of the B2A7 aquifer.

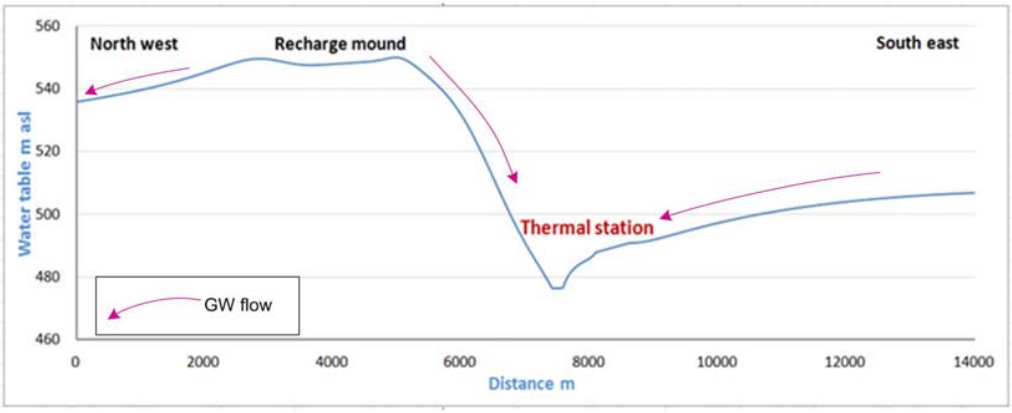

Figure 10: Water table cross section

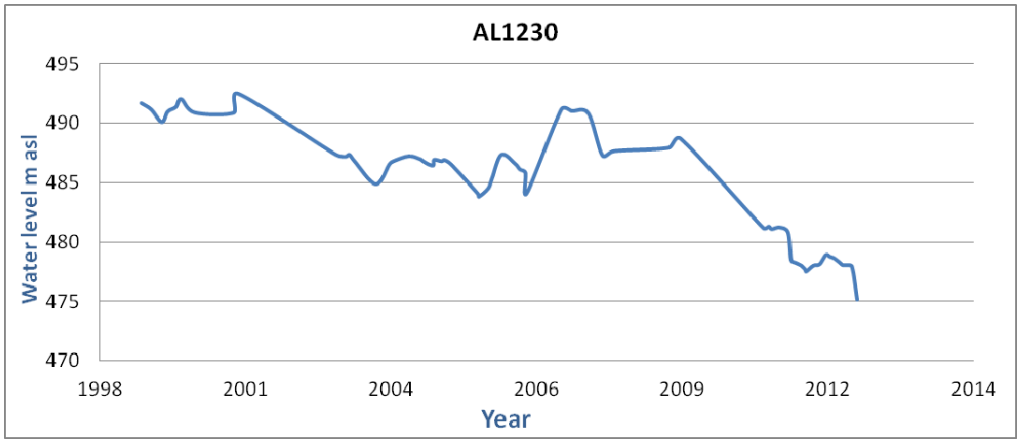

Figure 11: Groundwater hydrograph east of the thermal station (In general, declining water level).

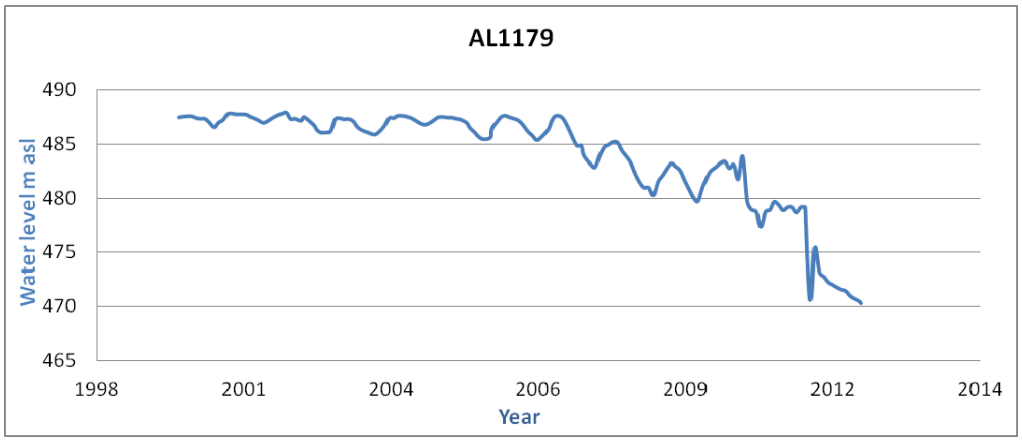

Figure 12: Groundwater hydrograph west of the thermal station (declining water level).

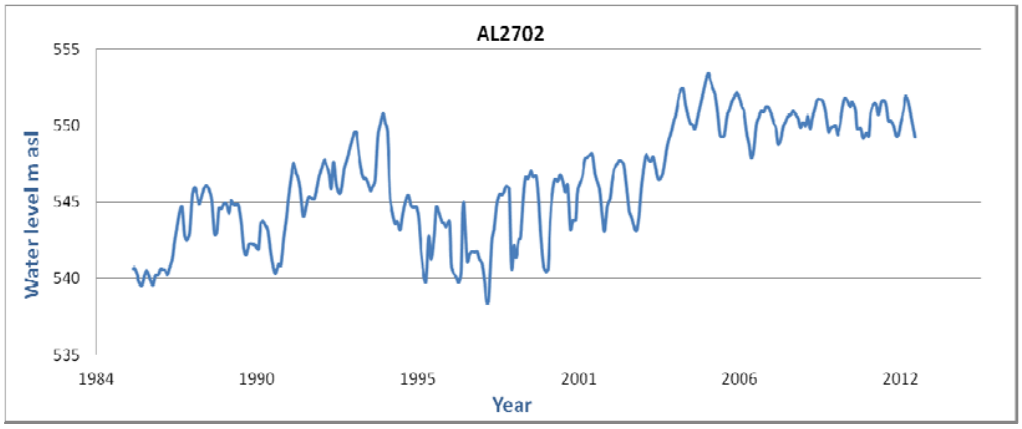

Figure 13: Groundwater hydrograph downstream of Samra treatment plant (Increasing water level).

6) Groundwater Quality

The salinity of the groundwater in the water wells of the plant, (wells: 1, 2, 3, 7, 8, 9, and 10) range from around 2000 to 4000 µS/cm, without a clear pattern of areal distribution.
The nitrate content, which can shed light on the origin of groundwater and the affecting environmental conditions range in average from around 35 to 80 mg/l. Natural, unpolluted groundwater in Jordan has values of less than 15mg/l. Therefore, it can be concluded that a major source of pollution causes the deterioration of the area's groundwater resources (Fig. 14)
The presence of phosphate in concentrations of 10 to 60 microgram/l is also a sign of pollution resulting from a municipal or agricultural type of wastes, but agriculture is very limited in the area and its wider surroundings. Therefore, the pollution can originate from household waste waters, which is collected and treated in Khirbet es Samra treatment plant lying 4km north of the power plant.

The other parameters of calcium, magnesium, sodium, potassium, chloride, sulfate, and bicarbonate are salinity indicators and reflect water rock interactions. Their concentration in the wells of the area can not allow specifying the origin of the water or its sources.
Well 2 in the northeastern area of the plant has low salinity (EC value) of around 2000 µS/cm. The same applies for wells 7 and 10 lying in the central western part of the area, with their low salinity of 2000 and 2100 mg/l (Fig. 15)
When combining the water quality findings with the groundwater flow pattern (Figure 9) the following can be concluded:

1. The area receives groundwater from all directions; north, east, south and west.
2. The groundwater coming from the east-northeast direction has relatively low salinity but the contributions of that flow to the groundwater of the area are limited in quantity.
3. The contributions from the recharge mouth in the area lying in the northwest of the plant also contribute to the groundwater resources of the area. But that groundwater on its underground course to the aquifer underlying the plant receives recharge from the effluents of Khibet es Samra along wadi Dhuleil.
4. Knowing that the effluents of Khirbet es Samra are highly aggressive and dissolve minerals from the rock matrix during their infiltration to the groundwater and when moving as a groundwater flow. Now, and depending on the flow pattern of the groundwater, and the permeability of the rocks and the geologic structures present in them, mixing ratios of the original groundwater with the infiltrating water from Khirbet es Samra effluents produce a variety of groundwater qualities even in wells hundreds of meters apart. Therefore, wells in the central western area show a high range of salinities within a small area, ranging from 2000 to 3800 µS/cm.
5. On its way to the plant site the groundwater coming from a southwestern direction flows in the underground of the Oil Refinery plant, which might contribute to the groundwater of the area with leakages, containing pollutants, which later on feed the groundwater underlying the Power Plant as indicated by the water quality of well 9.

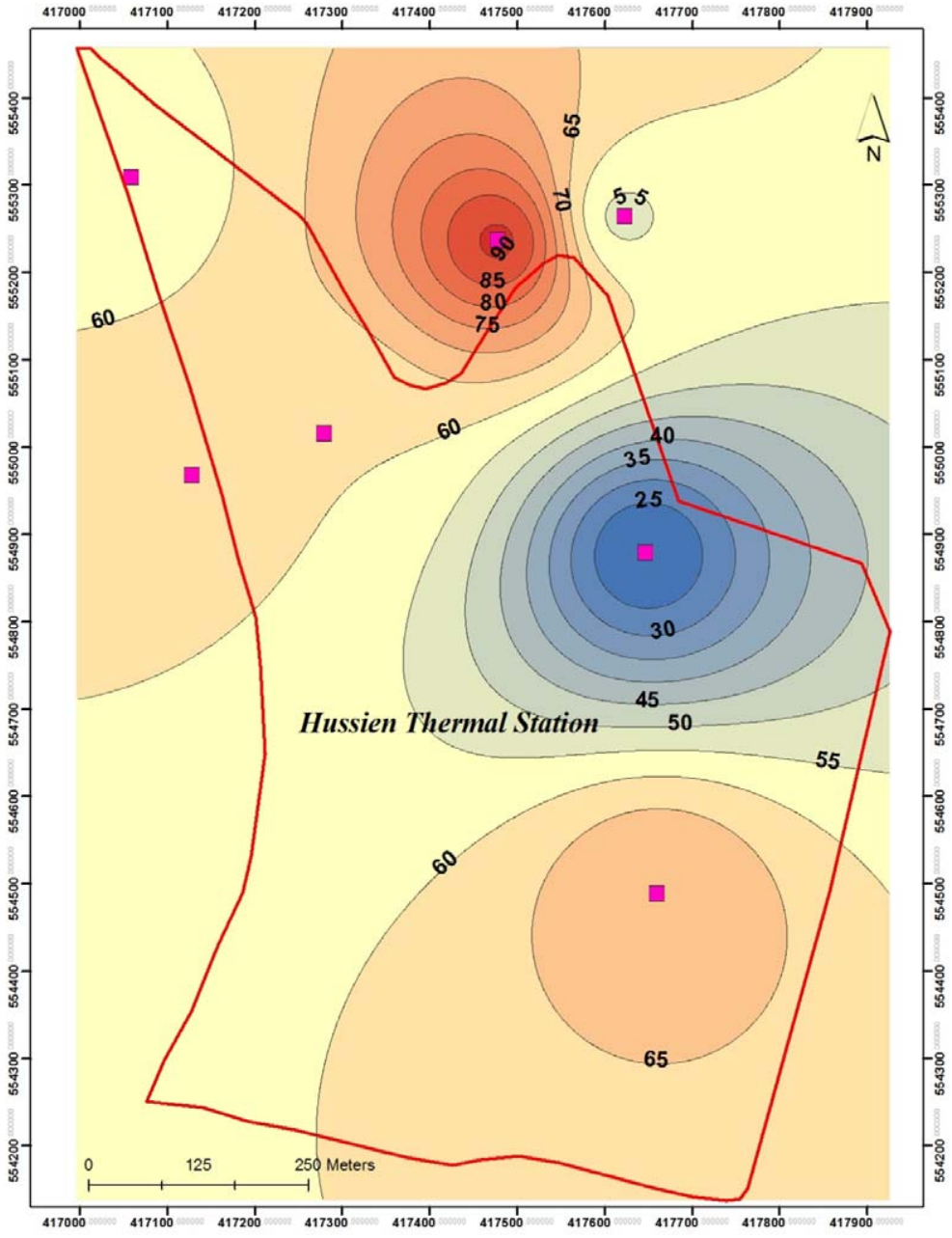

Figure 14: Concentrations of NO3 in the thermal plant area in mg/l.

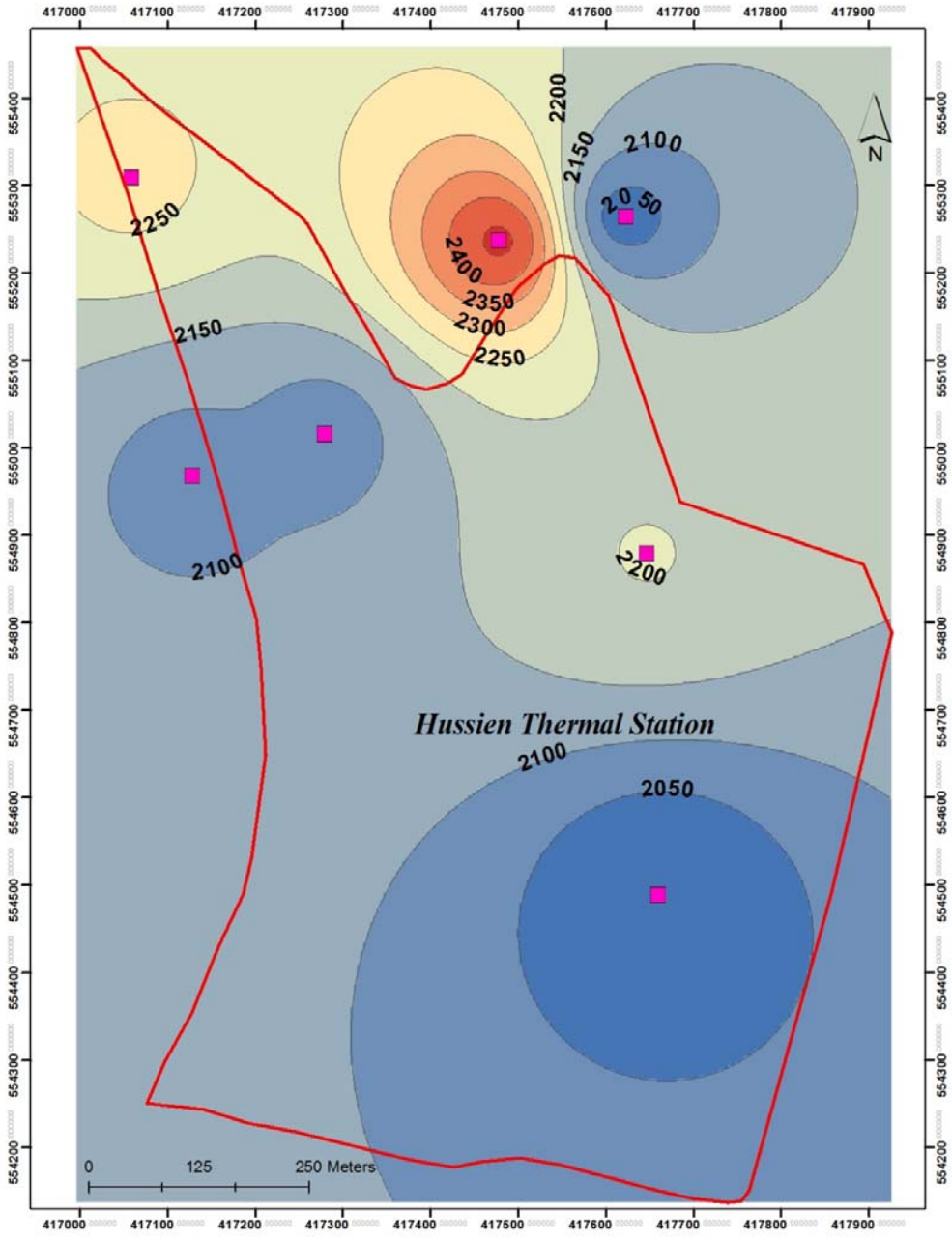

Figure 15: TDS value in the thermal plant area mg/l.

7) Recommendations

The power plant can drill more wells in the plant or its surroundings areas and can extract more water. But that water will continue to remain of impaired quality until the recent improvement of treatment in Khirbet es Samra are reflected in the water quality of the wells. Given the above, the following serves as a recommendation for the power plant.

1) Whether the water is taken from the groundwater underlying the plant or its further surroundings or from the effluents of Khirbet es Samra directly or indirectly from wadi Dhuleil is the same for the water balance of the area. Therefore, it is recommended that negotiations with the Ministry of Water and Irrigation (MoWI) take place in order to provide the power plant with treated waste water instead of getting it after infiltration and flow to the existing wells of the power station

2) Drilling wells or deepening of existing wells into the deeper aquifer A4, Hummar Formation can also provide water with good quality. But, such wells may need development to enhance their yield because their yields under natural conditions may not be high enough to serve the purpose or the power station. In addition, the depth to the A4 may be 350 m and more, but the water level will certainly be shallower than the aquifer, because the aquifer; A4 in the area is confined. Deepening the current wells or drilling new deep wells require penetrating the A56 unit which is around 110 m, so the available wells needs to be deepen with at least 200 additional meter for each well to go through the A56 Aquitard unit and penetrate the productive A4 unit with a good saturated thickness.