PPU College Of Engineering and Technology
The Home of Competent Engineers and Researchers

Electrical and Computer Engineering Department

Communication Engineering program

Graduation Project

WCDMA vs. LTE in terms of Coverage,Capacity,and Quality in Hebron City

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DEDICATION

This Project Gratitude is dedicated to Allah, the One above, who blesses us abundantly every day.

To the one who helped in the success and gave us the drive and discipline to tackle any task with enthusiasm and determination, our supervisor:

Dr. Khalid Hijjeh

To all JAWWAL Mobile Team:

Eng. Arafat Tmezi

Eng. Abeer Mteer

Lovingly dedicated to our respective parents and family who have been our constant source of inspiration. Without their love and support, this project would not have been made possible.

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Our class peer project group for the cooperation and camaraderie.

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Lastly, we offer our regards and blessings to all of those who supported us in any respect during the completion of the project.

ABSTRACT

The world is currently witnessing great advancements in all aspects of life particularly in the realms of technology and telecommunication. The project is meant to keep on track with the advancements in telecommunication and hence make it adaptable to the applied systems worldwide to meet and provide services that greatly facilitate communication and networking. This was the main reason for our team to conduct a research based on a comparison between two of the most advanced and widespread systems namely the third and fourth generations and then check the advantages and disadvantages of each through action planning and the distribution of stations to cover Hebron with the assistance of a specialized team from Jawwal.

The team has provided us with a specialized planning tool able to make a genuine resemblance between sites aimed to be developed by the planners of this project and the real sites that exist on the ground. This project is supposed to answer all the questions that nag in the minds of the users, funding bodies and employers about the technology which could be used in Hebron to meet the needs of its inhabitance.

الملخص

الوقت الحالي هو عصر التطور والتكنلوجيا، عصر التقدم والابتكارات، عصر الاتصالات المتقدمة. الانسان بطبعه متطلب، الأغلب يريد ويحصل على أحدث الأجهزة المحمولة، فكيف إذا علم الانسان أن الاتصالات المتقدمة والأجيال الجديدة سوف تسهل وتسرع وتختصر عليه الكثير من الأمور في جميع أمور حياته، في عمله، بيته، حتى دراسته.

المقارنة بين الجيل الثالث والجيل الرابع هي ما يبحثه هذا المشروع ويحاول الوصول الى أقرب النتائج عن طريق المحاكاة باستخدام أداة تخطيط متخصصة ومتطورة بحيث تقوم بمحاكاة بين المواقع التي سوف يضعها مخططين هذا المشروع باستخدام أداة التخطيط وبين مواقع حقيقية موجودة على أرض الواقع. نعم، ممكن أن يرى البعض أن نتيجة المقارنة بين جيلين أحدهما قد اخذ كفايته من الانتشار والشهرة وهو الجيل الثالث، والجيل الاخر وهو الجيل الرابع الذي لا يزال ينمو ويتطور على يد أمهر المهندسين وأيضا لم يتم تطبيقه في العديد من الدول النامية والمتقدمة، ولكن هل نتيجة المقارنة ستكون مختلفة عن النتيجة المتوقعة في حال كان التخطيط لمدينة الخليل؟ .

أي من الجيلين هو الجيل المناسب لمدينة الخليل؟ وما الذي يقوم على هذه المحددات؟، وهل في حالة فوز الجيل الرابع وهو جيل السرعة والتطور ينصح تطبيقه السنوات الحالية أم السنوات القادمة؟، والتساؤل الأهم، هل ينصح بالانتقال من الجيل الثاني الي الجيل الثالث أم الرابع؟ اتخاذ هذه القرارات والاجابة عن هذه الأسئلة لا ولن يتم بمحض الصدفة أو القيام ببحث جوجل أو انه شيء متوقع بمجرد انه قرار اتخذته دول متقدمة تكنلوجيا، أنه على مدينة الخليل التزام ما انطبق على دول أخرى! .

ان اتخاذ مثل هذه القرارات يتم بعد عمل تخطيط مطول للمدينة التي سيتم اطلاق جيل جديد اليها ,حيث أن المستثمرين وأصحاب الشركات لن يقوموا بالتمويل أو تطبيق الجيل فورا دون اثباتات عن طريق محاكاة للمواقع التي سيتم وضعها على أرض الواقع , وهذا المشروع سوف يقوم بالإجابة عن جميع التساؤلات التي في عقول المستخدمين والممولين والمشغلين ,عن طريق عمل تخطيط لمدينة الخليل ومحاكاة لمواقع على أرض الواقع ,وفي حال فوز الجيل الرابع سوف يتم اثبات هذه النتيجة فنيا عبر مشروعنا بأذن الله .

.

LIST OF ABRIVIATIONS

1G	First generation of cellular system
2G	Second generation of cellular system
3G	Third generation of cellular system
3GPP	Third Generation Partnership Project

A

AMC	Adaptive Modulation and Coding
AMPS	Advanced mobile phone service
ANR	Automatic Neighbor Relations
ARP	Allocation and Retention Priority
AWGN	Additive White Gaussian Noise

B

BER	Bit Error Ratio
BLER	Block Error Rate
BS	Base Station
BW	Band Width

BWA Broadband Wireless Access

C

CCO Capacity Optimization

CINR Carrier to Interference plus Noise Ratio

CDMA Code Division Multiple Access

CFO Carrier Frequency Offset

CP Cyclic Prefix

CPICH Common Pilot Channel

CW Carrier Wave

D

D-AMPS Dual-mode Advanced mobile phone service

DFT-S-OFDM Discrete Fourier Transform Spread OFDM

DL Down Link

DMS Data management System

E

EDGE Enhanced Data rates for GSM and TDMA Evolution

eNB	Evolved Node B
EPS	Evolved Packet System
EPC	Evolved Packet Core
ETSI	European Telecommunication Standards Institute
EU	Enhanced Uplink
E-UTRAN	Evolved- Universal terrestrial Radio Access Network

F

FCS	Fast Cell Selection
FDD	Frequency Division Duplexing
FDMA	Frequency Division Multiple Access
FER	File Error Rate
FHARQ	Fast Hybrid Automatic Repeat request
FSS	Frequency Selective Scheduling
FTP	File Transfer Protocol

G

GERAN	GSM EDGE Radio Access Network
GPR	Guaranteed Bit Rate
GPRS	General Packet Radio Service

GSM Global System for Mobile Communication

H

HARQ Hybrid Automatic Repeat Request

HO Hand Over

HSDP High-Speed Downlink Packet

HS-DSCH High-Speed Downlink Shared Channel

HSDPA High-Speed Downlink Packet Access

HSPA High Speed Packet Access

HSUPA High Speed Uplink Packet Access

I

ICI Inter Carrier Interference

ID Identity

IM Instant Messaging

IMT-2000 International Mobile Telecommunications-2000

IMT-Advanced International Mobile Telecommunications-Advanced

IP Internet Protocol

ISI	Inter Symbol Interference
IS-95	Interim Standard 95
ITU	International Telecommunication Union

J

J-TACS	Japanese Total Access Communications System

K

KPI	Key Performance Indicators

L

LAN	Local Area Network
LSTI	LTE/SAE Trial Initiative
LTE	Long Term Evolution
LTE Advanced	Long Term Evolution Advanced
LTE-RAN	LTE Radio Access Network

M

MAC	Medium Access Control
MAI	Multi-Access Interference
MBSFN	Multicast Broadcast Single Frequency Network
MCS	Mobile Switching Center
MIMO	Multi Input Multi Output
MISO	Multiple Input Single Output
MLB	Mobility Load Balancing
MM	Multimedia
MME	Mobility Management Entity
MMS	Multimedia Messaging Service
MS	Mobile Station

N

NGMN	Next Generation Mobile Networks
NMS	Network Management System
NMT	Nordic Mobile Telephony

O

OFDM	Orthogonal Frequency Division Multiplexing
OFDMA	Orthogonal Frequency Division Multiple Access

P

PAPR	Peak to Average Ratio
PC	Personal Computer
PCI	Physical Cell ID
PCM	Pulse Code Modulation
PCRF	Policy Control and Charging Rules Function
PDC	Personal digital Communication
PDN	Packet Data Network
PIC	Parallel Interference Cancellation
PUCCH	Physical Uplink Control Channel
PUSCH	Physical Uplink Shared Channel

Q

QCI	QoS Class Identifier
QOS	Quality of Service

QPSK	Quadrature Phase Shift Keying

R

RAN	Radio Access Network
RBS	Radio Base Station
RF	Radio Frequency
RLB	Radio Link Budgets
RMS	Root Mean Square
RNC	Radio Network Controller
RRM	Radio Resource Management
RSRP	Reference Signal Received Power
RSRQ	Reference Signal Received Quality
RTP	Real-time Transport Protocol
RX	Receive antennas

S

SAE	System Architecture Evolution
SC-FDMA	Single Carrier Frequency Division Multiple Access
SDMA	Spatial Division Multiple Access
SDP	Session Description Protocol

SGSN	Serving GPRS Support Node
SIC	Successive Interference Cancellation
SIMO	Single Input Multiple Output
SINR	Signal to Interference plus Noise Ratio
SIP	Session Initiation Protocol
SISO	Single Input Single Output
SMS	Short Message Service
SNR	Signal to Noise Ratio

T

TACS	Total Access Communication System
TDD	Time Division Duplex
TD-CDMA	Time Division Duplexing-code Division Multiple Access
TDMA	Time division Multiple Access
TD-SCDMA	Time Division Synchronous Code Division Multiple Access
TTI	Transmission Time Interval
TE	Terminal Equipment
TFP	Total Factor Productivity
TX	Transmit antennas

U

UPE	User Plane Entity
UE	User Equipment
UL	Uplink
UTRA	Universal Terrestrial Radio Access
UMTS	Universal Mobile Telecommunication System
UTRAN	UMTS Terrestrial Radio Access Network

V

VoIP	Voice over Internet Protocol

W

WCDMA	Wideband Code Division Multiple Access
WIFI	Wireless Fidelity
WiMAX	Worldwide Interoperability for Microwave Access
WLAN	Wireless Local Area Network
WWW	World Wide Web

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CHAPTER ONE
INTRODUCTION

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1.1 Overview

This project investigates the upcoming 4th generation of wireless cellular networks compared to the 3rd generation in terms of capacity, coverage, and quality depending on previous studies, researches, and simulations. More specifically ,this chapter shall discuss the general idea of this project which will be an introduction to this project plans beginning from the first semester and giving initial 3G and LTE planning and simulation and ending with future plans which shall be enhanced over this work planned network .

1.2 Project Main Idea

Technology now takes wireless to new generation while service providers want the applications that new technology could enable. Users aim at better wireless networking technology to take advantage of the device's online functionality; those demands posed some interesting engineering challenges that lead them to bring many technical benefits to cellular networks. 2G to 3G migration offered the promise of a completely new business model from voice and SMS services to the mobile internet and rich content. Unlike 2G-to-3G, 3G-to-4G is evolutionary.

The long term evolutionary access technology called LTE (Long Term Evolution) describes standardization work by 3GPP (Third Generation Partnership Project) to define a new high speed radio access method for mobile communication systems and promises to revolutionize the use of data services on the move. LTE primary objective is to enable operators to better and more cost-effectively transport the rapidly growing of mobile IP data traffic on their networks [1].

There are major changes between LTE and 3G, although it uses a different form of radio interface, OFDMA/SC-FDMA instead of WCDMA. There are also many similarities with the earlier forms of 3G architecture. LTE can be checked to provide further evolution of a functionality and increase speeds and general improved performance. In addition to this, LTE is an all-IP packet switched network [2].

However, many would say that the result of this comparison through planning is already known as it is the most up-to-date with many choices and flexibility it provides. If LTE beats 3G in Hebron city, then this project will prove this reality and gives real evidence through simulations and analysis. Each technology will be used in its best configurations, and when it can give its best coverage, capacity, and quality, then the comparison will be made.

On one hand, 3G might be suitable for Hebron city but still it is not better than and as fast as LTE which everyone will be looking for in the future. However, the entire world knows that the era of 3G is nearly over; it is the time for the newest, latest, and fastest technology. The most confusing question is how to move from GSM to 3G or LTE now or within the next 5-10 years?

LTE is still under improvement, but 3G was in control for long time. LTE, which is the internet of things, represents the future .Operators will not deploy 3G or LTE without planning results according to our expectations as it needs minimum number of sites. With the use of multiple bandwidths and multiple frequencies, interference will be less, and operators will pay less for the best.

1.3 Objectives

The main objectives of the project are as follow:

1) Make a Plan for Hebron city, and do simulation analysis through Mentum Planet Tools in Jawwal for capacity, coverage, and quality of 3G and LTE.
2) Comparing between the two systems considering many frequencies to record accepted results according to simulations in terms of coverage, capacity and quality.

1.4 3G and LTE Planning

The planning process aims to use the available spectrum in an efficient way, minimize the interference effectively and allow maximum number of users sending and receiving appropriate signal in a cell.

3G and LTE planning go through three stages: the initial Planning (also called system dimension), detailed planning and the optimization and monitoring. Each of these stages requires additional considerations such as propagation measurements, traffic demand measurements, geographical area to be covered, frequency band, allocated bandwidth.

Capacity and Coverage Planning in LTE, like that of 3G. The main goal of LTE capacity planning is to support the subscriber's traffic requirements, whilst at the same time achieving low blocking and delay within the network. In contrast, the goal of LTE coverage planning is to ensure the availability of the network and its services in the desired service area [3].

1.4.1 3G and LTE Capacity Planning

To undertake capacity planning, there are specific parameters to be known to plan in a useful way such as the number of subscribers, kind of services they used to have and traffic analysis. These demands encouraged the operators to enhance the network from 3G to LTE to have higher data rate that matches the new applications with high speed needed in the telecommunication world.

LTE is ten times faster than the 3G. According to references, it is capable of downloading speeds of 100 megabits per second (Mbps) [9]. That's fast enough to download a full movie in high quality in 3 minutes because of using packet switching to move data and voice at the same time while in 3G, data can be download from 800 to 950 (Kbps)[4].

What this project planners need to provide after capacity planning is higher data rates, efficient network, lower and even no interference through LTE and enhancements over 3G.Through planning, results will answer questions such as which is the technology with the best performance? in addition, Where to use which technology first?

1.4.2 3G and LTE Coverage Planning

Radio coverage planning is the most important process for network quality. It includes coverage analysis - the most critical step in coverage planning-. Moreover, RLB (Radio Link Budget) - the heart of coverage planning- computes the power received by the user given the transmitted power and the losses and gains along the path between transmitter and receiver [3].

The researchers shall plan and design the coverage of 3G and LTE in Hebron area to check the traffic outcome, and interference with other networks; a coverage plan with sufficient coverage and performance will be done. So, appropriate sites with smart antennas are also needed. With all these requirements, time and cost will be taken into consideration.

Channel power levels ,Antenna tilt ,azimuth and height are the coverage planning parameters to be improved and planed effectively ; the higher the power the larger the coverage area, and antenna tilt has similar effect as power ; the larger the antenna tilt the smaller coverage area we get. So interference can efficiently be handled with azimuth changes. Finally yet most importantly, antenna height is very important because high antennas cause a lot of interference [5].

Better system coverage, higher received signal strength levels, design a network with minimum coverage requirements and provide faster and cheaper plans are what the project engineers aspire to achieve through coverage planning for both 3G and LTE technologies.

1.4.3 3G and LTE Quality Planning

Quality of Service (QoS) is considered as an important parameter in a network. Whenever the number of subscribers increases, then the Quality of Service becomes more important. Engineers define Quality of Service (QoS) as the ability of a network to provide a certain level of service to a certain type of traffic. The Quality of Service includes three issues over different wireless technologies that are Delay, Packet Loss, and Jitter (Delay Variation) [7].

Through quality of service planning, minimizing losses have to be done otherwise; QoS may suffer. QoS means we need to deliver services to users during minimum time because retransmission will not be possible for such application like VOIP [7].QoS is related to traffic differentiation and using multiple point- to -point communication services between two network elements.

The existence of MIMO and OFDMA will improve reliability and QoS. QoS is not only needed in higher load but also we want good quality at any load, especially when there is multiple services provided to the user such LTE networks .Well done Traffic engineering and network planning will ensure an acceptable Qos with affordable price which is what users look forward to have side by side with new high data rates services.

The teamwork aims at better performance and quality of service regardless the environment to be planned. Different types of services are supposed to be noticed in planning results and measurements for 3G, LTE as 3G provides a good quality, and LTE continues the enhancement and provides better quality services with higher data rates.

1.5 Motivation

People these days are obsessed by having the latest technologies, and every one hopes to have the latest phone version. Applications in these phones such as iPhone, Blackberry, and Galaxy s3 are all free but require higher data rates, wider coverage and better quality. All these challenges motivated operators to apply suitable generations for users such 3G and LTE. This project shall discuss the advantages and disadvantages of both generations through planning capacity, coverage, and quality in Hebron area to come up with a decision by which generations will satisfy user demands especially in Hebron city.

1.6 3G and LTE Technologies

1.6.1 3G Technologies

1) W-CDMA (Wideband Code Division Multiple Access): it provides wideband spectrum in addition to code division multiple accesses that give the 3G with higher data rates and more capacity.
2) TD-SCDMA (Time Division Synchronous Code Division Multiple Access): In 2G, it was either TDMA or CDMA but for 3G both of them have been combined so this technology enables uplink and downlink transmission and it helps multiplexing FDMA technology with both TDMA and CDMA to get use from the whole frequency band to a specific service.
3) GPRS (General Packet Radio Switching): where data is divided into packets of information and then transmitted through radio signals.
4) IP connectivity: it is for voice calls or message and video conferences and calls.

1.6.2 LTE Technologies

1) MIMO (Multiple Input Multiple Output): it is a revolutionary technique that took advantage of multiple parallel radios to send information farther and faster .It provides customers with increased data throughput for mobile high-speed data applications without using additional power or bandwidth. MIMO systems use multiple antennas at both transmitter and receiver to increase capacity and SINR of the wireless channels.

2) OFDMA (Orthogonal Frequency Division Multiple Access): this technology provides higher capacity at wider bandwidths. It enables orthogonally in the uplink by synchronizing users in time and frequency, and it enables single frequency network coverage and gives excellent coverage.

3) SC-FDMA (single carrier frequency division multiple access): is a technique for high data rates, uplink communications in future cellular systems. It shows good spectrum efficiency, essentially almost the same overall complexity.

4) SDMA (Spatial Division Multiple Access): this technique is different from other traditional cellular network systems; it enables channeling of radio signals depending on the mobile location. It protects the quality of radio signals, enhances the efficiency, and it can provide a collision- free access to the wireless channels.

1.7 Related Works

There are many studies in the wireless communication field, books, papers, projects and many internet sites that talk about the latest technologies. Researchers and operators are also still doing their best studying and enhancing what is in market. There are studies concerning 3G, LTE, 3G and LTE and some researches about 3G and LTE planning in terms of coverage, capacity and quality.

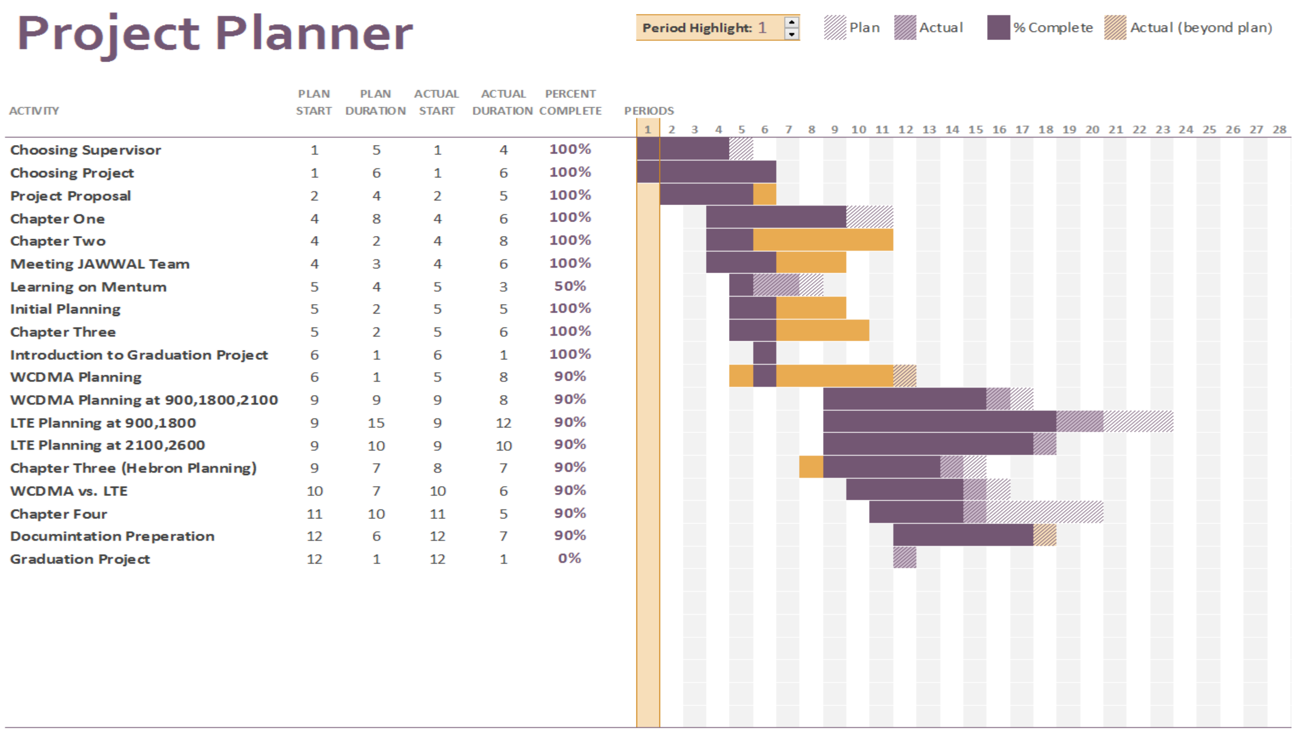
First of all a project with Jawwal was done last year concerning LTE, the LTE Optimizing and Dimensioning. They made a simulation for the whole West Bank area, in addition to a MATLAB code using the SON and Neural Network to enhance the capacity, coverage and quality. This work, on the other hand, is much different than what engineers of LTE project did as it is designed only for Hebron city.

Referring to previous studies like this Master Thesis [6] that explain different steps of dimensioning process, methods and models for coverage planning are developed for dimensioning of LTE networks. It also explains SINR relation to capacity planning and RLB to coverage planning through several analysis techniques. However, this master thesis is very comprehensive, hoping to get use of the information included to improve this work and making use of expert’s experiences.

An interesting IEEE paper [8] provides an overview about 3.5G in these developing countries: Jordan as a case study. It also discusses people's expectations about this service via conducting a questionnaire targeted Internet users. The paper also presents a network assessment experimental test carried out to evaluate the network QoS at selected places of the area where this service is provided. It is not that similar to this project as this paper is more interesting since it is relates to Middle East countries to have such a developed technology.

1.8 Project Plan

Table 1.1: Project Plan



ACTIVITY	PLAN START	PLAN DURATION	ACTUAL START	ACTUAL DURATION	PERCENT COMPLETE
Choosing Supervisor	1	5	1	4	100%
Choosing Project	1	6	1	6	100%
Project Proposal	2	4	2	5	100%
Chapter One	4	8	4	6	100%
Chapter Two	4	2	4	8	100%
Meeting JAWWAL Team	4	3	4	6	100%
Learning on Mentum	5	4	5	3	50%
Initial Planning	5	2	5	5	100%
Chapter Three	5	2	5	6	100%
Introduction to Graduation Project	6	1	6	1	100%
WCDMA Planning	6	1	5	8	90%
WCDMA Planning at 900,1800,2100	9	9	9	8	90%
LTE Planning at 900,1800	9	15	9	12	90%
LTE Planning at 2100,2600	9	10	9	10	90%
Chapter Three (Hebron Planning)	9	7	8	7	90%
WCDMA vs. LTE	10	7	10	6	90%
Chapter Four	11	10	11	5	90%
Documintation Preperation	12	6	12	7	90%
Graduation Project	12	1	12	1	0%

1.9 Conclusion

With our wireless needs of wireless network, it causes the rapid growth of wireless network service and its technologies. As indicated in this chapter, 3G still exists as a voice centric domain technology and a few capacity for data with lower data rates. On the viewpoints of future trend, the convergence of heterogeneous networks, for example, LTE (Long Term Evolution) will offer higher data rates but needs many frequencies. LTE and 3G planning aspects in terms of coverage, capacity, and quality were briefly mentioned in this introductory chapter.

CHAPTER TWO

THEORITICAL BACKGROUND

Contents

2.1 Overview

The game is no longer played only with voice. Operators should look at users as their children/grandchildren who will be the active population in 15-20 years' time.

This revolution carries many amplifications, some of which are discussed in what has been summarized in this chapter for both technologies. Starting with wireless generations, going through 3G and LTE technologies, and ending with problems that would face wireless communications .

2.2 Generations of Wireless Technologies

Looking back to when it all started it begun several decades ago, the following is a historical overview, based on informal terms in the mobile industry, and here is a quick run –down:

The birth of Wireless Communication from 1800s when M.G Marconi did the first successful radio link between land base station and a tugboat [2] ,so 1G is not the first mobile network there were many networks with very low capacity and mobility that wasn`t supported strongly compared to cellular systems.

The first international communication system was the analog NMT system (Nordic mobile Telephony) in the Nordic countries, AMPS (Advanced mobile phone service) was introduced in North America at the same time, TACS (Total Access Communication System) and J-TACS, was also one of the first generation (1G) technologies, all of those was providers for voice only transmitted with analog FDMA [4] and each user fully occupies the radio channel of 30KHz [2].

Second generation (2G) supports both voice and data with digital TDMA or CDMA, in 2G with a data rate of 9.6Kbp it provided voice services, such as caller ID, and other data services such as the Short Message Service (SMS), fax, and ring-tone downloads. 2G includes systems like GSM (Global system for Mobile communication), D-AMPS (Dual-mode AMPS), PDC (Personal digital Communication) and IS-95 [3] .

GSM is the most popular system of 2G enhancements and the one that Palestinian territories still use. GSM uses 900MHz band , but the lack of capacity in this band encourage to use new frequency bands like 1800MHz which suitable for populated areas [1] .The channel is 200KHz uses 124 two way channels with FDD (one frequency for uplink and different one for downlink)[2].

GPRS (General Packet Radio Service) is referred to as 2.5G and data rates went up to 171.2 Kbps providing new and better applications. GPRS is an "always-on" service, since it allowed many applications such remote credit card authorization, email, fax, and web browsing, etc. [4]. Regardless to GPRS advantages, it was not capable to offer multimedia applications. Then through EDGE (Enhanced, Data rates for GSM and TDMA Evolution), referred to as 2.75G, having data rate of 500kbps [5].

The ITU (International Telecommunication Union) started to work on IMT-2000, which is an introduction for the third generation (3G) that offers advancements on the 1G and 2G networks such as multimedia applications like video and broadband services [3]. Then the ETSI (European Telecommunication Standards Institute) choose WCDMA and TD-CDMA as multiple access methods for FDD (Frequency Division Duplex) and TDD (Time Division Duplex) mode of UMTS (Universal Mobile Telecommunication System), respectively [4].

The 3GPP was established to produce globally technical specifications and reports for a 3rd generation mobile system based on GSM core networks and the radio access technologies such as UTRA (Universal terrestrial Radio Access) and both FDD and TDD modes[4] .There is two different implementations for 3G, UMTS and cdma2000 (Released by 3GPP2) [5].

Then 3GPP implemented WCDMA as Release 99 that supports both circuit switched and packet switched up to theoretical rate 2 Mbps. The first step in the evolution of WCDMA radio access is the introduction of HSDPA known as release 5 and HSUPA, it is also called as EU (Enhanced Uplink) specified in Release 6 of the 3GPP/WCDMA. HSDPA and EU is referred as HSPA [2]. HSPA provides DL and UL data rates up to approximately 14 and 5.7 Mbps, respectively and significantly improves capacity [8].

3GPP release 7 is MIMO that used to improve capacity and especially the HSPA advanced rates up to 84 Mbps in DL [4]. After that the 3GPP was extended through having another member, the Evolved UTRAN (E-UTRAN) to complete the work item “3G Long Term Evolution (LTE) –Evolved Packet System RAN” as Release 8, and sometimes referred to as 3.9G with data rates are up to 100Mbps in full mobility or 1Gbps in low mobility DL and up to 50Mbps UL[9] . 3G LTE was introduced to specify the new worldwide radio access, the evolved core network, and System Architecture Evolution (SAE) technologies [9].

The ITU defined IMT-Advanced or LTE Advanced as 4G and it meant to support theoretical bit rates up to approximately 1Gbps where network is all-IP ,it will simply be called LTE in Release 10[4] . Actually, LTE Advanced is the same built as LTE in Release 8 but with extra features such simultaneous communication through different base stations and spectrum aggregation [8].

In the near future, there is two paths for 4G technologies. One path is as mentioned before that come from the evolution of 3GPP/3GPP2 which is LTE Advanced, and the other path is 4G that may come from revolution of IEEE802.16e (Mobile WIMAX) or the combination of these two paths is also possible[9] .

2.3 Theoretical Overview of Third Generation of 3GPP (3G)

2.3.1 Introduction to 3G

The author of my generation once said about 3G: “The old business model of 'coverage, coverage, coverage' will evolve to one of 'capacity, capability and content' and true evaluation will have to be made of the volume of expected usage, the value that customers will expect for their money and the variety of services that can be offered” [16] .

3G or advanced system or mobile multimedia will make evolution in term of IP core technology, but a revolution in service and applications. Many refer to the 3G standards (UMT‘2000or UMT’S) or purely the radio interface technology. The air interface of the 3G is a variant of W-CDMA and its network including all the base stations, switches, gateways, databases and the wired link between them.

New added Services specified in 3G [14], Multimedia Messaging, text messaging has grown into instant messaging IM on the internet, MMS Location based services: operators nowadays can identify the location of a mobile and works as a map to the user , and Ecommerce, such checking your bank account, or ordering goods through internet.

WCDMA provides high transfer rates, efficient support of asymmetric traffic ,transmission using packet switching through the radio interface and high efficiency in spectrum use. The Base Station (BS) also known as a Node B; is part of the UMTS Terrestrial Radio Access Network (UTRAN). The Node B is to perform fundamental tasks of transmission and reception of radio, filtering of the signal, amplification, modulation and demodulation of the signal and bean interface to the Radio Network Controller (RNC).

2.3.2 3G Technologies

2.3.2.1 WCDMA

WCDMA was designed to serve future applications that support parallel transmission of bit streams of different (QOS) parameters with maximum data rate reach to 2Mbps, these applications could be carried over internet using IP protocols there is a need for another wireless network to support this amount of data and enable access online easily to the applications. This wireless network is WLAN, which can offers more capacity to the system and wider and useful bandwidth [11].

WCDMA evolution can be discussed in three phases [11]:

1) HSDPA is the first phase, a completed study was done by 3GPP focused on a high-speed downlink shared channel (HS-DSCH) mean and considered as a part of release 5. The main improvements of HS-DSCH include adaptive modulation and coding (AMC), Fast hybrid automatic repeat request (FHARQ) and Fast cell selection (FCS).

2) UHSD Uplink High-Speed Data, High-Speed Access for TDD is the second phase ,in which new enhancements in HSCDPA for both FDD and TDD will be seen which could include MIMO and FCS.it should be taken in account that uplink is important and can benefits the end user when enhance the data rates in uplink .

3) Capacity Improvements in Uplink and Downlink, and Further Data Rate Enhancement .The high grow of data rates predict the need for enhancing of WCDMA data rates up to 10 Mbps.

2.3.2.2 TD-SCDMA

Time division synchronous code division multiple access (TD-SCDMA) is a Chinese-developed 3G standard that has been adopted by the ITU, and by 3GPP as one of the worldwide 3G standards. TD - SCDMA also Supports all radio network scenarios (Wide Area - Macro, Local Area - Micro, Hot Spots - Pico and Corporate Networks) so it allows full service coverage [18] .

TD-SCDMA It is a time division duplex (TDD) standard. This ability to transmit and receive on the same frequency makes TD-SCDMA well suited for data-intensive applications. In addition, it uses TDMA in addition to the CDMA used in WCDMA. This reduces the number of users in each timeslot, which reduces the implementation complexity of multiuser detection and beam forming schemes, but the non-continuous transmission also reduces coverage and mobility .

TD-SCDMA uses QPSK Modulation and its Bandwidth is 1.6 MHz and its Supporting data transmission at speeds up to 2 Mbps, .The TD-SCDMA standard provides a lots of advantages where it is does not require costly duplexers in the handsets to enable simultaneous transmission ,whether on the uplink or downlink, also can reduce the efficiency of the system [21] .

2.3.3 3G Capacity

Shannon formula determine the maximum data rate or channel capacity such that [11], the formula show that the limits on data rate are the bandwidth and the SNR value.

$$C=BW \, Log_2 \left(1+\frac{S}{N}\right) \qquad \text{Eq. (2.1)}$$

Such that, BW: The available bandwidth to communicate, S: Power of received signal

N: The power in the white noise.

WCDMA system is limited by interference, also when some mobiles are far from the base station and need to use their maximum power to access with lower QoS, this will lead to high interference and some of MS are out of service. Solving this problem can be achieved by two ways increasing the number of BS this will increase the infrastructure cost, or using the relaying which will increase the capacity of the system. Also using MIMO technology, which provide parallel communication through multiple antennas at the transmitter and / or the receiver this, will increase the capacity of the channel.

2.3.4 3G Coverage

In WCDMA network multiple services co-exist, .Different services (voice, data) have different processing gains, Eb/No performance, as a result, different receiver SNR requirements. In addition to those the WCDMA coverage depends on the load characterization ,hand over ,and power control effects .So ,in the case of WCDMA the coverage threshold is dependent on the number of users and used bit rates in all cells ,and so its cell and service specific .

When the network load is higher, the covering distance will be longer, when the network load is increased due to the increase of users, the cell coverage area will be reduced. Therefore, the location and the number of BS needed in 3G planning must be determined from both coverage and capacity.

Propagation models are used to evaluate coverage; the two main models are free space loss and planet earth loss, which would require detailed knowledge of the location, dimension and many parameters of every tree ,building, and terrain feature in the area to be covered. This is too complex and yields to unnecessary details. One appropriate way of accounting for these complex effects is through empirical model.

There are many empirical prediction models among them are, Okumura – Hate model, Cost 231 – Hate model ,Cost 231 Wolfish – Ikegami model. These models depend on location, frequency range and clutter type such as urban, sub-urban and countryside [19].

2.3.5 3G QoS

QoS in 3G is considered end-to-end service, where it include from a Terminal Equipment (TE) to another TE to achieve a certain Quality of Service, this can be done as the following, a QoS bearers service are set up from the source to the destination _ with defined characteristics and functionality of a service _ where each bearer service includes all aspects that provide a needed QoS, and these aspects are the control signaling user plane transport and QoS management functionality. There are four different QoS classes, which are conversational, streaming class, interactive class, and background class, the main distinguishing factor between these QoS classes is how delay sensitive the traffic, there are Comparison between Qos class is shown in Table 2.3. [10]

Table 2.1: UMTS QoS classes [10]

Traffic class	Conversational class conversational RT	Streaming class streaming RT	Interactive class Interactive best effort	Background Background best effort
Fundamental characteristics	Preserve time (variation) between information entities of the stream Conversational pattern (stringent and low delay)	Preserve time relation (variation) between information entities of the stream	Request response pattern - Preserve payload content	Destination is not expecting the data within a certain time - Preserve payload content
Example of the application	voice	streaming video	Web browsing	background download of emails

2.4 Theoretical Overview of Long Term Evolution of 3GPP (LTE)

2.4.1 Introduction to LTE

The work on LTE was initiated in late 2004 to provide a new radio-access technology depending on packet-switched data only. LTE will bring several enhancements to the 3G radio interface on peak data rates, user/system throughput, spectral efficiency, and control/user-plane latency [15]. In addition, requirements were also set on spectrum flexibility, as well as enabling a transparent connection with GSM and WCDMA standard, and with WLAN and WIMAX .

WIMAX, Flash OFDM or even WIFI took attention in the world of communication it is expected that those will deliver superior price performance compared to others, in 2G and 3G this might be true, but LTE is more competitive [15].

People nowadays agree that there will not be a single service but a number of services ,they are expecting 8 services from LTE .The services are :Speech telephony ,Video telephony , streaming Multimedia(MM) ,world wide web (WWW) , location based service , file download Email and multimedia Messaging Service (MMS).

2.4.2 LTE Architecture

The LTE architecture, which is different of the one of the previous systems, called SAE, System Architecture Evolution. The network architecture is called EPS. Actually, there is E-UTRAN at the access side and EPC, evolved packet core. This core also known as SAE, and for the access part instead of E-UTRAN, more common term is used which is LTE. 3GPP Rel-8 based on all IP infrastructure [17] .LTE-RAN has only eNodeB (base stations) (no more BSC nor RNC as previous system) [20].

A number of ‘proof points ‘by the LSTI to be agreed between vendors and operators in order to prove that LTE/SAE will be able to meet the industry’s expectations. The LSTI is concerned with trials of the technology on actual implementations of the standard. It compares measurements from equipment in the lab and field against requirements and design targets from both 3GPP and NGMN [22].

The proof points are as follows [22]:

1) Peak data rates are up to 100Mbps (DL) and 50Mbps(UL)
2) Expected data rates to the users are as follows :
    i. User equipment speed up to 350km/hour
    ii. Sharing resources between multiple users per cell
    iii. Benefit from frequency selective scheduling (FSS) and multi-user MIMO.
3) Voice over internet protocol (VOIP) and end –to-end quality of service support.
4) Latency but there is different types of latency :
    i. Idle-active Control-plane latency: which is the time taken to set up a connection with a user, to enable communication, should be< 100 ms.
    ii. Air interface User-plane latency: which is the time taken for each data packet to travel from source to destination ,should be < 10 ms
    iii. End-to-End User plane latency: represents the minimum time for a User Equipment (a phone or a data card (UE)) to send a packet to an external server and receive a response and should be <20ms especially for services such as voice and video conferencing to work well.
5) Handovers and interruption time, so a very fast break-before-make “hard” handover has been implemented for LTE/SAE.

2.4.3 LTE Technologies

2.4.3.1 OFDMA

Orthogonal Frequency Division Multiplexing (OFDM) technology is applied in the LTE systems and the OFDMA is used on the downlink, which is used to achieve high peak data rates in high spectrum bandwidth along with MIMO. On the uplink, LTE uses an approach called SC-FDMA, which has some similarities with OFDMA but will have a 2 to 6 dB Peak to Average Ratio (PAPR) advantage over the OFDMA method used by other technologies such as IEEE 802.16e.h [23].

OFDMA defined as the system performance improvement due to the increase in the number of users, where it provide multiple access to a common bandwidth or channel to multiple user as shown in Fig. 2.1 . In OFDMA, the user is assigned a specific frequency band in the spectrum, and during a call that user is the only one who has the right to access the specific band [24].

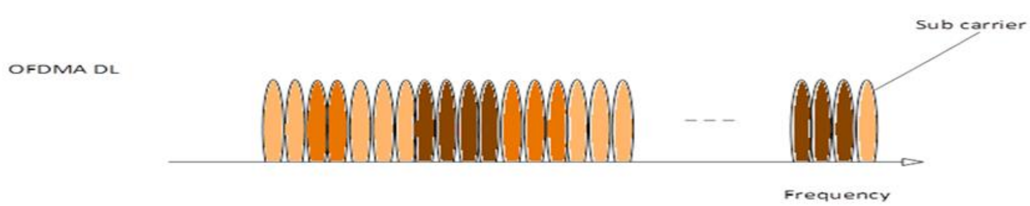


Figure 2.1: OFDMA Downlink [24]

OFDMA at the physical layer, in combination with a Medium Access Control (MAC) layer, provides an optimized resource allocation and Quality of Service (QoS) support for different types of services such offering broadband wireless access at data rates of multiple Mbps to the end-user and within a range of several kilometers. Besides, it is suitable for broadcasting even in Multiple-Input Multiple-Output (MIMO) scenarios.

2.4.3.2 SC-FDMA

For the LTE up-link, SC-FDMA (Single Carrier Frequency Division Multiple Access) system was adopted by the 3GPP (Third Generation Partnership Project) as standard method, which is implemented via discrete Fourier transform, spread OFDM (DFT-S-OFDM). SC-FDMA as shown in Fig. 2.2 below is a technique for high data rate uplink communications in future cellular systems. It shows good spectrum efficiency, essentially almost the same overall complexity [25].

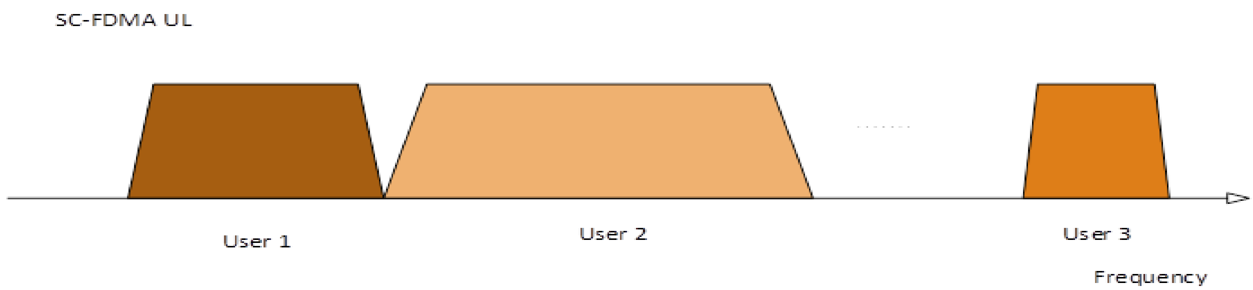


Figure 2.2: SC-FDMA Uplink [24]

However, SC-FDMA system is very sensitive to frequency synchronization errors, since different users always have different CFOs (Carrier Frequency Offset), which might happened due to Doppler shift. The multiple CFOs destroy the orthogonally among subcarriers, and this will lead to many other challenges in the uplink such ICI (Inter Carrier Interference) and MAI (Multi Access interference) and those two will minimize the quality of received signals.

Feedback method is used for CFO's correction and this can be done through downlink control channel to transmit the estimated CFO information obtained by base stations and send it to each user, then each user can correct their CFO's by adjusting the carrier frequency. However, this method will increase overhead, so the alternative way is signal processing in the uplink through SIC (Successive Interference Cancellation) as well as PIC (Parallel Interference Cancellation) methods.

In SC-FDMA uplink communications, all subcarriers are divided into several groups. Instead of being modulated on all available subcarriers, data symbols from one user are transmitted on one group of subcarriers; frequency domain orthogonally is maintained among intra-cell users, which allows the enhanced Node B (eNB, where eNB is synonymous to base station) the ability to efficiently manage the amount of interference seen at the base station.

2.4.3.3 SDMA

SDMA (Spatial Division Multiple Access) is technology employs antenna arrays; it consists of a digital component and multidimensional nonlinear signal processing techniques to increase the capacity and quality of many wireless communication systems. Antenna arrays along with adaptive signal processing techniques used side by side at base stations improving beside coverage and capacity also the efficiency leading to lower cost deployments with cells of moderate to large size [26].

SDMA achieves an improvement in wireless information transmission through information that is collected in the spatial dimension in addition to the temporal dimension , and this way it took its name “Spatial “ .However, Spatially selective transmission and reception of radio frequency energy provides an increases in wireless system capacity, coverage and quality [27].

SDMA is flexible since it allows the creation of new services added to the original ones, it is also not restricted to specific type of modulation or air interface, it can adapt with the currently deployed air interfaces.

2.4.4 3G and LTE Joint Technologies

2.4.4.1 MIMO

Multiple-input Multiple-Output (MIMO) technology with multiple antennas at the transmitter and the receiver, it can be found in several standards of future wireless communication systems including IEEE 802.11n, 802.16(WIMAX), HSPDA, and 3GPP- LTE, 3GPP-LTE Advanced (LTE-Adv.) as well as the latest versions of Wi-Fi [28].

More recently, Releases 8 and 9 of E-UTRAN 3GPP specifications for Long-Term Evolution (LTE) include advanced forms of MIMO implementation, and MIMO technology enhancements are being studied to be included in Release 10 [24], in order to enhance the possibility of providing increased capacity at low SNR values [28].

According to the number of transmit antennas (TX) and the number of receive antennas (RX) , as Figures 2.3 and 2.4 shows, wireless systems can be classified as single-input single-output (SISO) , single-input multiple-output (SIMO) , multiple-input single-output (MISO) , and multiple-input multiple-output (MIMO) systems, where the input and output are with respect to the channel between the transmitter and the receiver [29] .

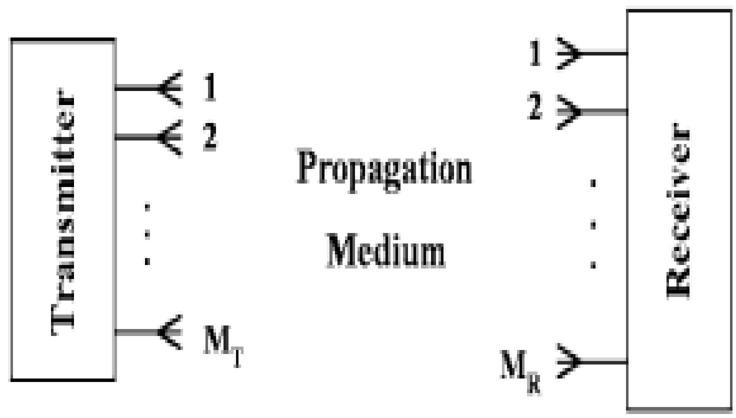


Figure 2.3: MIMO general scheme [29]

MIMO techniques are well known to permit the benefit of diversity to the transmitter side in addition to the receiver. MIMO is to overcome the challenges in high-speed wireless data transmission, and it can enhance the capacity and performance of wireless communication systems.

For a time-invariant AWGN channel with bandwidth B and received SNR γ, the maximizing input distribution is Gaussian, which results in the channel capacity [28].

$$C = B \log_2 (1 + \eta) \text{ bps} \qquad \text{Eq. (2. 2)}$$

The use of MIMO technology in future transmission systems for broadcasting, multicasting and unicasting is because of the possible reduction in transmission station.[29] But there is also four main advantages of using MIMO [28] :

1) Capacity gain: increases spectral efficiency and makes no need for additional power, namely, spatial multiplexing.
2) Diversity gain: improves link reliability by providing multiple (ideally) independently fading signal paths between transmitter and receiver

3) beam forming gain: it is a smart antenna technique with multiple antennas at the BS side and only one antenna at the MS side ,it offer enhancement on capacity and performance of the network without need for increasing power or wider frequency band , because it will focus the power toward the intended receiver and we will get higher SNR .

4) In addition, array gain: improves coverage by improving the received signal-to-noise ratio (SNR) through coherent combining of the signals arriving at the receive antenna array.

2.4.4.2 TDD and FDD

Frequency division duplex is a technique uses the idea that the transmission and reception of signals are achieved simultaneously using two different frequencies where one frequency band is used to transmit and another used to receive , FDD technique is require for the channel separation between the transmission and reception frequencies [30] .

Time division duplex (TDD) means that the system uses only a single frequency and it shares the channel between transmission and reception, spacing them apart by multiplexing the two signals on a time [35]. TDD schemes is suitable for small distances with the possibility of unbalanced data traffic, while FDD schemes are better over greater distances and where the traffic is balanced. LTE supports both TDD mode and FDD mode. Although the time domain structure is the same for both duplexing schemes, there are some differences between TDD mode and FDD mode [30].

2.4.5 LTE Capacity

The capacity of LTE system not only defined by throughput also the number of users that can communicate with in the same cell simultaneously. For that, LTE is required to support up to 200 users per cell for the spectrum reaches 5MHz, also at least 400 users per cell in wider spectrum. Not all these users will be active in the cells; only a small subset of these users would be actively receiving or transmitting [31].

The technology used in LTE uplink is (SC-FDMA) which depend on orthogonally between different users; this indicates that the spectral efficiency increased two to three over WCDMA uplink. The CP (cyclic prefix) of the SC-FDMA make the use of a simple receiver with frequency domain equalization in the eNodeB easier, this improves the uplink spectral efficiency.

Voice is real time traffic service, so it is important to give the system capacity for such services (e.g. VOIP). It is a challenge in LTE, which depends on adaptive scheduling; the requirement of the system capacity is defined as satisfied VOIP users under limited traffic and limited allowable delay.

2.4.6 LTE Coverage

Coverage analysis gives an estimation of the resources needed to provide service in the deployment area with the given system parameters. In this section, the radio link budget is explained and the cell radius of a particular LTE sector is calculated based on the propagation models.

A link budget is the accounting of all of the gains and losses from the transmitter, through the medium (propagation loss, cable loss, antenna gains, etc.) to the receiver in a radio system. Link budget equation in the wireless channel is [31]:

$$P_{RX}=P_{TX}+G_{TX}+G_{RX}-L_{TX}-L_{RX}+PM-PL \qquad \text{Eq. (2. 3)}$$

Where the P_{Rx} is the received power (dBm), P_{Tx} is the transmitter output power (dBm), GTX is the transmitter antenna gain (dBi), G_{RX} is the receiver antenna gain (dBi), and. L_{TX} and L_{RX} are the cable and other losses on the transmitter and receiver side (dB), respectively. PM is the planning margin, and PL is the path loss - (85-120) dB. A planning margin of – (10 – 25) dB is added to account for the required received signal allowance for fading, prediction errors and additional losses.

Coverage performance can be enhanced by improving any item in the RLB. Typically, this can be achieved through higher transmitted power, antenna with higher gains or by improving diversity solutions .SINR is central to the RLB and so to the process of dimensioning [31].

Where SINR average defined as SINR ave =S / I + N Eq. (2.4)

Where S is the average received signal power, I is the average interference power, and N is the noise power. The average interference power can be further decomposed as I = I own + I other ; where I own and I other are the average own-cell, and other-cell interference power [42], and we need to take into account the Inter-symbol interference due to multipath ,and Inter-carrier interference due to Doppler spread which are the own signal interference**.**

2.4.6.1 RLB Calculations

This section contains calculations for data radio "link budget" calculations. Note that the calculations are based on assumptions of certain circumstances and should only be used as a guideline for radio network design. In reality, many factors can have an impact on the radio link.

Link budget equation in the wireless channel is as was mentioned above which can be used to calculate any of the factors within the equation below:

$P_{RX}=P_{TX}+G_{TX}+G_{RX}-L_{TX}-L_{RX}+PM-PL$

PTX=47dBm, G_{TX} (dBi) antenna gain=16dBi, G_{RX} (dBi) for mobile=0dBi, $L_{TX}=L_{RX}$=2-3dB for each meter, this project considered it 3dB, PL= -120 dB, PM= - 25 dB

P_{RX}=47+16+0-3-3-120—25 = -88dBm

2.4.7 LTE Quality

QoS is also defined as a set of techniques that are found in any network to manage bandwidth, delay, jitter, and packets loss for flows in a network, the purpose of every QoS mechanism is to influence at least one of these four characteristics and, in some cases, all four of these [32] .

LTE provides different level of Qos as per application, where each bearer (user data) path in LTE is assigned a set of QoS criteria, and if a user have services requiring different QoS criteria, then additional bearer paths may be added.

Firs parameter is latency, which is a measure of time delay experienced in a system the amount of time it takes a packet to travel from source to destination, the other parameter is jitter that defined as the variation in the time between packets arriving across a network.

The second parameter is packet loss, it is a term used to indicate the loss of data packets during transmission over a network. Packet loss may occur for a variety of reasons but normally occurs because of high network latency or overloading of switches or routers that are unable to process or route all the incoming data.

The last parameter is throughput, it is known as the amount of data moved successfully from one place to another in a given time period, and it characterized through specific parameters, those are the Guaranteed Bit Rate (GPR), and Non-Guaranteed Bit Rate.

Guaranteed Bit Rate (GBR) bearers the network resources are fixed and do not change after bearer establishment or modification, this is a guaranteed service data flow, so it is used for real time services, such as conversational voice and video, and it has a minimum amount of bandwidth that is reserved by the network. While Non-GBR bearers do not have specific network bandwidth allocation, so Non-GBR bearers are used for best-effort services, and table 2.2 will clarify QCI’s in LTE.

Table 2.2: Standardized QoS Class Identifiers (QCIs) for LTE [32]

QCI	Resource	Priority	Packet delay (ms)	Packet loss	Services
1	GBR	2	100	10^-2	Conversational voice
2	GBR	4	150	10^-3	Conversational voice (live streaming)
3	GBR	3	50	10^-3	Real-time gaming
4	GBR	5	300	10^-6	Non-conversational video (buffered streaming)
5	NON-GBR	1	100	10^-3	IMS signaling
6	NON-GBR	6	300	10^-6	Video (buffered streaming)
7	NON-GBR	7	100	10^-3	Voice, video (live streaming), interactive streaming
8	NON-GBR	8	300	10^-6	TCP-based (e.g. WWW, e-mail), FTP, P2P, etc.,
9	NON-GBR	9	300	10^-6	

2.5 Technical Challenges of Wireless Communications

2.5.1 Multipath Propagation

In wireless telecommunications, multipath is the propagation phenomenon that results in radio signals reaching the receiving antenna by two or more paths. The effects of multipath include constructive and destructive interference, and phase shifting of the signal. Destructive interference causes fading. Where the magnitudes of the signals arriving by the various paths have a distribution known as the Rayleigh distribution, this is known as Rayleigh fading. Where one component (often, but not necessarily, a line of sight component) dominates, a Rician distribution provides a more accurate model, and this is known as Rician fading[33] .

In wireless systems, fading may either be due to multipath propagation, referred to as multipath induced fading, or due to shadowing from obstacles affecting the wave propagation, sometimes referred to as shadow fading. Fading is separated in what follows:

1) Slow fading: Slow fading can be caused by events such as shadowing, where a large obstruction such as a hill or large building obscures the main signal path between the transmitter and the receiver. The received power change caused by shadowing is often modeled using a log-normal distribution with a standard deviation according to the log-distance path loss model.
2) Fast fading: occurs when the coherence time of the channel is small relative to the delay constraint of the channel.

In digital radio communications (such as GSM) multipath can cause errors and affect the quality of communications. The errors are due to inter symbol interference (ISI). Equalizers are often used to correct the ISI. Alternatively, techniques such as orthogonal frequency division modulation and rake receivers may be used.

2.5.2 Frequency Reuse

Because only a small number of radio channel frequencies were available for mobile systems, engineers had to find a way to reuse radio channels to carry more than one conversation at a time .The solution the industry adapted is was called frequency planning or frequency reuse .

Frequency reuse is the process of using the same radio frequencies on radio transmitter sites within a geographic area, which are separated, by sufficient distance to cause minimal interference with each other. Frequency reuse allows for a dramatic increase in the number of customers that can be served (capacity) within a geographic area on a limited amount of radio spectrum (limited number of radio channels).

2.6 Conclusion

The main aim of this project is to make a comparison between 3G and 4G in term of capacity, coverage, and quality. So these previous studies that this chapter implemented help us in the realm of getting knowledge in 3G and LTE capacity ,coverage, and quality .In addition, study each generation technologies . It helps us as researchers to better understand the problems that would face us through the path of this project.

CHAPTER THREE
WCDMA AND LTE PLANNING FOR HEBRON CITY

Contents

3.1 Overview

This chapter will go deeply in the WCDMA and LTE planning process theoretically, basing through every planning steps; starting with initial planning with ten sites which was completed in the introduction of graduation project last semester, detailed planning this semester for both technologies on different frequencies for each ; 900MHz ,1800MHz,2100MHz and 2600MHz .

Of course, Mentum planning tool will be briefly described, Hebron background information will be introduced, geodetics (Clutter, heights), and project data will be included . Finally yet importantly, clear comparisons and sites modifications for each frequency, that each technology will work on, will be written and specified in results.

3.2 WCDMA Radio Network Planning

3.2.1 WCDMA Radio Network Planning Process

Planning should meet current standards and demands and keep up with future requirements. Uncertainty of future traffic growth and service needs and high bit rate services require knowledge of coverage and capacity enhancements methods, real constraints Coexistence and co-operation of 2G and 3G for old operators, and environmental constraints for new operators.

There are many conditions in the process of planning such as capacity not constant, separate analysis for UL/DL, joint coverage/capacity analysis. WCDMA Radio Planning main objective parameters in general are pointed as follow:

1. coverage
2. capacity (blocking)
3. good link quality (BER, FER)
4. throughput delay, for packet services

What is new in WCDMA planning is that on the one hand it is a multiservice environment having highly sophisticated radio interface, such as Bit rates from eight Kbit/s to two Mbit/s, in addition to variable rate. Cell coverage and service design for multiple services are needed to have different bit rate, satisfactory QoS requirements, and various radio link coding/throughput adaptation schemes .

On the other hand the WCDMA works through providing air interface, Capacity and coverage coupled, fast power control, planning a soft handover overhead, cell dominance and isolation, and vulnerability to external interference. Finally yet importantly, a coexistence of 2G and 3G sites is necessary along with handover between 2G and 3G systems, and service continuity between 2G and 3G as shown in fig.3.1.

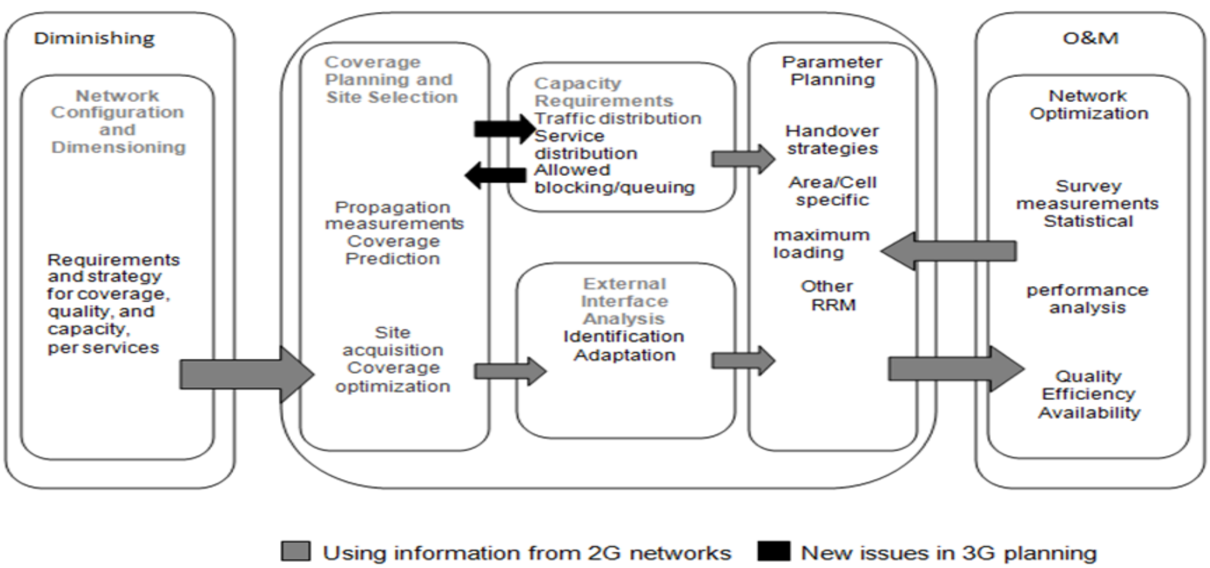


Figure3.1: WCDMA Radio Network Planning Process [34]

3.2.2 WCDMA Planning Methods

3.2.2.1 WCDMA Initial Planning

Initial Planning:(i.e. system dimensioning) provides the first and most rapid evaluation of the network size as well as the associated capacity of elements involved as shown in Fig. 3.2. This includes both the radio access network as well as the core network.

The target of the dimensioning phase is to estimate the required site density and site configurations for the area of interest. Initial RAN planning activities include radio link budget (RLB) and coverage analysis, capacity estimation, and finally, estimation for base station hardware and sites, radio network controllers (RNC), equipment at different interfaces, and core network elements.

In the RLB calculation in uplink direction the limiting factor is the mobile station transmit power, in downlink direction the limit is the total base station transmit power .When balancing the uplink and downlink service areas both links must be considered. Interference margin, slow fading margin, and power control are also done under the RLB calculations.

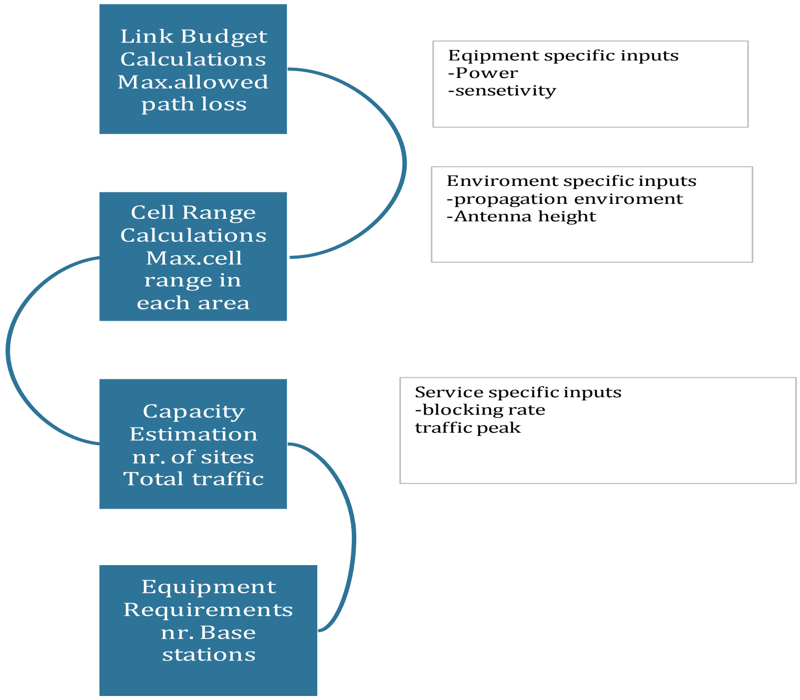


Figure3.2: WCDMA Initial Planning (Dimensioning Process)

3.2.2.2 WCDMA Detailed Planning

Detailed planning phase, dimensioned density of the base stations (and sectors) is transferred on the digital map. The analysis of WCDMA is an iterative process ,where the capacity requirements are considered as discrete mobile events in the simulations.

In this phase of WCDMA, planning one must perform multiple analyses in order to detect when the network will meet a given set of requirements. Within the planning phase, one may use procedures for interference control, which are targeted to proper site selection, configuration of the sites and antennas ,antenna tilting etc.

In the case of WCDMA networks, the detailed planning is itself an optimization process. In the case of the 2G, the detailed planning concentrated strongly on the coverage optimization. The 3G planning is more interference and capacity analysis than just a coverage area estimation. During radio network planning base station configurations need to be optimized, antenna selections, antenna directions, and even site locations need to be tuned as much as possible in order to meet the QoS and the capacity and service requirements with minimum cost.

To achieve an optimum result the tool must have knowledge of radio resource algorithms in order to perform operations and make decisions like the real network. Uplink and downlink coverage probability analysis ought to be performed for different services and for common channels to guarantee proper network performance.

3.2.2.3 WCDMA Optimizing

WCDMA optimization includes many fields such Key Performance Indicator (KPI), Power control, handovers, and how to improve voice and data KPI. The performance parameters calculated by the simulator include best server maps, coverage per service maps and SHO areas. Output concerning the mobile station transmit power, base station transmit power,throughput per cell, load per cell, blocking and SHO probability as well as number of active base stations per mobile are given in a statistical manner, i.e. distribution ,mean value and standard deviation. The so-called cell breathing can be demonstrated to show the complex interaction between coverage and capacity.

The increasing traffic and the demand for high data rate services in WCDMA networks prompt the need for an automatic network optimization. Current optimization methods adapt physical parameters, such as the antennas' tilt or azimuth. A further capacity increase can be achieved by an optimization of Radio Resource Management (RRM) parameters.

The 3G traffic classes (conversational, interactive, streaming, background) ,QoS provisioning mechanisms and possibility for customer differentiation, together with the joint management and traffic sharing between 2G and 3G networks provide challenging playground on one hand for vendors, and on the other hand for service providers and network operators.

The process starts with the quality definition. The overall end-to-end quality target is defined and for each service type, the quality criteria are determined. The thresholds are then set for each related key performance indicator (KPI).

Network performance data can be gathered from Network Management Systems (NMS), drive tests, protocol analyzers and/or customer complaints. Network reporting tools provide statistical and pre-analyzed information about the quality. Based on the network configuration and status of the network, quality in detail is analyzed and individual corrections are done by solving the individual parameters affecting the reported quality [35].

Tuning of the individual parameters is carried out in an iterative loop until the quality is met. Finally, in addition to tuning single parameters, the general solution has to be found. After the corrections have been implemented to the network, the quality cycle starts from the beginning.

The role of optimization is to provide automated or manual means to improve the performance of the network. Furthermore, the task of optimization is to understand and translate the relationship between measured network performance and set QoS targets.The definition of performance in the case of 3G is changing; it shall be capacity-quality trade-off management, rather than traditional performance improvement. For more knowledge about this issue, see [35,36].

3.3 LTE Radio Network Planning

3.3.1 LTE Radio Network Planning Process

Long Term Evolution (LTE) is the latest and most enhanced broadband wireless access (BWA) technology. LTE is the latest standard in the mobile network technology tree that previously realized the GSM/EDGE and UMTS technologies. LTE is expected to ensure 3GPP's competitive edge over other cellular technologies. The standardization process of LTE is almost at its end. With industrial attachment, very few radio planning works of LTE are going on. However, because of certain commercial issues those works are not widely available [6].

3.3.2 LTE Initial Planning (I.e. dimensioning)

The first stage of the initial planning process needs to collect data, the required coverage, and kind of services to be deployed, capacity and quality of service .the main aim of this stage is to determine the optimal number of sites to meet all these limitations on the network. Thus this stage includes a simplified simulation to reach to the coverage and capacity estimations .also it involves meeting coverage requirements for subscribers, at the same time supporting the services and network capacity thresholds.

LTE Dimensioning process starts with the Radio Link Budget Calculations; RLB computes the power received by the user given a specific transmitted power. RLB comprises of all the gains and losses in the path of signal from transmitter to the receiver.

This includes transmitter and receiver gains as well as losses and the effect of the wireless medium between them; these losses include body loss, cable losses and some margins.

Therefore, link loss (Link Loss) can be written as [6] :

Link loss = (RxGains * TX Gains / Pathless * RxLosses * TX Losses * Other Losses)

Eq. (3.1)

where RLB gives the maximum allowed path loss, from which cell size is calculated using a suitable propagation model , For LTE, the basic RLB equation can be written as follows (in units of dB):

Path Loss = TX Power(dB)+ TX Gains(dB)- TX Losses(dB)- Required SINR(dB) +RxGains(dB) - RxLosses(dB)- RxNoie(dB) Eq. (3.2)

In brief, the network dimensioning process goes like that in Fig. 3.3 in the following pages:

1) The pre-planning information is taken as input for network dimensioning. Besides, the probable height of Base Stations at the sites and few other parameters are determined in order to use as input.
2) A spreadsheet-based tool should be developed for the particular requirement. The tool makes use of Link Budget for cell coverage estimation. A system level simulator may be used for the best estimation of capacity, which is an input for the tool.
3) The spreadsheet-based tool determines the cell range using coverage analysis. If the capacity in the range can be handled, then the final number of cells and their locations are determined.

In addition, it provides expected variation of these results with time. Decision is made about few parameters in dimensioning phase. For example, target MCS, BLER, BS configuration, e.g. 3-sector/Omni, antenna types, MIMO type etc. The results of dimensioning assists in estimation of core network, and initial implementation cost. Thus, it helps in calculation of probable return, planning the tariff strategy, overall business planning, etc.

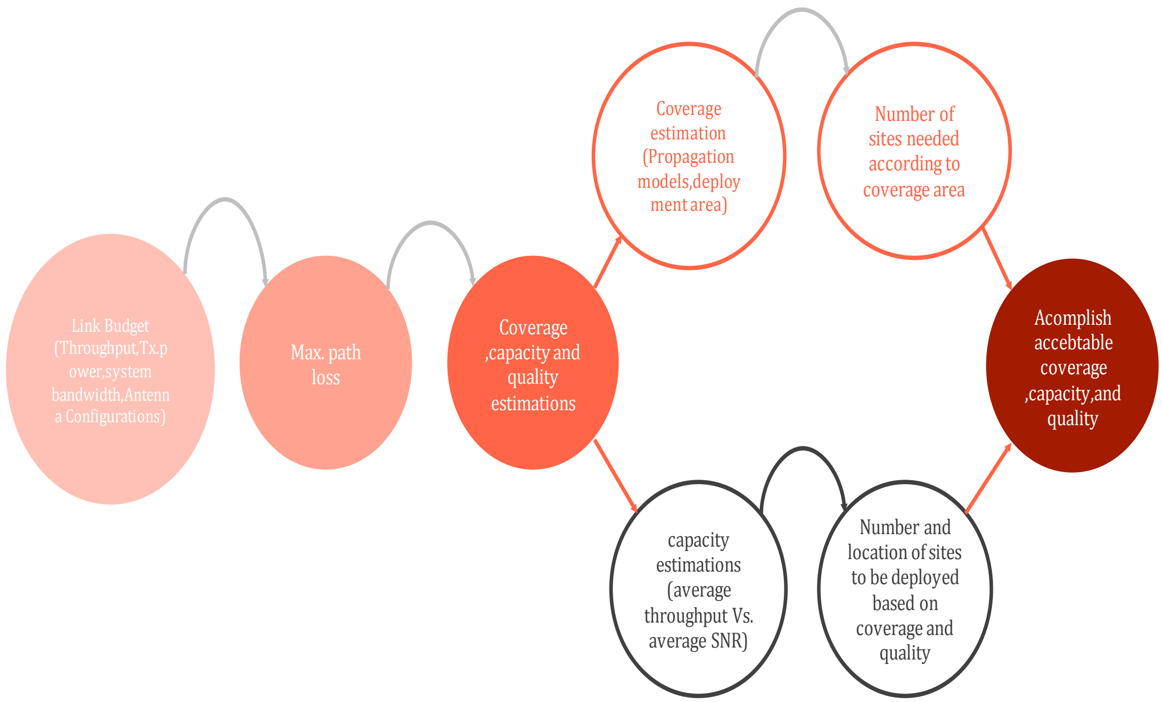


Figure3.3: LTE Dimensioning

3.3.3 LTE Detailed Planning

To make effective detailed planning, the information gathered from the initial planning- such as exited base station of the sites, coverage predictions and capacity targets are required ,it is important that the planned area has actual propagation data, as well as the information on the radio network requirements to make a detailed predictions taking into account the type of the antennas used ,terrain ,the clutter used in the around area ,this conclude a better estimation of the sites in coverage than the initial planning as previously discussed .

This produces is more accurate, detailed plan of the area and determines the number of the sites. What follows is some predicted outputs of this stage:

Model Tuning: This process modifies theoretical propagation model so that it closely meets the actual propagation environment. This process can be done by using the CW (carrier wave) Measurements. Then, Site collection: this is a problem in all cellular systems, in this process the needed sites are selected from the candidates .and find the KPI (Key Performance Indicator) for capacity and coverage. Capacity and Coverage Planning in LTE: The goals of this process are supporting the required user's traffic, achieving low blocking a delay in the network; ensure the availability of the services in the desired area.

Configuration Planning: The main aim of this process is to enable the planner to determine the E-UTRAN configuration .This would include determining the correct configuration of the cells, eNB and their features sets. Parameter Planning: Some tuning of the network parameters, this will enable the planner to identify the maximum intensity on the cells and other thresholds. Site locations (and Height) ,antenna directions and down tilts , and finally frequency Plan .

3.3.4 LTE Optimizing

This is the most important phase while making LTE plan. Further details are discussed in this phase such as collecting data to be used in tuning the network like throughput in each site and of the parameter settings (e.g. frequency plan, tilt, azimuth antenna orientation).

There are different fields to be optimized, such as coverage, capacity, interference, configuration and parameters. Outputs produced in this stage are: final list of sites and site locations (and height), optimized antenna directions and down tilt, an optimized neighbor cell lists for each site, mobility (handover and cell reselection). Parameters for each site are an optimized frequency plan, and detailed coverage predictions (e.g. Signal Strength, Signal Quality Best CINR, Best Server Areas, Uplink and Downlink Throughput).

3.4 Project Planning Workflow Design

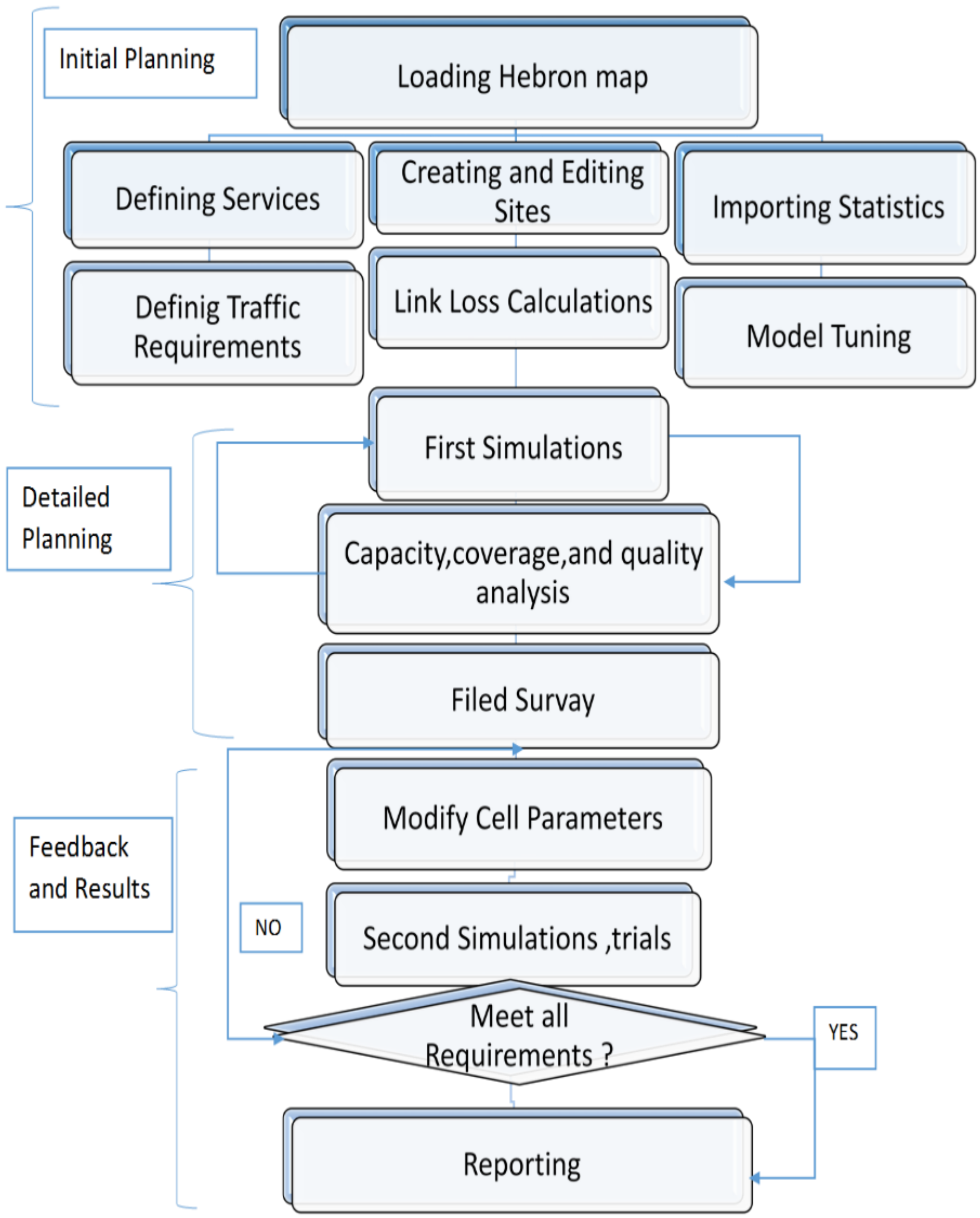


Figure 3.4: Project Network Planning Process

3.4.1 Input Data Preparation

Preparing input data for planning process which was simplified previously in Fig.3.4

3.4.1.1 Digital Map for Hebron City

In this project, it is worth mentioning that the map of the area is badly needed in the process of planning for coverage, prediction, topological data (terrain), morphological data (terrain type), building location, height, and resolution: urban areas, rural areas, or low urban.

3.4.1.1.1 Hebron Background Information

This is a map of Hebron, a Palestinian city that has an area of 42 km^2. Hebron is located to southern part of Jerusalem. The average height of the city is about (927) meters above sea level and there are many mountains in Hebron area [Wikipedia].

Figure 3.5: Hebron City from Google Earth

3.4.1.1.2Hebron Polygon with Geographic Area

This map shows Hebron polygon which is the area of Hebron City without its villages. This polygon is what this project planners hope to cover with 70-80 sites. Planners should take coverage, capacity and quality into account. It's all about trials; it's like a hard game ,change azimuth ,tilt, height and power ,but keep looking at clutter, and at Hebron area mountains and Villages as shown in the grid legend below .Heights range from 799.0000 till 1022.999 meter .

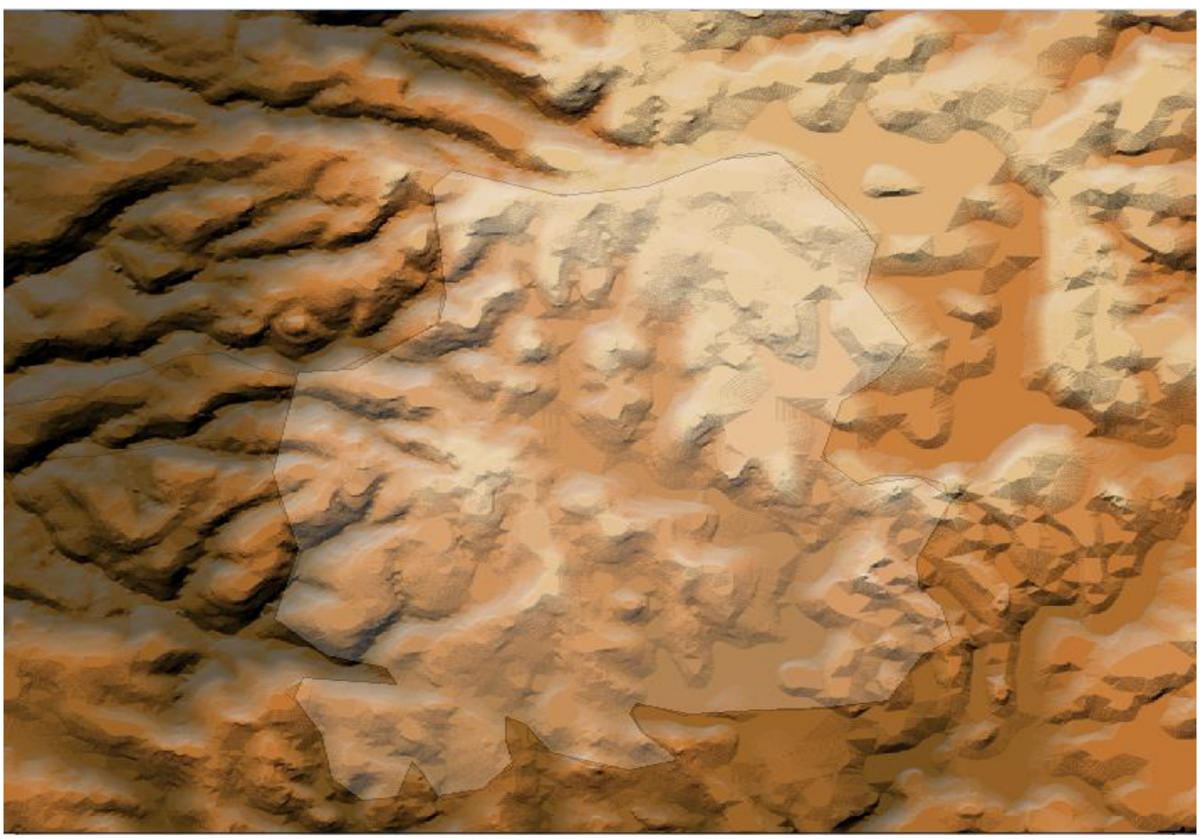


Figure 3.6: Hebron polygon (almost 30Km^2)

3.4.1.1.3 Hebron Clutter (Population Distribution)

This map shows Hebron polygon clutter which means the distribution of population for Hebron city. The most color is green which classifies Hebron city as a Low Urban area; Orange means its semi open (Not many population).This map is used in the planning process. When planners want to cover a specific area, they must consider clutter. Some times when I add more and more sites, it causes interference, so there is a need to remove some of them, and so there is no need to cover semi open areas, as sites are removed from semi open ones.

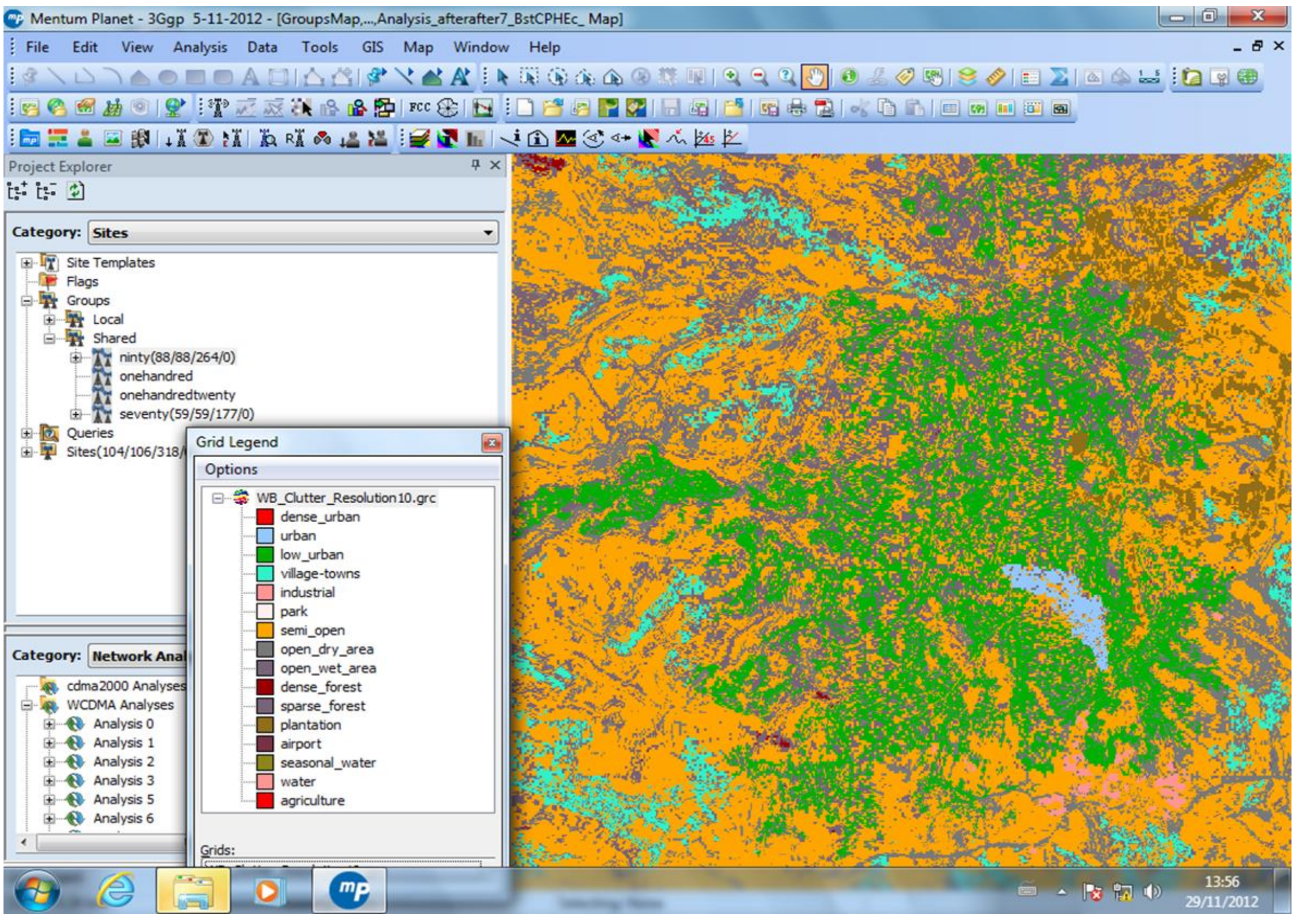


Figure 3.7: Hebron Clutter

3.4.1.2 Antenna Configurations

There must be a Logical concept containing antenna radiation pattern, antenna gain, frequency band. This antenna is DBXLH_6565C_VTM, and was chosen carefully since it is the latest of its kind and chosen by operators and planners. This antenna radiation pattern made it special in terms of its beam forming and very small side lobes.

Table 3.1: DBXLH_6565C_VTM parameters specifications [ANDREW]

Frequency (MHz)	824 - 896	870 - 960	1710 - 1880	1850 - 1990	1920 - 2180
Polarization	$\pm 45^{\circ}$	$\pm 45^{\circ}$	$\pm 45^{\circ}$	$\pm 45^{\circ}$	$\pm 45^{\circ}$
Gain (dBd/dBi)	14.6/16.7	15/17.1	15.7/17.8	16.1/18.2	16.2/18.3
Azimuth BW (Deg.)	68	65	65	63	62
Beam Tilt (Deg.)	0-8	0-8	0-6	0-6	0-6
VSWR	<1.5:1	<1.5:1	<1.5:1	<1.5:1	<1.5:1
Impedance (Ohms)	50	50	50	50	50
Max. Input Power (Watts)	250	250	250	250	250

3.4.1.1.3 DBXLH_6565C_VTM Model Number Sequence

Each antenna is independently capable of field adjustable electrical down tilt, interlaced dipole technology providing for attractive, low wind load mechanical package, and provides two independent dual pol antennas. Abbreviations are specified in fig.3.8.

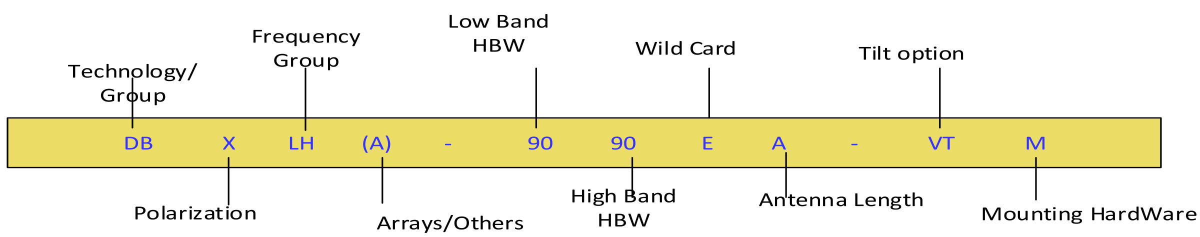


Figure 3.8: Antenna Abbreviations [ANDREW BS Antennas]

Being more specific for the project antenna as what will be shown next and in Fig.3.9:

DB= stands for Dual Band X =dual polarization

LH =Frequency Group (L=800/900MHZ (824-960) H=Wideband UMTS (1710-2180))

C=Antenna Length, C=102.4 in (2.6m) VT=Variable Electrical Tilt

M=Standard Down Tilt Mount and Pipe Mount

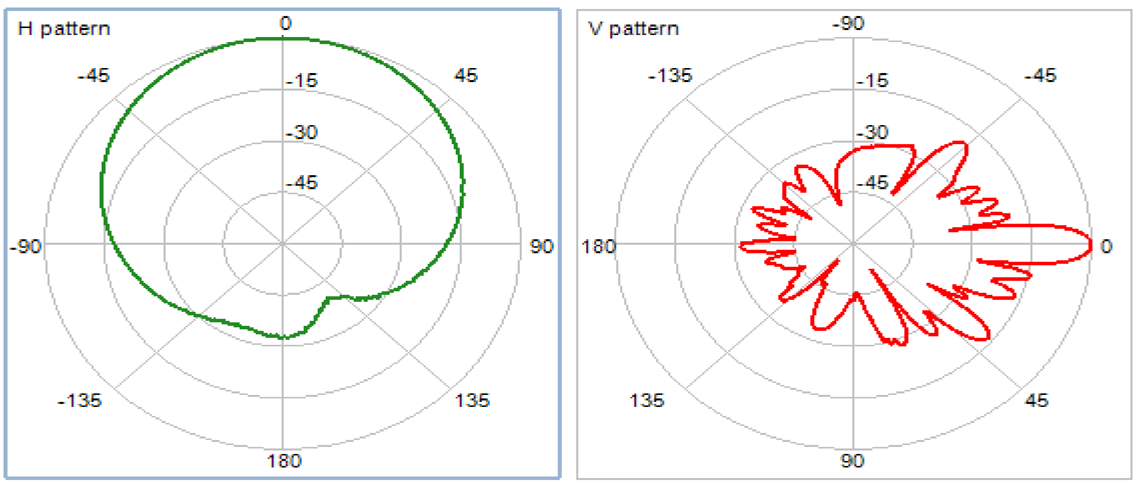


Figure 3.9: Antenna Azimuth Pattern [ANDREW BS Antennas]

3.4.1.3 PGM Propagation Model

The Planet General Model is a good propagation model to use for macro-cell planning. It is best used for frequencies between 150 and 2000 MHz where the distance between the transmitter and the receiver ranges between 1 and 100 kilometers. Ideally, when using this model, the base station antenna heights should range between 30 - 1000 meters, and the mobile station antenna heights should be between 1 and 10 meters.

3.4.1.3.1 Standard Propagation Model

The received signal strength at the mobile is given by the following equation [37]:

$$P_{RX}=P_{TX}+K_1+K2Log(d)+K3Log(H_{eff})+K_4Diffraction+K_5log(H_{eff})Log(d)+K_6(H_{meff})+k_{ClUTTER}$$

Eq. (3.3)

Where

P_{RX} is the receive power in dBm

P_{TX} is the transmit power (ERP) in dB

K_1 is the constant offset in dB

K_2 is the multiplying factor for log (d)

With the two-piece model, both K_1 and K_2 can be assigned two sets of values. One set is used for d< distance and the other for d> distance, where distance is the distance in meters away from the base site specified in the Model Editor.

K_3 is the multiplying factor for log (H_{eff}) .It compensates for gain due to

Antenna height.

K_4 is the multiplying factor for diffraction calculation

K_5 is the Okumura-Hata type of multiplying factor for log (H_{eff}) log (d)

K_6 is correction factor for the mobile effective antenna height gain (k_6H_{eff})

d is the distance, in meters, of the receiver from the base site

H_{eff} is the effective height of base site antenna from ground

Diffraction is the value calculated for loss due to diffraction over an obstructed path. The value produced is a negative number so a positive multiplication factor, K4 is required.

$K_{CLUTTER}$ is the gain in dB for the clutter type at the mobile position in Planet DMS. In Mentum Planet, $K_{CLUTTER}$ represents a loss.

H_{meff} is the mobile effective antenna height

The correlation factor calculations determine the model components that are similar with the actual path loss. A high correlation value (1) between a model component and path loss implies high similarity, indicating that the component can model path loss well.

Comparing this propagation model to Okumura Model it also has limits that are :

1) Frequency = 150 MHz to 1920 MHz
2) Mobile station antenna height: between 1 m and 10 m
3) Base station antenna height: between 30 m and 1000 m
4) Link distance: between 1 km and 100 km.

Okumura's model is one of the most widely used models for signal prediction in urban areas. This model is applicable for frequencies in the range 150 MHz to 1920 MHz (although it is typically extrapolated up to 3000 MHz) and distances of 1 km to 100 km. It can be used for base station antenna heights ranging from 30 m to 1000 m.

The Okumura model is formally expressed as [Wikipedia]:

$$L = L_{FSL} + A_{MU} - H_{MG} - H_{BG} - \sum K_{correction} \qquad \text{Eq.(3.4)}$$

where,

L = The median path loss. Unit: Decibel (dB)

L_{FSL} = The Free Space Loss. Unit: Decibel (dB)

A_{MU} = Median attenuation. Unit: Decibel (dB)

H_{MG} = Mobile station antenna height gain factor.

H_{BG} = Base station antenna height gain factor.

$K_{correction}$ = Correction factor gain (such as type of environment, water surfaces, isolated obstacle etc.)

Comparing PGM to Okumura-Hata model ; the Hata-Okumura model is best suited for large cell coverage (distances up to 100 km) and it can extrapolate predictions up to the 2GHz band. This model has been proven to be accurate and is used by computer simulation tools. Here is the analytical approach to the model[Wikipedia]:

$$PL = 69.55 + 26.16 \log(f) - 13.82 \log(ht) - a(hm) + [44.9 - 6.55 \log(ht)] \log(d) \text{ dB} \qquad \text{Eq.(3.5)}$$

$$a(hm) = [1.1 \log(f) - 0.7]\, hm - [1.56 \log(f) - 0.8] \text{ dB}$$

where f - operating frequency (MHz)

ht - transmitting station antenna height (m)

hm - mobile unit antenna height (m)

a(hm) - correction factor for mobile unit antenna height (dB)

d - distance from transmitting station.

3.4.1.4 BTS Type (RBS 6000 ERICSON)

RBS 6000 supports all-common frequencies for GSM, WCDMA, and LTE in virtually any combination .the RBS 6000 is the first mainstream commercial product to include LTE .for the operator, this means that timing becomes less critical. Coverage and capacity can be expanded remotely using activation keys. This RBS gives the ability to expand the capacity in each technology related to the market demand.

3.4.2 Project Planning Process

This project planning process described in what will be followed and more specified through this project block diagram in Fig. 3.4. After locating Hebron Polygon area and importing sites, this project team will start editing sites and cells, and of course adding and modifying sites manually, and site by site.

3.4.2.1 Project 3G and LTE Frequency Bands

Defining service and traffic requirements ,bit rate and bearer service type are assigned to each service.In the project it has planned to serve 50K user and 1Km cell radios. After defining service and traffic requirements, this project team will match the default propagation models to the measurements, and then tuning functions per cell basis. This project team will work on several frequency bands to get results to make reasonable comparisons.

WCDMA Carrier Number	Carreier Name	Center Frequency MHz	Noise (dB)	BW (MHz)	Standard
1	Band 1	955	4	5	Rel.99
2	Band 2	1755	4	5	Rel.99
3	Band 3	2112	4	5	Rel.99

Table 3.2: WCDMA Frequency Bands

LTE Carrier Number	Carreier Name	DL .Center Frequency MHz	UL. Center frequency MHz	BW (MHz)	Standard	MIMO
1	Band 1	955	900	5	LTE FDD	4X4
2	Band 2	2595	2620	5	LTE FDD	4X4
3	Band 3	1910	1870	5	LTE FDD	4X4
4	Band 4	2100	2120	5	LTE FDD	4X4

Table 3.3: LTE Frequency Bands

3.5 Mentum Planet Planning Tool

Mentum Planet is a wireless network planning & optimization software that offers the ability to design better networks through quality engineering solutions for the networks, Mentum Planet provides you with all the tools you need to accurately design, analyze, and optimize wireless networks.

There are main features of Mentum Planet, below is a list of some of this features [37] :

1) Project Explorer: organizes all components of a project into a hierarchical structure, enabling you to easily manage all project-related data including sites, network analyses, network data, and surveys.

2) Site Editor: brings together all the parameters you need to specify when defining base station technologies, sites, and sectors.

3) Traffic Map Generator: Using the Traffic Map Generator, you can create traffic maps based on various sources of data.

4) Interference Matrix Generator: analyzes the potential for co-channel and adjacent-channel interference in your wireless network. If required, you can include traffic map information in the interference matrix calculations.

5) Network Data Import Wizard: You can import switch statistics for use in

traffic maps, interference matrices, neighbor lists, and other Mentum Planet analysis tools.

6) Performance-related: data you can import includes dropped call rates, blocked call rates, and traffic levels. The Network Data tool can also produce a thematically mapped display of the imported data by sector.

7) Survey Data tool: Using the Survey Data node in the Project Explorer, you can import, manage, and visualize survey data.

8) Subscriber Settings: dialog box contains all the parameters you need to define the characteristics of your network subscribers including the mobile equipment and services they use as well as the Quality of Service threshold.

9) MapInfo Professional : where Mentum Planet includes a full version of MapInfo Professional, an industry standard mapping tool that gives you access to a full suite of raster and vector analysis tools, cartographic-quality tools.

3.6 Hebron City WCDMA and LTE Detailed Planning

At the end of last semester ten sites initial planning were discussed. Not so many results planners can come up with only ten sites, so more sites are needed .Same coverage for both as in the initial planning the same frequency for both technologies are used. LTE until now has gotten the best quality and capacity; 3G provided a very good coverage but less capacity and not very efficient quality.

Hebron city detailed planning; WCDMA will study planning in 900MHz, 1800MHz, and 2100MHz with 5MHz bandwidth .However, LTE will be deployed in those same bands and within 2600MHz band, with 5MHz bandwidth and 4x4 MIMO.

3.6.1 Tuning Tilt and Azimuth for this Project

In an interference-limited WCDMA and LTE system, network planning and the optimal installation of infrastructure component are important issues. During the network planning process, it is very important to identify the key network design factors and define how to take them into account to achieve optimally performing networks This is not only to increase system capacity but also to allow for smooth network operations, modern antennas provide adaptation mechanisms with which the antenna down-tilt angle can be adapted to the various needs of the network.

This is dependent on the locations of the base station sites, the resulting cell sizes, and the current traffic situations. The simulations were presented in this chapter before showed basic effects on network coverage and capacity due to changes in the antenna down-tilt and up-tilt angle configurations.

The most effective parameter in network optimization is the antenna tilt. Antenna tilts need to be set such that the traffic within the own cell is served with maximum link gain ,but the same time the interference in the neighboring cells is minimized .the possible tilt angles are typically restricted because of technical and civil engineering reasons . Especially in the case of collocated sites with multiband antennas, there might be strong restrictions on the possible tilt angles to be taken into account during optimization. Antenna beam width and tilt improves the coverage of the planned area. Proper tuning of beam width and tilt gives better coverage and performance. With the tilt, we direct irradiation further down (or higher), concentrating the energy in the new desired direction.

The basic rule of designing antenna tilt is that the height of the antenna should be selected with respect to the wanted amount of cell range. When the antenna is tilted down, we call it 'down tilt', which is the most common use, in this project the tilt with positive values that were used are 4,and 7 which means down tilt .In addition, 0 means with almost no tilt , up tilt which is negative, such using -4, and -7 degree in this project, which will be cleared next through figures .

Applying tilt to zero degree for some sites means that it is almost without tilt; that is the default part. Figure 3.10 below shows the zero tilting. However, in sites modifications as seen in appendix B, when the site tilt is set to zero this means that there is a need for the coverage to be almost straight and this means that the area that planers are covering should be seen clearly from all sides and not to have valley beside a mountain because it won't be covered with zero tilt.

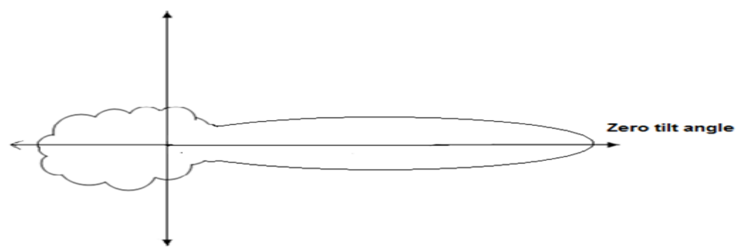


Figure 3.10: Zero Tilt Angle

When the tilt is set to be positive, this is down tilt .For example, site as was noticed in appendix B for site 21 for WCDMA at 900MHz the tilt was changed from 0 to 7, this means that the area was not covered when tilt was zero and it was on a mountain so to cover lower areas, down tilt is needed, the down tilt angle is as figure 3.11 clarifies. Moreover, the majority of the radiated power is concentrated within the sector; the reduction of the power towards the horizon avoids interference problems with the adjacent cells.

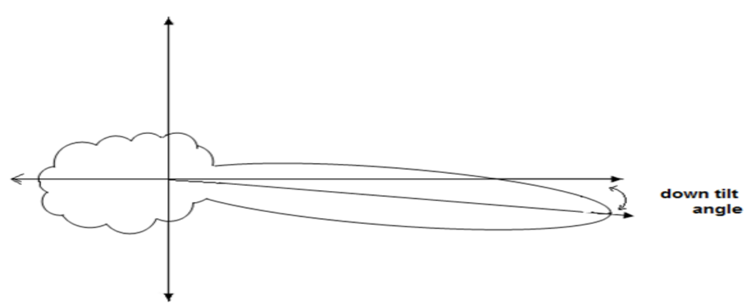


Figure 3.11: Down Tilt Angle

When the tilt is negative, we get up tilt .For example, site 8 in WCDMA at 900MHz, this site tilt was changed from 0 to -7 and same principle for LTE sites. This means that this site was in a valley and I need to cover a higher area around our coverage so the tilt angle should be up. This figure 3.12 below shows the up tilt angle.

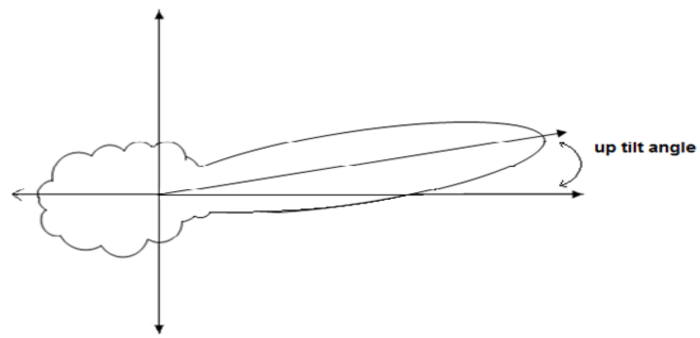


Figure 3.12: Up Tilt Angle

The tilt is used when we want to reduce interference and/or coverage in some specific areas, having each cell to meet only its designed area. The default tilt is slightly larger in smaller cells because these are cells are in dense areas, and a slightly smaller coverage loss will not have as much effect as in larger cells. A good tilts choice maintains network interference levels under control, and consequently provides best overall results.

Optimization of azimuth angles of sectored sites is for great importance in particular in case of antennas with rather small horizontal beam width .in this case the difference between the antenna gains in the direction of the main lobe and the half-angle between neighboring sectors is comparatively large and cell of neighboring sites might need to be adjusted such that maximum coverage is achieved .it is observed that during optimization, azimuth changes are in particular introduced in order to reduce coverage problems for possible azimuth angles ,typically even stronger restrictions apply than for the tilt angles .Moreover, in this project the planners start the azimuth angles with (0,120,240),then some changes on these values to have better coverage in all directions of the site , or in a specific region around the this site .

Through this project, some sites needed four sectors and others needed only three, this depends on the area, planners cannot give azimuth angles with the same values for all sectors; because when sectors of different sites have same azimuth angles LOS and interference occurrence will be with higher probability than when close sectors have different tilt and azimuth angles.

3.6.2 WCDMA (Rel.99) Detailed Planning

Although the overall dynamics of CDMA markets are overshadowed by the migration to LTE, CDMA operators continue to upgrade their networks to provide capacity for higher numbers of bandwidth-intensive data services, as well as escalating traffic load.

3.6.2.1 WCDMA (Rel.99) at 900MHz

The availability of having multiple solutions with proper interworking eventually eases the deployment of WCDMA at 900 MHz while preparing the future evolutions on GSM networks toward new technology developments.

Moreover, such solutions associated with WCDMA deployments also provide a significant opportunity for many operators to upgrade their existing networks to a more modern radio access method, allowing them to offer an enhanced service quality. The project 900MHz workflow design is shown in fig.3.13 below.

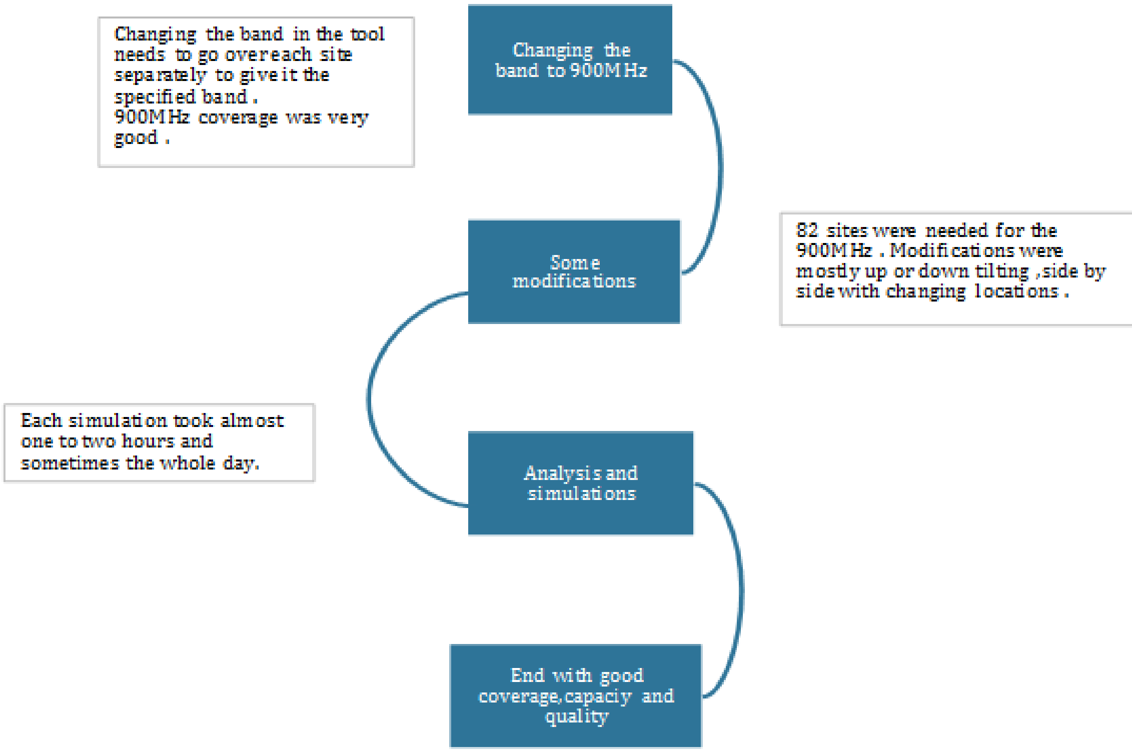


Figure 3.13: WCDMA 900MHz Workflow

3.6.2.1.1 WCDMA Coverage at 900MHz

Coverage benefits of 900MHz spectrum were excellent; it provides a very efficient coverage with less number of sites while not many modifications needed. Eighty two (82) sites were used through our planning process; coverage at 900MHz was not that difficult, but this project planner made so many analysis and modifications as in table 3.11 in appendix B. This figure below shows the coverage of final modifications with parameters as shown in table 3.4 in appendix A ,having blue zone with(-70dBm) strength which is the best .

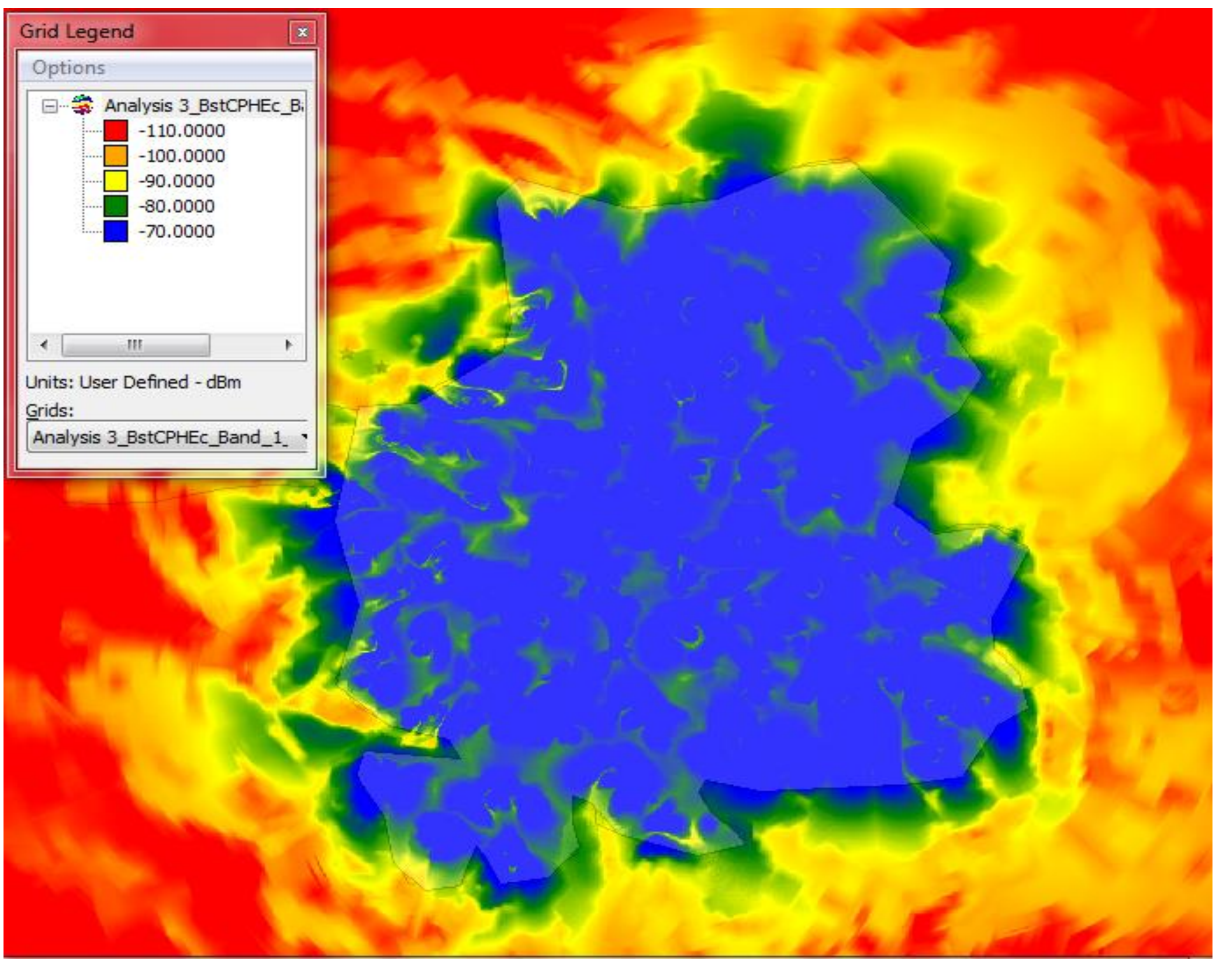


Figure 3.14: WCDMA Coverage at 900MHz

3.6.2.1.2WCDMA Quality (C/I) at 900 MHz

In Order to get the wanted quality, signal strength needs to be greater than interference by a certain amount; higher data rates requires higher CIR (Signal to Interference Ratio).The project planners tried to minimize interference as much as they can , especially when having large number of sites , but planners should also consider not to have LOS between antennas. Modifications were mostly changing azimuth and keep a reasonable distances between sites ,also reduce power in middle areas as much as possible. The less the negative the better the quality, (-12dB) which is the orange zone, (-8dB) in yellow zone are the best quality for 900MHz, as the figure bellow clarifies.

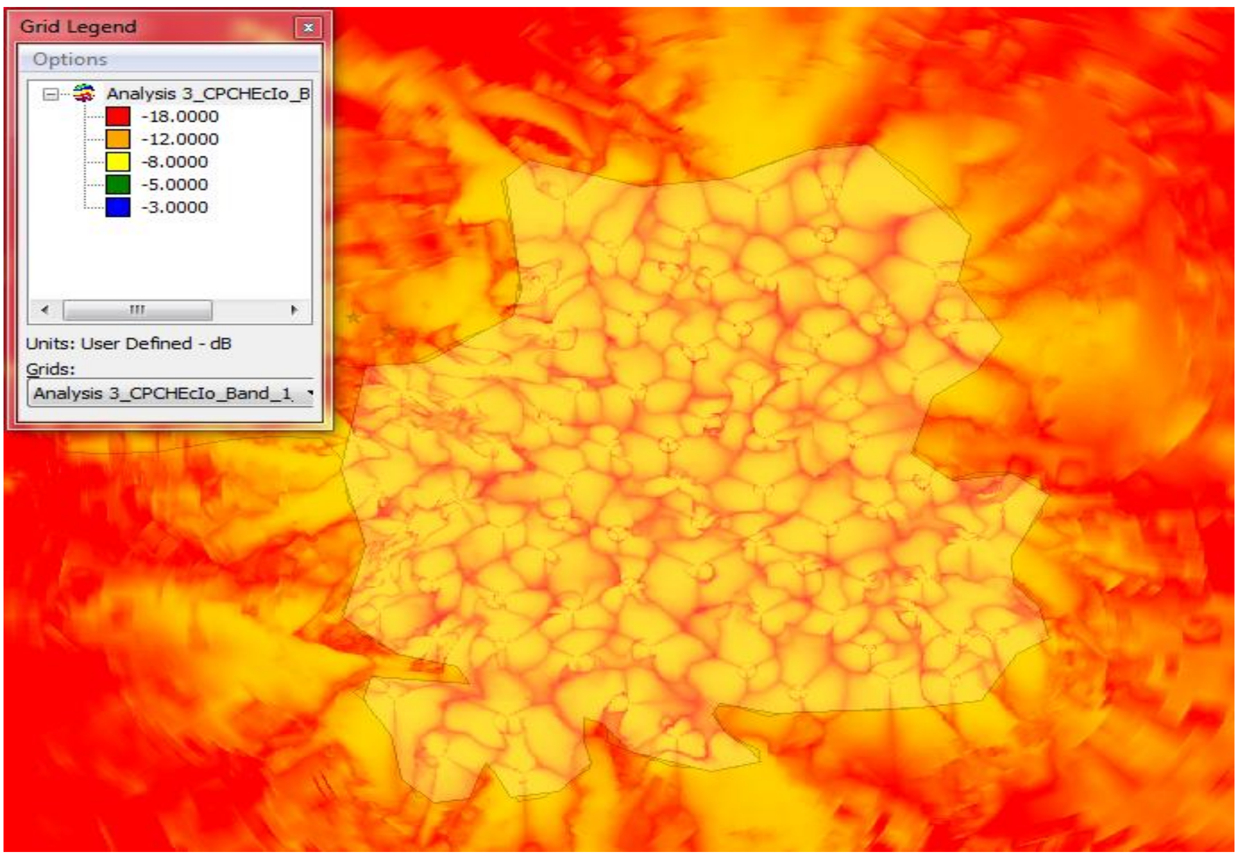


Figure 3.15: WCDMA C/I at 900MHz

3.6.2.1.3WCDMA DL. Capacity at 900MHz

Improvements on CIR leads to improvements on capacity and this was proved according to Shannon formula. Project planners tried to get the Max. data rate for WCDMA as much as possible , tilt was changed , CIR was improved , modulation techniques was used according to the area ; QPSK ,16QAM … etc. , the tool chooses the best modulation technique to apply within the area to be covered . This figure shows the Max. DL. achievable data rate, light green zone with 384Kbps, and little red zone with 128Kbps.

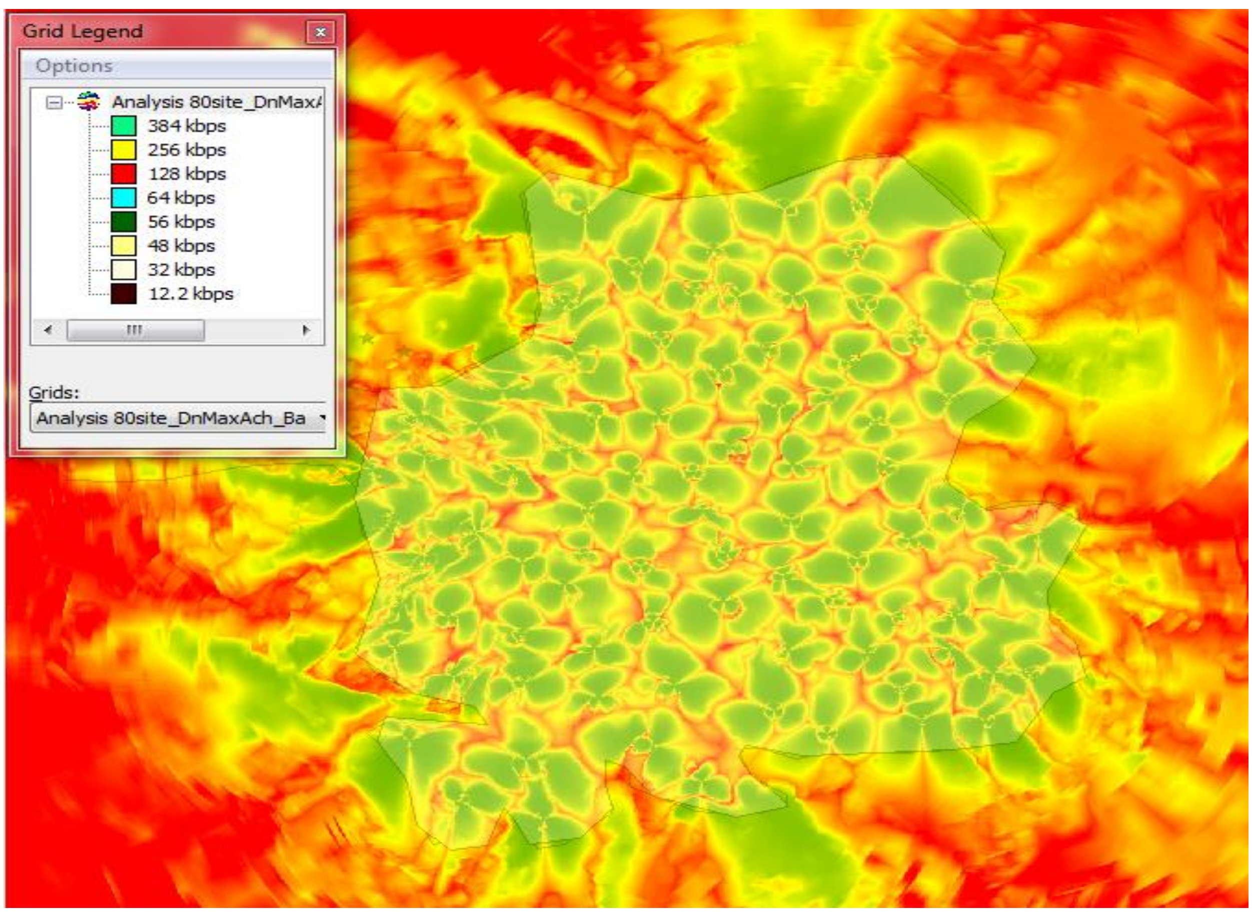


Figure 3.16: WCDMA Max. Achievable Data Rates at 900MHz

3.6.2.2 WCDMA (Rel.99) at 1800MHz

The 1800 MHz frequency is widely available, and re-using the existing GSM 1800 MHz networks enables fast rollouts. The 1800 MHz band provides a good blend of bandwidth, which determines the data rates, and coverage that allows re-use of the 1800 antenna site grid. The workflow design for 1800MHz was as shown in fig3.17 below.

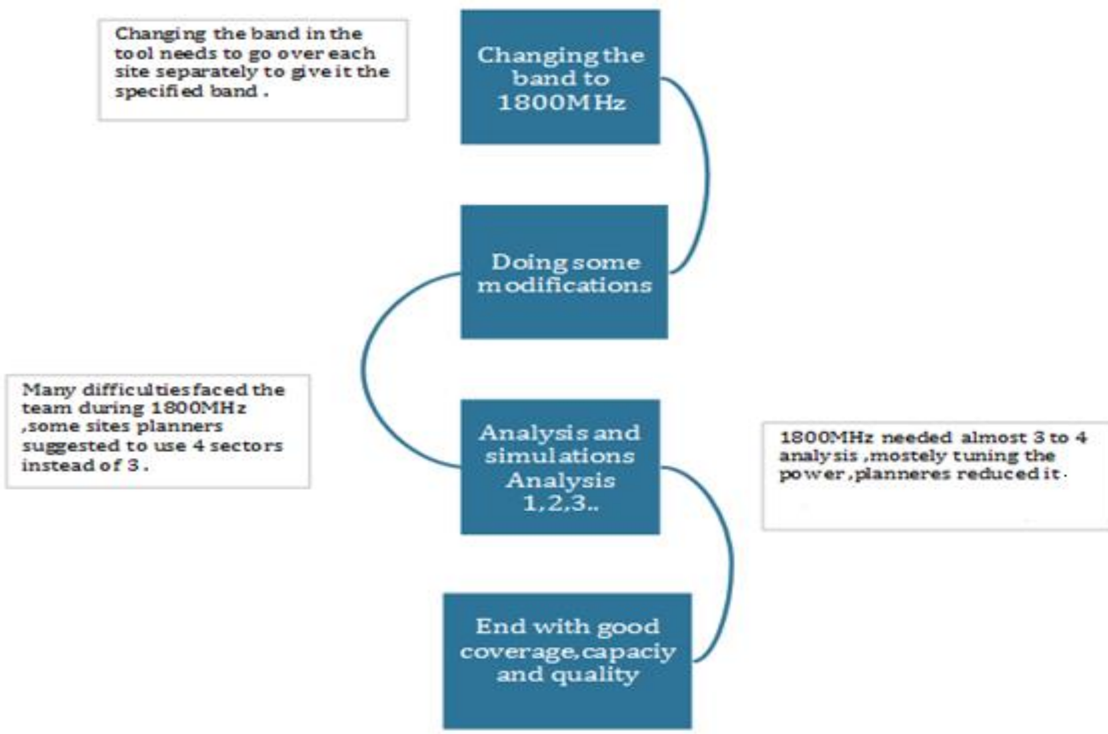


Figure 3.17: WCDMA 1800MHz Workflow

3.6.2.2.1 WCDMA Coverage at 1800MHz

Coverage in the 1800MHz was more difficult than 900MHz; another site was added and more sectors for the sites were added to enhance the coverage especially in South-west Hebron. This figure shows the final coverage that this project planner could come up with after changing the tilt and adding sectors as specified in appendix B table 3.12 ,and the final values of the eighty four (84) sites are also cleared in appendix A table 3.5 . (-70dBm) which is the blue zone was the dominant.

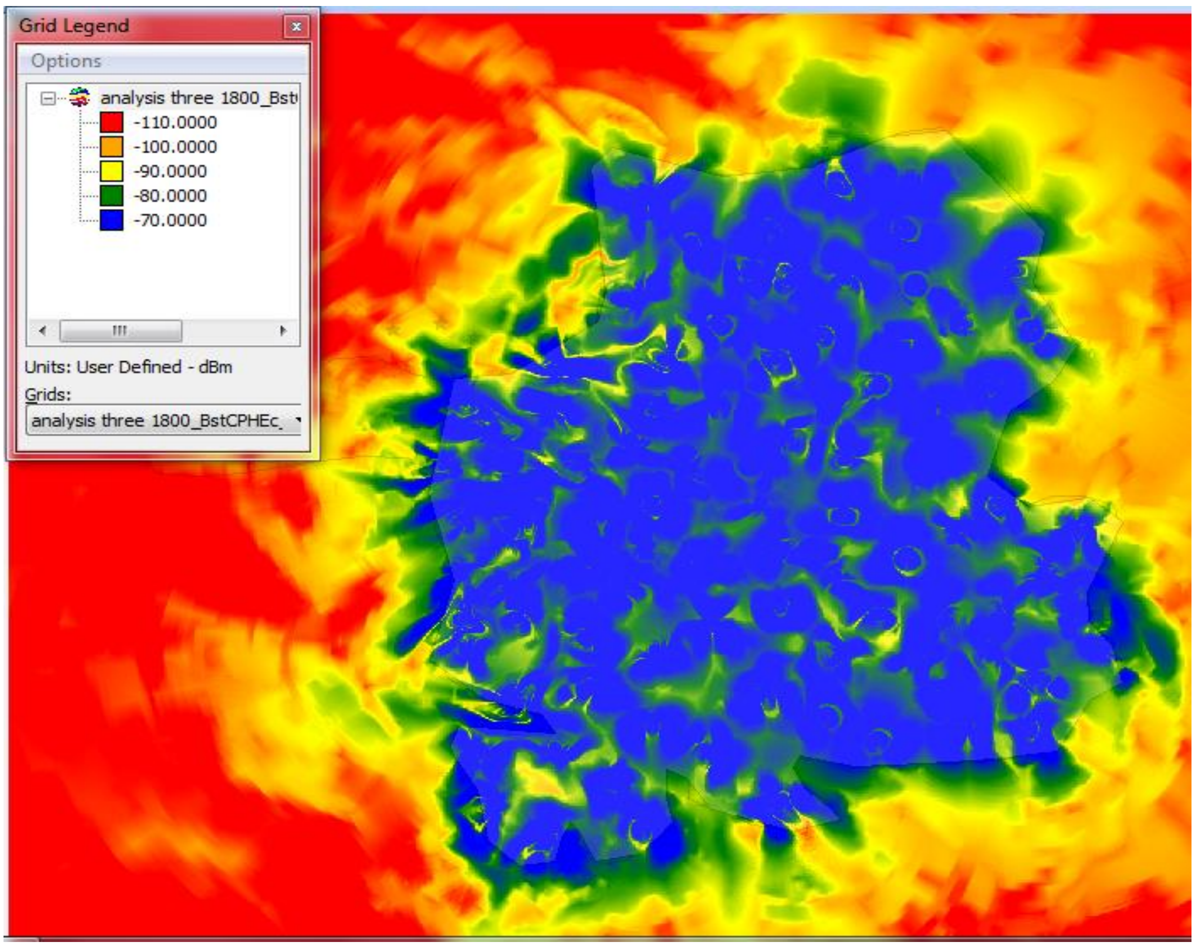


Figure 3.18:WCDMA Coverage at 1800MHz

3.6.2.2.2WCDMA Quality (C/I) at 1800MHz

This figure shows the final analysis of CIR for 1800MHz; the ultimate solution was to reduce power to 40 and 30 dBm because the first analysis showed many interferences with 47dBm power. Some areas as some would notice reached (-5 dB) which is the light green zone covering the areas that have sites with four sectors, others reached (-18,-12,-8 dB) red, orange and yellow zones respectively.

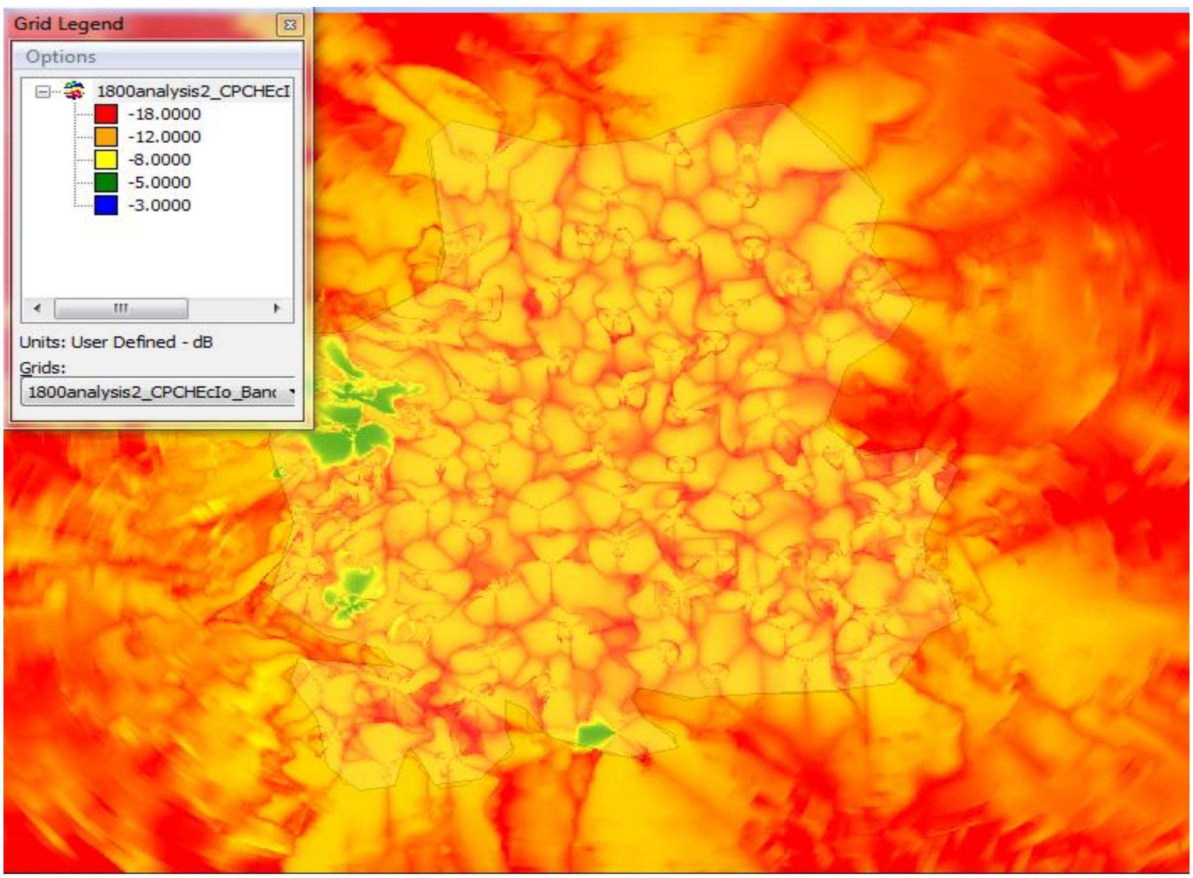


Figure 3.19: WCDMA C/I at 1800MHz

3.6.2.2.3 WCDMADL. Capacity at 1800MHz

This figure shows the max data rate that could be achieved; it's very much related to CIR results , dark blue areas with 1291.5Kbps is in the area where planners used four sectors for the site instead of three. It also reached 384Kbps,465.5Kbps,256Kbps with light blue, light green, and yellow respectively .

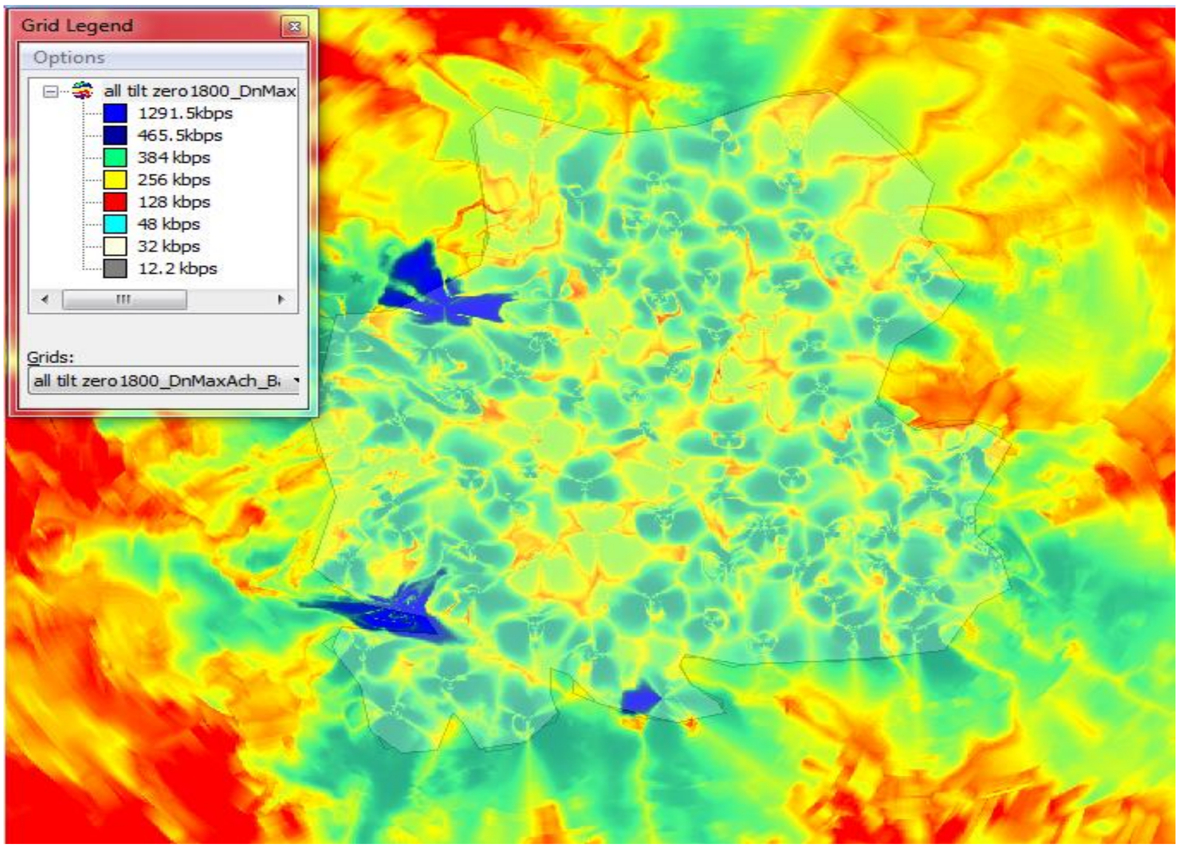


Figure 3.20: WCDMA Max. Achievable Data Rates at 1800MHz

3.6.2.3 WCDMA (Rel.99) at 2100MHz

More data rate will be achieved than 1800 and 900 MHz, as noticed as planners go up the frequencies the number of sites are becoming more, and the achievable data rate in also increasing. Deploying and planning with 2100MHz was much easier than 1800MHz with also less site modifications as cleared in appendix A table 3.6 and final values for all site parameters can be found in appendix B table 3.13. The workflow of 1200MHz planning is specified in figure 3.21 below.

The 2100 MHz band has provided increased capacity through new spectrum. 900 MHz reforming to WCDMA contributes through improved spectral efficiency and extended high bit rate coverage.

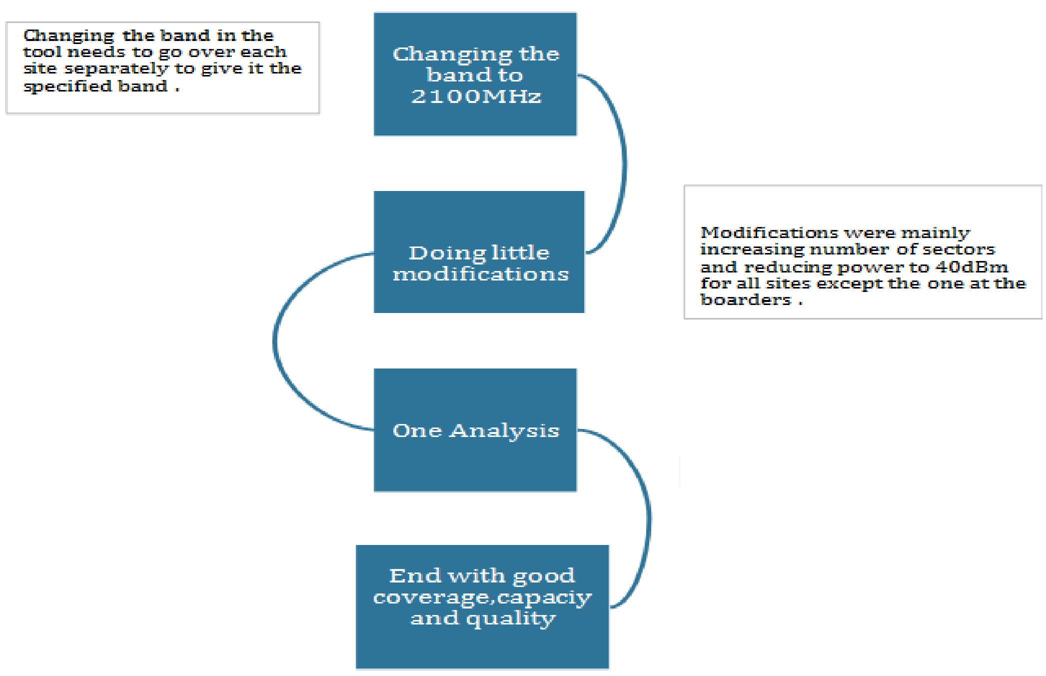


Figure 3.21: WCDMA at 2100MHz Workflow

3.6.2.3.1 WCDMA Coverage at 2100MHz

The figure below shows the 2100MHz coverage, blue zone for (-70dBm) and classified as good ,not so many modifications were done ,and it ended up with eighty five(85) sites modification. Table 3.13 in appendix B shows that mostly the tilt was changed for some areas and adding more sectors for others.

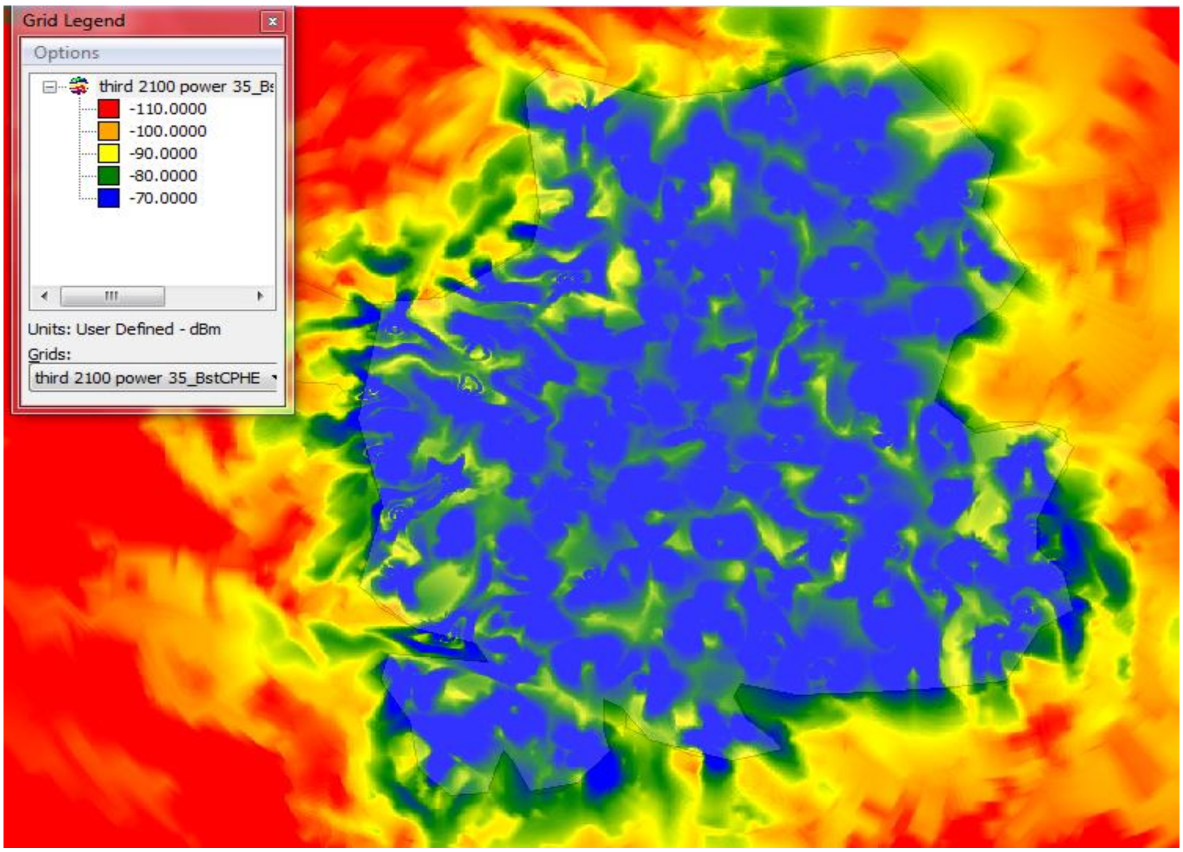


Figure 3.22: WCDMA coverage at 2100MHz

3.6.2.3.2 WCDMA Quality (C/I) at 2100MHz

Reducing power is the solution that this project planners did to minimize interference in most areas since increasing the number of sites exposes planners to more difficulties such LOS and interference plus noise which leads to reducing power for middle areas to 40dBm and keeps some sites at boarders with 47dBm.This figure shows CIR for 2100MHz; interference is reduced more and more; signal power is getting higher ,light pink with -1dB,dark blue with -3dB,green with -5dB etc.

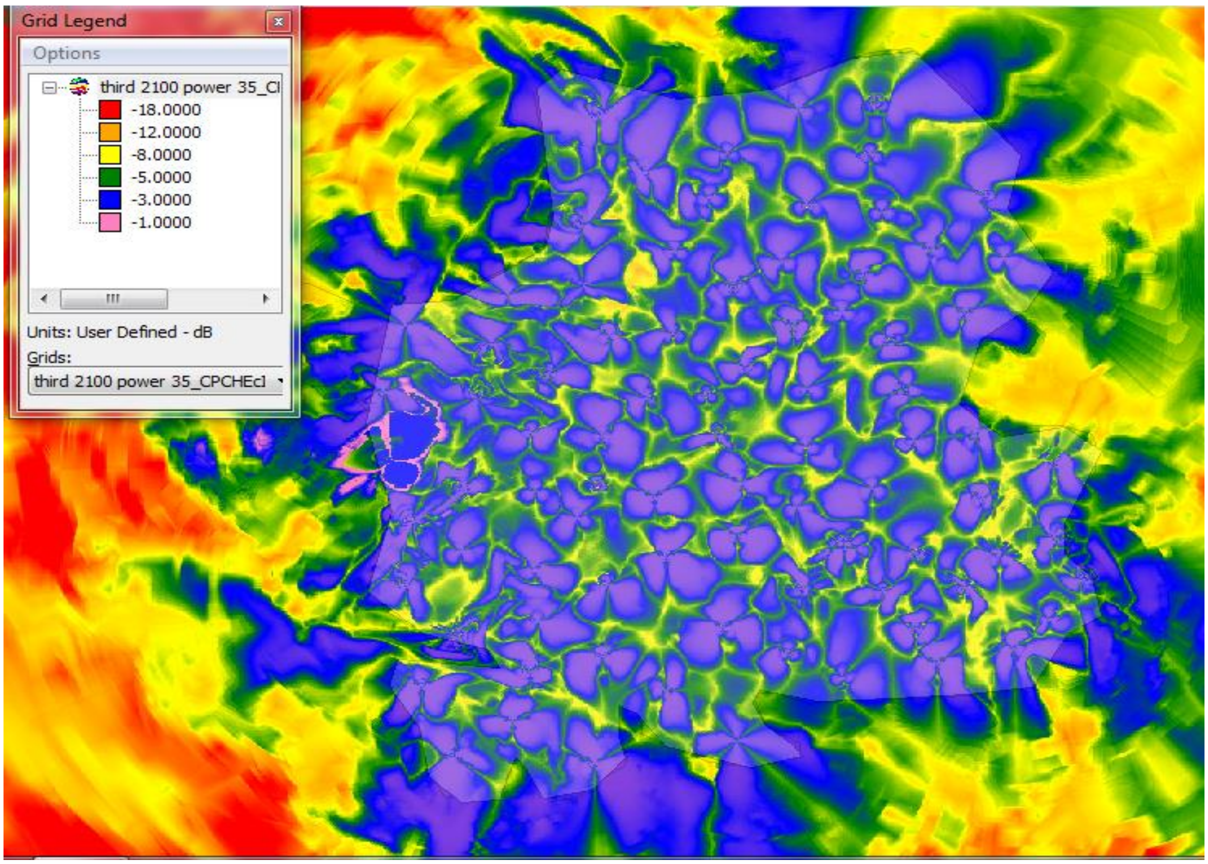


Figure 3.23: WCDMA C/I at 2100MHz

3.6.2.3.3 WCDMA DL. Capacity at 2100MHz

This figure shows the maximum achievable data rate at 2100MHz, light pink zoon provides 2094.5Kbps which is in west areas, and the purple zone provides 1291.5Kbps. Data rates in areas, that planners used four sectors, increased as cleared in the figure .On the other hand, green zone provides 871.0Kbps which is found mostly in middle areas.

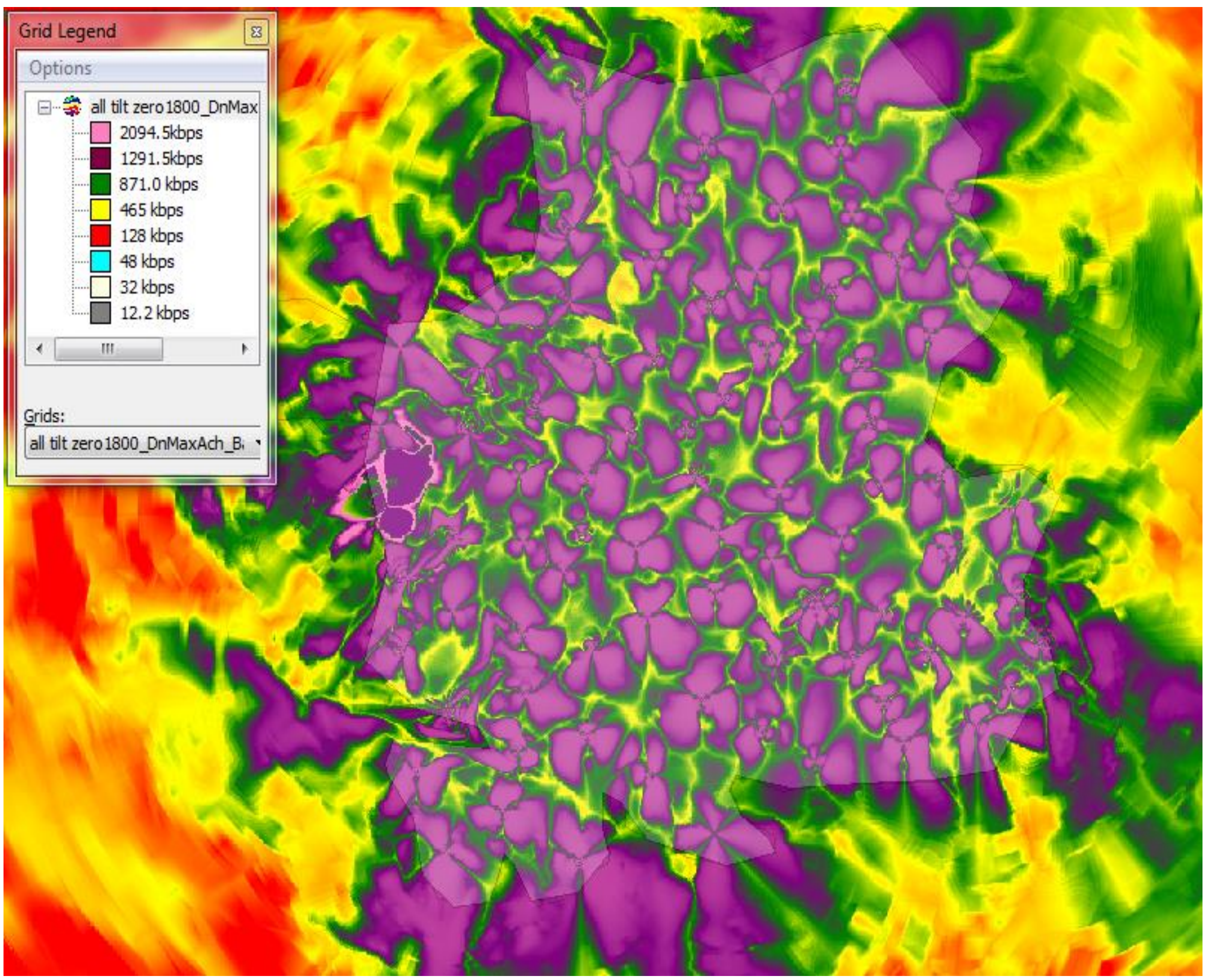


Figure 3.24: WCDMA Max. Achievable Data Rates at 2100MHz.

3.6.2.3.4 WCDMA Challenging Areas

WCDMA planning was also challenging, 900MHz gave the best coverage with not so many hard modifications, but the next frequencies were not that easy. Hebron City is known as a city full of mountains and there is some valleys at you saw in the geographical map cleared at the beginning of this project. Planners tried everything starting with azimuth tuning and ending with location change and tilt; up and down tilt was not that easy, when site is in a valley and surrounded with mountains planners need to make up tilt, etc.

This figure below shows the area planners found the most difficult through planning that is North-West and South-West of Hebron area. Final figures as stated before were after doing modifications and simulations over those areas to get the targeted results.

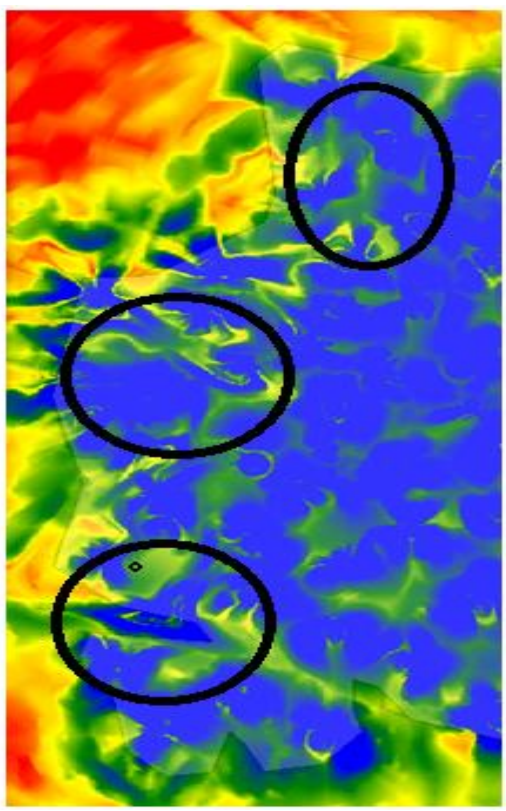


Figure 3.25: WCDMA Challenging Areas

3.6.3 LTE Detailed Planning

LTE has many spectral options. Frequency bands specified for LTE include 700MHz, 900MHz, 1800MHz, 2100MHz and 2600MHz. 900MHz and 1800MHz for LTE is one of the latest ideas to be implemented to avoid interference problems with existing GSM and 3G devices, and also allowing for the co-existence on the 900MHz and 1800MHz frequency bands of GSM, 3G and either LTE or WIMXA based 4G technology.

3.6.3.1 LTE at 900MHz

The 900 MHz band is ubiquitous and the most harmonized worldwide wireless telecommunication Spectrum band available today. It also has the benefit of increased coverage and subsequent reduction in network deployment costs compared to deployments at higher frequencies, making it a strategic spectrum band. Furthermore, 900MHz offers improved building penetration and is particularly well suited to supporting those regions that have a predominantly rural population.

In addition, with the improved spectrum efficiency, LTE deployment in the 900 MHz band would bring the highest capacity benefit and also provide operators the ability to deploy an LTE network with greater coverage at a much reduced cost compared to higher frequency spectrum hence provide a good mobile broadband data countrywide layer.

Finally, deploying LTE in 900MHz can also bring the additional cost and logistic benefits of being able to deploy LTE at existing GSM sites, as the coverage of GSM/LTE in 900MHz should be very similar.

3.6.3.1.1 LTE Coverage at 900MHz

LTE coverage at 900MHz was excellent with few analysis and modifications as shown in appendix A, table 3.7 and table 3.14 appendix B which clarifies final parameter values. Dark purple with -60dBm is the best and lighter purple with-75dBm.Sixty eight sites (68) were used to cover Hebron city which is less than WCDMA 900MHz coverage .

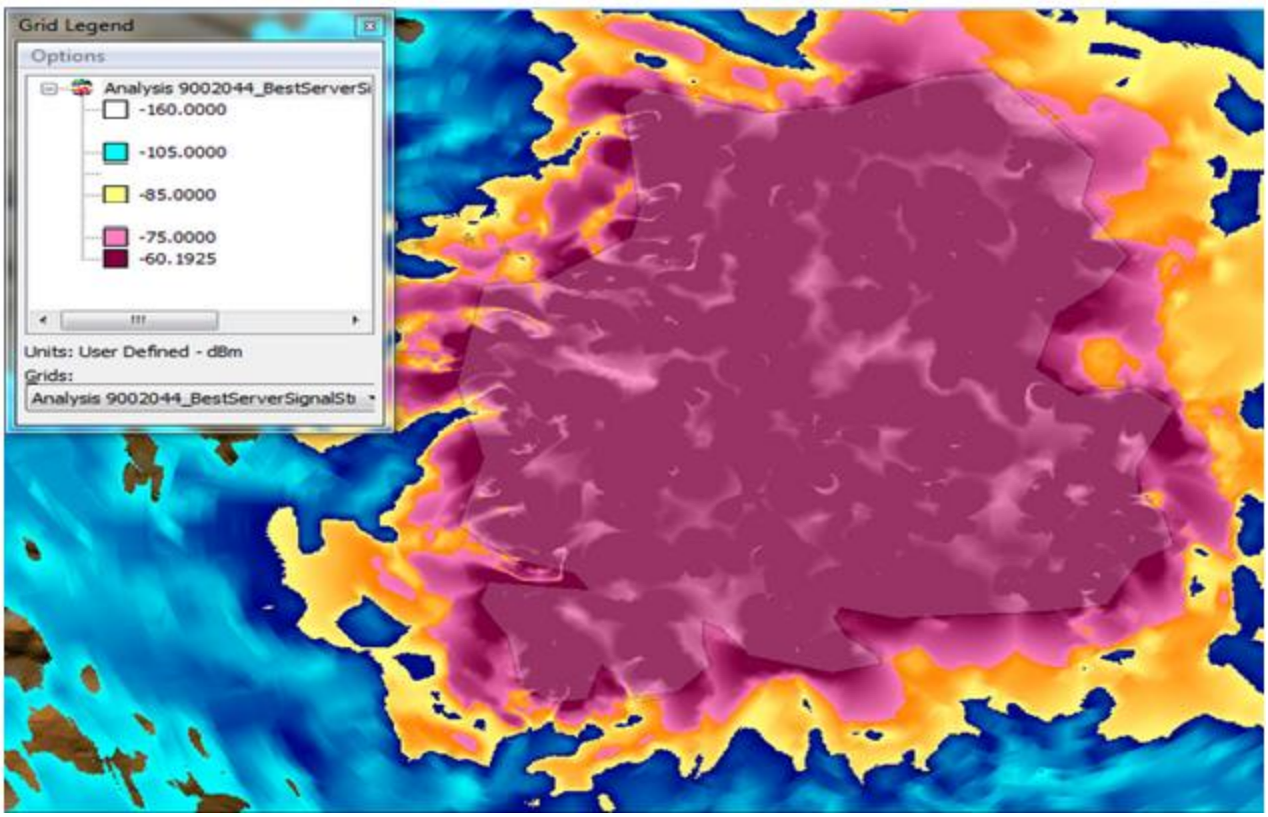


Figure 3.26: LTE Coverage at 900MHz

3.6.3.1.2 LTE Quality(C/I) at 900MHz

LTE signal to interference was very good compared to WCDMA. This figure below shows that signal power reached 30dB with red zone around the site and 20 dB in the orange zone around the site. LTE interference is minimized in the 900MHz mobile band.

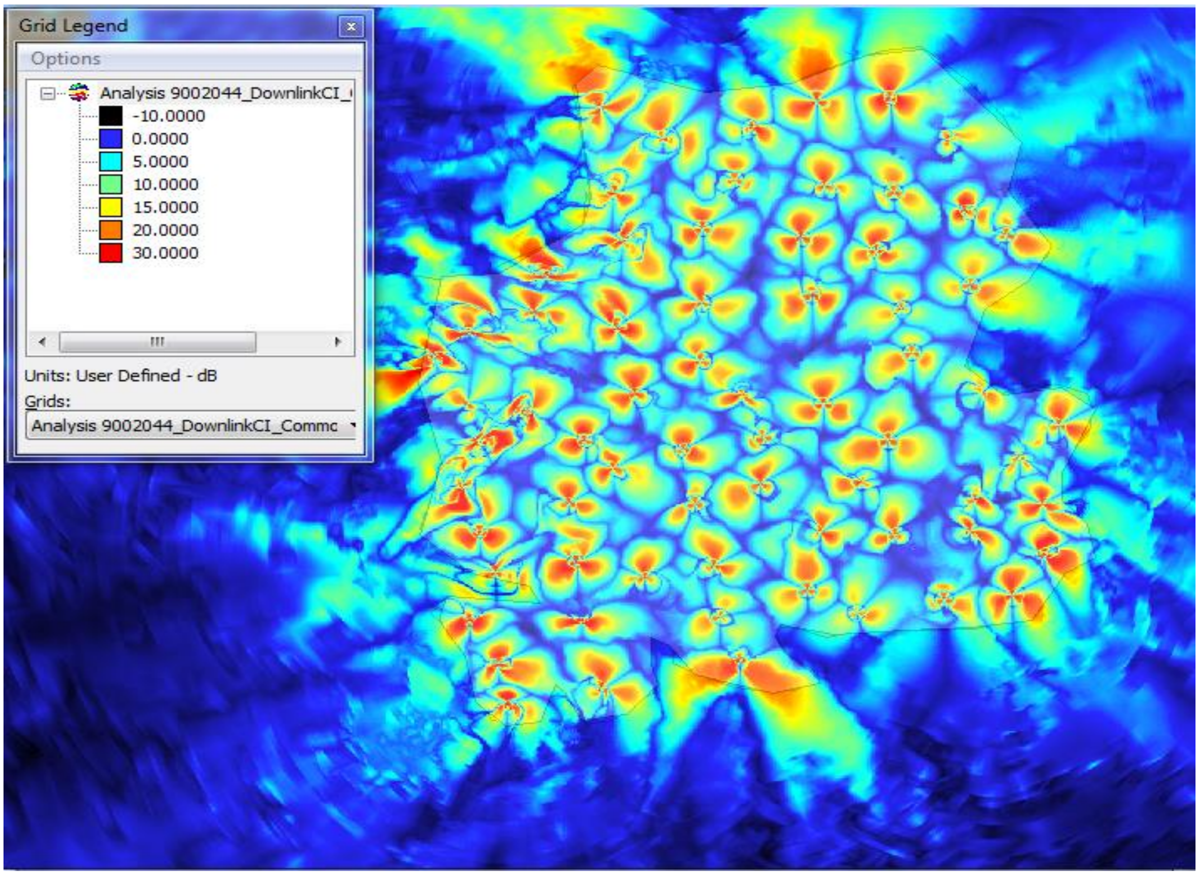


Figure 3.27: LTE Quality(C/I) at 900MHz

3.6.3.1.3 LTE DL. Capacity at 900MHz

This figure shows the LTE capacity with 5MHz bandwidth reached 50Mbps in the red zone around the site and 30Mbps in other places around the site.

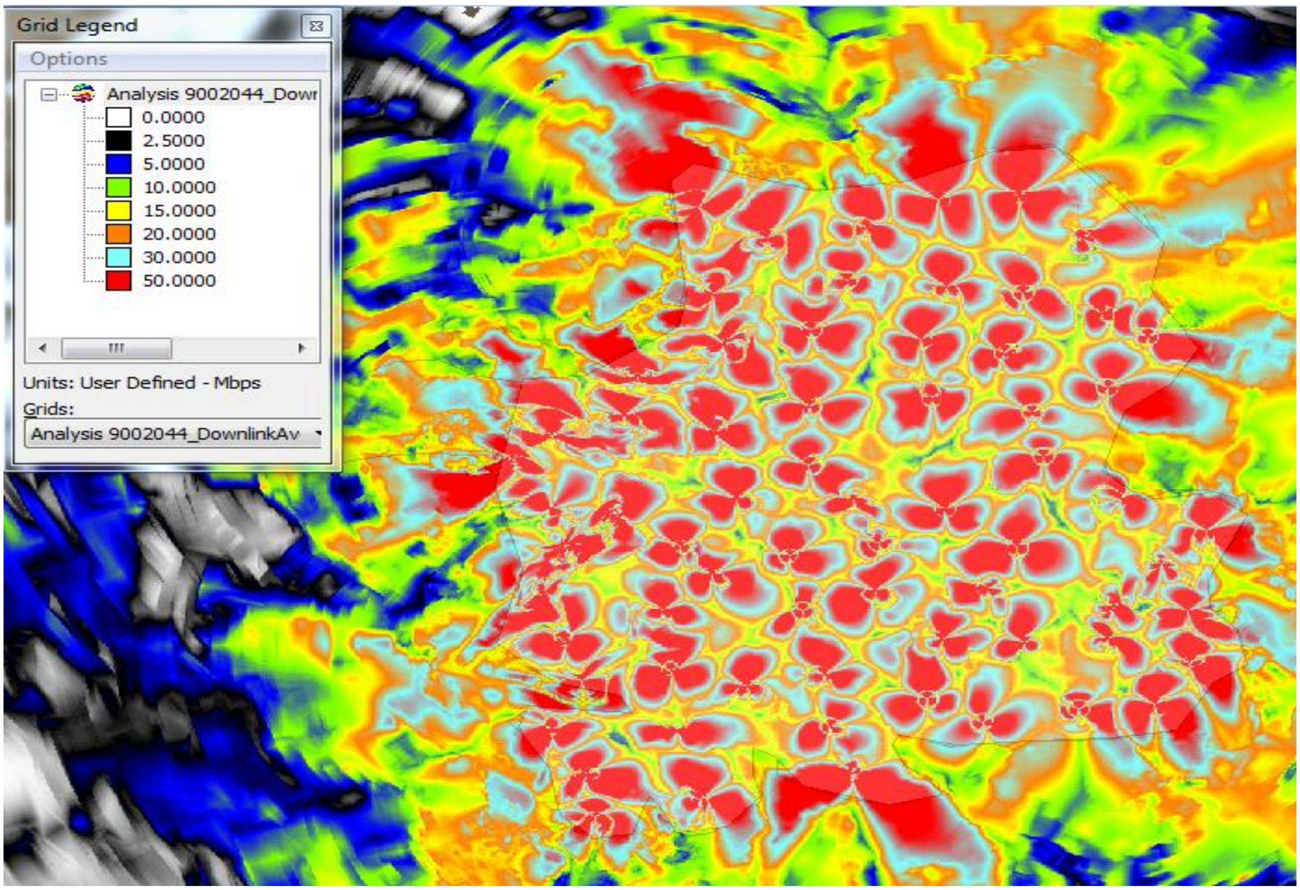


Figure 3.28: LTE Max. Achievable data Rates at 900MHz

3.6.3.2 LTE at 1800MHz

The 1800 MHz frequency is widely available, and re-using the existing GSM 1800 MHz networks enables fast rollouts. The 1800 MHz band provides a good blend of bandwidth, which determines the data rates, and coverage, which allows re-use of the 1800 antenna site grid.

Deploying LTE network in this spectrum enables the possibility to provide networks for fast mobile broadband services with a substantially wider coverage at a lower cost than when using 2.1GHz and 2.6 GHz, which requires a considerably larger number of base stations.

Where 1800 MHz spectrum is free or becomes available, it can be used for LTE. The bandwidth alternatives of 5, 10 and 15 MHz support providing enhanced use experience beyond today's WCDMA networks When an operator acquires a new 1800 MHz license the case is simpler and even an LTE-only operation at 1800 MHz becomes an option.

3.6.3.2.1 LTE Coverage at 1800MHz

Coverage planning in the 1800MHz was more difficult than 900MHz; more sites were added to enhance the coverage especially in South-west Hebron. The detailed modifications are shown in table 3.15 in appendix B and table 3.8 in appendix A .The following Figure shows the signal strength in the area after the deployment of seventy (70)sites . The values ranges from -60 dBm in purple zone to almost -75 dBm in light pink zone.

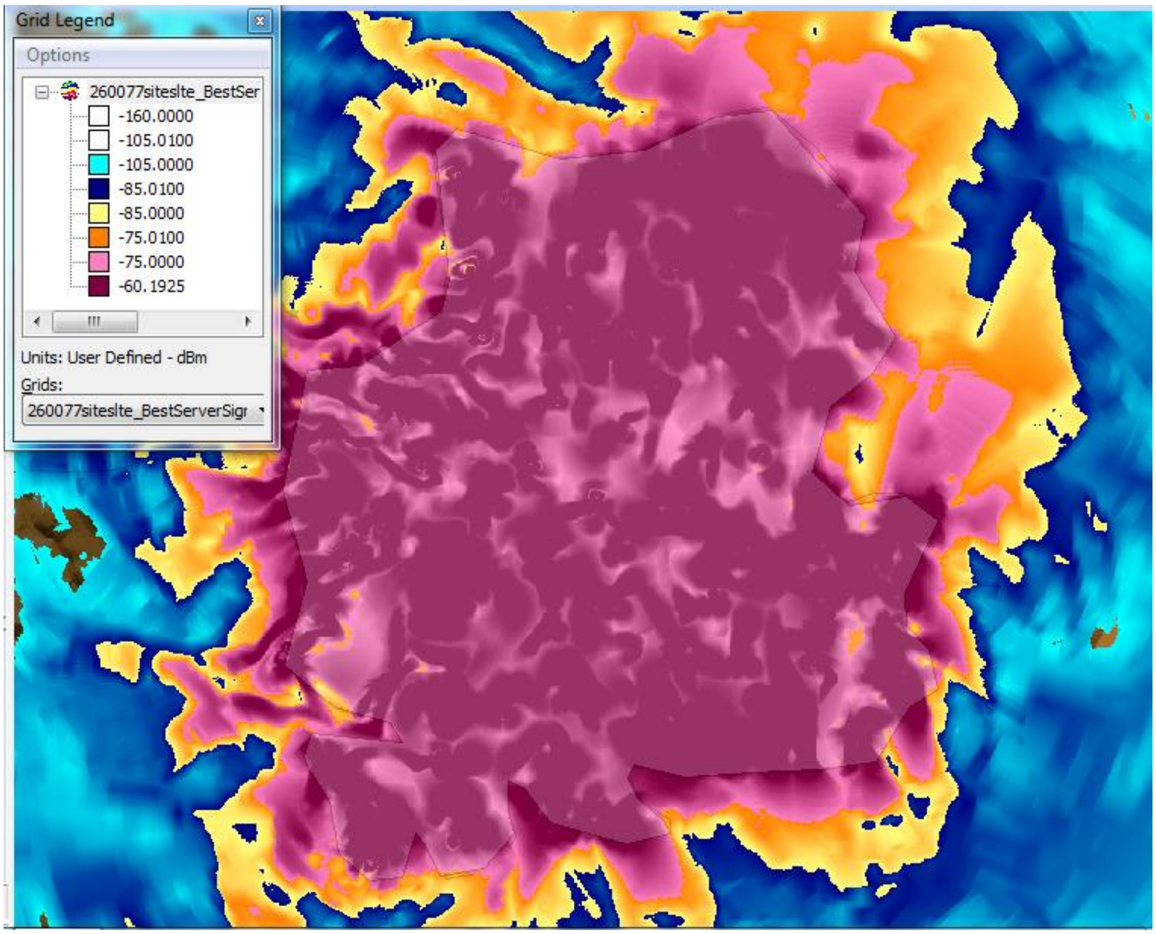


Figure 3.29: LTE coverage at 1800MHz

3.6.3.2.2 LTE Quality(C/I) at 1800MHz

The following Figure shows the DL signal to interference ratio**(C/I)**. The values range from 30 dB with red zone around the site to be almost 0 dB, it is also clear in the figure that some areas with light blue reached 5dB. Signal strength in the 1800MHz still larger than interference because sites did not suffer LOS ; planers accomplished this through changing azimuth and keeping sites as far as possible from each other with minimum distance of 300 to 400m .

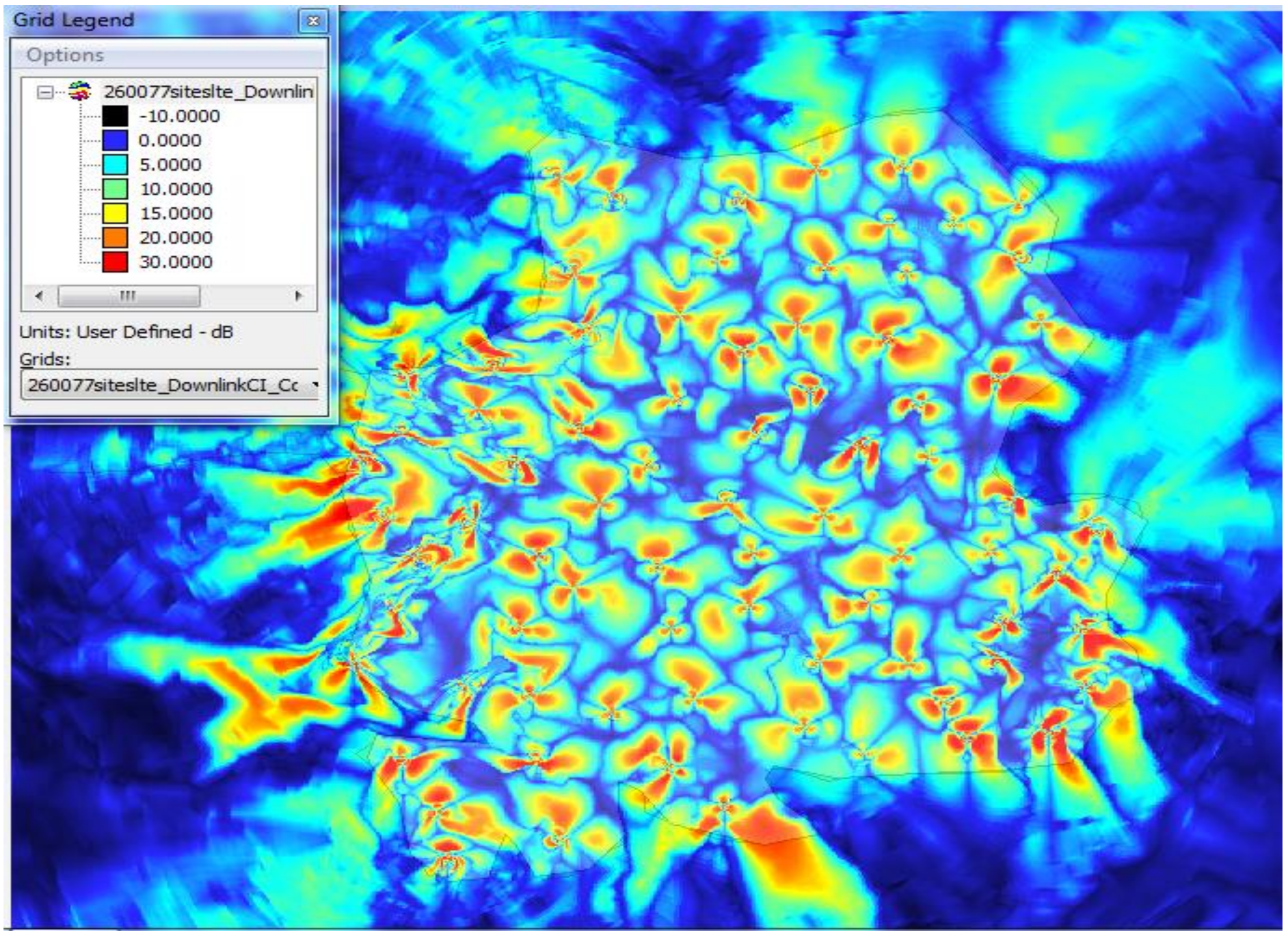


Figure 3.30: LTE Quality (C/I) at 1800MHz

3.6.3.2.3 LTE DL. Capacity at 1800MHz

This figure shows the Max. Achievable data rates, that Mentum planning tool could come up with the existence of MIMO capacity, should increase. But due to limited bandwidth with a value of 5MHz, 1800MHz data rates are from 30 ,45 and 54 Mbps with red , orange and light green zones respectively .

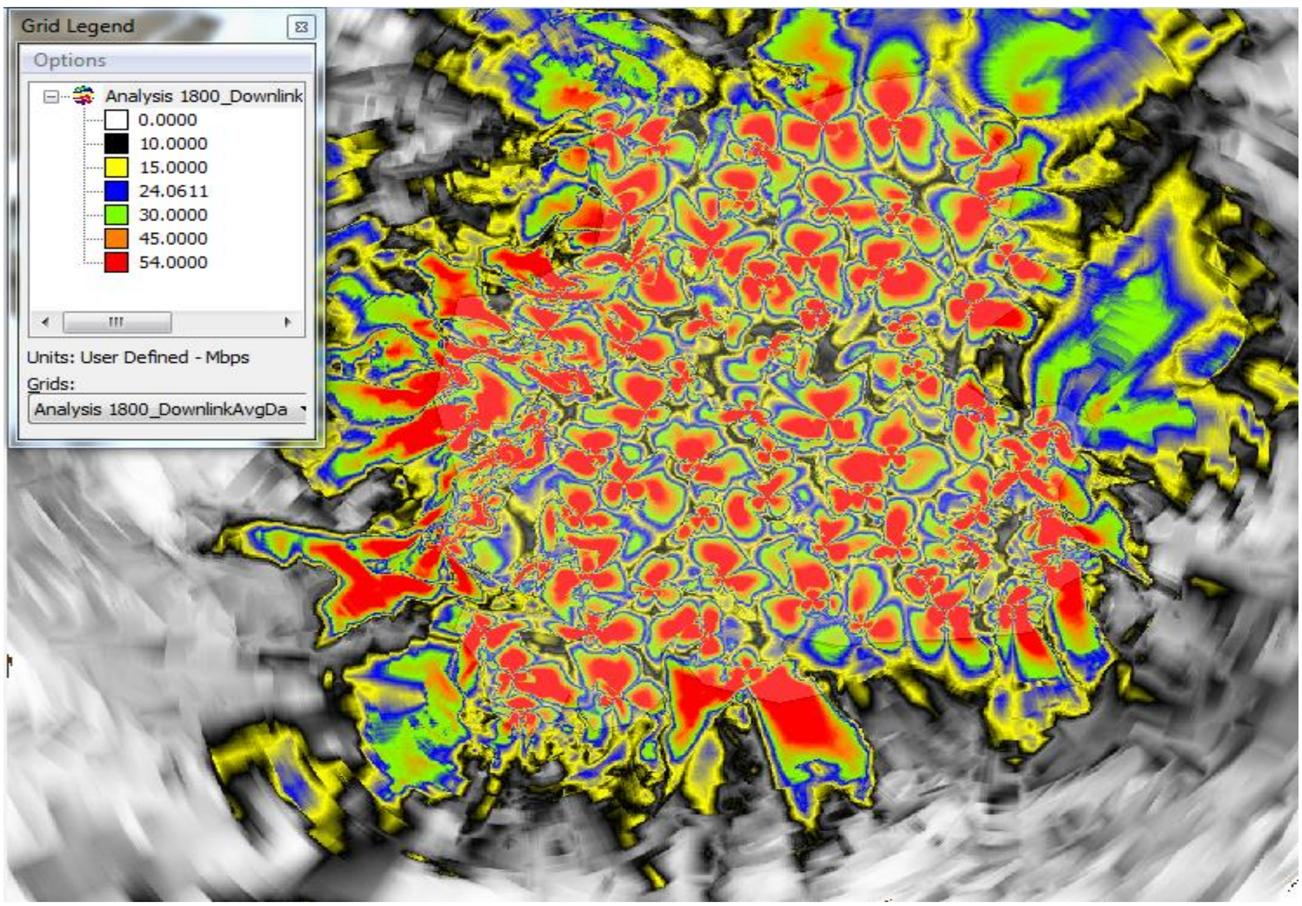


Figure 3.31: LTE Max. Achievable Data Rates at 1800MHz

3.6.3.3 LTE at 2100MHz

3.6.3.3.1 LTE coverage at 2100MHz

This figure shows coverage when having number of sites equal to seventy-five (75 sites) and the final sites values are in table 3.9 in appendix A.

When the frequency was changed from 1800MHz to 2100MHz, the coverage was bad, so to enhance the coverage new five sites were added, sites modifications can be found in table 3.16 in appendix B. The team work find that the same regions that have problems in 1800MHz still have the same problem in 2100MHz frequency, but the signal strength still good and no severe problems were found.

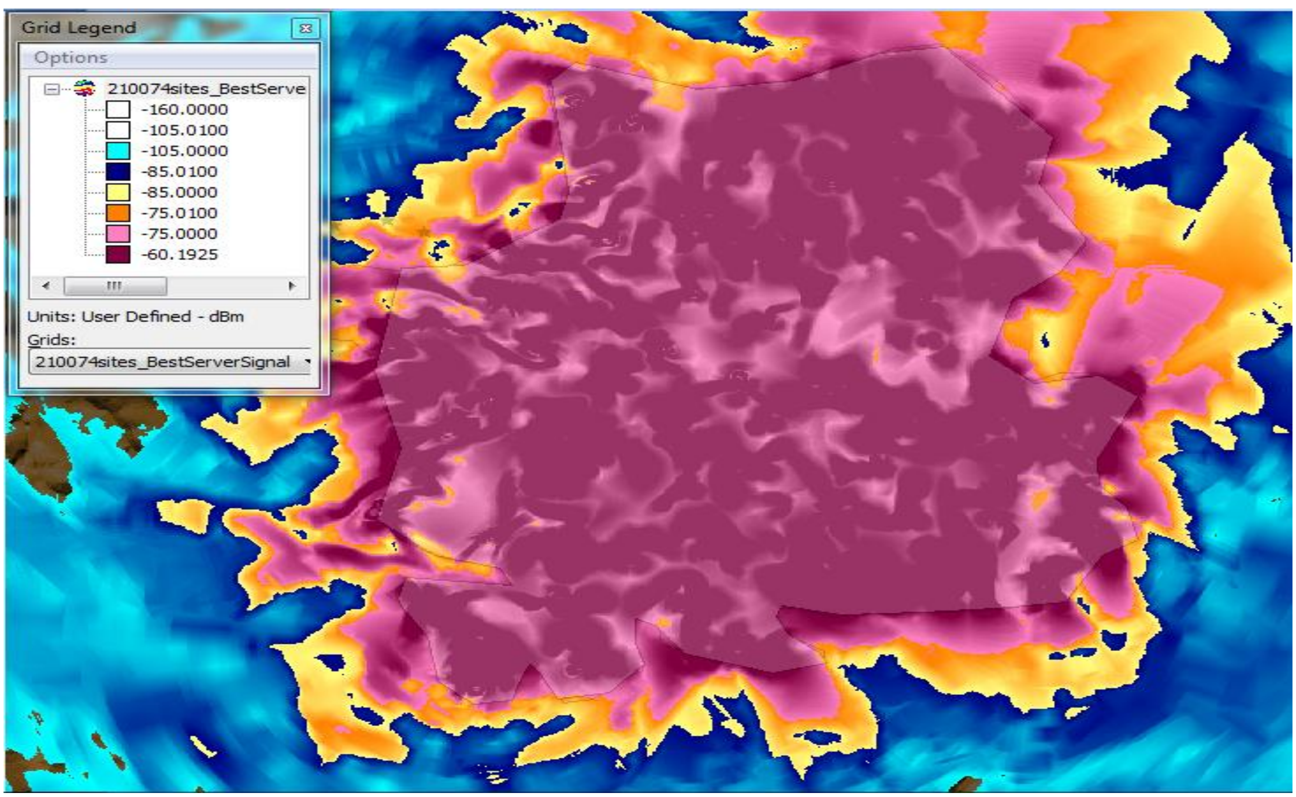


Figure 3.32: LTE Coverage at 2100MHz

3.6.3.3.2 LTE Quality (C/I) at 2100MHz

The following Figure shows the DL signal to interference ratio (C/I) which ranges from 20 dB to almost 0 dB. Reducing power is the solution to minimize the interference in most areas since increasing the number of sites in the high populated regions as in the middle exposes planners to more difficulties such LOS and interference plus noise . As shown in the figure, the worst result is in the middle of the city as expected; this is due to the short distances between sites in these regions. Coverage in count of quality was one of the issues planners faced, so minimizing coverage to get strong signal and less interference.

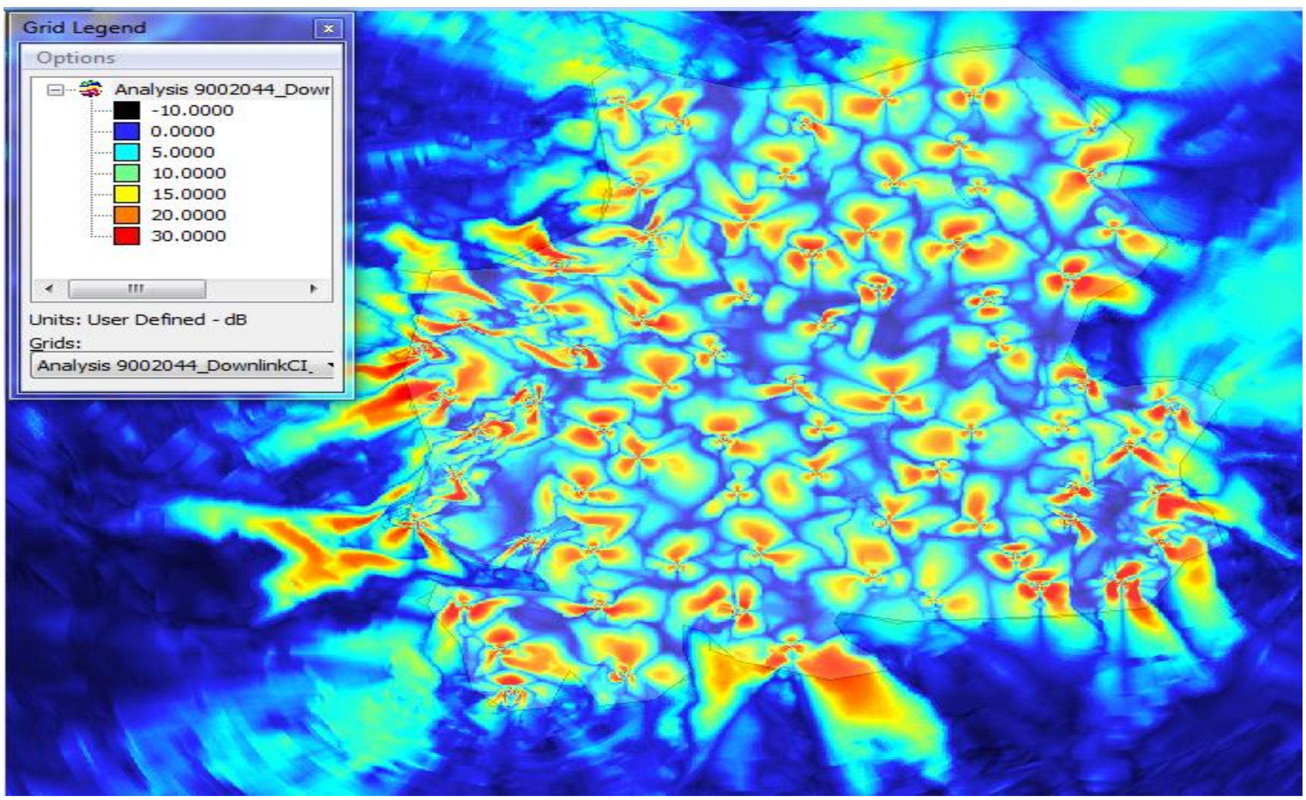


Figure 3.33: LTE Quality(C/I) at 2100MHz

3.6.3.3.3 LTE DL. Capacity at 2100MHz

The following figure shows the DL data rate which seems high in most regions and low in few others, and is predictable due to the nature of Hebron city and the limitations that faced the planning process. Data rate values range from 15Mbps to 64.9Mbps.

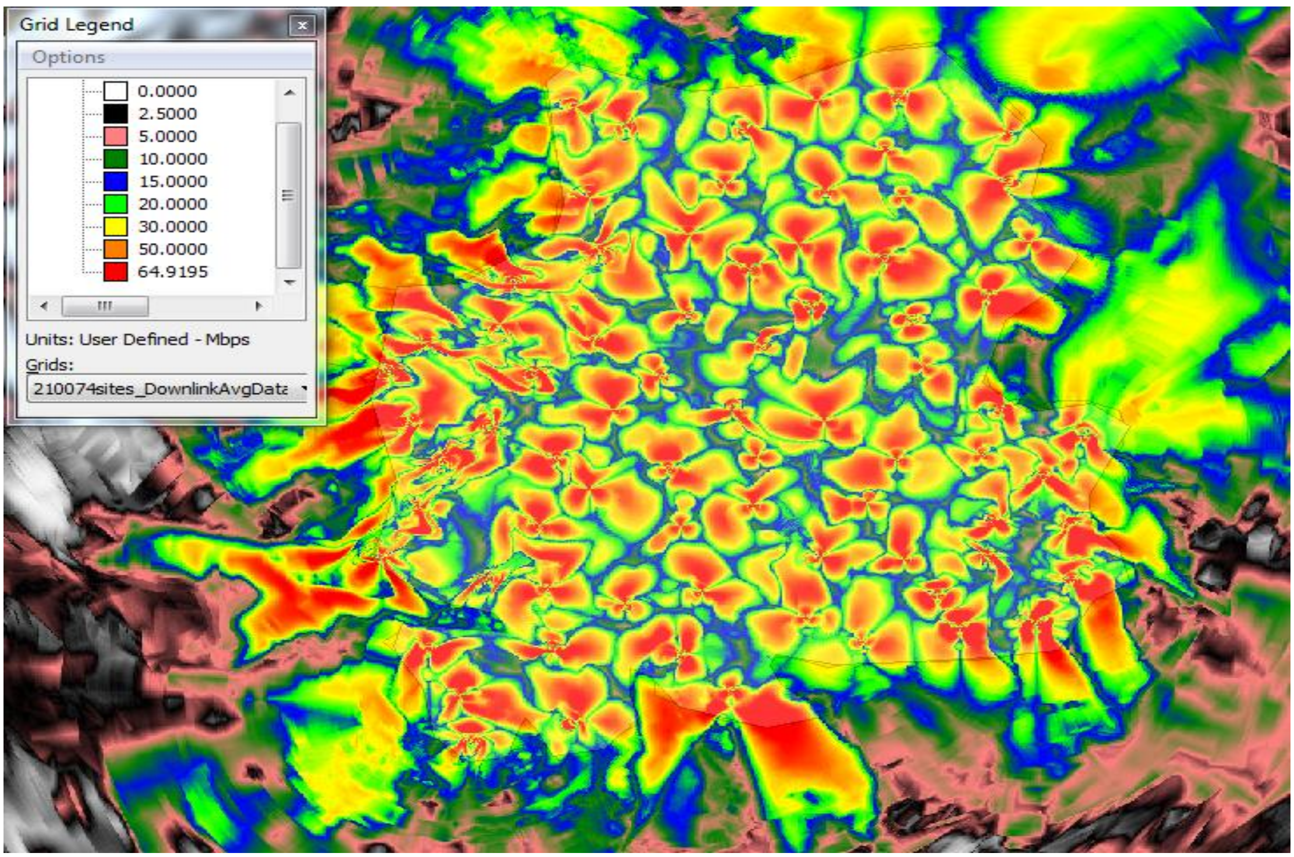


Figure 3.34: LTE Max. Achievable Data Rates at 2100MHz

3.6.3.4 LTE at 2600MHz

The 2600 Mhz frequency range has a much shorter range, It is suitable especially for LTE development in cities and urban areas where the base stations due to high demand must already be much closer than in the country side. More data rate will be achieved than 2100, 1800 and 900 MHz, as noticed as planners go up the frequencies the number of sites are becoming more, and the achievable data rate is increasing. all modifications are cleared in table 3.17 in appendix B and table 3.10 in appendix A to achieve the best coverage ,quality and capacity.

3.6.3.4.1 LTE Coverage at 2600MHz

This figure shows the coverage of 2600MHz frequency with seventy eaight (78) sites .The values range from -60 dBm in purple zone and -75dBm in light pink zone. This coverage is acceptable with the existence of some challenges in some areas such as East Hebron that reached -85dBm.

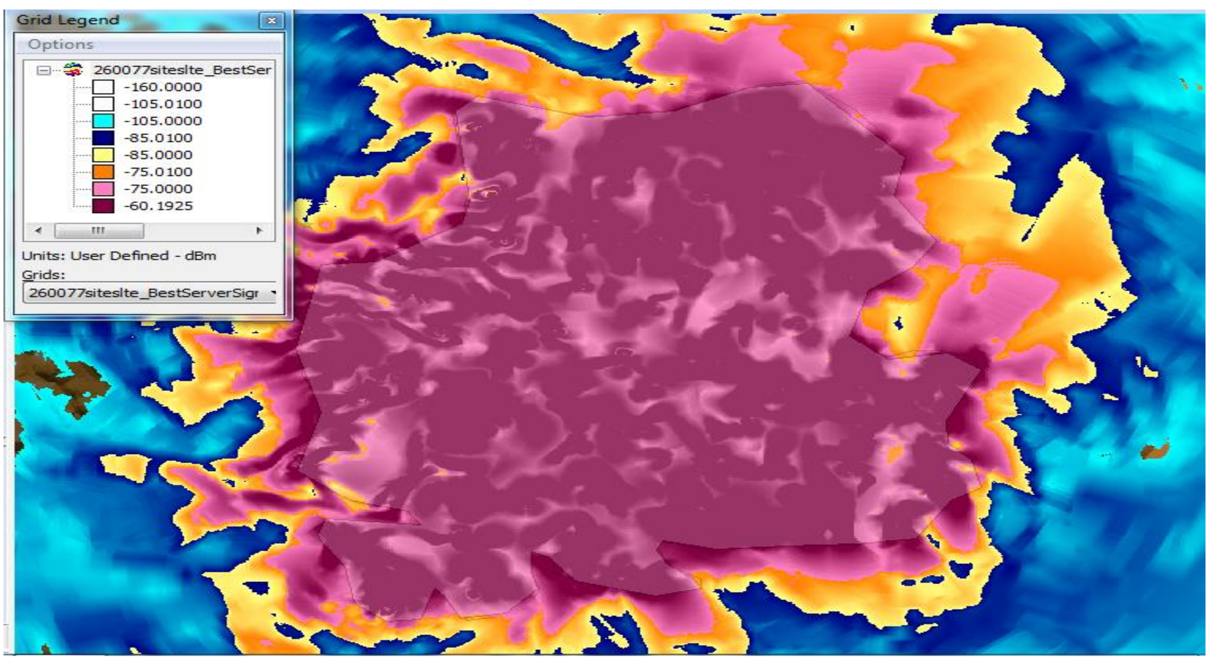


Figure 3.35: LTE Coverage at 2600MHz

3.6.3.4.2 LTE Quality(C/I) at 2600MHz

The Figure shows the DL signal to interference ratio**(C/I)**. The values range from 0dB in dark blue areas, 20dB and 30dB around each site. Some interference is found especially with the existence of sites with four sectors. Centered areas has more interference, west Hebron was little bit difficult but with acceptable interference because planners tried to minimize the power in places with crowded sites.

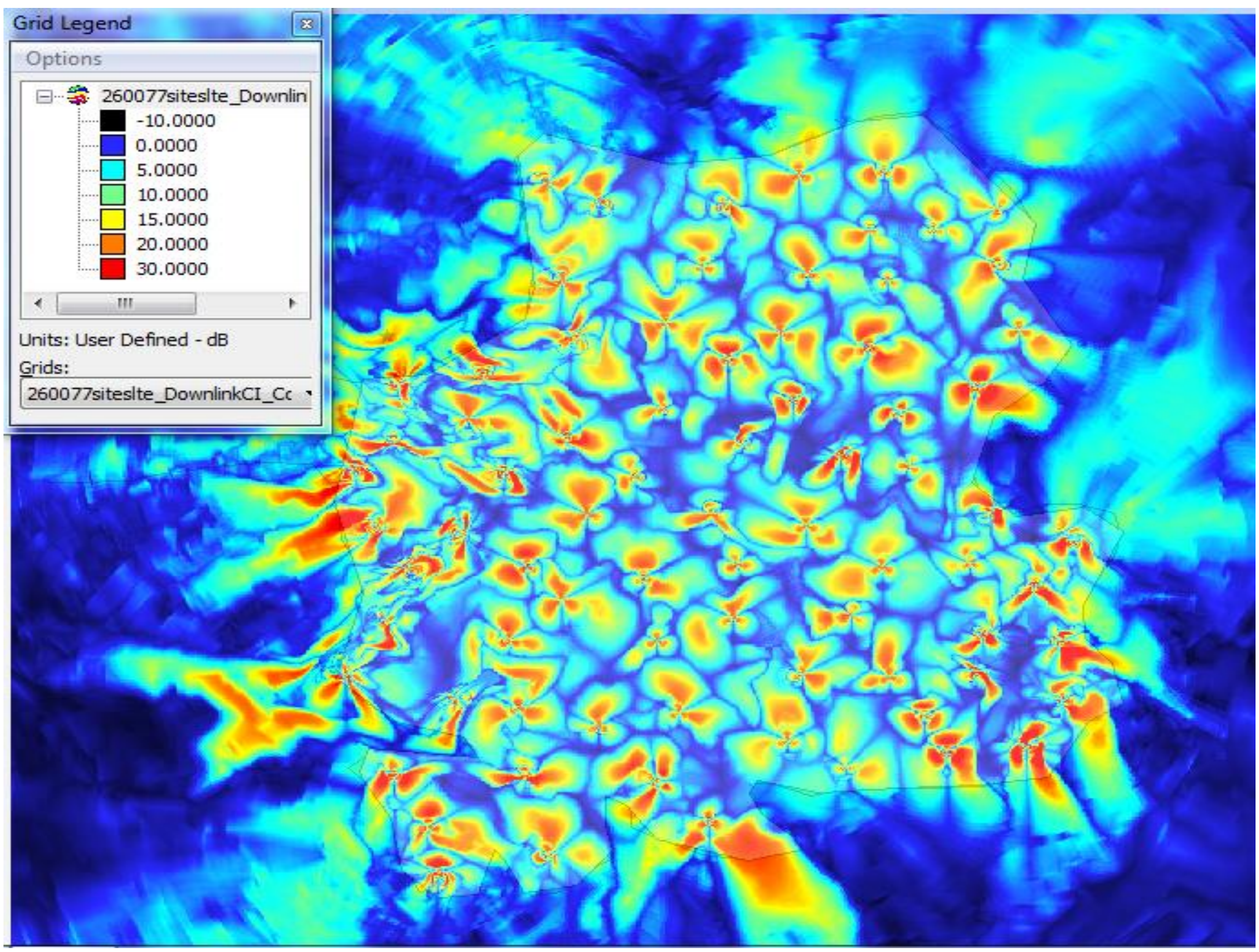


Figure 3.36: LTE quality (C/I) at 2600MHz

3.6.3.4.3 LTE DL.Capacity at 2600MHz

This figure shows the Max. Data rates using that could be achieved as clarified in the figure data rates ranges from 10 to 71 Mbps, red zone with 71Mbps and yellow with 71Mbps etc.

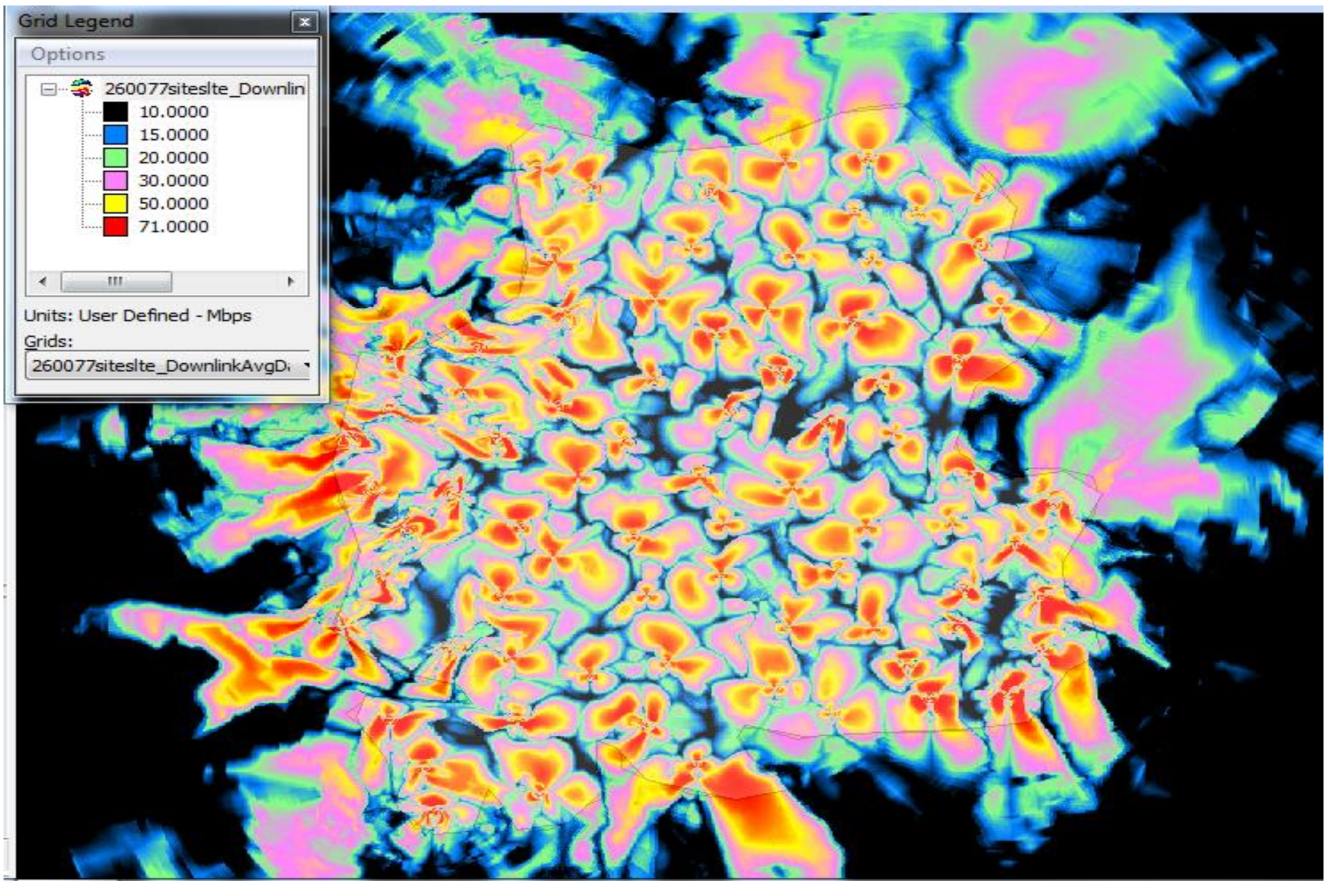


Figure 3.37: LTE Max. Achievable Data Rates at 2600MHz

3.6.3.4.4 LTE Challenging Areas

LTE bands after the 900MHz was challenging. As shown in tables in Appendix B, two to three analysis were needed for each frequency. The most challenging part was in coverage as will be clarified in some pictures that will come next and that were taken from previous analysis before getting final acceptable signal strength.

This is West and East Hebron , Orange with -75 is not good coverage; this area was hard in almost all frequencies , it's full of mountains and valleys at the same time ,many sites were needed ,also sites with four sectors were needed .

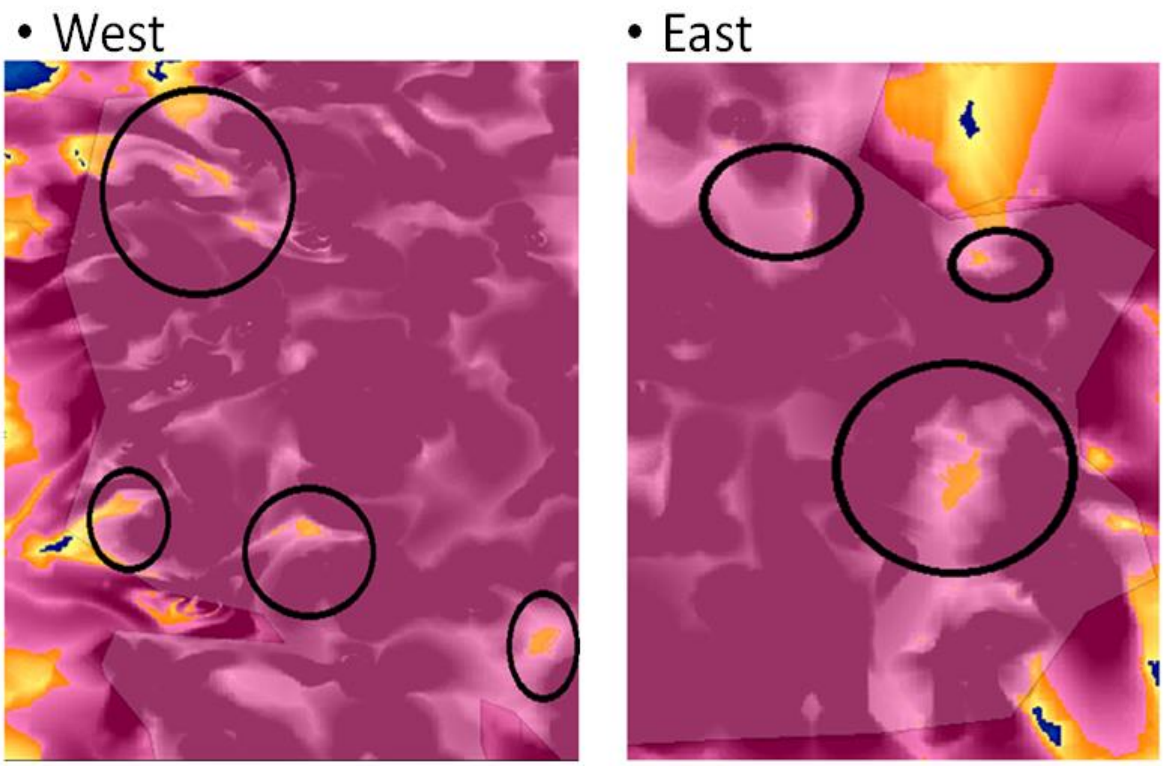


Figure 3.38: LTE Challenging Areas

3.6.4 WCDMA and LTE Sites Survey

A **wireless site survey**, sometimes called an RF site survey or wireless survey, is the process of planning and designing a wireless network, to provide a wireless solution that will deliver the required wireless coverage, data rates, network capacity, roaming capability and Quality of Service (QoS). The survey usually involves a site visit to test for RF interference, and to identify optimum installation locations for access points. This requires analysis of building floor plans, inspection of the facility, and use of site survey tools.

As part of the wireless site survey, the effective range boundary is set, which defines the area over which signal levels needed support the intended application. This involves determining the minimum signal to noise ratio (SNR) needed to support performance requirements.

WCDMA and LTE Challenging areas was mentioned in previous sections of this chapter ,sections are : 3.6.2.3.4 for WCDMA and 3.6.3.4.4 for LTE . In addition , challenging areas that planners found difficulties in planning even when trying many tuning trials through simulations and analysis .

The selected and most challenging sites through the process of planning in this project were Site 2 in figure 3.39 in appendix C with coardinates of longtitude: 35°3’50.28” and latitude of : 31°31’37.28 ", Site 4 in figure 3.40 in appendix C with coardinates of longtitude : 35° 1'39.28"and latitude of : 31°30'19.25", Site 80 in figure 3.41 in appendix C with coardinates of longtitude : 35°4’9.49"and latitude of : 31°30’41.90" , and Site 83 in figure 3.42 in appendix C with coardinates of longtitude : 35° 6'1.98"and latitude of : 31°31'31.88" Google Earth map and directions to each location is cleared in appendix C .

3.6.4.1 Site 2 Survey

Site 2 was close to Bani Naim but its exact location as figure 3.39 in appendix C shows, it was on road 60. Site survey means that this project's planners need to go to the field to get pictures for the whole location and check the reason that this site is not transmitting nor giving a good coverage even after doing many improvements.

This project planners went to the field to do the survey, road 60 is under the control of Israeli occupation so planners were forbidden to take pictures for this area. The second solution was to head to Bani Naim to move the location to a proper area in this village . However, many difficulties appeared during the survey. For example, survey in Bani Naim, so it was suggested to move it from road 60 to Bani Naim as shown in appendix C figure 3.43.

Planners then moved the location of Site 2 to Bani Naim on Mentum Planning Tool for to see the result after changing its location as shown in figure 3.44 for WCDMA and figure 3.45 for LTE, because this site was challenging in both technologies and on most of the frequencies. However, WCDMA and LTE quality was also enhanced to reach 10dB.

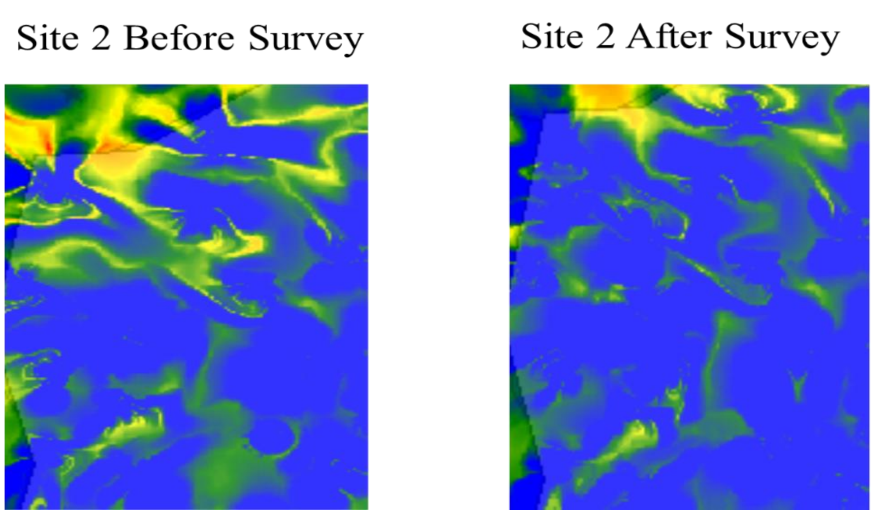


Figure 3.44: Site 2 WCDMA Coverage before and after Site Survey

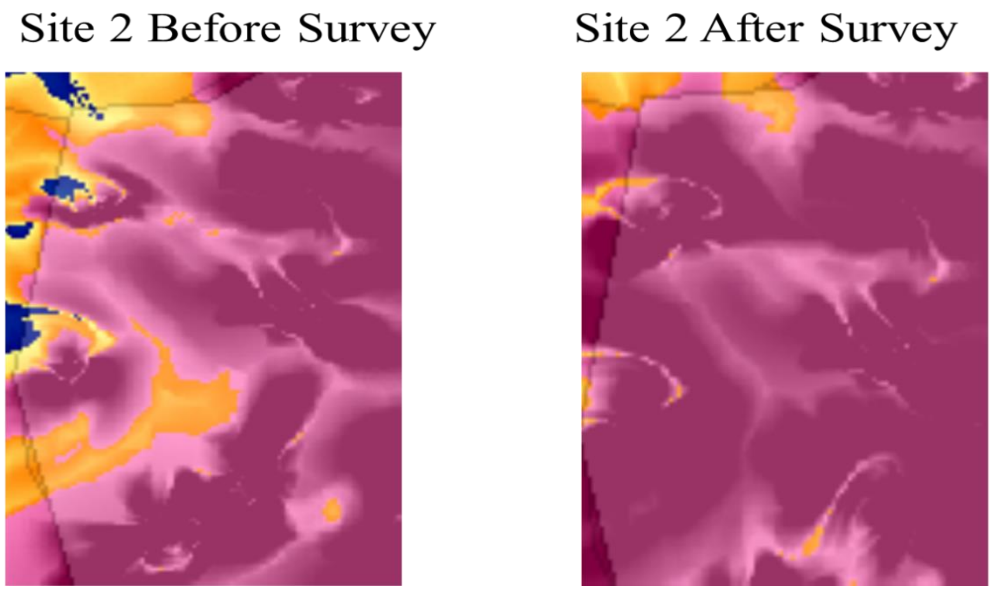


Figure 3.45: Site 2 LTE Coverage before and after Survey

3.6.4.2 Site 4 Survey

Site 4 was challenging in WCDMA coverage planning, its location is shown in appendix C figure 3.40 along with the directions to reach it. Site 4 location was in Dura, so planners went to survey to change the location of the site to get better coverage and quality.

Site 4 was in a crowded area in Dura Down Town and between many buildings as figure 3.46 shows, and the coverage was bad. Planners suggested moving it to a higher location above the center in Dura as shown in figure 3.47. WCDMA Coverage after doing the enhancements on Mentum Tool is shown in figure 3.51.

Figure 3.46: Site 4 First Location in Dura Down Town

Figure 3.47: Site 4 Final Location in Dura Down Town

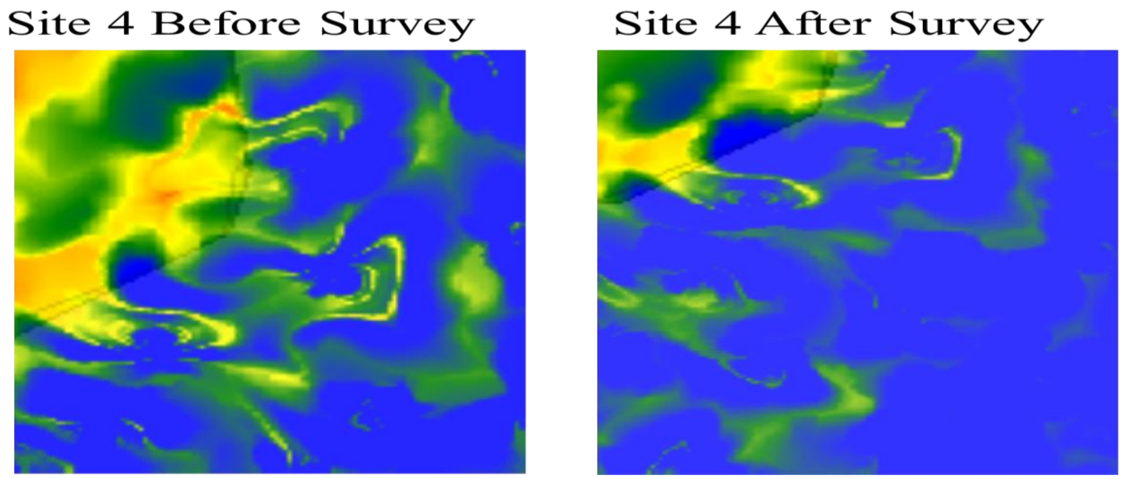


Figure 3.51: Site 4 WCDMA Coverage before and after Survey

3.6.4.3 Site 80 Survey

Site 80 was a challenging site in WCDMA planning. The main problems were in quality and coverage. Its location on Google Earth is shown in figure 3.41 was near Hagai which is one of the occupation settlements, and similar to site 2 scenario planners was not allowed to take pictures of the location also its not allowed to place sites in those occupied areas and most of the time it’s out of service. However, planners suggested changing the whole location of the site to place it within a different area under the Palestinian authority such Alhawooz as shown in figure 3.52 in appendix C.

Site 80 was moved to Alhawooz area, so planners went to change the location of the site on the Mentum Tool to see the result if coverage and quality were enhanced. Figure 3. 53 next shows that coverage became better and quality is now acceptable.

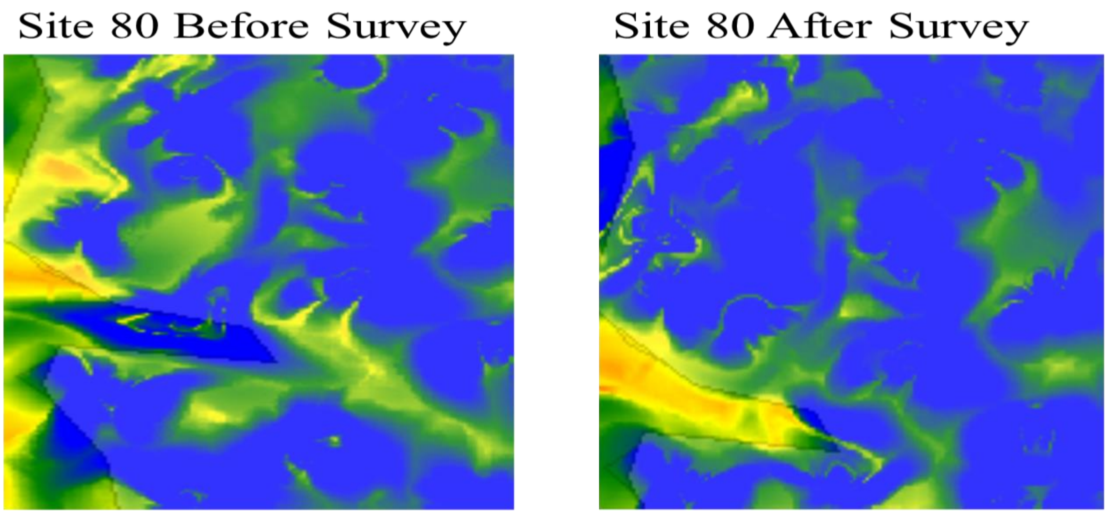


Figure 3.53: Site 80 WCDMA Coverage before and after Survey

3.6.4.4 Site 83 and Site 10 Survey

Site 83 Location on Google Earth is shown in figure 3.42 in appendix C. This site was in a crowded area in Hebron as shown in figure 3.54 below, which is down town. Planners suggested providing this site with 5 to 6 sectors since there will be more traffic on it. However, it was moved a few meters from its original location because it was very close to Jewish cemetery. Site 10 was placed near site 83 so both of them needed survey.

Planners suggested that site 83 should be moved above one of the three buildings shown in figure 3.55 below. However, site 10 was also moved as shown in figures 3.56 and 3.57 shown below.

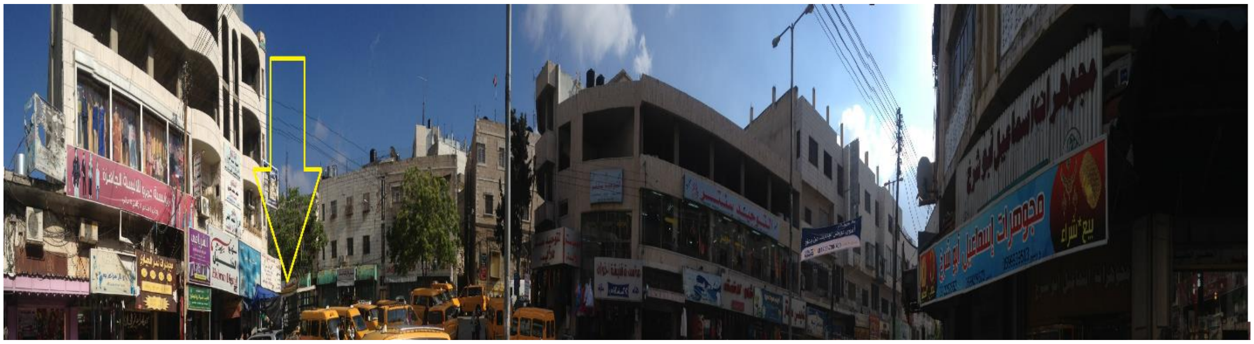


Figure 3.54: Site 83 First Location in Hebron Down Town

Figure 3.55: Site 83 Final Location in Hebron Down Town

Figure 3.56: Site 10 First Location in Hebron Down Town

Figure 3.57: Site 10 Final Location in Hebron Down Town

Planners moved the site to more proper place to serve as many users as possible, it's better to place a site with many sectors than placing more than one site in this crowded area as shown in appendix C in figures 3.59 ,3.60 and 3.61 because more overhead and interference will occur due to huge traffic . Figure 3.58 shows coverage after changing the location of both sites 83 and 10 on Mentum Tool.

LTE was not that difficult in down town, sites 18, and 21 were deployed in down town, interference was not bad, and coverage was very good in most frequencies.

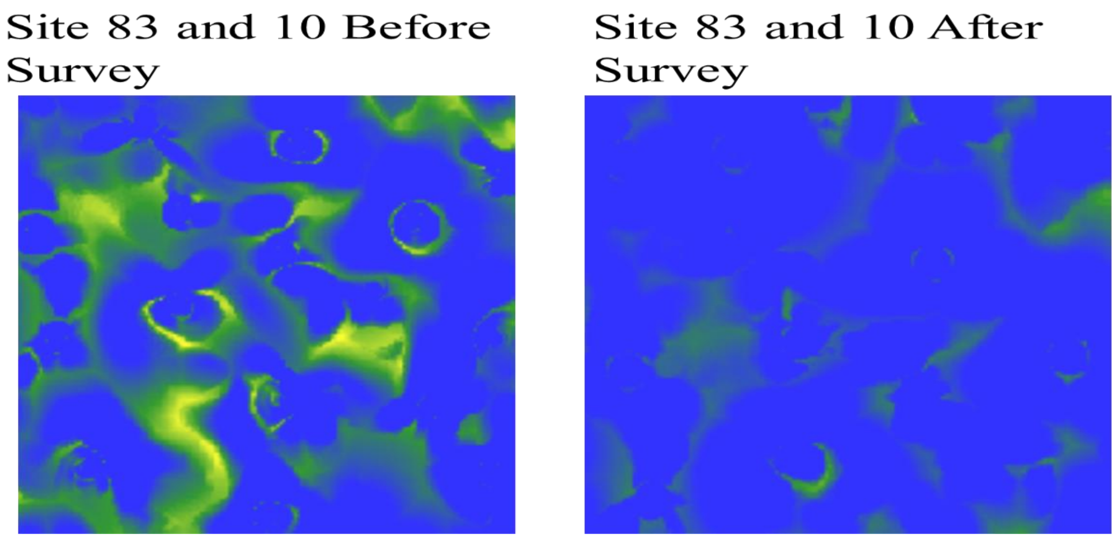


Figure 3.58: Site 83 and Site 10 WCDMA Coverage before and after Survey

CHAPTER FOUR
WCDMA VS. LTE IN HEBRON CITY

Contents

4.1 Overview

This Chapter will discuss planning results, comparing WCDMA to LTE, and their low and high frequencies with each other. In addition, many charts will be displayed to make the comparison more clear and summarize the idea to the readers.

4.2 WCDMA and LTE Planning Results

Future demands are now going for exploiting existing 2G frequencies below 1 GHz (for example 900 MHz and 850 MHz) for the deployment of broadband (or so-called 3G) technologies. These motivations are to reduce the costs and expand the capacity of mobile broadband networks beyond what can be achieved with broadband networks deployed in the core 3G bands (i.e. 2.1 GHz and 1.7 GHz depending on the region and country). The 3G systems deployed by the majority of 2G operators (i.e. the GSM or 3GPP community) are based on the WCDMA (wideband code division multiple access) air interface.

The introduction of 3G systems into 2G bands, which involves their partial occupation of existing GSM 850/900 MHz frequencies, raises both technical and regulatory issues. In the technical or engineering context, it poses risks of a degradation of the quality and an increase in the number of dropped voice calls of GSM subscribers if no reasonable allocation of frequencies is made between the 3G and 2G networks. Reciprocally a potentially adverse effect of the existing GSM network on the new 3G network must be mitigated.

In the regulatory and competitive context, the issue is one of policies that affect how increasingly precious spectrum below 1 GHz, which includes current 850/900 MHz allocations as well as future or in a very few countries recently allocated new digital dividend spectrum, should be made available to (or even redistributed among) competing mobile operators.

The characteristics of different frequency bands have a significant impact on the costs of operators’ network deployments, depending on which bands are available to them to achieve the most economical coverage of a national territory that exhibits wide variations in population densities and traffic demands (Mbps/unit area) in different regions.

In addition to commercial issues related to the fairness or reasonableness of competitive conditions in mobile markets, there are other implications for policy and regulation associated with access to frequencies below 1GHz. Operators who have no access to frequencies below 1GHz cannot compete efficiently to secure Universal Service funds available for rural areas, and/or may be economically handicapped in trying to fulfill coverage and roll-out obligations that may be imposed by regulators as one of the conditions of the mobile licenses they are awarded.

4.2.1 WCDMA Planning Results

Frequencies below 1 GHz can offer significant advantages over higher frequency bands, including: (1) Lower network costs in network deployments in coverage limited (such rural) areas thanks to their longer propagation ranges (substantially fewer base stations are required), and (2) Superior in-building penetration to provide better service indoors (and reduce the need for solutions such as femtocells), which is where much, or even the majority of "mobile" communications traffic is actually delivered and initiated.

On the other side, the total bandwidths i.e. raw capacities, that are available at higher frequencies are greater than in bands below 1GHz, while in areas (such urban; Hebron is urban) where the number of base stations needed to provide sufficient capacity area-wide is capacity- rather than coverage-limited their shorter propagation ranges are advantageous since channel reuse is possible with smaller separations without causing harmful interference. Hence the ideal frequency holdings for an operator trying to cover a range of urban, suburban, and rural areas includes a mix of high and low (below 1GHz) frequencies.

4.2.1.1 WCDMA 900 vs. WCDMA 2100

Taking it from a physical point of view, the physics of radio wave propagation help explain one of the great advantages of WCDMA 900: The lower the carrier frequency, the further radio signals can travel. This means it takes fewer radio cells to cover the same area, making WCDMA 900 the perfect solution for extending coverage.

The cost savings of using 900 MHz compared to 2100 MHz for providing 3G services can be considerable, amounting to a reduction of between 40-60% in terms of numbers of base stations in some areas. It also enables savings in backhaul links since fewer stations have to be connected and greater concentrations of traffic can be achieved (more users per base station). In addition 900 MHz can be used to help meet needs for capacity expansion that are being driven by the combination of increases in mobile broadband subscribers and in the amounts of traffic each one generates from use of new increasingly powerful mobile devices such as smartphones, as well as wireless broadband-enabled laptops and netbooks.

Rollout of WCDMA 900 can be fast compared to WCDMA2100. Based on this project results planners can practically skip new site acquisition and building, and still get an excellent 3G coverage. One way to do this would be to deploy a conventional 2100MHz WCDMA network. On the downside, a 3G system operating in the 2100MHz frequency band requires more new sites than systems operating at 900MHz because each base station's coverage radius is smaller and in-building propagation is weaker.

Like WCDMA 2100, WCDMA 900 is evolving towards higher data speeds and increased efficiency. 3GPPRelease 8 will bring downlink data rates up to 43 Mbps and uplink data rates up to 11 Mbps. Other evolutionary advances in HSPA will reduce mobile devices' power consumption and therefore increase their operational autonomy.

4.2.1.2 WCDMA 900MHz vs. GSM 900MHz

WCDMA at a frequency of 900MHz looked to be the ideal choice. However, what about in the real world? 2G equipment also runs at 900MHz, so these networks would have to co-exist in the same band. What is more? Planning, testing, and implementing a WCDMA 900MHz overlay requires a great deal of highly specialized expertise.

The challenges encountered when deploying 900MHz spectrum include:

1) Managing and minimizing interference between the GSM and 3G (WCDMA) network

2) Protecting existing investments through sharing of feeders and antennas.

3) Maintaining overall GSM capacity and quality, despite, as is typical, using 5MHz of spectrum allocations in 900MHz for a single WCDMA carrier.

4) Separate (non-shared) sites which offer the advantage as compared to shared sites (see the following) of a smaller number of WCDMA sites (lower 3G equipment costs) thanks to this technology's greater range, but on the other hand entails increased interference between the two networks, and greater costs for the new sites and all their auxiliary equipment which cannot share any of the original GSM site resources, as well as lower overall efficiency in the backhaul infrastructure.

5) Site sharing in which the existing GSM sites are used for the 3G network, saving money on auxiliary equipment and other cost associated with additional sites, and also reducing interference between the GSM and WCDMA networks compared to a scenario in which sites are not shared. By adjusting the transmit power of the WCDMA network, its coverage area and that of the GSM network can be made to be essentially the same. If antennas are not shared, the coverage of each network can be optimized through the setting of their down tilt angle and azimuth.

4.2.1.3 WCDMA 900MHz vs. WCDMA 1800MHz

1800MHz band should not be forgotten so this situation with all these frequencies is challenging, 1800MHz provides less interference, additional capacity and higher performance. The 1800MHz band already has a global footprint, as more than 350 operators in 148 countries have spectrum assets in that band, providing great potential for global mobile broadband deployment. The network is becoming the differentiator, and one significant aspect of ensuring high performance mobile broadband for the mass market is having access to sufficient radio spectrum to deliver the required capacity and coverage.

The regulatory situation varies from one country to another. Many countries allow the 900MHz and 1800MHz bands to be used for any technology, while in others they are earmarked for GSM only. However, Figure 4.1 shows WCDMA final comparison chart.

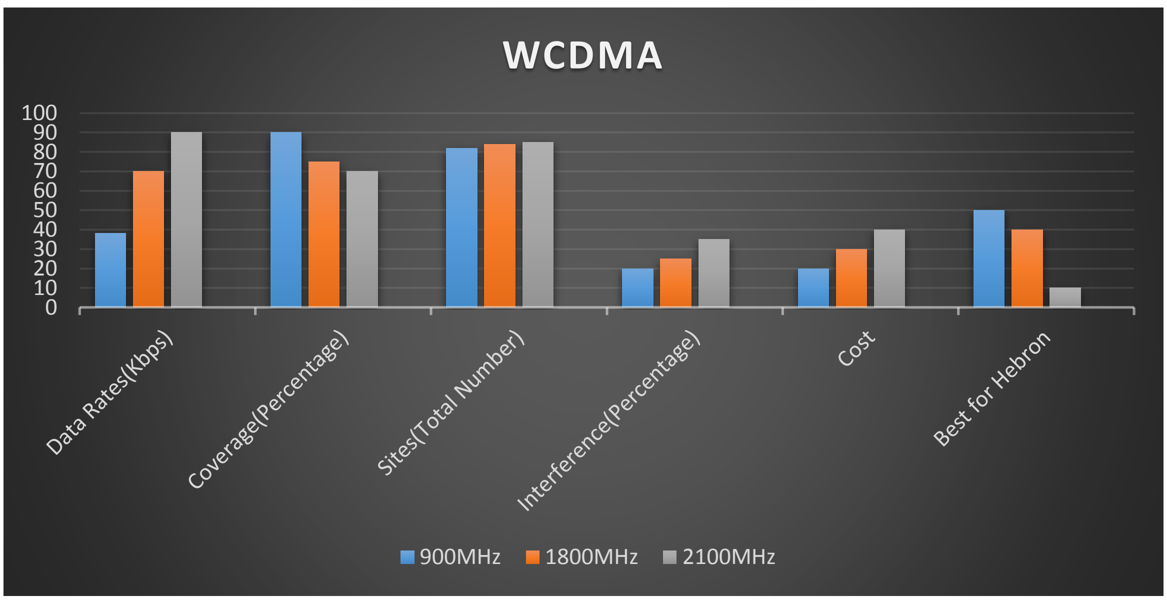


Figure 4.1: WCDMA Planning Comparison Chart for Hebron City

4.2.1.3 WCDMA Negative C/I

Negative C/I as noticed in all results in WCDMA is due to WCDMA processing gain which can be defined as the ratio between rate of spreaded signal and rate of non spreaded signal. Processing Gain = 10 log (Chip rate /Bit rate) [9].

Eb_No is also related to QOS of a service, which in terms related to bit error rate.Technically it is the minimum signal to noise needed by infrastructure equipment after despreading it signal. This is a value used to compare different infrastructure vendors. Eb_No changes with the service type.

According to this project, PG = 25dB according to equation $PG=10\log_{10}(3.82MHz/12.2KHz)=25dB$. Where, 12.2 KHz is QPSK modulation bandwidth.

4.2.2 LTE Planning Results

Interest in this extreme form of mobile network sharing is being stimulated by the scarcity of spectrum and the notably greater efficiency, i.e. higher capacities of emerging OFDMA-based mobile broadband technologies by which LTE will be the most widely exploited when they are deployed in much wider channel widths than previous generations of mobile systems.

The benefits in terms of the cost/performance of mobile networks are greater in the emerging LTE than in previous eras of mobile technology since the performance of LTE deployments is notably improved and indeed only manifestly superior to WCDMA and HSPA+ when it is deployed in wide channel widths .In contrast, WCDMA is only designed for deployment with 5 MHz carriers. Yet, the wider the channels or the bandwidths of individual licenses that are allocated in a band the fewer the number of separate licensees it accommodates. However, in order to realize the techno-economic benefits of LTE over 3G predecessors, 20+ MHz channel bandwidths are desirable.

The most critical next steps for many countries in exploiting wireless to expand affordable broadband coverage involve decisions about the 2.6GHz and the digital dividend bands (850,900MHz) which are complementary with respect to achieving national coverage from urban to rural areas with the optimum techno-economic deployments.

4.2.2.1 LTE Low Frequencies vs. High Frequencies

Many people believe that radio frequencies below one GH are ideal for mobile communications while lower frequencies provide some advantages, as the industry increasingly has to deploy capacity-constrained networks, the differences between low and high frequencies become much less significant. In capacity-oriented networks, all spectrum is highly prized and provides almost identical carrying capacity.

Lower frequencies do offer advantages as noticed in this project especially the 900MHz, but from another point of view is that these advantages are often overstated. Most usage of mobile broadband networks will occur within higher population densities in which networks will have to be designed for capacity rather than coverage. In these scenarios, low and high frequencies offer almost equivalent performance. In addition, to that ,deploying LTE in 900MHz can also bring the additional cost benefits of being able to deploy LTE at existing GSM sites as the coverage of GSM/LTE in 900MHz should be very similar.

While trying to cover an area with the minimum number of sites, using 1800 MHz takes somewhere between 2 to 4 times as many sites as 900 MHz .The exact ratio depends on multiple factors such as path loss, the link budget, cell tower height, and the geometry of the area being covered. The biggest difference is the frequency and the larger number of cell sites required for the higher frequency.

As a result, a 900 MHz LTE deployment makes a lot of sense as a network built for coverage. Even wireless networks that use the most advanced wireless technologies available such as LTE, have extremely limited capacity. It only takes a handful of users simultaneously streaming video in a coverage area to consume sector capacity. For that reason, operators who are looking for networks built for coverage that is what lower frequencies offer, will need to add capacity once they start loading their networks with subscribers.

A result for higher frequencies takes more sites to build out at 1.8GHz, but the increased number of sites simultaneously translates to much greater capacity. So even if it were to take three times as many sites for 1.8 GHz as for 900 MHz, the 1.8 GHz network will have three times as much capacity as the 700 to 900 MHz network, and the overall LTE network now has four times the total capacity as it did with just the 900 MHz band.

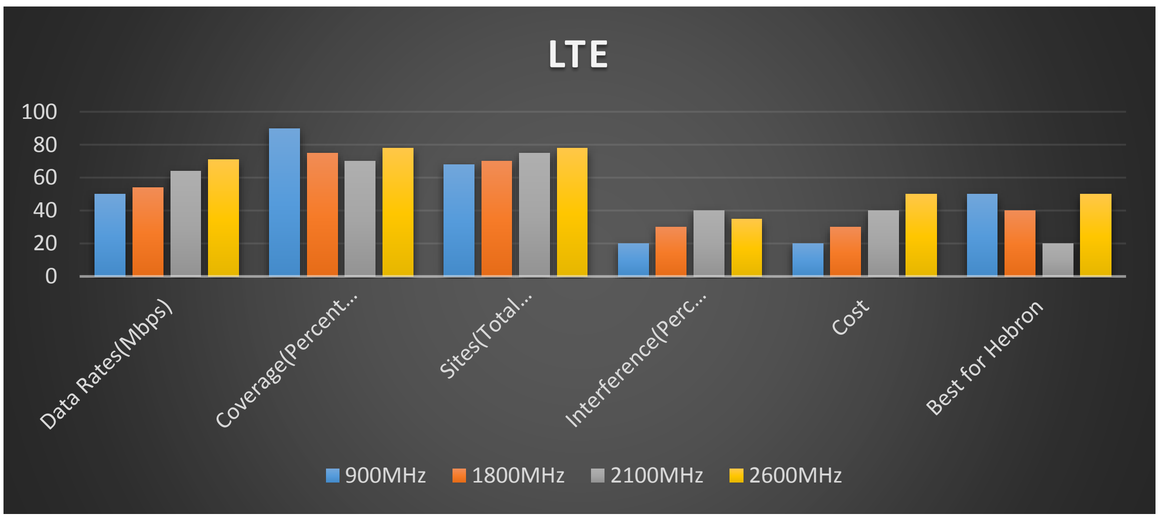


Figure 4.2: LTE Hebron Planning Comparison Chart for Hebron

Of course, if an operator builds on higher frequencies, such as 1.7 GHz, 1.8GHz, 1.9 GHz, or 2.6 GHz in the first place, then he would have a high capacity network from the beginning. As such, a network built at just higher frequencies would not ultimately cost any more to achieve comparable capacity.

The bottom line is that lower frequencies do offer advantages, but through this project research, planner's point of view is that these advantages are often overstated. Most usage of mobile broadband networks will occur within higher population densities in which networks will have to be designed for capacity rather than coverage as figure 4.2 shows. In these scenarios, low and high frequencies offer almost equivalent performance.

4.3 WCDMA vs. LTE

WCDMA was specified in the 3GPP release 99 and 4 of the specification, while LTE was specified in the 3GPP release 8 and 9. Unlike WCDMA, LTE supports variable bandwidth from 1.25MHz to 20MHz. When the data rates were compared, LTE provided massive downlink speeds than WCDMA. In addition, the spectral efficiency is much higher in LTE than that of the WCDMA.

4.3.1 WCDMA 900MHz vs. LTE 900MHz

4.3.1.1 WCDMA Coverage vs. LTE Coverage at 900MHz

Figure 4.3 shows both WCDMA and LTE coverage at 900MHz frequency, and according to table 4.1 in appendix B and according to coverage statistics, LTE provided better coverage but WCDMA coverage is also acceptable.

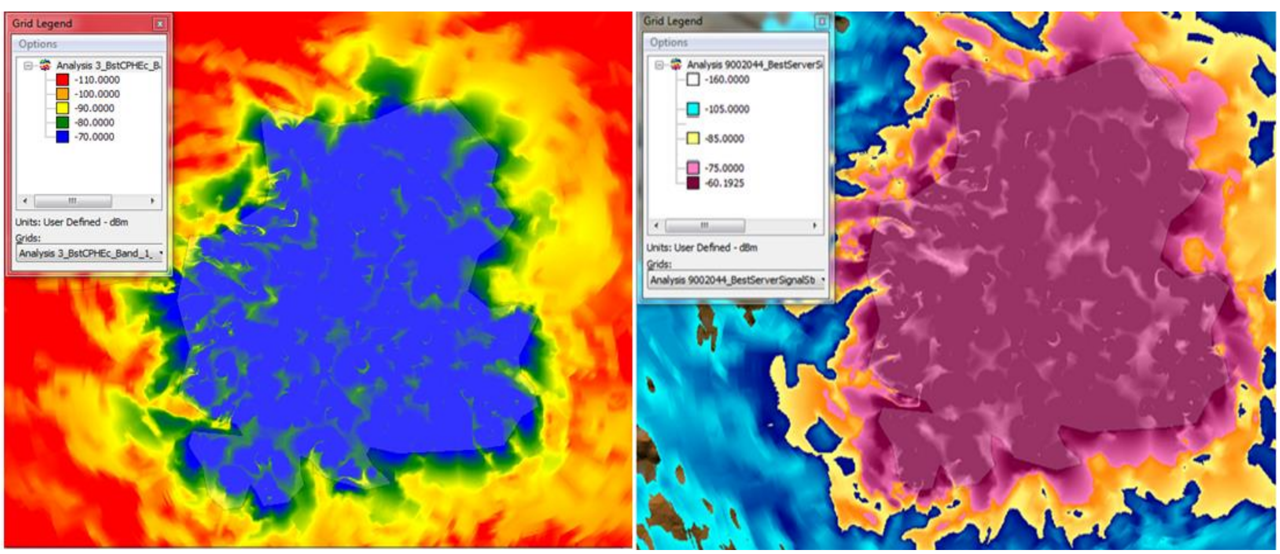


Figure 4.3: WCDMA vs. LTE Coverage at 900MHz

4.3.1.2 WCDMA Quality vs. LTE Quality at 900MHz

Figure 4.4 shows C/I , less interference resulted in LTE 900MHz since planners used 68 sites, but in WCDMA 82 sites were used .However, chapter three explained each figure in details.

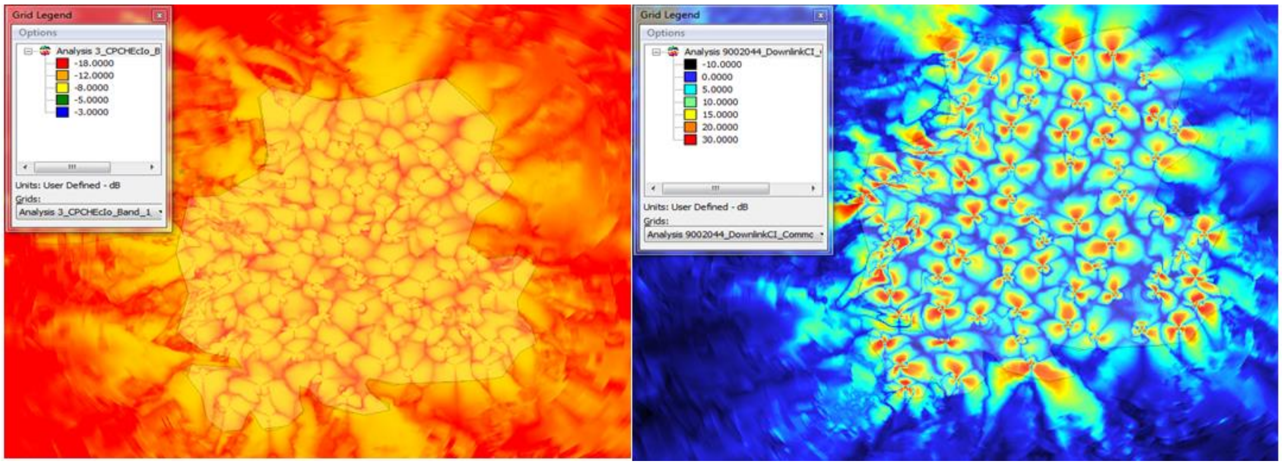


Figure 4.4: WCDMA vs. LTE C/I at 900MHz

4.3.1.3 WCDMA Capacity vs. LTE Capacity at 900MHz

WCDMA data rate through planning Hebron reached 256.0 to 384.0Kbps but higher data rates were achieved through LTE planning, it reached 20 to 50Mbps.Figure 4.5 shows each technology data rates on Mentum Tool.

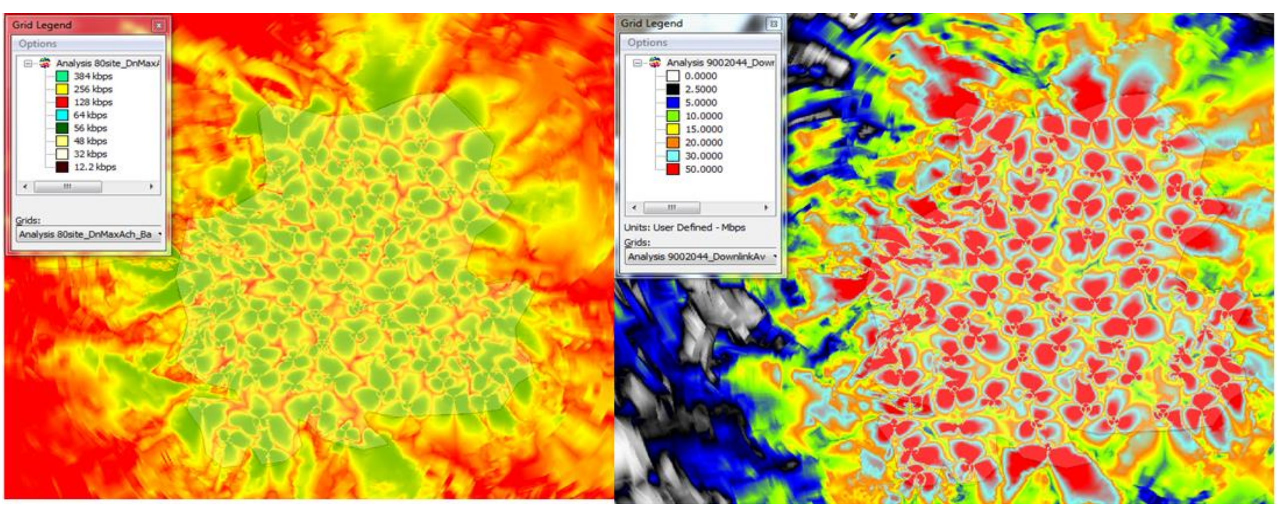


Figure 4.5: WCDMA vs. LTE Capacity at 900MHz

4.3.2 WCDMA 1800MHz vs. LTE 1800MHz

4.3.2.1 WCDMA Coverage vs. LTE Coverage at 1800MHz

WCDMA at 900MHz and 1800MHz is a good choice to be deployed in Hebron, but LTE coverage is better than WCDMA coverage as noticed in figure 4.6.

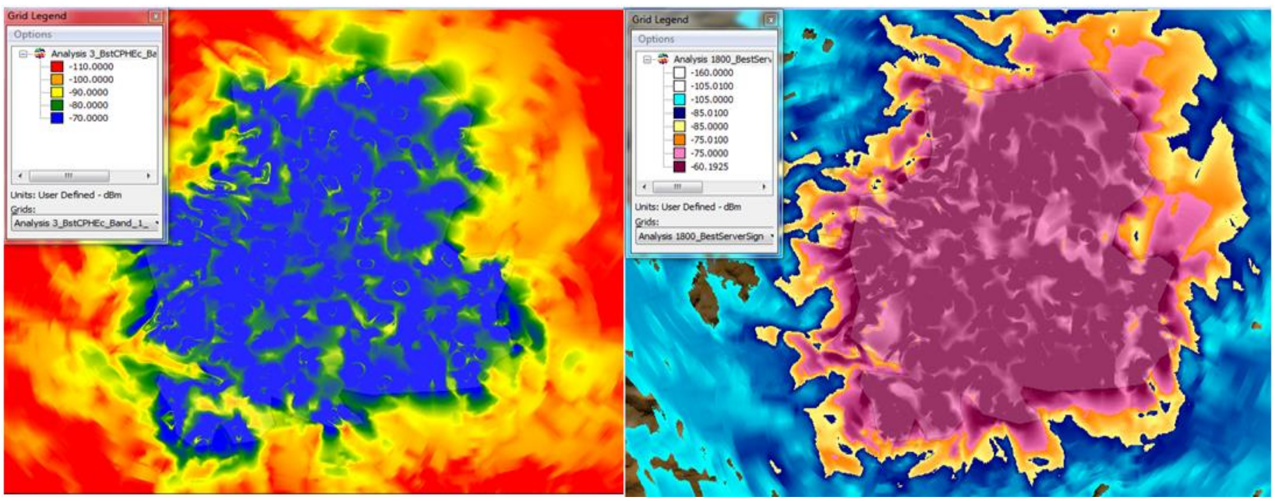


Figure 4.6: WCDMA vs. LTE Coverage at 1800MHz

4.3.2.2 WCDMA Quality vs. LTE Quality at 1800MHz

Acceptable interference in WCDMA but much less interference in LTE with much higher signal strength as shown in figure 4.7.

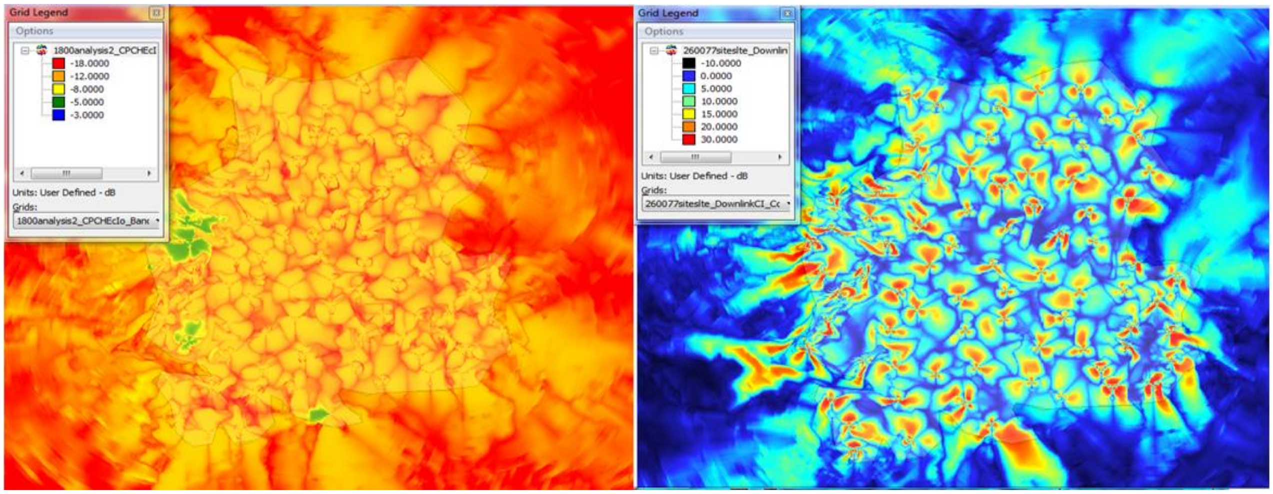


Figure 4.7: WCDMA vs. LTE Quality at 1800MHz

4.3.2.3 WCDMA Capacity vs. LTE Capacity at 1800MHz

WCDMA data rates at 1800MHz reached 465.5 to 1291.5Kbps but of course, much higher capacities in LTE that reached 20 to 54Mbps in most areas, as shown in figure 4.8.

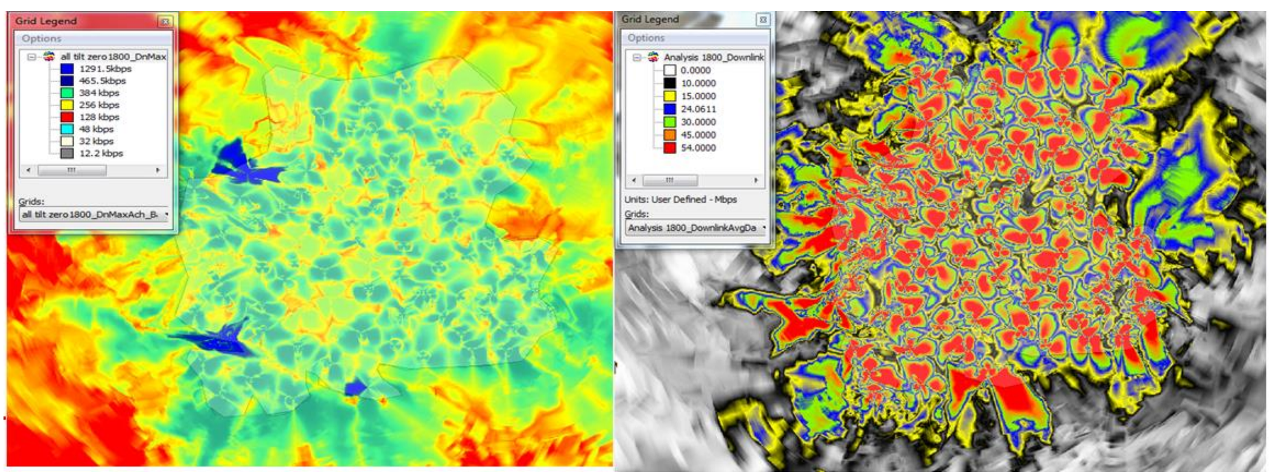


Figure 4.8: WCDMA vs. LTE Capacity at 1800MHz

4.3.3 WCDMA 2100MHz vs. LTE 2100MHz

4.3.3.1 WCDMA Coverage vs. LTE Coverage a 2100MHz

2100MHz WCDMA coverage was good but not better than 1800MHz compared to both WCDMA and LTE, as mentioned in table 4.1 in appendix B. Figure 4.9 shows coverage for both technologies at 2100MHz band.

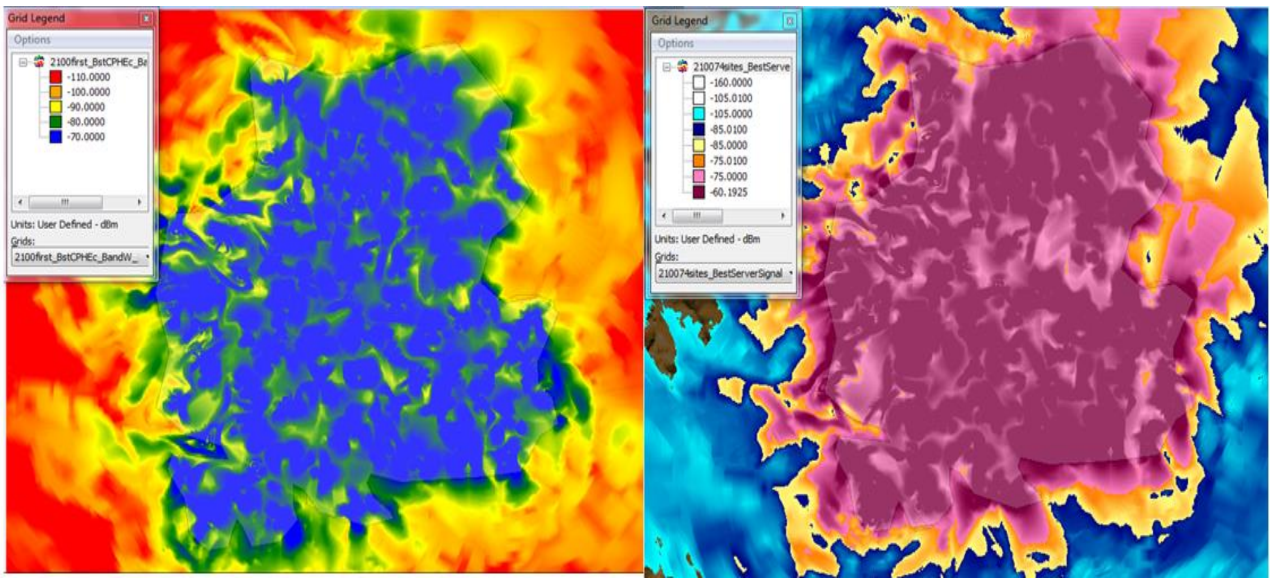


Figure 4.9: WCDMA vs. LTE Coverage at 2100MHz

4.3.3.2 WCDMA Quality vs. LTE Quality at 2100MHz

LTE Quality at 2100MHz is excellent but in WCDMA, interference is much higher as shown in figure 4.10.

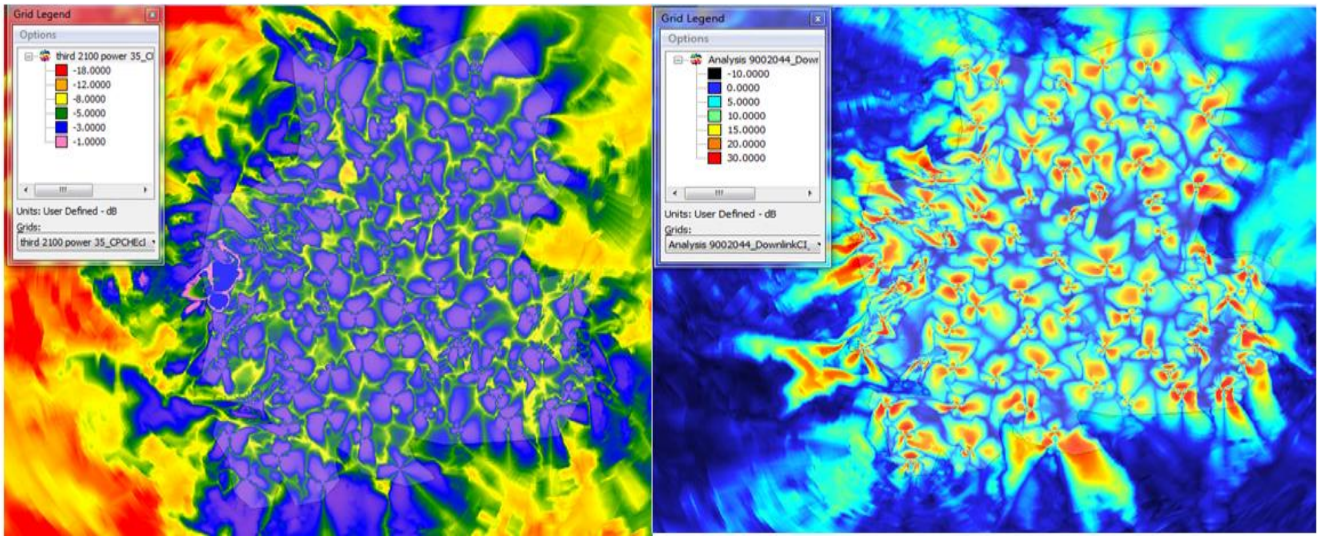


Figure 4.10: WCDMA vs. LTE Quality at 2100MHz

4.3.3.3 WCDMA Capacity vs. LTE Capacity at 2100MHz

WCDMA data rates reached 871.0 to 2094.5Kbps but in LTE, it reached 15 to 64.9Mbps.However, WCDMA in this band needed 85 sites and LTE needed 75 sites as shown in figure 4.11.

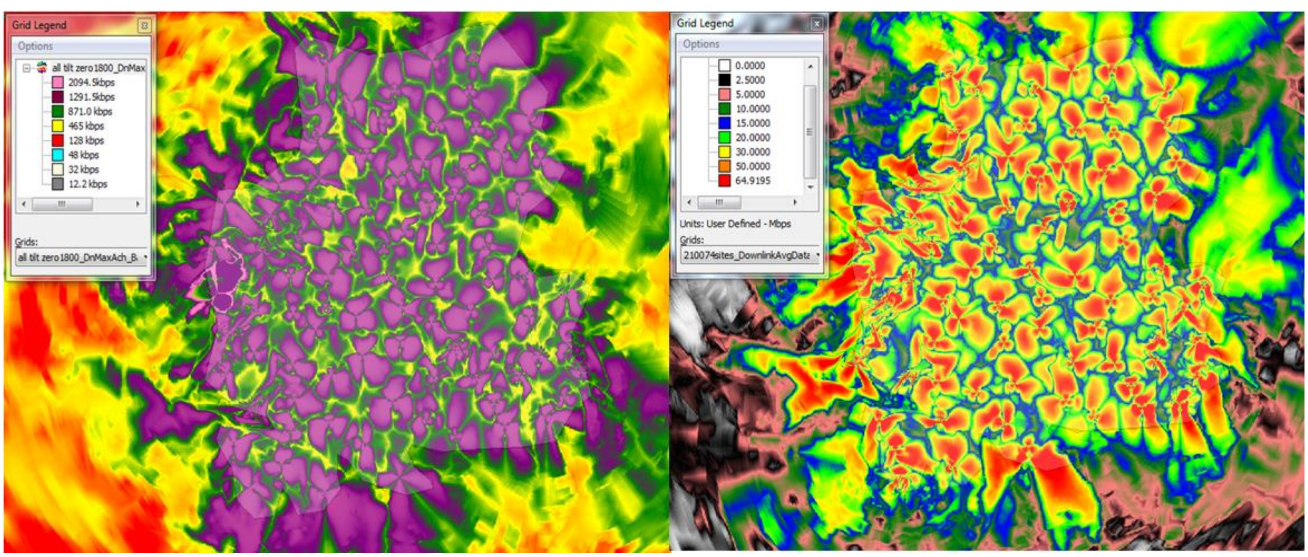


Figure 4.11: WCDMA vs. LTE Capacity at 2100MHz

Taking Hebron (Urban and low Urban areas) as a case study, 900MHz and 1800MHz licensed are only allowed for GSM because of Israeli restrictions. This case study showed that after taking the technology and equipment license, WCDMA is a good choice to be deployed for Hebron city at 900MHz or 1800MHz. However, LTE can take license to work on those frequencies; other countries have already deployed it in accordance with traffic demands and many other obligations.

WCDMA 900MHz have spectral efficiency features since it enables considerable reduction in number of sites, amount of site hardware, and site visits. WCDMA in the 900 MHz band is a cost effective way to deliver nationwide high-speed wireless coverage. It achieves a 60 percent reduction in cell sites required to serve rural areas and delivers improved Quality of Service in urban areas by enhancing in-building penetration by 25 percentile

Compared to WCDMA, LTE is expected to substantially improve end-user throughputs, sector capacity and reduce user plane latency to deliver a significantly improved user experience as shown in figure 4.12 and table 4.1 in appendix B. As such, the industry expects that Service Providers will wait to deploy LTE in the deployment of 900 MHz and newly licensed 2.5-2.6 GHz bands.

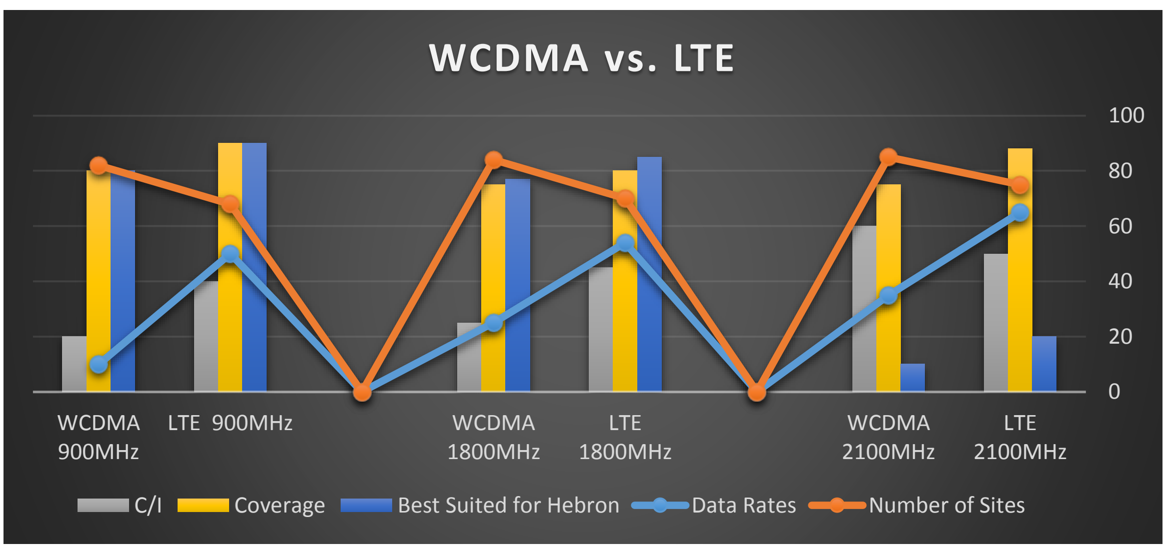


Figure 4.12: WCDMA vs. LTE Chart, Final Comparison for Hebron City

4.4 Conclusion

WCDMA vs. LTE was the main subject of this project. Hebron city, which is classified as low urban to urban area, was the case to be studied through planning and optimizing on different frequencies. According to this, project planners make the comparison in terms capacity coverage and quality and as was mentioned in detail in this chapter, which embraces the conclusion. However, WCDMA at 900 and 1800MHz is good to be deployed because of its excellent coverage and minimum cost, but if operators and planners consider the capacity, then LTE at 900MHz comes, as a choice .It is true that it will cost more, but higher data rates and excellent coverage will be provided to the end users.

Table 4.1: Final WCDMA (Rel.99) and LTE FDD Comparison Results

WCDMA(Rel.99) Vs. LTE FDD							
Parameters	WCDMA(Rel.99) 5MHz BW			LTE FDD 5MHz BW			
	900MHz	1800MHz	2100MHz	900MHZ	1800MHz	2100MHz	2600MHz
Coverage	BEST compared to WCDMA other freq.	Very Good but needed many work and simulation.	Good Coverage resulted with not so many modifications	Best Coverage and much better than 900WCDMA .	Very Good Coverage Much better than 1800 WCDMA.	Good Coverage little bit better than 2100 WCDMA.	Very Good Coverage with this higher frequency.
Max. DL. Data Rates Kbps,Mbps	256.0 to 384.0Kbps	465.5 to 1291.5Kbps	871.0 to 2094.5Kbps	20 to 50Mbps	20 to 54Mbps	15 to 64.9Mbps	10 to 71Mbps
C/I	-8 to -12 dB Strong signal strength with less interference	-5 to -12 dB Strong signal strength with acceptable interference.	-1 to -8 dB Strong signal power but little interference was found.	0 to 30dB Very strong signal power and un noticed interference .	0 to 20 dB Interference I some places, particularly where there is sites with four sectors.	Mostly 0dB, and in middle areas 5 to 20 dB .	0 to 5 to 20 dB according to areas and some interference in crowded areas.
Coverage Statistics %	75% was covered with blue zone having -75dBm, and 20% with -80dBm.	65% was covered with -75dBm, 15% was covered with -80dBm, and 10% was covered with -90dBm.	60% was covered with -75dBm , 10% was covered with -80dBm, and 15% was covered with -90dBm.	75% was covered with -60dBm, 25% with -75dBm.	60% was covered with -60dBm ,15% with -75dBm,and 25% with -85dBm.	55% was covered with -60dBm, 10% with -75dBm, and 30% with -85dBm.	60% was covered with -60dBm, 20%with -75dBm, and 10% with -85dBm.
Sites Tabular Editor	Appendix A Table 3.4	Appendix A Table 3.5	Appendix A Table 3.6	Appendix A Table 3.7	Appendix A Table 3.8	Appendix A Table 3.9	Appendix A Table 3.10
Modifications	Appendix B Table 3.11	Appendix B Table 3.12	Appendix B Table 3.13	Appendix B Table 3.14	Appendix B Table 3.15	Appendix B Table 3.16	Appendix B Table 3.17
Total Number of Sites	82	84	85	68	70	75	78

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APPENDIX A

Sites Tabular Editor

(Sites Parameters)

APPENDIX B

Planning Analysis and Modifications

APPENDIX C

Sites Locations and Destination

For Sites Survey

APPENDIX D

WCDMA and LTE for Hebron City Coverage and quality before and after

APPENDIX A

Table 3.7: Final sites parameter values at 900MHZ for LTE

Tabular Editor	**900MHz LTE**				
Site ID	**Antenna ID**	**Azimuth(degree)**	**Mechanical Tilt(degree)**	**Height(m)**	**Power(dBm)**
Site-1	**1**	**0**	**0**	**15**	**47**
Site-1	**2**	**120**	**0**	**15**	**47**
Site-1	**3**	**250**	**0**	**15**	**47**
Site-2	**1**	**300**	**7**	**15**	**47**
Site-2	**2**	**150**	**7**	**15**	**47**
Site-2	**3**	**40**	**0**	**15**	**47**
Site-3	**1**	**0**	**0**	**15**	**47**
Site-3	**2**	**120**	**-4**	**15**	**47**
Site-3	**3**	**240**	**-4**	**15**	**47**
Site-4	**1**	**330**	**7**	**15**	**47**
Site-4	**2**	**80**	**7**	**15**	**47**
Site-4	**3**	**240**	**7**	**15**	**47**
Site-5	**1**	**0**	**0**	**15**	**47**
Site-5	**2**	**120**	**0**	**15**	**47**
Site-5	**3**	**240**	**0**	**15**	**47**
Site-6	**1**	**0**	**0**	**15**	**47**
Site-6	**2**	**120**	**0**	**15**	**47**
Site-6	**3**	**240**	**0**	**15**	**47**
Site-7	**1**	**0**	**0**	**15**	**47**
Site-7	**2**	**120**	**0**	**15**	**47**
Site-7	**3**	**240**	**0**	**15**	**47**
Site-8	**1**	**330**	**0**	**15**	**47**
Site-8	**2**	**120**	**0**	**15**	**47**
Site-8	**3**	**240**	**0**	**15**	**47**
Site-9	**1**	**20**	**0**	**15**	**47**
Site-9	**2**	**120**	**0**	**15**	**47**
Site-9	**3**	**250**	**0**	**15**	**47**
Site-10	**1**	**0**	**0**	**15**	**47**
Site-10	**2**	**120**	**0**	**15**	**47**
Site-10	**3**	**240**	**0**	**15**	**47**
Site-11	**1**	**0**	**0**	**15**	**47**
Site-11	**2**	**120**	**0**	**15**	**47**

Site-11	**3**	**240**	**0**	**15**	**47**	
Site-12	**1**	**0**	**0**	**15**	**47**	
Site-12	**2**	**90**	**0**	**15**	**47**	
Site-12	**3**	**240**	**0**	**15**	**47**	
Site-13	**1**	**0**	**0**	**15**	**47**	
Site-13	**2**	**120**	**0**	**15**	**47**	
Site-13	**3**	**240**	**0**	**15**	**47**	
Site-14	**1**	**0**	**0**	**15**	**47**	
Site-14	**2**	**120**	**4**	**15**	**47**	
Site-14	**3**	**240**	**7**	**15**	**47**	
Site-15	**1**	**0**	**0**	**15**	**47**	
Site-15	**2**	**120**	**0**	**15**	**47**	
Site-15	**3**	**240**	**0**	**15**	**47**	
Site-16	**1**	**0**	**0**	**15**	**47**	
Site-16	**2**	**120**	**0**	**15**	**47**	
Site-16	**3**	**240**	**0**	**15**	**47**	
Site-17	**1**	**0**	**0**	**15**	**47**	
Site-17	**2**	**120**	**0**	**15**	**47**	
Site-17	**3**	**240**	**0**	**15**	**47**	
Site-18	**1**	**0**	**0**	**15**	**47**	
Site-18	**2**	**120**	**0**	**15**	**47**	
Site-18	**3**	**240**	**0**	**15**	**47**	
Site-19	**1**	**0**	**0**	**15**	**47**	
Site-19	**2**	**120**	**0**	**15**	**47**	
Site-19	**3**	**240**	**0**	**15**	**47**	
Site-20	**1**	**0**	**0**	**15**	**47**	
Site-20	**2**	**120**	**0**	**15**	**47**	
Site-20	**3**	**240**	**0**	**15**	**47**	
Site-21	**1**	**200**	**-4**	**15**	**47**	
Site-21	**2**	**340**	**7**	**15**	**47**	
Site-21	**3**	**100**	**0**	**15**	**47**	
Site-22	**1**	**0**	**7**	**15**	**47**	
Site-22	**2**	**120**	**7**	**15**	**47**	
Site-22	**3**	**240**	**7**	**15**	**47**	
Site-23	**1**	**0**	**7**	**15**	**47**	
Site-23	**2**	**120**	**7**	**15**	**47**	

Site-23	2	240	7	15	47	
Site-24	1	0	7	15	47	
Site-24	2	120	7	15	47	
Site-24	3	240	7	15	47	
Site-25	1	0	0	15	47	
Site-25	2	120	0	15	47	
Site-25	3	240	0	15	47	
Site-26	1	0	7	15	47	
Site-26	2	120	7	15	47	
Site-26	3	240	7	15	47	
Site-27	1	0	7	15	47	
Site-27	2	120	7	15	47	
Site-27	3	240	7	15	47	
Site-28	1	0	7	15	47	
Site-28	2	120	7	15	47	
Site-28	3	240	7	15	47	
Site-29	1	0	0	15	47	
Site-29	2	120	0	15	47	
Site-29	3	240	0	15	47	
Site-30	1	40	0	15	47	
Site-30	2	120	0	15	47	
Site-30	3	240	0	15	47	
Site-31	1	0	0	15	47	
Site-31	2	120	7	15	47	
Site-31	3	240	7	15	47	
Site-32	1	40	0	15	47	
Site-32	2	120	0	15	47	
Site-32	3	240	0	15	47	
Site-33	1	0	0	15	47	
Site-33	2	120	7	15	47	
Site-33	3	240	7	15	47	
Site-34	1	0	0	15	47	
Site-34	2	120	0	15	47	
Site-34	3	240	0	15	47	
Site-35	1	0	0	15	47	
Site-35	2	120	0	15	47	

Site-35	3	240	0	15	47	
Site-36	1	0	0	15	47	
Site-36	2	130	-4	15	47	
Site-36	3	240	-4	15	47	
Site-37	1	0	4	15	47	
Site-37	2	120	0	15	47	
Site-37	3	240	4	15	47	
Site-38	1	0	0	15	47	
Site-38	2	120	4	15	47	
Site-38	3	240	4	15	47	
Site-39	1	0	0	15	47	
Site-39	2	120	0	15	47	
Site-39	3	240	0	15	47	
Site-40	1	0	0	15	47	
Site-40	2	120	0	15	47	
Site-40	3	240	0	15	47	
Site-41	1	0	0	15	47	
Site-41	2	120	0	15	47	
Site-41	3	240	0	15	47	
Site-42	1	0	0	15	47	
Site-42	2	120	0	15	47	
Site-42	3	240	0	15	47	
Site-43	1	0	0	15	47	
Site-43	2	120	0	15	47	
Site-43	3	240	0	15	47	
Site-44	1	0	4	15	47	
Site-44	2	120	4	15	47	
Site-44	3	240	0	15	47	
Site-45	1	0	0	15	47	
Site-45	2	80	0	15	47	
Site-45	3	260	0	15	47	
Site-46	1	0	7	15	47	
Site-46	2	120	7	15	47	
Site-46	3	240	7	15	47	
Site-47	1	0	0	15	47	
Site-47	2	120	0	15	47	

Site-47	3	240	0	15	47	
Site-48	1	300	7	15	47	
Site-48	2	160	7	15	47	
Site-48	3	230	7	15	47	
Site-49	1	0	0	15	47	
Site-49	2	120	0	15	47	
Site-49	3	240	0	15	47	
Site-50	1	45	-4	15	47	
Site-50	2	130	0	15	47	
Site-50	3	240	0	15	47	
Site-51	1	0	-4	15	47	
Site-51	2	90	0	15	47	
Site-51	3	180	0	15	47	
Site-52	1	0	4	15	47	
Site-52	2	120	4	15	47	
Site-52	3	200	4	15	47	
Site-53	1	0	-7	15	47	
Site-53	2	120	0	15	47	
Site-53	3	240	0	15	47	
Site-54	1	0	0	15	47	
Site-54	2	120	0	15	47	
Site-54	3	240	0	15	47	
Site-55	1	0	0	15	47	
Site-55	2	120	0	15	47	
Site-55	3	240	0	15	47	
Site-56	1	0	4	15	47	
Site-56	2	100	4	15	47	
Site-56	3	240	0	15	47	
Site-57	1	330	0	15	47	
Site-57	2	180	7	15	47	
Site-57	3	80	0	15	47	
Site-58	1	220	4	15	47	
Site-58	2	300	0	15	47	
Site-58	3	80	4	15	47	
Site-59	1	0	0	15	47	
Site-59	2	120	-4	15	47	

Site-59	**3**	**240**	**-4**	**15**	**47**	
Site-60	**1**	**0**	**7**	**15**	**47**	
Site-60	**2**	**120**	**0**	**15**	**47**	
Site-60	**3**	**240**	**0**	**15**	**47**	
Site-61	**1**	**30**	**4**	**15**	**47**	
Site-61	**2**	**120**	**4**	**15**	**47**	
Site-61	**3**	**220**	**4**	**15**	**47**	
Site-62	**1**	**330**	**0**	**15**	**47**	
Site-62	**2**	**120**	**0**	**15**	**47**	
Site-62	**3**	**45**	**0**	**15**	**47**	
Site-63	**1**	**0**	**0**	**15**	**47**	
Site-63	**2**	**120**	**0**	**15**	**47**	
Site-63	**3**	**270**	**0**	**15**	**47**	
Site-64	**1**	**0**	**0**	**15**	**47**	
Site-64	**2**	**120**	**0**	**15**	**47**	
Site-64	**3**	**240**	**0**	**15**	**47**	
Site-65	**1**	**0**	**0**	**15**	**47**	
Site-65	**2**	**120**	**0**	**15**	**47**	
Site-65	**3**	**240**	**0**	**15**	**47**	
Site-66	**1**	**0**	**4**	**15**	**47**	
Site-66	**2**	**120**	**4**	**15**	**47**	
Site-66	**3**	**240**	**0**	**15**	**47**	
Site-67	**1**	**0**	**0**	**15**	**47**	
Site-67	**2**	**120**	**7**	**15**	**47**	
Site-67	**3**	**240**	**7**	**15**	**47**	
Site-68	**1**	**0**	**7**	**15**	**47**	
Site-68	**2**	**120**	**4**	**15**	**47**	
Site-68	**3**	**240**	**7**	**15**	**47**	

Table 3.8: Final sites parameter values at 1800MHz for LTE

Tabular Editor	1800MHz LTE				
Site ID	Antenna ID	Azimuth (degree)	Mechanical Tilt(degree)	Height(m)	Power(dBm)
Site-1	1	0	0	15	47
Site-1	2	120	0	15	47
Site-1	3	250	0	15	47
Site-2	1	300	7	15	47
Site-2	2	150	7	15	47
Site-2	3	40	0	15	47
Site-3	1	0	0	15	47
Site-3	2	120	-4	15	47
Site-3	3	240	-4	15	47
Site-4	1	330	0	15	47
Site-4	2	80	0	15	47
Site-4	3	240	-4	15	47
Site-5	1	0	0	15	47
Site-5	2	120	0	15	47
Site-5	3	240	0	15	47
Site-6	1	0	0	15	47
Site-6	2	120	0	15	47
Site-6	3	240	0	15	47
Site-7	1	0	0	15	47
Site-7	2	120	0	15	47
Site-7	3	240	0	15	47
Site-8	1	330	0	15	47
Site-8	2	120	0	15	47
Site-8	3	240	0	15	47
Site-9	1	20	0	15	47
Site-9	2	120	0	15	47
Site-9	3	250	0	15	47
Site-10	1	0	0	15	47
Site-10	2	120	0	15	47
Site-10	3	240	0	15	47
Site-11	1	0	0	15	47

Site-11	2	120	0	15	47
Site-11	3	240	0	15	47
Site-12	1	0	0	15	47
Site-12	2	90	0	15	47
Site-12	3	240	0	15	47
Site-13	1	0	0	15	47
Site-13	2	120	0	15	47
Site-13	3	240	0	15	47
Site-14	1	35	7	15	47
Site-14	2	120	7	15	47
Site-14	3	240	7	15	47
Site-15	1	0	4	15	47
Site-15	2	120	-4	15	47
Site-15	3	240	4	15	47
Site-16	1	0	0	15	47
Site-16	2	120	0	15	47
Site-16	3	240	0	15	47
Site-17	1	0	4	15	47
Site-17	2	120	4	15	47
Site-17	3	240	0	15	47
Site-18	1	0	0	15	47
Site-18	2	120	0	15	47
Site-18	3	240	0	15	47
Site-19	1	0	0	15	47
Site-19	2	120	0	15	47
Site-19	3	240	0	15	47
Site-20	1	0	0	15	47
Site-20	2	120	0	15	47
Site-20	3	240	0	15	47
Site-21	1	200	-4	15	47
Site-21	2	340	7	15	47
Site-21	3	100	0	15	47
Site-22	1	0	7	15	47
Site-22	2	120	7	15	47
Site-22	3	240	7	15	47
Site-23	1	0	7	15	47

Site-23	2	120	7	15	47
Site-23	2	240	7	15	47
Site-24	1	0	7	15	47
Site-24	2	120	7	15	47
Site-24	3	240	7	15	47
Site-25	1	0	0	15	47
Site-25	2	120	0	15	47
Site-25	3	240	0	15	47
Site-26	1	0	7	15	47
Site-26	2	120	7	15	47
Site-26	3	240	7	15	47
Site-27	1	0	7	15	47
Site-27	2	120	7	15	47
Site-27	3	240	7	15	47
Site-28	1	0	7	15	47
Site-28	2	120	7	15	47
Site-28	3	240	7	15	47
Site-29	1	0	0	15	47
Site-29	2	120	0	15	47
Site-29	3	240	0	15	47
Site-30	1	40	0	15	47
Site-30	2	120	0	15	47
Site-30	3	240	0	15	47
Site-31	1	0	0	15	47
Site-31	2	120	0	15	47
Site-31	3	240	0	15	47
Site-32	1	40	0	15	47
Site-32	2	120	0	15	47
Site-32	3	240	0	15	47
Site-33	1	0	0	15	47
Site-33	2	120	7	15	47
Site-33	3	240	7	15	47
Site-34	1	0	0	15	47
Site-34	2	120	0	15	47
Site-34	3	240	0	15	47
Site-35	1	0	0	15	47

Site-35	**2**	**120**	**0**	**15**	**47**
Site-35	**3**	**240**	**0**	**15**	**47**
Site-36	**1**	**0**	**0**	**15**	**47**
Site-36	**2**	**130**	**-4**	**15**	**47**
Site-36	**3**	**240**	**-4**	**15**	**47**
Site-37	**1**	**0**	**7**	**15**	**47**
Site-37	**2**	**120**	**7**	**15**	**47**
Site-37	**3**	**240**	**7**	**15**	**47**
Site-38	**1**	**0**	**7**	**15**	**47**
Site-38	**2**	**120**	**7**	**15**	**47**
Site-38	**3**	**240**	**7**	**15**	**47**
Site-39	**1**	**0**	**0**	**15**	**47**
Site-39	**2**	**120**	**0**	**15**	**47**
Site-39	**3**	**240**	**0**	**15**	**47**
Site-40	**1**	**0**	**0**	**15**	**47**
Site-40	**2**	**120**	**0**	**15**	**47**
Site-40	**3**	**240**	**0**	**15**	**47**
Site-41	**1**	**0**	**0**	**15**	**47**
Site-41	**2**	**120**	**0**	**15**	**47**
Site-41	**3**	**240**	**0**	**15**	**47**
Site-42	**1**	**0**	**0**	**15**	**47**
Site-42	**2**	**120**	**0**	**15**	**47**
Site-42	**3**	**240**	**0**	**15**	**47**
Site-43	**1**	**0**	**0**	**15**	**47**
Site-43	**2**	**120**	**0**	**15**	**47**
Site-43	**3**	**240**	**0**	**15**	**47**
Site-44	**1**	**0**	**4**	**15**	**47**
Site-44	**2**	**120**	**4**	**15**	**47**
Site-44	**3**	**240**	**0**	**15**	**47**
Site-45	**1**	**0**	**0**	**15**	**47**
Site-45	**2**	**80**	**0**	**15**	**47**
Site-45	**3**	**260**	**0**	**15**	**47**
Site-46	**1**	**0**	**7**	**15**	**47**
Site-46	**2**	**120**	**7**	**15**	**47**
Site-46	**3**	**240**	**7**	**15**	**47**
Site-47	**1**	**0**	**0**	**15**	**47**

Site-47	2	120	0	15	47
Site-47	3	240	0	15	47
Site-48	1	300	7	15	47
Site-48	2	160	7	15	47
Site-48	3	230	7	15	47
Site-49	1	0	0	15	47
Site-49	2	120	0	15	47
Site-49	3	240	0	15	47
Site-50	1	40	4	15	47
Site-50	2	160	0	15	47
Site-50	3	240	0	15	47
Site-51	1	0	-4	15	47
Site-51	2	120	0	15	47
Site-51	3	200	0	15	47
Site-52	1	0	-4	15	47
Site-52	2	120	4	15	47
Site-52	3	200	-4	15	47
Site-53	1	0	-7	15	47
Site-53	2	120	0	15	47
Site-53	3	240	0	15	47
Site-54	1	0	0	15	47
Site-54	2	120	0	15	47
Site-54	3	240	0	15	47
Site-55	1	0	0	15	47
Site-55	2	120	0	15	47
Site-55	3	240	0	15	47
Site-56	1	0	4	15	47
Site-56	2	100	4	15	47
Site-56	3	240	-4	15	47
Site-57	1	330	0	15	47
Site-57	2	220	7	15	47
Site-57	3	80	0	15	47
Site-58	1	220	4	15	47
Site-58	2	300	0	15	47
Site-58	3	80	4	15	47
Site-59	1	0	0	15	47

Site-59	2	120	-4	15	47
Site-59	3	240	-4	15	47
Site-60	1	0	7	15	47
Site-60	2	120	0	15	47
Site-60	3	240	0	15	47
Site-61	1	30	4	15	47
Site-61	2	120	4	15	47
Site-61	3	220	4	15	47
Site-62	1	330	0	15	47
Site-62	2	120	0	15	47
Site-62	3	60	0	15	47
Site-63	1	0	0	15	47
Site-63	2	120	0	15	47
Site-63	3	270	0	15	47
Site-64	1	0	0	15	47
Site-64	2	120	0	15	47
Site-64	3	240	0	15	47
Site-65	1	0	0	15	47
Site-65	2	120	0	15	47
Site-65	3	240	0	15	47
Site-66	1	0	4	15	47
Site-66	2	120	4	15	47
Site-66	3	240	0	15	47
Site-67	1	0	7	15	47
Site-67	2	120	7	15	47
Site-67	3	240	7	15	47
Site-68	1	0	7	15	47
Site-68	2	120	4	15	47
Site-68	3	240	7	15	47
Site-69	1	0	7	15	47
Site-69	2	120	7	15	47
Site-69	3	240	7	15	47
Site-70	1	0	7	15	47
Site-70	2	120	7	15	47
Site-70	3	240	7	15	47

Table 3.9: Final sites parameter values at 2100MHz for LTE

Tabular Editor	2100MHz LTE				
Site ID	**Antenna ID**	**Azimuth(degree)**	**Mechanical Tilt(degree)**	**Height(m)**	**Power(dBm)**
Site-1	1	0	0	15	47
Site-1	2	120	0	15	47
Site-1	3	250	0	15	47
Site-2	1	300	7	15	47
Site-2	2	150	7	15	47
Site-2	3	40	0	15	47
Site-3	1	0	0	15	47
Site-3	2	120	-4	15	47
Site-3	3	240	-4	15	47
Site-4	1	80	0	15	47
Site-4	2	120	0	15	47
Site-4	3	240	-4	15	47
Site-5	1	0	0	15	47
Site-5	2	120	0	15	47
Site-5	3	240	0	15	47
Site-6	1	0	0	15	47
Site-6	2	120	0	15	47
Site-6	3	240	0	15	47
Site-7	1	0	0	15	47
Site-7	2	120	0	15	47
Site-7	3	240	0	15	47
Site-8	1	330	0	15	47
Site-8	2	120	0	15	47
Site-8	3	240	0	15	47
Site-9	1	20	0	15	47
Site-9	2	120	0	15	47
Site-9	3	250	0	15	47
Site-10	1	0	0	15	47
Site-10	2	120	0	15	47
Site-10	3	240	0	15	47
Site-11	1	0	0	15	47

Site-11	**2**	**120**	**0**	**15**	**47**
Site-11	**3**	**240**	**0**	**15**	**47**
Site-12	**1**	**0**	**0**	**15**	**47**
Site-12	**2**	**90**	**0**	**15**	**47**
Site-12	**3**	**240**	**0**	**15**	**47**
Site-13	**1**	**0**	**0**	**15**	**47**
Site-13	**2**	**120**	**0**	**15**	**47**
Site-13	**3**	**240**	**0**	**15**	**47**
Site-14	**1**	**35**	**7**	**15**	**47**
Site-14	**2**	**120**	**7**	**15**	**47**
Site-14	**3**	**240**	**7**	**15**	**47**
Site-15	**1**	**0**	**4**	**15**	**47**
Site-15	**2**	**120**	**-4**	**15**	**47**
Site-15	**3**	**240**	**4**	**15**	**47**
Site-16	**1**	**0**	**0**	**15**	**47**
Site-16	**2**	**120**	**0**	**15**	**47**
Site-16	**3**	**240**	**0**	**15**	**47**
Site-17	**1**	**0**	**4**	**15**	**47**
Site-17	**2**	**120**	**4**	**15**	**47**
Site-17	**3**	**240**	**0**	**15**	**47**
Site-18	**1**	**0**	**0**	**15**	**47**
Site-18	**2**	**120**	**0**	**15**	**47**
Site-18	**3**	**240**	**0**	**15**	**47**
Site-19	**1**	**0**	**0**	**15**	**47**
Site-19	**2**	**120**	**0**	**15**	**47**
Site-19	**3**	**240**	**0**	**15**	**47**
Site-20	**1**	**0**	**0**	**15**	**47**
Site-20	**2**	**120**	**0**	**15**	**47**
Site-20	**3**	**240**	**0**	**15**	**47**
Site-21	**1**	**200**	**-4**	**15**	**47**
Site-21	**2**	**340**	**7**	**15**	**47**
Site-21	**3**	**100**	**0**	**15**	**47**
Site-22	**1**	**0**	**7**	**15**	**47**
Site-22	**2**	**120**	**7**	**15**	**47**
Site-22	**3**	**240**	**7**	**15**	**47**
Site-23	**1**	**0**	**7**	**15**	**47**

Site-23	2	120	7	15	47
Site-23	2	240	7	15	47
Site-24	1	0	7	15	47
Site-24	2	120	7	15	47
Site-24	3	240	7	15	47
Site-25	1	0	0	15	47
Site-25	2	120	0	15	47
Site-25	3	240	0	15	47
Site-26	1	0	7	15	47
Site-26	2	120	7	15	47
Site-26	3	240	7	15	47
Site-27	1	0	7	15	47
Site-27	2	120	7	15	47
Site-27	3	240	7	15	47
Site-28	1	0	7	15	47
Site-28	2	120	7	15	47
Site-28	3	240	7	15	47
Site-29	1	0	0	15	47
Site-29	2	120	0	15	47
Site-29	3	240	0	15	47
Site-30	1	40	0	15	47
Site-30	2	120	0	15	47
Site-30	3	240	0	15	47
Site-31	1	0	0	15	47
Site-31	2	120	0	15	47
Site-31	3	240	0	15	47
Site-32	1	40	0	15	47
Site-32	2	120	0	15	47
Site-32	3	240	0	15	47
Site-33	1	0	0	15	47
Site-33	2	120	7	15	47
Site-33	3	240	7	15	47
Site-34	1	0	0	15	47
Site-34	2	120	0	15	47
Site-34	3	240	0	15	47
Site-35	1	0	0	15	47

Site-35	2	120	0	15	47
Site-35	3	240	0	15	47
Site-36	1	0	0	15	47
Site-36	2	130	-4	15	47
Site-36	3	240	-4	15	47
Site-37	1	0	7	15	47
Site-37	2	120	7	15	47
Site-37	3	240	7	15	47
Site-38	1	0	7	15	47
Site-38	2	120	7	15	47
Site-38	3	240	7	15	47
Site-39	1	0	0	15	47
Site-39	2	120	0	15	47
Site-39	3	240	0	15	47
Site-40	1	0	0	15	47
Site-40	2	120	0	15	47
Site-40	3	240	0	15	47
Site-41	1	0	0	15	47
Site-41	2	120	0	15	47
Site-41	3	240	0	15	47
Site-42	1	0	0	15	47
Site-42	2	120	0	15	47
Site-42	3	240	0	15	47
Site-43	1	0	0	15	47
Site-43	2	120	0	15	47
Site-43	3	240	0	15	47
Site-44	1	0	4	15	47
Site-44	2	120	4	15	47
Site-44	3	240	0	15	47
Site-45	1	0	0	15	47
Site-45	2	80	0	15	47
Site-45	3	260	0	15	47
Site-46	1	0	7	15	47
Site-46	2	120	7	15	47
Site-46	3	240	7	15	47
Site-47	1	0	0	15	47

Site-47	2	120	0	15	47
Site-47	3	240	0	15	47
Site-48	1	300	7	15	47
Site-48	2	160	7	15	47
Site-48	3	230	7	15	47
Site-49	1	0	0	15	47
Site-49	2	120	0	15	47
Site-49	3	240	0	15	47
Site-50	1	40	4	15	47
Site-50	2	160	0	15	47
Site-50	3	240	0	15	47
Site-51	1	0	-4	15	47
Site-51	2	120	0	15	47
Site-51	3	200	0	15	47
Site-52	1	0	-4	15	47
Site-52	2	120	4	15	47
Site-52	3	200	-4	15	47
Site-53	1	0	-7	15	47
Site-53	2	120	0	15	47
Site-53	3	240	0	15	47
Site-54	1	0	0	15	47
Site-54	2	120	0	15	47
Site-54	3	240	0	15	47
Site-55	1	0	0	15	47
Site-55	2	120	0	15	47
Site-55	3	240	0	15	47
Site-56	1	0	4	15	47
Site-56	2	100	4	15	47
Site-56	3	240	-4	15	47
Site-57	1	330	0	15	47
Site-57	2	220	7	15	47
Site-57	3	80	0	15	47
Site-58	1	220	4	15	47
Site-58	2	300	0	15	47
Site-58	3	80	4	15	47
Site-59	1	0	0	15	47

Site-59	2	120	-4	15	47
Site-59	3	240	-4	15	47
Site-60	1	0	7	15	47
Site-60	2	100	0	15	47
Site-60	3	240	0	15	47
Site-61	1	30	4	15	47
Site-61	2	120	4	15	47
Site-61	3	220	4	15	47
Site-62	1	330	0	15	47
Site-62	2	120	0	15	47
Site-62	3	60	0	15	47
Site-63	1	0	0	15	47
Site-63	2	120	0	15	47
Site-63	3	270	0	15	47
Site-64	1	0	0	15	47
Site-64	2	120	0	15	47
Site-64	3	240	0	15	47
Site-65	1	0	0	15	47
Site-65	2	120	0	15	47
Site-65	3	240	0	15	47
Site-66	1	0	4	15	47
Site-66	2	120	4	15	47
Site-66	3	240	0	15	47
Site-67	1	0	7	15	47
Site-67	2	120	7	15	47
Site-67	3	240	7	15	47
Site-68	1	50	7	15	47
Site-68	2	120	0	15	47
Site-68	3	240	7	15	47
Site-69	1	0	7	15	47
Site-69	2	120	7	15	47
Site-69	3	240	7	15	47
Site-70	1	0	7	15	47
Site-70	2	120	7	15	47
Site-70	3	240	7	15	47
site-71	1	0	0	15	47

site-71	**2**	**120**	**0**	**15**	**47**
site-71	**3**	**240**	**0**	**15**	**47**
site-72	**1**	**315**	**0**	**15**	**47**
site-72	**2**	**45**	**0**	**15**	**47**
site-72	**3**	**120**	**0**	**15**	**47**
site-72	**4**	**240**	**0**	**15**	**47**
site-73	**1**	**0**	**0**	**15**	**47**
site-73	**2**	**120**	**0**	**15**	**47**
site-73	**3**	**240**	**0**	**15**	**47**
site-74	**1**	**0**	**7**	**15**	**47**
site-74	**2**	**120**	**7**	**15**	**47**
site-74	**3**	**240**	**7**	**15**	**47**
site-75	**1**	**0**	**7**	**15**	**47**
site-75	**2**	**120**	**7**	**15**	**47**
site-75	**3**	**240**	**7**	**15**	**47**

Table 3.10: Final sites parameter values at 2600MHz for LTE

Tabular Editor	2600MHz LTE				
Site ID	Antenna ID	Azimuth(degree)	Mechanical Tilt(degree)	Height(m)	Power(dBm)
Site-1	1	0	0	15	47
Site-1	2	120	0	15	47
Site-1	3	250	0	15	47
Site-2	1	300	7	15	47
Site-2	2	150	7	15	47
Site-2	3	40	0	15	47
Site-3	1	0	0	15	47
Site-3	2	120	0	15	47
Site-3	3	240	0	15	47
Site-4	1	330	7	15	47
Site-4	2	80	7	15	47
Site-4	3	240	7	15	47
Site-5	1	0	0	15	47
Site-5	2	120	0	15	47
Site-5	3	240	0	15	47
Site-6	1	0	0	15	47
Site-6	2	120	0	15	47
Site-6	3	240	0	15	47
Site-7	1	0	0	15	47
Site-7	2	120	0	15	47
Site-7	3	240	0	15	47
Site-8	1	330	0	15	47
Site-8	2	120	0	15	47
Site-8	3	240	0	15	47
Site-9	1	20	0	15	47
Site-9	2	120	0	15	47
Site-9	3	250	0	15	47
Site-10	1	0	0	15	47
Site-10	2	120	0	15	47
Site-10	3	240	0	15	47
Site-11	1	0	0	15	47

Site-11	2	120	0	15	47
Site-11	3	240	0	15	47
Site-12	1	0	0	15	47
Site-12	2	90	0	15	47
Site-12	3	240	0	15	47
Site-13	1	0	0	15	47
Site-13	2	120	0	15	47
Site-13	3	240	0	15	47
Site-14	1	0	0	15	47
Site-14	2	120	4	15	47
Site-14	3	240	7	15	47
Site-15	1	0	4	15	47
Site-15	2	120	-4	15	47
Site-15	3	240	4	15	47
Site-16	1	0	0	15	47
Site-16	2	120	0	15	47
Site-16	3	240	0	15	47
Site-17	1	0	4	15	47
Site-17	2	120	4	15	47
Site-17	3	240	0	15	47
Site-18	1	50	0	15	47
Site-18	2	120	0	15	47
Site-18	3	280	0	15	47
Site-19	1	0	0	15	47
Site-19	2	120	0	15	47
Site-19	3	240	0	15	47
Site-20	1	0	0	15	47
Site-20	2	120	0	15	47
Site-20	3	240	0	15	47
Site-21	1	200	0	15	47
Site-21	2	340	0	15	47
Site-21	3	100	0	15	47
Site-22	1	0	0	15	47
Site-22	2	120	0	15	47
Site-22	3	240	0	15	47
Site-23	1	0	7	15	47

Site-23	2	120	7	15	47
Site-23	2	240	7	15	47
Site-24	1	0	7	15	47
Site-24	2	120	7	15	47
Site-24	3	240	7	15	47
Site-25	1	0	0	15	47
Site-25	2	120	0	15	47
Site-25	3	240	0	15	47
Site-26	1	40	0	15	47
Site-26	2	120	7	15	47
Site-26	3	240	7	15	47
Site-27	1	0	7	15	47
Site-27	2	120	7	15	47
Site-27	3	240	7	15	47
Site-28	1	0	7	15	47
Site-28	2	120	7	15	47
Site-28	3	240	7	15	47
Site-29	1	0	0	15	47
Site-29	2	120	0	15	47
Site-29	3	240	0	15	47
Site-30	1	40	0	15	47
Site-30	2	120	0	15	47
Site-30	3	240	0	15	47
Site-31	1	0	0	15	47
Site-31	2	120	7	15	47
Site-31	3	240	7	15	47
Site-32	1	50	7	15	47
Site-32	2	120	7	15	47
Site-32	3	300	7	15	47
Site-33	1	0	0	15	47
Site-33	2	120	7	15	47
Site-33	3	240	7	15	47
Site-34	1	0	0	15	47
Site-34	2	120	0	15	47
Site-34	3	240	0	15	47
Site-35	1	0	0	15	47

Site-35	2	120	0	15	47
Site-35	3	240	0	15	47
Site-36	1	0	-7	15	47
Site-36	2	130	-4	15	47
Site-36	3	240	-4	15	47
Site-37	1	0	4	15	47
Site-37	2	120	0	15	47
Site-37	3	240	4	15	47
Site-38	1	0	0	15	47
Site-38	2	120	4	15	47
Site-38	3	240	4	15	47
Site-39	1	0	0	15	47
Site-39	2	120	0	15	47
Site-39	3	240	0	15	47
Site-40	1	0	0	15	47
Site-40	2	120	0	15	47
Site-40	3	240	0	15	47
Site-41	1	0	0	15	47
Site-41	2	120	0	15	47
Site-41	3	240	0	15	47
Site-42	1	0	0	15	47
Site-42	2	120	0	15	47
Site-42	3	240	0	15	47
Site-43	1	0	0	15	47
Site-43	2	120	0	15	47
Site-43	3	240	0	15	47
Site-44	1	0	4	15	47
Site-44	2	120	4	15	47
Site-44	3	240	0	15	47
Site-45	1	0	0	15	47
Site-45	2	80	0	15	47
Site-45	3	260	0	15	47
Site-46	1	0	7	15	47
Site-46	2	120	7	15	47
Site-46	3	240	7	15	47
Site-47	1	0	0	15	47

Site-47	**2**	**120**	**0**	**15**	**47**
Site-47	**3**	**240**	**0**	**15**	**47**
Site-48	**1**	**300**	**7**	**15**	**47**
Site-48	**2**	**120**	**7**	**15**	**47**
Site-48	**3**	**230**	**7**	**15**	**47**
Site-49	**1**	**20**	**7**	**15**	**47**
Site-49	**2**	**100**	**7**	**15**	**47**
Site-49	**3**	**300**	**7**	**15**	**47**
Site-50	**1**	**45**	**-4**	**15**	**47**
Site-50	**2**	**130**	**0**	**15**	**47**
Site-50	**3**	**240**	**0**	**15**	**47**
Site-51	**1**	**20**	**0**	**15**	**47**
Site-51	**2**	**300**	**0**	**15**	**47**
Site-51	**3**	**190**	**0**	**15**	**47**
Site-52	**1**	**0**	**-4**	**15**	**47**
Site-52	**2**	**120**	**4**	**15**	**47**
Site-52	**3**	**240**	**-4**	**15**	**47**
Site-53	**1**	**0**	**7**	**15**	**47**
Site-53	**2**	**120**	**7**	**15**	**47**
Site-53	**3**	**240**	**7**	**15**	**47**
Site-54	**1**	**0**	**0**	**15**	**47**
Site-54	**2**	**120**	**0**	**15**	**47**
Site-54	**3**	**240**	**0**	**15**	**47**
Site-55	**1**	**0**	**0**	**15**	**47**
Site-55	**2**	**120**	**0**	**15**	**47**
Site-55	**3**	**240**	**7**	**15**	**47**
Site-56	**1**	**0**	**4**	**15**	**47**
Site-56	**2**	**100**	**4**	**15**	**47**
Site-56	**3**	**240**	**0**	**15**	**47**
Site-57	**1**	**330**	**0**	**15**	**47**
Site-57	**2**	**180**	**7**	**15**	**47**
Site-57	**3**	**80**	**0**	**15**	**47**
Site-58	**1**	**0**	**4**	**15**	**47**
Site-58	**2**	**120**	**0**	**15**	**47**
Site-58	**3**	**240**	**4**	**15**	**47**
Site-59	**1**	**0**	**0**	**15**	**47**

Site-59	2	120	-4	15	47
Site-59	3	240	-4	15	47
Site-60	1	0	7	15	47
Site-60	2	120	0	15	47
Site-60	3	240	0	15	47
Site-61	1	0	4	15	47
Site-61	2	120	4	15	47
Site-61	3	220	4	15	47
Site-62	1	300	7	15	47
Site-62	2	110	7	15	47
Site-62	3	40	7	15	47
Site-63	1	0	7	15	47
Site-63	2	120	7	15	47
Site-63	3	270	7	15	47
Site-64	1	0	0	15	47
Site-64	2	120	0	15	47
Site-64	3	240	0	15	47
Site-65	1	0	0	15	47
Site-65	2	120	0	15	47
Site-65	3	240	0	15	47
Site-66	1	0	4	15	47
Site-66	2	120	4	15	47
Site-66	3	240	0	15	47
Site-67	1	0	7	15	47
Site-67	2	120	7	15	47
Site-67	3	240	7	15	47
Site-68	1	0	7	15	47
Site-68	2	120	4	15	47
Site-68	3	240	7	15	47
Site-69	1	0	0	15	47
Site-69	2	120	0	15	47
Site-69	3	240	0	15	47
Site-70	1	20	4	15	47
Site-70	2	90	4	15	47
Site-70	3	280	4	15	47
Site-71	1	0	7	15	47

Site-71	**2**	**120**	**7**	**15**	**47**
Site-71	**3**	**240**	**7**	**15**	**47**
Site-72	**1**	**340**	**7**	**15**	**47**
Site-72	**2**	**150**	**7**	**15**	**47**
Site-72	**3**	**260**	**14**	**15**	**47**
Site-73	**1**	**0**	**7**	**15**	**47**
Site-73	**2**	**120**	**7**	**15**	**47**
Site-73	**3**	**240**	**7**	**15**	**47**
Site-74	**1**	**0**	**7**	**15**	**47**
Site-74	**2**	**120**	**7**	**15**	**47**
Site-74	**3**	**240**	**7**	**15**	**47**
Site-75	**1**	**0**	**0**	**15**	**47**
Site-75	**2**	**120**	**0**	**15**	**47**
Site-75	**3**	**240**	**0**	**15**	**47**
Site-76	**1**	**0**	**7**	**15**	**47**
Site-76	**2**	**120**	**7**	**15**	**47**
Site-76	**3**	**250**	**7**	**15**	**47**
Site-77	**1**	**0**	**0**	**15**	**47**
Site-77	**2**	**120**	**0**	**15**	**47**
Site-77	**3**	**240**	**0**	**15**	**47**
Site-78	**1**	**0**	**7**	**15**	**47**
Site-78	**2**	**120**	**7**	**15**	**47**
Site-78	**3**	**240**	**7**	**15**	**47**

Table 3.4: Final sites parameter values at 900MHz for WCDMA

Tabular Editor	900MHz WCDMA				
Site ID	**Antenna ID**	**Azimuth(degree0**	**Mechanical Tilt(degree)**	**Height(m)**	**Power(dBm)**
Site-1	1	0	0	15	47
Site-1	2	120	0	15	47
Site-1	3	240	0	15	47
Site-2	1	300	7	15	40
Site-2	2	150	7	15	40
Site-2	3	40	0	15	40
Site-3	1	0	0	15	47
Site-3	2	120	7	15	47
Site-3	3	240	0	15	47
Site-4	1	330	7	15	40
Site-4	2	80	7	15	40
Site-4	3	240	7	15	40
Site-5	1	0	0	15	47
Site-5	2	120	0	15	47
Site-5	3	240	0	15	47
Site-6	1	0	0	15	47
Site-6	2	120	0	15	47
Site-6	3	240	0	15	47
Site-7	1	0	0	15	47
Site-7	2	120	0	15	47
Site-7	3	240	0	15	47
Site-8	1	330	-7	15	47
Site-8	2	120	-7	15	47
Site-8	3	240	-7	15	47
Site-9	1	30	0	15	43
Site-9	2	120	0	15	43
Site-9	3	250	0	15	43
Site-10	1	0	0	15	47
Site-10	2	120	0	15	47
Site-10	3	240	0	15	47
Site-11	1	0	0	15	47
Site-11	2	120	0	15	47

Site-11	3	240	0	15	47
Site-12	1	0	0	15	47
Site-12	2	90	0	15	47
Site-12	3	240	0	15	47
Site-13	1	0	0	15	47
Site-13	2	120	0	15	47
Site-13	3	240	0	15	47
Site-14	1	0	0	15	47
Site-14	2	120	4	15	47
Site-14	3	240	7	15	47
Site-15	1	0	4	15	47
Site-15	2	120	-4	15	47
Site-15	3	240	4	15	47
Site-16	1	0	0	15	47
Site-16	2	120	0	15	47
Site-16	3	240	0	15	47
Site-17	1	0	7	15	47
Site-17	2	120	7	15	47
Site-17	3	240	0	15	47
Site-18	1	30	7	15	47
Site-18	2	100	7	15	47
Site-18	3	180	7	15	47
Site-19	1	0	0	15	47
Site-19	2	120	0	15	47
Site-19	3	240	0	15	47
Site-20	1	0	0	15	47
Site-20	2	120	0	15	47
Site-20	3	240	0	15	47
Site-21	1	0	0	15	47
Site-21	2	120	0	15	47
Site-21	3	240	0	15	47
Site-22	1	0	0	15	47
Site-22	2	120	0	15	47
Site-22	3	240	7	15	47
Site-23	1	0	7	15	47
Site-23	2	120	7	15	47

Site-23	2	240	7	15	47
Site-24	1	0	7	15	47
Site-24	2	120	7	15	47
Site-24	3	240	7	15	47
Site-25	1	0	0	15	47
Site-25	2	120	0	15	47
Site-25	3	240	0	15	47
Site-26	1	40	0	15	47
Site-26	2	120	7	15	47
Site-26	3	240	7	15	47
Site-27	1	0	7	15	43
Site-27	2	120	7	15	43
Site-27	3	240	7	15	43
Site-28	1	0	7	15	47
Site-28	2	120	7	15	47
Site-28	3	240	7	15	47
Site-29	1	0	0	15	47
Site-29	2	120	14	15	47
Site-29	3	240	0	15	47
Site-30	1	0	0	15	47
Site-30	2	120	0	15	47
Site-30	3	240	0	15	47
Site-31	1	270	0	15	47
Site-31	2	10	0	15	47
Site-31	3	90	0	15	47
Site-32	1	50	7	15	47
Site-32	2	120	7	15	47
Site-32	3	300	7	15	47
Site-33	1	0	7	15	47
Site-33	2	120	7	15	47
Site-33	3	240	7	15	47
Site-34	1	0	0	15	43
Site-34	2	120	0	15	43
Site-34	3	240	0	15	43
Site-35	1	0	0	15	47
Site-35	2	120	0	15	47

Site-35	3	240	0	15	47
Site-36	1	60	7	15	47
Site-36	2	200	7	15	47
Site-36	3	330	7	15	47
Site-37	1	0	7	15	47
Site-37	2	120	0	15	47
Site-37	3	240	4	15	47
Site-38	1	0	0	15	47
Site-38	2	120	4	15	47
Site-38	3	240	4	15	47
Site-39	1	0	0	15	47
Site-39	2	120	0	15	47
Site-39	3	240	0	15	47
Site-40	1	0	0	15	47
Site-40	2	120	0	15	47
Site-40	3	240	0	15	47
Site-41	1	0	0	15	47
Site-41	2	120	0	15	47
Site-41	3	240	0	15	47
Site-42	1	0	0	15	47
Site-42	2	120	0	15	47
Site-42	3	240	0	15	47
Site-43	1	0	0	15	47
Site-43	2	120	0	15	47
Site-43	3	240	0	15	47
Site-44	1	0	4	15	47
Site-44	2	120	4	15	47
Site-44	3	240	0	15	47
Site-45	1	0	0	15	47
Site-45	2	80	0	15	47
Site-45	3	260	0	15	47
Site-46	1	0	7	15	47
Site-46	2	120	7	15	47
Site-46	3	240	7	15	47
Site-47	1	0	0	15	47
Site-47	2	120	0	15	47

Site-47	**3**	**240**	**0**	**15**	47
Site-48	**1**	**300**	**7**	**15**	47
Site-48	**2**	**120**	**7**	**15**	47
Site-48	**3**	**230**	**7**	**15**	47
Site-49	**1**	**0**	**7**	**15**	47
Site-49	**2**	**180**	**7**	**15**	47
Site-49	**3**	**280**	**7**	**15**	47
Site-50	**1**	**45**	**7**	**15**	47
Site-50	**2**	**130**	**0**	**15**	47
Site-50	**3**	**240**	**0**	**15**	47
Site-51	**1**	**20**	**0**	**15**	47
Site-51	**2**	**300**	**0**	**15**	47
Site-51	**3**	**190**	**0**	**15**	47
Site-52	**1**	**0**	**0**	**15**	47
Site-52	**2**	**120**	**0**	**15**	47
Site-52	**3**	**240**	**0**	**15**	47
Site-53	**1**	**0**	**-4**	**15**	47
Site-53	**2**	**120**	**4**	**15**	47
Site-53	**3**	**240**	**-4**	**15**	47
Site-54	**1**	**0**	**0**	**15**	43
Site-54	**2**	**120**	**0**	**15**	43
Site-54	**3**	**240**	**0**	**15**	43
Site-55	**1**	**0**	**0**	**15**	47
Site-55	**2**	**120**	**7**	**15**	47
Site-55	**3**	**240**	**7**	**15**	47
Site-56	**1**	**0**	**4**	**15**	47
Site-56	**2**	**100**	**4**	**15**	47
Site-56	**3**	**240**	**0**	**15**	47
Site-57	**1**	**330**	**0**	**15**	47
Site-57	**2**	**180**	**7**	**15**	47
Site-57	**3**	**80**	**0**	**15**	47
Site-58	**1**	**0**	**0**	**15**	47
Site-58	**2**	**120**	**0**	**15**	47
Site-58	**3**	**240**	**0**	**15**	47
Site-59	**1**	**0**	**7**	**15**	47
Site-59	**2**	**120**	**7**	**15**	47

Site-59	3	240	7	15	47
Site-60	1	0	7	15	47
Site-60	2	100	0	15	47
Site-60	3	240	0	15	47
Site-61	1	0	0	15	40
Site-61	2	120	0	15	40
Site-61	3	240	0	15	40
Site-62	1	300	7	15	40
Site-62	2	110	7	15	40
Site-62	3	40	7	15	40
Site-63	1	0	7	15	47
Site-63	2	120	7	15	47
Site-63	3	270	7	15	47
Site-64	1	0	0	15	47
Site-64	2	120	0	15	47
Site-64	3	240	0	15	47
Site-65	1	0	0	15	47
Site-65	2	120	0	15	47
Site-65	3	240	0	15	47
Site-66	1	0	4	15	43
Site-66	2	120	4	15	43
Site-66	3	240	0	15	43
Site-67	1	0	0	15	47
Site-67	2	120	7	15	47
Site-67	3	240	7	15	47
Site-68	1	0	0	15	40
Site-68	2	120	0	15	40
Site-68	3	240	0	15	40
Site-69	1	0	0	15	47
Site-69	2	120	0	15	47
Site-69	3	240	0	15	47
Site-70	1	20	4	15	47
Site-70	2	90	4	15	47
Site-70	3	280	4	15	47
Site-71	1	0	7	15	47
Site-71	2	120	7	15	47

Site-71	3	240	7	15	47
Site-72	1	340	7	15	47
Site-72	2	150	7	15	47
Site-72	3	260	24	15	47
Site-73	1	0	7	15	47
Site-73	2	120	7	15	47
Site-73	3	240	7	15	47
Site-74	1	0	7	15	47
Site-74	2	120	7	15	47
Site-74	3	240	7	15	47
Site-75	1	0	7	15	47
Site-75	2	120	7	15	47
Site-75	3	240	7	15	47
Site-76	1	0	7	15	47
Site-76	2	120	7	15	47
Site-76	3	250	7	15	47
Site-77	1	0	7	15	47
Site-77	2	120	7	15	47
Site-77	3	240	7	15	47
Site-78	1	0	-4	15	47
Site-78	2	120	-4	15	47
Site-78	3	240	-4	15	47
Site-79	1	0	0	15	47
Site-79	2	120	0	15	47
Site-79	3	240	0	15	47
Site-80	1	0	0	15	47
Site-80	2	120	0	15	47
Site-80	3	240	0	15	47
Site-81	1	0	0	15	47
Site-81	2	120	0	15	47
Site-81	3	240	0	15	47
Site-82	1	0	0	15	47
Site-82	2	120	0	15	47
Site-82	3	240	0	15	47

Table 3.5: Final sites parameter values at 1800MHz for WCDMA

Tabular Editor	1800MHz WCDMA				
Site ID	Antenna ID	Azimuth(degree)	Mechanical Tilt(degree)	Height(m)	Power(dBm)
Site-1	1	0	0	15	47
Site-1	2	120	0	15	47
Site-1	3	240	0	15	47
Site-2	1	300	7	15	40
Site-2	2	150	7	15	40
Site-2	3	40	0	15	40
Site-3	1	0	0	15	47
Site-3	2	120	0	15	47
Site-3	3	240	0	15	47
Site-4	1	330	7	15	40
Site-4	2	80	7	15	40
Site-4	3	240	7	15	40
Site-5	1	0	0	15	47
Site-5	2	120	0	15	47
Site-5	3	240	0	15	47
Site-6	1	0	0	15	47
Site-6	2	120	0	15	47
Site-6	3	240	0	15	47
Site-7	1	0	0	15	47
Site-7	2	120	0	15	47
Site-7	3	240	0	15	47
Site-8	1	330	0	15	47
Site-8	2	120	0	15	47
Site-8	3	240	0	15	47
Site-9	1	30	0	15	43
Site-9	2	120	0	15	43
Site-9	3	250	0	15	43
Site-10	1	0	0	15	47
Site-10	2	120	0	15	47
Site-10	3	240	0	15	47
Site-11	1	0	0	15	47
Site-11	2	120	0	15	47
Site-11	3	240	0	15	47

Site-12	1	0	0	15	47
Site-12	2	90	0	15	47
Site-12	3	240	0	15	47
Site-13	1	0	0	15	47
Site-13	2	120	0	15	47
Site-13	3	240	0	15	47
Site-14	1	0	0	15	47
Site-14	2	120	4	15	47
Site-14	3	240	7	15	47
Site-15	1	0	4	15	47
Site-15	2	120	-4	15	47
Site-15	3	240	4	15	47
Site-16	1	0	0	15	47
Site-16	2	120	0	15	47
Site-16	3	240	0	15	47
Site-17	1	0	4	15	47
Site-17	2	120	4	15	47
Site-17	3	240	0	15	47
Site-18	1	30	7	15	47
Site-18	2	100	7	15	47
Site-18	3	180	7	15	47
Site-19	1	0	0	15	47
Site-19	2	120	0	15	47
Site-19	3	240	0	15	47
Site-20	1	0	0	15	47
Site-20	2	120	0	15	47
Site-20	3	240	0	15	47
Site-21	1	0	0	15	47
Site-21	2	120	0	15	47
Site-21	3	240	0	15	47
Site-22	1	0	0	15	47
Site-22	2	120	0	15	47
Site-22	3	240	0	15	47
Site-23	1	0	7	15	47
Site-23	2	120	7	15	47
Site-23	2	240	7	15	47

Site-24	1	0	7	15	47
Site-24	2	120	7	15	47
Site-24	3	240	7	15	47
Site-25	1	0	0	15	47
Site-25	2	120	0	15	47
Site-25	3	240	0	15	47
Site-26	1	40	0	15	47
Site-26	2	120	7	15	47
Site-26	3	240	7	15	47
Site-27	1	0	7	15	43
Site-27	2	120	7	15	43
Site-27	3	240	7	15	43
Site-28	1	0	7	15	47
Site-28	2	120	7	15	47
Site-28	3	240	7	15	47
Site-29	1	0	0	15	47
Site-29	2	120	0	15	47
Site-29	3	240	0	15	47
Site-30	1	0	0	15	47
Site-30	2	120	0	15	47
Site-30	3	240	0	15	47
Site-31	1	270	0	15	47
Site-31	2	10	0	15	47
Site-31	3	90	0	15	47
Site-32	1	50	7	15	47
Site-32	2	120	7	15	47
Site-32	3	300	7	15	47
Site-33	1	0	0	15	47
Site-33	2	120	7	15	47
Site-33	3	240	7	15	47
Site-34	1	0	0	15	43
Site-34	2	120	0	15	43
Site-34	3	240	0	15	43
Site-35	1	0	0	15	47
Site-35	2	120	0	15	47
Site-35	3	240	0	15	47

Site-36	1	60	-7	15	47
Site-36	2	200	-4	15	47
Site-36	3	330	-4	15	47
Site-37	1	0	4	15	47
Site-37	2	120	0	15	47
Site-37	3	240	4	15	47
Site-38	1	0	0	15	47
Site-38	2	120	4	15	47
Site-38	3	240	4	15	47
Site-39	1	0	0	15	47
Site-39	2	120	0	15	47
Site-39	3	240	0	15	47
Site-40	1	0	0	15	47
Site-40	2	120	0	15	47
Site-40	3	240	0	15	47
Site-41	1	0	0	15	47
Site-41	2	120	0	15	47
Site-41	3	240	0	15	47
Site-42	1	0	0	15	47
Site-42	2	120	0	15	47
Site-42	3	240	0	15	47
Site-43	1	0	0	15	47
Site-43	2	120	0	15	47
Site-43	3	240	0	15	47
Site-44	1	0	4	15	47
Site-44	2	120	4	15	47
Site-44	3	240	0	15	47
Site-45	1	0	0	15	47
Site-45	2	80	0	15	47
Site-45	3	260	0	15	47
Site-46	1	0	7	15	47
Site-46	2	120	7	15	47
Site-46	3	240	7	15	47
Site-47	1	0	0	15	47
Site-47	2	120	0	15	47
Site-47	3	240	0	15	47

Site-48	1	300	7	15	47
Site-48	2	120	7	15	47
Site-48	3	230	7	15	47
Site-49	1	0	7	15	47
Site-49	2	180	7	15	47
Site-49	3	280	7	15	47
Site-50	1	45	7	15	47
Site-50	2	130	0	15	47
Site-50	3	240	0	15	47
Site-51	1	20	0	15	47
Site-51	2	300	0	15	47
Site-51	3	190	0	15	47
Site-52	1	0	0	15	47
Site-52	2	120	0	15	47
Site-52	3	240	0	15	47
Site-53	1	0	-4	15	47
Site-53	2	120	4	15	47
Site-53	3	240	-4	15	47
Site-54	1	0	0	15	43
Site-54	2	120	0	15	43
Site-54	3	240	0	15	43
Site-55	1	0	0	15	47
Site-55	2	120	0	15	47
Site-55	3	240	7	15	47
Site-56	1	0	4	15	47
Site-56	2	100	4	15	47
Site-56	3	240	0	15	47
Site-57	1	330	0	15	47
Site-57	2	180	7	15	47
Site-57	3	80	0	15	47
Site-58	1	0	0	15	47
Site-58	2	120	0	15	47
Site-58	3	240	0	15	47
Site-59	1	0	0	15	47
Site-59	2	120	-4	15	47
Site-59	3	240	-4	15	47

Site-60	1	0	7	15	47
Site-60	2	100	0	15	47
Site-60	3	240	0	15	47
Site-61	1	0	0	15	40
Site-61	2	120	0	15	40
Site-61	3	240	0	15	40
Site-62	1	300	7	15	40
Site-62	2	110	7	15	40
Site-62	3	40	7	15	40
Site-63	1	0	7	15	47
Site-63	2	120	7	15	47
Site-63	3	270	7	15	47
Site-64	1	0	0	15	47
Site-64	2	120	0	15	47
Site-64	3	240	0	15	47
Site-65	1	0	0	15	47
Site-65	2	120	0	15	47
Site-65	3	240	0	15	47
Site-66	1	0	4	15	43
Site-66	2	120	4	15	43
Site-66	3	240	0	15	43
Site-67	1	0	0	15	47
Site-67	2	120	7	15	47
Site-67	3	240	7	15	47
Site-68	1	0	0	15	40
Site-68	2	120	0	15	40
Site-68	3	240	0	15	40
Site-69	1	0	0	15	47
Site-69	2	120	0	15	47
Site-69	3	240	0	15	47
Site-70	1	20	4	15	47
Site-70	2	90	4	15	47
Site-70	3	280	4	15	47
Site-71	1	0	7	15	47
Site-71	2	120	7	15	47
Site-71	3	240	7	15	47

Site-72	1	340	7	15	47
Site-72	2	150	7	15	47
Site-72	3	260	24	15	47
Site-73	1	0	7	15	47
Site-73	2	120	7	15	47
Site-73	3	240	7	15	47
Site-74	1	0	7	15	47
Site-74	2	120	7	15	47
Site-74	3	240	7	15	47
Site-75	1	0	7	15	47
Site-75	2	120	7	15	47
Site-75	3	240	7	15	47
Site-76	1	0	7	15	47
Site-76	2	120	7	15	47
Site-76	3	250	7	15	47
Site-77	1	0	7	15	47
Site-77	2	120	7	15	47
Site-77	3	240	7	15	47
Site-78	1	0	-4	15	47
Site-78	2	120	-4	15	47
Site-78	3	240	-4	15	47
Site-79	1	0	0	15	47
Site-79	2	120	0	15	47
Site-79	3	240	0	15	47
Site-80	1	0	0	15	47
Site-80	2	120	0	15	47
Site-80	3	240	0	15	47
Site-81	1	0	0	15	47
Site-81	2	120	0	15	47
Site-81	3	240	0	15	47
Site-82	1	0	0	15	47
Site-82	2	120	0	15	47
Site-82	3	240	0	15	47
Site-83	1	0	0	15	47
Site-83	2	120	0	15	47
Site-83	3	240	0	15	47

Site-84	**1**	**0**	**7**	**15**	**47**
Site-84	**2**	**120**	**7**	**15**	**47**
Site-84	**3**	**240**	**7**	**15**	**47**

Table 3.6: Final sites parameter values at 2100MHz for WCDMA

Tabular Editor		2100MHzWCDMA			
Site ID	**Antenna ID**	**Azimuth(degree)**	**Mechanical Tilt(degree)**	**Height(m)**	**Power(dBm)**
Site-1	1	0	0	15	40
Site-1	2	120	0	15	40
Site-1	3	240	0	15	40
Site-2	1	300	7	15	47
Site-2	2	150	7	15	47
Site-2	3	40	0	15	47
Site-3	1	0	0	15	40
Site-3	2	120	7	15	40
Site-3	3	240	0	15	40
Site-4	1	330	7	15	47
Site-4	2	80	7	15	47
Site-4	3	240	7	15	47
Site-5	1	0	0	15	40
Site-5	2	120	0	15	40
Site-5	3	240	0	15	40
Site-6	1	0	0	15	40
Site-6	2	120	0	15	40
Site-6	3	240	0	15	40
Site-7	1	0	0	15	40
Site-7	2	120	0	15	40
Site-7	3	240	0	15	40
Site-8	1	330	-7	15	40
Site-8	2	120	-7	15	40
Site-8	3	240	-7	15	40
Site-9	1	30	0	15	40
Site-9	2	120	0	15	40
Site-9	3	250	0	15	40
Site-9	4	80	0	15	40
Site-10	1	0	0	15	40
Site-10	2	120	0	15	40
Site-10	3	240	0	15	40

Site-11	1	0	0	15	40
Site-11	2	120	0	15	40
Site-11	3	240	0	15	40
Site-12	1	0	0	15	40
Site-12	2	90	0	15	40
Site-12	3	240	0	15	40
Site-13	1	0	0	15	40
Site-13	2	120	0	15	40
Site-13	3	240	0	15	40
Site-14	1	0	0	15	40
Site-14	2	120	4	15	40
Site-14	3	240	7	15	40
Site-15	1	0	4	15	40
Site-15	2	120	-4	15	40
Site-15	3	240	4	15	40
Site-16	1	0	0	15	40
Site-16	2	120	0	15	40
Site-16	3	240	0	15	40
Site-17	1	0	7	15	40
Site-17	2	120	7	15	40
Site-17	3	240	0	15	40
Site-18	1	30	7	15	40
Site-18	2	100	7	15	40
Site-18	3	180	7	15	40
Site-19	1	0	0	15	40
Site-19	2	120	0	15	40
Site-19	3	240	0	15	40
Site-20	1	0	0	15	40
Site-20	2	120	0	15	40
Site-20	3	240	0	15	40
Site-21	1	0	0	15	40
Site-21	2	120	0	15	40
Site-21	3	240	0	15	40
Site-22	1	0	0	15	40
Site-22	2	120	0	15	40
Site-22	3	240	7	15	40

Site-23	1	0	7	15	40
Site-23	2	120	7	15	40
Site-23	2	240	7	15	40
Site-24	1	0	7	15	40
Site-24	2	120	7	15	40
Site-24	3	240	7	15	40
Site-25	1	0	0	15	40
Site-25	2	120	0	15	40
Site-25	3	240	0	15	40
Site-26	1	40	0	15	40
Site-26	2	120	7	15	40
Site-26	3	240	7	15	40
Site-27	1	0	7	15	40
Site-27	2	120	7	15	40
Site-27	3	240	7	15	40
Site-28	1	0	7	15	40
Site-28	2	120	7	15	40
Site-28	3	240	7	15	40
Site-29	1	0	0	15	40
Site-29	2	120	14	15	40
Site-29	3	240	0	15	40
Site-30	1	0	0	15	40
Site-30	2	120	0	15	40
Site-30	3	240	0	15	40
Site-31	1	270	0	15	40
Site-31	2	10	0	15	40
Site-31	3	90	0	15	40
Site-32	1	50	7	15	40
Site-32	2	120	7	15	40
Site-32	3	300	7	15	40
Site-33	1	0	7	15	40
Site-33	2	120	7	15	40
Site-33	3	240	7	15	40
Site-34	1	0	0	15	40
Site-34	2	120	0	15	40
Site-34	3	240	0	15	40

Site-35	1	0	0	15	40
Site-35	2	120	0	15	40
Site-35	3	240	0	15	40
Site-36	1	60	7	15	40
Site-36	2	200	7	15	40
Site-36	3	330	7	15	40
Site-37	1	0	7	15	40
Site-37	2	120	0	15	40
Site-37	3	240	4	15	40
Site-38	1	0	0	15	40
Site-38	2	120	4	15	40
Site-38	3	240	4	15	40
Site-39	1	0	0	15	40
Site-39	2	120	0	15	40
Site-39	3	240	0	15	40
Site-40	1	0	0	15	47
Site-40	2	100	0	15	47
Site-40	3	240	0	15	47
Site-40	4	300	0	15	47
Site-41	1	0	0	15	40
Site-41	2	120	0	15	40
Site-41	3	240	0	15	40
Site-42	1	0	0	15	40
Site-42	2	120	0	15	40
Site-42	3	240	0	15	40
Site-43	1	0	0	15	40
Site-43	2	120	0	15	40
Site-43	3	240	0	15	40
Site-44	1	0	4	15	40
Site-44	2	120	4	15	40
Site-44	3	240	0	15	40
Site-45	1	0	0	15	40
Site-45	2	80	0	15	40
Site-45	3	260	0	15	40
Site-46	1	0	7	15	40
Site-46	2	120	7	15	40

Site-46	3	240	7	15	40
Site-47	1	0	0	15	40
Site-47	2	120	0	15	40
Site-47	3	240	0	15	40
Site-48	1	300	7	15	40
Site-48	2	120	7	15	40
Site-48	3	230	7	15	40
Site-49	1	0	7	15	40
Site-49	2	120	7	15	40
Site-49	3	280	7	15	40
Site-49	4	80	7	15	40
Site-50	1	45	7	15	40
Site-50	2	130	0	15	40
Site-50	3	240	0	15	40
Site-51	1	20	0	15	40
Site-51	2	300	0	15	40
Site-51	3	190	0	15	40
Site-52	1	0	0	15	40
Site-52	2	120	0	15	40
Site-52	3	240	0	15	40
Site-53	1	0	-4	15	40
Site-53	2	120	4	15	40
Site-53	3	240	-4	15	40
Site-54	1	0	0	15	40
Site-54	2	120	0	15	40
Site-54	3	240	0	15	40
Site-55	1	0	0	15	40
Site-55	2	120	7	15	40
Site-55	3	240	7	15	40
Site-56	1	0	4	15	40
Site-56	2	100	4	15	40
Site-56	3	240	0	15	40
Site-57	1	330	0	15	40
Site-57	2	180	7	15	40
Site-57	3	80	0	15	40
Site-58	1	0	0	15	47

Site-58	2	120	0	15	47
Site-58	3	240	0	15	47
Site-59	1	0	7	15	40
Site-59	2	120	7	15	40
Site-59	3	240	7	15	40
Site-60	1	0	7	15	40
Site-60	2	100	0	15	40
Site-60	3	240	0	15	40
Site-61	1	0	0	15	47
Site-61	2	120	0	15	47
Site-61	3	240	0	15	47
Site-62	1	300	7	15	47
Site-62	2	110	7	15	47
Site-62	3	40	7	15	47
Site-62	4	70	7	15	47
Site-63	1	0	7	15	40
Site-63	2	120	7	15	40
Site-63	3	270	7	15	40
Site-64	1	0	0	15	40
Site-64	2	120	0	15	40
Site-64	3	240	0	15	40
Site-65	1	0	0	15	40
Site-65	2	120	0	15	40
Site-65	3	240	0	15	40
Site-66	1	0	4	15	40
Site-66	2	120	4	15	40
Site-66	3	240	0	15	40
Site-67	1	0	0	15	40
Site-67	2	120	7	15	40
Site-67	3	240	7	15	40
Site-68	1	0	0	15	47
Site-68	2	120	0	15	47
Site-68	3	240	0	15	47
Site-69	1	0	0	15	40
Site-69	2	120	0	15	40
Site-69	3	240	0	15	40

Site-70	1	20	4	15	40
Site-70	2	90	4	15	40
Site-70	3	280	4	15	40
Site-71	1	0	7	15	40
Site-71	2	120	7	15	40
Site-71	3	240	7	15	40
Site-72	1	340	7	15	40
Site-72	2	150	7	15	40
Site-72	3	260	24	15	40
Site-73	1	0	7	15	40
Site-73	2	120	7	15	40
Site-73	3	240	7	15	40
Site-74	1	0	7	15	40
Site-74	2	120	7	15	40
Site-74	3	240	7	15	40
Site-75	1	0	7	15	40
Site-75	2	120	7	15	40
Site-75	3	240	7	15	40
Site-76	1	0	7	15	47
Site-76	2	120	7	15	47
Site-76	3	250	7	15	47
Site-77	1	0	7	15	40
Site-77	2	120	7	15	40
Site-77	3	240	7	15	40
Site-78	1	0	-4	15	40
Site-78	2	120	-4	15	40
Site-78	3	240	-4	15	40
Site-79	1	0	0	15	40
Site-79	2	120	0	15	40
Site-79	3	240	0	15	40
Site-80	1	0	0	15	40
Site-80	2	120	0	15	40
Site-80	3	240	0	15	40
Site-81	1	0	0	15	40
Site-81	2	120	0	15	40
Site-81	3	240	0	15	40

Site-82	**1**	**0**	**0**	**15**	**40**
Site-82	**2**	**120**	**0**	**15**	**40**
Site-82	**3**	**240**	**0**	**15**	**40**
Site-83	**1**	**0**	**0**	**15**	**40**
Site-83	**2**	**120**	**0**	**15**	**40**
Site-83	**3**	**240**	**0**	**15**	**40**
Site-84	**1**	**0**	**7**	**15**	**40**
Site-84	**2**	**120**	**7**	**15**	**40**
Site-84	**3**	**240**	**7**	**15**	**40**
Site-85	**1**	**0**	**0**	**15**	**40**
Site-85	**2**	**120**	**0**	**15**	**40**
Site-85	**3**	**240**	**0**	**15**	**40**

APPENDIX B

Table 3.11: WCMDA Analysis and Modifications at 900MHZ

WCDMA Analysis and Modifications900MHz										
Modified and added Sites for 900MHz WCDMA Planning	Analysis One					Analysis Two				
	Tilt(-up, +down) degree	**Azimuth degree**	**Number of Sectors**	**changing Location**	**Added or existing site?**	**Tilt**	**Azimuth**	**Number of Sectors**	**Location**	**Added or existing site?**
Site 21	0	default 0,120 240 degree	3	x	existing	0 to 7	X*	x	To inside far from boarders	From analysis one
Site 77	0 to 7	default	3	x	existing	x	x	x	Shifted down	From analysis one
Site 78	0 to -4	default	3	x	existing	x	x		x	From analysis one
Site 80	0	default	3	x	New	x	x	x	x	From analysis one
Site 82,81	0	default	3	x	New	x	x	x	Moved up	From analysis one
Site 36	0 to 7	130 to 300 0 to 45 130 to 200	3	To higher area	modified	x	x	x	x	From previous analysis
Site 33	0 to 4		3	x	modified	4 to 7	x	x	To higher area	From previous analysis
Site 59	0 to 7	default	3	To north	modified	x	x	x	x	From previous analysis
Site 38	x	default	3	inside	modified	x	x	x	x	From previous analysis
Site 55	Sector1 0 to 7	default	3	Shift down	modified	x	x	x	x	From previous analysis
Site 58	0 to 7	default	3	Shift north	modified	x	x	x	x	From previous analysis
Site 30	0	default	3	x	x	x	x	x	x	Added in analysis 2
Site 8	x	x	x	x	x	0 to -7	x	x	to higher area	modified
Site 14	x	x	x	x	x	Sectors 1 and 2 ,0 to -7	x	x	height from 15 to 25 m	modified
Site 17	x	x	x	x	x	Sectors 1 and 2 0 to 7	x	x	x	modified
Site 29	x	x	x	x	x	Sector 2 ,0 to 14	x	x	x	modified
Site 3	x	x	x	x	x	Sector 2 ,0 to 7	x	x	x	modified
Site 56	x	x	x	x	x	x	x	x	Moved down	modified
Site 22	x	x	x	x	x	Sector 3,0to7	x	x	x	modified
Site 37	x	x	x	x	x	Sector 1 ,0 to 7	x	x	To cover the valley	modified

X* means that this site was not modified (Tuned) in tilt or azimuth or # of sectors or even its location.

Table 3.12: WCDMA Analysis and Modifications at 2100MHZ

WCDMA Analysis and Modifications 2100MHz						
Modified and added Sites for 2100MHz WCDMA Planning	Analysis One					
	Tilt(-up, +down) degree	Azimuth degree	Power (dBm)	Number of Sectors	changing Location	Added or existing site?
Site 49	x	0,70,180,280	x	3 to 4	x	existing
Site 40	x	x	47	3 to 4	x	existing
Site 68	7 to 0	x	47	x	x	existing
Site 35	x	x	47	x	x	existing
Site 76	7 to 0	x	47	x	x	existing
Site 62	x	x	47	3 to 4	x	existing
Site 61	x	x	47	x	x	existing
Site 2	0 to 7	x	47	x	Moved 100 north	existing
Site 4	x	x	47	x	Moved 200 south	existing
Site 58	x	x	47	x	x	existing
Site 9	x	x	x	3 to 4	x	existing
			All other sites power was down to 40dBm			
Site 85	x	x	x	x	x	New added

Table 3.13: WCDMA Analysis and Modifications at 1800MHZ

WCDMA Analysis and Modifications(Tuning) 1800MHz															
Modified and added Sites for 1800MHz WCDMA Planning	Analysis One					Analysis Two						Analysis Three			
	Tilt(-up, +down) degree	Azimuth degree	Number of Sectors	changing Location	Added or existing site?	Tilt	Azimuth	Number of Sectors	Location	Power (dBm)	Added or existing site?	Tilt	Added or existing site?	Power (dB)	Changing Location
Site 54	Sectors 1 and 2 ,0 to 7	x	3	x	Modified, it was in 900MHz analysis	x	x	x	x	47 to 43	From previous analysis	x		x	x
Site 34	Sectors 1 and 2,0 to 4	x	3	x	modified	x	x	x	x	47 to 43	From previous analysis	Sector2 ,4to 7	modified	x	x
Site 27	x	x	3	Moved up 30m	modified	x	x		Shifted down	47 to 43	From previous analysis	x	modified	x	x
Site 84,83	0	default	3	x	New	x	x	x	x	x	x	x	x	x	x
Site 9	x	x	3 to 4	Moved close to boarders	modified	x	x	x	x	47 to 43	From previous analysis	x	modified	x	Moved up 33m
Site 66	x	x	3	Shifted up 20m	modified	x	x	x	x	47 to 43	From previous analysis	x	modified	x	x
Site 31	x	0,120,240 to 10,90,180,270	3 to 4	x	modified	x	x	x	To higher area	47 to 43	From previous analysis	x	modified	x	To higher areas
Site 68	0 to -4	x	x	x	x	-4 to 7	x	default	x	47 to 43	From previous analysis	7	modified	40	x
Site 61	x	x	x	x	x	0to4	x	x	x	47	x	4 to0	modified	40	x
Site2	x	x	x	x	x	0to7	x	x	x	47	x	7 to0	modified	40	x
Site62	x	x	x	x	x	x	x	x	x	47	x	Sector2 ,0to 7	modified	40	x
Site50	x	x	x	x	x	0 to -4	x	x	x	47	x	-4to7	modified	x	200m To inside
Site12	x	x	x	x	x	x	x	x	x	47	x	0to7	modified	x	x
Site64	x	x	x	x	x	x	x	x	x	47	x	0to7	modified	x	150m Southwest Hebron
Site65	x	x	x	x	x	x	x	x	x	47	x	0to7	modified	x	x
Site43	x	x	x	x	x	x	x	x	x	47	x	0to7	modified	x	Moved down about 45m
Site44	x	x	x	x	x	x	x	x	x	47	x	0to7	modified	x	x
Site84	x	x	x	x	x	x	x	x	x	47	x	x	modified	40	Moved to higher area
Site 18	x	x	x	x	x	x	x	x	x	47	x	0to7	modified	x	downtown with 4 sectors
Site30	x	x	x	x	x	x	x	x	x	47	x	x	modified	x	200m South with 4 sectors with 130 degree
Site59	x	x	x	x	x	x	x	x	x	47	x	x	modified	x	Moved up 120m
Site8	x	x	x	x	x	x	x	x	x	47	x	x	modified	47	x
Site 4	x	x	x	x	x	0to7	x	x	x	47	x	7 to0	x	40	x

Table 3.14: LTE Analysis and Modifications at 900MHZ

LTE Analysis and Modifications for 900MHz										
	Analysis One					Analysis Two				
Modified and added Sites for 900MHz LTE Planning	Tilt(-up, +down) degree	Azimuth degree	Number of Sectors	changing Location	Added or existing site?	Tilt(-up, +down) degree	Azimuth degree	Number of Sectors	changing Location	Added or existing site?
Site 22	0	Default 0,120,240 degree	3	First analysis yet	New Added site	All sectors 0 to 7	x	x	To higher location	From analysis one
Site 52	0	Default 0,120,240 degree	3	First analysis yet	New Added site	0 to 4	Sector 3 from 240 to 200	x	Move it toward the north by 100m	From analysis one
Site 9	0	Default 0,120,240 degree	3	First analysis yet	New Added site	Default to 20,120, 250	x	x	To inside far from boarders	From analysis one
Site 60	0	Default 0,120,240 degree	3	First analysis yet	New Added site	Sector 1,0to 7	x	x	To inside far from boarders	From analysis one
Site 2	0	Default 0,120,240 degree	3	First analysis yet	New Added site	0to4	Sector (1,2,3) 120to 150 0 to 300 ,240to 40	x	x	From analysis one
Site 3	0	Default 0,120,240 degree	3	First analysis yet	New Added site	Sector 2&3, 0 to -4	x	x	Shifted down by 200m	From analysis one
Site 4	0	Default 0,120,240 degree	3	First analysis yet	New Added site	0to 7	Default to 330,80, 240	x	Shifted From a mountain to valley	From analysis one
Site 58	0	Default 0,120,240 degree	3	x	New Added site	Sector 1 and 3 ,0to4	From (0,120,240) to (220,300, 80)	x	Shifted to higher region	From analysis one
Site 61	0	Default 0,120,240 degree	3	First analysis yet	New Added site	0 to 4	0to30 240to220	x	To inside far from boarders	From analysis one
Site 62	0	Default 0,120,240 degree	3	First analysis yet	New Added site	x	Default to 330,120, 45	x	Shifted to a higher region	From analysis one
Site 50	0	Default 0,120,240 degree	3	First analysis yet	New Added site	Sector 1 ,tilt -4	Default to 45,130, 240	x	x	From analysis one
Site 8	0	Default 0,120,240 degree	3	First analysis yet	New Added site	x	Sector 1,0to 330	x	Move it toward the north by 200m in valley	From analysis one
Site 68	0	Default 0,120,240 degree	3	First analysis yet	New Added site	Sector 1 and3 ,0to7 Sector2, 0to 4	x	x	Shifted to higher region	From analysis one

Site 57	**0**	**Default 0,120,240 degree**	**3**	**First analysis yet**	**New Added site**		**Sector2 ,0to7**	**From (0,120,240) to (0,180,80)**	**x**	**x**	**From analysis one**
Site 34	**0**	**Default 0,120,240 degree**	**3**	**First analysis yet**	**New Added site**		**x**	**x**	**x**	**To region not covered**	**From analysis one**
Site 11	**0**	**Default 0,120,240 degree**	**3**	**First analysis yet**	**New Added site**		**x**	**x**	**x**	**Shifted to higher region**	**From analysis one**
Site 51	**0**	**Default 0,120,240 degree**	**3**	**First analysis yet**	**New Added site**		**Sector 1,0to -4**	**Default to 0,90,180**	**x**	**Shifted to the right**	**From analysis one**
Site 5	**0**	**Default 0,120,240 degree**	**3**	**First analysis yet**	**New Added site**		**x**	**x**	**x**	**Shifted to region not covered**	**From analysis one**
Site 63	**0**	**Default 0,120,240 degree**	**3**	**First analysis yet**	**New Added site**		**x**	**Sector 3, 240to270**	**x**	**x**	**From analysis one**
Site 48	**0**	**Default 0,120,240 degree**	**3**	**First analysis yet**	**New Added site**		**0 to7**	**Default to 300,160, 230**	**x**	**To inside far from boarders**	**From analysis one**
Site 15	**0**	**Default 0,120,240 degree**	**3**	**First analysis yet**	**New Added site**		**x**	**x**	**x**	**To inside far from boarders**	**From analysis one**
Site 14	**0**	**Default 0,120,240 degree**	**3**	**First analysis yet**	**New Added site**		**Sector2,0 to4 Sector4,0 to7**	**x**	**x**	**To inside far from boarders**	**From analysis one**
Site 20	**0**	**Default 0,120,240 degree**	**3**	**First analysis yet**	**New Added site**		**All sector 0 to 7**	**x**	**x**	**x**	**From analysis one**
Site 21	**0**	**Default 0,120,240 degree**	**3**	**First analysis yet**	**New Added site**		**0 to (-4,7,0)**	**(0,120,240) to (200,340, 200)**	**x**	**Shifted to not covered area**	**From analysis one**
Site 23	**0**	**x**	**x**	**x**	**New**		**0to7**	**x**	**x**	**x**	**From analysis one**
Site 24	**0**	**x**	**x**	**x**	**New**		**0to7**	**x**	**x**	**x**	**From analysis one**
Site 36	**0**	**x**	**x**	**x**	**New**		**Sector2 and 3, 0to-4**	**Sector2, 120to130**	**x**	**x**	**From analysis one**

Table 3.15: LTE Analysis and Modifications at 1800MHZ

LTE Analysis and Modifications for 1800 MHz											
Modified and added Sites for 1800MHz LTE Planning	Analysis one						Analysis two				
	Tilt(-up, +down) degree	Azimuth degree	Number of Sectors	changing Location	Added or existing site?	power	Tilt(-up, +down) degree	Azimuth degree	Number of Sectors	changing Location	Added or existing site?
Site 19	0	x	3	x	existing	47	x	x	3	To inside far from boarders	From analysis one
Site 14	0	(35,120,240)	3	x	existing site	47	Sector 2&3 ,0to 7	x	3	x	From analysis one
Site 41	0	x	3	x	existing	47	x	x	3	To inside far from boarders	From analysis one
Site 51	0	(0,120,220)	3	x	existing site	47	Sector1,0to -4	Sector3,220 to200	3	x	existing site
Site 15	0	x	3	Shifted down	existing site	47	Sector 1&3,0to4 Sector 2, 0to-4	x	3	x	existing site
Site 17	0	x	3	x	existing	47	Sector1&2, 0to4	x	3	x	From analysis one
Site 52	0	(0,120,200)	3	Shifted to down region	existing site	47	Sector1&3 ,0to-4 Sector2, 0to4	x	3	x	existing site
Site 50	Sector1,-7 Sector2&3, 0	x	3	Shifted to valley region	existing site	47	Sector1,0to-4	Sector1, 0to40 Sector2, 120to160	3	x	existing site
Site 9	0	x	3	x	existing site	47	x	x	3	Shifted to the North by 300m	existing site
Site 53	0	x	3	x	existing	47	Sector1 0to-7	x	3	x	existing site
Site 56	0	x	3	x	existing	47	Sector1&2 0to4 Sector3 0to-4	x	3	Shifted to the right	From analysis one
Site 62	0	x	3	x	existing site	47	x	Sector3,45to60	3	x	existing site
Site 61	0	x	3	x	existing site	47	All sectors 0to 4	x	3	x	existing site
Site 4	Sector 3, -4 Sector1&2, 0	x	3	x	existing site	47	x	x	3	Shifted to the North	existing site
Site 57	0	x	3	Shifted to higher region	existing site	47	Sector2 0to4	Sector 2 180to220	3	x	existing site
Site 37	0	x	3	x	existing	47	All 7	x	3	x	From analysis one
Site 38	0	x	3	x	existing	47	All 7	x	3	x	From analysis one
Site 31	0	x	3	x	existing	47	Sector2&3 7 to 0	x	3	Shifted to the South	From analysis one

Site 59	**0**	**x**	**3**	**x**	**existing**	**47**	**x**	**x**	**3**	**Shifted to the South**	**From analysis one**	
Site 67	**0**	**x**	**3**	**x**	**existing**	**47**	**Sector 1,0to7**	**x**	**3**	**Shifted to the South**	**From analysis one**	
Site 27	**0**	**x**	**3**	**x**	**existing**	**47**	**x**	**x**	**3**	**To inside far from boarders**	**From analysis one**	
Site 69	**0**	**x**	**3**	**x**	**New**	**47**	**All 7**	**x**	**3**	**100m to north**	**From analysis one**	
Site 70	**0**	**x**	**x**	**x**	**x**	**x**	**All 7**	**default**	**x**	**x**	**New added in analysis two**	

Table 3.16: LTE Analysis and Modifications at 2100MHZ

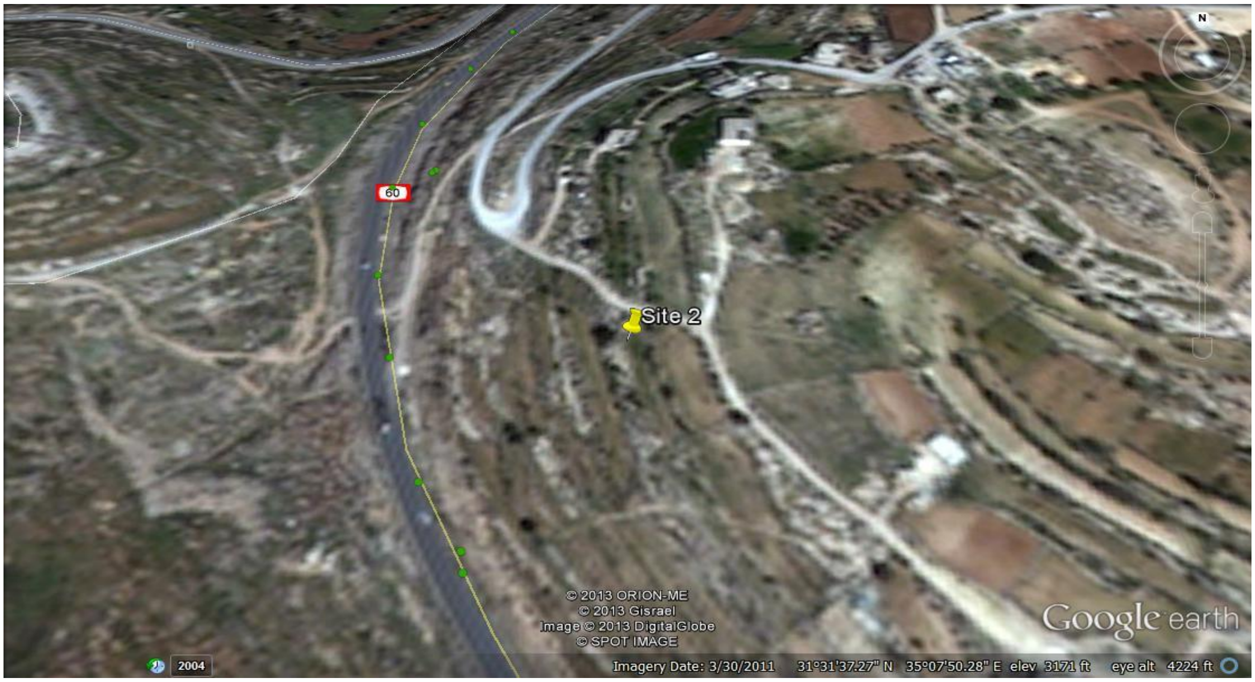
LTE Analysis and Modifications for 2100 MHz										
Modified and added Sites for 2100MHz LTE Planning	Analysis one					Analysis two				
	Tilt(-up, +down) degree	Azimuth degree	Number of Sectors	changing Location	Added or existing site?	Tilt(-up, +down) degree	Azimuth degree	Number of Sectors	changing Location	Added or existing site?
Site 4	All sectors 7	Default 0,120,240 degree	3	Shifted to not covered region	Existing site	x	Sector 1, 0 to 80	3	x	Existing site
Site 2	0	(150,300,40)	3	Shifted to higher region	Existing site	Sector 2&1,0to7	x	3	x	Existing site
Site 9	0	x	3	x	Existing site	x	sector 1 &3 , 0to20 240to250	3	x	Existing site
Site 5	0	x	3	x	Existing site	x	x	3	Shifted to bad covered region	Existing site
Site 60	0	x	3	Shifted to the North	Existing site	Sector1,0to7	Sector 2,120to100	3	x	Existing site
Site 35	0	x	3	x	existing	x	x	3	x	From analysis one
Site 58	0	x	3	x	Existing site	x	(0,120,240)	3	x	Existing site
Site 71	0	default	3	x	New added	x	x	3	x	From analysis one
Site 72	0	Default	3	x	New added	x	(315,45,120,240)	4	Shifted to a higher region	From analysis one
Site 68	0	x	3	x	Existing site	x	Sector1,0to50	3	x	Existing site
Site 23	0	Default	3	x	Existing site	x	x	3	Moved 200m north	Exiting site
Site 44	0	Default	3	x	Existing site	Saector2&3,tilt 4	x	3	Shifted down 20m	Exiting site
Site73	0	x	x	x	x	x	x	x	x	New added
Site74	0	x	x	x	x	0to7	x	x	Moved 50m up	New added
Site75	0	x	x	x	x	0to7	x	x	To north 120m	New added

Table 3.17: LTE Analysis and Modifications at 2600MHz

LTE Analysis and Modifications 2600MHz												
	Analysis One						Analysis Two					
Modified and added Sites for 2600MHz LTE Planning	Tilt(-up, +down) degree	Azimuth degree	Number of Sectors	changing Location	Added or existing site?	Power (dBm)	Tilt	Azimuth	Number of Sectors	Location	Added or Existing site?	Power (dBm)
Site 2	0 to7	x	x	Moved 20m down	modified	47	x	x	x	x	Moved again to higher area	x
Site 18	x	0 to 30 240 to 280	x	x	modified	40	x	30 to50	x	x	x	x
Site25	x	x	x	x	modified	40	x	x	x	Moved to north 120m	modified	x
Site49	x	0 to20 120 to100 240 to 300	x	x	modified	40	0to7	x	x	x	modified	x
Site53	x	x	x	x	modified	40	0to7	x	x	x	modified	x
Site73	x	x	x	x	modified	40	0to7	x	x	x	modified	40to43
Site 15	x	x	x	Moved up 255m	modified	x	x	x	x	x	x	x
Site 74	x	x	x	x	modified	x	x	x	x	x	x	x
Site 75	x	x	x	x	modified	x	7 to 0	x	x	x	modified	
Site 72	x	120 to 340	x	Shifted 170m south	modified	x	Down tilt for sector 3 0to14	x	x	x	modified	x
Site 51	x	0to20 120 to190 240 to300	x	Moved 100m inside	modified	x	x	x	x	x	x	x
Site 48	x	120 to 160	x	x	modified	x	x	x	x	x	x	x
Site 8	0to7	x	x	from valley to clear position like mountain	modified	x	x	x	x	x	x	x
Site 76	default	default	default	x	New added in eastern area	x	x	x	x	x	Moved 100m up	47
Site 26	x	x	x	x	modified	x	7to0 To cover boarders	x	x	x	modified	x
Site 60	0to7	x	x	x	modified	x	x	120to140	x	x	modified	x
Site 63	x	x	x	x	x	x	0to7	x	x	x	modified	x
Site 70	0to7	x	x	x	modified	x	x	240to300		x	modified	x
Site 62	x	x	x	x	x	x	Sectors1,2, 3 ,0to7	From default to 40,110,20 0,300	x	3 to 4 sectors	x	x
Site 77	x	x	x		x	x	x	default	default	x	New in south	47
Site 78	x	x	x	x	x	x	0to7	default	default	x	In middle area	47

APPENDIX C

Sites Locations and Destination on Google Earth for Sites Survey



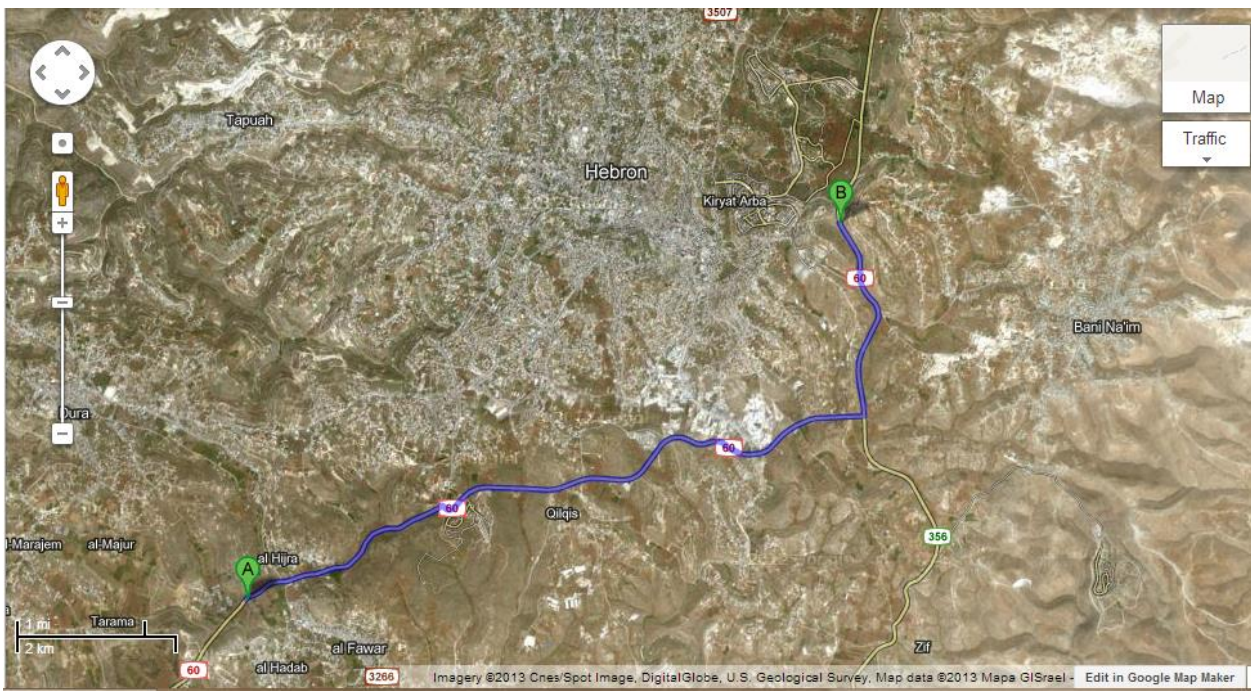


Figure 3.39: Site 2 Location and Direction from Google Earth before Edit

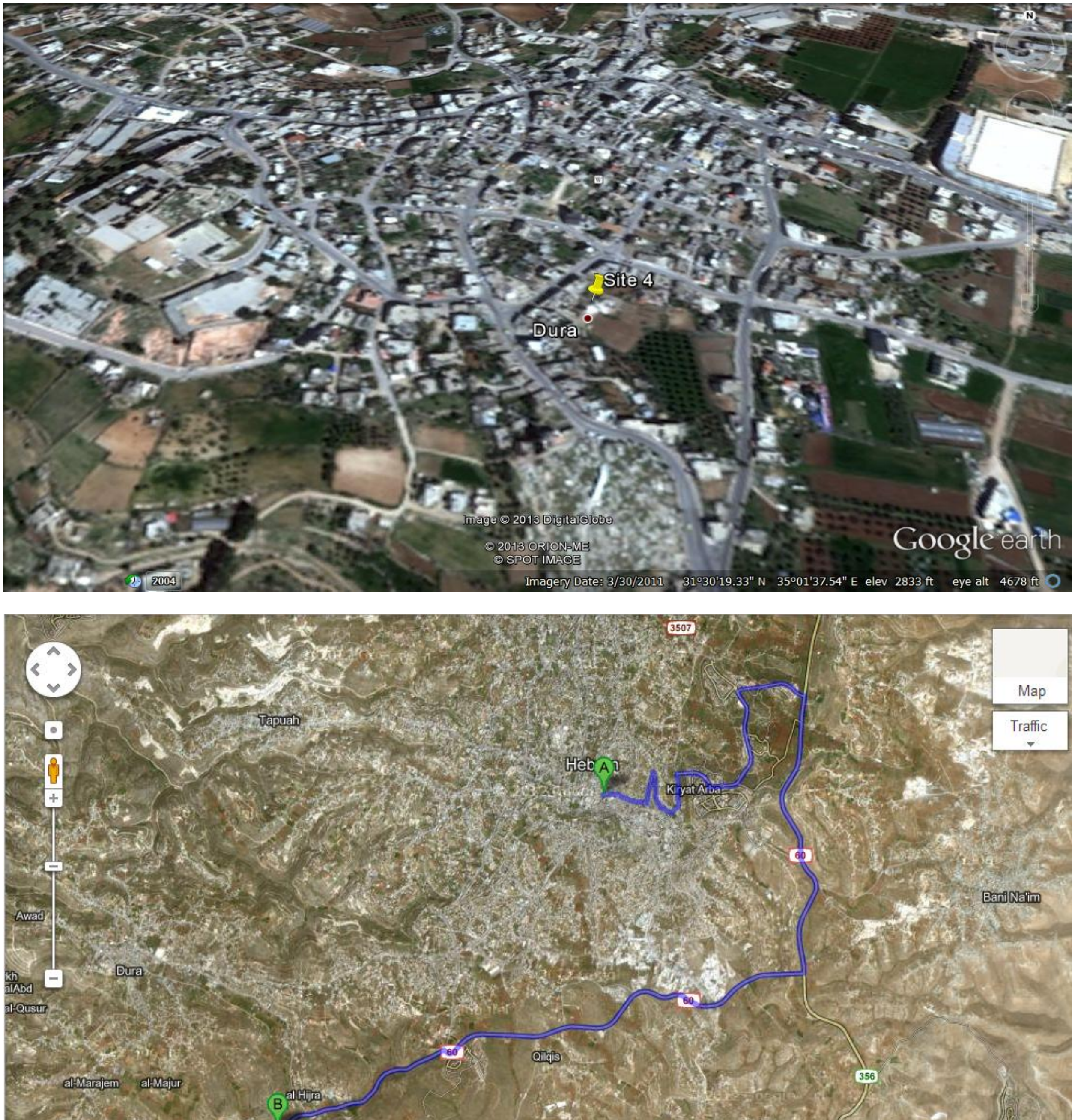


Figure 3.40: Site 4 Location and Direction from Google Earth before Edit

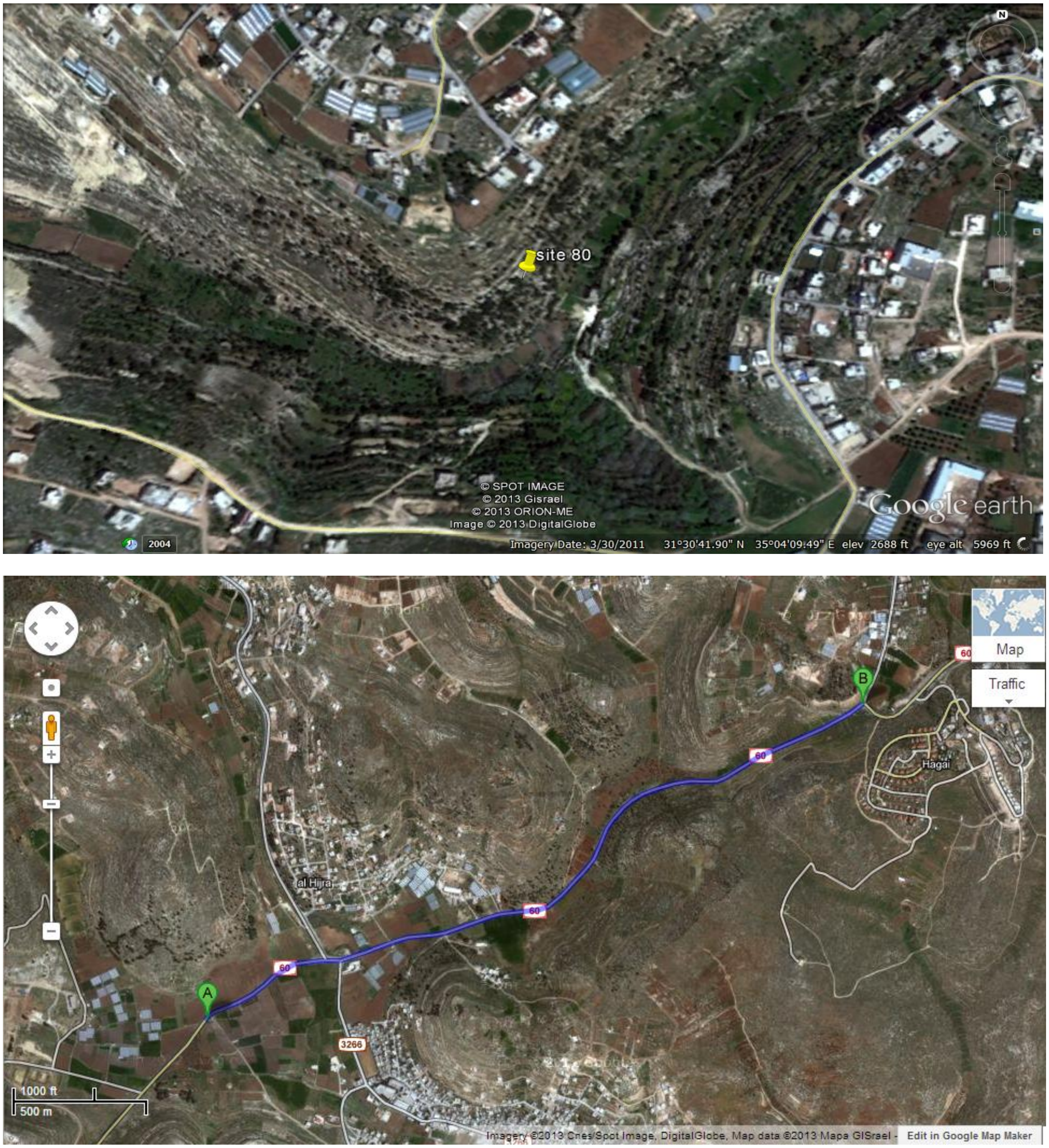


Figure 3.41: Site 80 Location and Direction from Google Earth before Edit

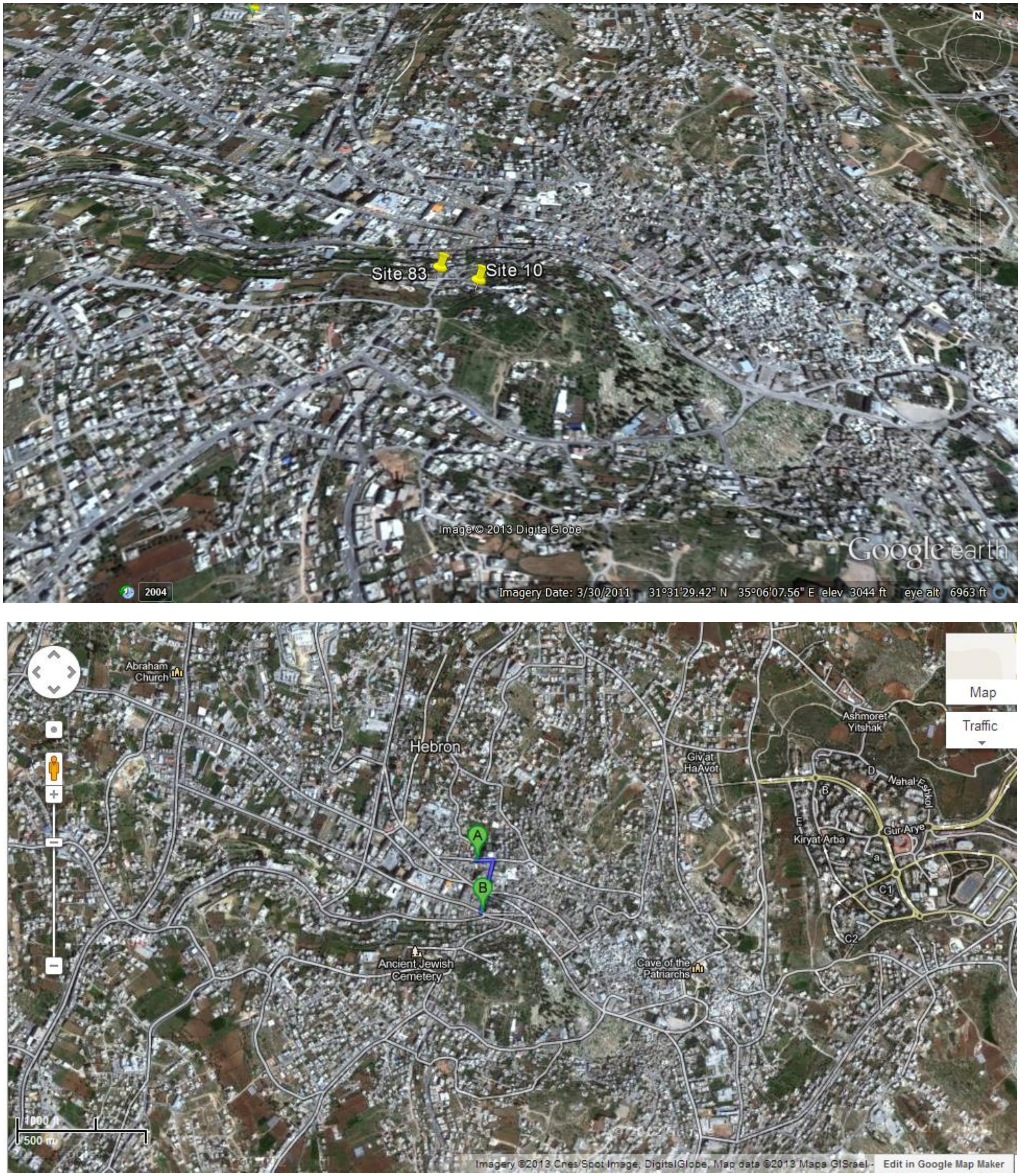


Figure 3.42: Site 83 and Site 10 Location and Direction from Google Earth before Edit

Figure 3.43: Site 2 Location moved from Road 60 to Bani Naim

Figure 3.52: Site 80 Location from Hagai settlement to Alhawooz area

Figure 3.48: Site 4 Location from First Direction of View

Figure 3.49: Site 4 Location from Second Direction of View

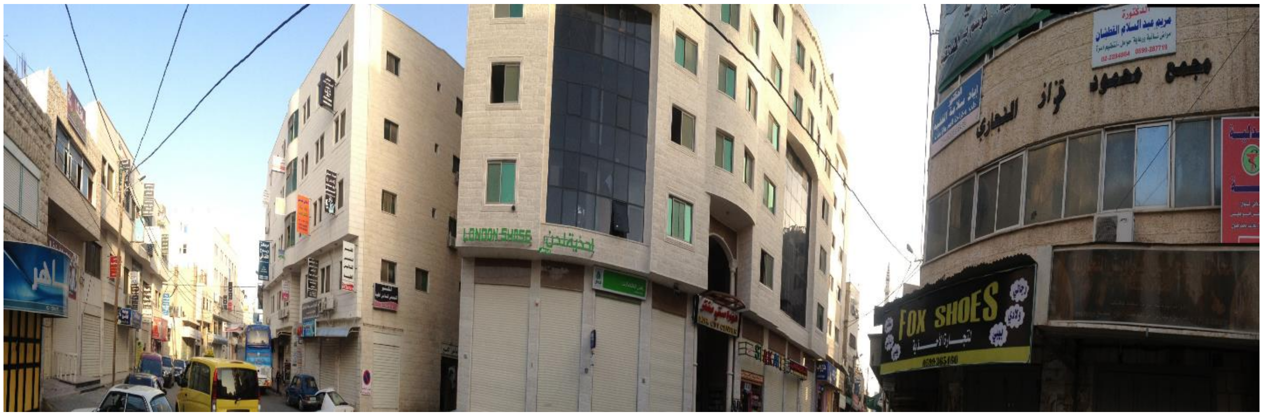


Figure 3.50: Site 4 Location from Third Direction of View

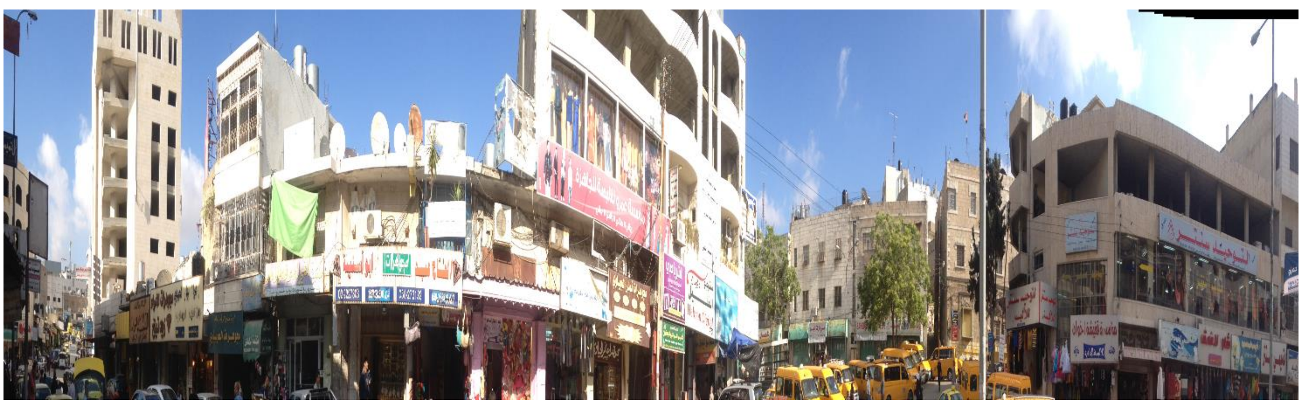


Figure 3.59: Site 83 Panorama location View in Hebron Down Town

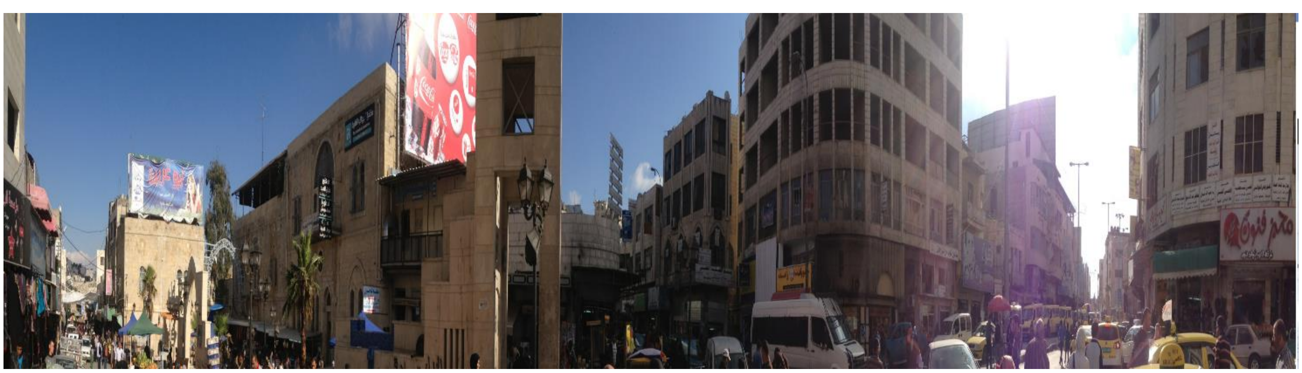


Figure 3.60: Site 10 Panorama Location View in Hebron Down Town

Figure 3.61: Sites 83 and 10 Panorama Location View from different angle

APPENDIX D

WCDMA and LTE Coverage and quality before and after

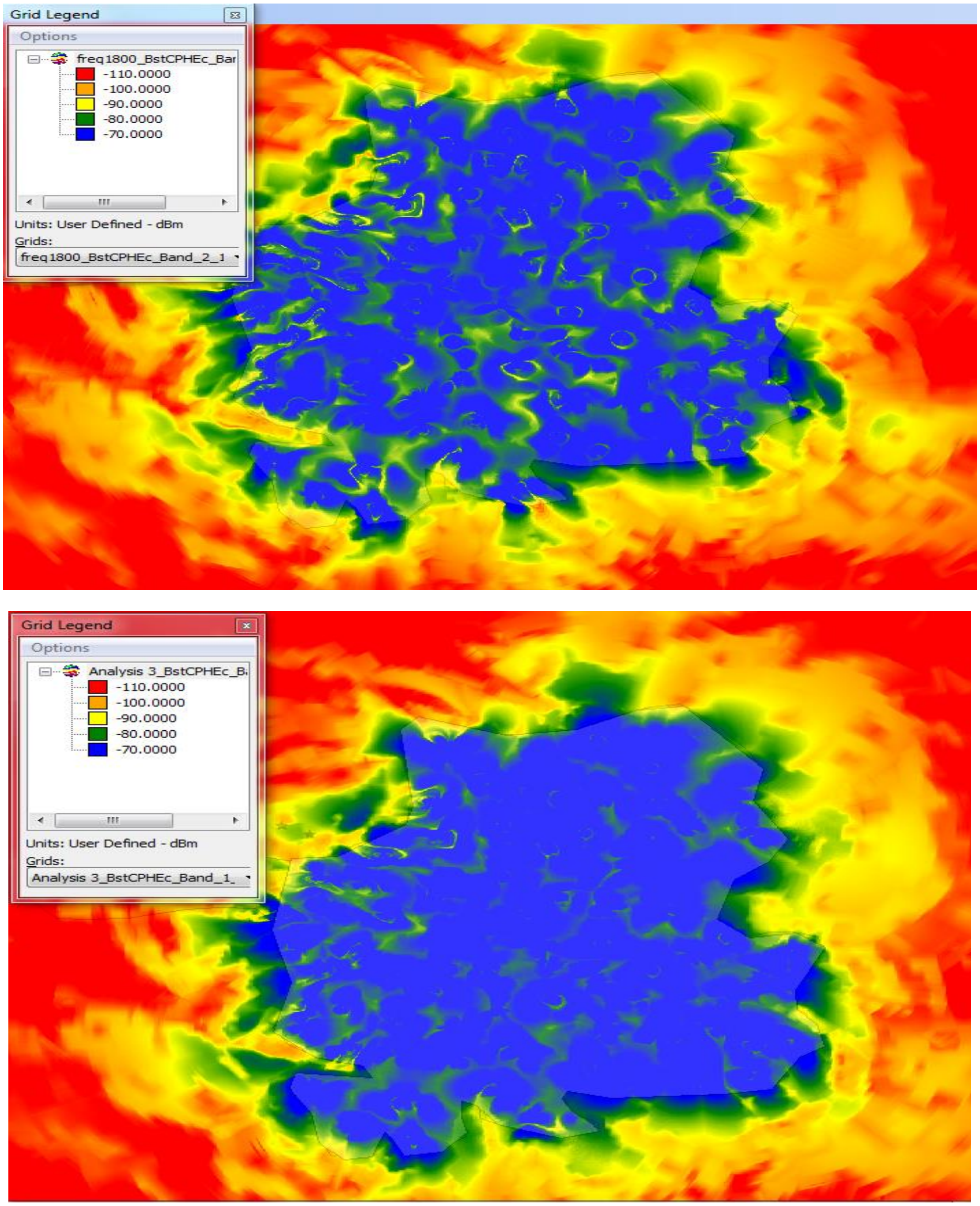
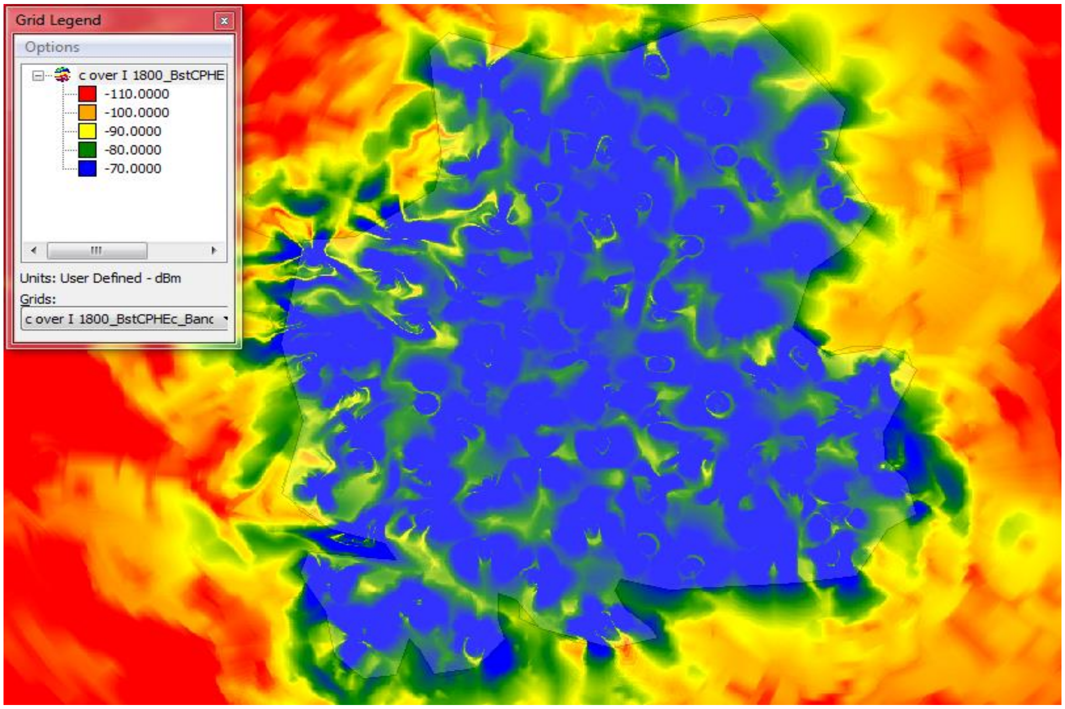


Figure 3.62: WCDMA Hebron Coverage Before and After Tuning at 900MHz



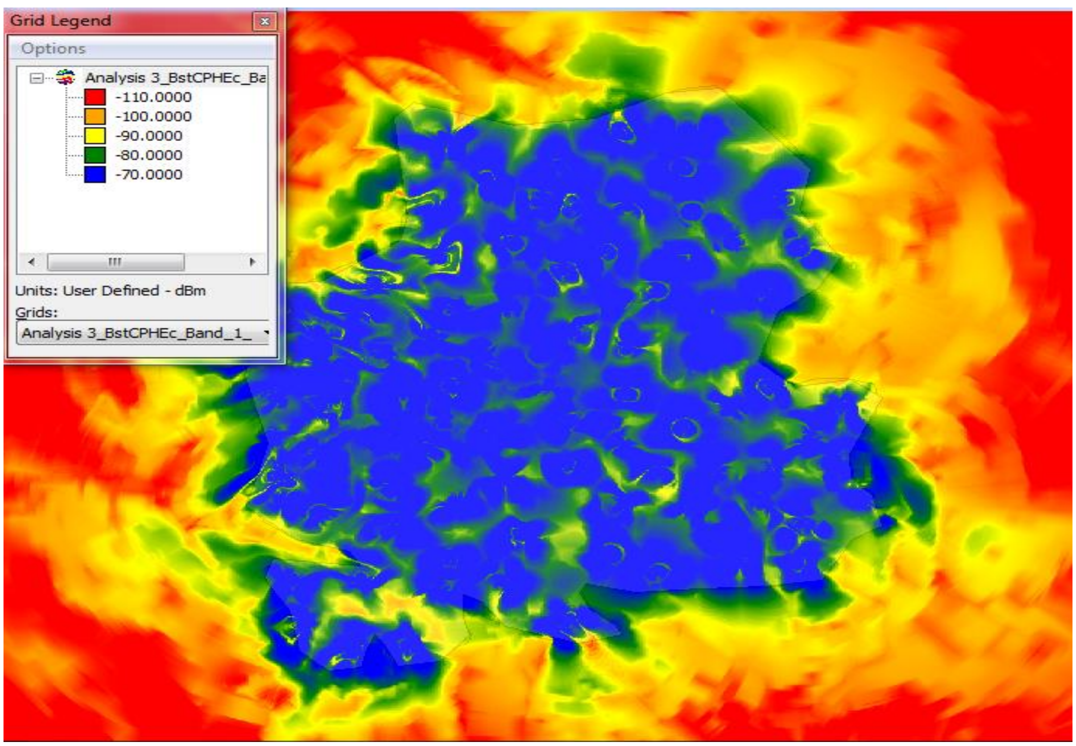


Figure 3.63: WCDMA Hebron Coverage Before and After Tuning at 1800MHz

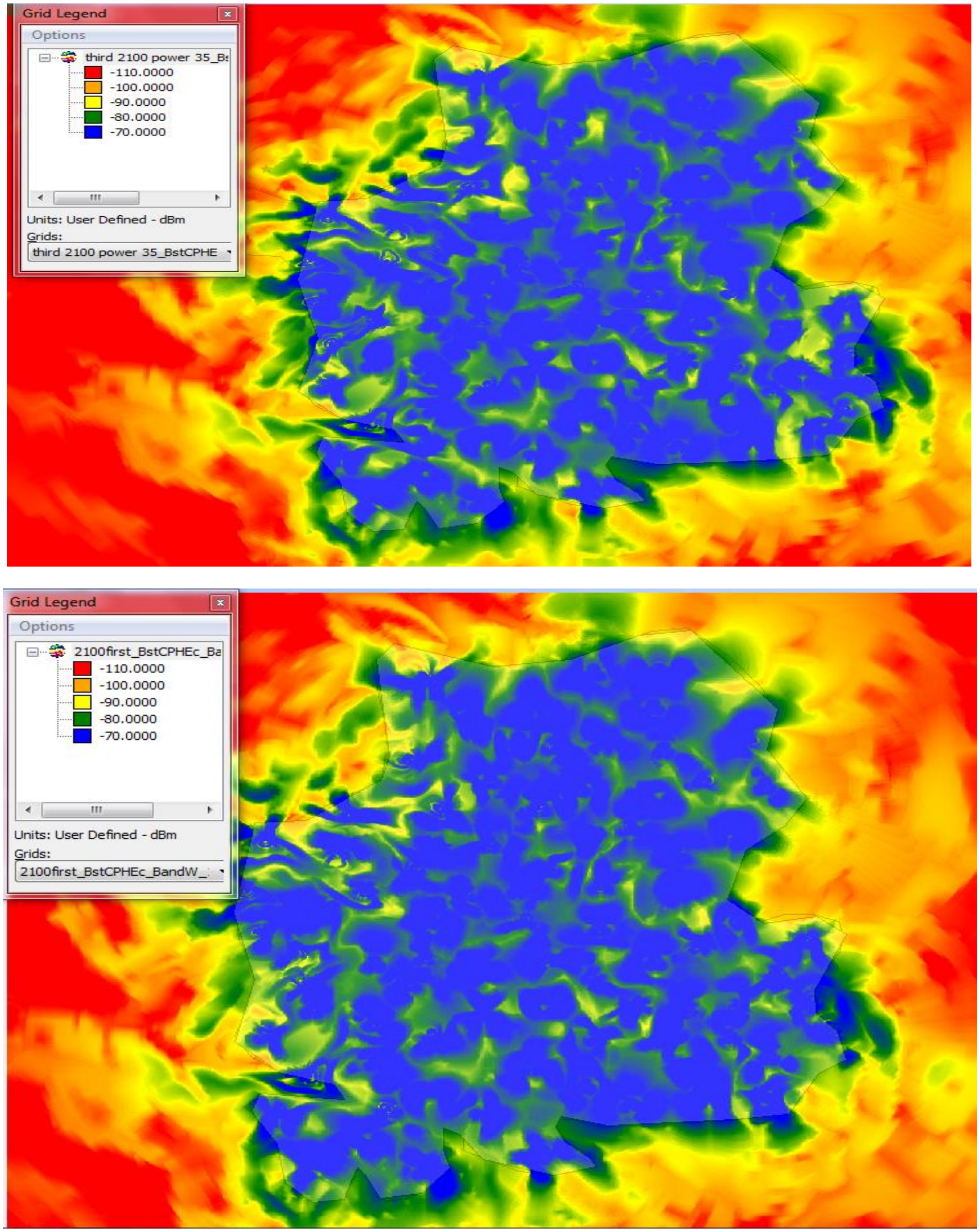
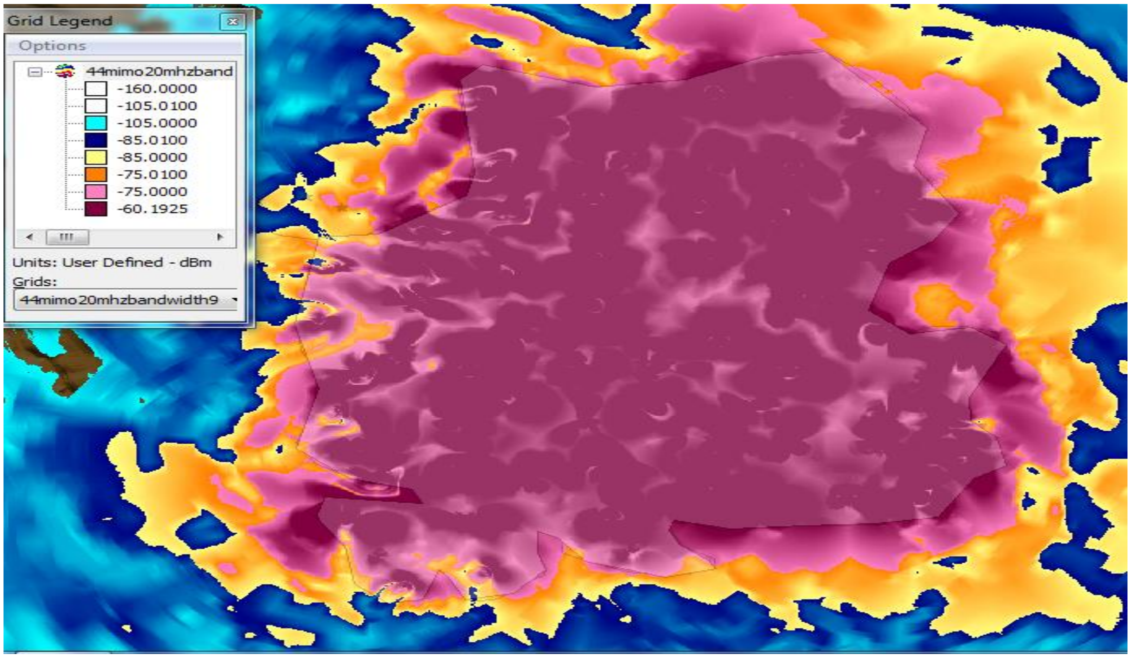


Figure 3.64: WCDMA Hebron Coverage Before and After Tuning at 2100MHz



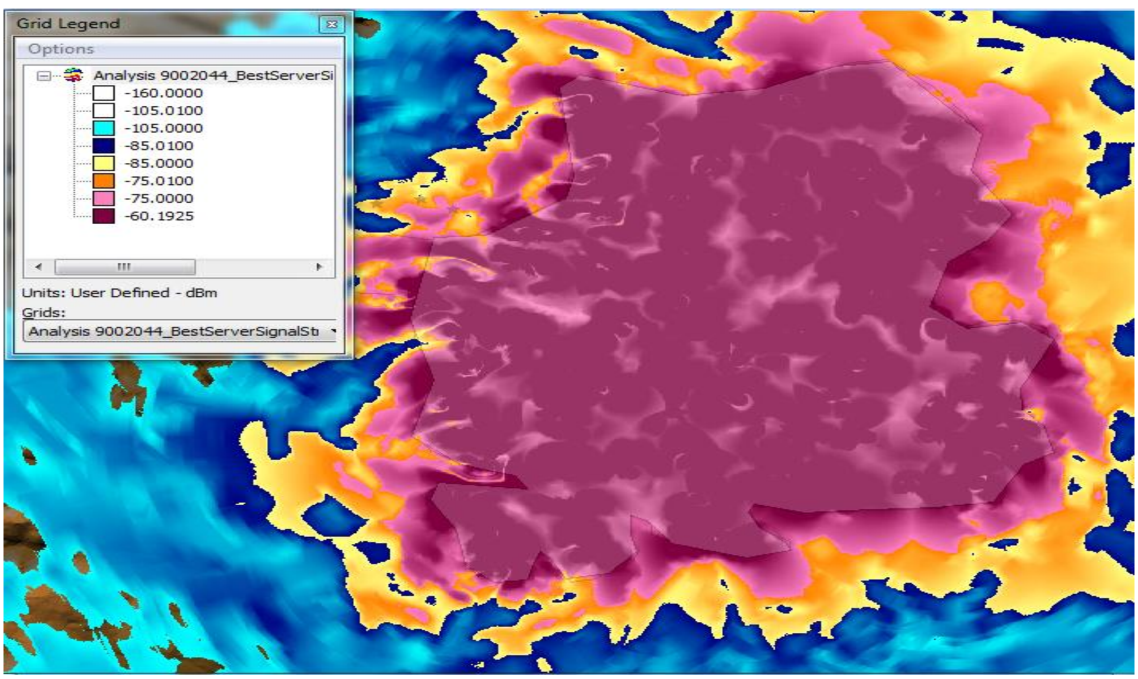


Figure 3.65: LTE Hebron Coverage Before and After Tuning at 900MHz

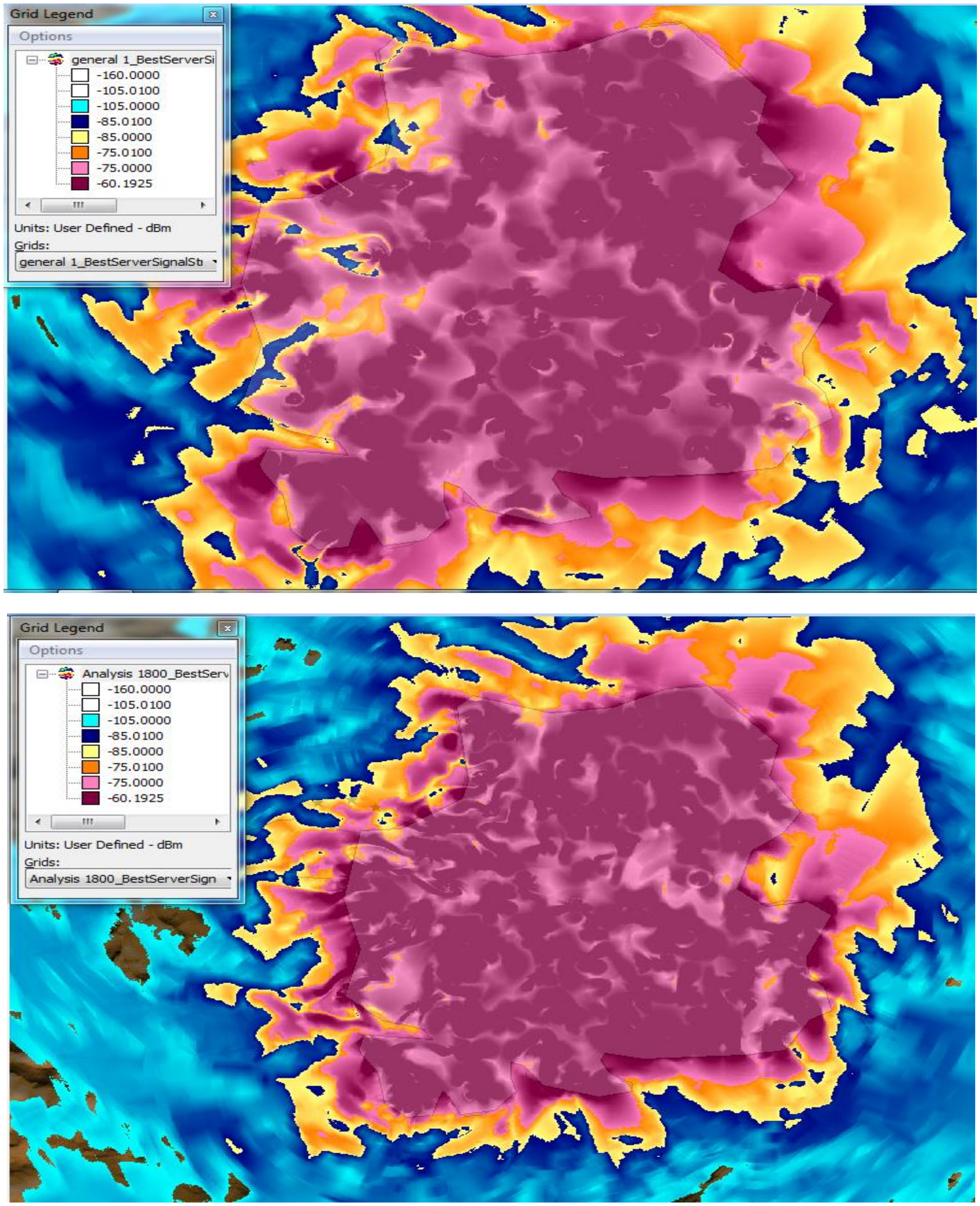
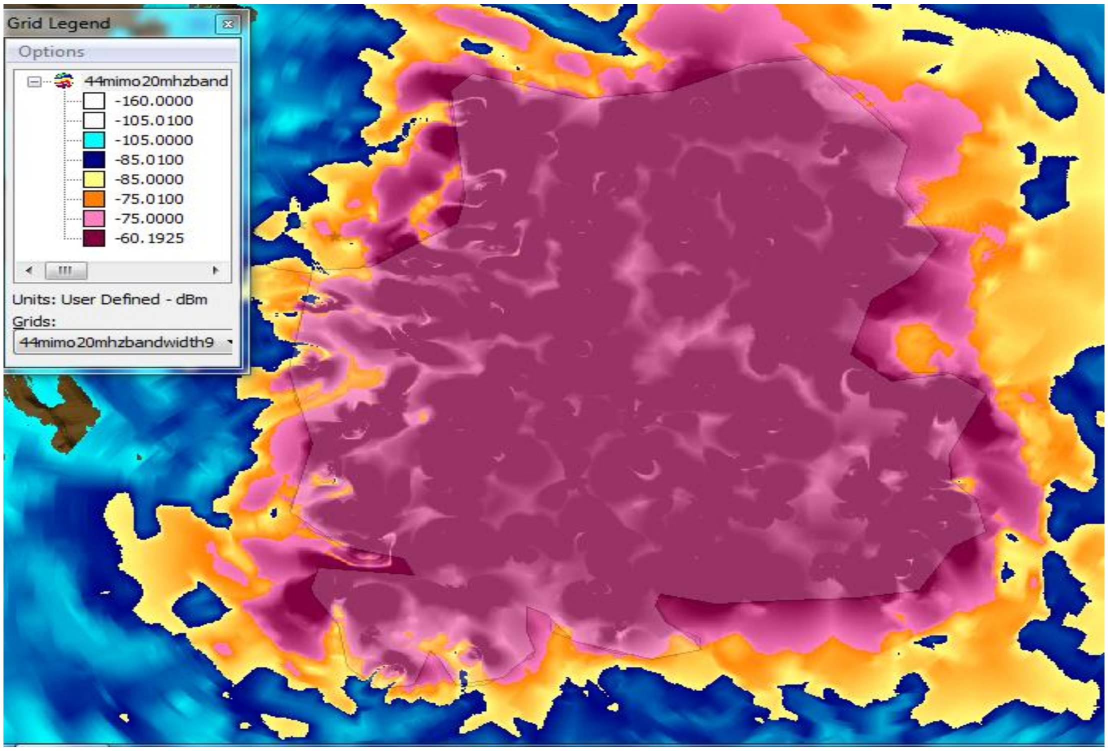


Figure 3.66: LTE Hebron Coverage Before and After Tuning at 1800MHz



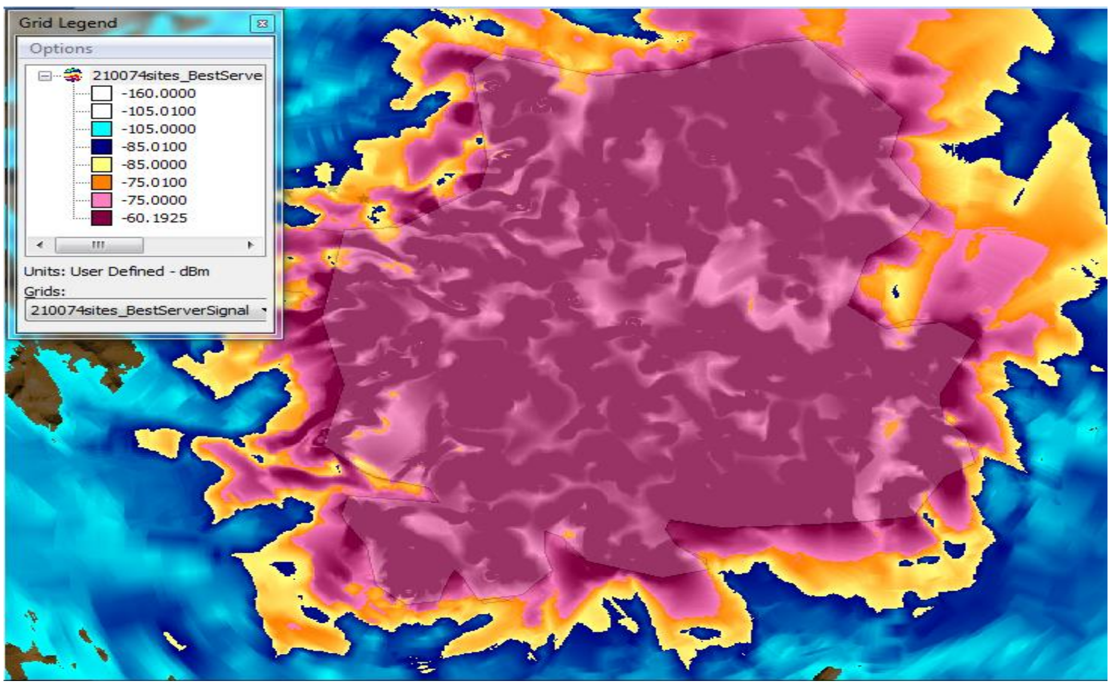


Figure 3.67: LTE Hebron Coverage Before and After Tuning at 2100MHz

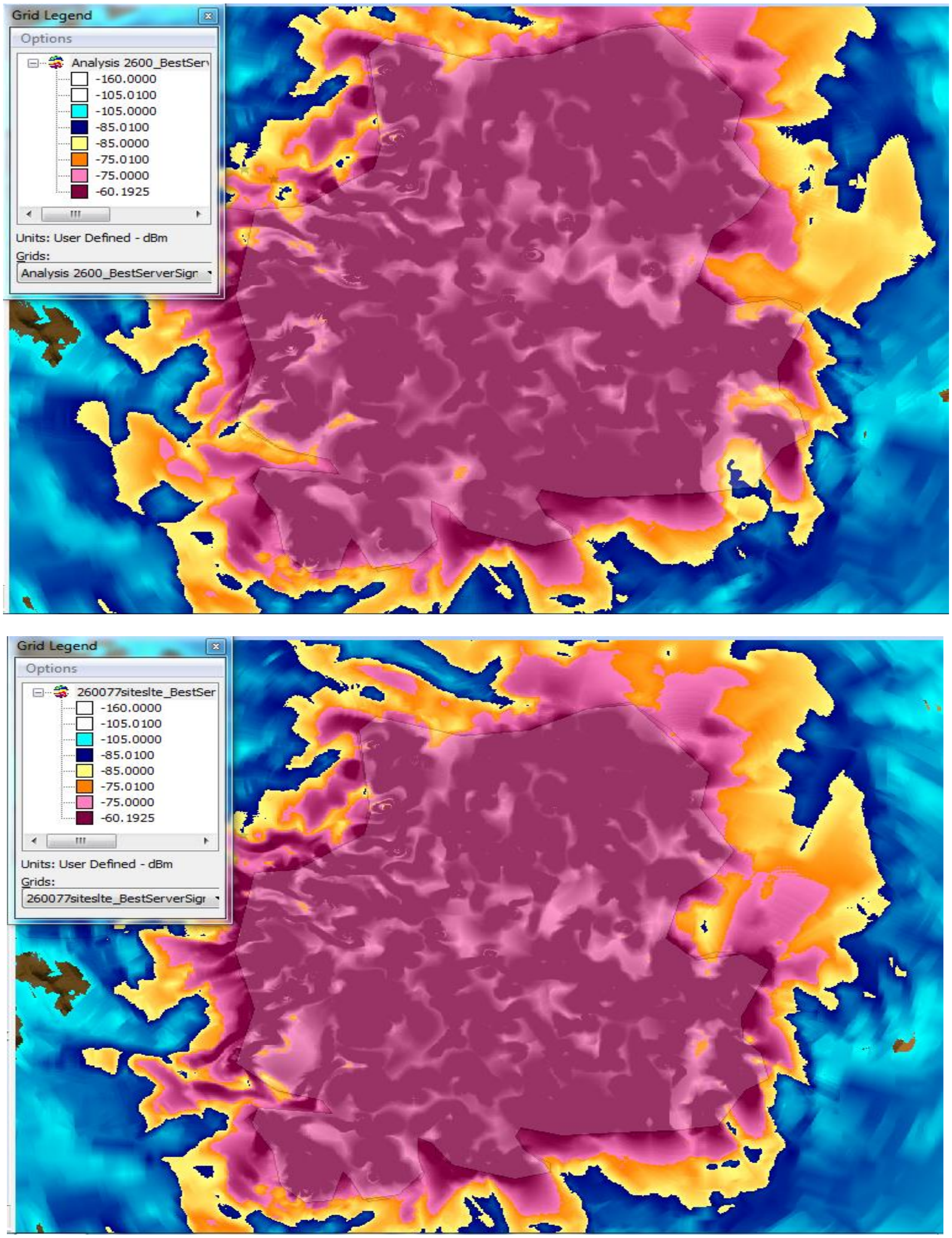


Figure 3.68: LTE Hebron Coverage Before and After Tuning at 2600MHz

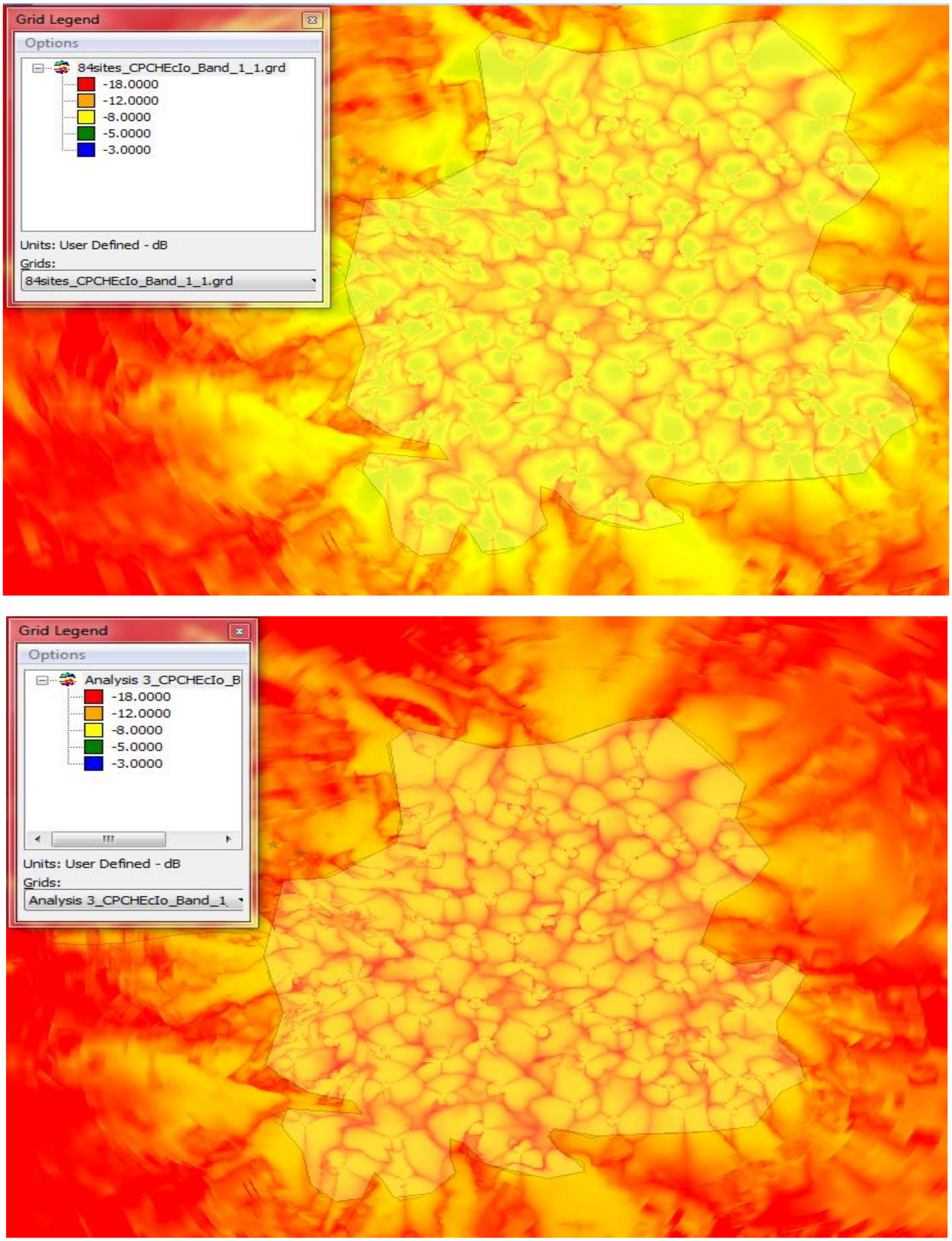


Figure 3.69: WCDMA Hebron Quality Before and After Tuning at 900MHz

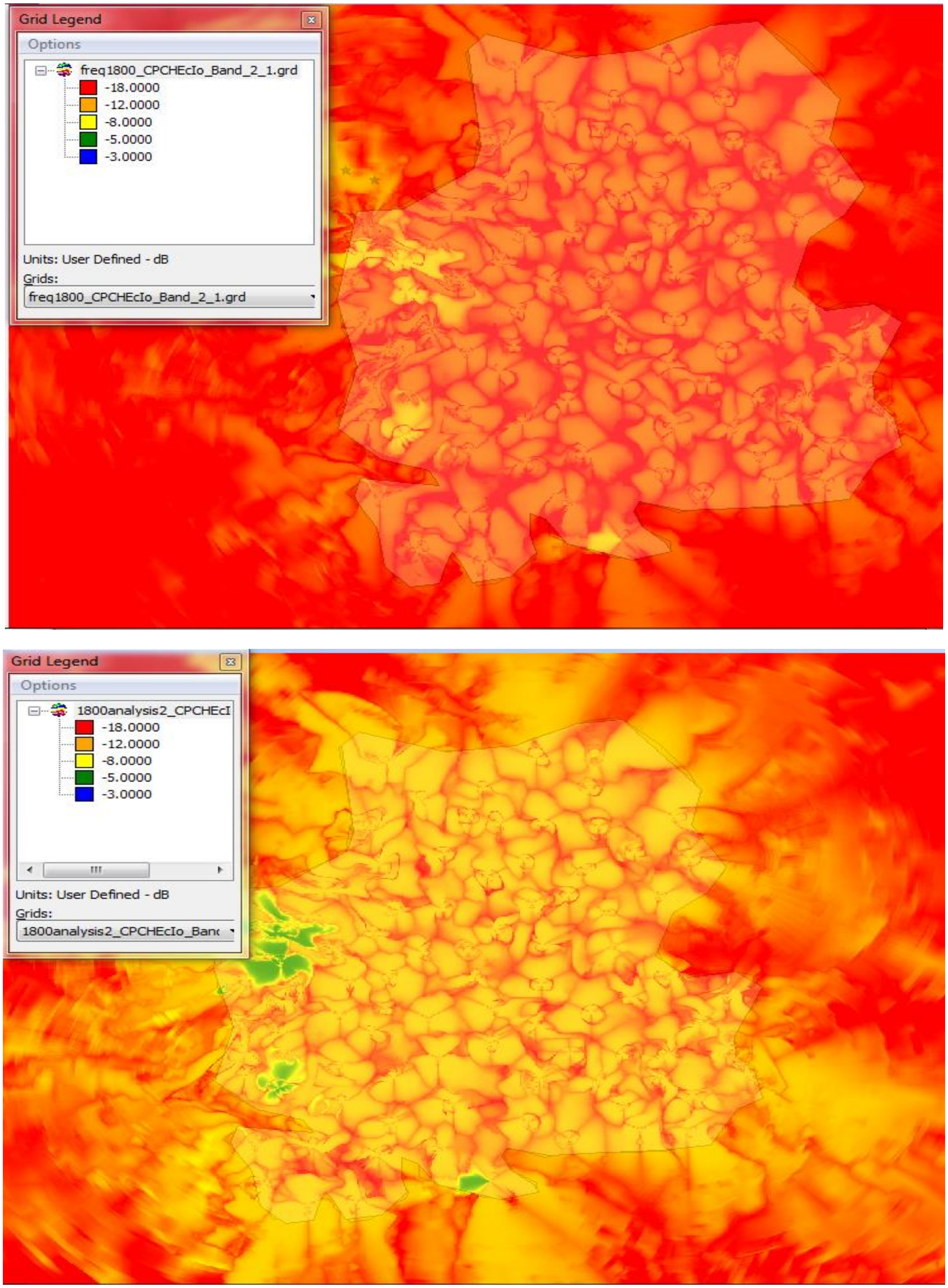


Figure 3.70: WCDMA Hebron Quality Before and After Tuning at 1800MHz

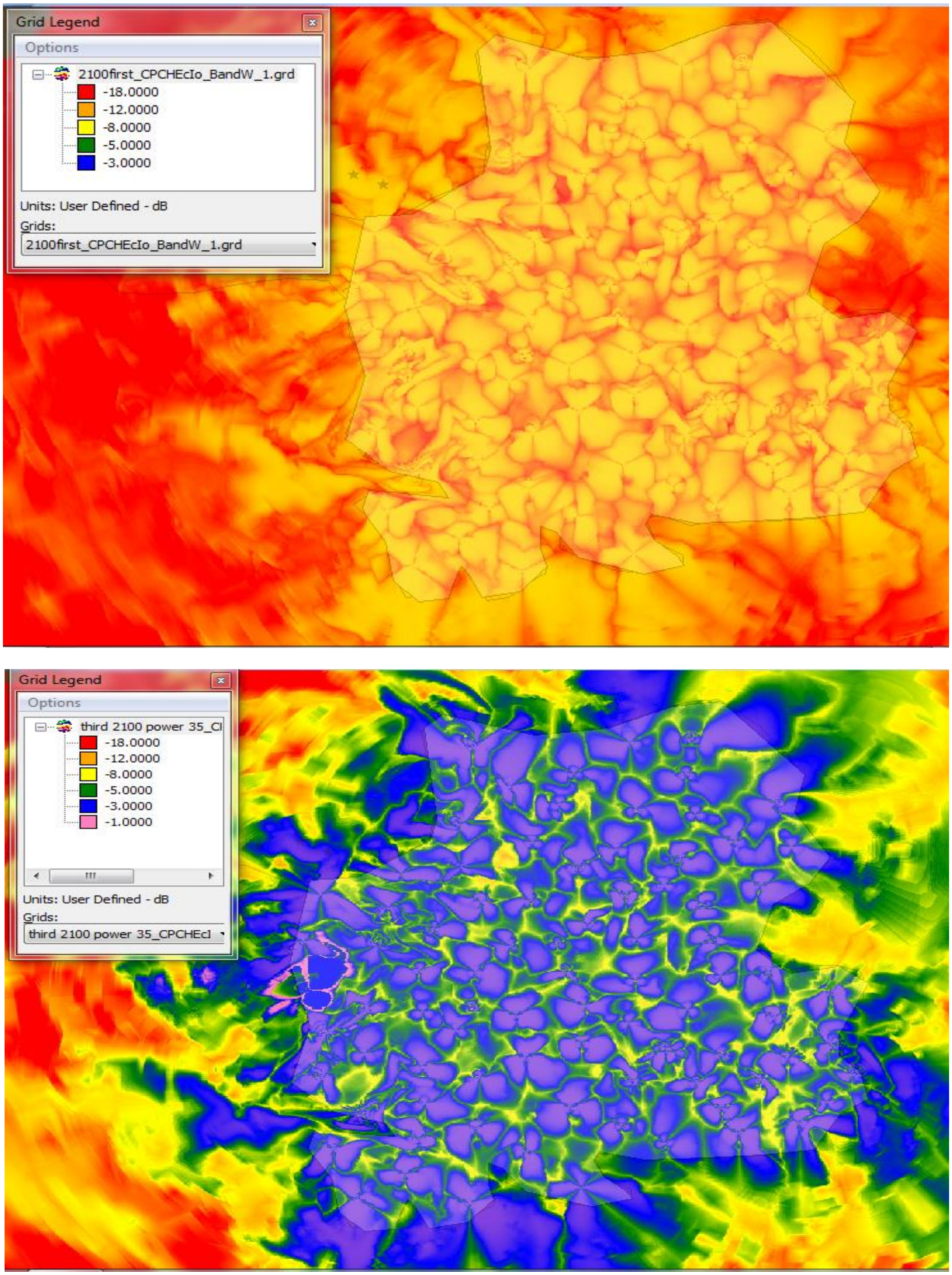


Figure 3.71: WCDMA Hebron Quality Before and After Tuning at 2100MHz

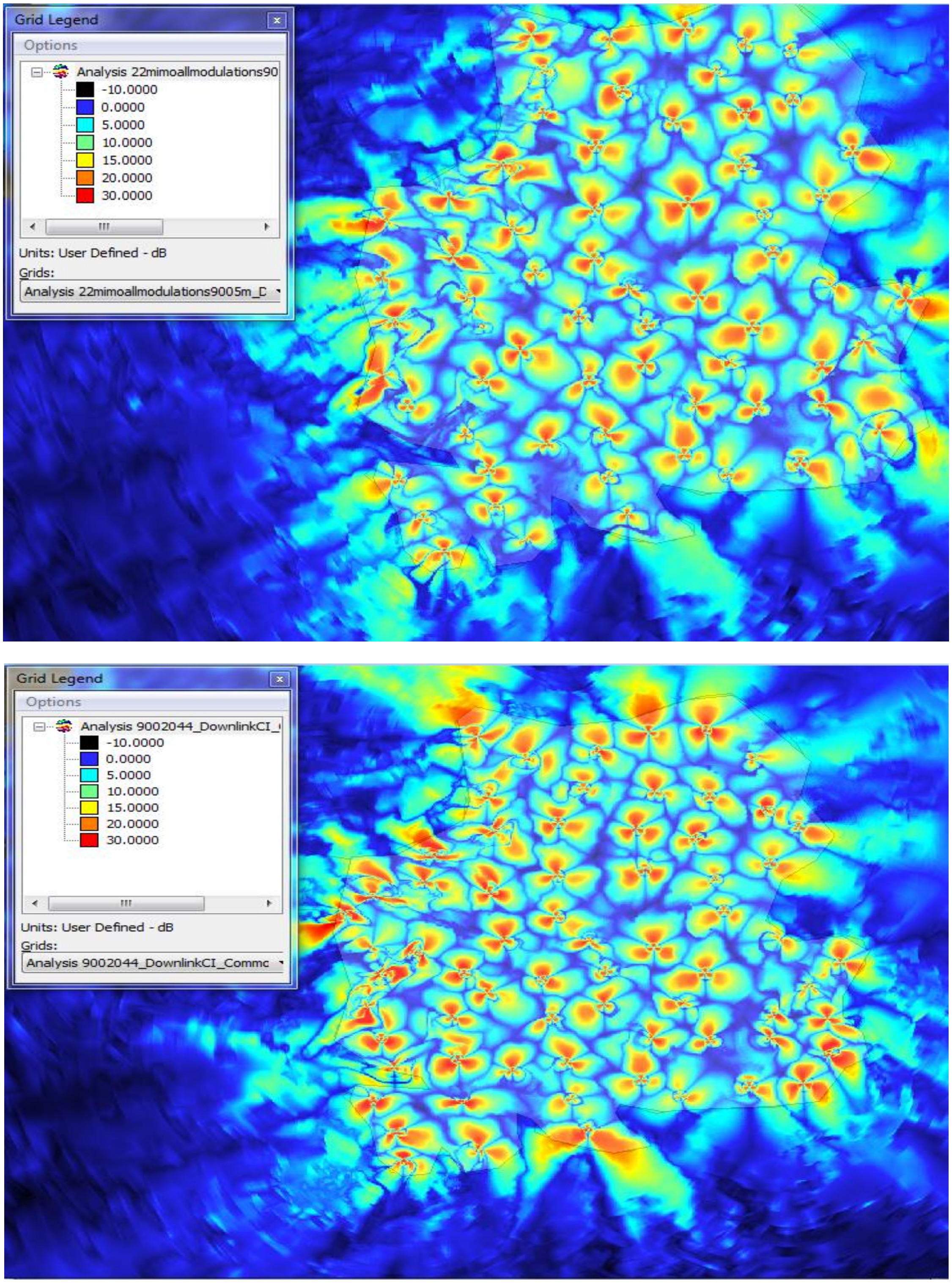


Figure 3.72: LTE Hebron Quality Before and After Tuning at 900MHz

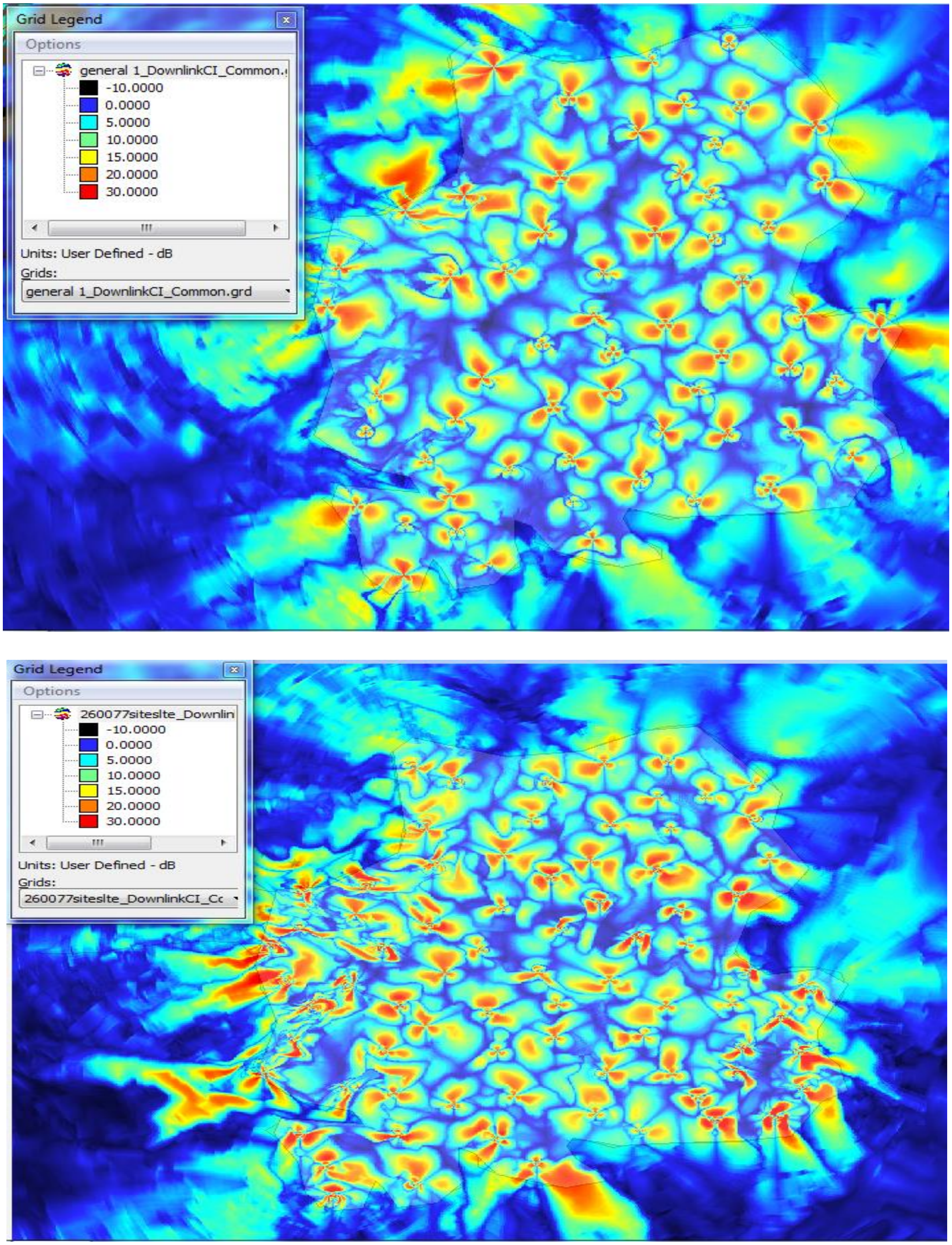
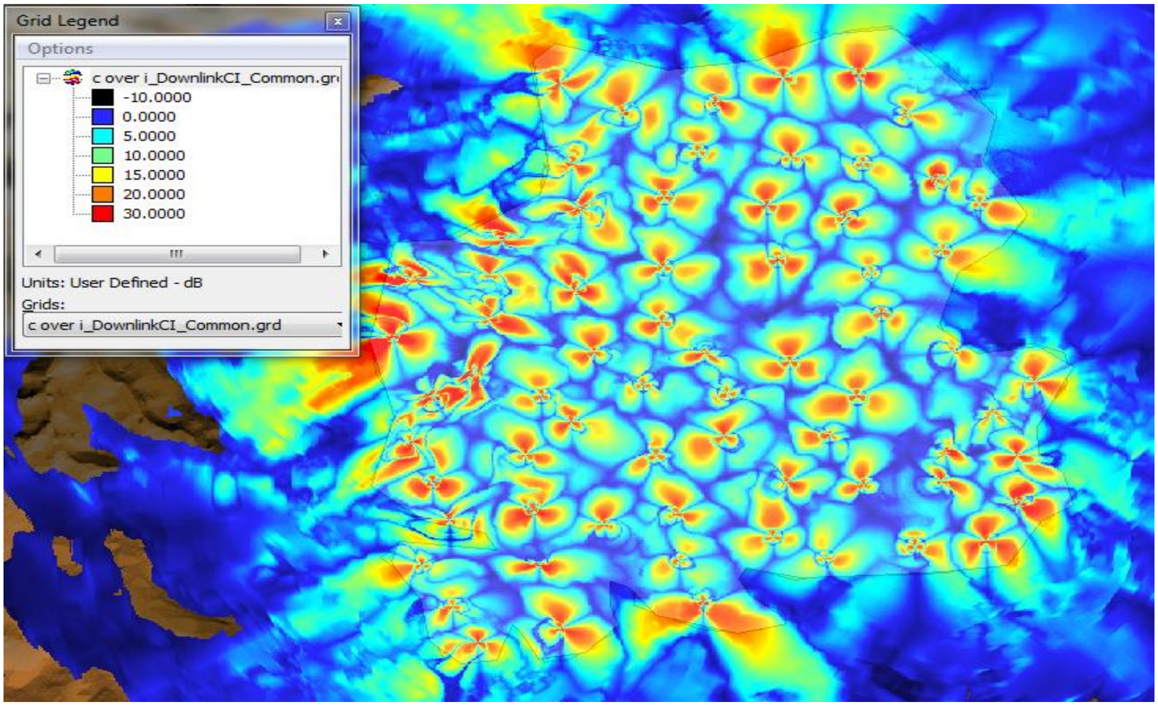


Figure 3.73: LTE Hebron Quality Before and After Tuning at 1800MHz



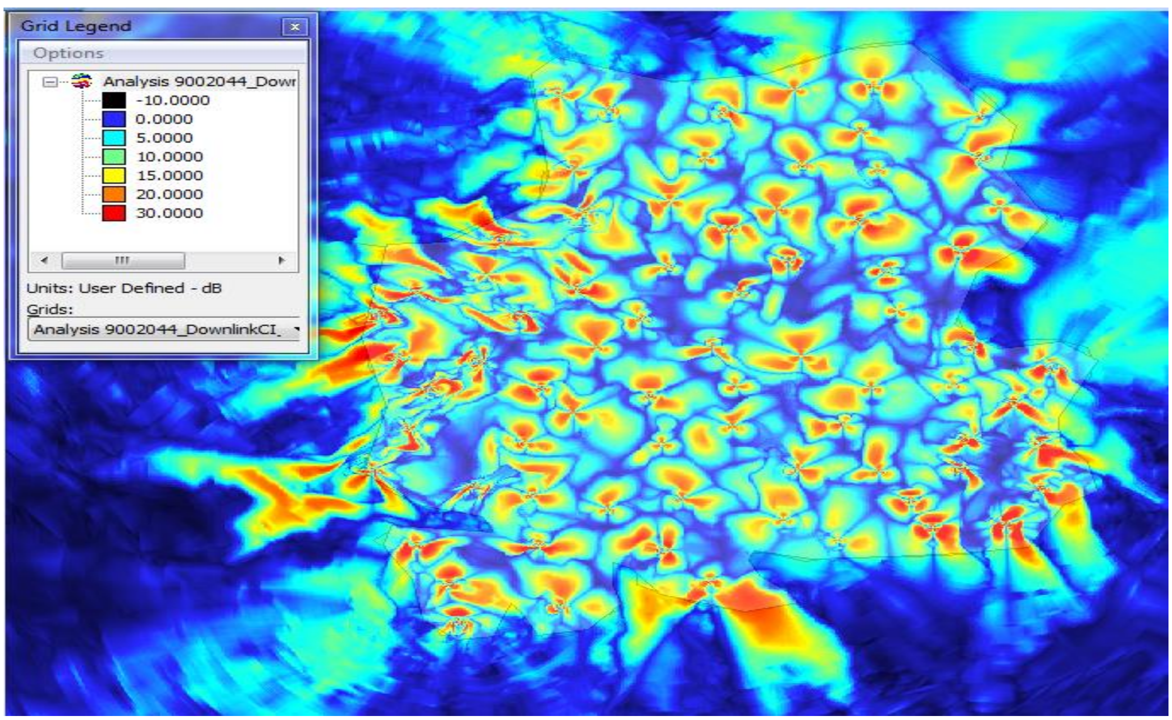
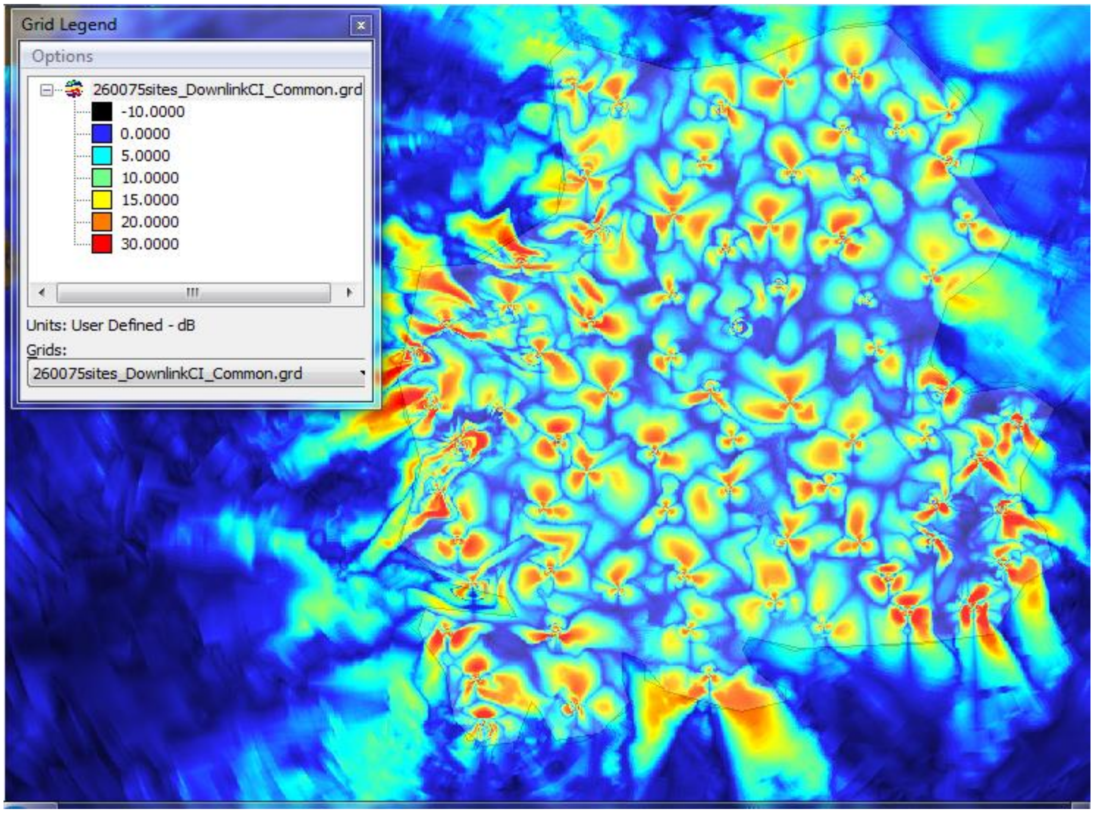


Figure 3.74: LTE Hebron Quality Before and After Tuning at 2100MHz



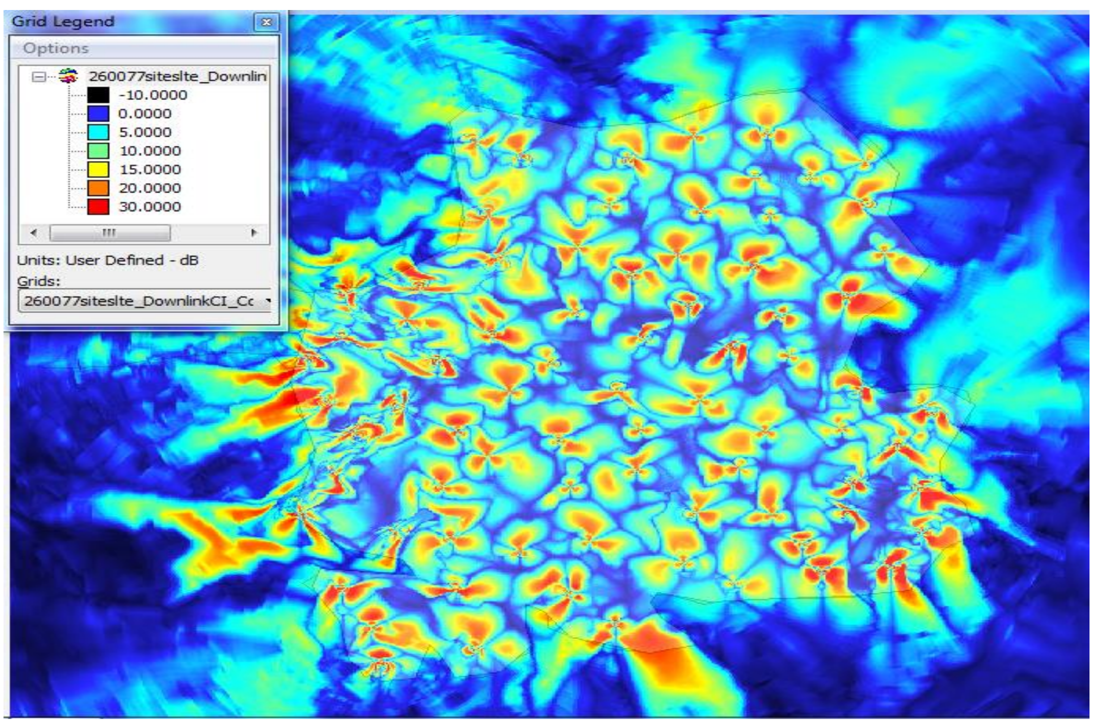


Figure 3.75: LTE Hebron Quality Before and After Tuning at 2600MHz