



CONSTRUCTION MANUAL

Guide on sustainable construction techniques for Low-Cost Housing



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Email: b.weber@dw-namibia.org Website: www.dw-namibia.org

Author: Tapiwa Chipo G. Maruza Printed by: John Meinert Printing (Pty) Ltd.

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1. Introduction

This manual aims to provide a guideline to house owners and builders on good construction practices for safe and affordable housing. The descriptions in this manual follow the standards and regulations as set out by local authorities in Namibia to ensure quality and sustainable buildings. To build a house many processes need to be followed and many professionals are involved. Firstly, is the preparation of building plans followed by the procurement of the building materials and finally the actual construction of the building. These processes will be explained in detail in this manual.

2. Building Plans - The Building on Paper

These drawings are known as 'building plans' and they show the local authority how your house will look and with which material the house will be constructed with. The building plans also show the builder, the joiner, the plumber and the electrician how to build the house. Building standards differ depending on the local authority, therefore, it is very important to consult the local authority and ensure that the building plans are approved before construction begins.

Local authorities require a fee to inspect and approve building plans. They will also inspect the construction of the house at various stages to ensure that it is in accordance with the approved building plans. If the owner wants to extend their house after it is completed, they must submit new building plans showing the house's additions. Once the plan is approved, they can construct the extension. Each local authority requires a different set of drawings so it is very important to get the building checklist from the local authority that explains what should be included in the building plans.

A typical set of building drawings include:

- a) Site Plan a view of the plot from above
- b) Floor Plan a view of the house from above
- c) Elevations views of the sides of the house
- d) Sections a view cutting through the house showing the inside of the floors, walls and roof

Other drawings that a local authority may need are:

- a) Electrical Layout
- b) Roof Plan
- c) Pavement Section
- d) Sewer Section
- e) Window and Door Schedule
- f) Septic Tank and Conservancy Tank Plan and Section
- g) Coverage Table

Building plans are the building on paper. The plans will be used to show the materials and all the characteristics of the house. Always make sure that the plans are according to the regulations set out by the Local Authority.

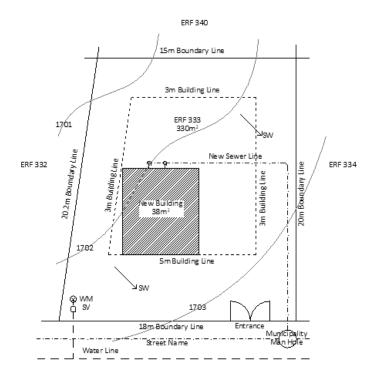


Figure 1: Typical Site Plan (by Author)

2.1 Site Plan

The site plan is usually on a scale of 1:200. The scales of drawings differ depending on the local authority one must verify with the building control department before submitting their plans. The site plan will show information such as the location of the house on the plan and how it is positioned, the dimensions (measurements) of the plot and the house and the distances of the house to the boundary walls, building lines, access into the plot, the topography (slope) and landscape, how the water and sewer pipes connect to the main municipality pipes and the manhole. Local authorities have different requirements, for example, building lines differ from town to town.

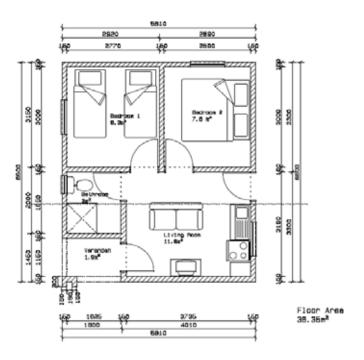


Figure 2: Floor Plans (DW Okahao Demo House)

2.2 Floor Plan

The floor plans are usually on a scale of 1:100. Floor plans show the rooms inside the building, the walls, doors and windows. The floor plan should be well dimensioned, clearly showing the size of rooms, walls and openings. Plumbers and joiners also use the floor plan to understand where the cupboards and the plumbing fixtures are. Each room must be clearly labelled with the floor finishes indicated and all structural elements such as beams, and columns indicated.

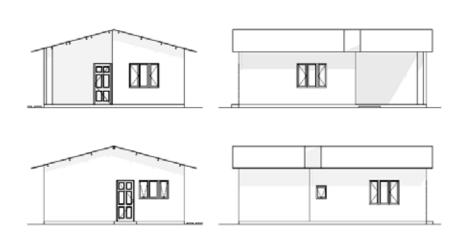


Figure 3: Building Elevations (Image by Author)

2.3 Elevations

All four elevations must be shown and clearly labelled either North, South, East or West Elevation. The main purpose of the elevations is to show the height of the building, exterior surfaces and windows and doors.

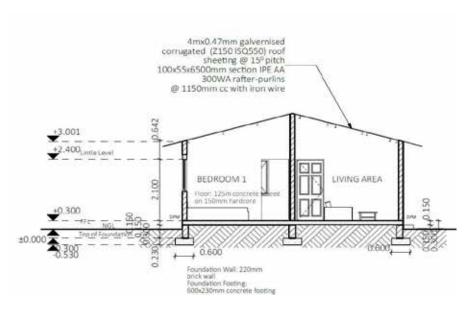


Figure 4: Building Section (Image by Author)

2.4 Sections

Sections are meant to show the inside of the building. It's a 'cut-through' of the building. The section is very important because it shows the materials used in construction. A typical section will show the depth and type of foundation, the floor from the ground level to the finished floor level, the thickness of the exterior and interior walls, structural support over openings and the roof, the ceiling, the beams and purlins and finally the roof materials and how all these roofing elements are attached. The section also shows the levels of the building. The key levels are the depth of the foundation, the natural ground level, the finished floor level, the lintel level (the top of the windows and doors), the ceiling level and finally the top of the roof.

2.4 Other Drawings

Depending on the municipality other drawings may be required. Drawings such as the electrical layout that shows all electrical features and how they are connected or the roof plan that shows the roof sheets and how they slope away from each other. The sewer section would show how each of the plumbing features is connected and how they connect to the manhole. The pavement section would show the relationship of the front of the building to the boundary wall to the pavement and the road outside. Other municipalities request a coverage table that shows the area of the site and the area of the house footprint.

3. Procurement of Materials

One of the purposes of a building plan is to assist in the preparation of a Bill of Quantities also known as a BoQ. A BoQ is a list of all the building materials that are needed to construct the building and in what quantities each material must be purchased. Once the BoQ is prepared the material can be purchased from local construction, building and hardware stores. In addition to the material cost, there is also the cost of transportation, therefore it is better to buy materials from nearby stores.

It is important to consider and prepare for the safe storage of the building materials once they have reached the site. If the owner of the house has employed the main contractor, then this is the responsibility of the main contractor on-site, but it is still important for the owner to consider the safety of the materials purchased. If the owner has contracted multiple subcontractors to do construction and has committed themselves to supervising the construction of the house, then the safekeeping of the materials becomes the sole responsibility of the homeowner.

4. Building the House

4.1 Clearing Site

Before construction begins the site must be properly cleared to remove rubble and unwanted vegetation. At this stage, any trees that should be preserved during construction should be marked so that they are not damaged. It is also important that sanitary facilities be provided for the builders on site. Once the site is clear the construction parameters must be set out. If the site is level, then this means that the corners of the house are marked on-site to show where the house will be. If the site requires cutting and filling to level the site, then this must be done first before setting out.

4.2 Bulk Earthworks and Excavations

At times a site must be levelled and major excavation work, cut and filling, is required. The depth and soil type will determine the complexity of the excavation work and very complicated excavation should be done by a professional to ensure safety. Part of excavation work is the excavation of trenches for foundations.

4.3 Foundation

The purpose of the foundations is to evenly distribute the weight of the building to the ground. The ground is excavated according to the specifications in the building plans.

It is important to treat the excavated trenches with ant and termite poison before pouring the concrete for the footings to prevent infestation in the future. Concrete is usually mixed and poured. Once the concrete is set 220mm foundation walls are built just above ground level. The average depth of a foundation wall is 300mm to the top of the foundation, but this differs with local authorities and site conditions. It is very important to

ensure that the damp proof membrane, DPM, is laid so that ground moisture does not go into the walls.

If the foundation wall is higher than 1m it is important that the very second layer is reinforced for stability. Foundation walls may also act as reinforcing walls. These are walls that are designed and built to hold back soil, as such they should be stronger and waterproof. Once the walls are built the foundations are backfilled. Soil is put back in layers and compacted until the ground level is reached.

The foundation is the base of the building where ALL the forces of the building settle. It is important to make sure that the trenches, footings and foundations are inspected and approved by the local authority.



Figure 5: Foundation Trenches (setting out and foundations dug. (weebly.com))

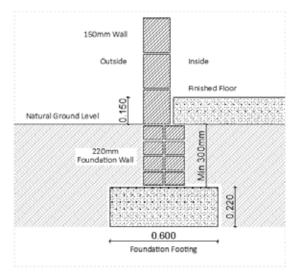


Figure 6: Typical Foundation Section (Image by Author)

4.4 Floors

Typically, a concrete floor slab is 150mm thick. The specifications of the floor depend on the local authority, so it is important to ensure that the building complies. Usually, a floor is a mix of concrete, sand and aggregate. DPM must be laid to ensure that the floor is waterproof, and moisture is not taken up from the ground.

4.5 Walls

Once the floor is complete, construction of the walls to roof heights starts. To ensure that the walls are straight the corners are built first and the internal walls are built later. Openings for the windows and doors are left open. It is very important to ensure that the lintels are placed above the windows and doors so that the openings do not 'sag' or collapse inwards. For structural stability of the walls, it is important to include brick force at specific intervals in the layers of the bricklayers.

4.5.1 Brick Types

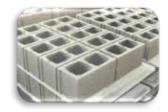
Super Brick 220x105x72mm



Block Brick 300x100x150



Hollow Brick 390x150x190



Bricks come in different types, sizes and strengths. The most common brick is the 220x105x75mm super bricks. These bricks are strong and durable, and they come as face bricks that do not need to be plastered over and painted. More affordable bricks are block bricks or hollow block bricks. These bricks are larger and are more affordable but are less durable as compared to super bricks which is why these bricks should be plastered and painted. Some councils do not allow block bricks and hollow bricks to be used to build firewalls, super bricks should be used in this case.

Figure 7: Brick types (cement-bricks-blocks - Jenkor and solid concrete block brick - Bing images)

4.6 Roof

Once the walls are complete the next stage is to construct the roof. The roof construction should be according to the specifications in the section in the building plans. If the roof is made of timber, a carpenter will be needed and if it is made of steel the builder can continue the works, for complex roofs a welder is required.

4.6.1 Types of Roofs

There are different roof types, and they have different advantages and disadvantages. Some of the most common types of roofs in Namibia are the Open Gable and the Hip roofs (commonly known as diamond roofs). This is because these roofs have good drainage and water runs off the roof easily without gathering in one place.

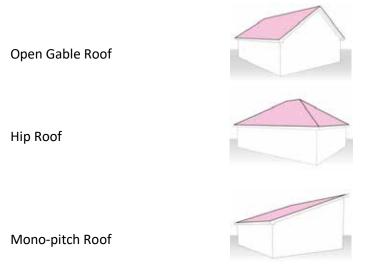
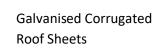


Figure 8: Roof types (Hip Roof vs. Gable Roof - Pros & Cons of Each Type (roofingcalc.com))

4.6.2 Types of Roof Sheets

Like different roof types there are different roof sheets to choose from. The two most common roof sheets are galvanised corrugated sheets and IBR sheets. Galvanised corrugated sheets are more affordable than IBR sheets.







IBR Sheets

Figure 9: Galvernised and IBR roof sheets (Galvanised Steel Corrugated Roofing & Cladding Sheet | corrugatedplasticroofing.co.uk and IBR Roofing Sheets – Syscot Electrical and Hardware)

4.7 Plumbing and Electrical

At this stage of construction, water and electrical PVCs can be installed into the walls. PVC pipes come in different thicknesses and diameters to fit different purposes. The plumber connects and lays the pipes according to the drawings and connects them to the manhole and main waterline.

It is very important to ensure that the electrician who installs the electrical wiring and fixtures should have a Wiring and Compliance Licence from the local electrical distributor. This is a matter of safety because faulty wiring can easily cause an electrical fire.

4.8 Finishes

Finishing a house is one of the final steps in the building process. Finishing a house is not only to make it look attractive but also to protect the building materials. The most common types of finishes on the walls of a house are plastering and painting. Plastering and painting a house protects the bricks from rain and wind. This is important especially if you use a block or hollow bricks that wear quickly. Super bricks are stronger, and they do not need to be plastered and painted if the owner wishes to leave them as is.

The other consideration is the material used for the window and door frames. The owner can choose either aluminium windows or standard steel windows. Standard steel windows are much cheaper than aluminium windows.

There are so many finishes to choose from, plastering, painting and face bricks. The choice of finishes on a house should be determined by what you like, what you can afford and what is durable and long-lasting.

4.9 Final Completion and Handover

Once the building is complete the building is handed over to the owner. The owner must thoroughly inspect the building to ensure that there are no defects on the building. Defects can either be minor or major and they should be corrected by the contractor or the builder. Minor defects are small and do not affect the structural stability of the building or the usability of the building, for example, chipped paint or a cracked tile.

Major defects however affects the main structure of the building and usually present themselves as large cracks in the brickwork, a plumbing system that is not working or other serious problems that affect living in the house.

Defects can also be latent or patent. Patent defects are obvious to see and can be identified immediately for example a cracked tile while latent defects may take time to present themselves. A common example of a latent defect is a leaking roof. If a house is completed in the dry season the roof may seem sound but when it rains months later it starts to leak, showing it was built incorrectly. The builder is required to fix these defects once they are detected.

The building inspector will also conduct an inspection at final completion to ensure that the building is built properly and according to the building plans.

Building a house is an investment. Do not hesitate to become fully involved with the process and with all the professionals involved.

5. Other Considerations

5.1 Firewalls

One of the key elements of a building is firewalls. Firewalls are important because they are walls that are placed in specific places to ensure that in the event of a fire, the fire will not spread too quickly throughout the house and to neighbouring houses.

Firewalls are supposed to be 220mm thick brick walls plastered and painted on both sides. Firewalls should be placed in key places, for example, between living units in a complex, between the garage and adjacent rooms, along a boundary wall if the house is built along the boundary wall or if the walls are built closer than 1.5m away from the next house.

Local authorities are very strict about firewalls because they ensure the safety of the occupants and neighbouring houses in the event of a fire.

5.2 Building a Double Storey House

Building a double-storey house is more complicated and more expensive than building a single storey house. The benefit of building a double-storey house is that it allows for higher density on smaller plots and leaves more space for the garden.

When building a double-storey house, it is important to make sure that the walls on the ground floor are 220mm thick super brick walls so that they can support the walls for the storey above. To ensure that a double-storey building is structurally stable it is important to get an engineer to draw structural drawings to submit to the municipality in addition to the drawings by the architect.

The more complicated the building, the more expensive it is to plan and build. Local Authorities require professionals to ensure that the buildings are safe for the owner and the neighbours around.

5.3 Consent from the Neighbours

It is important to get your neighbours' consent if you are building past the building line. This is because building past the building line your structure will affect their house, so they have the right to decide if you should build that close to their house. A neighbour gives consent on a municipal consent form as well as putting their signature on the plans that are submitted to the municipality.

5.4 Other Professionals in the Building Process

When building a house there are several professionals who are needed from the planning to the completion of construction. Usually, the first professional is the architect whose responsibility of drawing up the plans to submit to the municipality. Sometimes the architect will also continue working on the project making sure that the building is constructed according to the plans. Projects also require a structural engineer if the building is a double-storey building or if it is a complicated building.

A quantity surveyor's responsibility is to calculate the quantities of the building materials and the cost of the building. The larger the building the more the need to involve all the professionals in the planning phase.

During construction the contractor or the builder also requires professional skills such as an electrician, plumber and carpenter to help in the construction of the building.

Low-cost housing combines the skills of all the professionals in the planning phases to provide pre-prepared plans.

5.5 Incremental Building

Incremental building refers to the practice of building a house in small sections over a long period of time rather than building the whole house at once. When building an incremental house, it is important to take into consideration future construction. It is common to lay foundations and floors for future construction and to 'tooth' the wall that will continue to be constructed in the future.

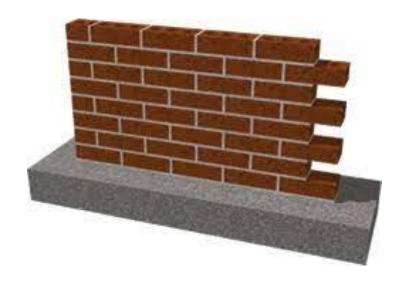


Figure 10: Toothing in a wall to continue construction at a later date (toothing in wall construction - Google Search)

6. Annexures

6.1 Annexure 1: The Role of the Local Authority and the Building Inspector

Role of the Local Authority – Building Department

- 1. To provide building guidelines and a building checklist.
- 2. To approve building plans. If the building plans do not meet the requirements the building department of the local authority will request that changes be made before they approve

Role of the Building Inspector in (Local Authority)

- 1. Once construction has started the building inspector will inspect the foundation depths and position to ensure that the building is within the boundary lines. The erf pegs must be clearly visible.
- 2. Inspection of the DPM in the foundations.
- 3. Inspection of open drainage before the pipes are covered up
- 4. Inspection after drainage is covered. Inspection of the plumbing fixtures and connection.
- 5. Inspection of door and window schedule
- 6. Inspections of room sizes being more than 7m²
- 7. Inspections on the quality control of the roof

6.2 Annexure 2: The Building Plan Checklist

GENERAL (APPLICATION FORM)	MINIMUM PLAN SIZES : 4/A3 = A	1			
rf Number	Size of arches/openings		Special foundation - Cimbebasia & Prosperita, New Aca		Existing buildings all
Suburb Name	Roof support @ demolished walls		FFL to ceiling height		New buildings (properly indicated)
Description of Plan	Selfclosing firedoors between house + garage		FIREWALLS (1: 100)		Existing sewer lines
street Name	100mm step between house + garage		Section thru firewall		New sewer lines
rea of building - existing	Sliding door size		Foundation inside boundary line		Connection details (ss, vp, og, re's, lrb)
Owner Full detail	Windows no's / codes / details		Parapet height (300 mm above roof level)		Distances :
rchitect Full detail	Windows 10% of floor area (5% to open)		THATCH (1:100)		buildings to boundaries
XTRA	Boundary wall plan		Sprinklers - 2,25 L / min / m² or waterpoint within 3m		between buildings
ingineer's letter	Position of section		Firewalls on boundaries		roof + windows min 1500mm to boundary
ingineer's plans	Storeroom maximum 15m²		Thatch exceeding 20m² to be 3 m from boundaries		Concrete encasing for sewer pipes under floors
leighbour letter of consent	Pool backwash to internal sewer			Sewer Service ducts + access to ducts	
Service stamps	Engineering letter for pool closer than 1500mm to existing wall or building SEWER SECTION (1: 100)		Thatch- Position, measurements & Firewalls		
PLAN LAYOUT (1: 100 min)	ELEVATIONS (1:100 min) Cover levels		Neigbours signature on site plan		
rea of new and scale	Headings - north,south etc. FFL on elevations, slope of ground on elevatio		Invert levels		BOUNDARY / GARDEN WALLS (1: 100)
cale of drawings	SECTION (1:100)		Fall (slope)		Elevation, CJ + Spacing
Ise and areas of new rooms	Headings & scales		ss, og, re's, Irb, to be indicated		Plastered & Painted Both Sides
ull details of first adjacent rooms	Section to be thru new building		Sewer pipe materials		Section
emolishing - dotted lines - yellow	Roof covering - specify		Must be on scale		Foundation inside boundary line
Cross ventilation in rooms	Roof slope		SITE LAYOUT (1: 200) or (1:100}		Top of foundation on streetside to be 600mm
imensions of additions	Roof painted - certain areas		Erf daigram (Surveyor-general)		below street level
irewalls for buildings closer than 1500 mm	Purlins - sizes & spacing		Erf measurements, show from beacon to beacon		Indicate erf boundary on section
Distance to boundaries	Trusses - sizes & spacing		Adjacent erf no's (all)		Boundary wall plan
irewalls exceed buildings by 1500 mm	Rafters - sizes & spacing		Building lines (3m & 5 m)		PAVEMENT (1:100)
irewalls between house & garage	Wallplates - sizes		Contour lines		Section thru pavement with levels
latch new walls + Colour	Brandering - sizes		Contour levels		Ramp 1:50 fall towards street
Mechanical vents & roof vents	Ceiling material - specify		Gates, sliding swing within property boundary		Pavement section for relaxation of 5m building lin
fin. size of inhabitable rooms - 7m²	Roof supports - indicated		North point		PLAN SCRUTINZER:
lin. internal dimensions of inhabitable rooms = 210	Ramp Details		Street name		ARCHITECT/DESIGNER:
Itered rooms - total new area	Walls - hatch new		Mun sewer line & mun. waterline + manholes		DATE:
overage legend	Height - FFL to NGL min 150mm		Waterline (new houses)		SIGNATURE:

Applicant:	Erf No.:	Tel. No.:	
City of Windhoek	Donathont of List and Transact District	Department of Orban and Harbport Framming Urban Planning Division	

NEIGHBOUR CONSENT FORM

COMMENTS REQUIRED FOR:

- More than 2 Storey Residential Dwelling Exceeding of coverage Exceeding of outbuilding size
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the Owner of Erf, which is adjacent* to Erf, have seen the drawing showing the structure to be erected thereon. More than 2 Storey residential dwelling			
the Owner of Erf een the drawing showing the structure to be e AGREE AGREE O AGREE O	(1) ADJACENT ERF OWNER'S COMMENTS:		
More than 2 Storey residential dwelling AGREE OBJECT Exceeding of Coverage Exceeding of outbuilding size Reason for objection, if any:		r of Erf	, which is adjacent*
AGREE AGREE		ng showing the structure to b	se erected thereon.
AGREE AGREE	More than 2 Storey residential dwelling	AGREE	OBJECT
AGREE	Exceeding of Coverage	AGREE	OBJECT
Reason for objection, if any:	Exceeding of outbuilding size	AGREE	OBJECT
	Reason for objection, if any:		

I herewith declare that the above is true and correct

Signatory				Signatory must attach copy of ID
	Ogned.	Tel	Date:	Signatory

^{*}Immediate neighbours include owners of properties that share borders or are separated by pan-handle accesses or small watercourses and public open spaces as well as those opposite across the street.

6.4 Annexure 4: The Inspection Form

Department of Urban Planning & Property Management	Norma: Servetura: Dotte:
NOTICE THAT THE FOUNDATION EXCAVATIONS ARE READY FOR INSPECTION	And the state of t
Thereby give notice that the foundation excavation of the building on Erf No.: No.: Thereby give notice that the foundation excavation of the building on Erf No.: The necessary sanitary facilities are available on site.	that the foundation excavation of the building on Erf No.:
The foundations excavations will be ready for inspection on	/20
NAME OF OWNER:	NAME OF BUILDER:
Checked:// 20	Building Inspector:
NOTE: ANY PRESON BEGINNING TO ERECT A BUILDING IF INSPECTION SUP IS NOT FILLED OUT O	NOTE: ANY PERSON REGENEING TO ERECT A BUILDING WITHOUT GNING NOTCE SHALL RE GUILTY OF AN OFFENCE. IF INSPECTION SUP IS NOT FILLED OUT COMPLETELY, INSPECTION WILL NOT RE DONE
City of Windhoek City of Windhoek Department of Management Building Control District	Inspection Report Received Name: Senature: Date:
NOTICE THAT THE DAMP PROCE COLIDSE ARE BEADY FOR INSPECTION	THE RESIDENCE AND ASSESSMENT OF THE PERSON NAMED OF THE PERSON NAM
I hereby give notice that the damp proof course of the building on Erf No.:	o: Street Subutb: Bulding Plan
is laid and ready fo	
NAME OF OMNER:	NAME OF BULDER:
Checked: / / 20	Building Inspection stip is not felled out comments y inspection will not be howe
City of Windhoek	Inspection Report Received
Legisliment of Urban Marving & Property Management L. Building Control Division	Name: Sgnature: Date:
NOTICE THAT THE UNCOVERED DRAINS ARE READY FOR INSPECTION	
I hereby give notice that the uncovered drains of the building on Erf No.:	e notice that the uncovered drains of the building on Erf No.: "Steet: "Steet: "Bublib: "Bublib: "Bublic Brain Properties and ready for open inspection to the Municipal Drainage Regulations and ready for open inspection to the manual properties and ready for open inspection to the manual properties and ready for open inspection to the manual properties and ready for open inspection to the manual properties and ready for open inspection to the manual properties and ready for open inspection to the manual properties and ready for open inspection to the manual properties and ready for open inspection to the manual properties and ready for open inspection to the manual properties and the manual properties are manual properties and the manual properties and the manual properties and the manual properties are manual properties and the manual properties and the manual properties and the manual properties and the manual properties are manual properties and the manual properties
NAME OF OWNER:	NAME OF BUILDER.
Checked:/20	Building Inspector.
	IF INSPECTION SUP IS NOT FILLED OUT COMMETELY, INSPECTION WILL NOT BE DONE
City of Windhoek	Inspection Report Received
Building Control Division	Name: Sgnature: Date:
NOTICE THAT THE DRAINS ARE READY FOR FINAL INSPECTION	
I hereby give notice that the dialnage of the building on Eff No.:	notice that the drainage of the building on Erf No.:
Inspection on	o nati as well as life manicipal challage ingulations and loa

City of Windhoek	Inspection Report Received
Building Control Dission	Name: Date:
NOTICE OF COMPLETION OF BUILDING	8
I hereby give notice that the building on Ert Not:	I hereby give notice that the building on Ef No.:
NAME OF OWNER: Tel.:	NAME OF BULDER.

NAME OF BUILDER:

NAME OF OWNER:

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