

# Challenging Sites

**A challenging site sets particularly stringent constraints on the design of your home. The conditions that provide those constraints may include both physical and social factors. This fact sheet outlines a number of strategies and techniques available to address the design challenges of constrained sites.**

It may be preferable not to build on a challenging site because of the environmental impacts that result from site constraints. On the other hand, such sites often provide exciting opportunities for creating a sustainable home and are worth investigating.

The design and construction of a home for a challenging site raises three questions:

1. What are the characteristics of this type of site?
2. What difficulties does this type of site create for the homeowner, builder or designer?
3. What principles can assist in addressing these difficulties in order to reduce environmental impacts?

## Delivering sustainable outcomes

This is about examining ways to deal with difficult constraints whilst minimising environmental impacts.

The following constraints provide a useful starting point:

- > **Structural:** topography, natural and artificial structures.
- > **Environmental:** climatic, health, visual and acoustic parameters.
- > **Spatial:** size, shape and volume.
- > **Location:** remoteness, proximity, servicing.
- > **Ecology:** ecological value, landscaping.

## STRUCTURAL

Structural constraints apply to the physical factors of the site that include topography, natural and artificial structures.

Topographic conditions relate to geological conditions that have been created over time. Three key factors are:

- > Site slope (fall).
- > Ground conditions.
- > Storm water run-off.

### Site slope

A steep site generally has a gradient in excess of 30°. The slope of a site has an impact on the type of home that can be built, ie flat land house types (slab on ground) are good for flat sites whilst hillside houses (such as pole framed houses) match steep sloping sites. This typology aims to minimise the amount of cut and fill needed to accommodate the slope. The slope may also be non-uniform with some parts steeper than others, sometimes with a cross fall with the slope running diagonally across the site. Steep sites require careful consideration of the contours for an appropriate design response.

Three environmental strategies often used on steep sites are to:

- > Balance cut and fill.
- > Avoid retaining wall being higher than one metre.
- > Build along contours.

### Ground conditions

Ground conditions influence the type of foundations and disturbances to the site. Different soil conditions present different constraints dependent on the design requirements for rock, sand, clay or wetlands.

The most challenging and difficult ground conditions are clay and wetlands due to the instability associated with the conditions found where sites contain this type of material. Rock on the other hand presents the most stable ground condition but large environmental penalties occur with building basement structures in these conditions.

## Storm water run-off

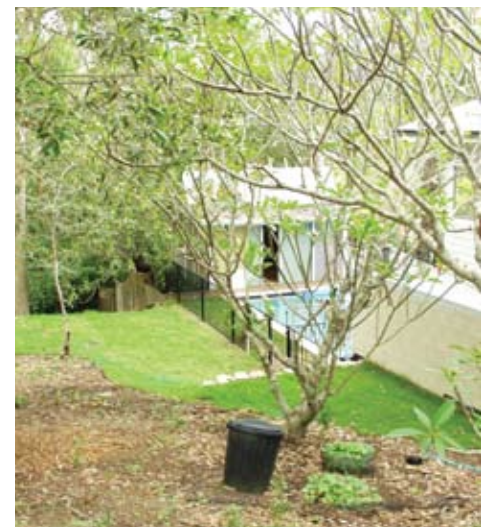
Steeply sloping sites increase storm water run-off both above and below the surface. This can create a major constraint on building and consideration needs to be given to both the site slope and ground conditions in relation to the hydrology.

Strategies for environmentally responsive design include:

- > Directing storm water run-off to appropriate destinations.
- > Collecting and utilising run-off for landscaping.
- > Minimising interference with sub-surface hydrology.

Early identification of artificial and existing environmental effects is crucial.

Artificial structures on or below the site ground level are best identified early in the site selection and site analysis phase. The consequences of artificial structures can be as important as for pre-existing natural structures. In particular this includes environmental issues such as waste, pollution and services whether subsurface or overhead. Costs of mitigating existing environmental conditions can create an unintended design challenge; early identification is critical for effective site planning and later construction work.



Hillside housing offers its own challenges.

## ENVIRONMENTAL

Environmental constraints result from the variability of a site's biophysical conditions and include climatic, health, visual and acoustic parameters.

Four main environmental strategies apply:

- > Undertake and integrate climatic analysis in site selections and site planning.
- > Look for positive local effects of the 'mesoclimate' – eg. nearby hillsides to the west providing shade from the late afternoon sun.
- > Set priorities for key environmental factors such as solar access and air flow that can generate solutions.
- > Address environmental problems at source where possible rather than on the site.

Exposure to extreme climatic elements occurs where the site is directly affected by the full force of wind, water and sun (macro climate conditions) without moderation from the structural constraints described above (ie local topographical or artificial structures). Opportunities exist to address the constraint by careful examination of the meso and microclimate of the site, and by studying the local history of extreme weather conditions.

Vulnerability of the site to extreme conditions can create a significant impact on site planning and building location. Life threatening events such as flooding, storm damage (adjacent trees) and fire create measurable risks. Minimising risks involves careful site planning and ongoing maintenance. Sites that are exposed to 100 year flood levels as well as storm and fire paths, should be identified and planning measures adopted.

The mesoclimate is the resultant modification of the regional climate by topography and other local conditions. There are five main mesoclimates:

- > Coastal – sea breeze/land breeze effect, which moderate regional extremes; storm exposure is an important consideration.
- > Flat open country – subject to accelerated wind speeds, minor changes in topography can have significant effects.
- > Woodlands and forests – differential solar access and airflow, higher humidity.
- > Valleys – differential solar access and temperatures dependent on location and elevation.
- > Cities – elevated ambient temperatures, differential solar access and airflow, increased turbidity.

Challenging sites occur where the topography and other factors negatively impact on the climate – eg. reducing the effects of natural heating or cooling. Where two mesoclimates overlap, for example cities in coastal areas, the benefits of one can be negated by the other.

Microclimate conditions are the effects of local and adjacent structural conditions on the mesoclimate conditions of temperature, humidity and airflow. Challenging sites occur where these microclimate conditions negate climatic effects used in passive design. For example when adjacent buildings overshadow the site and limit solar access in winter.

### Other environmental parameters (health, visual, acoustic).

These include identification of excessive noise, pollution and smells. Identification of these parameters can be difficult as the phenomena may be intermittent, for example noise from an air conditioner may only occur during hot nights, air pollution may only occur with a particular wind direction.

## SPATIAL

Spatial challenges occur when there is not a proper fit between the size, shape or volume of the block, the building program and environmental factors. Strategies to address spatial challenges include:

- > Keeping the building footprint to 50 per cent of the site area.
- > Make every metre count for greater planning flexibility.
- > Consider the building as a 'volume' on a tight site.
- > Consolidate blocks rather than undertaking subdivision.

### Shape of block

The subdivision of land for building in Australia usually results in rectangular blocks of land. Non-rectangular geometries of small area are often constraining. These often result from subdivision of an existing block into two blocks.

'Setbacks' are the clearances between the site boundary and the building walls required by planning rules – creating non-orthogonal geometries on a block and preventing construction in those areas. 'Setbacks' constrain the height and location of walls above the ground and have a profound influence on the building volume and spatial configuration.

A 'tight site' is where there is little flexibility in the fit. The shape of the block and the building program determines building responses and environmental factors. This can lead to the need for specific design solutions to overcome issues of poor orientation, circulation and access (See Howard Street case study at the end of this fact sheet).

Options to be considered for mitigating the effects of a tight site include:

- > Reducing the physical building footprint.
- > Increasing the number of building levels.
- > Consolidating blocks.

A way of increasing plan flexibility with tight sites is to reduce the ratio of the building's ground floor area to site area (building footprint). Effective planning that eliminates waste space helps to optimise a building's footprint. Increasing the number of storeys reduces the building footprint on the ground and releases site area allowing optimisation of orientation, circulation and access. Where these measures fail, it is often better to consolidate blocks to make a larger spatial context.

## LOCATION

Location challenges occur when remoteness, proximity and servicing become design constraints. Remote sites may have limited access to building services (gas, water, electricity and waste disposal) and to other networks such as road, rail, bus and pedestrian mobility. A significant constraint on the design of a sustainable home may result from it being located in a protected area.

Remote sites are those located at a distance from main population centres which creates challenges for the supply of materials and services. Increased energy is required for transportation of construction materials, and the availability of skilled tradespeople is often limited.

### Services accessibility

The lack of access to services leads to greater reliance on building autonomy and the need to provide services on site. Additional technologies for water, energy and waste disposal are needed on site. Ironically this can lead to a better environmental solution.

## Pedestrian and vehicular access

Challenging sites may prevent easy access of vehicles and pedestrians. On sloping sites this can involve steep access roads or large amounts of cut and fill to gain access. Access for disabled pedestrians requires a slope of no more than one in one so steep sites may need excessively long ramps for access. Provision of a lift may be a cost-effective option in these situations.

## ECOLOGY

Site ecology constraints include issues of ecological value and landscaping and arise from the challenges of dealing with the interrelation of living organisms on a site where humans are one of the resident species. Flora and fauna studies are needed when sites may have high ecological value and endangered or unique species are part of the habitat of the site. How to restore ecological value can become the primary challenge.

Environmental strategies for changing sites with high ecological values include:

- > Establishing a habitat conservation area.
- > Monitoring ongoing impacts of construction.
- > Monitoring activities that may disturb the habitat.

## Habitat conservation

Maintaining existing habitats is a central issue on sites with high ecological value. This involves establishing an inventory of existing species and examining impacts of site planning on the species distribution and viability of habits. Establishing areas for habitat conservation becomes a central strategy, in which case it becomes crucial to reduce the noise and light pollution impacts of the home on these areas.

[See: 2.5 Biodiversity On-site]

## Restoring ecological value

The process of subdivision often results in the removal of existing flora and fauna. Inner-city sites rarely contain even remnant vegetation. Measures to restore ecological value are then needed. Reintroducing the local gene pool of the soil is an imperative. If the soil from the site's clearance has been stored it can be reintroduced across the site. Consideration of subsurface and surface hydrology is needed to re-establish catchments and enhance catchments of water flow across the site. Depending on the site, the creation of wildlife pathways can allow animal movement across blocks and provide flora food sources for both humans and native animals.

Challenging sites occur where there is little ecological value or pre-existing ecology has been destroyed. Increasing the ecological value of the site as part of the landscaping plan is an obvious strategy. Such a strategy is particularly applicable to inner-urban sites. Strategies that increase biodiversity range from restoration of indigenous species to the establishment of permaculture gardens. [See: 2.4 Sustainable Landscapes]

### ADDITIONAL READING

Goulding J, Lewis O and Steemers T (1992), *Energy Conscious Design: A Primer for Architects*, BT Batsford, London.

Hyde, R (2000), *Climate Responsive Design*, Spon Press, UK.

Hyde R, Watson S, Cheshire W and Thompson M (eds) (2007), 'Green Globe Design and Construct Standard' in *The Environmental Brief*, Routledge, UK.

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## Case Study: Howard St Fremantle, WA

The brief was to design a passive solar, energy efficient home on a tight, urban infill block. The long narrow block with an 8m frontage, was orientated 45° to north, with the northern façade facing the street and garage access only possible to the front. Solar access was compromised due to an existing two story neighbouring building and the block was bordered high parapet walls on both sides. The brief posed quite a challenge for the designer.



To overcome the obstacles the front living room wall of the home was angled to face directly North and a saunders ceiling with tapered ranking gable windows was incorporated to increase solar access. Air volume was minimised and thermal mass introduced on the floor and vertical internal walls. This ceiling and window configuration effectively almost doubled solar heat gain, which is then able to be stored in the vertical thermal mass.

Two internal courtyards were introduced to allow further solar gain. Combined with carefully selected shading for summer protection the courtyards also assist with airflow in summer to naturally cool the home.

Source: Solar Dwellings – Energy Efficient Homes

