LOW CARBON LIVING CRC

Precinct Information Modelling
Technical Investigations:
Land Use and Development Types

Australian Government
Department of Industry, Innovation and Science

Business
Cooperative Research
Centres Programme

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Acknowledgements

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Acronyms

BIM   Building Information Model

IFC   Industry Foundation Classes

PIM   Precinct Information Model

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Executive Summary

This technical investigation reports on the common way state planning departments and local governments proscribe development of private and public land.

The context for this is to develop a digital representation of the system, to support for example the tools emerging that examine the performance of scenarios for development (such as the Tonsley Master Plan, with its zonal development plan). The NSW system is examined as a basis for implementing a planning system in detail:

- the methods adopted to define zoning and their permitted uses;

- how terms in the Local Envrionment Plan systems can be defined and made accessable digitally using the buildingSMART data dictionary (bsDD);

- an prototype implementation of the system has been developed and is described.

Introduction

Development of land in all Australian States follows Planning Department Legislation that sets out the zones in which these developments may occur and what developments types are allowed on that land. The discussion below examines the NSW Local Environment Planning (LEP) system in general and the specific LEP for the City of Sydney of which the Broadway Precinct in Sydney is a part.

Figure1 PIM Typologies

FUNCTIONAL

BUILT FACILITY

ELEMENTAL

OCCUPANCY
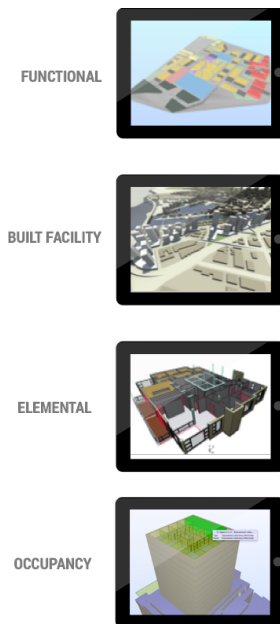
These precinct typologies are being implemented in the PIM model reflecting increasing scales of detail and organisational complexity.

The work in this Technical Investigation focusses on the early concept planning stages using Functional and Occupancy typologies where sustainability tools like Precinx and SSIM are regularly used to propose and assess low carbon options

What resources – specifically libraries of objects – are available or needed to support development planning in this phase? One of the most substantive protocols are the Planning Instruments used by State agencies to control development, and it is this that we now describe in terms of a digital library.

Government Planning Protocols

To understand better the process of development within Government planning agencies and what methods exist we examined the NSW Government protocols.

The NSW Department of Planning requires Local Environment Plans (LEP) for all councils to follow guidelines defined here http://www.legislation.nsw.gov.au.

The NSW LEP legislation inter alia provides for the following:

- the concept of Land Use Zones (see Appendix 1)

- the concept of Development Types, referred to as permitted uses based a master list of Permitted land uses (see Appendix 2)

- adoption of approved Council Local Environment Plans

The relevance of this Planning system is that all land is classified and development approvals are made in accordance with the LEP rules and concepts.

We have adopted this system as the basis of the Precinct Model representations, and implemented a number of trial examples.

Figure 2 LEP Definition Process
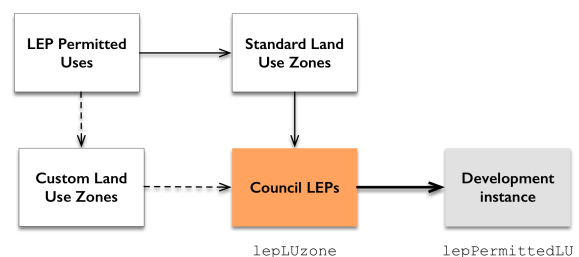
Each Council's use of Standard LEPs can be customised and most are.

New Zones may be created (from the list of Permissible Land Use types), as for example in the City of Sydney LEP: *B8 Metropolitan Centre*; *SP1 Special Activities*; *SP2 Infrastructure*; *RE1 Public Recreation*; and *UL Unzoned land*.

An example of this process is set out in Table 1 below using Land Use (LU) **R1 General Residential** for the City of Sydney (the responsible Council for the Broadway Precinct) and examples of the same R1 Zone for Manly and Lake Macquarie Councils.

Investigation shows that these Land Use defintions vary from Council to Council i.e. R1 In Sydney is different to R1 for Manly and Lake Macquarie Councils, although the list of Permissible Uses is used with the same definition.

In this particiular case, the differences in permissible uses, reflects the different nature of CBD, seaside suburban and semi-rural Councils respectively.

Sydney Local Environmental Plan 2012

Figure 3 below shows Land Use Zoning for the wider precinct surrounding the PIM Broadway site, in the Loclal Government Area (LGA) of Sydney.

Figure 3 Broadway Land Use Zoning for Sydney LEP 2012
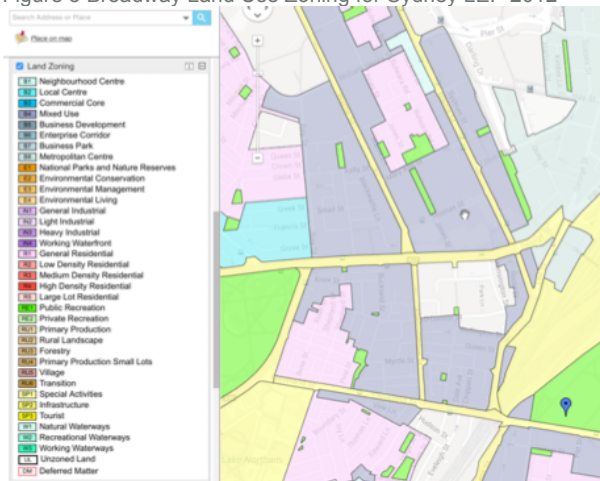
Land Use Zones

Using the City of Sydney example Pemitted Uses for this LGA are:

R1   General Residential

B4   Mixed Use

B8   Metropolitan Centre

(SP1   Special Activities - not in Broadway Precinct)

SP2   Infrastructure

RE1   Public Recreation

UL   Unzoned land

The establishment of a LEP comprises the creation of Land Use Zones e.g. *R1 General Residential*, from standard templates, which utilise a set of standardised Permissible Uses.

The LU Zones template comprises four parts: *Objectives of zone, Permitted without consent, Permitted with consent* and *Prohibited*. Parts 2, 3 and 4 define precise constraints for the Uses specified.

R1 is shown in full below:

Zone R1   General Residential

1   Objectives of zone

• To provide for the housing needs of the community.

• To provide for a variety of housing types and densities.

• To enable other land uses that provide facilities or services to meet the day to day needs of residents.

• To maintain the existing land use pattern of predominantly residential uses.

2   Permitted without consent

Home occupations

3   Permitted with consent

Attached dwellings; Bed and breakfast accommodation; Boarding houses; Child care centres; Community facilities; Dwellinghouses; Food and drink premises; Group homes; Home industries; Horticulture; Hostels; Multi dwelling housing; Neighbourhood shops; Places of public worship; Residential flat buildings; Respite day care centres; Roads; Roadside stalls; Semi-detached dwellings; Seniors housing; Sewage reticulation systems; Shop top housing; Shops; ***Any other development not specified in item 2 or 4***

4   Prohibited

Agriculture; Air transport facilities; Airstrips; Amusement centres; Animal boarding or training establishments; Boat building and repair facilities; Boat launching ramps; Camping grounds; Car parks; Caravan parks; Charter and tourism boating facilities; Commercial premises; Crematoria; Depots; Eco-tourist facilities; Entertainment facilities; Environmental protection works; Exhibition villages; Extractive industries; Farm buildings; Forestry; Freight transport facilities; Function centres; Heavy industrial storage establishments; Helipads; Highway service centres; Industrial retail outlets; Industries; Mooring pens; Moorings; Mortuaries; Passenger transport facilities; Port facilities; Recreation facilities (major); Recreation facilities (outdoor); Registered clubs; Research stations; Restricted premises; Rural industries; Service stations; Sewerage systems; Sex services premises; Storage premises; Tourist and visitor accommodation; Transport depots; Truck depots; Vehicle body repair workshops; Vehicle repair stations; Veterinary hospitals; Warehouse or distribution centres; Waste or resource management facilities; Water recreation structures; Water supply systems; Wholesale supplies

Land Use Zones are classified by *category* as shown below.

Table 1: Land Use Zone Categories

Code	Category Name
RU	Rural
R	Residential
B	Business
IN	Industrial
SP	Special Purpose
RE	Recreation
E	Environment Protection
W	Waterway Zones

The fuill list of land use Zones is defined in Appendix 1.

Table 2 Comparison of Three Council LEP R1 LU Definitions

City of Sydney 2012	Manly 2013	Lake Macquarie 2014
Attached dwellings	Attached dwellings	Attached dwellings
Bed and breakfast accommodation	Bed and breakfast accommodation	Bed and breakfast accommodation
Boarding houses	Boarding houses	Boarding houses
Child care centres	Boat launching ramps	Business premises
Community facilities	Boat sheds	Child care centres
Dwelling houses	Child care centres	Community facilities
Food and drink premises	Community facilities	Dual occupancies
Group homes	Dual occupancies	Dwelling houses
Home industries	Dwelling houses	Environmental facilities
Horticulture	Emergency services facilities	Environmental protection works
Hostels	Environmental protection works	Exhibition homes
Multi dwelling housing	Flood mitigation works	Exhibition villages
Neighbourhood shops	Group homes	Flood mitigation works
Places of public worship	Health consulting rooms	Group homes
Residential flat buildings	Home businesses	Home-based child care
Respite day care centres	Home industries	Home businesses
Roads	Hostels	Home industries
Roadside stalls	Information and education facilities	Hotel or motel accommodation
Semi-detached dwellings	Jetties	Hostels
Seniors housing	Multi dwelling housing	Information and education facilities
Sewage reticulation systems	Neighbourhood shops	Kiosks
Shop top housing	Places of public worship	Markets
Shops	Recreation areas	Multi dwelling housing
	Recreation facilities (indoor)	Neighbourhood shops
	Residential flat buildings	Places of public worship
	Respite day care centres	Recreation areas
	Roads	Recreation facilities (outdoor)
	Semi-detached dwellings	Residential flat buildings
	Seniors housing	Respite day care centres
	Shop top housing	Restaurants or cafes
	Signage	Roads
	Water recreation structures	Secondary dwellings
	Water recycling facilities	Semi-detached dwellings
	Water supply systems	Seniors housing
		Serviced apartments
		Shop top housing
		Signage

PIM LEP Interface

How does a PIM contribute to greater efficiencies to development processes and sustainability outcomes?

Noting that the NSW Planning process and concepts are conceptually very close between all States & Territories in Australia we have implemented in the PIM framework support for these concepts.

Any precinct development needs in the first instance to determine the Land Use types appropriate and the specific permitted uses. While a Council planner will have a different end use to a designer of developer, all of these parties can access a integrated digital solution.

The PIM solution comprises:

- Use of the buildingSMART Data Dictionary (bsDD), cloud based, to hold definitions of the relevant concepts

- Creation of a pilot database of NSW Council LEP Configurations

- Development of BIM authoring tool library parts with two examples of functionality

- Adoption of the ifcSpatialZone entity to represent LU Zones and Development types in the open Standard Precinct model

bsDD

Accordingly we construct the following:

- a dictionary of Land Use *terms* in the bsDD
- a dictionary of Permitted Use *terms*

In the bsDD we create a set of *Subjects* of the terms of Permitted uses. Each Use has a definition (in the bsDD a *Description*).

Council LEP Plan Database

As discussed above, any Council can customise the standard NSW Land Use Zones for their LEP. Accordingly the proposed inpmementation of the system needs to be able to access an external database describing the specific settings of a Council LEP. This is necessary since the bsDD does not contain data of this sort.

The concepts be modelled in the NSW LEP Database are:

- Local Council Name
- LEP Name & Date Legislated
- For each Land Use Zone, a list of Permitted Development Type uses

This database is a component of the PIM interface to the Land Use system. Note these land use and development type terms are mandated by Governments (albeit with minor differences between the States and Territories at present) and it it would be practical and very beneficial if these became national standards that would cover every type of built asset development.

Table 3: bsDD Defintion of terms (Examples from the City of Sydney):

Zone Code	Zone Name	Permitted Use	Use Definition
R1	General Residential	*dwelling house*	means a building containing only one dwelling. Note. Dwelling houses are a type of *residential accommodation*—see the definition of that term in this Dictionary.
RE1	Public Recreation	*electricity generating works*	means a building or place used for the purpose of making or generating electricity.
B4	Mixed Use	*educational establishment*	means a building or place used for education (including teaching), being: (a) a school, or (b) a tertiary institution, including a university or a TAFE establishment, that provides formal education and is constituted by or under an Act.
SP1	Special Activities	*horticulture*	means the cultivation of fruits, vegetables, mushrooms, nuts, cut flowers and foliage and nursery products for commercial purposes, but does not include a plant nursery, turf farming or viticulture. Note: Horticulture is a type of *intensive plant agriculture*—see the definition of that term in this Dictionary.
B8	Metropolitan Centre	*recreation facility (major)*	means a building or place used for large-scale sporting or recreation activities that are attended by large numbers of people whether regularly or periodically, and includes theme parks, sports stadiums, showgrounds, racecourses and motor racing tracks.

The diagram below sets out the structure of the pilot implementation of the 175 land use types in the bsDD.

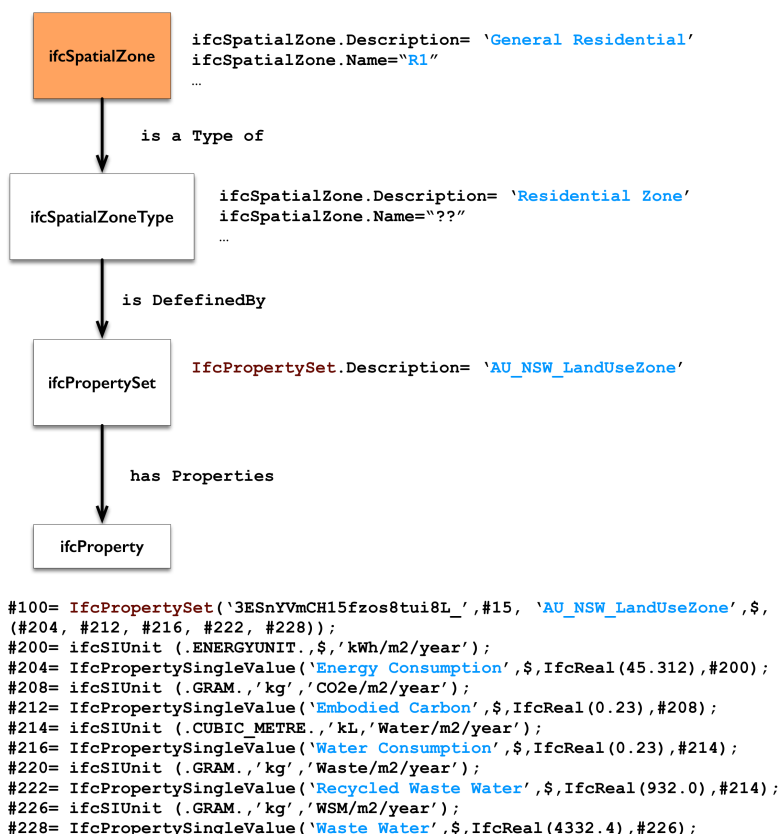Figure 4 bsDD Information Structure: Land Use terms
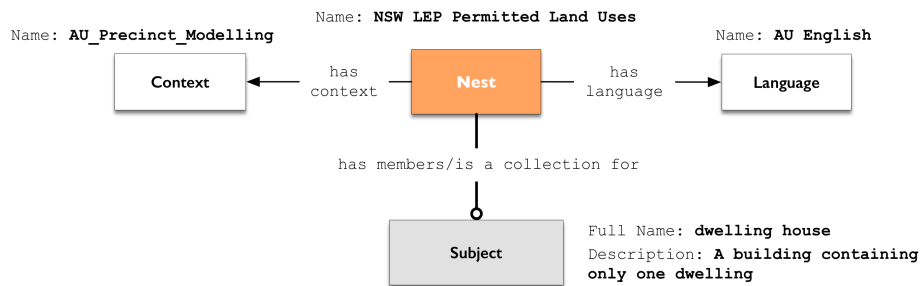
A similar structure is used for the Permitted Uses (check DMa what did we call the **NSW Permitted Land Uses** or /and?

PIM Spatial Zones - IFC Model Mapping

Figure 5 below specifies the implementation of the **Zonal** concept for a *single Land Use Zone type*. A similar structure will apply to a Zone containing several land use instances.

Figure 5 IFC Implementation Structure: (Note the values are for demonstration only)


```
#100= IfcPropertySet('3ESnYVmCH15fzos8tui8L_',#15, 'AU_NSW_LandUseZone',$,
(#204, #212, #216, #222, #228));
#200= ifcSIUnit (.ENERGYUNIT.,$,'kWh/m2/year');
#204= IfcPropertySingleValue('Energy Consumption',$,IfcReal(45.312),#200);
#208= ifcSIUnit (.GRAM.,'kg','CO2e/m2/year');
#212= IfcPropertySingleValue('Embodied Carbon',$,IfcReal(0.23),#208);
#214= ifcSIUnit (.CUBIC_METRE.,'kL','Water/m2/year');
#216= IfcPropertySingleValue('Water Consumption',$,IfcReal(0.23),#214);
#220= ifcSIUnit (.GRAM.,'kg','Waste/m2/year');
#222= IfcPropertySingleValue('Recycled Waste Water',$,IfcReal(932.0),#214);
#226= ifcSIUnit (.GRAM.,'kg','WSM/m2/year');
#228= IfcPropertySingleValue('Waste Water',$,IfcReal(4332.4),#226);
```

For individual land use types a property set e.g. 'AU_NSW_PermittedLandUse' would have the same set of properties with appropriate data as shown for 'AU_NSW_LandUseZone' above.

It is envisaged that the ETWW performance measures will be accessible for all of the NSW LEP land use types.

LandUse /Development Pilot Scenario

BIM Library Tools Access

Two BIM authoring tools were used to implement differing access methods:

- Graphisoft ArchiCAD with Library Zone objects & embedded database for Zone and Development types

- Autodesk Revit with a link to the cloud bsDD to access development types

Both examples take the zonal approach and constructed development scenarios similar to the Tonsley Park Master plan method.

Case 1: Planning Zones

In this case a planner is making *land use* selections for the development precinct. The master list of NSW Land Use Types is used and a selection made. This functionality matches the Tonsley Park Master Plan method. All attributes of the LU object conform to the terminology, graphic presentation and attributes of the NSW LEP system.
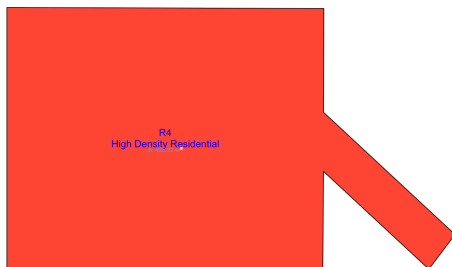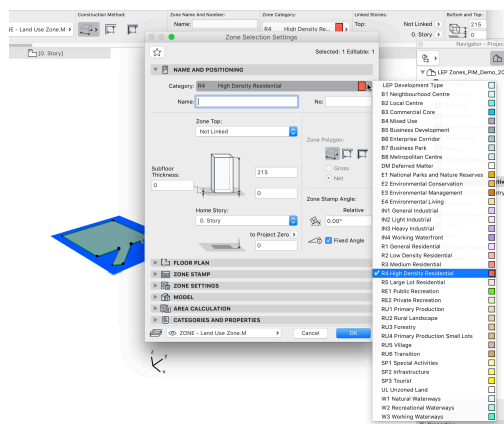
Figure 6 Creating a Land Use Type.


Figure 7 Defining Land Use types:

This is the outcome Local Governments achieve with a gazetted Local Environment Plan. The library object Zone_LEP_LandUses.gsm has predefined classification of the 28 standard Land Use types, including the colour defined by NSW Department of Planning. A collection of these is this an LEP or it could be a proposal for a green/grey/brown field development.

The zone representation is a 2D polygon, defining the extent of the use. The Revit example demonstrates access to the bsDD which allows importing the environmental and embodied carbon properties. This specific library part demonstrates the ease of support for library objects for planning functionality and embodied carbon performance.

Case 2: Development Types

This example goes a step further by allowing 3D modellling of the LEP objects, enhancing the understanding of the development, and also potentially more precise geomtric details such as the volume of a facility, number of stories, surface areas etc.

The library object understands the LU Zone setting, in this case R4 from the first case (Figs 8 & 9). As explained above whilst NSW Planning provides LU Zone standard templates, a Council may (and usually does) modifiy its scope to meet local conditions.

A number of Sydney suburban Council LEP details have been entered into a small demonstration database within the library part. Once the Council is selected, the Permitted Devlopment types are configured and selected to suit.

Figure 8 Selecting the Council.
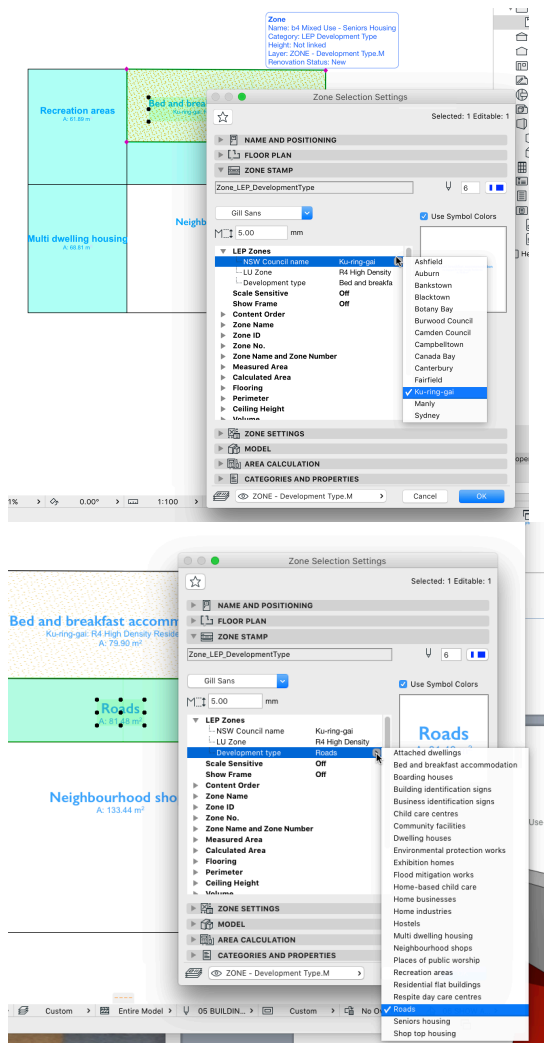
The Designer can now configure a development plan, always using permitted Use Types.

Figure 9 Detailed Development Plan and 3D model:
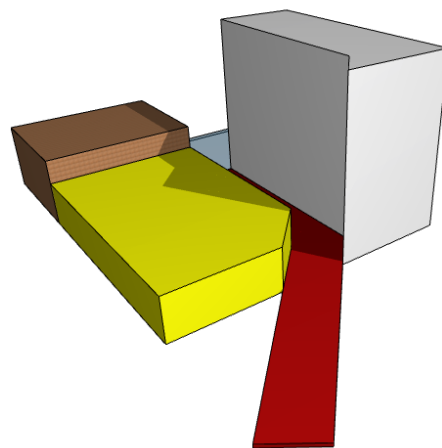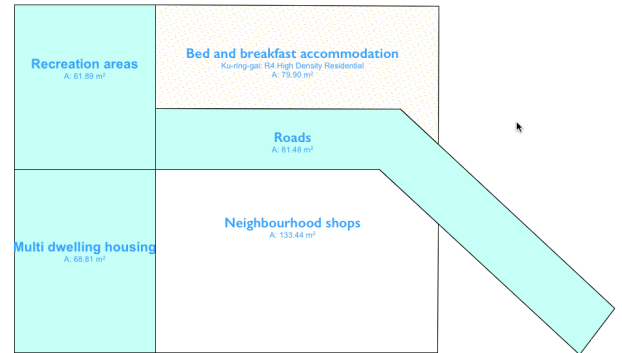
The result is a proposal using concepts and definitions directly conforming to the Planning regulations.

## Case 3: Accessing bsDD for types & CO2e Properties

The example for Revit is add-in software that has similar functionality to the ArchiCAD example. That is, the add-in allows a user to create land use areas, and development type massing in a Revit project model. However, in this case, the typing of those entities is handled via referencing relevant concepts that are defined in the buildingSMART Data Dictionary (bsDD).

Figure 10 shows the interface to the 3 functions that the PIM add-in provides.

Figure 10 PIM Revit add-in interface
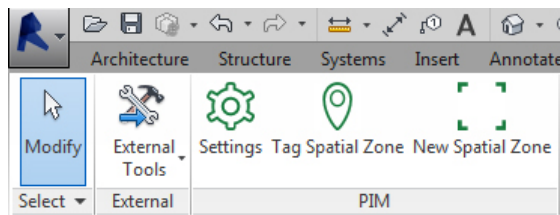
The Settings function looks up bsDD to find the environmental property definitions that are associated with a spatial zone.

Figure 11 bsDD concepts for spatial zone and environmental properties
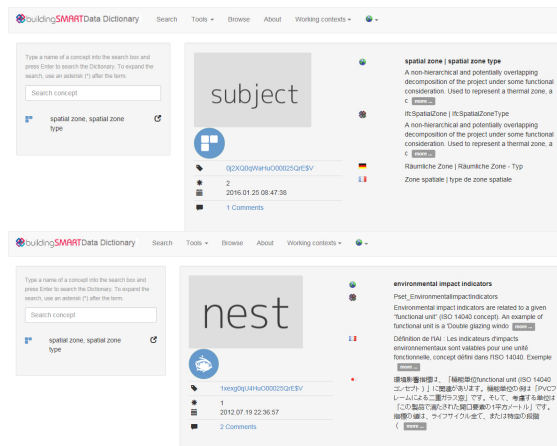
The properties that are found are placed in a Revit shared parameters file for use with the Revit area and massing entities. The list of properties is shown in Figure 12 as they appear in Revit.

Figure 12 Properties sourced from bsDD and added as Revit shared parameters
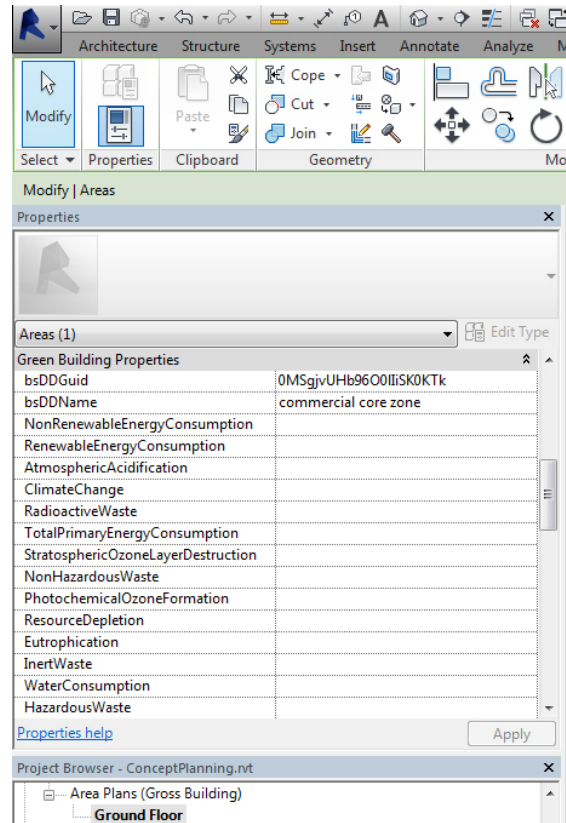
All concepts in bsDD are created with a globally unique identifier and at least one name is expressed in International English. Note that the properties shown in Figure 12 include a bsDDGuid and a bsDDName. These are there to preserve the user's choice for their currently selected spatial zone as a permanent reference back to the original source location in bsDD.

Spatial zones can be drawn directly in Revit, then tagged later with their land use or development type identifiers using the Tag Spatial Zone tool. Alternatively, the New Spatial Zone tool allows a user to draw and tag all in one consolidated operation. A land use is created as a Revit area entity. A development type is created as a Revit 3D mass. Figure 13 shows the interface to tag an area (land use).

Figure 13 Tagging a land use spatial zone

Figure 14 shows the interface to create a new spatial zone, in this case a development type. Because development types are created as Revit masses, for this case there is also a field that can be edited to set the number of storeys (height) of the resultant mass.

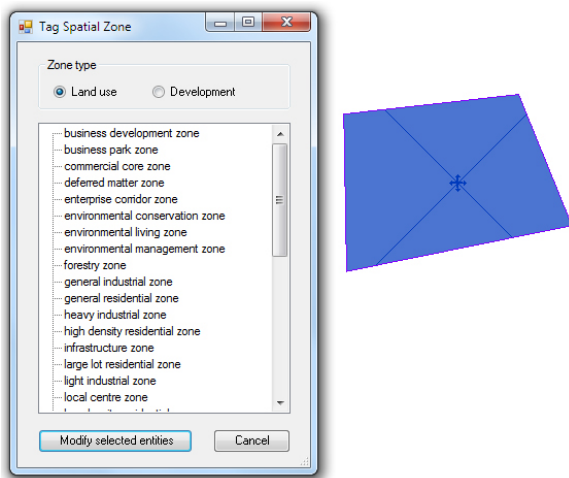Figure 14 Creating a new development type spatial zone

Figure 15 shows two development type masses sitting on a podium mass.

Figure 15 Resulting Revit 3D massing model

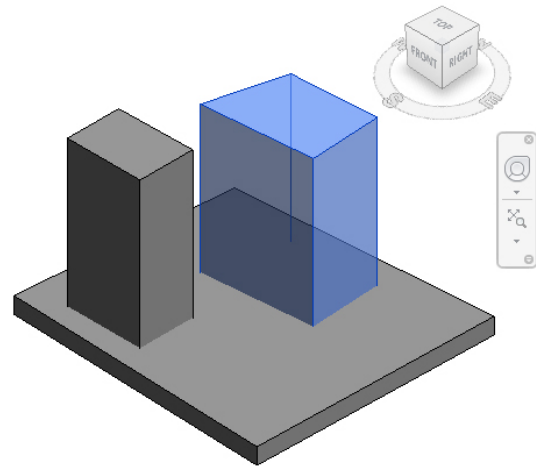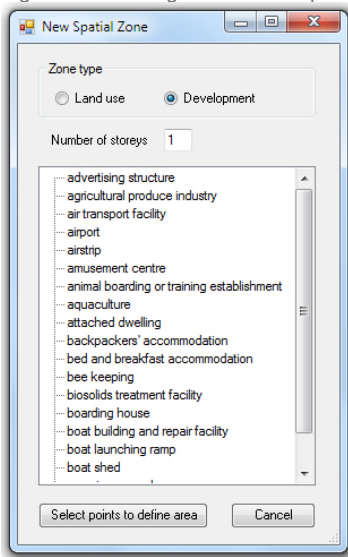# Simulating the Development & Assessment Process
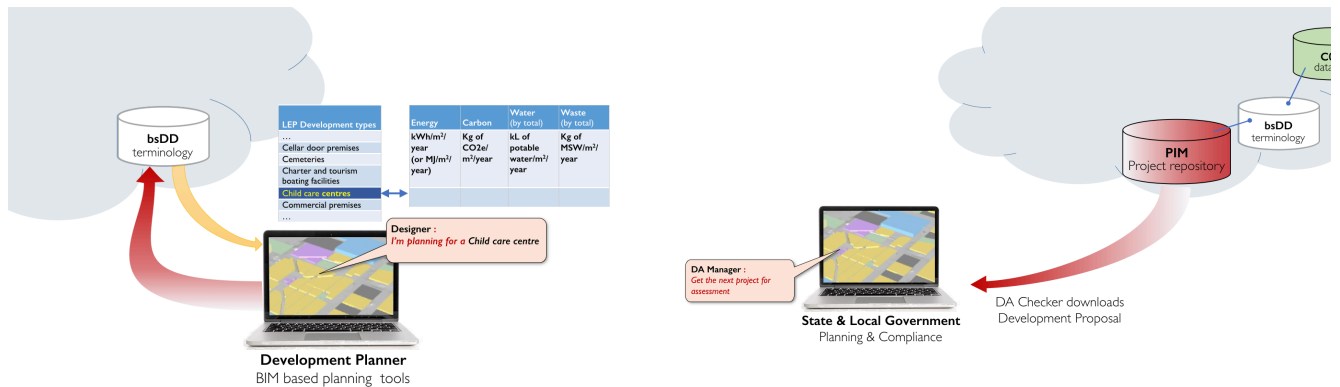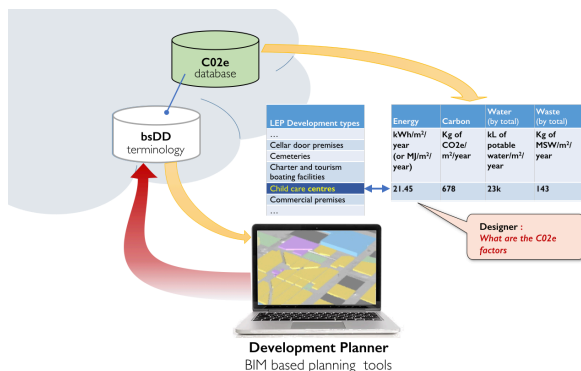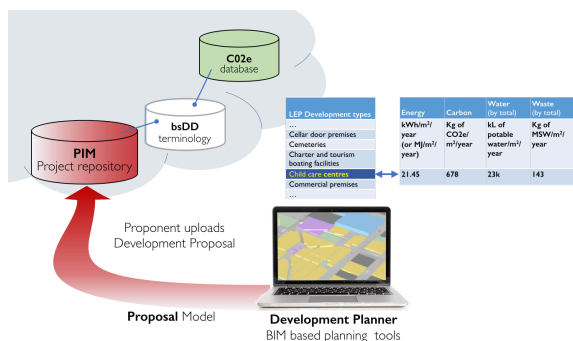

Step 1: A designer is designing a ChildCare Centre and seeks the definition of approriate Embodied Carbon performance data. His selection of the use type brings up the property set from the bsDD

Step 2: The sdesigner now needs the values of the enbodied carbon metrics and accesses an Embodied Carbon database filling in the values.

Step 3: The design is completed and the PIM model updated in their PIM project repository, then uploaded to the Council's DA submissions repository

Step 4: Activated by an automatic notice of a DA submission the Council Assessor loads the proponent's proposal model
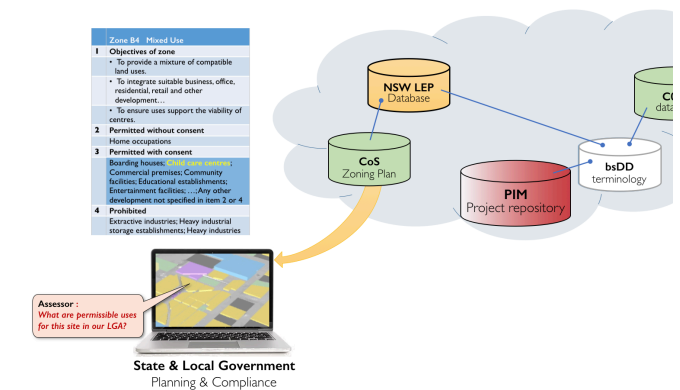
Step 5: The assessor chacks that the use proposed in the Land Use zone in question is an approved development type under the Council's LEP.

If permitted the assessor now runs a measurement tool (similar in function to SSIM, Precinx, or eTools etc) that analyse the model & determines compliance.
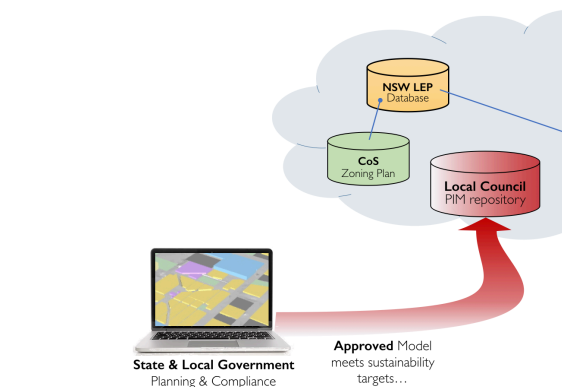
Step 6: The evaluated project is then approvred or not and updated in the PIM repository and email advice provided to the proponent.

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Appendices

Table 4 Land Use Zones

The standard **land use zones** under this Plan are as follows:

Zones	Type
Rural Zones	
RU1	Primary Production
RU2	Rural Landscape
RU3	Forestry
RU4	Primary Production Small Lots
RU5	Village
RU6	Transition
Residential Zones	
R1	General Residential
R2	Low Density Residential
R3	Medium Density Residential
R4	High Density Residential
R5	Large Lot Residential
Business Zones	
B1	Neighbourhood Centre
B2	Local Centre
B3	Commercial Core
B4	Mixed Use
B5	Business Development
B6	Enterprise Corridor
B7	Business Park
B8	Metropolitan Centre
Industrial Zones	
IN1	General Industrial
IN2	Light Industrial
IN3	Heavy Industrial
IN4	Working Waterfront
Special Purpose Zones	
SP1	Special Activities
SP2	Infrastructure
SP3	Tourist
Recreation Zones	
RE1	Public Recreation
RE2	Private Recreation
Environment Protection Zones	
E1	National Parks and Nature Reserves
E2	Environmental Conservation
E3	Environmental Management
E4	Environmental Living
Waterway Zones	
W1	Natural Waterways
W2	Recreational Waterways
W3	Working Waterways

Table 5 Permitted LEP Land Use Development Types

Development types are as follows taken from NSW LEP Land Use Table, 25 Jan 2016

A match of land use types was aligned with the NSW LEP Dictionary, so there is a subset of used Land Uses and their corresponding Definition.

advertising structure	commercial premises	group home
agricultural produce industry	community facility	group home (permanent) or permanent group home
air transport facility	community land	group home (transitional) or transitional group home
airport	correctional centre	hardware and building supplies
airstrip	crematorium	hazardous industry
amusement centre	dairy (pasture-based)	hazardous storage establishment
animal boarding or training establishment	dairy (restricted)	health consulting rooms
aquaculture	depot	health services facility
archaeological site	drainage	heavy industrial storage establishment
attached dwelling	dual occupancy (attached)	heavy industry
backpackers' accommodation	dual occupancy (detached)	helipad
bed and breakfast accommodation	dwelling	heliport
bee keeping	dwellinghouse	heritage conservation area
biosolids treatment facility	eco-tourist facility	heritage item
boarding house	educational establishment	heritage significance
boat building and repair facility	electricity generating works	high technology industry
boat launching ramp	emergency services facility	highway service centre
boat shed	entertainment facility	home-based child care
brothel	environmental facility	home business
building	exhibition home	home industry
building identification sign	exhibition village	home occupation
bulky goods premises	extensive agriculture	home occupation (sex services)
business identification sign	extractive industry	horticulture
business premises	farm building	hospital
camping ground	farm stay accommodation	hostel
canal estate development	feedlot	hotel or motel accommodation
car park	fish	industrial activity
caravan park	flood mitigation work	industrial retail outlet
cellar door premises	food and drink premises	industrial training facility
cemetery	forestry	industry
charter and tourism boating facility	freight transport facility	information and education facility
child care centre	function centre	intensive livestock agriculture
classified road	funeral home	intensive plant agriculture
coastal protection works	garden centre	
	general industry	

jetty

kiosk

landscaped area

landscaping material supplies

light industry

liquid fuel depot

livestock processing industry

marina

market

medical centre

mine

mixed use development

mooring

mooring pen

mortuary

moveable dwelling

multi dwellinghousing

navigable waterway

neighbourhood shop

offensive industry

offensive storage establishment

office premises

open cut mining

parking space

passenger transport facility

place of public worship

plant nursery

port facilities

private open space

pub

public administration building

public land

public reserve

public utility infrastructure

rainwater tank

recreation area

recreation facility (indoor)

recreation facility (major)

recreation facility (outdoor)

relic

research station

residential accommodation

residential care facility

residential flat building

resource recovery facility

respite day care centre

restaurant or cafe

restricted premises

restriction facilities

retail premises

road

roadside stall

rural industry

rural supplies

rural worker's dwelling

 sawmill or log processing works

school

self-storage units

semi-detached dwelling

seniors housing

service station

serviced apartment

sewage reticulation system

sewage treatment plant

sewerage system

sex services

sex services premises

shop

shop top housing

signage

small bar

spa pool

stock and sale yard

storage premises

swimming pool

take away food and drink premises

telecommunications facility

telecommunications network

temporary structure

timber yard

tourist and visitor accommodation

transport depot

truck depot

turf farming

underground mining

vehicle body repair workshop

vehicle repair station

vehicle sales or hire premises

veterinary hospital

viticulture

warehouse or distribution centre

waste disposal facility

waste or resource management facility

waste or resource transfer station

water recreation structure

water recycling facility

water reticulation system

water storage facility

water supply system

water treatment facility

watercourse

waterway

wetland

wharf or boating facilities

wholesale supplies

Reference

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