Assessing the Visual Impact of Development on Open Space[1]

A Structured Approach for Describing and Analysing Site-level Effects of Development on Community Preference for Scenery

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SUMMARY

A series of prototype scenic preference models have been developed from a set of community survey data collected for the Caboolture scenic amenity study to demonstrate an improved and structured approach for describing and analysing site-level effects of development on community preference for scenery. This suite of models can be used for field validation of scenic preference maps, allocation of scenic preference ratings to maps, and development impact assessment.

These models have been developed from landscape attributes derived from community descriptions of their responses to photos, and uses a polygon-based approach to delineate and calculate the proportion of different landscape characteristics sensitive to small landscape features.

Basic analysis of peoples responses to scenery indicates that four factors influence community judgements about scenery: aesthetic values, natural values, utility values, and rural character. The proposed structure for describing landscapes and analysing peoples responses to scenery takes into account these four factors.

All models have been developed by multiple regression analysis using responses from individual people, instead of average community responses. This new procedure is more reliable than the cell-based data recording procedure reliant on decision-tree statistical analysis used in earlier scenic amenity studies.

This new approach should be adopted in any future scenic amenity studies. There is amble opportunity to further refine these prototype models using the full data sets from both the Lockyer and Caboolture Scenic Amenity Studies, to produce a suite of scenic preference models for operational development impact assessment.

The procedures described here provide a structured approach for governments to record and incorporate community opinions about scenery into the strategic planning of land use, and development impact assessment.

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RECENT SCENIC AMENITY STUDIES

The Regional Landscape Strategy Advisory Committee (RLSAC) has developed and applied a repeatable approach for mapping the scenic amenity of open space in south east Queensland over the past three years. These projects have been undertaken in conjunction with Local Governments including the Brisbane City Council, Gatton Shire Council, Caboolture Shire Council, Laidley Shire Council, Esk Shire Council, and the Ipswich City Council. Queensland Government agencies and Industry bodies such as the Environmental Protection Agency, Powerlink Queensland, Queensland Rail, and the Department of Main Roads have also contributed to these projects.

The scenic amenity approach is reliant on measuring the community appreciation of scenery to produce maps that highlight people's preferences for different types of landscapes. The visual exposure of landscapes is a second layer of information used to produce maps of scenic amenity. Scenic amenity maps provide a 'trigger' that highlight landscapes where the impact of development on scenic values of open space should be considered by local governments when evaluating development proposals. Places with higher scenic amenity have greater visual impact constraints on development than places with lower scenic amenity.

CURRENT APPROACH TO SITE ASSESSMENT OF DEVEOPMENT IMPACT ON SCENIC AMENITY

Standards for assessing the visual impact of development on scenery have been affected through introduction of the RLSAC scenic amenity mapping methodology in south east Queensland. This approach is reliant on a high level of structured community involvement to define scenic values. While most scenic amenity studies to date have sought to produce maps of scenic amenity, they have also recognised the need to develop field-based procedures to evaluate the impacts of development on scenery. For example, the Lockyer Scenic Amenity Study (Gatton Shire Council et al, 2003) included a set of guidelines for field evaluation of scenic impacts (see Appendix 1).

These guidelines recognise the need for a field-based procedure to measure the impact of development on scenery that involves the evaluation of photographs of the development. These guidelines also provide a series of options for reducing scenic impacts until a photo model is available for operational use. These options include measures such as modifying the location and area of evident development, altering colours to make the development less obtrusive, using trees and other vegetation to screen the development, and choosing an appropriate architectural style. Whilst these guidelines provide an agreed set of criteria for evaluating scenic impacts, the approach also recognises the need for a more comprehensive tool for site level application that recognises the complexity of interaction between the type of open space and the type of development.

PREVIOUS PROCEDURES FOR MODELLING SCENIC PREFERENCE

The procedure for analysing community preferences for scenery is reliant on showing a series of photographs to people that represent the 'viewing population' of that study area. People are asked to record their preference for the scenery depicted on each photograph on a scale from 1 (least preferred) to 10 (most preferred). This approach follows the methodological definition of scenic preference by the Regional Landscape Strategy Advisory Committee (Preston, 2001).

> *"Scenic preference: A rating of the community's liking for scenery of open space compared to areas occupied by built structures, measured using photographs. It includes people's visual response, as well as other sensory and emotional responses."*

Photographs are selected to depict the range of scenery and the range of development that would normally impact on scenery in that study area. Despite some limitations, the use of photographs to depict scenery is preferred to in-situ evaluation of scenery because it provides several practical advantages. These include encouraging people to principally respond to visual features of the landscape (rather than other sensory or transient factors) of specific landscape features. Photos also provide a standard visual stimulus that is equally accessible to people regardless of their locality, age, mobility, familiarity with landscapes, or technological aptitude.

These prior mapping studies of scenic amenity have recorded landscape characteristics evident on photos that coincide with mapping categories depicted on local government and natural resources maps. For example, the presence of trees and cropping is recorded from photographs to coincide with maps showing trees and cropping. Peoples rating of scenery from photos with trees or cropping can then be allocated to commensurate mapping categories.

The proportion of different landscape types on photos has been recorded using a 'grid cell' approach for particular landscape attributes. A transparent overlay marked with 100 cells of equal area is laid over each photograph, and characteristics of each cell are recorded, such as the type of land cover, the type of development, and its colour. It is then possible to indicate the amount of any landscape type in any photo by calculating the proportion of cells of each type in the photo. For example, a photo may have 50 cells covering trees, 20 percent covering water, 10 percent covering buildings, and 20 percent covering sky.

Two different statistical techniques have been used to define a quantitative relationship between peoples recorded rating of scenery (1 to 10), and the proportion of each landscape type measured from photographs. Multiple regression was used in the Glen Rock and Moggill studies to predict scenic preference. The analysis particular approach used in these studies produces an equation that predicts scenic preference from the amount of various landscape types represented on photos. The following equation demonstrates this type of model (Preston, 2001, p 49)

> *Scenic preference rating = 4.5 + 0.15 x amount of water in photo + 0.03 x amount of dense trees or green grass in photo + 0.71 * elevation range*

A statistical technique called 'decision tree analysis' was used in the Caboolture Shire Scenic Amenity Study (Caboolture Shire Council *et al*, 2003) and the Lockyer Scenic Amenity Study (Gatton Shire Council *et al*, 2002) to develop similar models for predicting scenic preference rating as depicted in Figure 1.

PREVIOUS PROCEDURES FOR ANALYSING PEOPLE'S RESPONSE TO DEVELOPMENT

These previous studies have also used various analysis techniques to indicate the impact of development on people's preference for scenery. For example, the Moggill

Scenic Amenity Study (Preston, 2001) included different types of development in the regression model used to predict scenery:

> *Scenic preference rating = 6.6 - 0.255 x transmission lines in photo - 0.16 x buildings in photo - 0.07 x power lines in photo - 0.04 x bare soil in photo - 0.03 x bitumen road in photo + 0.01 x trees in photo*

The Caboolture Scenic Amenity Study (Forest Images, 2003) adopted a different approach, by analysing the proportion of evident development (all buildings, roads, earthworks, and infrastructure except farmland and farming structures) against peoples scenic preference rating (Figure 2).

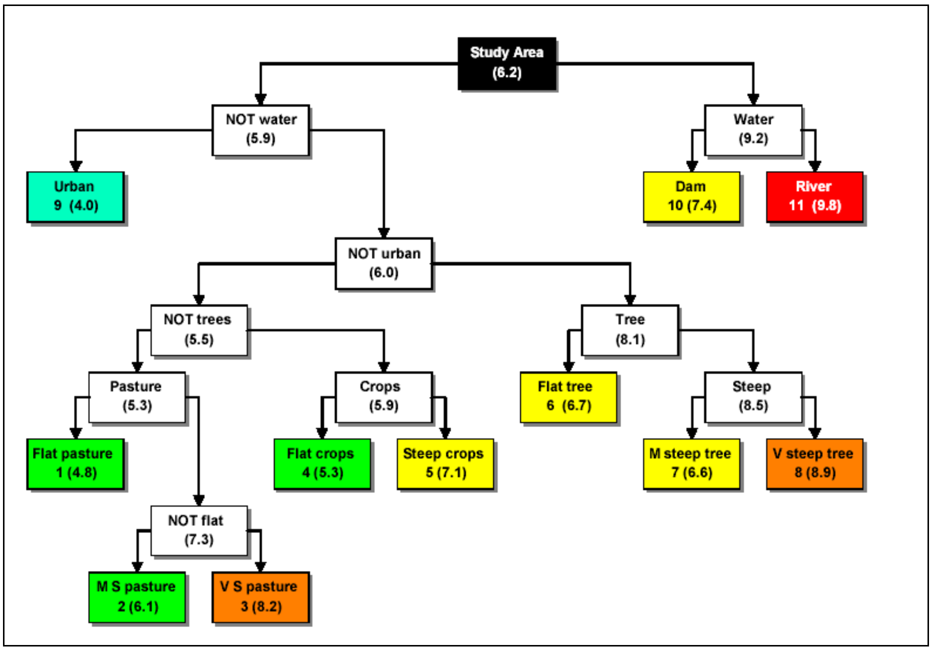

Figure 1. Example of a' decision tree' model used to predict scenic preference in the Lockyer Scenic Amenity Study

Figure 2. Relationship between evident development and Community Rating of Scenery in the Caboolture Scenic Amenity Study

LIMITATIONS OF PROCEDURES USED TO EVALUATE IMPACTS

Whilst these studies have produced operationally coherent and statistically valid results, they have several limitations that are not fully coincident with the philosophy of scenic amenity being defined by people from the community, and the need for the scenic amenity approach to assist with managing development impacts.

With the possible exception of analysis conducted for the Caboolture Study (Figure 2), models from previous studies have been developed for the purpose of producing maps of scenic preference. As a consequence, they have focussed on measuring scenic characteristics of photos that are represented on available mapping. This approach is reliant on a simplified measurement and analysis process that omits many features that can be seen on photographs hat can not be mapped. Such features include, for example, fences, building form (and colour), and recreation structures.

The definition and choice of characteristics recorded from photos was developed by professionals undertaking the scenic amenity study, not by the people who scored the photos. This provides an opportunity for error, where characteristics important to how people read and interpret landscapes are omitted from scenic preference models. Similarly, it is possible that attributes defined by professionals may focus attention on landscape features that have little effect on how the community responds to scenery or the effects of development.

The cell-based approach used in prior scenic amenity studies is of sufficient resolution (17mm x 13 mm cells for 17cm x 13cm photos) for recording the proportion of broad landscape types used in mapping (eg. Pasture, forest), but is less precise when recording the amount of smaller but significant developments, particularly in the mid-ground or background. Many developments are smaller than a cell, and would require adoption of complex attributing procedures.

Regression analysis of response data for the Moggill and Glen Rock studies was based on estimates of the average community response, rather than individual responses. Many types of scenery, for example, some crops or rural-residential areas evoke a wide variety of responses. This analysis approach would inflate statistical measures of model reliability and may lead to the inclusion of landscape characteristics that do not accurately reflect community agreement about scenic values. Statistical analysis procedures should be used that recognise the diversity of people’s responses to scenery.

Most previous scenic amenity studies have not provided a clear relationship between mapped scenic preference classes, and development assessment procedures that occur within them. The Caboolture Scenic Amenity Study (Caboolture Shire et at, 2003) used the same data set to develop both a mapping model and a development assessment model.

PERSSURES FOR RAPID DEVELOPMENT ASSESSMENT

Recent debate about development pressure in South East Queensland has highlighted the need for government to improve its capacity to respond swiftly and confidently when evaluating the impact of development on scenery in a manner that reliably reflects community sentiment.

Field assessment procedures will need to be suitable for ready application by development assessment officers, and suitable for implementation by development proponents. These procedures must reflect community views about scenery and the effects of development. The way forward is to develop statistical models suitable for site-level assessment of development proposals. These procedures should be based on around the use of photographs of development proposals, than can be analyse to nature of community responses to development, without having to fully re-engage the community.

REQUIREMENTS OF AN IMPROVED APPROACH

Our understanding of the strengths and limitations of previous scenic amenity studies provides an opportunity to develop an improved and structured approach to assessing the visual impacts of development that:

- is integrated with the mapping of scenic amenity,
- provides greater sensitivity to the impact of developments,
- gives greater opportunity for community input into the choice of landscape characteristics used to evaluate visual impact, and
- can be used for field validation of scenic preference mapping.

The study method has been used to address these challenges is to:

1. Identify features regularly identified by people as influencing their preference for scenery
2. Develop a proposed conceptual model that refines the definition of community-identified influences on people's preference for scenery.
3. Record community-identified landscape attributes for photos using a procedure that is sensitive to the recording of smaller but significant - development features, and which can be feasibly related to available mapping.
4. Analyse the relationship between people's scenic preference rating of scenery and community-defined landscape attributes to produce a prototype model that predicts community preference for scenery.
5. Provide advice on further application or development of this approach.

UNDERSTANDING LANDSCAPE FEATURES RECOGNISED BY PEOPLE

All the scenic amenity studies to date have provided interview participants with the opportunity to identify the landscape characteristics they noticed on photos that influenced their rating of scenery. This information has been reported in a summary manner in all studies, but has not been analysed to develop explicit conclusions that can influence the design of these studies.

In the Caboolture and Lockyer Scenic Amenity Studies, people were asked to record what they liked or disliked about the scenery that affected their overall scoring of each photo. Some typical responses were:

- "I like it because it's a farm and it's a bit different"
- "I like the rolling green hills and the dam"

- “I like it because it's like a subtropical rainforest”
- “I like the rolling green hills”

A starting point for analysing this information is to look at a simple frequency analysis was undertaken of words used to describe scenery. Table 1 and Table 2 list words people used to record features they liked or disliked about scenery.

Table 1. Words people used most often to describe attributes they like about scenery

Word	*Count*	*Word*	*Count*	*Word*	*Count*	*Word*	*Count*
Trees	132	country	13	area	8	life	5
Water	89	colour	13	waves	7	surroundings	4
Natural	43	sand	12	very	7	healthy	5
peaceful	37	looks	12	quiet	7	great	5
mountains	35	greenery	12	lush	7	grazing	5
scenery	25	vegetation	11	landscape	7	enjoyable	5
background	25	untouched	11	cool	7	beauty	5
Bush	24	farming	11	cattle	7	beach	5
Hills	22	setting	10	calming	7	well	4
View	21	rolling	10	wildlife	6	tree	4
Open	20	cows	10	views	6	tide	4
Land	20	calm	10	sky	6	shapes	4
Green	20	buildings	10	scene	6	seagulls	4
Clean	20	tidy	9	pretty	6	relax	4
relaxing	18	spaces	9	love	6	refreshing	4
Nice	18	native	9	left	6	people	4
River	17	look	9	family	6	peace	4
Good	17	rural	8	clouds	6	openness	4
beautiful	16	place	8	animals	6	mangroves	4
Grass	15	pineapples	8	variety	5	lovely	4
Colours	15	not	8	tall	5	live	4
Space	14	neat	8	swamp	5	interesting	4
mountain	14	lots	8	sea	5	growth	4
Blue	14	bushland	8	productive	5	forest	4
Shade	13	birds	8	liked	5	foreground	4

Table 2. Words people used most often to describe attributes they dislike about scenery

Word	*Count*	*Word*	*Count*	*Word*	*Count*	*Word*	*Count*
trees	67	land	7	traffic	5	view	4
powerlines	30	natural	7	unattractive	5	water	4
grass	29	road	7	area	4	behind	3
ugly	20	bush	6	cluttered	4	building	3
buildings	19	development	6	concrete	4	built	3

Word	Count	Word	Count	Word	Count	Word	Count
rubbish	19	dirty	6	dry	4	colour	3
dead	17	landscape	6	earth	4	cut	3
untidy	17	left	6	electricity	4	cutting	3
Tower	15	looks	6	Forest	4	drab	3
background	13	more	6	hidden	4	enough	3
boring	13	powerline	6	industry	4	erosion	3
power	12	sign	6	large	4	eyesore	3
dull	11	uninteresting	6	muddy	4	fencing	3
industrial	11	vegetation	6	needs	4	gardens	3
cleared	10	bushland	5	out	4	greenery	3
overhead	10	commercial	5	pine	4	housing	3
lack	9	dump	5	plants	4	intrusion	3
clearing	8	ground	5	poles	4	like	3
lines	8	highway	5	shade	4	line	3
scenery	8	houses	5	stark	4	looking	3
signs	8	landscaping	5	strip	4	lying	3
unkept	8	look	5	too	4	man-made	3
bare	7	much	5	towers	4	messy	3
fence	7	pipe	5	tree	4	nature	3
foreground	7	steel	5	unnatural	4	neglected	3

It is clear that people used a variety of different words to describe what they like or dislike. At least five different 'levels' of words are recognisable. These are:

- Landscape qualities (eg. Green, muddy) (measurable qualifiers - adjectives)
- Landscape element (eg. Trees, signs) (readily measured - nouns)
- Land uses or landscape types (eg. Farmland, Bushland)
- Cognitive or affective response (eg. natural, peaceful, messy)
- Like or dislike

People also tend to use different words to communicate a similar same meaning. For example, bushland and forest are similar landscape types, and unkept and untidy are similar cognitive or affective responses. A series of categories were used to develop simplified peoples responses according to (a) landscape qualities, elements or types, and (b) affective or cognitive responses.

Table 3 and Table 4 indicate how often these landscape categories were associated with different response categories. For example Table 3 shows that 'open space' is the most frequently reported "liked" landscape characteristic, associated with a 'feeling of spaciousness'. Similarly, Table 4 shows that the most frequently reported landscape characteristic is "cleared trees" whish is associated with several response characteristics being "loss of nature", "untidy" and "waste".

Table 3. Groups of words people used to describe what they *like* about scenery by affective or cognitive category

	(b) Affective or cognitive response category																					
(a) Landscape qualities, element or types	BEAUTIFUL	COUNTRY LANDSCAPE	SPACEOUS FEELING	INTERESTING	INVITING	LIKE NATURE	NEAT	NEED AGRICULTURE	NEED ELECTRICITY	NEED INDUSTRY	NEED QUARRIES	NEED TRANSPORT	NEED WATER	NICE PLACE TO LIVE	OWNED AND MANAGED	PEACEFUL	PEACEFUL AND RELAXING	PLEASANT COLOURS	RELAXING	UNSPOILT	UNTOUCHED	Total Like
OPEN SPACE			25		1			1									1					28
CLEARED TREES																						0
LANDSCAPE	3	8	2				1	1														15
TREES	1		2			3								2							3	11
OCEAN	1		3											1		5			4			14
BUSHLAND	2		1		1	3															2	9
GRASS		2	1																			3
BUILDINGS										1												1
CROPS	1				1		1	4														7
RIVER	1		1													4				1	1	8
SIGNS															1							1
FARMS		1					1	5														7
INDUSTRIAL BUILDINGS							1			1												2
NOT ENOUGH TREES																						0
CONCRETE					1																	1
HOUSES																						0
MOUNTAINS		1	3		1																	5
RECREATION FACILITIES					2											1						3
COMMERCIAL BUILDINGS																						0
HIGHWAY												2										2
LONG GRASS																						0
MELALEUCA					1	1															2	4
SHADY TREES					3		1															4
BACKGROUND MOUNTAINS			3																			3
BIRDS	1				1	1																3
CATTLE		1						1								1						3
COLOURS																		2				2
GRASS & MOUNTAINS	1		1													1						3
GREEN COLOURS																		2	1			3
HOUSE		1													1	1						3

Table 4. Groups of words people used to describe what they *dislike* about scenery into affective or cognitive category

(a) Landscape qualities, element or types	**(b) Affective or cognitive response category** BORING	BUSY	DROUGHT	ENCLOSED FEELING	FIRE HAZARD	INTRUSION TO NATURE	LOSS OF NATURE	SPOILED LANDSCAPE	UGLY	UNINVITING	UNPLEASANT COLOURS	UNPRODUCTIVE	UNTIDY	WASTE	Total Dislike
OPEN SPACE															0
CLEARED TREES	1				1		5		1				8	4	20
LANDSCAPE	1														1
TREES				1	1		1						2		5
OCEAN															0
BUSHLAND						1	1						1		3
GRASS												2	4		6
BUILDINGS	1					2		1	2				1		7
CROPS								1							1
RIVER															0
SIGNS						1		1	5						7
FARMS															0
INDUSTRIAL BUILDINGS	1								3	1					5
NOT ENOUGH TREES								1		4			1		6
CONCRETE									3				1		4
HOUSES	1					2		1	1						5
MOUNTAINS															0
RECREATION FACILITIES										2					2
COMMERCIAL BUILDINGS		1							3						4
HIGHWAY		1											1		2
LONG GRASS	1												3		4
MELALEUCA															0
SHADY TREES															0
BACKGROUND MOUNTAINS															0
BIRDS															0
CATTLE															0
COLOURS	1														1
GRASS & MOUNTAINS															0
GREEN COLOURS															0
HOUSE															0

These tables highlight the significant use of cognitive (intellectual) processes that influence people's preference of scenery.

COMMUNITY-IDENTIFIED INFLUENCES ON PEOPLES PREFERENCE OF SCENERY

Separate analysis of information Tables 1 and 2 has been undertaken to identify the range of affective qualities (emotional effects) and cognitive responses (thinking responses) that people have to scenery with a view to developing landscape classes that coincide with peoples conscious and unconscious process for evaluating scenery. Figure 1 illustrates a proposed conceptual model that identifies the main responses that people taken into account when evaluating their responses to scenery. This model recognises the range of pleasing or unpleasant characteristics that people look at, as well as the utility values of landscapes, their natural values, and liking of country or rural landscapes.

Table 5. A proposed conceptual model of community responses to scenery

	Positive responses	Negative responses
Aesthetic	• Pleasing to look at	• Unpleasant to look at
	peaceful, spacious feeling, relaxing, beautiful, neat, inviting, pleasant colours	Busy, untidy, boring, ugly, uninviting
Utility	• Positive benefits (economic, social) to community	• Low community benefits
	infrastructure, agriculture, community value	drought, fire risk, unproductive
Nature	• High nature or conservation values	• Loss of natural values
	nature, untouched	loss of nature, intrusion to nature
Character	• Appealing because of its rural character	• Loss of rural character
	country feeling	spoiled landscape

Data on peoples responses to scenery was further categorised according to the four principal response categories to indicate the extent that each factor may have affected peoples responses. Table 6 shows that just over aesthetics was the main consideration in just over two-thirds of cases, nature was a major factor in 15% of cases, and utility or character was a consideration in 11% and 7% of cases.

Table 6. Frequency that different response categories influenced peoples judgements about scenery

Response category	*Frequency*
Aesthetics	68%
Nature	15%
Utility	11%
Character	7%

The model in Table 5 and the above analysis highlights the need to describe landscapes, not only according to their aesthetic properties, but also according to their natural and utility values. It is important to describe landscapes according to their:

- Aesthetic values
- Utility values
- Natural values
- Rural character

RECORDING COMMUNITY-IDENTIFIED LANDSCAPE ATTRIBUTES FROM PHOTOS

The conceptual model in Table 5 leads to the conclusion that people use several levels of interpretation to reach decisions about their preference for scenery. At least two levels of classification are necessary to provide an adequate discrimination of landscape attributes .

- Firstly, in terms of landscape types that correspond to land use types or a group of land cover types, such as farm land, bushland, or industrial land. This level is essentially a grouping of 'things that go together', which have a particular suite of expected aesthetic, recreational, utility, and natural values.
- Secondly, the presence of particular landscape elements. Landscape elements include objects such as trees, water, buildings etc.

From this understanding of people's process for interpreting scenery, a series of 16 landscape type classifications, and 29 different landscape elements were developed for application to a test set of 30 photographs from the Caboolture Scenic Amenity Study. These photos were selected to represent a range of both developed and undeveloped natural and rural landscapes. This set did not include any coastal photos because of the other influences and people's responses to coastal images.

These landscape classes are:

Landscape Types

Built-up landscapes

1. Commercial
2. Industrial
3. Refuse facility
4. Road corridor
5. Urban housing

Natural or rural landscapes

6. Cropping
7. General open space
8. Integral coastal
9. Integral hinterland forest
10. Mountain
11. Pasture
12. Picnic and play
13. River

Semi-built-up landscapes

14. Industrial bushland
15. Modified forest

Landscape Elements

Built Elements (non-farm)

1. Building commercial

2. Building industrial
3. Building park
4. Building unknown
5. Building urban
6. Built element industrial
7. Built element recreation
8. Built element road
9. Built element rubbish
10. Built element urban
11. Built element utility
12. Road bitumen
13. Road unsealed
14. Sign commercial
15. Sign information
16. Tower

Built-Elements (farm)

17. Building farm
18. Built element farm

Natural or rural elements

19. Bare soil
20. Crops
21. Grass in corridor
22. Grass natural bushland
23. Grass parkland
24. Grass pasture
25. Stack of dead trees
26. Vegetation exotic
27. Vegetation natural
28. Vegetation planted
29. Water inland

As has been noted in the introduction of this report, many of these landscape types and elements are relatively small, the previous grid-cell based approach was considered inadequate.

An alternative approach was therefore developed based on the delineation of polygons around both landscape types, and around landscape elements as they occur within landscape types.

A transparent overlay was placed over each photograph and each component was delineated on the overlay using a black felt pen. Each polygon was allocated an identification number and the area calculated by overlaying a grid over the polygon, and estimating the area of each polygon to the nearest 0.1 percent of the photo area.

As illustrated in Table 7, a series of attributes were recorded for each polygon, These included:

- PhotoID
- PolyID
- Distance class
- Topo class
- Landscape type
- Landscape element
- Landscape quality
- Quality / variety
- Colour
- Area of polygon

Table 7. Extract from the landscape attribute database used to record photo charatacteristics

PhotoID	PolyID	Distance class	Topo class	Landscape type	Landscape element	Landscape quality	Quality / variety	Colour	Area of polygon
BH23	4	CLOSE	FLAT	PASTURE	ELEM FARM	ANIMAL FARM	CATTLE BEEF	O3	0.50

Figure 3. Demonstration of the polygon approach for classifying landscape types and elements

PREDICTING COMMUNITY PREFERENCE FOR SCENERY AND RESPONSE TO DEVELOPMENT

Whilst Decision Tree Analysis was a useful approach to analysis of photo response data in the Caboolture and Lockyer scenic amenity studies, it provides limited opportunities for analysing peoples response to development, and does not allow for an integrated approach that combines mapping of scenic preference, field evaluation of scenic preference, and site evaluation of development impacts.

For this reason, multiple regression analysis has been undertaken to analyse the relationship between people's responses and landscape attributes defined above.

The first prototype model that has been developed would allow the field estimation of scenic preference rating. All 15 Landscape Type variables are statistically significant. This model, based on all peoples responses (ie. Not just average responses) has a Multiple R^2 of 0.475. Note that the largest positive term in the model is the amount of mountains in the photo, and the largest negative term in the model is the amount of industrial land in the photo.

Table 8. A prototype model for field validation of scenic preference maps

Landscape Category	*Coefficient*	*Std.Err*	*t*
Intercept	4.4384	0.0824	53.8383
Mountain	+0.1436	0.0076	18.8876
Integral Coastal Forest	+0.0109	0.0007	14.9309
Integral Hinterland Forest	+0.0105	0.0004	25.8765

Pasture	+0.0097	0.0005	21.2076
River	+0.0081	0.0003	25.6466
Picnic area	+0.0066	0.0008	8.1965
Cropping	+0.0050	0.0008	6.6933
Modified forest	-0.0032	0.0012	-2.5395
Urban housing	-0.0063	0.0015	-4.1544
Road corridor	-0.0073	0.0005	-13.7343
Industrial bushland	-0.0076	0.0006	-13.8687
Refuse facility	-0.0124	0.0021	-5.9112
Open land	-0.0125	0.0011	-11.1418
Commercial	-0.0149	0.0010	-14.2299
Industrial	-0.0175	0.0022	-7.9914

A second prototype model has been developed to demonstrate the structure of a model that can be used to illustrate the effect of built development on people's preference for scenery. Note that the 'built element term' has been weighted according to the luminosity (or brightness) of the building. Details on the calculation of luminosity are given in Appendix 2. Farming buildings and infrastructure were not included in this model since these landscape elements generally have a neutral or positive influence on peoples preferences. This second prototype development impact model has a Multiple R^2 of 0.483.

Table 9. A prototype model for field validation assessment of development impact

Attribute	Coefficient	Std.Err	*t*
Intercept	4.4218	0.0777	57.0174
Mountain	0.1447	0.0074	20.2138
Integral coastal forest	0.0110	0.0007	15.8676
Integral hinterland forest	0.0105	0.0004	27.2299
Pasture	0.0100	0.0004	23.1385
River	0.0087	0.0003	28.5672
Picnic area	0.0073	0.0008	9.8701
Cropping	0.0054	0.0007	7.6496
Commercial	0.0041	0.0013	6.3286
Modified forest	0.0027	0.0012	2.9812
Industrial bushland	-0.0060	0.0005	-2.4029
Refuse facility	-0.0076	0.0021	-12.0926
Open land	-0.0124	0.0011	-4.0893
All built element (non farm) (weighted by luminosity)	-0.0189	0.0011	-10.9100

The model in Table 9 provides a useful demonstration of the interaction of landscape type, and a combined variable that demonstrates the impact of industrial, commercial, urban buildings or utility infrastructure on people's preference for scenery.

In addition to validating scenic preference maps and evaluating the effect of development, regression analysis can also be used to indicate scenic preference ratings that should be allocated to mapped scenic preference classes, by treating the presence of each landscape types as a categorical variable.

Table 10 shows the coefficients used to model scenic preference for mapped landscape types. The multiple R^2 of this model is 0.418. Figure 4 shows the ratings of reach landscape type produced by implementation of this model.

Table 10. A prototype model for predicting scenic preference rating for mapping

Landscape Category	*Coefficient*	*Std.Err*	*t*
Intercept	4.51	0.05	83.10
River	+3.45	0.12	28.09
Pasture	+2.38	0.11	22.04
Integral Hinterland Forest	+2.31	0.10	23.16
Integral Coast Forest	+2.08	0.13	16.31
Picnic Area	+1.97	0.24	8.25
Mountains	+1.47	0.09	16.02
Cropping	+0.99	0.13	7.65
Modified forest	-0.51	0.23	-2.19
Open land	-1.88	0.12	-15.48
Road Corridor	-2.02	0.13	-15.78
Industrial Bushland	-2.08	0.13	-16.19
Commercial	-2.22	0.14	-16.39
Industrial	-2.32	0.27	-8.72
Refuse Facility	-2.92	0.47	-6.23

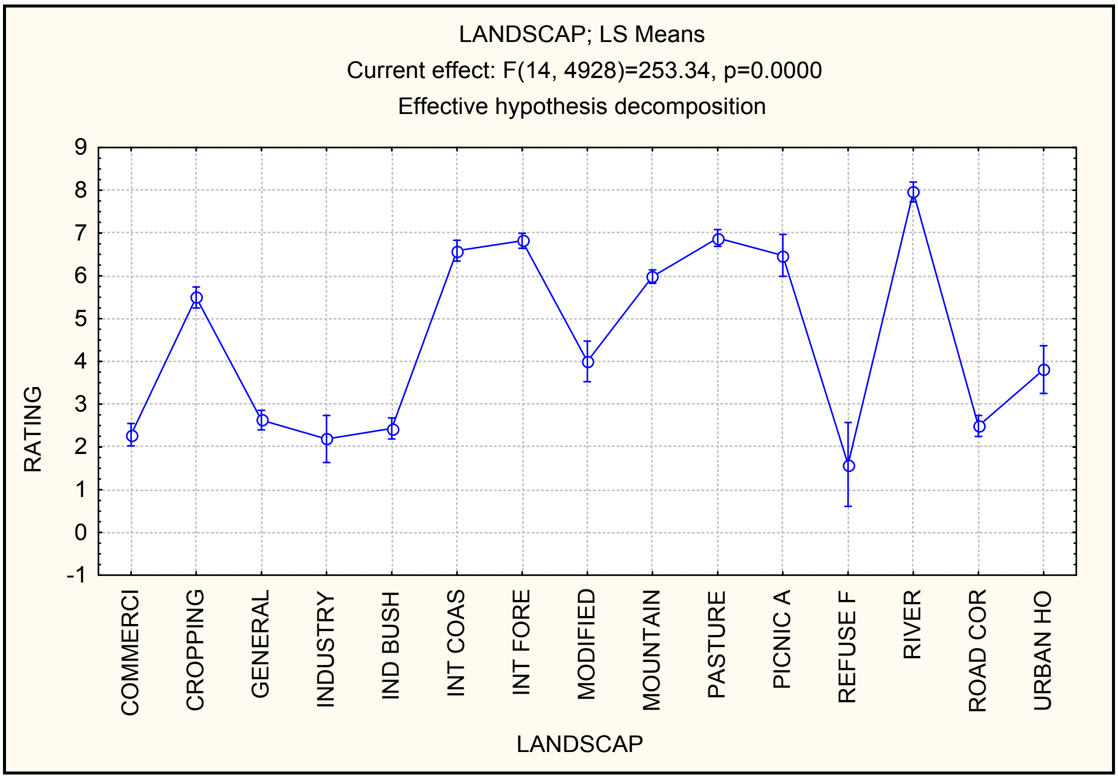

Figure 4. Average ratings produced by implementation of the prototype mapping model

FURTHER APPLICATION AND DEVELOPMENT OF THIS APPROACH

The approach demonstrated here has considerable value in providing an integrated approach to assessing the visual impact of development, mapping of scenic preference, and field validation of scenic preference maps.

The procedures described in this study are suitable for

1. Adoption as the preferred technique for description and analysis of photo content in any future scenic amenity studies, to replace the approach of decision tree analysis and cell-based evaluation of landscape attributes, and
2. Further refinement and application using the full photo sets from the Lockyer and Caboolture Scenic Amenity Studies to produce an operational visual impact model for development assessment.

REFERENCES

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RLSAC (2002). Minutes of meeting 34 of the Regional Landscape Strategy Advisory Committee.

Appendix 1.

Extract from the Lockyer Scenic Amenity Study (Gatton Shire Council et al, 2002)

pages 132-134

Appendix 17. Proposed guidelines for evaluating visual impacts

17.1 Introduction

These guidelines outline general procedures for on-site assessment and general reduction and reporting of visual impacts.

17.2 Scope of these guidelines

These guidelines are intended to apply to all new developments on all land tenures. Government bodies with different jurisdictions and responsibilities are encouraged to develop or refine the technical or procedural elements of these guidelines to simultaneously reflect the cross-tenure coordination functions of the integrated planning act and other specific requirements of other legislation and policy.

17.3 Assessing impact of proposed developments

17.3.1 Assessing possible impact on scenic preference

The effect of proposed developments would ideally be evaluated using a "scenic preference photo model" that would indicate the percentage reduction of scenic preference from a series of photographs depicting the development within the surrounding landscape.

An interim approach to evaluation and recommendation of possible impacts will entail:

• Assess the mapped scenic amenity rating (1-10) for the proposed development site.

• Undertake a site assessment to verify the basic land cover type (eg. crop, forest, pasture) and topography (flat, steep) and visual exposure to confirm or refine the mapped scenic amenity class.

• Determine the appropriate management objectives for this scenic amenity class.

• Identifying important viewing locations. It is necessary to identify the lines of sight from all major locations that view the landscape where the structure may be located.

• Acquire photos of the development site from the most frequently used viewing locations.

• Sketching the development on the photos, including landscaping.

• Evaluate the proportion of the photo (low, moderate, high) where development would be evident.

• Refer to photos and tables in this report to evaluate approximate reduction in scenic preference or visual exposure.

• Provide assessment advice to development approvals officer indicating approximate reduction of scenic amenity that would result from proposed development.

• Provide advice on methods that would reduce visual impacts.

17.4 Options for reducing impacts

17.4.1 Modifying location and volume of evident development

The most effective mechanism to reduce the volume of evident development is to locate the development to reduce the apparent size of the infrastructure from important viewing locations.

This may entail either:

• Increasing the distance between the development and important viewing locations.

• Locating the structure in a topographic location that is partly hidden from important viewing locations.

• Reducing the height and width of the structure which presents to the viewing locations.

17.4.2 Altering the colours to make it less obtrusive

Where movement of the structure is only partly possible, it is desirable to reduce the colour contrast of the structure and the main background seen from viewing locations.

The main requirement is to firstly assess the dominant colours of the surrounding landscape that will be seen as the main background to the structure from the principal viewing location. It may be best to take a photo of the landscape from this location so that this colour can be assessed against the possible colours of the structure.

The most important objective is to ensure the colours have a low difference in luminosity or brightness (ie. use dark colours for development if background is generally dark).

Secondly, colours should be compatible where possible (ie. occupy adjacent locations on a colour wheel) (eg. if background is green, use colours which have green, grey, or blue).

It is possible to gain assistance from the EPA or a landscape consultant to select colours that have low colour contrast and luminosity difference.

17.4.3 Use of screening trees and vegetation

Trees and other vegetation can be used to reduce the volume of evident structure, and decrease the colour contrast against the background. Species should be chosen that are of adequate height and density to screen the development within the shortest period of time. Trees should be selected to meet visual mitigation objectives and other objectives wherever possible (eg. biodiversity, shade, low risk to drainage pipes, low fire risk).

It is preferable to use existing vegetation to screen the structures rather than plant new trees because of the time involve in waiting for growth of the new trees. It is preferable to supplement existing remnant trees where possible.

Care should also be taken to ensure that maximum efficiency is gained in careful placement of trees. It may be that trees can be most effectively planted part way between the viewing location and the structure, rather than immediately adjacent. Tree planting schemes should be accompanied by a watering and maintenance plan.

17.4.4 Choice of appropriate architectural style

In addition to choice of colours that are complimentary to the surrounding landscape, it is possible to minimise impacts through choice of a design that is in keeping with the rural or bushland character and the cultural heritage of the district. Good design elements can be incorporated into even functional structures at minimal cost.

17.5 Context specific suggestions for different landscapes

17.5.1 Forests

Steep forests provide many opportunities to 'hide' the development in depressions away from major viewing locations or use existing trees to screen the development.

A buffer of 50 m to 200m of existing native vegetation is often required to effectively completely a highly contrasted development.

Under-plantings of compatible and dense canopy species can reduce the width of the required buffer.

17.5.2 Crop lands

Crop lands are difficult environments to mitigate visual impacts because of the open landscape and low abundance of existing trees. Careful placement of structures and some screen planting can be effective in reducing the impact of the development.

17.5.3 Pastures

Pastures are also challenging but may have more undulations to locate the structure. Trees or regrowth is more common in these landscapes.

17.5.4 Waterways

Water provides a major distraction to any development but care must be taken to ensure the structure does not detract from peoples experience of the water body. This can be achieved by sensible location and screening.

17.6 Other considerations

17.6.1 Ensuring views to areas of high visual exposure are maintained.

Any development proposal should also recognise the views that may be lost by building the structures or mitigation trees in the landscape. For example, it may be possible to move a structure to allow road users to still view mountains in the background. This requirement may be greater than the need to mitigate the impact of the structure itself.

Appendix 2. Calculation of luminosity

Luminance is basically the brightness of an object, calculated using the following formula:

$$luminance = (0.3 \times Red) + (0.59 \times Green) + (0.11 \times Blue) \times 255$$

Each polygon is allocated one of 16 possible colour codes, with RGB values and a calculated luminosity as follows:

colour	name	group	R	G	B	Luminosity
G1	Light green	Green	15	140	70	95
G3	Dark Green	Green	50	70	60	63
G2	Mid green	Green	110	120	80	113
B3	Dark Blue	Blue	50	80	120	75
Y2	Mid Yellow	Yellow	170	160	50	151
Y3	Dark Yellow	Yellow	100	90	35	87
Y1	Light Yellow	Yellow	230	200	60	194
B1	Light Blue	Blue	180	200	220	196
B2	Mid Blue	Blue	70	110	120	99
E1	Light Grey	Grey	200	200	200	200
E2	Mid Grey	Grey	140	140	140	140
E3	Dark Grey	Grey	70	70	70	70
W1	White	White	255	255	255	255
O1	Light Brown	Brown	200	170	130	175
O2	Mid Brown	Brown	140	80	40	94
O3	Dark Brown	Brown	70	30	5	39
R3	Dark Red	Red	120	40	30	63
R2	Mid Red	Red	170	50	20	83
R1	Light Red	Red	200	50	20	92
K1	Black	Black	0	0	0	0