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A modelling assessment of the air quality impact in the Collie region of 1 x 200 and 2 x 200 MW power stations at Bluewaters

prepared for

Griffin Energy

by

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Executive Summary

The air-quality model TAPM has been used to evaluate the separate impacts on air quality of proposed 200 megawatt (MW) and 2 x 200 MW power stations in the Collie mining and power generation area. The proposed site at Bluewaters is 4 km north-west of Collie power station. A 12-month period (2001) was simulated by TAPM using four nested grids down to a grid spacing of 0.5 km for prediction of pollutant concentrations.

Hourly-varying emissions of sulfur dioxide (SO_2) for each day of the year were used for Muja and Collie power stations (obtained from Western Power). For the same sources, hourly-varying emission files for nitrogen oxides (NO_x), carbon monoxide (CO), mercury (Hg), polycyclic aromatic hydrocarbons (PAH), fluoride and particulate matter with aerodynamic diameter less than 10 microns (PM_{10}) were calculated by scaling the hourly SO_2 rates by the ratio of the annual emission of each pollutant to the annual SO_2 value. Emissions from Worsley power station, taking into account the proposed upgrade, were considered constant. Constant emission rates for all pollutants for the proposed power stations were obtained from Griffin Energy.

The proposed sources were evaluated under a worst-case scenario that included emissions from the four stages of Muja power station (A, B, C and D), Worsley power station, Collie power station, and an expanded (or additional) Collie power station with identical characteristics to the existing station. The following findings arise from an examination of the highest SO_2 concentrations over a 12-month period.

- Scenario 1 (proposed 200 MW Bluewaters I power station in isolation) produced *hourly-averaged* concentrations below the NEPM standard at all times.
- Scenario 2 (proposed 2 x 200 MW Bluewaters I + II power station in isolation), produced *hourly-averaged* concentrations below the NEPM standard on all days except one.
- For scenario 3 (sources Muja A, B, C and D, Collie, Collie expansion (identical to Collie), Worsley and Bluewaters I), there were exceedances of the NEPM standard for hourly-averaged concentrations on 27 days, associated with both Collie and Muja power stations (Figure A.3).
- For scenario 4 (scenario 3 sources plus Bluewaters II), there were also 27 exceedance days. Comparison with scenario 5 (sources Muja A, B, C and D, Collie, Collie expansion, and Worsley) shows that the proposed sources do not lead to any additional exceedance days.

For 24-hour averaged concentrations of SO_2 (Figures A.11 to A.15), only one exceedance occurred for scenarios 3 and 4 (no contribution from Bluewaters), and for annual-averaged concentrations (Figures A.16 to A.20), the NEPM limit was exceeded for scenarios 3 and 4, though with no contribution from the proposed Bluewaters sources.

For all scenarios, SO_2 NEPM standards were not exceeded at Collie township for any of the averaging periods.

Predicted concentrations of carbon monoxide, mercury, PAH, fluoride, nitrogen dioxide and ozone were all below NEPM standards or World Health Organisation

guidelines, while exceedances of PM_{10} NEPM standards were due to emissions from Muja power station and occurred in the near vicinity.

In summary, the TAPM modelling shows that emissions from both the proposed 200 MW and 2 x 200 MW power station do not lead to an increase in the number of days on which the NEPM standard for hourly-averaged SO_2 is exceeded. This is under a scenario that includes the existing Muja, Collie and Worsley power stations plus an expansion of the Collie station.

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1 Introduction

This report presents results from an air-pollution modelling study in the Collie mining and power-generation area, located about 150 km south-south-west of Perth. The study for Griffin Energy Pty Ltd evaluates the separate impacts of a 200 MW and 400 (2 x 200) MW proposed power stations at Bluewaters on the proposed Coolangatta industrial estate. An annual simulation, for 2001, is carried out with the air-pollution model TAPM and various concentration statistics for a number of pollutants were calculated and assessed against NEPM standards and health guidelines. Previous studies were done for Griffin Energy by Physick and Edwards (2004a, 2004b) for 150 and 200 MW power stations.

In this study, TAPM is used in tracer mode to model ground-level concentrations of
- SO_2, CO, mercury, PAH, and fluoride,

and in reactive chemistry mode to predict ground-level concentrations of
- PM_{10}, NO_2 and O_3.

Emissions are modelled from existing point sources in the region, from natural sources (soil nitrogen oxides (NO_x) and biogenic volatile organic compounds (VOC) emissions), and from the proposed power station sources.

2 Emissions Data and Modelling Setup

The locations of the Collie and Muja power stations, the power station associated with the refinery at Worsley, the proposed site at Bluewaters for the Griffin Energy power station and the Collie township, are shown on the topographic map in Figure 2.1.

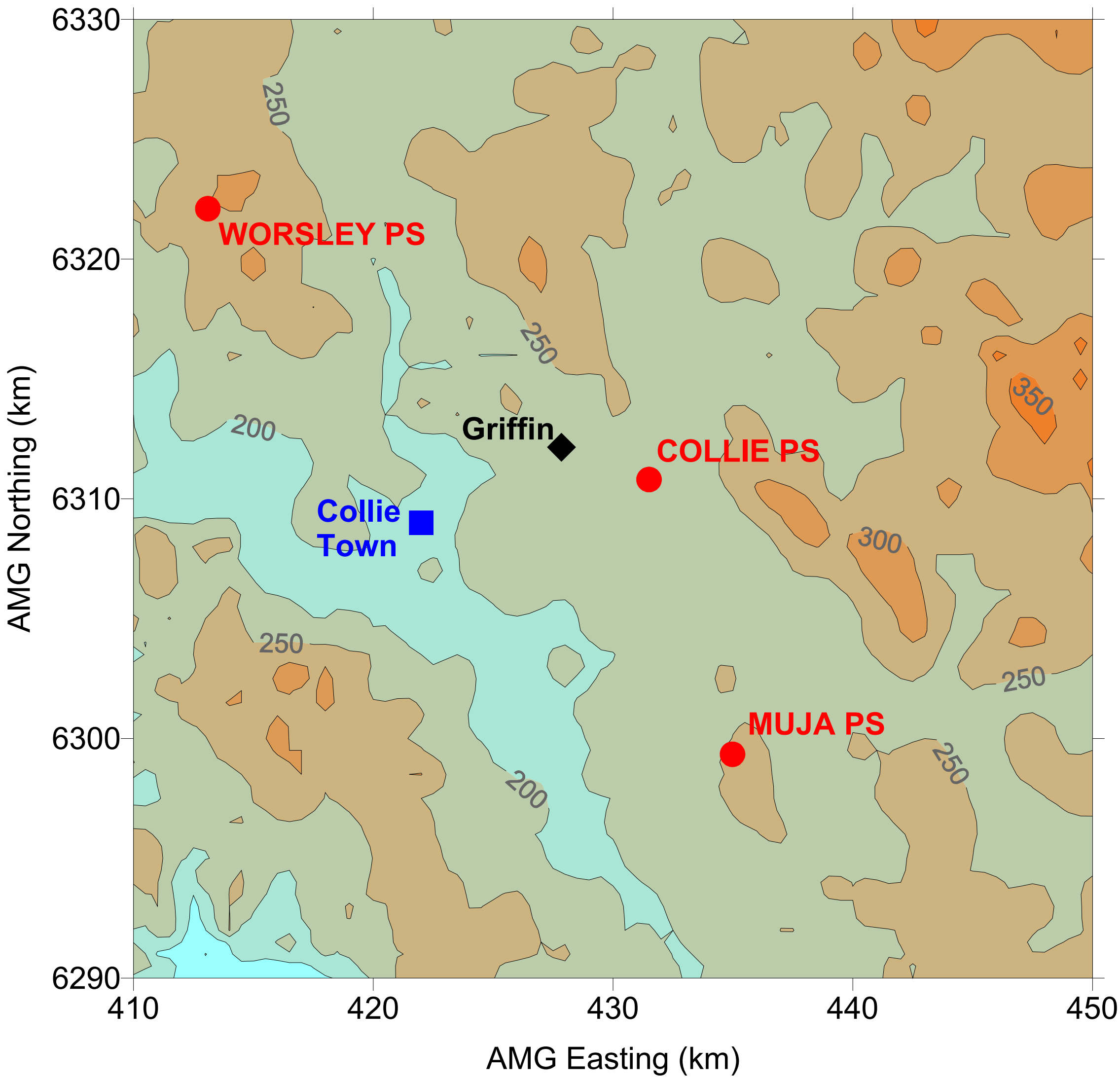

Figure 2.1 Topographic map of the study region showing the location of the Collie, Muja and Worsley power station sources (●), the Collie township (■) and the proposed Griffin Energy site at Bluewaters (♦). Contours indicate terrain height above sea level (m).

2.1 Sulfur dioxide emissions

2.1.1 Existing sources

In this report, the existing Collie power station is referred to as Collie A, as three of the emission scenarios include an addition (Collie B) to Collie A. The expanded Collie power station (A+B) is modelled as one source, with double the emissions of Collie A, but the increased buoyancy from the two flues within the one stack is taken into account by increasing the stack radius (by the square root of 2). Collie A+B has the same hourly profile of emissions as Collie A (but double the mass). The emissions file for 2001, used in this study with the kind permission of Western Power, for Muja A, Muja B, Muja C, Muja D and Collie A, consists of hourly-averaged SO_2 data from the five power station point sources, and a constant emission rate from the Worsley power station stack. The Muja sources lie approximately in a straight line (oriented $300^o/120^o$) with a separation of 55 m between A and B, 122 m between B and C, and

116 m between C and D. Collie power station, which came online at the end of 1998, is 13 km north-north-west of Muja, and Worsley power station is 32 km north-west of Muja (Figure 2.1). Locations of these sources and emission parameters at maximum continuous rating are listed in Table 2.1. *Actual emission parameters vary hour by hour and are contained in the emissions files used in the modelling.* Note that the Worsley stack contains three flues, each with a diameter of 2.3 m. Combining them into a single stack for the modelling, and maintaining the same flow rate, gives an effective diameter of 4.0 m for this stack. The Worsley emission rate for SO_2 in Table 2.1 includes the proposed upgrade, and consequently is 10% higher than that used in previous work for Griffin Energy (Physick and Edwards, 2004a).

Hourly exit temperatures were calculated using relations between temperature and MW load for each unit, developed in Section 4.1.1 of Pitts (2002) – note that each stage at Muja (i.e. A, B, C and D) consists of two units. Hourly exit velocities for each stage were taken to be proportional to load.

Table 2.1 Locations, in Australian Map Grid (AMG) coordinates, and emission parameters at maximum continuous rating for the six existing power station stacks (from Pitts 2002), and for the proposed sources (Bluewaters I, II and Collie B).

Source (stack)	AMG Easting (km)	AMG Northing (km)	Stack Height (m)	Stack tip diameter (m)	Exit temp. (deg C)	Exit velocity (m s^{-1})	SO_2 (g s^{-1})
Muja A	435.785	6298.979	98	3.94	200	19.0	297
Muja B	435.734	6299.001	98	3.94	200	19.0	297
Muja C	435.636	6299.074	151	5.91	133	20.4	784
Muja D	435.525	6299.109	151	5.91	133	19.0	746
Collie A	431.227	6310.439	170	5.23	152	24.4	550
Collie A+B	431.227	6310.439	170	7.40	152	24.4	1100
Worsley	413.074	6322.109	76	4.00	130	23.7	374
Bluewaters I	427.850	6312.150	100	4.13	130	24.0	296
Bluewaters I+II	427.850	6312.150	100	5.84	130	24.0	592

2.1.2 Proposed sources

This study evaluates the impact on air quality of a 200 MW power station (Bluewaters I) and a 2 x 200 MW power station (Bluewaters I+II). Source characteristics and site location are listed in Table 2.1. Bluewaters I is a 200 MW station powered by a turbine, and Bluewaters II is identical to Bluewaters I. However the combined two-turbine 400 MW power station, denoted Bluewaters I+II in Table 2.1, consists of two flues within one stack. The exit temperature and exit velocity are the same as for Bluewaters I, but the emissions are double and the stack diameter (equivalent) increases to 5.84 m, from 4.13 m for Bluewaters I. For the TAPM simulation, there is no hourly variation in emissions from these sources; for each hour, SO_2 is emitted at the maximum rate.

2.2 Emissions of NO_x, PM_{10}, CO, Hg, PAH and fluoride

Total annual emissions of these pollutants for the existing sources were obtained from the national pollutant inventory (NPI) website and are listed in Table 2.2. Hourly-varying emission rates were calculated by scaling the hourly SO_2 rates by the ratio of the annual emission of each pollutant to the annual SO_2 value. Annual emissions for the proposed Griffin source at Bluewaters are also listed in Table 2.2, and the constant hourly emission rate is used for the simulations.

Following advice from DEP, concentrations of VOCs are not considered in this study as the emission rate from coal combustion in the Collie region is very small.

Table 2.2 Annual emissions (kg) from existing power stations in the Collie area, and from the proposed Griffin energy power station Bluewaters I. Emissions for Bluewaters I+II are double those for Bluewaters I. The corresponding emission rate in g/s is shown in parentheses for NO_x, PM_{10} and SO_2, although only Worsley and Bluewaters are modelled as emitting at these constant rates. Existing data are sourced from NPI website for year 2001-2002.

Emission	Muja	Collie	Worsley	Bluewaters I
NOx	23,000,000 (729)	3,900,000 (124)	4,025,000 (124)	3,815,000 (121)
PM_{10}	17,000,000 (539)	180,000 (5.7)	1,000,000 (32)	283,800 (9)
Carbon Monoxide	870,000	3,500,000	1,500,000	2,933,000
Mercury	250	41	690	30.5
PAH	35	9.8	18	6
Fluoride	260,000	36,000	60,000	18,600
SO_2	36,000,000 (1142)	14,000,000 (444)	11,795,000 (374)	9,335,000 (296)

It should be noted that for Collie power station, the actual total SO_2 emissions used in the modelling for 2001 was 12,400,000 kg, a reduction of 11.4% from the NPI website value in Table 2.2. This was mainly due to a total of 5 weeks when the power station was not operating in the period September through November. The same reduction applies to emissions of the other pollutants in Table 2.2. Muja actually put out 40,843,000 kg of SO_2, an increase of 11.9% over the value in Table 2.2.

2.3 Soil and biogenic emissions

VOC emissions at 30°C and a photosynthetic active radiation (PAR) level of 1000 μ mol m^{-2} s^{-1}, calculated according to vegetation type, are input on a 3-km spaced grid covering the total modelled region. Similarly, gridded NO_x emissions from the soil are input at 30°C. Throughout a simulation, TAPM adjusts the emissions according to temperature (VOC and NO_x) and PAR level (VOC).

2.4 Background emissions

A single value of background O_3 (20 ppb) was used for all months of the year. It is also necessary to assign a background value for R_{smog}, partly to account for a general background concentration of VOCs but also to compensate for the omission of some inorganic radical-producing reactions in the GRS photochemical mechanism. Following the Pilbara work of Hurley et al. (2003b), a value of 0.2 ppb was chosen as most suitable for our situation, i.e. dominant point sources emitting into a relatively pristine background environment. This contrasts to the R_{smog} value of 1.0 deemed appropriate for the urban environment of Perth, a city of 1 million people and associated area sources (Physick *et al*. 2002).

In the absence of any local monitoring data, the background value of PM_{10} was set to zero. However, it should be noted that emissions from activities associated with mining operations have not been included in this study.

2.5 Emission scenarios

The impact of the Bluewaters sources is evaluated against the worst-case situation for existing and proposed sources. This includes the Muja A and B sources as well as Muja C and D, and an expansion of Collie power station to double its current capacity. Ground-level concentrations are evaluated for
scenario 1 - the proposed Bluewaters I source in isolation,
scenario 2 - the proposed Bluewaters I and II sources in isolation,
scenario 3 - existing sources Muja A, B, C, D, Worsley (including proposed upgrade), Collie (denoted as Collie A) and an expansion of Collie A with the same characteristics (denoted Collie B), and Bluewaters I,
scenario 4 - sources from scenario 3 plus Bluewaters II,
scenario 5 - existing sources Muja A, B, C, D, Worsley (including proposed upgrade), Collie (denoted as Collie A) and an expansion of Collie A with the same characteristics (denoted Collie B)
The various scenarios are outlined in Table 2.3.
Only scenarios 3, 4 and 5 are simulated for the secondary pollutants NO_2, O_3 and PM_{10}.

Table 2.3. Scenarios to be modelled.

	Scenario				
	1	**2**	**3**	**4**	**5**
Muja A, B			x	x	x
Muja C, D			x	x	x
Collie A			x	x	x
Collie B			x	x	x
Worsley			x	x	x
Bluewaters I	x	x	x	x	
Bluewaters II		x		x	

2.6 Modelling

As part of their study of monitoring data and model verification in the Collie region, Hibberd and Physick (2003) examined wind data at 10 m above the ground for Collie monitoring station for 6 years (1996 – 2001) and concluded that, though there are some year-to-year variations in the speed and direction distributions, with 1996 having noticeably fewer south-easterlies than other years, the variations are small. The years 1997, 1998, and 2001 selected for modelling in that study represent "typical" years.

We feel that it is not necessary to take annual variability into account for this region by modelling more than one year and for our study we have chosen to model 2001.

2.6.1 TAPM

TAPM (Hurley, 2002) was developed at CSIRO Atmospheric Research and consists of prognostic meteorological and air pollution modules that can be run for multiplenested domains. The meteorological module is an incompressible, non-hydrostatic, primitive equation model for three-dimensional simulations. It predicts the three components of the wind, temperature, humidity, cloud and rainwater, turbulent kinetic energy and eddy dissipation rate, and includes a vegetation/soil scheme at the surface and radiation effects. The model is driven by six-hourly analysis fields (on an approximately 100-km spaced grid) of winds, temperature and specific humidity from the Bureau of Meteorology's Global Assimilation and Prediction system (GASP). These analyses contain the larger-scale synoptic variability, while TAPM is run for much finer grid spacings and predicts the meteorology at smaller scales.

The air pollution module solves prognostic equations for pollutant concentration using predicted wind and turbulence fields from the meteorological module. It includes gas- and aqueous-phase chemical reactions based on an extended version of the Generic Reaction Set (GRS) developed at CSIRO Energy Technology, a plume-rise module, and wet and dry deposition effects.

TAPM has been used by CSIRO in previous studies involving assessment of new or expanding industries in the Pilbara region (Noonan 1999, 2002a, b, Hurley et al. 2003a, b), as well as in verification studies for the Pilbara region (Physick and Blockley, 2001, Physick et al. 2002, Hurley et al. 2004) and for Collie (Hibberd and Physick, 2003a, b). For TAPM Version 2.6 (used in this study), ranked plots of modelled SO_2 concentrations against observed concentrations at three sites in the Collie monitoring network for 2001 are shown in Figure 2.2. A ranked plot consists of paired modelled and observed concentrations after the hourly values in each annual set have been ranked from highest to lowest, and can easily identify whether a model is predicting too high or too low, and whether this occurs at the low, medium or high end of the concentrations. Figure 2.2 shows that TAPM slightly overpredicts in the low and medium concentration ranges, but that over prediction is more marked at the higher end, especially at Shotts and Bluewaters. Model predictions are best at the site furthest from the sources, Collie.

2.6.2 Grids

The meteorological simulations were carried out on four nested grids (each 35 x 35 x 25 gridpoints) with grid spacings of 30, 10, 3 and 1 km. The grid spacings for the corresponding air quality simulations (45 x 45 x 25) over smaller domains were 15, 5, 1.5 and 0.5 km. All grids were centred at (33°23′ S, 116°15.5′ E) – between Collie monitoring site, Collie power station and Muja power stations - and corresponding to (431017, 6305957) metres in AMG coordinates. All sources and monitoring stations are situated on the innermost grid, except the Worsley power station which is on the 1.5-km spaced grid.

Emissions from Collie A and B and Bluewaters sources were dispersed using the Lagrangian particle module on the innermost grid. For this 0.5-km spaced grid, the Lagrangian technique provides greater accuracy than the Eulerian approach in estimating ground-level concentrations near the source (within 5 km).

The land-use classification was obtained from the dataset accompanying the TAPM modelling package. Terrain elevation was obtained from AUSLIG data (250-m resolution). The monthly values of deep soil moisture were assigned according to some preliminary meteorological simulations in which temperatures at 10 m were compared to observations. A value of 0.10 was used for November to April, 0.20 May to August and 0.15 for September and October. As determined in Hibberd and Physick (2003a, b), buoyancy enhancement factors N_E of 1.8 for Muja stacks A and B, and 2.0 for Muja stacks C and D were assigned.

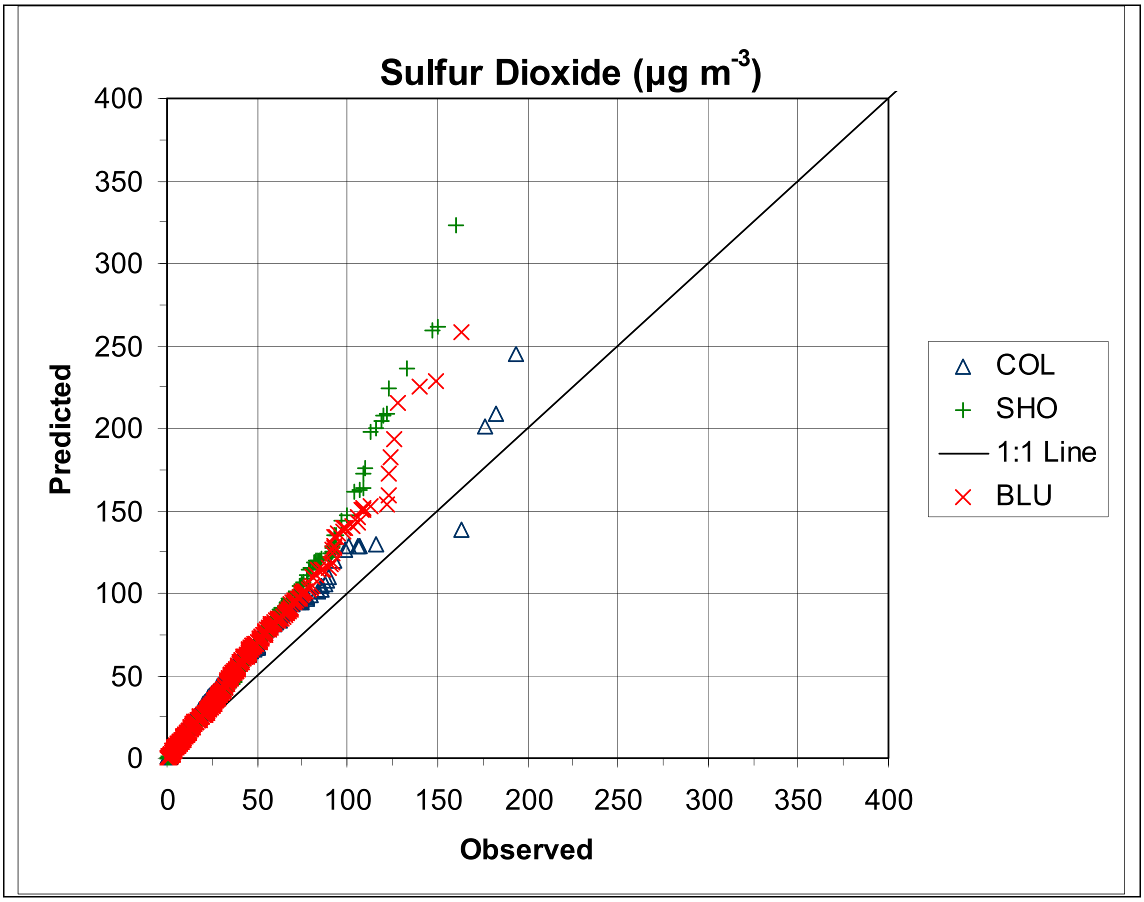

Figure 2.2 Plot of ranked model predictions (TAPM V2.6) against ranked observations of hourly-averaged SO_2 concentrations for 2001 at three monitoring sites, Collie (Δ), Shotts (+) and Bluewaters (×).

2.6.3 Summary of TAPM Configuration

The configuration for TAPM version 2.6 used in this study is:

- four nested grids (each 35 x 35 x 25 gridpoints) for the meteorology with grid spacings of 30, 10, 3 and 1 km;
- grid spacings for the corresponding air quality simulations (45 x 45 x 25 gridpoints) of 15, 5, 1.5 and 0.5 km (Note that that the meteorology and air quality grids do not cover exactly the same area, though they are centred at the same point.);
- all grids centred at (33°23′ S, 116°15.5′ E), corresponding to (431017, 6305957) metres in AMG coordinates;
- land-use classification obtained from the data set accompanying the TAPM modelling package;
- terrain elevation obtained from AUSLIG data (250-m resolution);

- deep soil moisture values of 0.10 for November to April, 0.20 for May to August and 0.15 for September and October;
- buoyancy enhancement factors N_E of 1.8 for Muja stacks A and B, and 2.0 for Muja stacks C and D;
- background values of 20 ppb and 0.2 ppb for ozone and R_{smog} respectively;
- Lagrangian particle mode used for emissions from Collie A, B and Bluewaters in all scenarios;

The TAPM input files (including the emission files) for 2001 and the various scenarios are included on a CD prepared with this report.

3 Results

Concentration statistics from the annual simulations are presented for the various averaging times associated with the NEPM standards for each pollutant. During post-processing of a simulation, gridded fields of the highest and the ninth-highest concentration at each gridpoint of the innermost grid (22 x 22 km^2) are calculated. The maximum value on each of these grids is presented here in tabular form for most pollutants. The highest and the ninth-highest concentration at the Collie township are also shown. Also listed is the NEPM standard and the number of days on which it is exceeded. Contours of the highest concentrations over the innermost grid are plotted for all pollutants except O_3 which is plotted on the second outermost grid, and the distribution of the ninth-highest concentration is also plotted for SO_2, NO_2, O_3 and PM_{10}.

3.1 Sulfur dioxide

3.1.1 Hourly-averaged concentrations

Hourly-averaged concentration statistics from scenario 1 (Bluewaters I in isolation) and scenario 2 (Bluewaters I and II in isolation) are presented in Table 3.1. The highest predicted concentration for scenario 1 for the year (391 µg m^{-3}) throughout the domain does not exceed the NEPM standard of 570 µg m^{-3}. For scenario 2, the standard is exceeded (583 µg m^{-3}), though on only one day. Although the emissions in scenario 2 are double those of scenario 1, the ground-level concentrations are less than double because of the greater initial buoyancy flux associated with scenario 2, and hence higher plume-rise height. Examination of the contour distributions in Figure A.1 for scenario 1 in Appendix A shows that the annual highest concentration in the region occurs about 2 km to the east of the proposed site, as the elevated plume is convectively mixed (fumigated) to the ground. Similar areas of high concentration are also evident elsewhere and for scenario 2 in Figure A.2, illustrating the importance of morning fumigation in producing high concentrations relatively far from the source. In scenario 2, the maximum occurs 7 km to the northwest of the site.

Also shown in Table 3.1 are the concentration statistics from scenario 3 (existing sources plus Collie B plus Bluewaters I) and scenario 4 (sources from scenario 3 plus Bluewaters II). The NEPM standard for SO_2 is predicted to be exceeded in the region on 27 days for both scenarios. However the additional source in each scenario does not add any extra exceedance days over the total for the Muja, Collie A and B and Worsley combination (scenario 5).

The maximum concentration in scenarios 3, 4 and 5 occurs about 2 km east of Muja power station (Figures A.3 – A.5), with small contributions from Bluewaters I (41 µg m^{-3}) and Bluewaters I+II (149 µg m^{-3}). There is also a small exceedance area northeast of Collie power station (Figure A.5), which is unaffected by either of the proposed power stations. The addition of Bluewaters I does not lead to an increase in the number of exceedance areas (Figure A.3), but emissions from Bluewaters II, in concert with Collie, lead to small areas 5 km southwest of Bluewaters and 8 km northwest of the proposed station (Figure A.4).

Contour plots of the 9th-highest concentration distribution can be found in Figures A.6 to A.10, and agree with the general findings above, although there is barely any contribution from the Bluewaters sources to the domain-wide maximum just east of Muja.

The concentration statistics shown in Table 3.2 for Collie township show that predicted concentrations for all scenarios are well below the NEPM standard. Contributions from Bluewaters I to the highest concentration at Collie are negligible, but Bluewaters II emissions increase it by 9%.

Table 3.1 Statistics from the TAPM simulation for 2001 for hourly-averaged concentrations of sulfur dioxide (μg m^{-3}) over the innermost modelling domain (22 x 22 km^2).

Scenario	1	2	3	4	5
Highest	391	583	1104	1212	1063
9th-highest	198	245	596	602	594
NEPM standard	570	570	570	570	570
Exceedance days	0	1	27	27	27

Table 3.2 Statistics from the TAPM simulation for 2001 for hourly-averaged concentrations of sulfur dioxide (μg m^{-3}) at the Collie township.

Scenario	1	2	3	4	5
Highest	147	191	345	373	343
9th-highest	79	141	148	169	147
NEPM standard	570	570	570	570	570
Exceedance days	0	0	0	0	0

3.1.2 Short-term concentrations

Estimates of the annual highest and 9th-highest 10-minute and 3-minute averages of SO_2 at Collie township (Tables 3.2a and 3.2b) have been made using a power law dependence of the concentration on averaging time of the form:

$$\frac{c_a}{c_m} = \left(\frac{t_m}{t_a}\right)^p, \qquad (1)$$

where c_a is the concentration for an averaging time t_a, estimated from the concentration c_m for an averaging time t_m (here 1 hour), and p is the exponent. This procedure is included as an approved method in the NSW EPA Modelling Guidance (NSW EPA, 2001).

Equation (1) has been derived from data for maximum annual concentrations. However, an analysis of the data given by Hibberd (1998) shows that the exponent is approximately the same for the 9th-highest values.

For tall stack emissions, Katestone (1998) recommends a value of $p = 0.4$. The uncertainty in the exponent is quoted by Hibberd (1998) as ±10%, which translates to an uncertainty of about ±10% in the estimated concentrations.

The best guideline for concentrations shorter than 1 hour is the NHMRC goal of 715 µg m^{-3} (250 ppb) for 10-minute average concentrations, which is used in a number of jurisdictions as a guideline in licensing applications.

The predicted 10-minute concentrations at Collie in Table 3.2a show that the NHMRC guideline value is only exceeded in scenario 4, by 49 µg m^{-3}.

Table 3.2a Statistics from the TAPM simulation for 2001 for 10-minute-averaged concentrations of sulfur dioxide (µg m^{-3}) at the Collie township.

Scenario	**1**	**2**	**3**	**4**	**5**
Highest	301	391	706	764	702
9th-highest	162	289	303	346	301
Old NHMRC Guideline (250 ppb for 10-minute avg)	715	715	715	715	715

Table 3.2b Statistics from the TAPM simulation for 2001 for 3-minute-averaged concentrations of sulfur dioxide (µg m^{-3}) at the Collie township.

Scenario	**1**	**2**	**3**	**4**	**5**
Highest	487	633	1143	1236	1137
9th-highest	262	467	491	560	487

3.1.3 24-hour and annual-averaged concentrations

Tables 3.3 and 3.4 show that SO_2 emissions from either of the proposed sources in isolation would not lead to any exceedances of the 24-hour NEPM standard (228 µg m^{-3}). The highest concentrations (81 and 111 µg m^{-3} respectively) occur at about 4 km to the northwest of the site for each scenario (Figures A.11 and A.12). For scenarios 3 and 4, the NEPM standard is exceeded on one day (Table 3.3), and Figures A.13 - A.15 show that the exceedance occurs within 2 km of Muja, with no contribution from the proposed Bluewaters sources.

The highest annual-averaged concentrations for scenarios 1 and 2 (Table 3.5 and Figures A.16 and A.17) are 4 µg m^{-3} and 5 µg m^{-3}, well below the NEPM standard of 57 µg m^{-3}. The highest annual-averaged concentrations for the region for scenarios 3, 4 and 5 are predicted to be 62 μg m^{-3} (Table 3.5), with the small exceedance area occurring at Muja power station (Figures A.18 - A.20).

Table 3.3 Statistics from the TAPM simulation for 2001 for 24-hourly-averaged concentrations of sulfur dioxide (μg m^{-3}) over the innermost modelling domain (22 x 22 km^2).

Scenario	1	2	3	4	5
Highest	81	111	234	234	234
9th-highest	47	58	177	177	177
NEPM standard	228	228	228	228	228
Exceedance days	0	0	1	1	1

Table 3.4 Statistics from the TAPM simulation for 2001 for 24-hourly-averaged concentrations of sulfur dioxide (μg m^{-3}) at the Collie township.

Scenario	1	2	3	4	5
Highest	15	27	44	44	44
9rd-highest	7	11	26	29	25
NEPM standard	228	228	228	228	228
Exceedance days	0	0	0	0	0

Table 3.5 Annual-averaged concentrations of sulfur dioxide (μg m^{-3}) from the TAPM simulation for 2001, over the innermost modelling domain (22 x 22 km^2) and at the Collie township.

Scenario	1	2	3	4	5
Domain-wide	6	7	62	62	62
Collie township	0.6	0.9	5	5	4
NEPM standard	57	57	57	57	57

The World Health Organisation (2000) provides guideline concentrations, above which SO_2 is considered to have a detrimental effect on vegetation. The guidelines are in the form of annual averages and are listed in Table 3.5a for different vegetation types. While comparison to model values in Table 3.5 shows that the guideline values are exceeded for scenarios 3, 4 and 5, examination of the contour plots for the annual-average SO_2 concentrations in Figures A.18 - A.20 shows that the exceedance area for crops, forest and natural vegetation is only within a 2 km radius of Muja power station and that emissions from the proposed Bluewaters sources and Collie power station do not contribute to these concentrations. For lichen, the distance extends to 3.5 to 4 km from Muja. Figures A.18 and A.19 show that the addition of the Bluewaters sources, in combination with Collie A and B, produces an exceedance area for lichen of about 3 km^2 for Bluewaters I and 8 km^2 for Bluewaters II, in the near vicinity of those sources.

Table 3.5a WHO guidelines for SO_2 and vegetation for Europe

Vegetation Category	**Guideline ($\mu g/m^3$)**	**Time Period**
Agricultural Crops	30	Annual and winter mean (6 month winter)
Forests and Natural Vegetation	20	Annual and winter mean (6 month winter)
Lichens	10	Annual Mean

3.2 Carbon monoxide

Eight-hourly-averaged concentrations of CO are considerably lower than the NEPM standard throughout the region (Table 3.6). The contour distributions (Figures B.1 to B.5 in Appendix B) show that the highest concentrations actually occur in the Bluewaters and Collie power station area. This suggests that the annual CO emissions on the NPI website for Muja (Table 2.2) are too low, as it is likely that the highest concentrations actually occur close to Muja power station, as seen for other pollutants in this Report.

Table 3.6 Statistics from the TAPM simulation for 2001 for 8-hourly-averaged concentrations of carbon monoxide ($\mu g\ m^{-3}$) over the innermost modelling domain (22 x 22 km^2).

Scenario	**1**	**2**	**3**	**4**	**5**
Highest	53	74	80	91	49
9^{th}-highest	47	60	69	80	37
NEPM standard	10,400	10,400	10,400	10,400	10,400

3.3 Mercury

Mercury is injurious to human health (renal tubular effects), with the World Health Organisation recommending an annual-averaged concentration of 1 $\mu g\ m^{-3}$ as a recommended upper limit for mercury concentrations in air. The highest annual-averaged concentrations in the region and at Collie township (Table 3.7) are three orders of magnitude smaller than the WHO guideline value. A plot of the regional distribution can be seen in Figures C.1 to C.5 of Appendix C.

Table 3.7 Annual-averaged concentrations of mercury (μg m^{-3}) from the TAPM simulation for 2001, over the innermost modelling domain (22 x 22 km^2) and at Collie township.

Scenario	1	2	3	4	5
Domain-wide	1.9E-05	2.2E-05	4.5E-04	4.5E-04	4.5E-04
Collie township	2.0E-06	3E-06	6.4E-05	6.5E-05	6.2E-05
WHO guideline	1	1	1	1	1

3.4 PAH

Polycyclic aromatic hydrocarbons (PAH) are considered an air toxic and are associated with lung cancer. The WHO guidelines discuss the concentrations of benzo [a} pyrene (BaP) in terms of an excess lifetime cancer risk. For example, lifetime exposure to a BaP concentration of 1.2 ng m^{-3} is 1 in 10,000. Table 3.8 shows that concentrations in the region and at Collie are two to three orders of magnitude smaller than the 1 in 10,000 risk guideline concentration. A plot of the regional distribution can be seen in Figures D.1 to D.5 of Appendix D.

Table 3.8 Annual-averaged concentrations of PAH (μg m^{-3}) from the TAPM simulation for 2001, over the innermost modelling domain (22 x 22 km^2) and at Collie township. The WHO guideline value is the concentration that produces an excess lifetime cancer risk of 1 in 10,000.

Scenario	1	2	3	4	5
Domain-wide	3.7E-06	4.4E-06	6.1E-05	6.1E-05	6.0E-05
Collie township	4E-07	6E-07	4.6E-06	4.8E-06	4.2E-06
WHO guideline	1.2E-03	1.2E-03	1.2E-03	1.2E-03	1.2E-03

3.5 Fluoride

Fluoride damage to vegetation was first recognised during the middle of the nineteenth century. The Australian and New Zealand Environment Council published the National Goals for Fluoride in Ambient Air and Forage in 1990 (ANZEC 1990). For our study, we compare modelled concentrations to the ANZEC maximum acceptable 24-hour average ambient fluoride concentration for General Land Use, a value of 2.9 μg m^{-3}. For Specialised Land Use, taking into account sensitive commercially valuable plants (e.g. grape vines), ANZEC recommend a value of 1.5 μg m^{-3}. For further background information and a discussion of the impact of fluoride emissions on grape vines in the Hunter Valley region, see Taylor et al. (2003).

The highest modelled concentration for all four scenarios (1.7 µg m^{-3} – see Table 3.9) occurs within 2 km of Muja power station (Figures E.1 to E.5 of Appendix E). The highest value in the vicinity of Collie power station and the Bluewaters site is about 0.4 µg m^{-3} (Figure E.4).

Table 3.9 Statistics from the TAPM simulation for 2001 for 24-hourly-averaged concentrations of fluoride (µg m^{-3}) over the innermost modelling domain (22 x 22 km^2).

Scenario	1	2	3	4	5
Highest	0.2	0.2	1.7	1.7	1.7
9th-highest	0.1	0.1	1.3	1.3	1.3
ANZEC goal	2.9	2.9	2.9	2.9	2.9

3.6 Nitrogen dioxide

Table 3.10 shows that the highest hourly-averaged concentration of 100 ppb (associated with Muja power station) is below the NEPM standard of 120 ppb for both proposed scenarios, as is the highest value of 21 ppb at Collie township (Table 3.11). The maximum annual-averaged value is 6 ppb at Muja power station (Table 3.12). The proposed power stations Bluewaters I or I+II do not contribute to any of these values.

The contour plots of the highest, 9th-highest and annual-averaged concentrations in Appendix F illustrate that the largest values occur in the vicinity of Muja power station. They also show that for both scenarios the higher hourly-averaged NO_2 concentrations in the general vicinity of the Collie and Griffin power stations are typically 30-40 ppb, and well below the NEPM standard of 120 ppb, although Bluewaters I+II does combine with Collie A+B to produce concentrations exceeding 70 ppb about 3 km east of Collie power station (Figures F.4 and F.5.

Table 3.10 Statistics from the TAPM simulation for 2001 for hourly-averaged concentrations of nitrogen dioxide (ppb) over the innermost modelling domain (22 x 22 km^2).

Scenario	3	4	5
Highest	100	100	100
9^{th}-highest	54	54	54
NEPM standard	120	120	120
Exceedance days	0	0	0

Table 3.11 Statistics from the TAPM simulation for 2001 for hourly-averaged concentrations of nitrogen dioxide (ppb) at the Collie township.

Scenario	3	4	5
Highest	24	24	24
9^{th}-highest	21	21	21
NEPM standard	120	120	120
Exceedance days	0	0	0

Table 3.12 Annual-averaged concentrations of nitrogen dioxide (ppb) from the TAPM simulation for 2001, over the innermost modelling domain (22 x 22 km^2) and at Collie township.

Scenario	3	4	5
Domain-wide	6	6	6
Collie township	1	1	1
NEPM standard	30	30	30

3.7 Ozone

Ozone forms from the precursor gases NO_x and VOCs under warm temperatures and in the presence of sunlight. Formation takes a few hours, and continues as long as there is sunlight and NO_x, and in this time the air mass can travel far from the precursor source. For this reason, we have chosen to examine concentration statistics and plot contours over the 5-km spaced grid, covering an area of 220 x 220 km^2, one hundred times larger than the area of the innermost 0.5 km-spaced grid. Comparison of ozone concentrations on the sub-region of the 5-km grid that corresponds to the 0.5 km grid shows that there is negligible difference (up to 2 ppb) between the ozone values for the two different grid spacings.

The statistics for hourly-averaged and 4-hourly-averaged ozone concentrations for the region and at Collie township are tabulated in Tables 3.13 to 3.16. A striking feature is the narrow range of concentrations. This occurs because the VOC sources (vegetation and a general background source) are spread evenly throughout the region, and are not large. The contour distribution in the plots of Appendix G suggests that the background plus natural emissions (VOC, NO_x) may be responsible for up to 40 ppb of ozone and that the additional NO_x from the power stations may contribute up to 12 ppb.
The maximum hourly-averaged concentration (53 ppb) is the same for each scenario and occurs within a broad band of concentrations over 50 ppb stretching for 100 km to the north of the power stations (see plots in Appendix G). Concentrations are well below NEPM standards, with only three ppb difference between the hourly and 4-hourly maximum. Comparison with the plots from scenario 5 in Appendix G shows that the addition of extra NO_x from either of the proposed Bluewaters stations has a negligible effect on ozone concentrations.

Table 3.13 Statistics from the TAPM simulation for 2001 for hourly-averaged concentrations of ozone (ppb) over the 5-km spaced modelling domain (220 x 220 km^2).

Scenario	3	4	5
Highest	53	53	53
9th-highest	47	47	47
NEPM standard	100	100	100
Exceedance days	0	0	0

Table 3.14 Statistics from the TAPM simulation for 2001 for hourly-averaged concentrations of ozone (ppb) at the Collie township.

Scenario	3	4	5
Highest	47	48	47
9th-highest	42	42	42
NEPM standard	100	100	100
Exceedance days	0	0	0

Table 3.15 Statistics from the TAPM simulation for 2001 for 4-hourly-averaged concentrations of ozone (ppb) over the 5-km spaced modelling domain 220 x 220 km^2).

Scenario	3	4	5
Highest	50	50	50
9^{th}-highest	46	46	46
NEPM standard	80	80	80
Exceedance days	0	0	0

Table 3.16 Statistics from the TAPM simulation for 2001 for 4-hourly-averaged concentrations of ozone (ppb) at the Collie township.

Scenario	3	4	5
Highest	47	47	47
9^{th}-highest	40	40	40
NEPM standard	80	80	80
Exceedance days	0	0	0

3.8 PM_{10}

Total PM_{10} emissions from the Muja power station are 50-100 times larger than those from the proposed Griffin power stations, and 75 times larger than those from Collie A or B. Hence, it is to be expected that there will be negligible difference between the higher concentrations from the two scenarios and this is borne out in Table 3.17. The contour plots in Appendix H show that the highest PM_{10} concentration in the vicinity of the Griffin and the Collie power stations is between 10 and 20 $\mu g\ m^{-3}$ for each scenario.

The highest regional concentration of 106 $\mu g\ m^{-3}$ easily exceeds the NEPM standard for a 24-hour average of 50 $\mu g\ m^{-3}$ and occurs within 2 kms of the Muja power station. Exceedances are found out to a distance of about 6 km from the source (Figures H.1 and H.2). At the Collie township, highest concentrations are at levels that are less than half of the NEPM standard (Table 3.18).

Table 3.17 Statistics from the TAPM simulation for 2001 for 24-hourly-averaged concentrations of PM_{10} ($\mu g\ m^{-3}$) over the innermost modelling domain (22 x 22 km^2).

Scenario	3	4	5
Highest	106	106	106
9th-highest	80	80	80
NEPM standard	50	50	50
Exceedance days	141	141	141

Table 3.18 Statistics from the TAPM simulation for 2001 for 24-hourly-averaged concentrations of PM_{10} ($\mu g\ m^{-3}$) at the Collie township.

Scenario	3	4	5
Highest	21	21	21
9th-highest	11	11	11
NEPM standard	50	50	50
Exceedance days	0	0	0

4 Summary

4.1 Sulfur dioxide

The following findings arise from an examination of the highest concentrations over a 12-month period for the four emissions scenarios.

- Scenario 1 (proposed 200 MW Bluewaters I power station in isolation) produced *hourly-averaged* concentrations below the NEPM standard at all times.
- Scenario 2 (proposed 2 x 200 MW Bluewaters I + II power station in isolation), produced *hourly-averaged* concentrations below the NEPM standard on all days except one.
- For scenario 3 (sources Muja A, B, C and D, Collie, Collie expansion (identical to Collie), Worsley and Bluewaters I), there were exceedances of the NEPM standard for hourly-averaged concentrations on 27 days, associated with both Collie and Muja power stations (Figure A.3).
- For scenario 4 (scenario 3 sources plus Bluewaters II), there were also 27 exceedance days. Comparison with scenario 5 (sources Muja A, B, C and D, Collie, Collie expansion, and Worsley) shows that the proposed sources do not lead to any additional exceedance days.

For 24-hour averaged concentrations of SO_2 (Figures A.11 to A.15), only one exceedance occurred for scenarios 3 and 4.

For annual-averaged concentrations (Figures A.16 to A.20), the NEPM limit was exceeded for scenarios 3 and 4, though with no contribution from the proposed Bluewaters sources.

For all scenarios, NEPM standards were not exceeded at Collie township for any of the averaging periods.

4.2 Carbon monoxide, mercury, PAH and fluoride

Concentrations of carbon monoxide (Appendix B) were well below the NEPM 8-hourly-averaged concentration standard, while annual- averaged concentrations of mercury (Appendix C) and PAH (Appendix D) were orders of magnitude smaller than WHO guidelines for the protection of human health. 24-hourly-averaged fluoride concentrations (Appendix E) were below the ANZEC goals for vegetation relating to General Land Use.

4.3 Nitrogen dioxide, ozone and particulate matter

NO_x emissions in the Collie region are dominated by those from the Muja power station (six times larger than those of Collie or Griffin power stations). Consequently, the largest concentrations of NO_2 are associated with Muja (see plots in Appendix F), though the highest hourly- and annual-averaged concentrations predicted by TAPM are below the NEPM standard.

Maximum ozone concentrations are often found far from the sources of the precursor gases, and for this reason ozone statistics were examined over a larger region (220 x 220 km^2) than for the other pollutants. Highest concentrations predicted were 53 ppb for hourly-averaged and 50 ppb for four-hourly-averaged ozone (Appendix G), well below the NEPM standards of 100 ppb and 80 ppb respectively. The major component of these concentrations could be attributed to background ozone and precursor emissions from natural sources (soil, vegetation). There is no difference in the concentration statistics from scenarios 3 and 4, suggesting that NO_x emissions from the proposed station would have no effect on the higher regional ozone concentrations.

Regional PM_{10} levels (highest 24-hour concentration of 106 µg m^{-3}) are well above the NEPM standard (50 µg m^{-3}) for as far as 6 km from Muja power station, but are well below the standard near Collie and Bluewaters stations (Appendix H). The higher concentrations are not affected by additional emissions from the Bluewaters sources and highest concentrations at the Collie township are less than half of the NEPM standard.

In summary, the TAPM modelling shows that emissions from both the proposed 200 MW and 2 x 200 MW power station do not lead to an increase in the number of days on which the NEPM standard for hourly-averaged SO_2 is exceeded. This is under a scenario that includes the existing Muja, Collie and Worsley power stations plus an expansion of the Collie station.

Acknowledgments

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Appendix A Contour plots for TAPM SO_2 concentrations

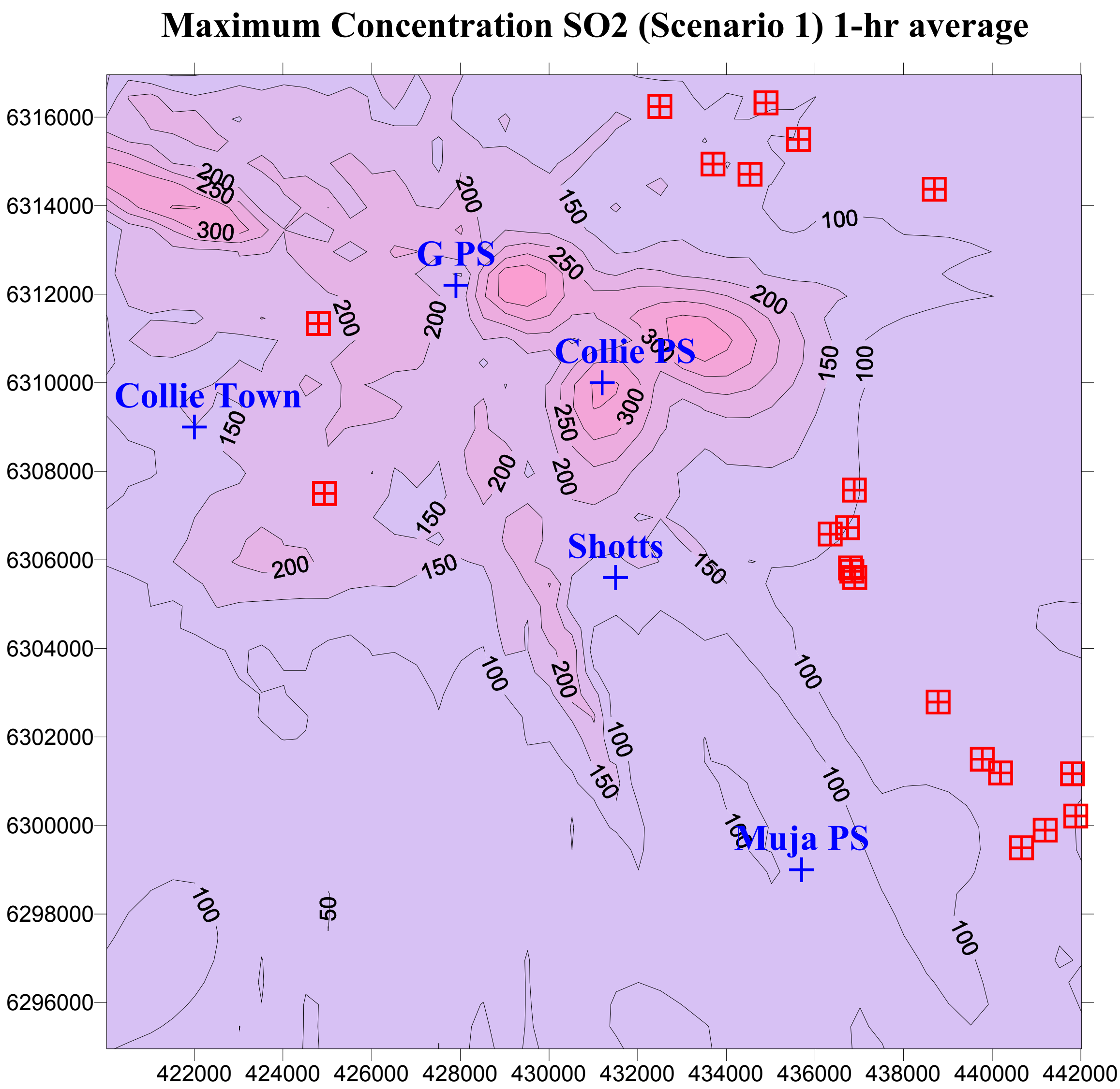

Figure A.1 For Scenario 1 (Bluewaters I), contours of *highest* hourly-averaged concentration of SO_2 ($\mu g\ m^{-3}$) modelled by TAPM for 2001. Red window symbol denotes buildings. G PS denotes the location of the proposed Griffin station at Bluewaters.

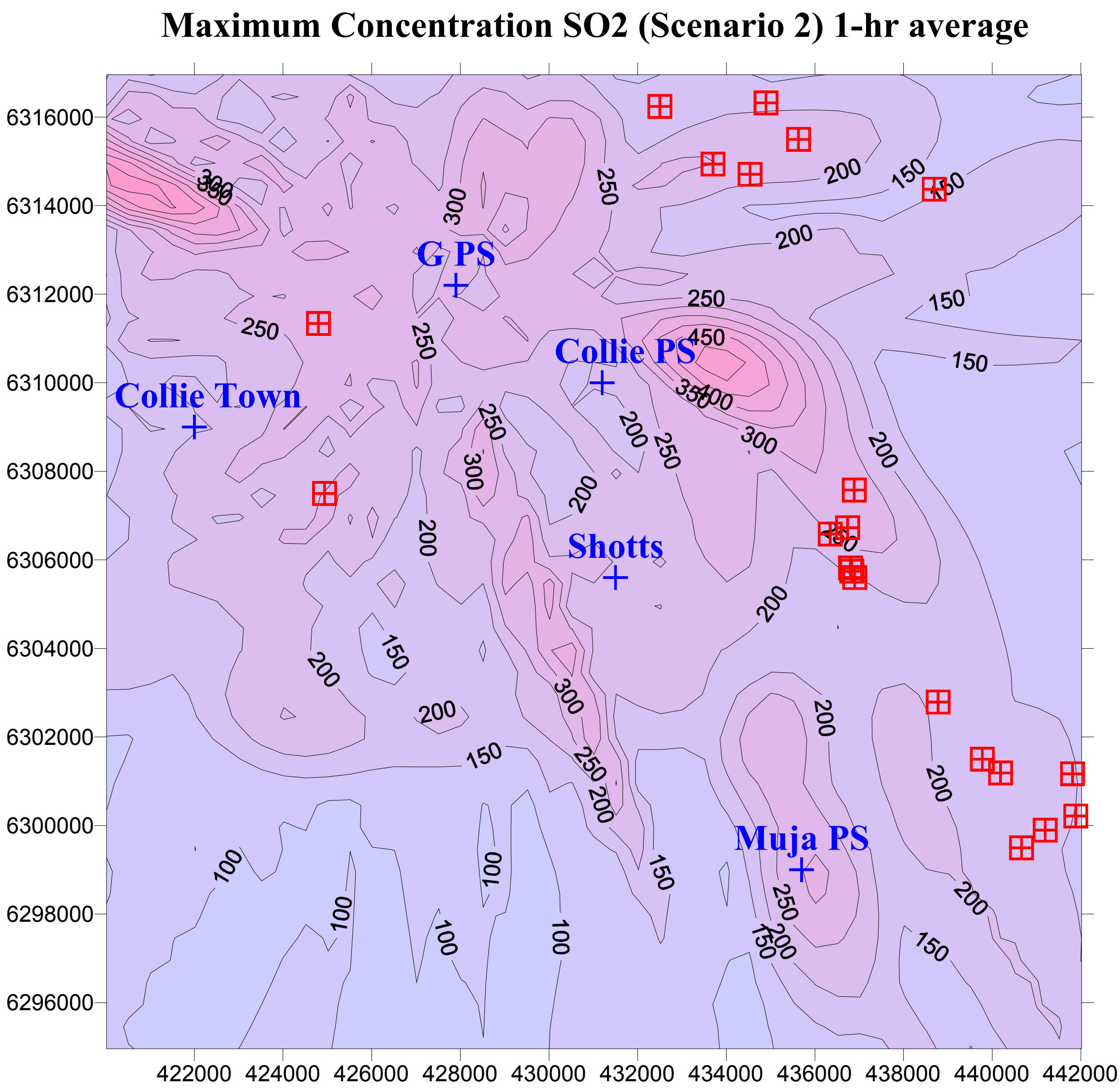

Figure A.2 For Scenario 2 (Bluewaters I + II), contours of *highest* hourly-averaged concentration of SO_2 ($\mu g\ m^{-3}$) modelled by TAPM for 2001. Red window symbol denotes buildings. G PS denotes the location of the proposed Griffin station at Bluewaters.

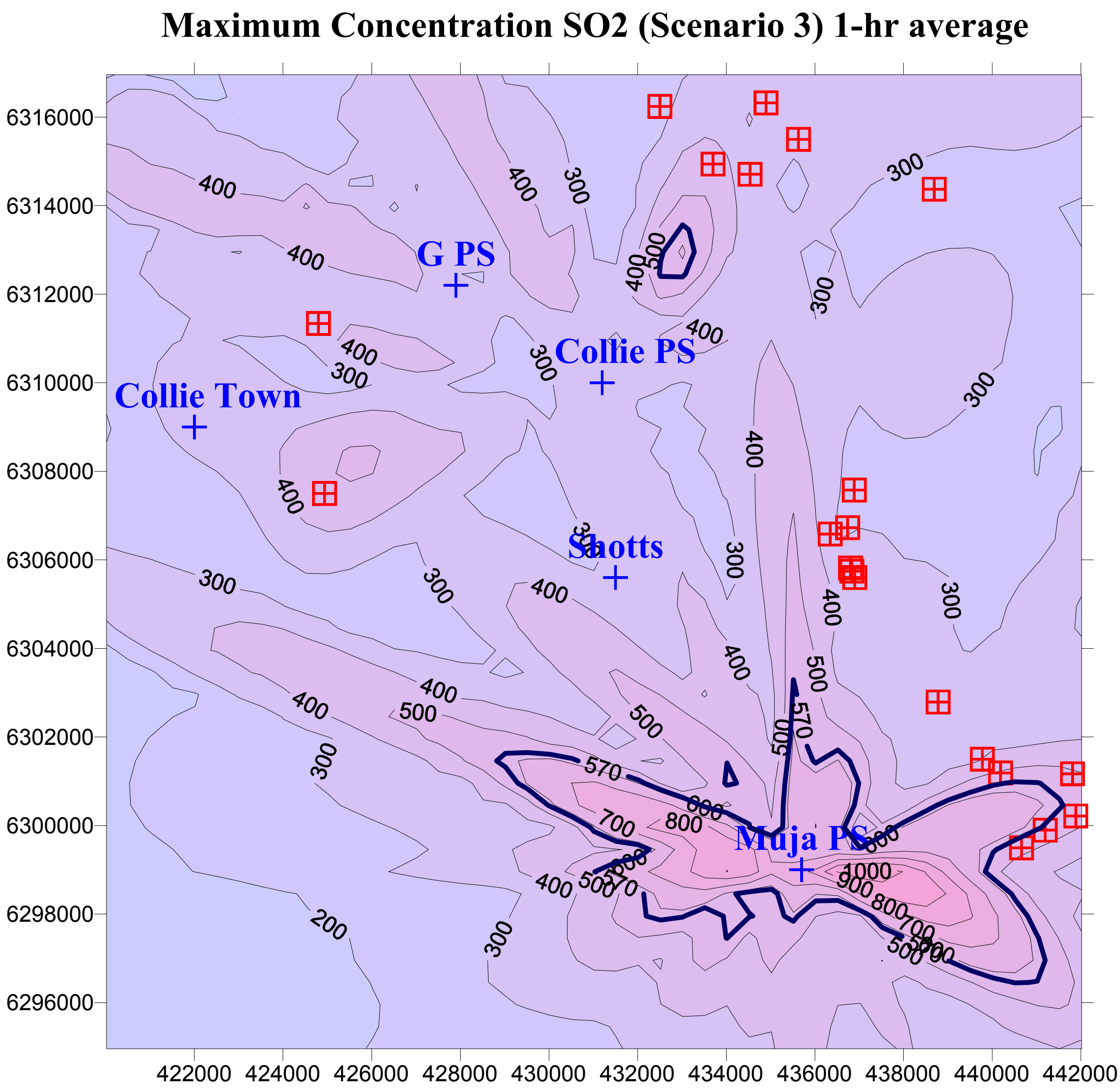

Figure A.3 For Scenario 3 (Muja A B, Muja C, D, Collie A, B, Worsley and Bluewaters I), contours of *highest* hourly-averaged concentration of SO_2 (μg m^{-3}) modelled by TAPM for 2001. Thick contour denotes NEPM standard (570 μg m^{-3}), red window symbol denotes buildings. G PS denotes the location of the proposed Griffin station at Bluewaters.

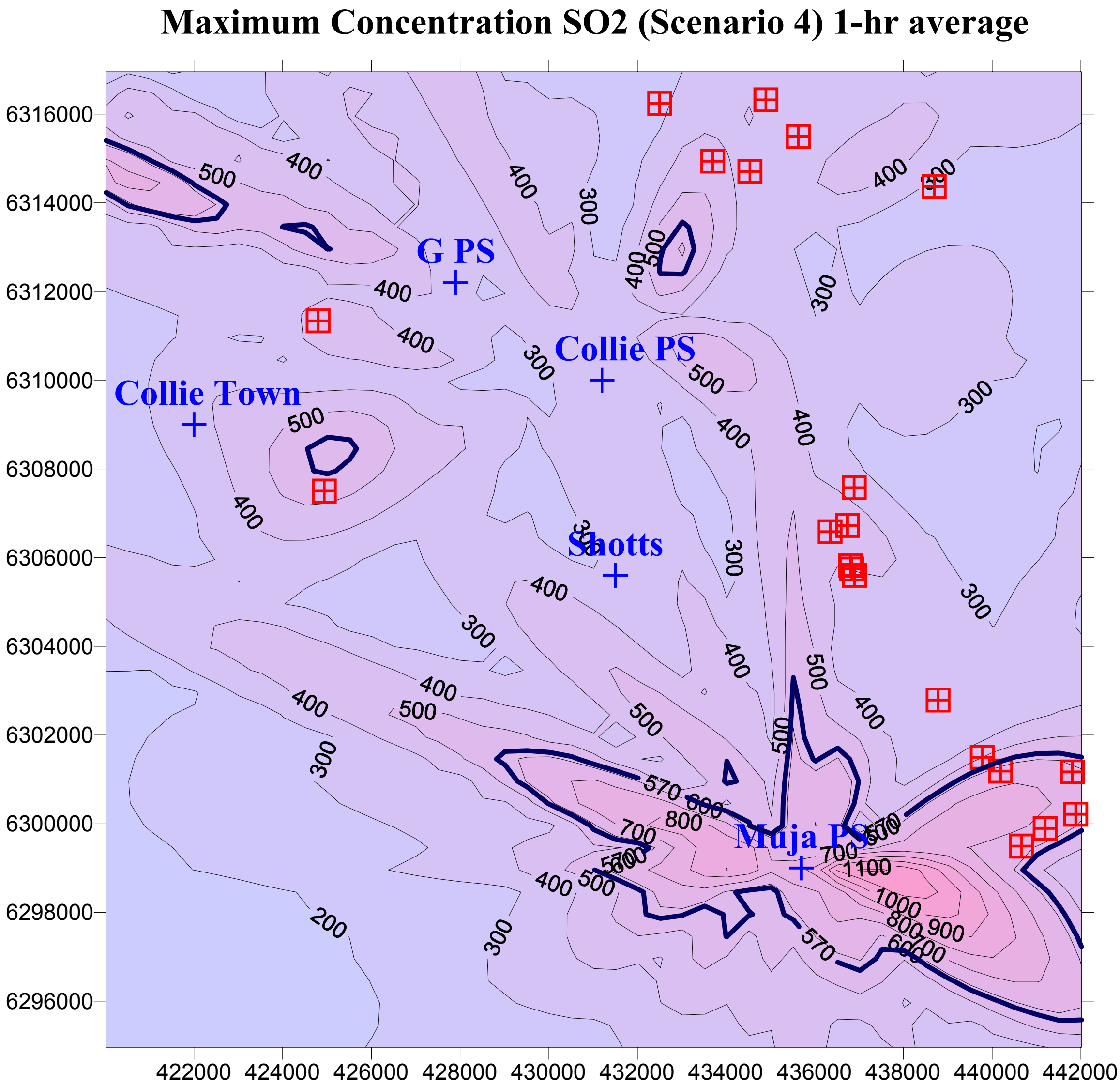

Figure A.4 For Scenario 4 (Muja A B, Muja C, D, Collie A, B, Worsley, and Bluewaters I + II), contours of *highest* hourly-averaged concentration of SO_2 ($\mu g\ m^{-3}$) modelled by TAPM for 2001. Thick contour denotes NEPM standard (570 $\mu g\ m^{-3}$), red window symbol denotes buildings. G PS denotes the location of the proposed Griffin station at Bluewaters.

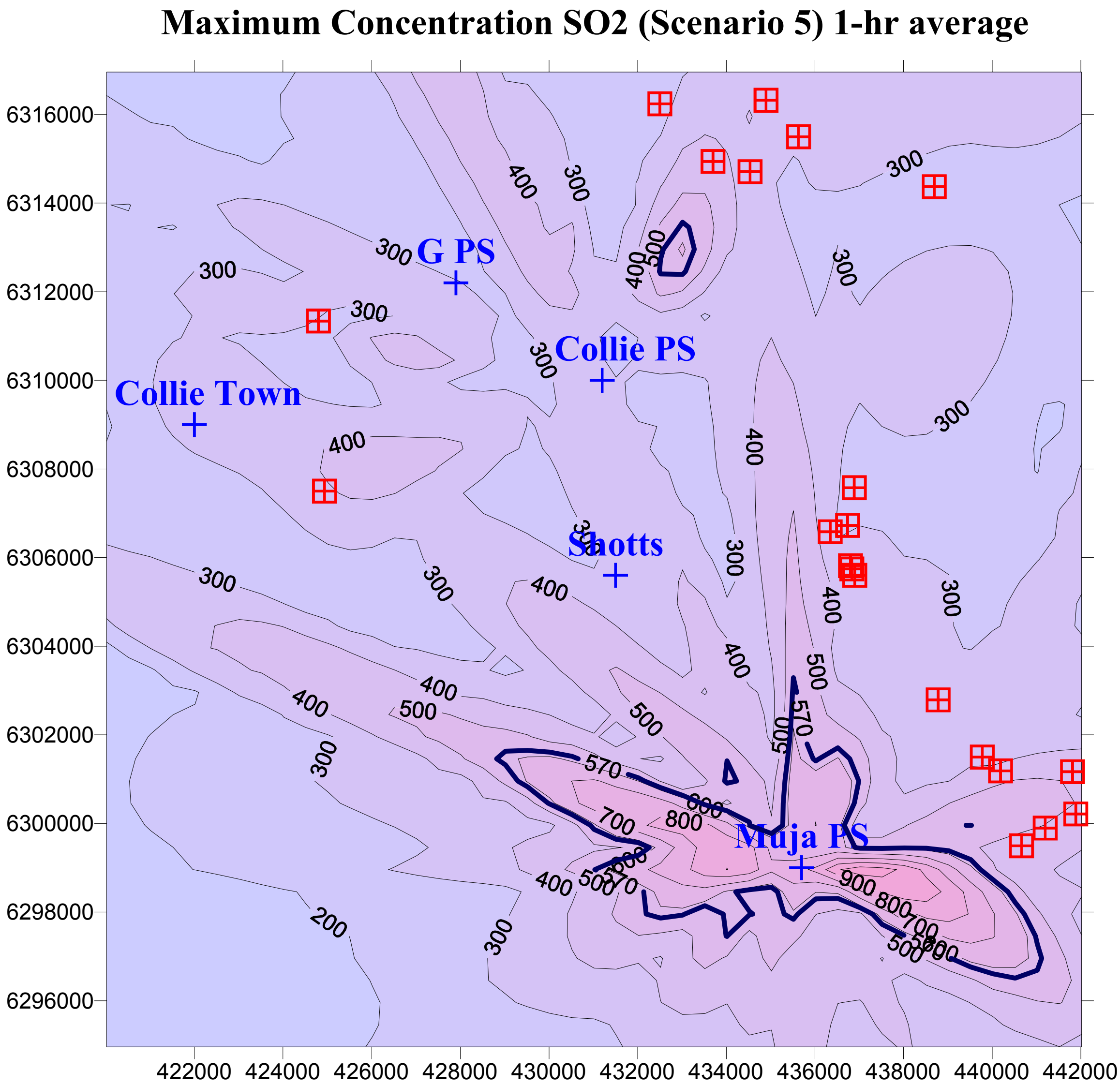

Figure A.5 For Scenario 5 (Muja A B, Muja C, D, Collie A, B, and Worsley), contours of *highest* hourly-averaged concentration of SO_2 (μg m^{-3}) modelled by TAPM for 2001. Thick contour denotes NEPM standard (570 μg m^{-3}), red window symbol denotes buildings. G PS denotes the location of the proposed Griffin station at Bluewaters.

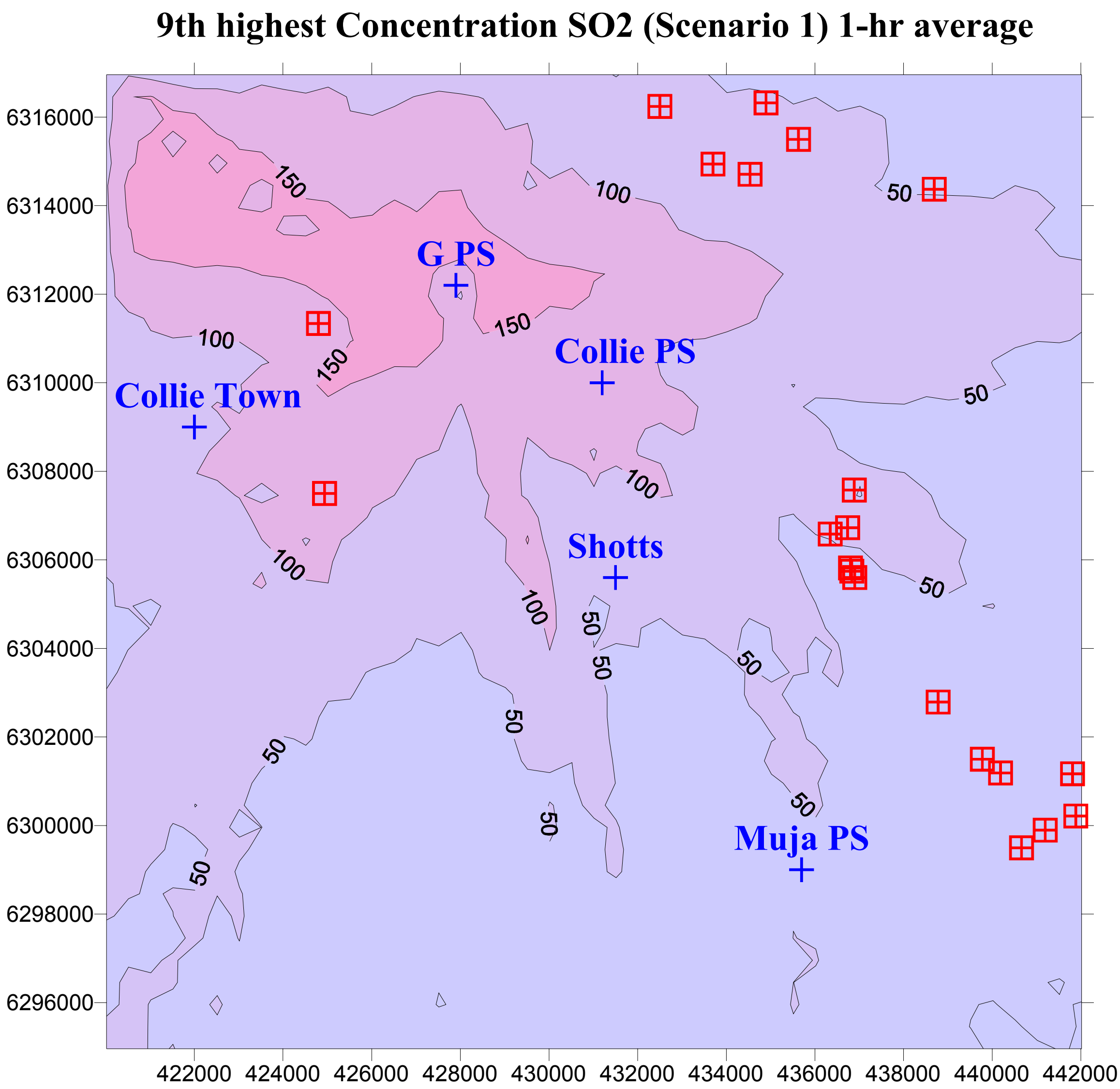

Figure A.6 For Scenario 1 (Bluewaters I), contours of *9th-highest* hourly-averaged concentration of SO_2 ($\mu g\ m^{-3}$) modelled by TAPM for 2001. Red window symbol denotes buildings. G PS denotes the location of the proposed Griffin station at Bluewaters.

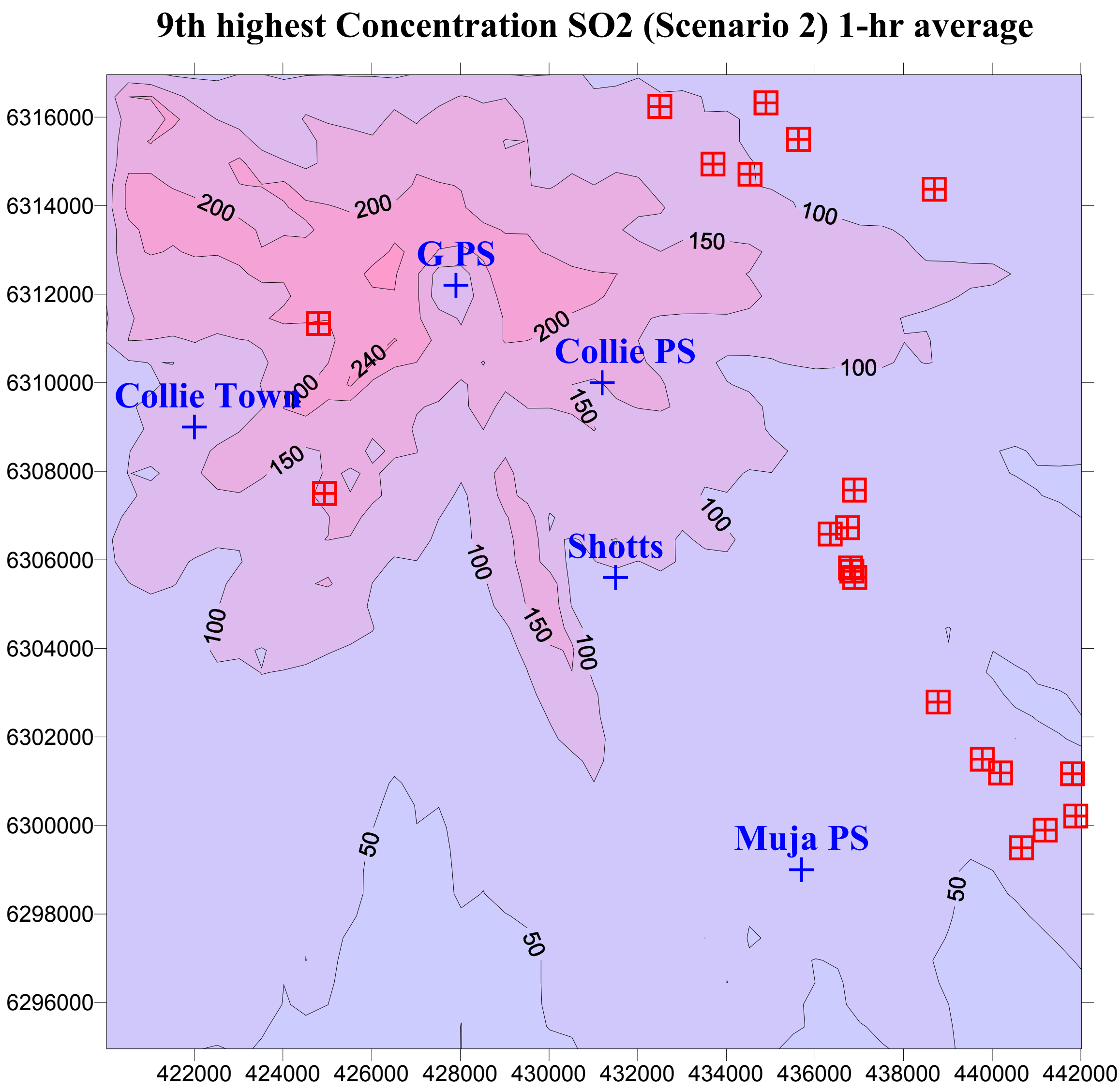

Figure A.7 For Scenario 2 (Bluewaters I + II), contours of *9th-highest* hourly-averaged concentration of SO_2 ($\mu g\ m^{-3}$) modelled by TAPM for 2001. Red window symbol denotes buildings. G PS denotes the location of the proposed Griffin station at Bluewaters.

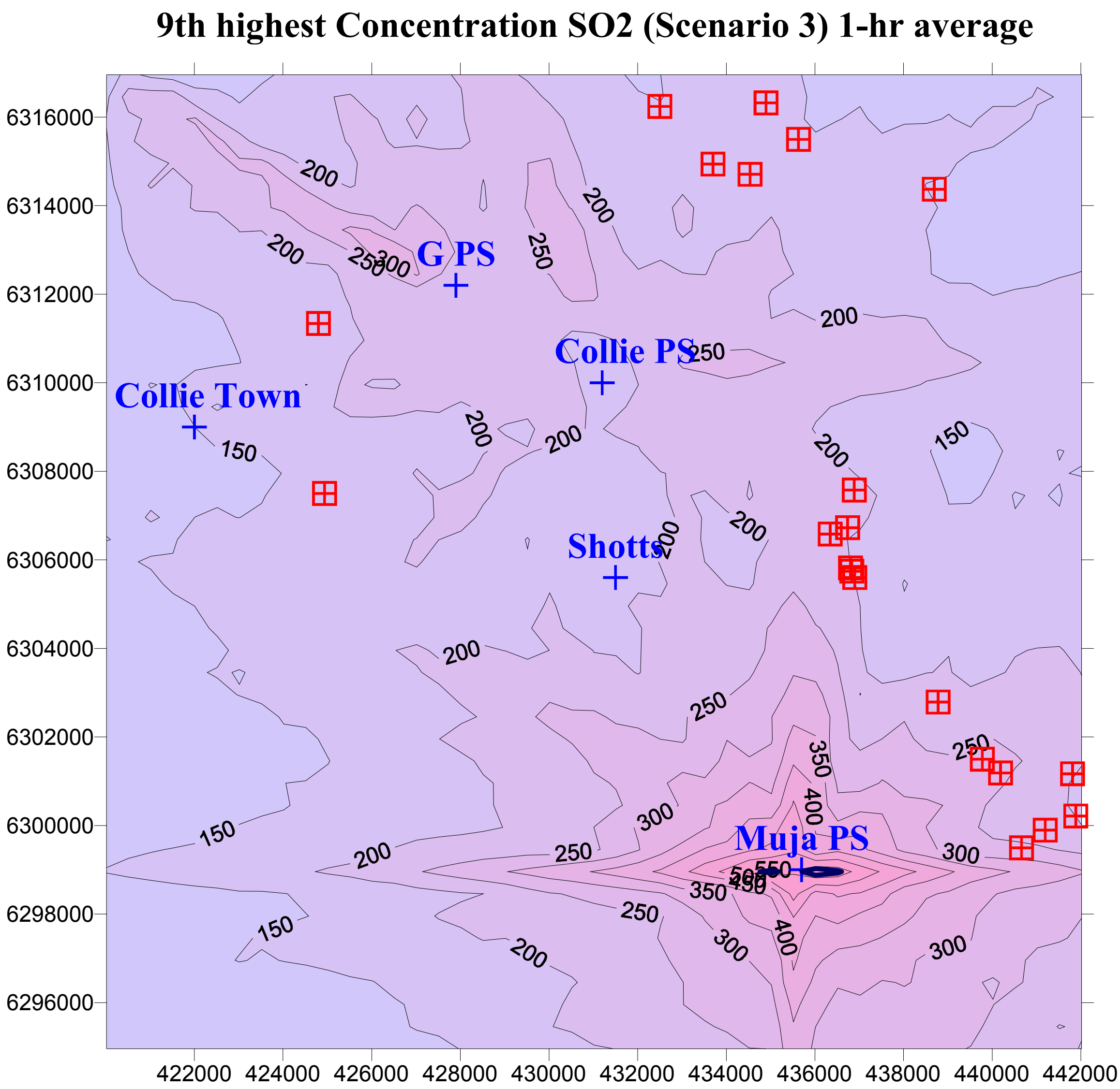

Figure A.8 For Scenario 3 (Muja A B, Muja C, D, Collie A, B, Worsley and Bluewaters I), contours of *9th-highest* hourly-averaged concentration of SO_2 ($\mu g\ m^{-3}$) modelled by TAPM for 2001. Thick contour denotes NEPM standard (570 $\mu g\ m^{-3}$), red window symbol denotes buildings. G PS denotes the location of the proposed Griffin station at Bluewaters.

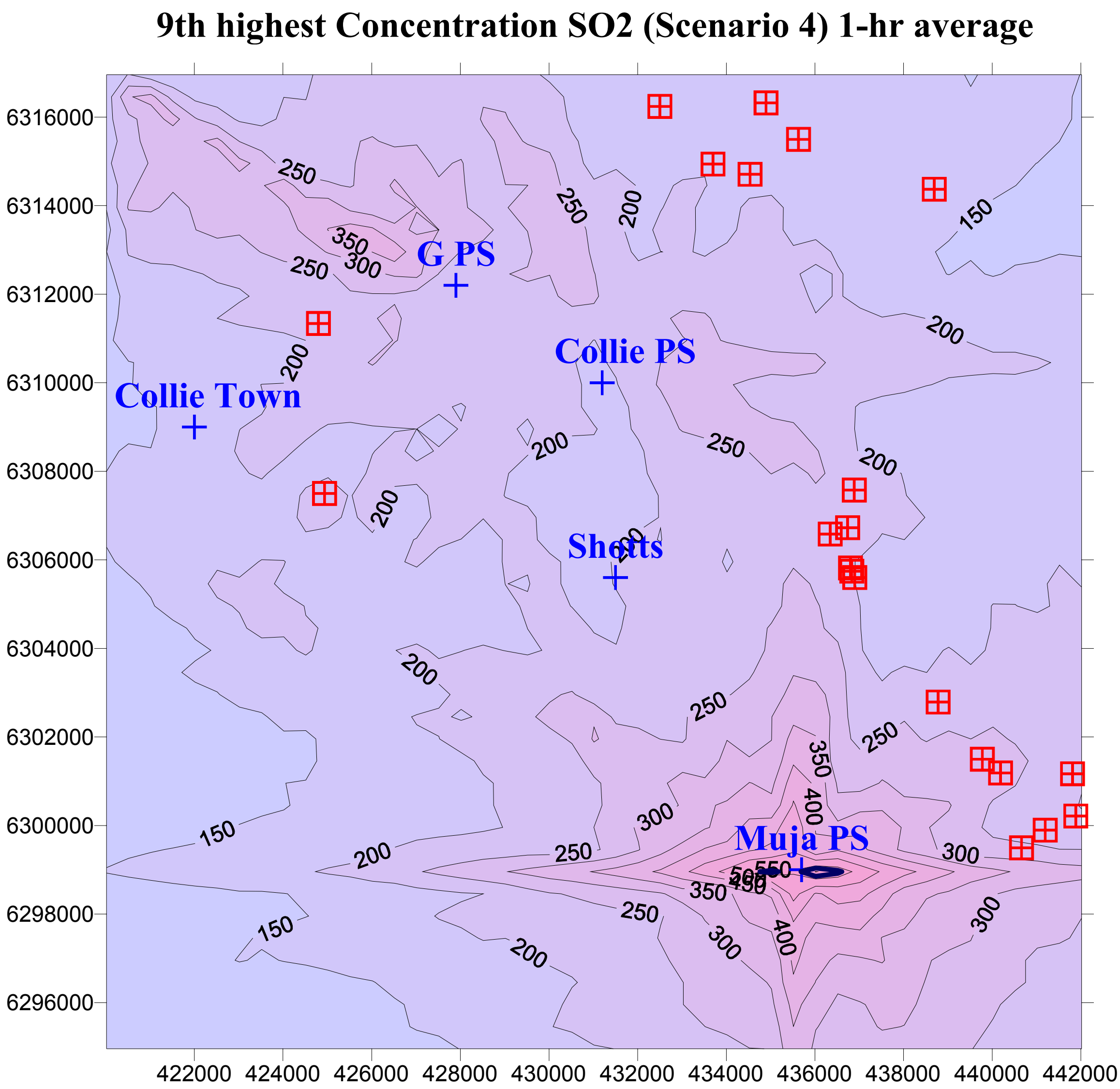

Figure A.9 For Scenario 4 (Muja A B, Muja C, D, Collie A, B, Worsley, and Bluewaters I + II), contours of *9^th^-highest* hourly-averaged concentration of SO_2 ($\mu g\ m^{-3}$) modelled by TAPM for 2001. Thick contour denotes NEPM standard (570 $\mu g\ m^{-3}$), red window symbol denotes buildings. G PS denotes the location of the proposed Griffin station at Bluewaters.

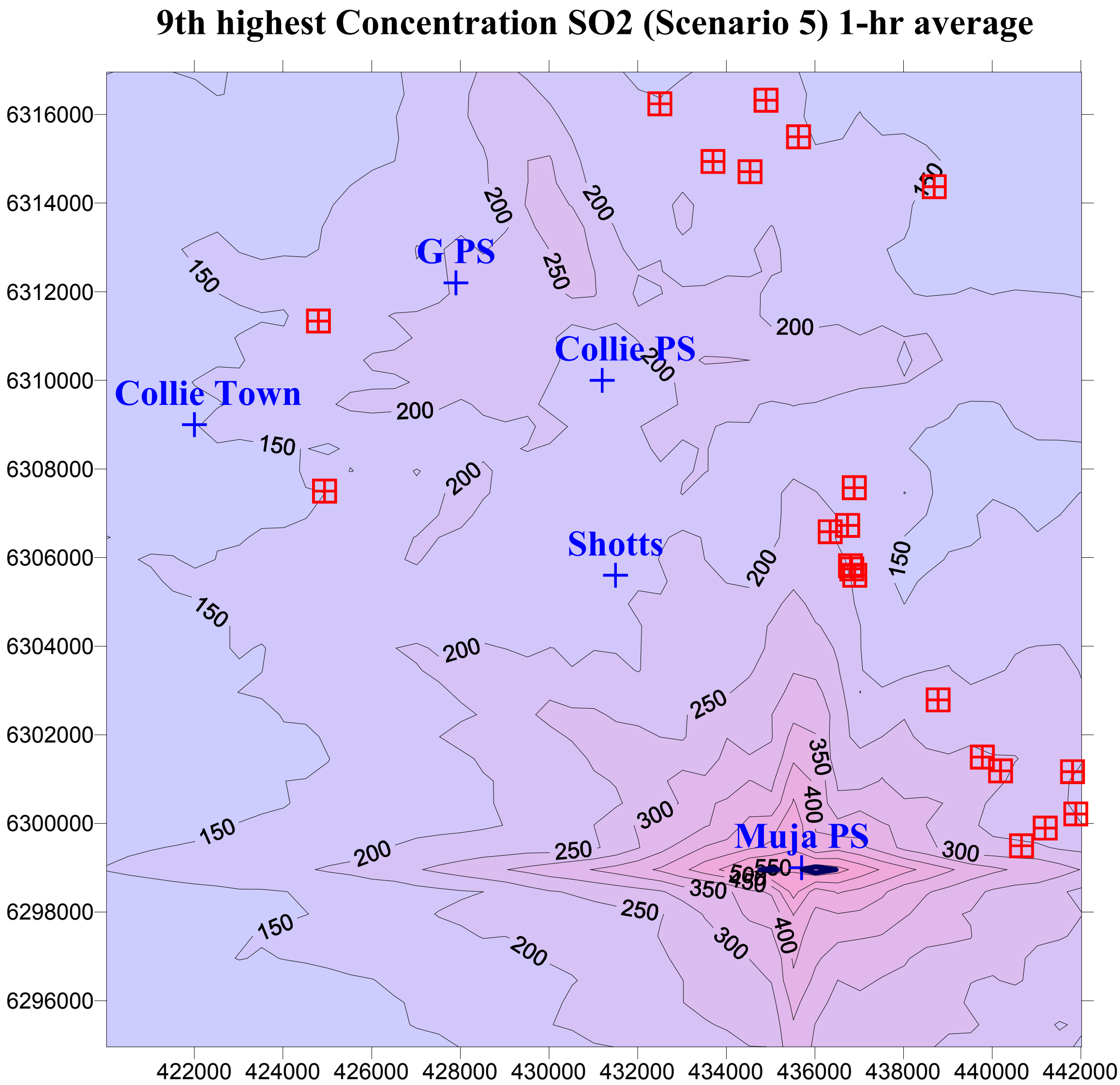

Figure A.10 For Scenario 5 (Muja A B, Muja C, D, Collie A, B, and Worsley), contours of *9th-highest* hourly-averaged concentration of SO_2 ($\mu g\ m^{-3}$) modelled by TAPM for 2001. Thick contour denotes NEPM standard (570 $\mu g\ m^{-3}$), red window symbol denotes buildings. G PS denotes the location of the proposed Griffin station at Bluewaters.

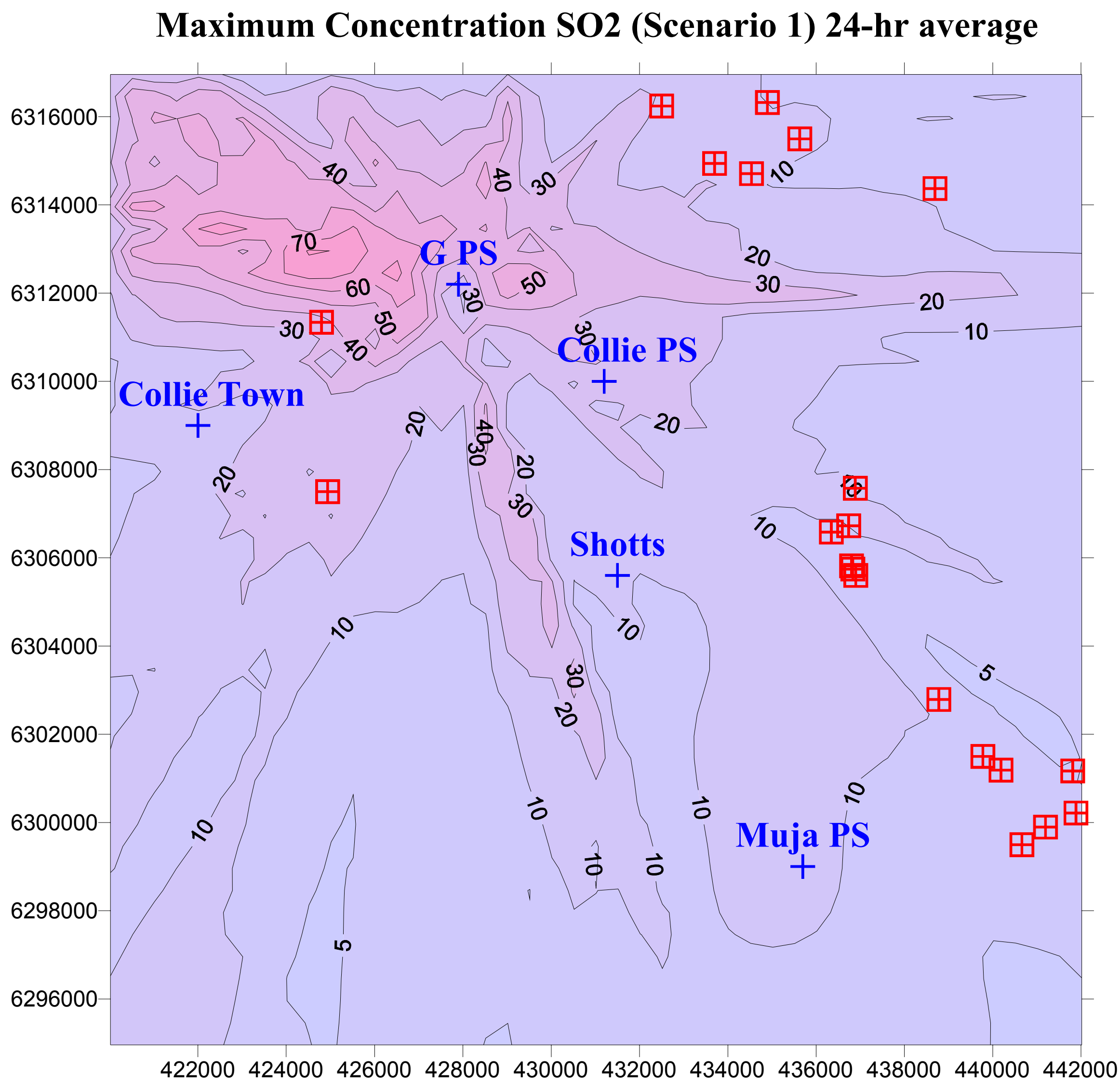

Figure A.11 For Scenario 1 (Bluewaters I), contours of *highest* 24-hour-averaged concentration of SO_2 ($\mu g\ m^{-3}$) modelled by TAPM for 2001. Red window symbol denotes buildings. G PS denotes the location of the proposed Griffin station at Bluewaters.

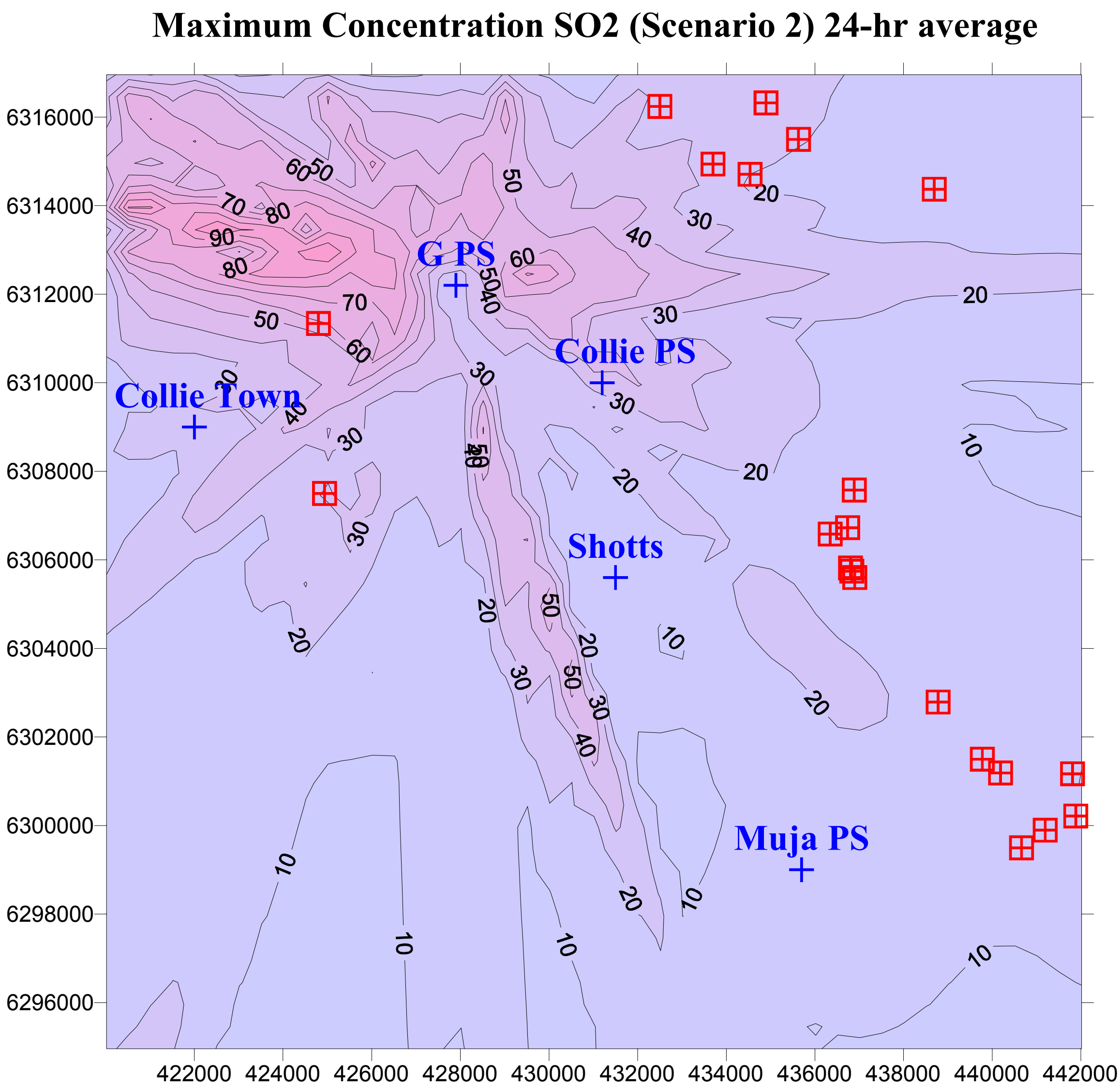

Figure A.12 For Scenario 2 (Bluewaters I + II), contours of *highest* 24-hour-averaged concentration of SO_2 ($\mu g\ m^{-3}$) modelled by TAPM for 2001. Red window symbol denotes buildings. G PS denotes the location of the proposed Griffin station at Bluewaters.

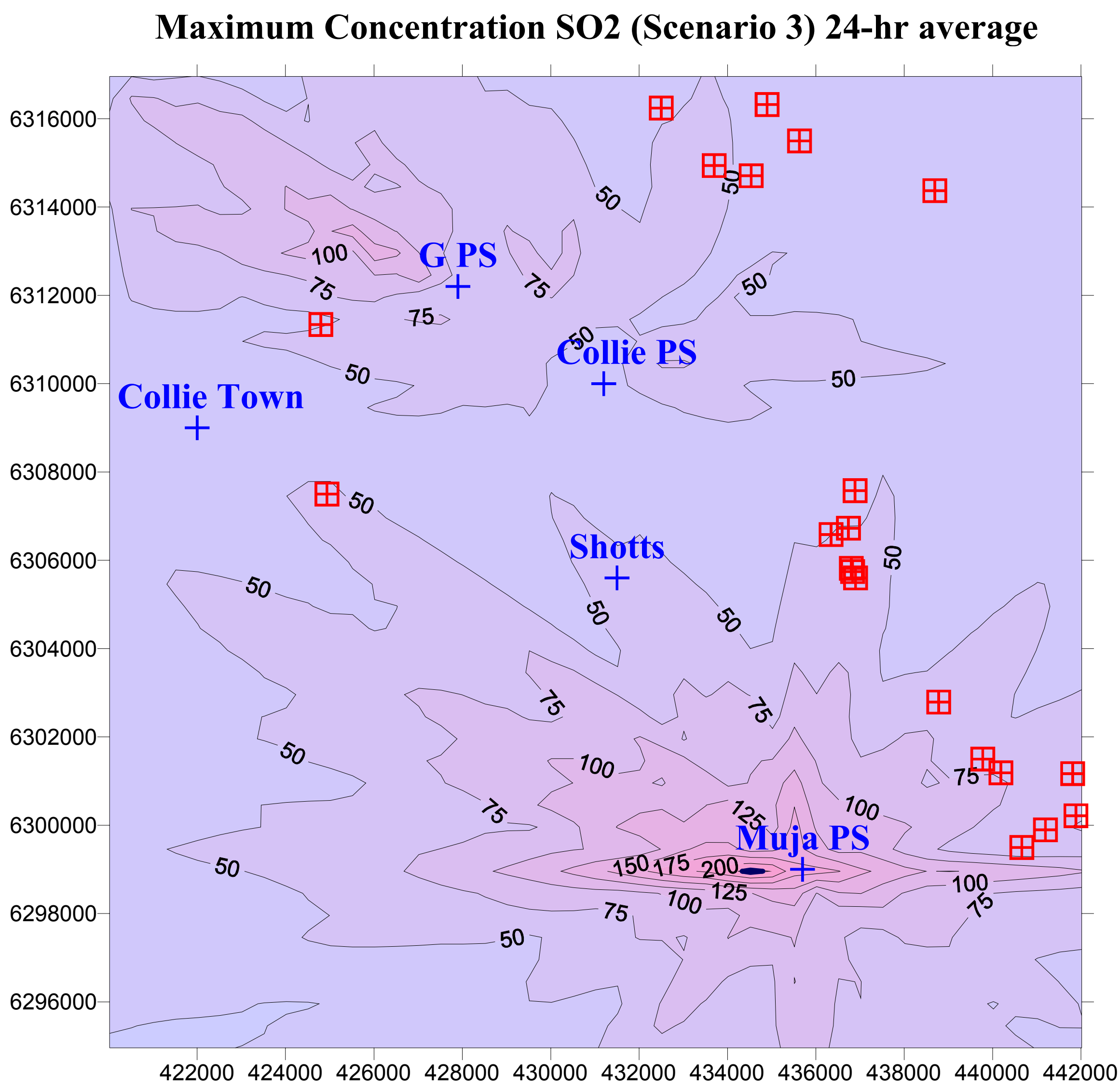

Figure A.13 For Scenario 3 (Muja A B, Muja C, D, Collie A, B, Worsley and Bluewaters I), contours of *highest* 24-hour-averaged concentration of SO_2 ($\mu g\ m^{-3}$) modelled by TAPM for 2001. Thick contour denotes NEPM standard (228 $\mu g\ m^{-3}$), red window symbol denotes buildings. G PS denotes the location of the proposed Griffin station at Bluewaters.

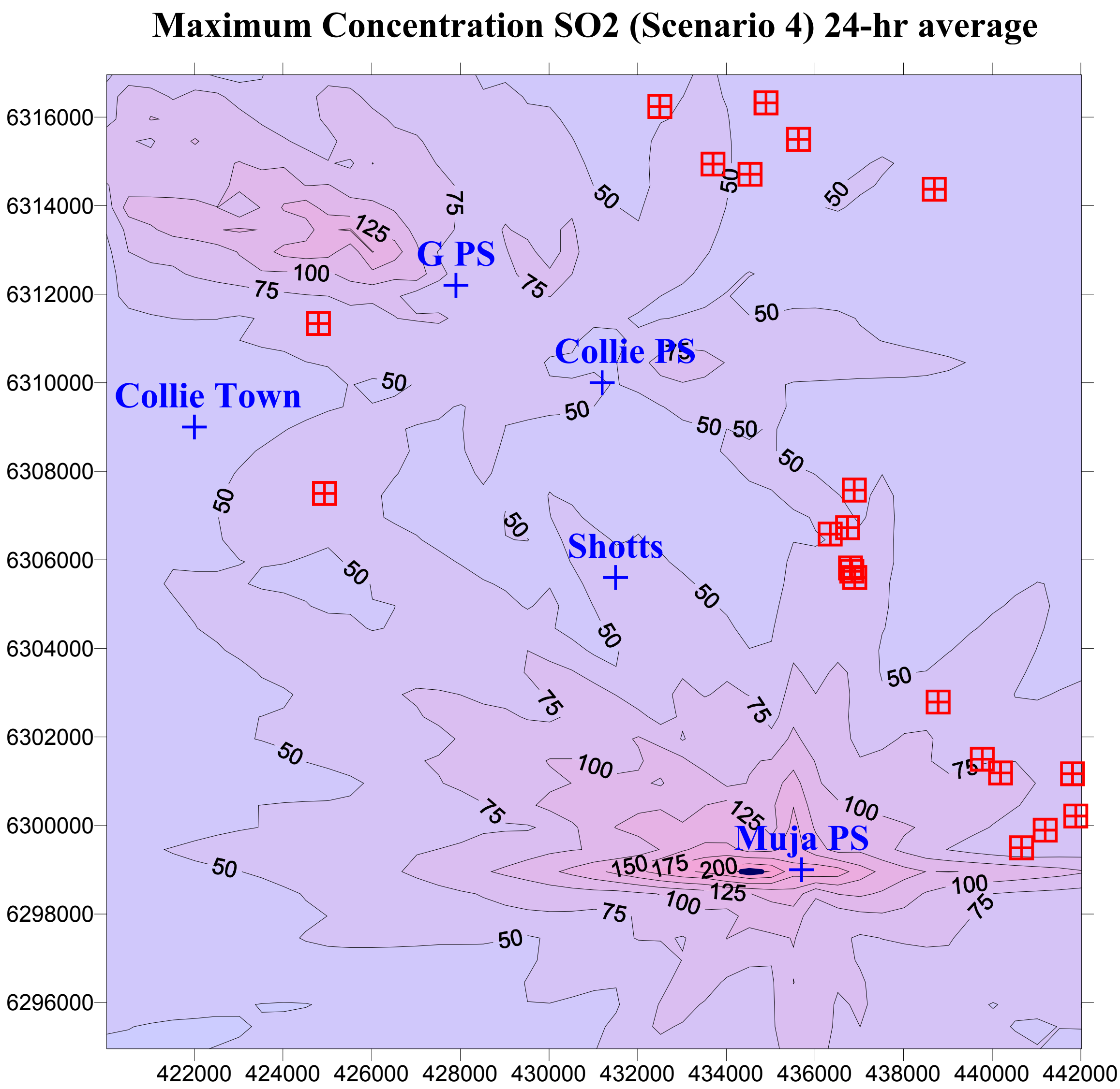

Figure A.14 For Scenario 4 (Muja A B, Muja C, D, Collie A, B, Worsley, and Bluewaters I + II), contours of *highest* 24-hour-averaged concentration of SO_2 ($\mu g\ m^{-3}$) modelled by TAPM for 2001. Thick contour denotes NEPM standard (228 $\mu g\ m^{-3}$), red window symbol denotes buildings. G PS denotes the location of the proposed Griffin station at Bluewaters.

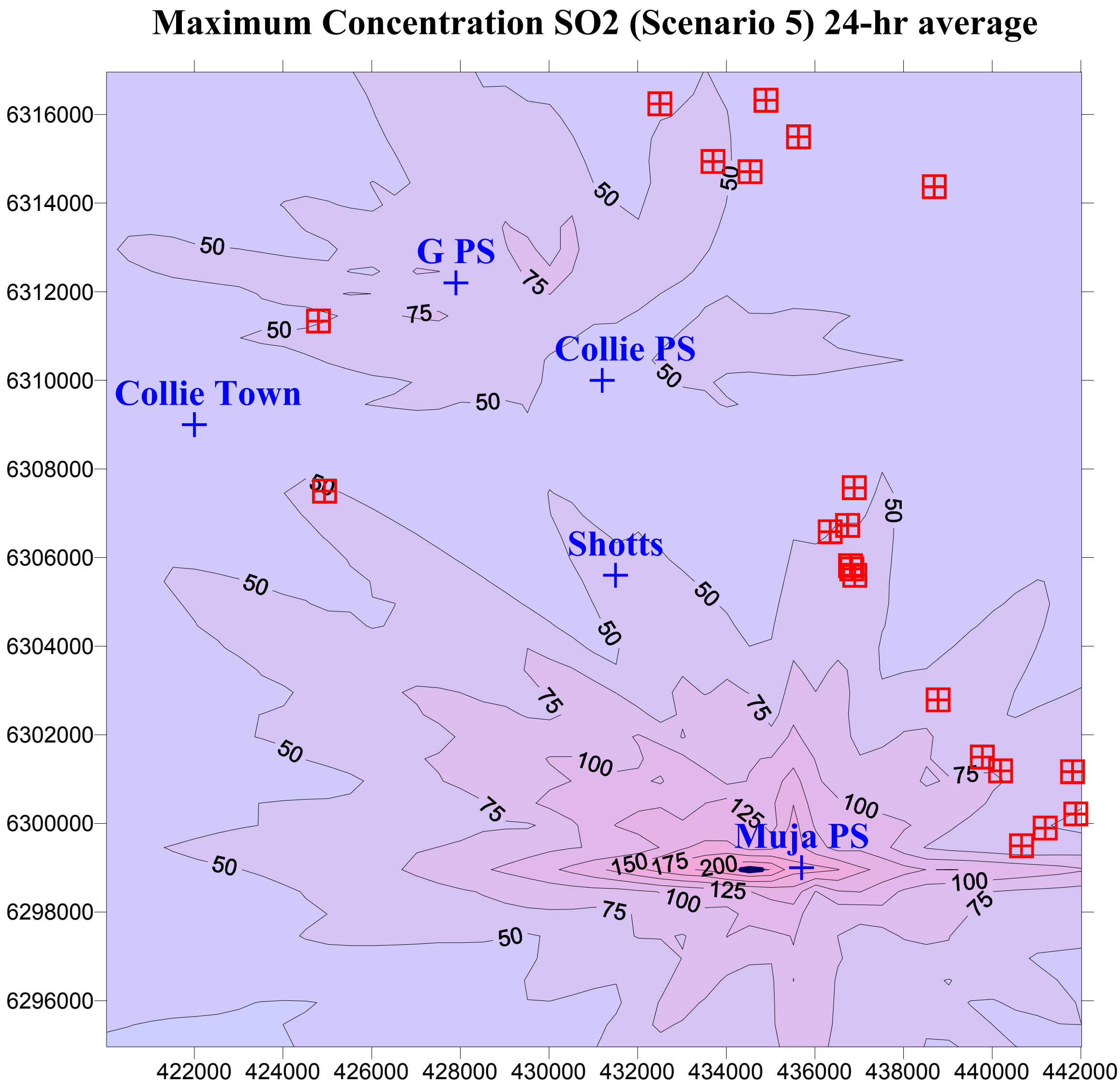

Figure A.15 For Scenario 5 (Muja A B, Muja C, D, Collie A, B, and Worsley), contours of *highest* 24-hour-averaged concentration of SO_2 (μg m^{-3}) modelled by TAPM for 2001. Thick contour denotes NEPM standard (228 μg m^{-3}), red window symbol denotes buildings. G PS denotes the location of the proposed Griffin station at Bluewaters.

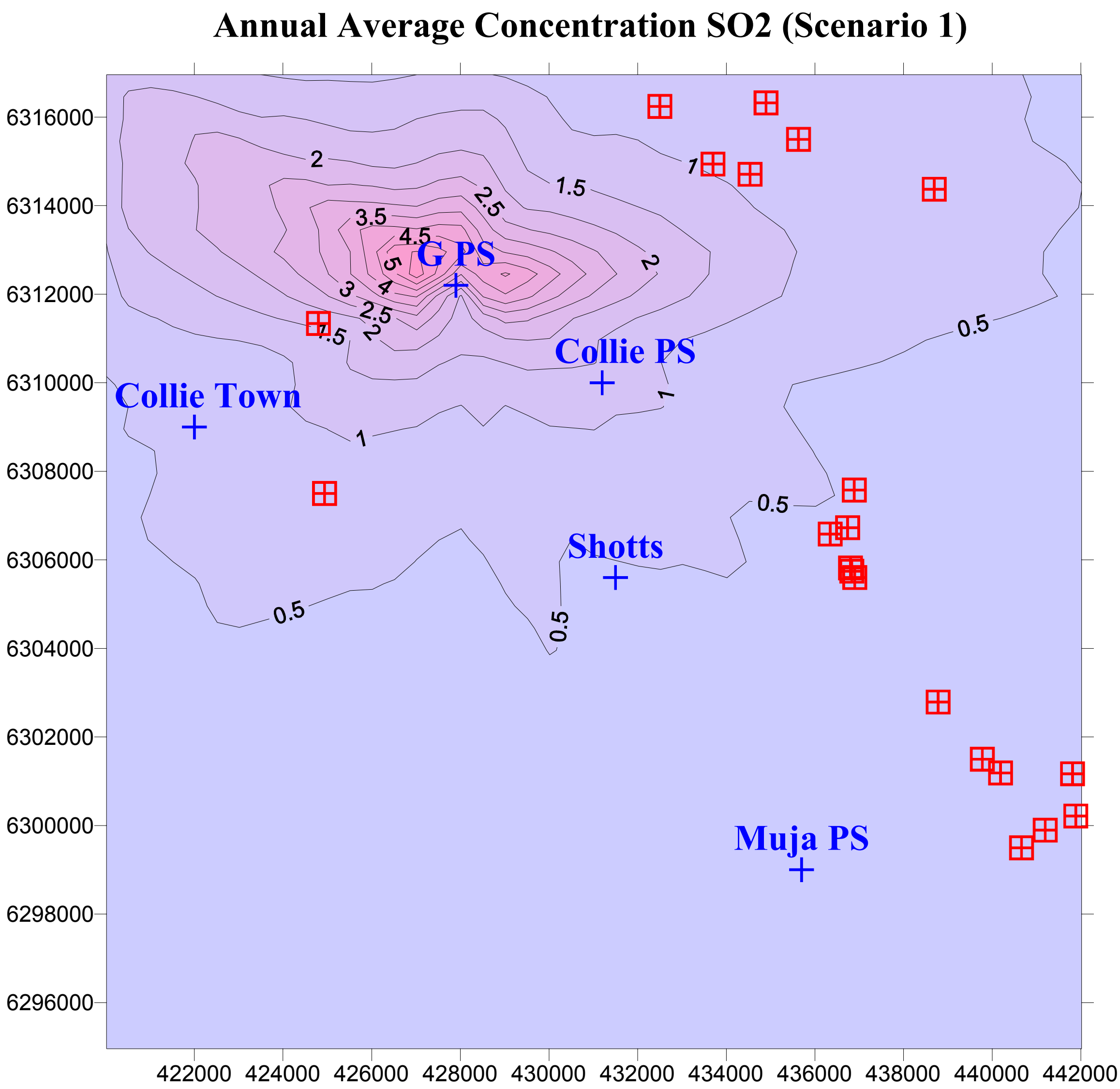

Figure A.16 For Scenario 1 (Bluewaters I), contours of annual-averaged concentration of SO_2 ($\mu g\ m^{-3}$) modelled by TAPM for 2001. Red window symbol denotes buildings. G PS denotes the location of the proposed Griffin station at Bluewaters.

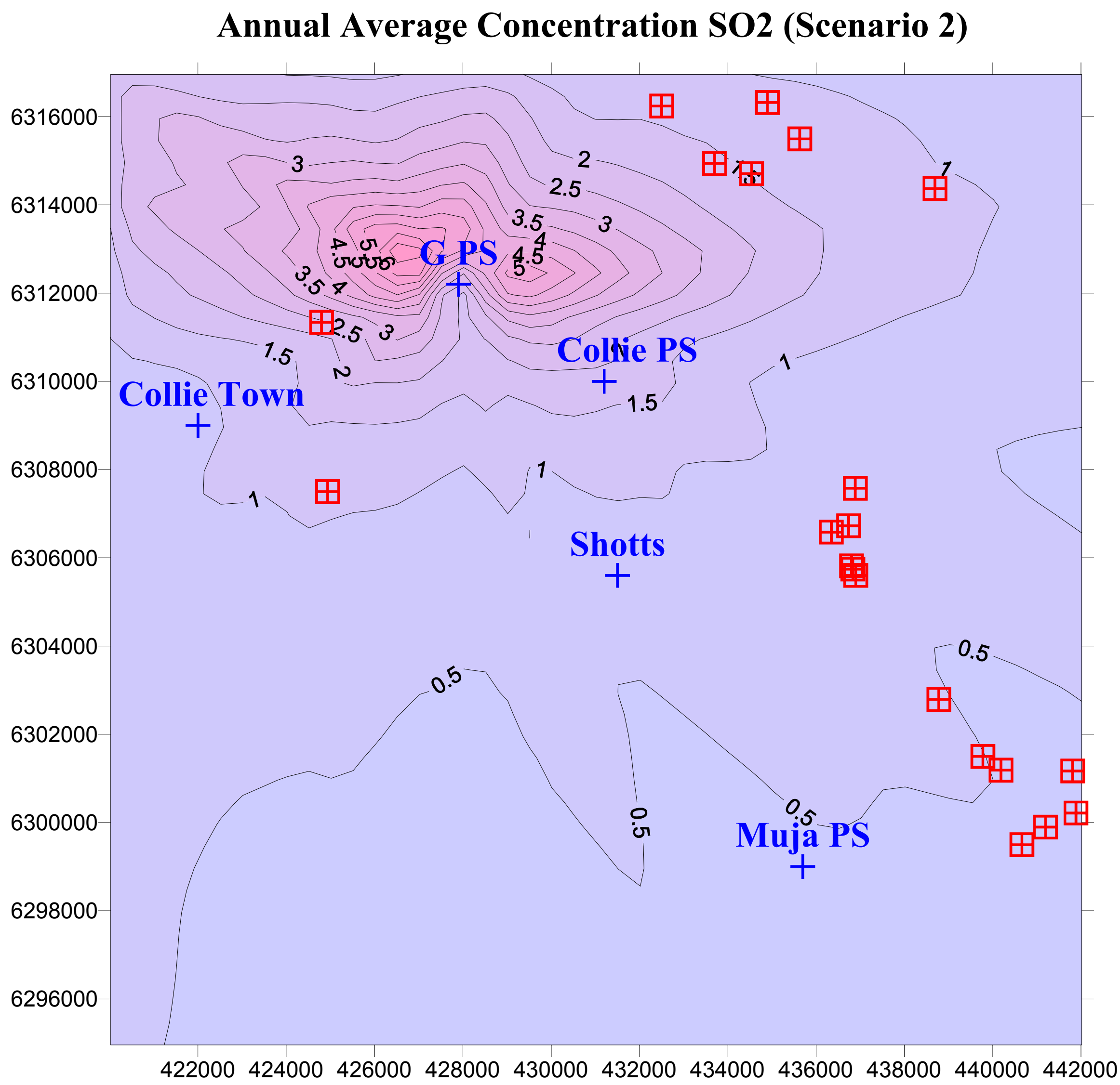

Figure A.17 For Scenario 2 (Bluewaters I + II), contours of annual-averaged concentration of SO_2 ($\mu g\ m^{-3}$) modelled by TAPM for 2001. Red window symbol denotes buildings. G PS denotes the location of the proposed Griffin station at Bluewaters.

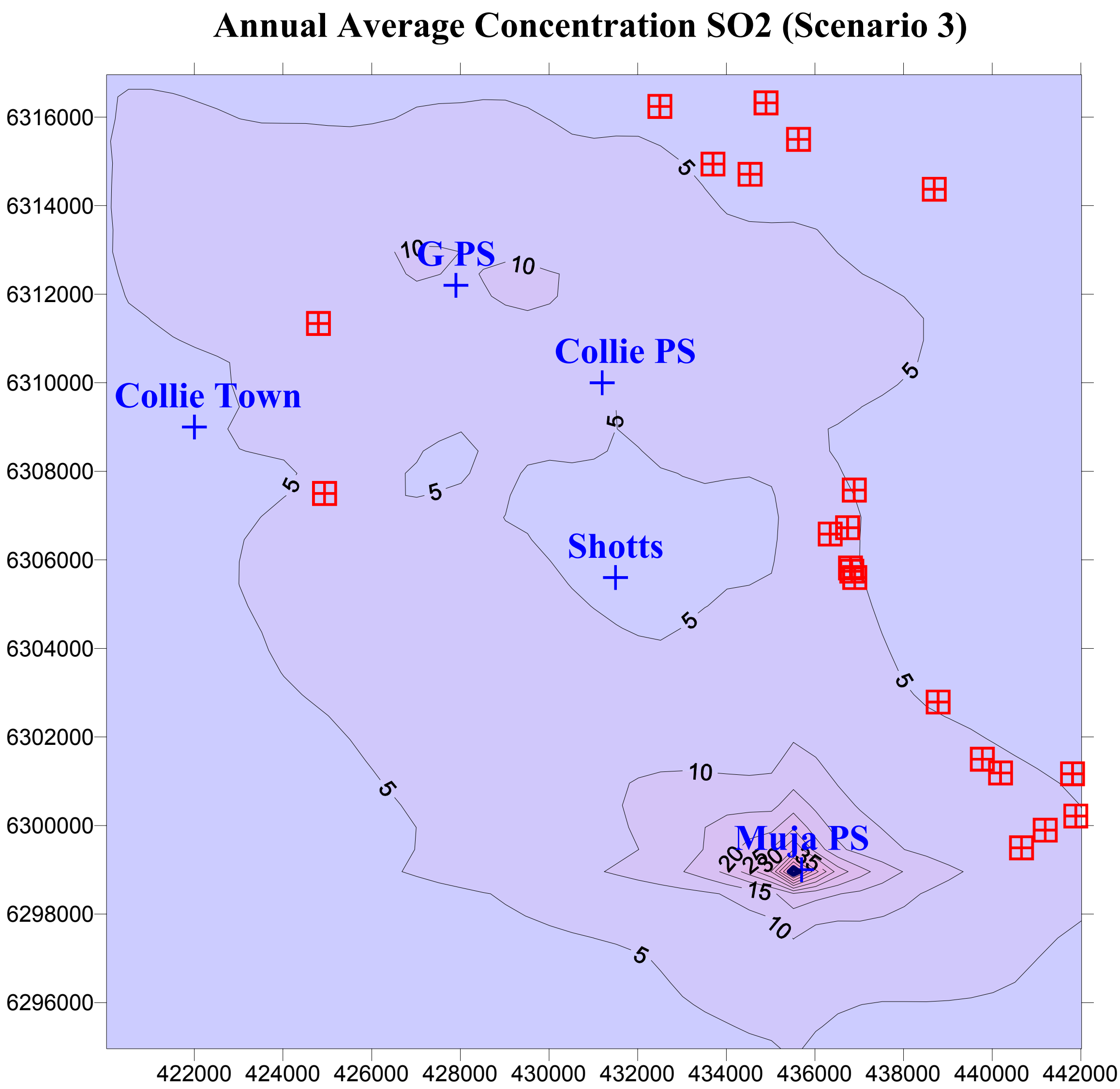

Figure A.18 For Scenario 3 (Muja A, B, Muja C, D, Collie A, B, Worsley and Bluewaters I), contours of annual-averaged concentration of SO_2 ($\mu g\ m^{-3}$) modelled by TAPM for 2001. Red window symbol denotes buildings. G PS denotes the location of the proposed Griffin station at Bluewaters.

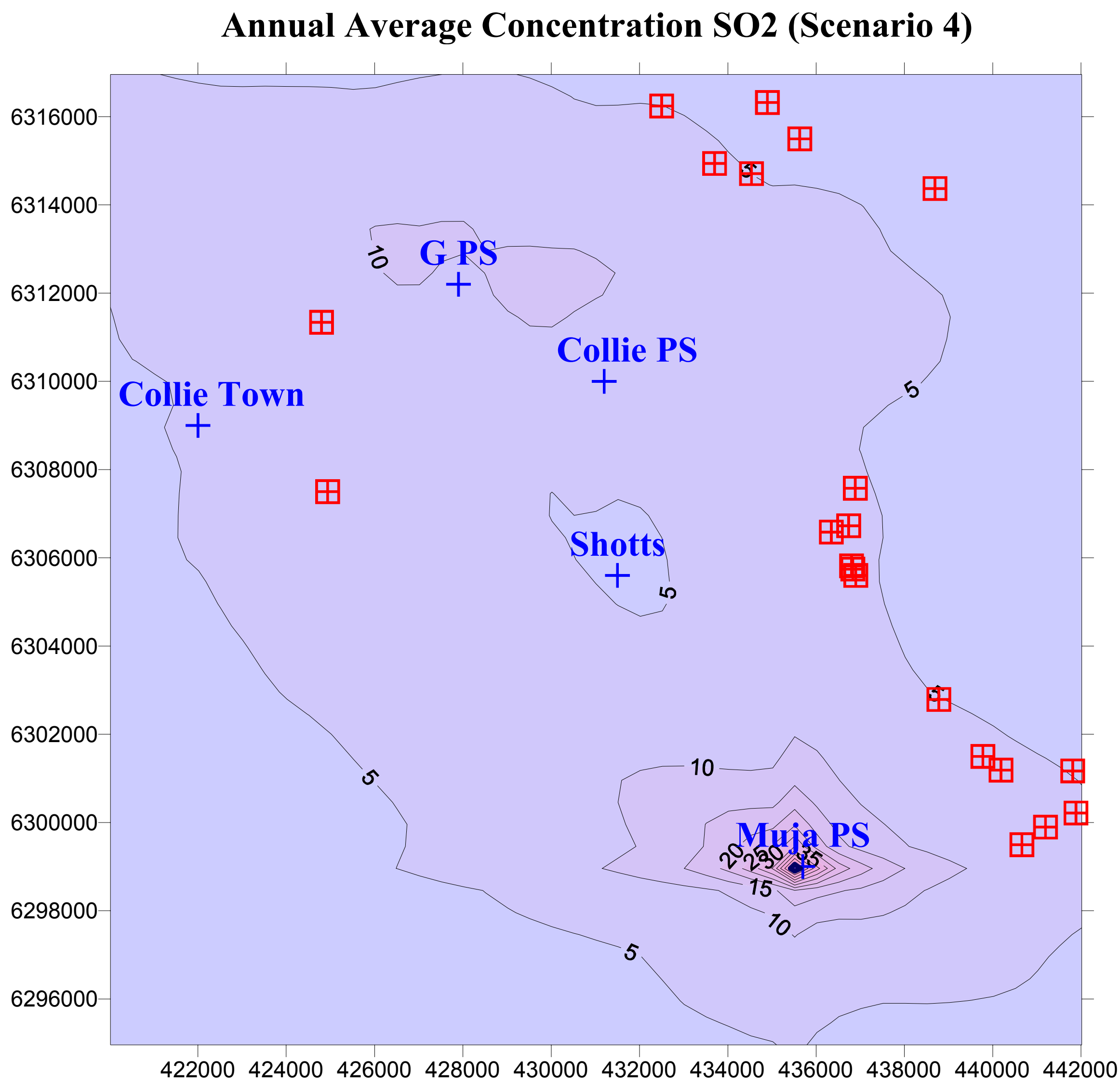

Figure A.19 For Scenario 4 (Muja A, B, Muja C, D, Collie A, B, Worsley, and Bluewaters I + II), contours of annual-averaged concentration of SO_2 (μg m^{-3}) modelled by TAPM for 2001. Red window symbol denotes buildings. G PS denotes the location of the proposed Griffin station at Bluewaters.

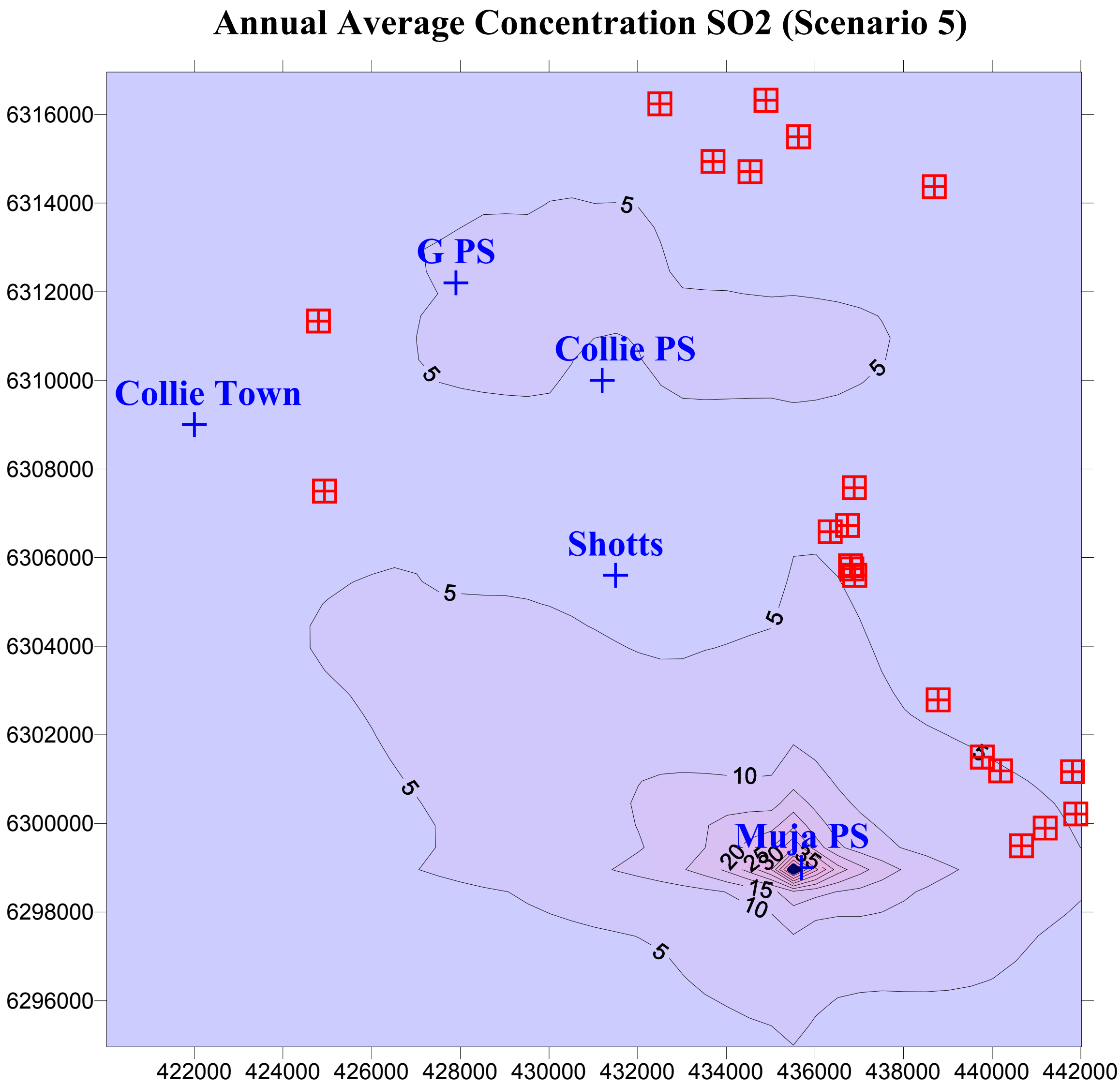

Figure A.20 For Scenario 5 (Muja A, B, Muja C, D, Collie A, B, and Worsley), contours of annual-averaged concentration of SO_2 ($\mu g\ m^{-3}$) modelled by TAPM for 2001. Red window symbol denotes buildings. G PS denotes the location of the proposed Griffin station at Bluewaters.

Appendix B Contour plots for TAPM CO concentrations

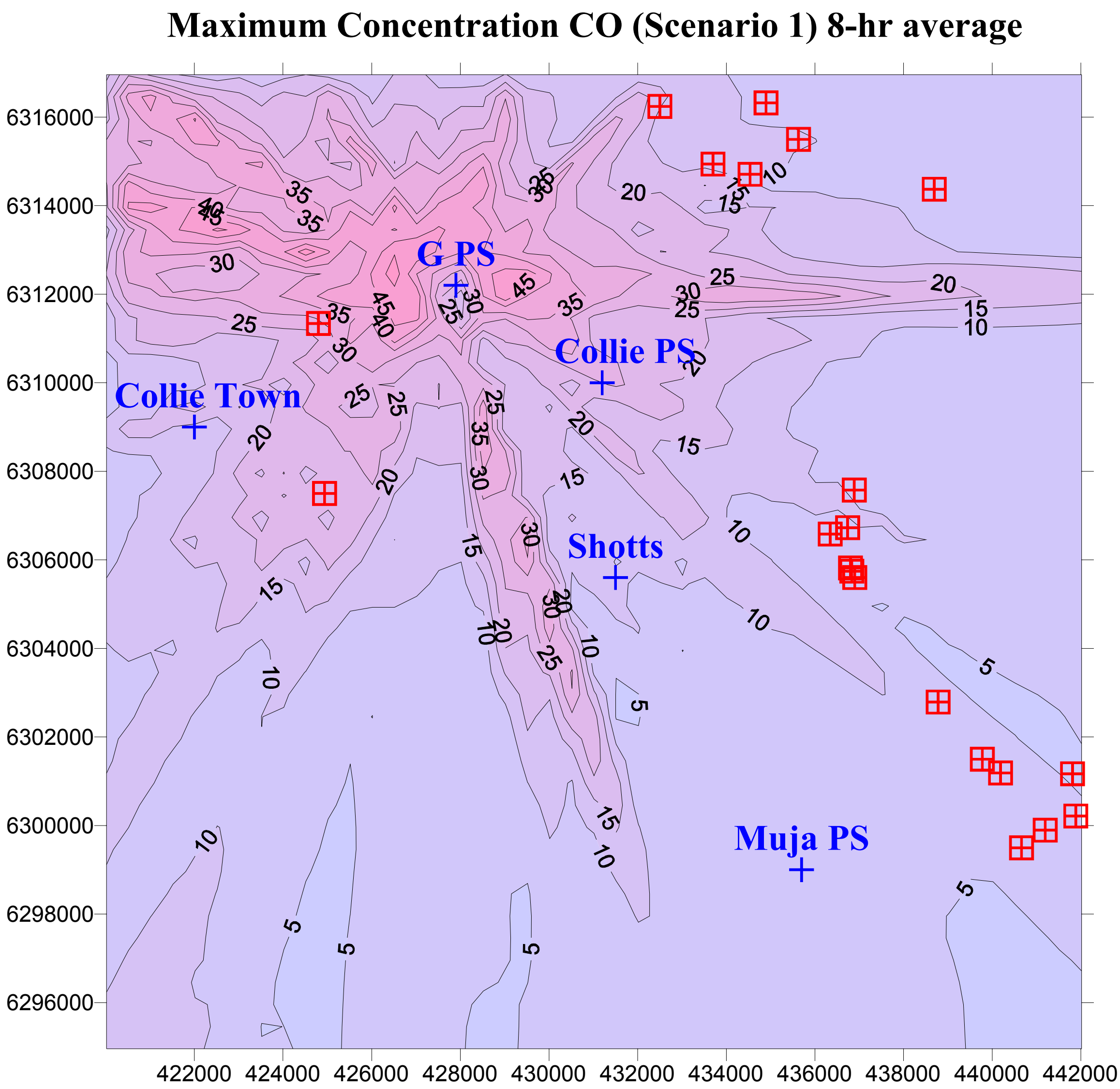

Figure B.1 For Scenario 1 (Bluewaters I), contours of *highest* 8-hour-averaged concentration of CO (μg m^{-3}) modelled by TAPM for 2001. Red window symbol denotes buildings. G PS denotes the location of the proposed Griffin station at Bluewaters.

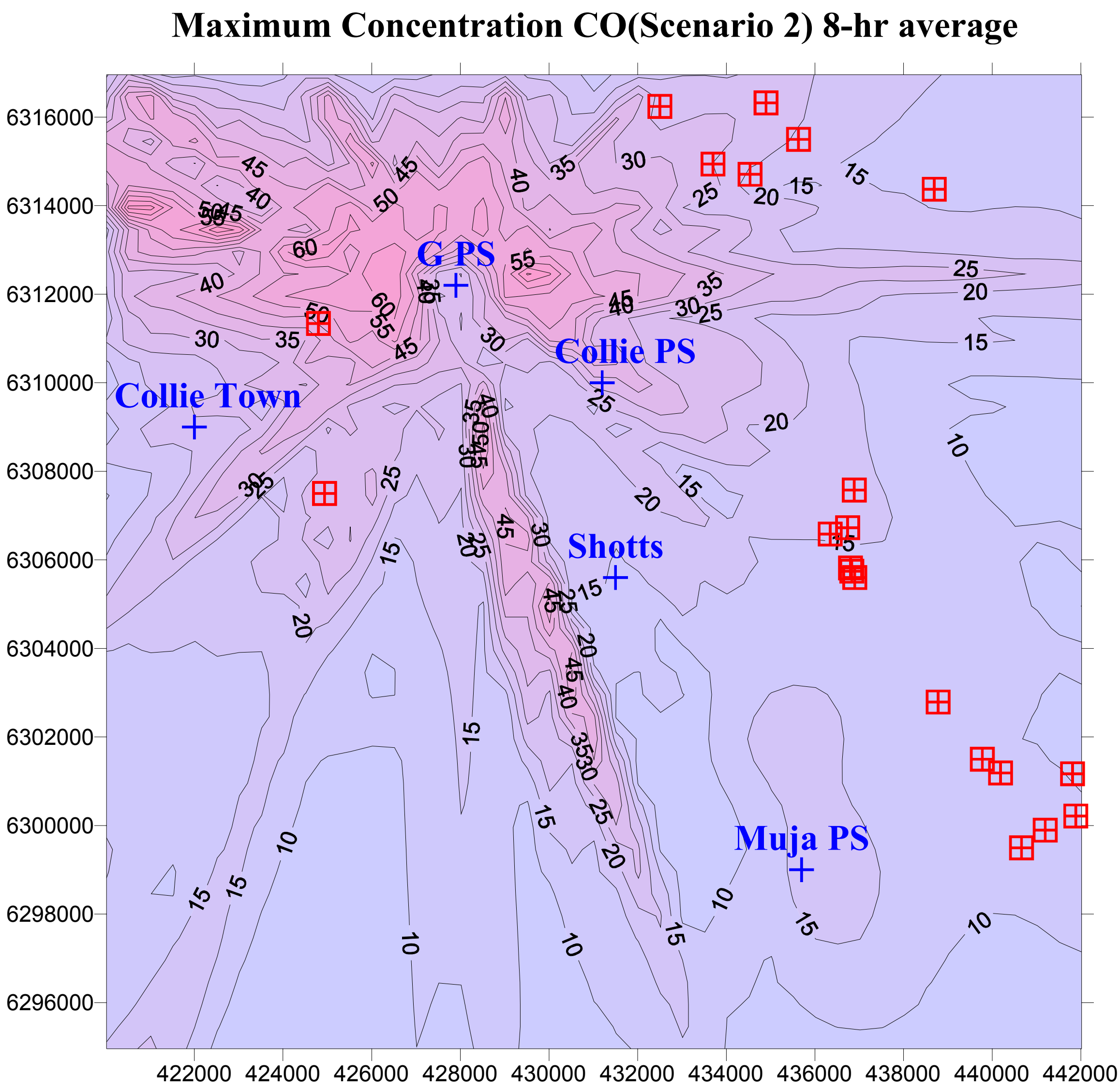

Figure B.2 For Scenario 2 (Bluewaters I + II), contours of *highest* 8-hour-averaged concentration of CO (μg m^{-3}) modelled by TAPM for 2001. Red window symbol denotes buildings. G PS denotes the location of the proposed Griffin station at Bluewaters.

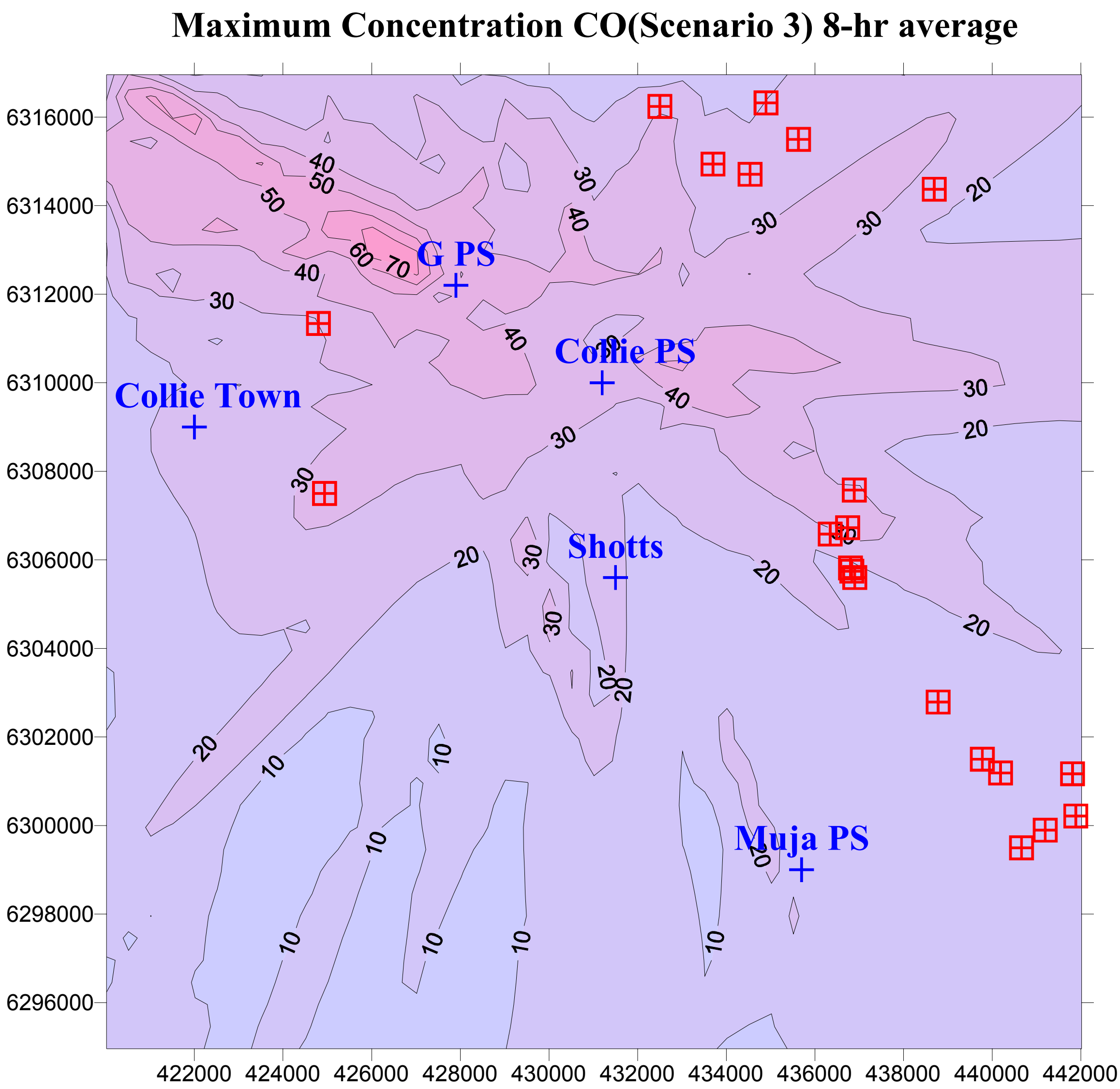

Figure B.3 For Scenario 3 (Muja A, B, Muja C, D, Collie A, B, Worsley and Bluewaters I), contours of *highest* 8-hour-averaged concentration of CO (μg m^{-3}) modelled by TAPM for 2001. Red window symbol denotes buildings. G PS denotes the location of the proposed Griffin station at Bluewaters.

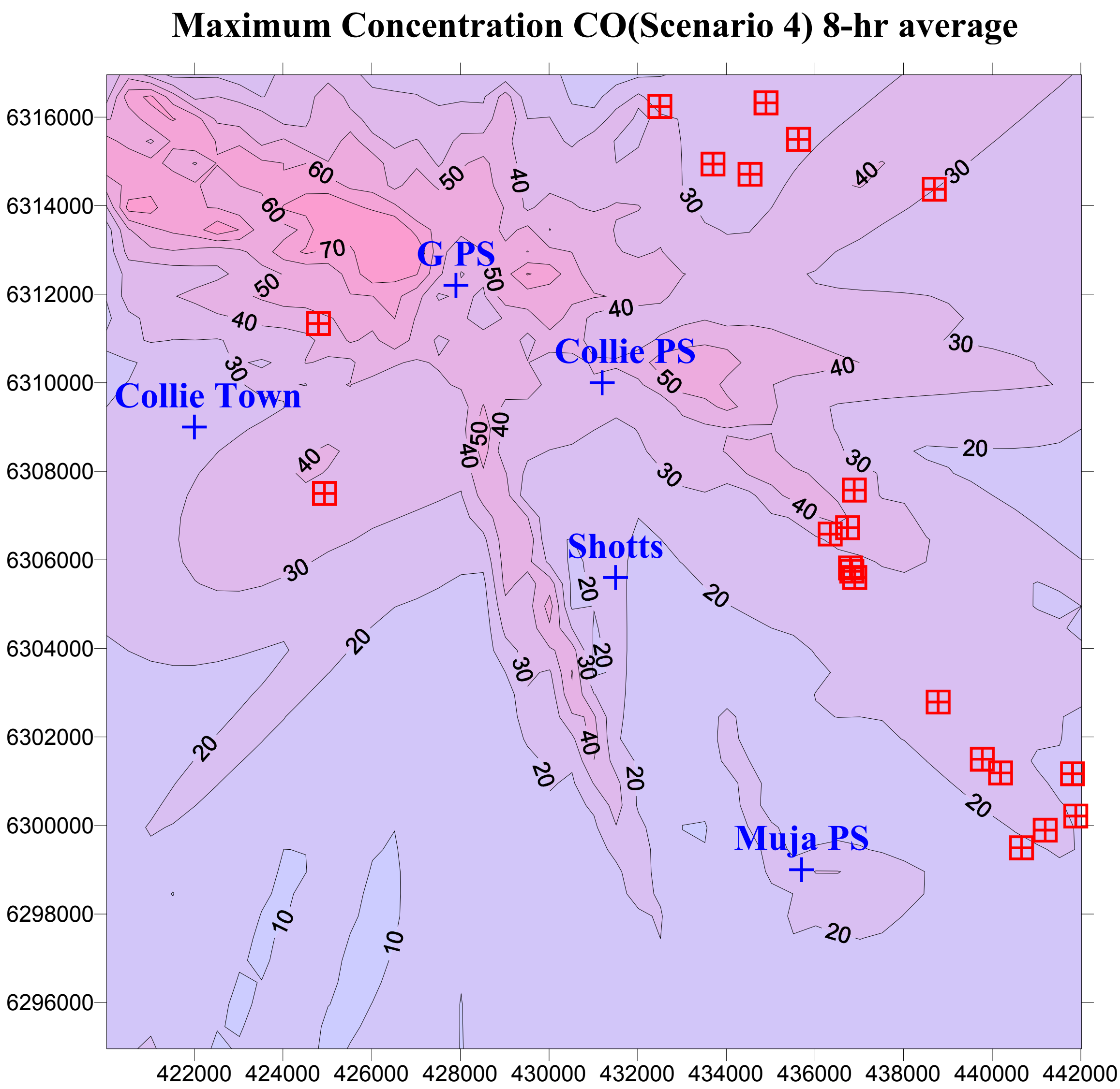

Figure B.4 For Scenario 4 (Muja A, B, Muja C, D, Collie A, B, Worsley, and Bluewaters I + II), contours of *highest* 8-hour-averaged concentration of CO (μg m^{-3}) modelled by TAPM for 2001. Red window symbol denotes buildings. G PS denotes the location of the proposed Griffin station at Bluewaters.

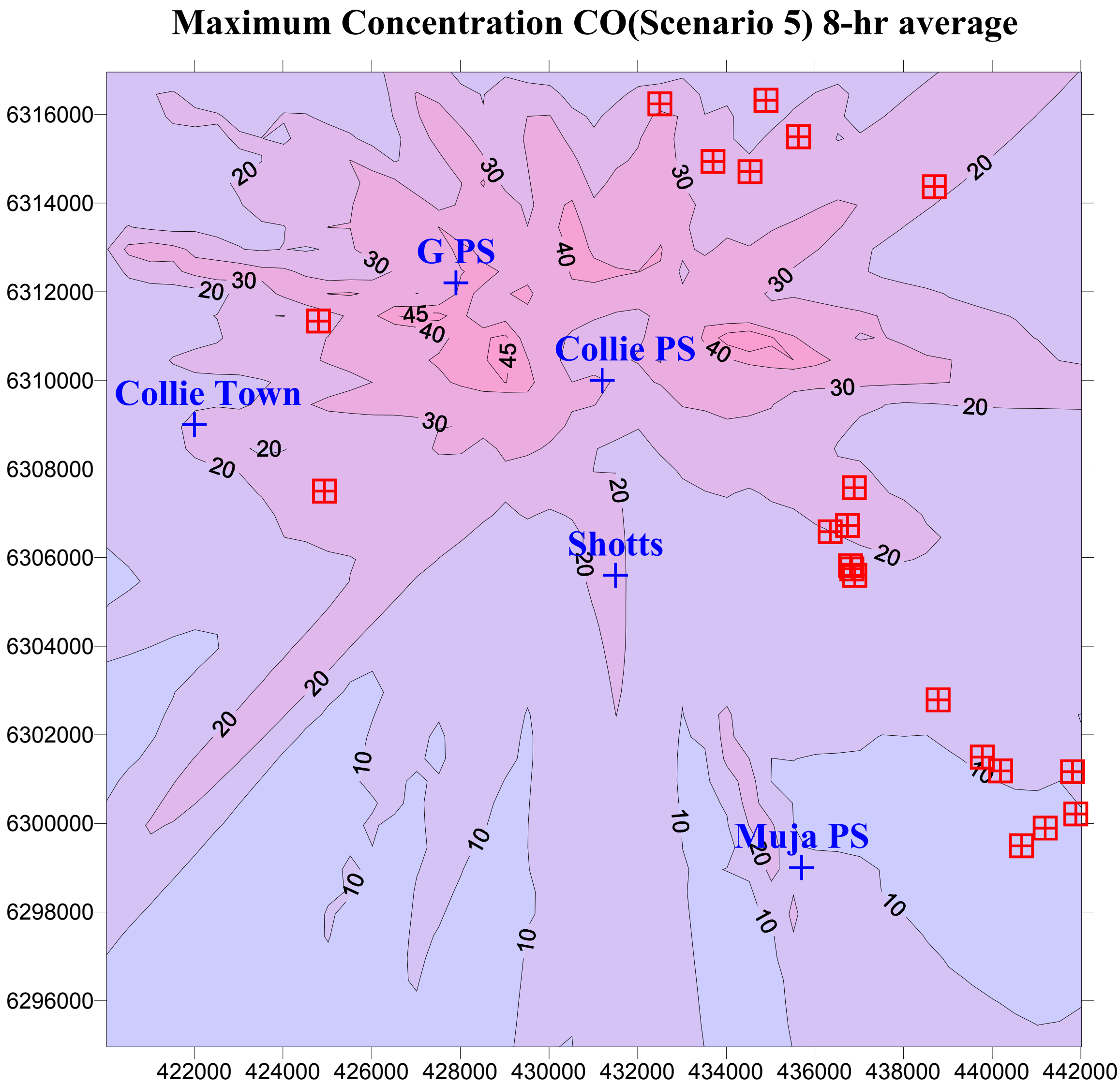

Figure B.5 For Scenario 5 (Muja A, B, Muja C, D, Collie A, B, and Worsley), contours of *highest* 8-hour-averaged concentration of CO (µg m^{-3}) modelled by TAPM for 2001. Red window symbol denotes buildings. G PS denotes the location of the proposed Griffin station at Bluewaters.

Appendix C Contour plots for TAPM Hg concentrations

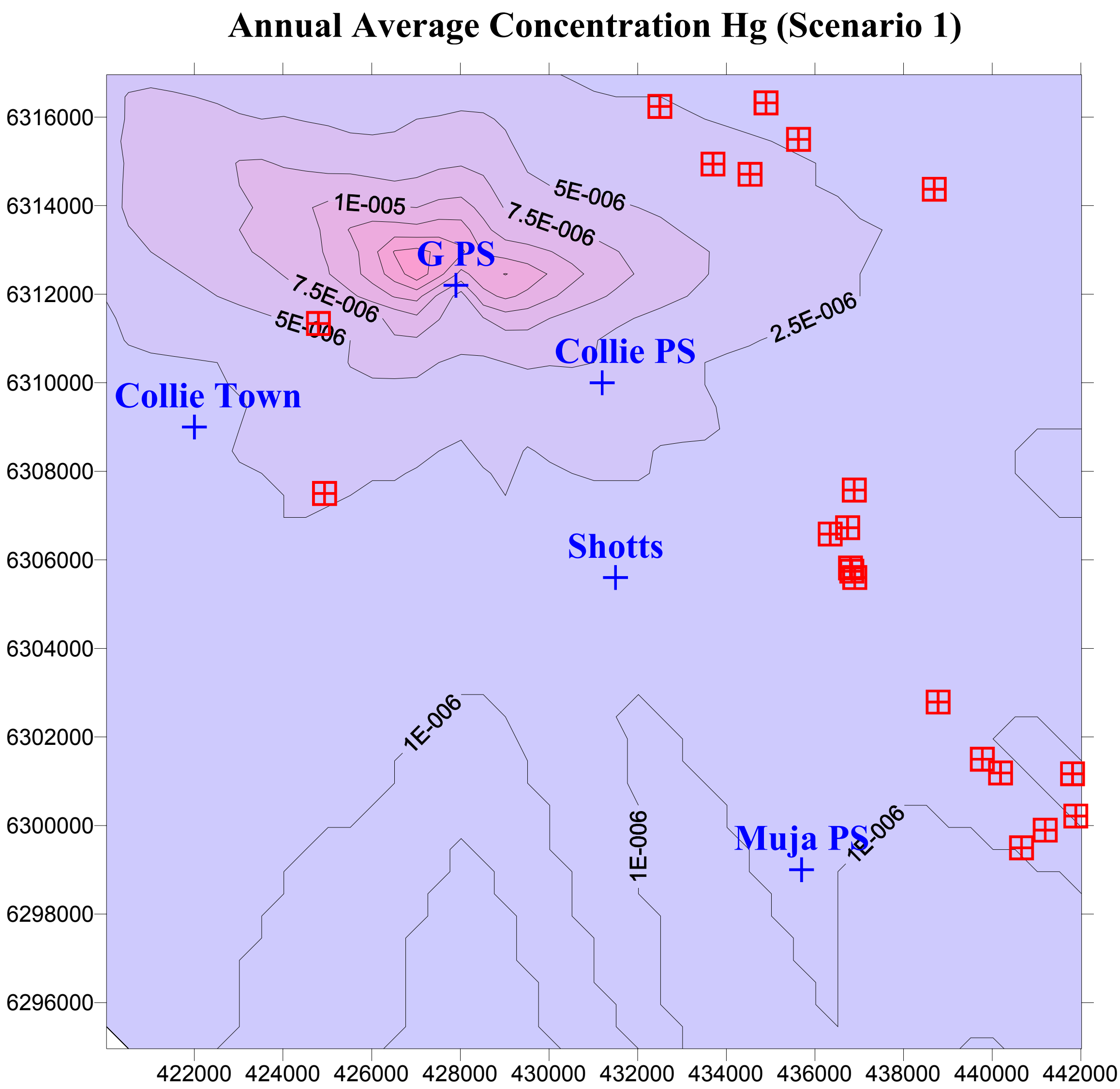

Figure C.1 For Scenario 1 (Bluewaters I), contours of annual-averaged concentration of Hg (μg m^{-3}) modelled by TAPM for 2001. Red window symbol denotes buildings. G PS denotes the location of the proposed Griffin station at Bluewaters.

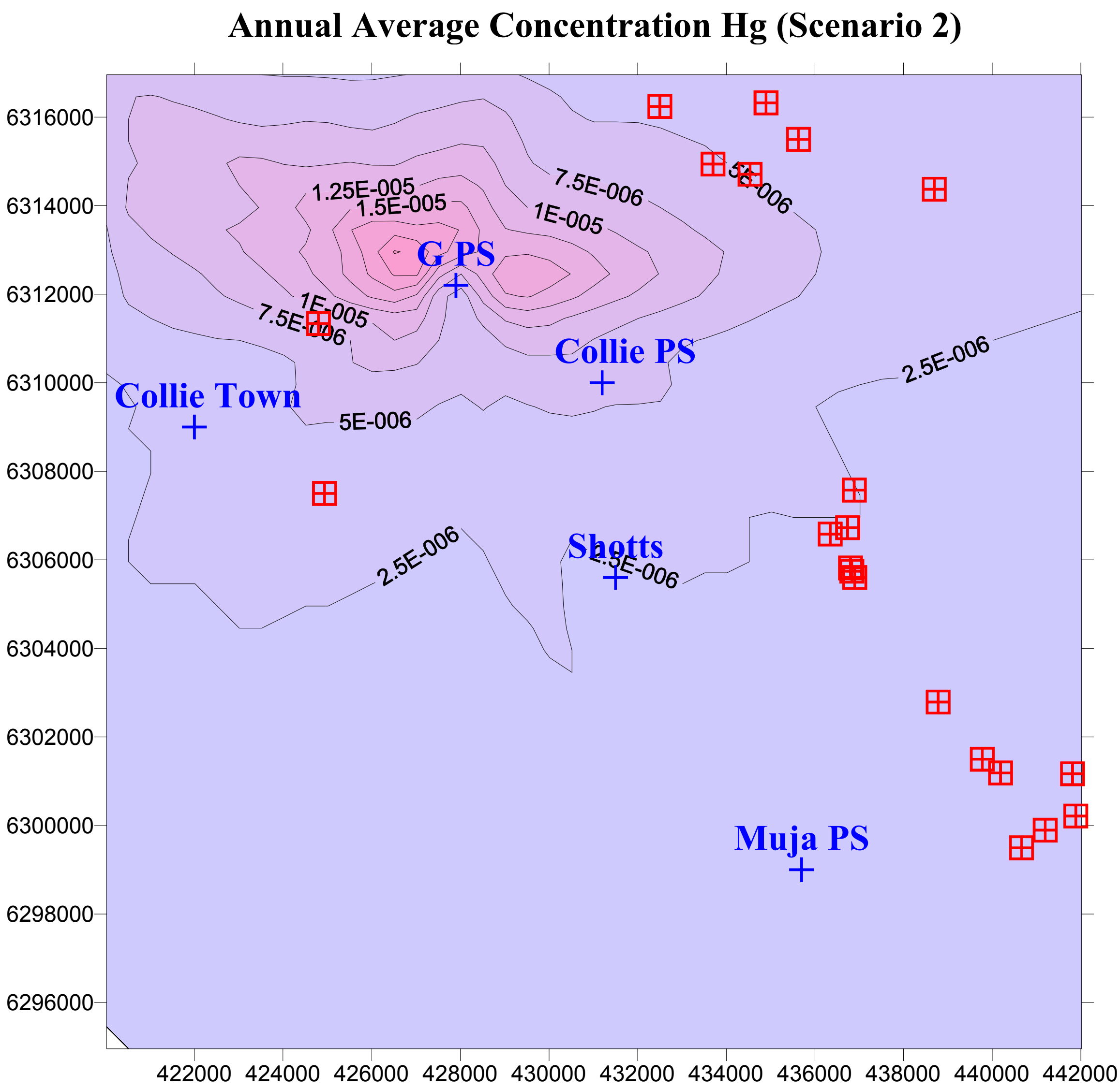

Figure C.2 For Scenario 2 (Bluewaters I + II), contours of annual-averaged concentration of Hg (µg m^{-3}) modelled by TAPM for 2001. Red window symbol denotes buildings. G PS denotes the location of the proposed Griffin station at Bluewaters.

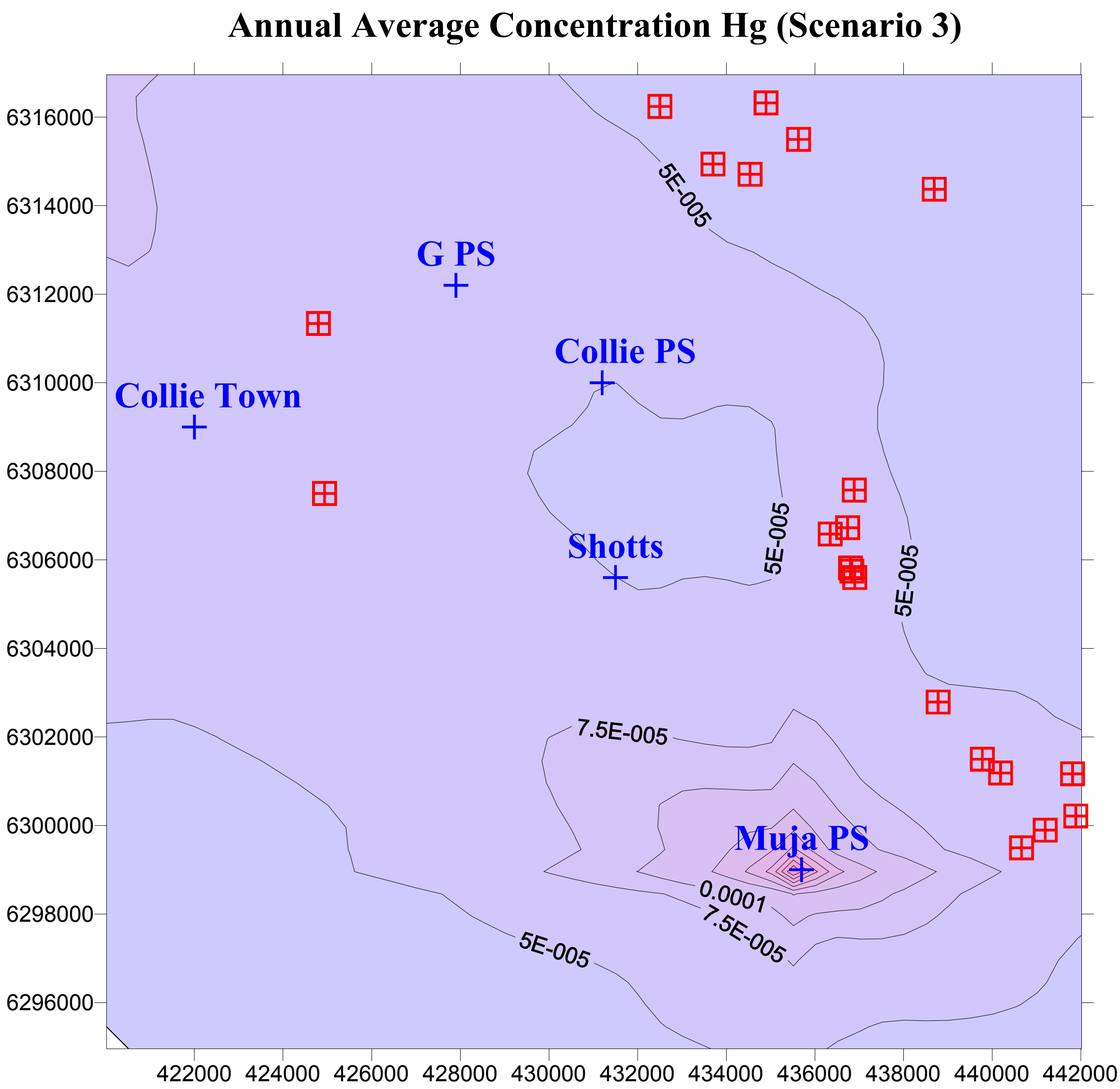

Figure C.3 For Scenario 3 (Muja A, B, Muja C, D, Collie A, B, Worsley and Bluewaters I), contours of annual-averaged concentration of Hg (μg m^{-3}) modelled by TAPM for 2001. Red window symbol denotes buildings. G PS denotes the location of the proposed Griffin station at Bluewaters.

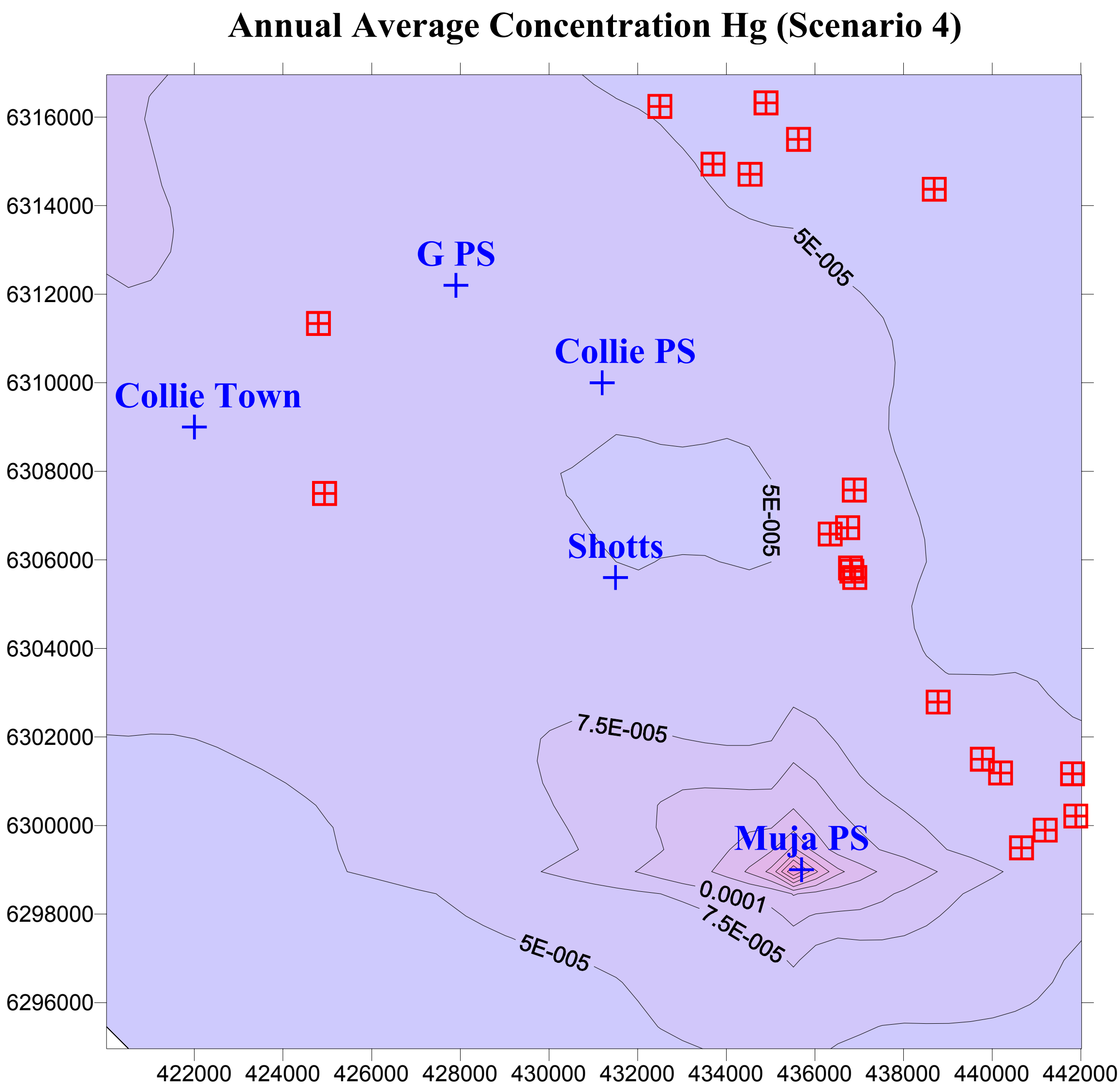

Figure C.4 For Scenario 4 (Muja A, B, Muja C, D, Collie A, B, Worsley, and Bluewaters I + II), contours of annual-averaged concentration of Hg (μg m^{-3}) modelled by TAPM for 2001. Red window symbol denotes buildings. G PS denotes the location of the proposed Griffin station at Bluewaters.

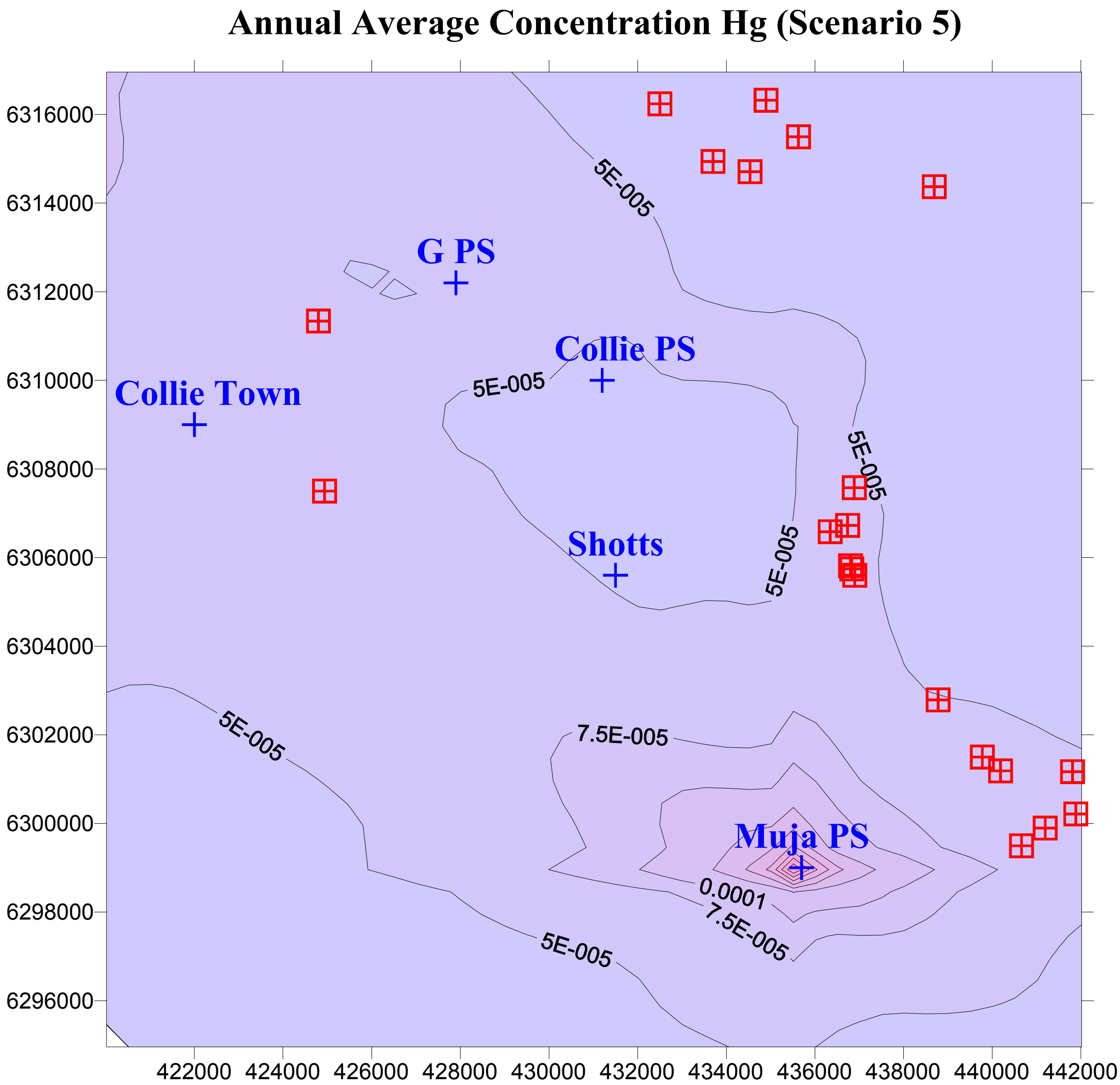

Figure C.5 For Scenario 5 (Muja A, B, Muja C, D, Collie A, B, and Worsley), contours of annual-averaged concentration of Hg (μg m^{-3}) modelled by TAPM for 2001. Red window symbol denotes buildings. G PS denotes the location of the proposed Griffin station at Bluewaters.

Appendix D Contour plots for TAPM PAH concentrations

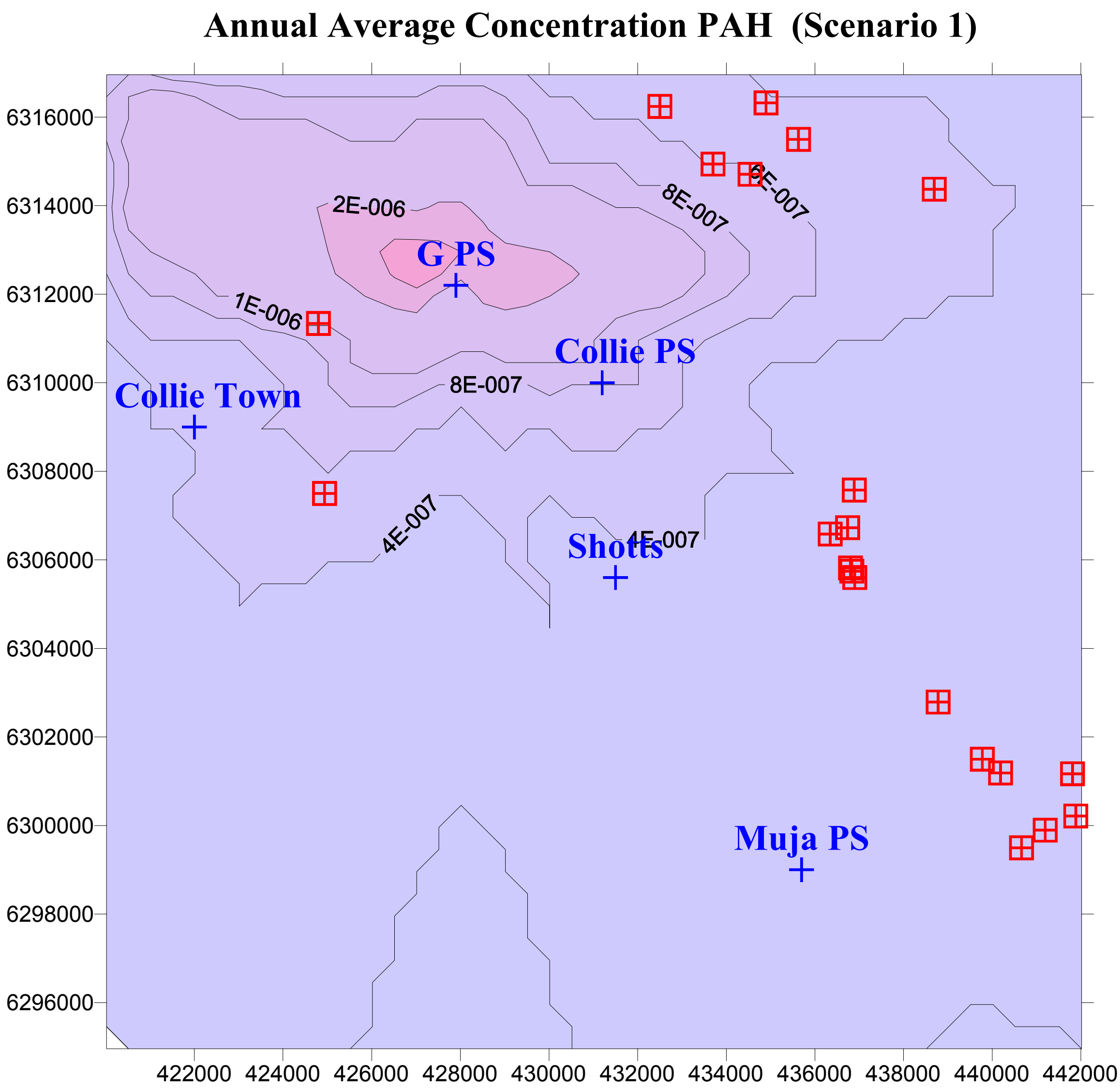

Figure D.1 For Scenario 1 (Bluewaters I), contours of annual-averaged concentration of PAH (µg m^{-3}) modelled by TAPM for 2001. Red window symbol denotes buildings. G PS denotes the location of the proposed Griffin station at Bluewaters.

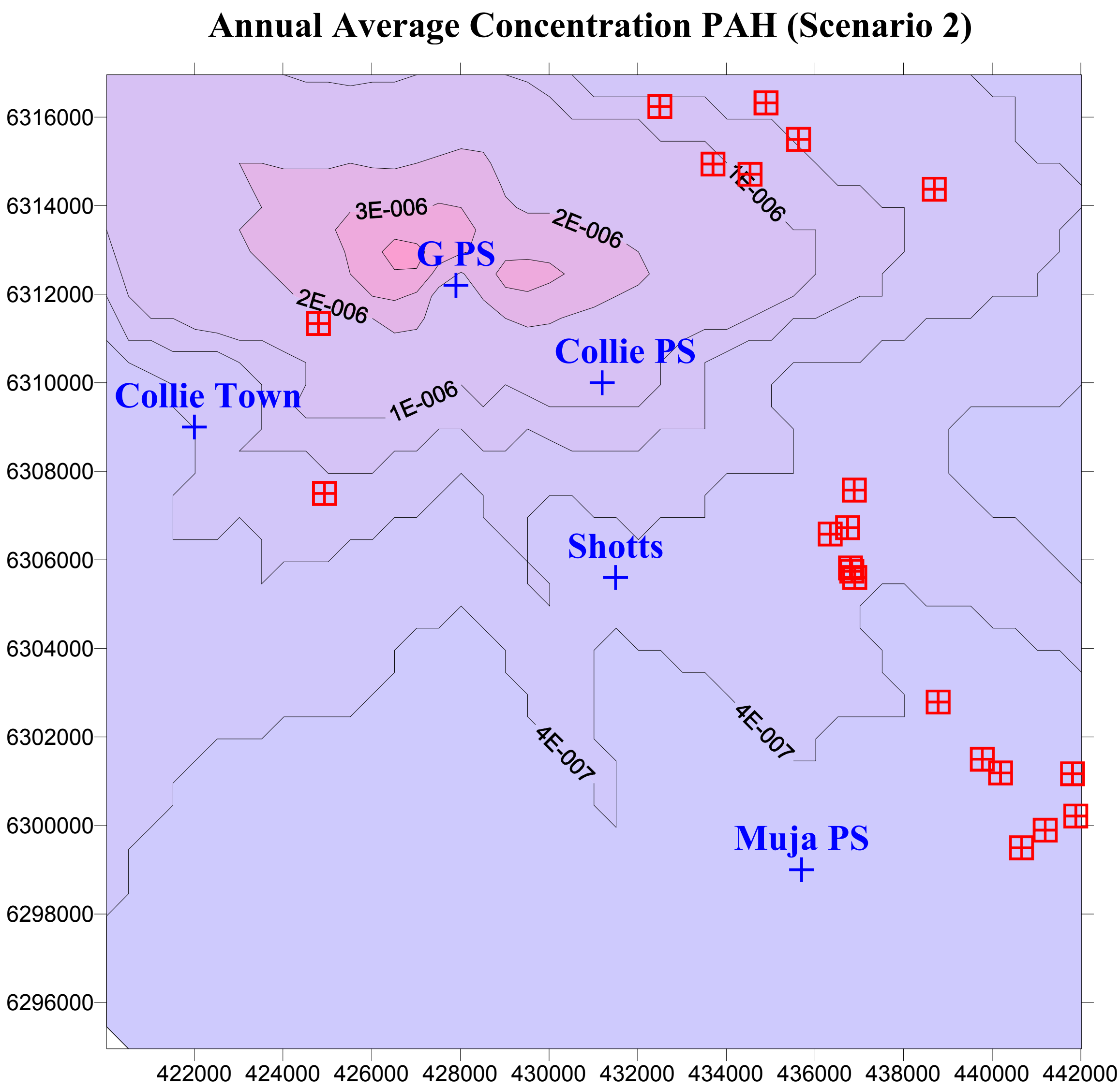

Figure D.2 For Scenario 2 (Bluewaters I + II), contours of annual-averaged concentration of PAH (µg m^{-3}) modelled by TAPM for 2001. Red window symbol denotes buildings. G PS denotes the location of the proposed Griffin station at Bluewaters.

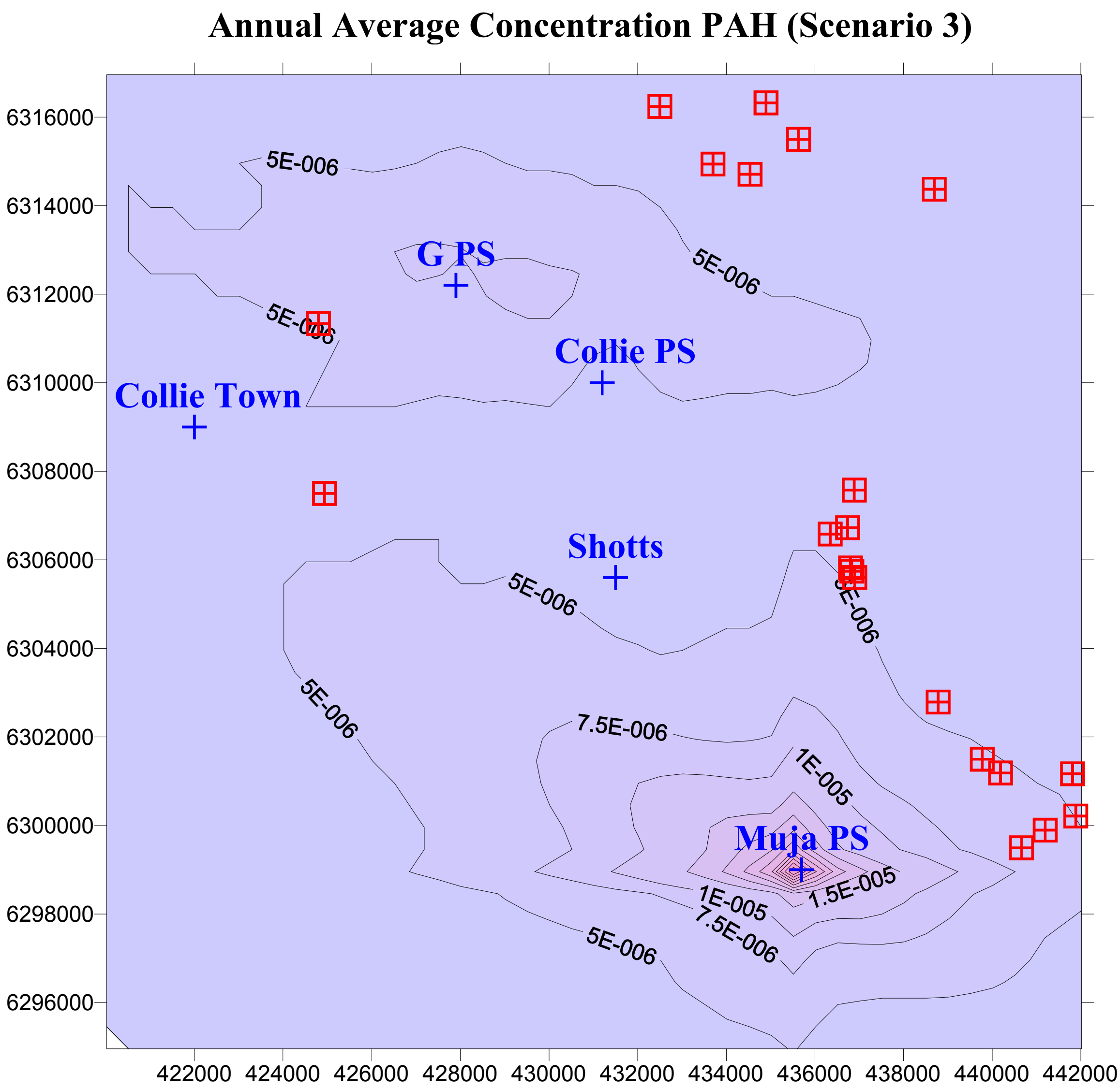

Figure D.3 For Scenario 3 (Muja A, B, Muja C, D, Collie A, B, Worsley and Bluewaters I), contours of annual-averaged concentration of PAH (μg m^{-3}) modelled by TAPM for 2001. Red window symbol denotes buildings. G PS denotes the location of the proposed Griffin station at Bluewaters.

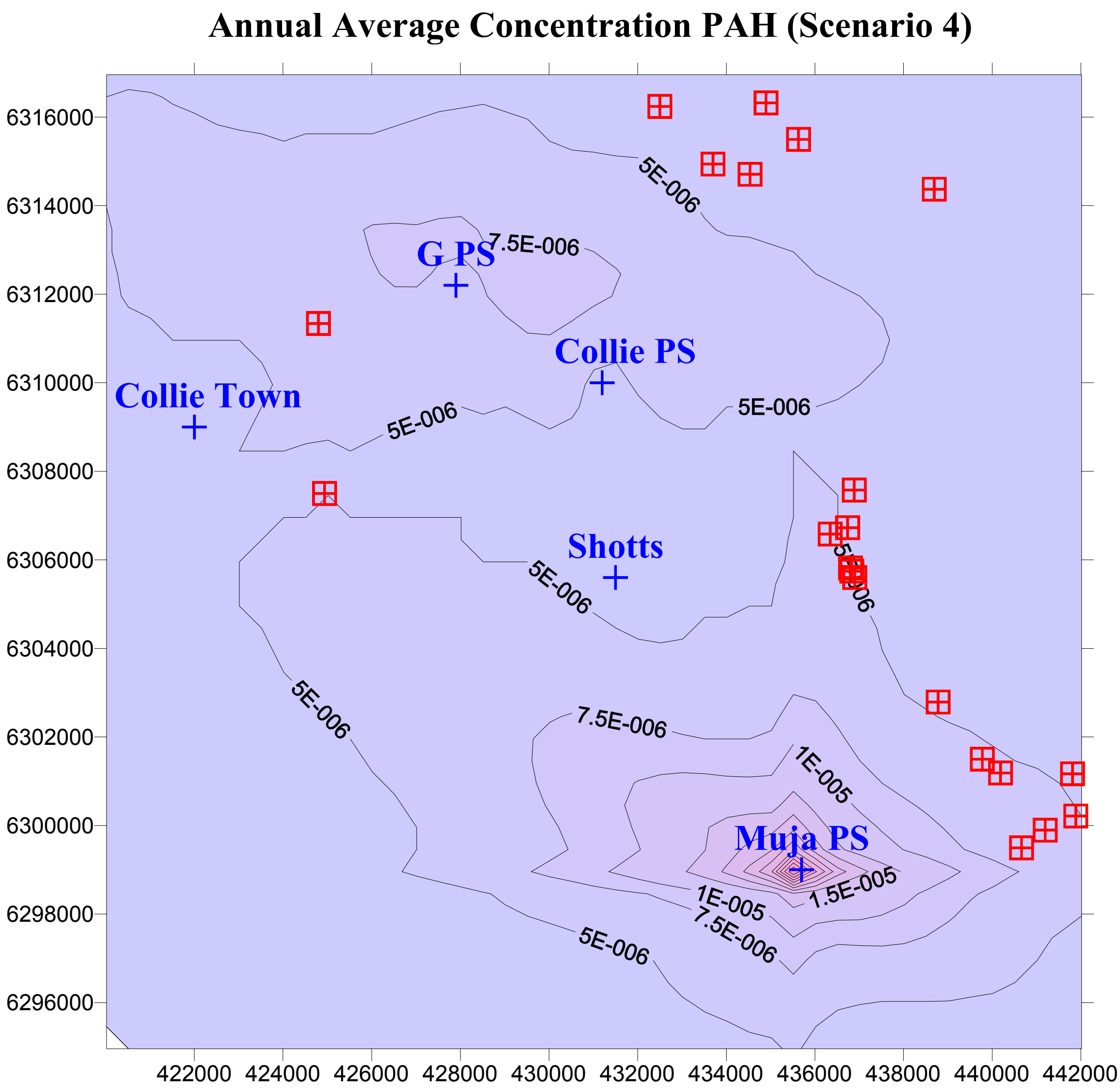

Figure D.4 For Scenario 4 (Muja A, B, Muja C, D, Collie A, B, Worsley, and Bluewaters I + II), contours of annual-averaged concentration of PAH (μg m^{-3}) modelled by TAPM for 2001. Red window symbol denotes buildings. G PS denotes the location of the proposed Griffin station at Bluewaters.

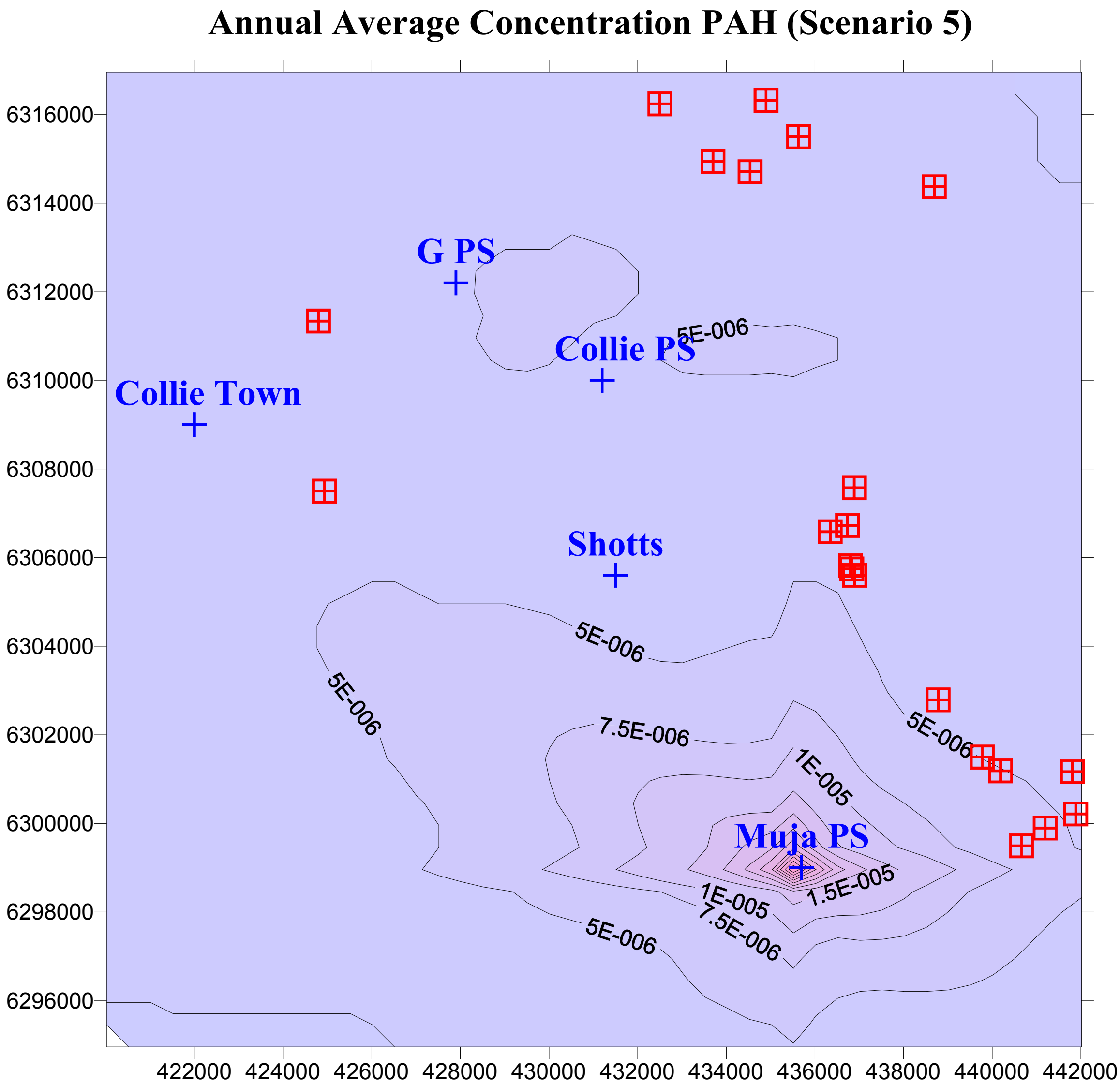

Figure D.5 For Scenario 5 (Muja A, B, Muja C, D, Collie A, B, and Worsley), contours of annual-averaged concentration of PAH (μg m^{-3}) modelled by TAPM for 2001. Red window symbol denotes buildings. G PS denotes the location of the proposed Griffin station at Bluewaters.

Appendix E Contour plots for TAPM FI concentrations

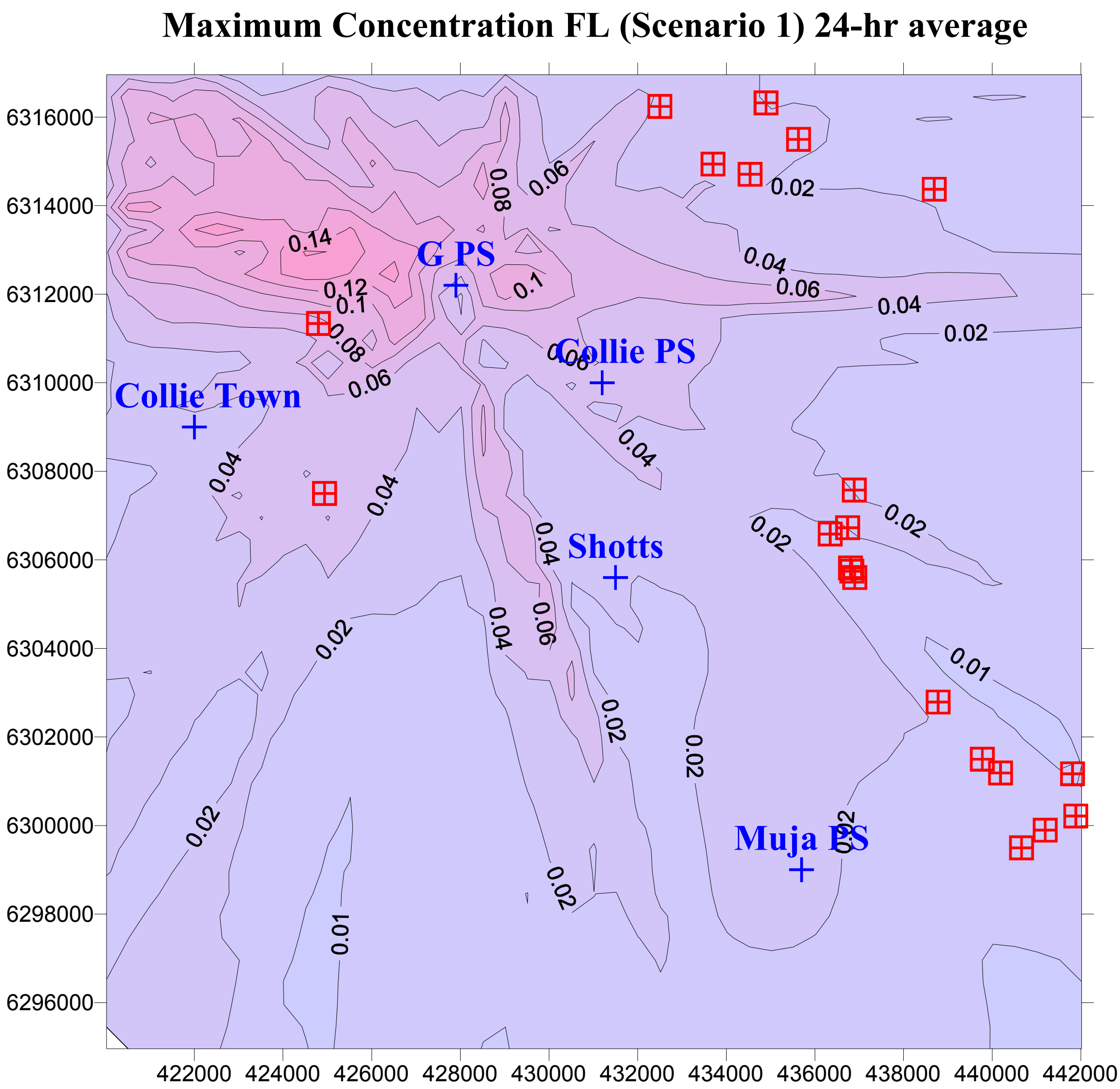

Figure E.1 For Scenario 1 (Bluewaters I), contours of *highest* 24-hour-averaged concentration of fluoride (μg m^{-3}) modelled by TAPM for 2001. Red window symbol denotes buildings. G PS denotes the location of the proposed Griffin station at Bluewaters.

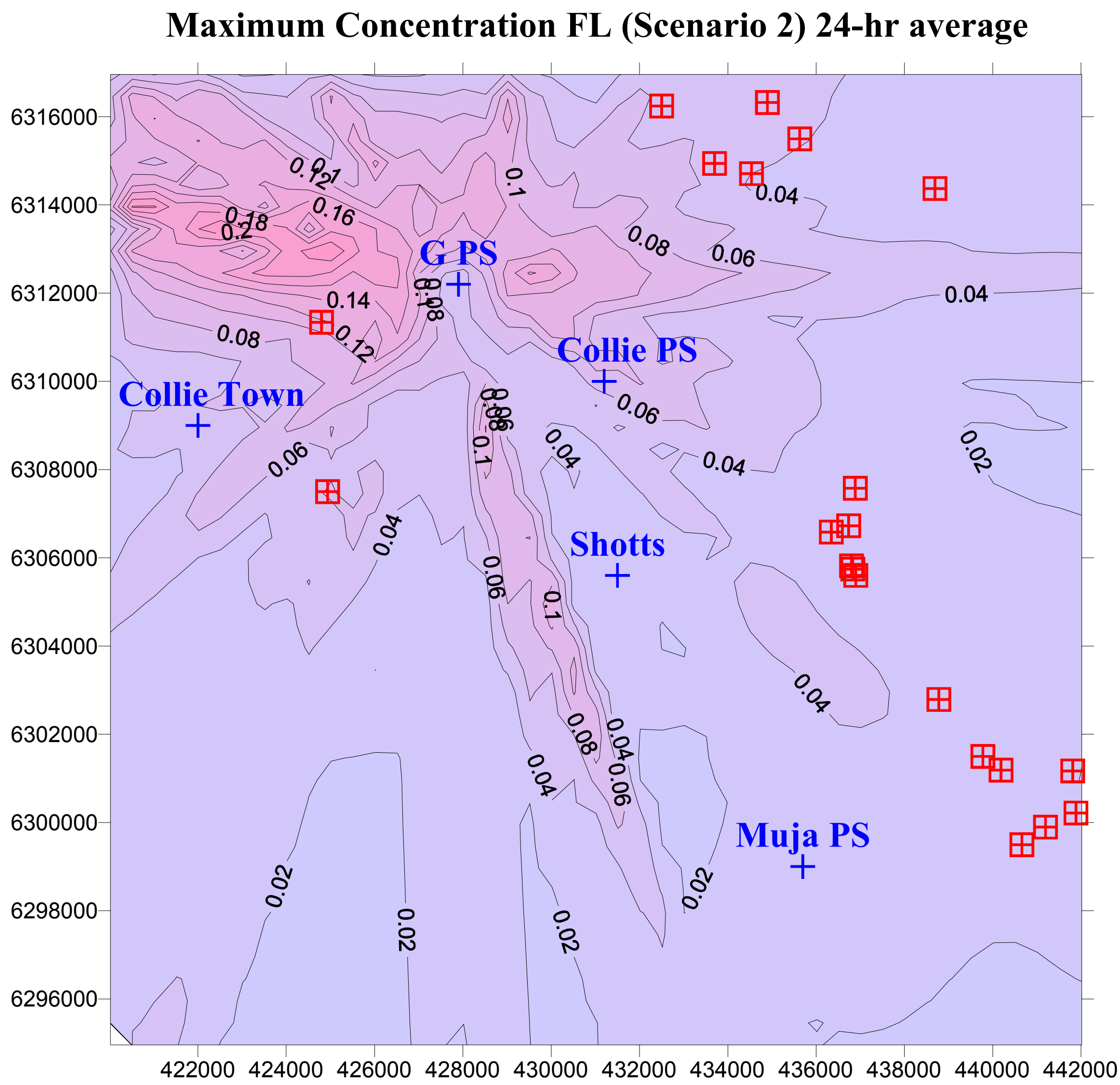

Figure E.2 For Scenario 2 (Bluewaters I + II), contours of *highest* 24-hour-averaged concentration of fluoride (μg m^{-3}) modelled by TAPM for 2001. Red window symbol denotes buildings. G PS denotes the location of the proposed Griffin station at Bluewaters.

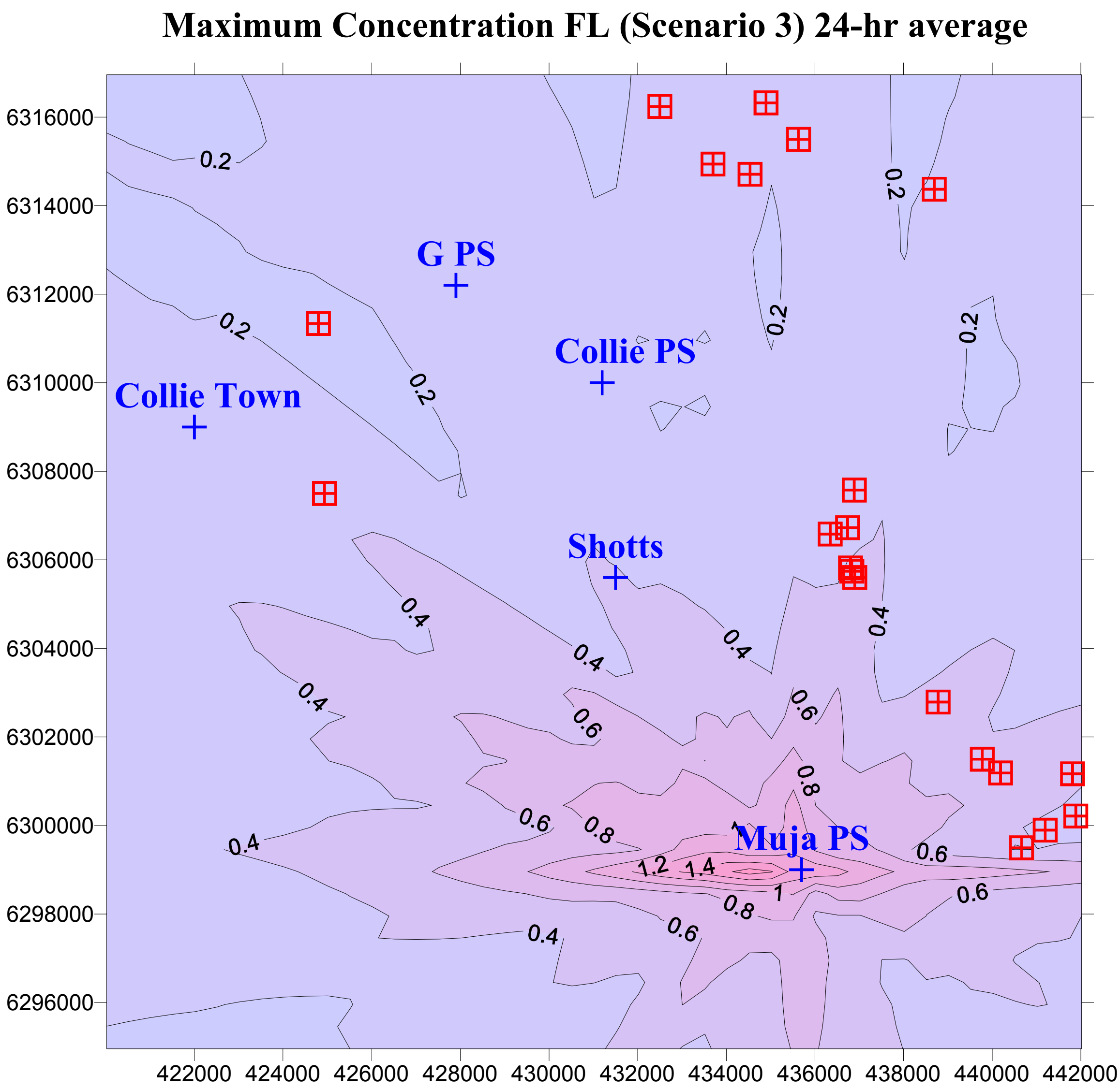

Figure E.3 For Scenario 3 (Muja A, B, Muja C, D, Collie A, B, Worsley and Bluewaters I), contours of *highest* 24-hour-averaged concentration of fluoride (μg m^{-3}) modelled by TAPM for 2001. Red window symbol denotes buildings. G PS denotes the location of the proposed Griffin station at Bluewaters.

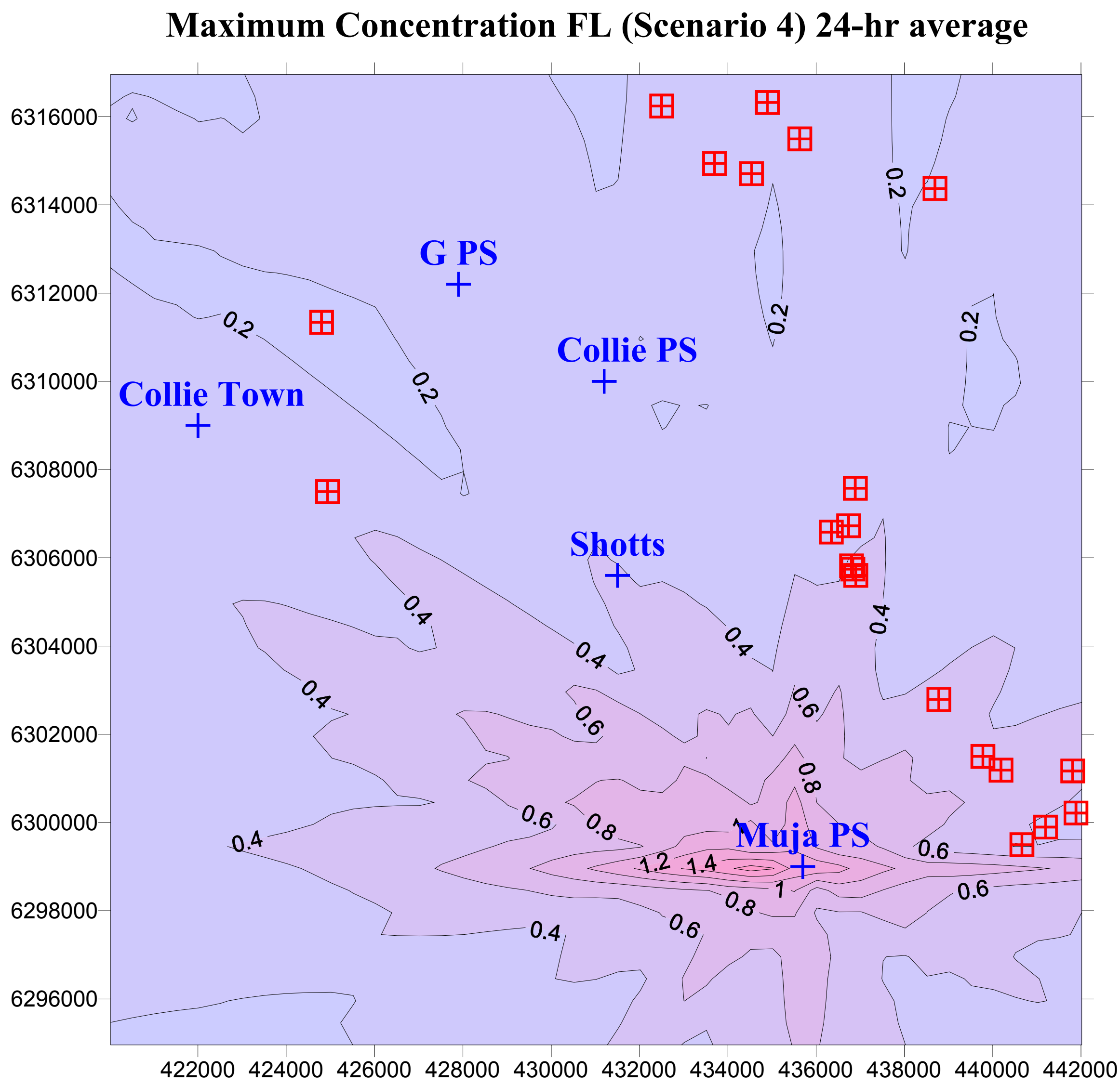

Figure E.4 For Scenario 4 (Muja A, B, Muja C, D, Collie A, B, Worsley, and Bluewaters I + II), contours of *highest* 24-hour-averaged concentration of fluoride (µg m^{-3}) modelled by TAPM for 2001. Red window symbol denotes buildings. G PS denotes the location of the proposed Griffin station at Bluewaters.

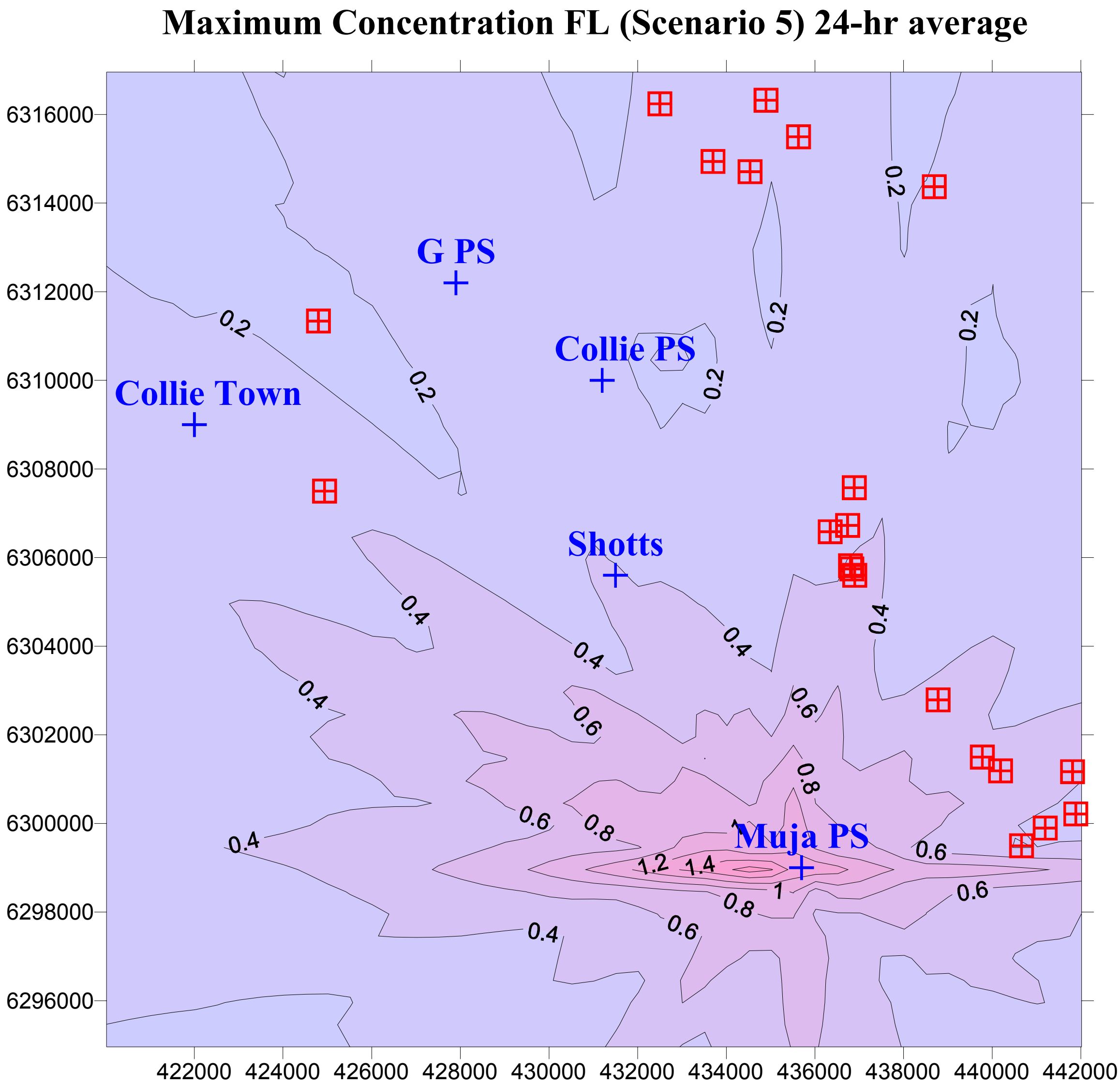

Figure E.5 For Scenario 5 (Muja A, B, Muja C, D, Collie A, B, and Worsley), contours of *highest* 24-hour-averaged concentration of fluoride (μg m^{-3}) modelled by TAPM for 2001. Red window symbol denotes buildings. G PS denotes the location of the proposed Griffin station at Bluewaters.

Appendix F Contour plots for TAPM NO_2 concentrations

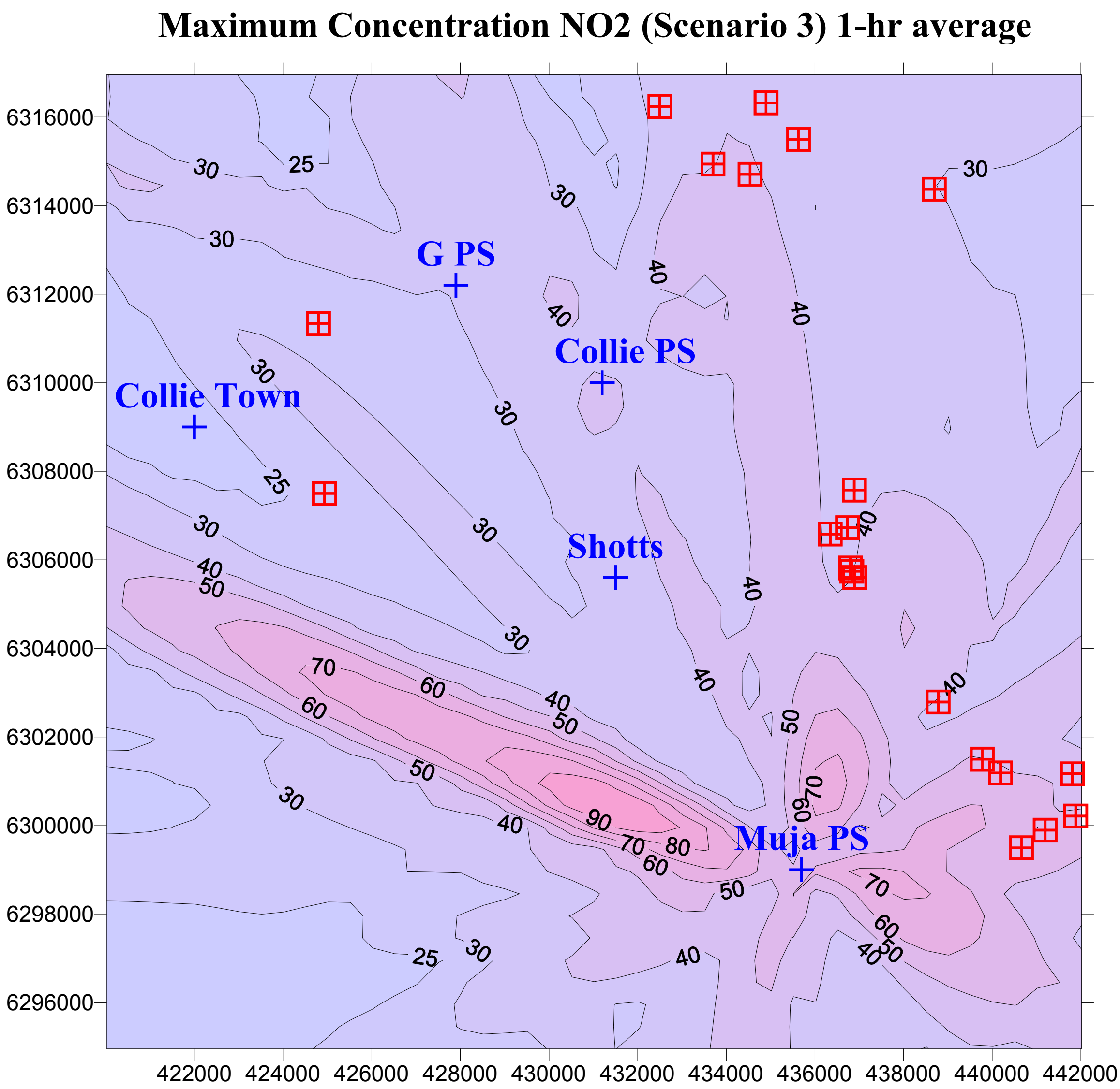

Figure F.1 For Scenario 3 (Muja A, B, Muja C, D, Collie A, B, Worsley and Bluewaters I), contours of *highest* hourly-averaged concentration of NO_2 (ppb) modelled by TAPM for 2001. Red window symbol denotes buildings. G PS denotes the location of the proposed Griffin station at Bluewaters.

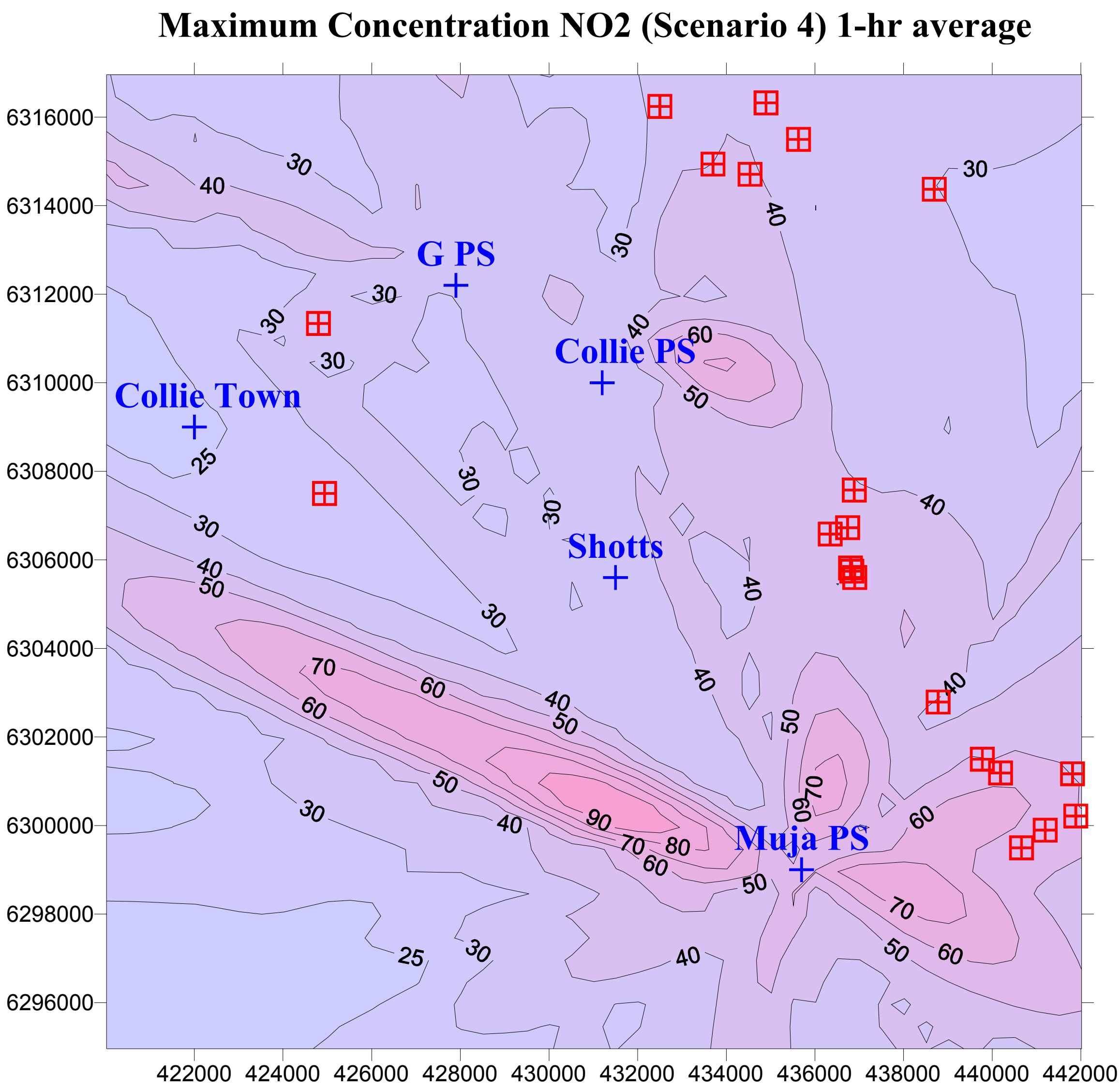

Figure F.2 For Scenario 4 (Muja A, B, Muja C, D, Collie A, B, Worsley, and Bluewaters I + II), contours of *highest* hourly-averaged concentration of NO_2 (ppb) modelled by TAPM for 2001. Red window symbol denotes buildings. G PS denotes the location of the proposed Griffin station at Bluewaters.

Maximum Concentration NO2 (Scenario 5) 1-hr average

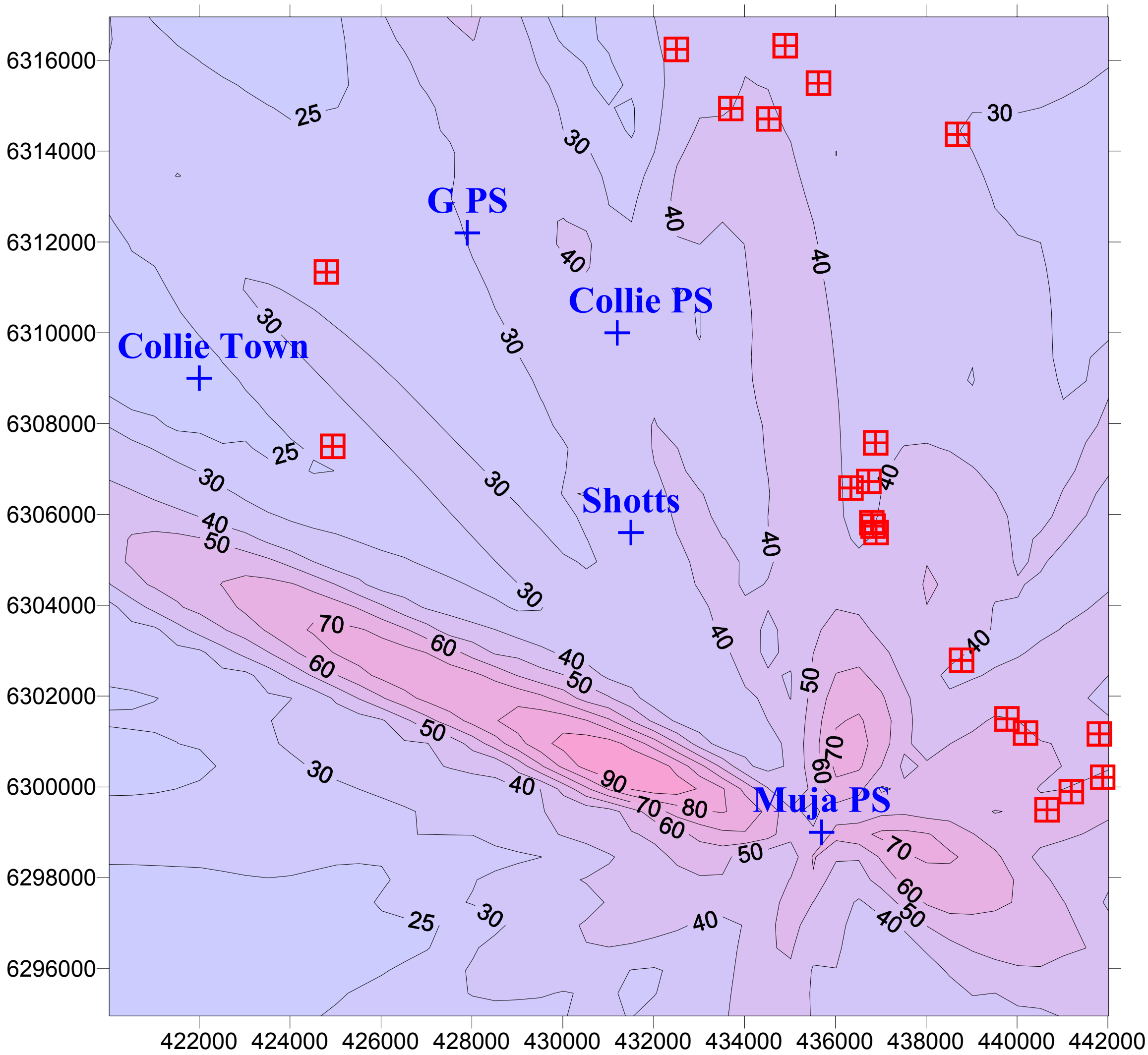

Figure F.3 For Scenario 5 (Muja A, B, Muja C, D, Collie A, B, and Worsley), contours of *highest* hourly-averaged concentration of NO_2 (ppb) modelled by TAPM for 2001. Red window symbol denotes buildings. G PS denotes the location of the proposed Griffin station at Bluewaters.

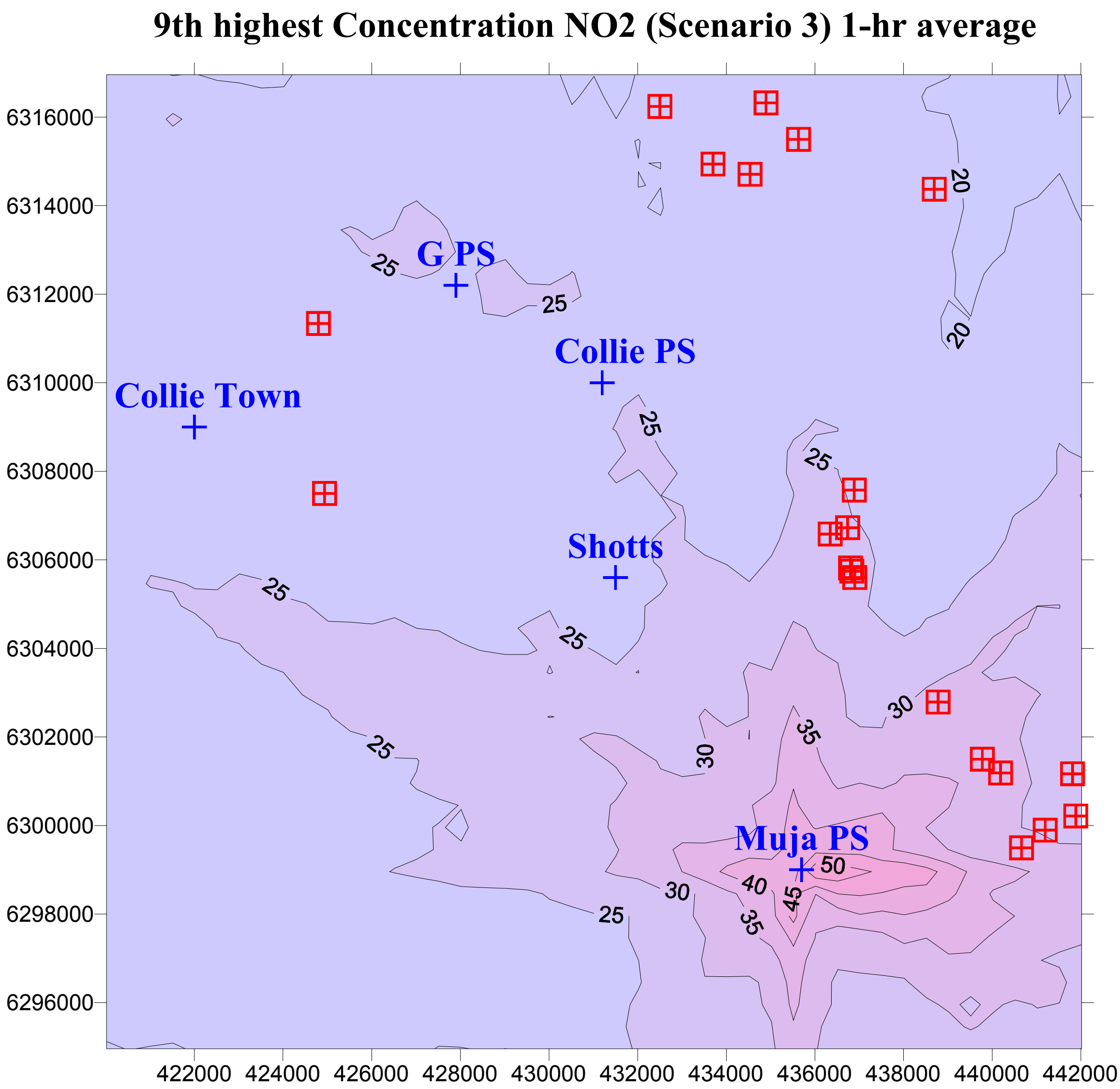

Figure F.4 For Scenario 3 (Muja A, B, Muja C, D, Collie A, B, Worsley and Bluewaters I), contours of *9th-highest* hourly-averaged concentration of NO_2 (ppb) modelled by TAPM for 2001. Red window symbol denotes buildings. G PS denotes the location of the proposed Griffin station at Bluewaters.

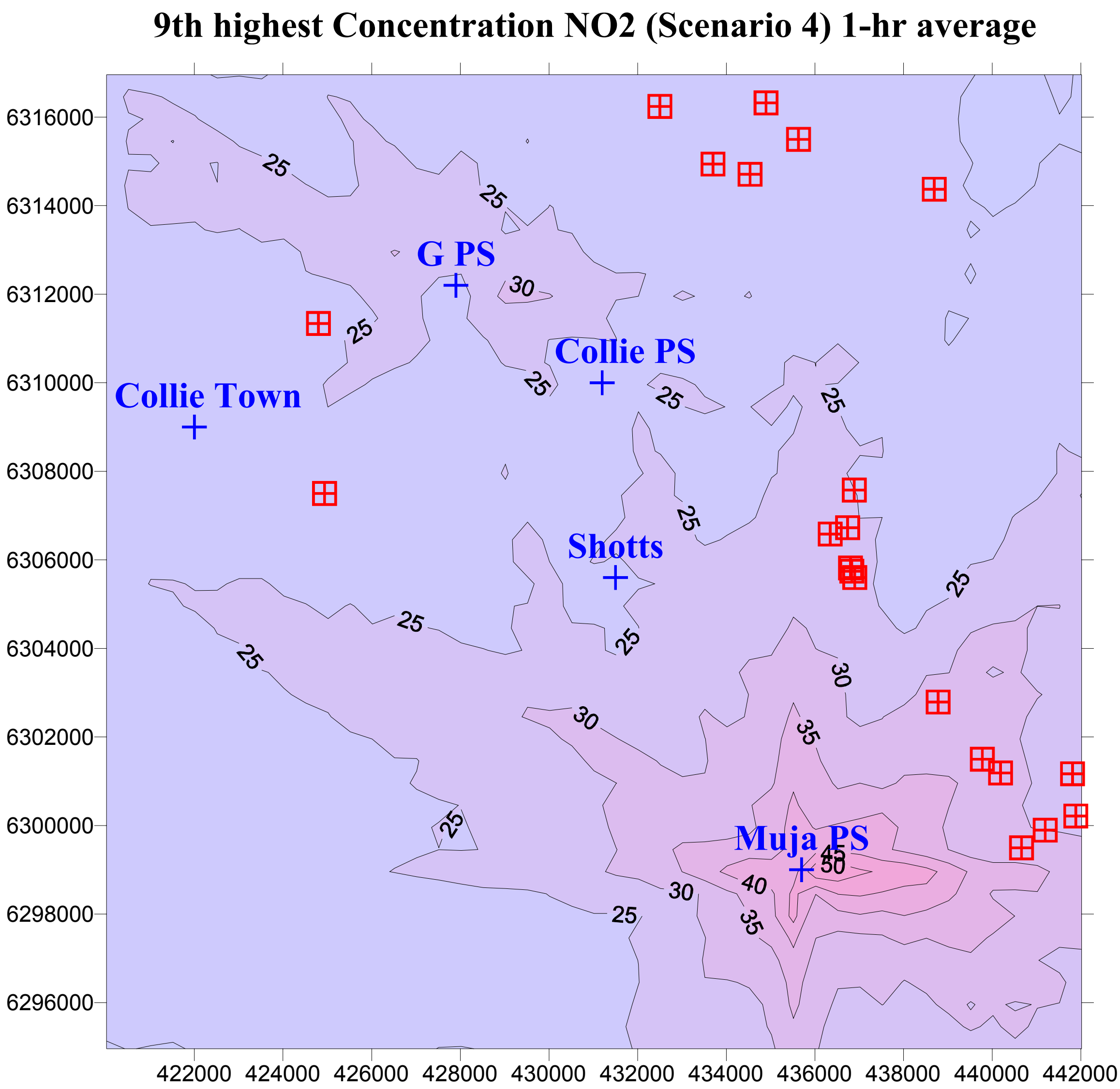

Figure F.5 For Scenario 4 (Muja A, B, Muja C, D, Collie A, B, Worsley, and Bluewaters I + II), contours of *9th-highest* hourly-averaged concentration of NO_2 (ppb) modelled by TAPM for 2001. Red window symbol denotes buildings. G PS denotes the location of the proposed Griffin station at Bluewaters.

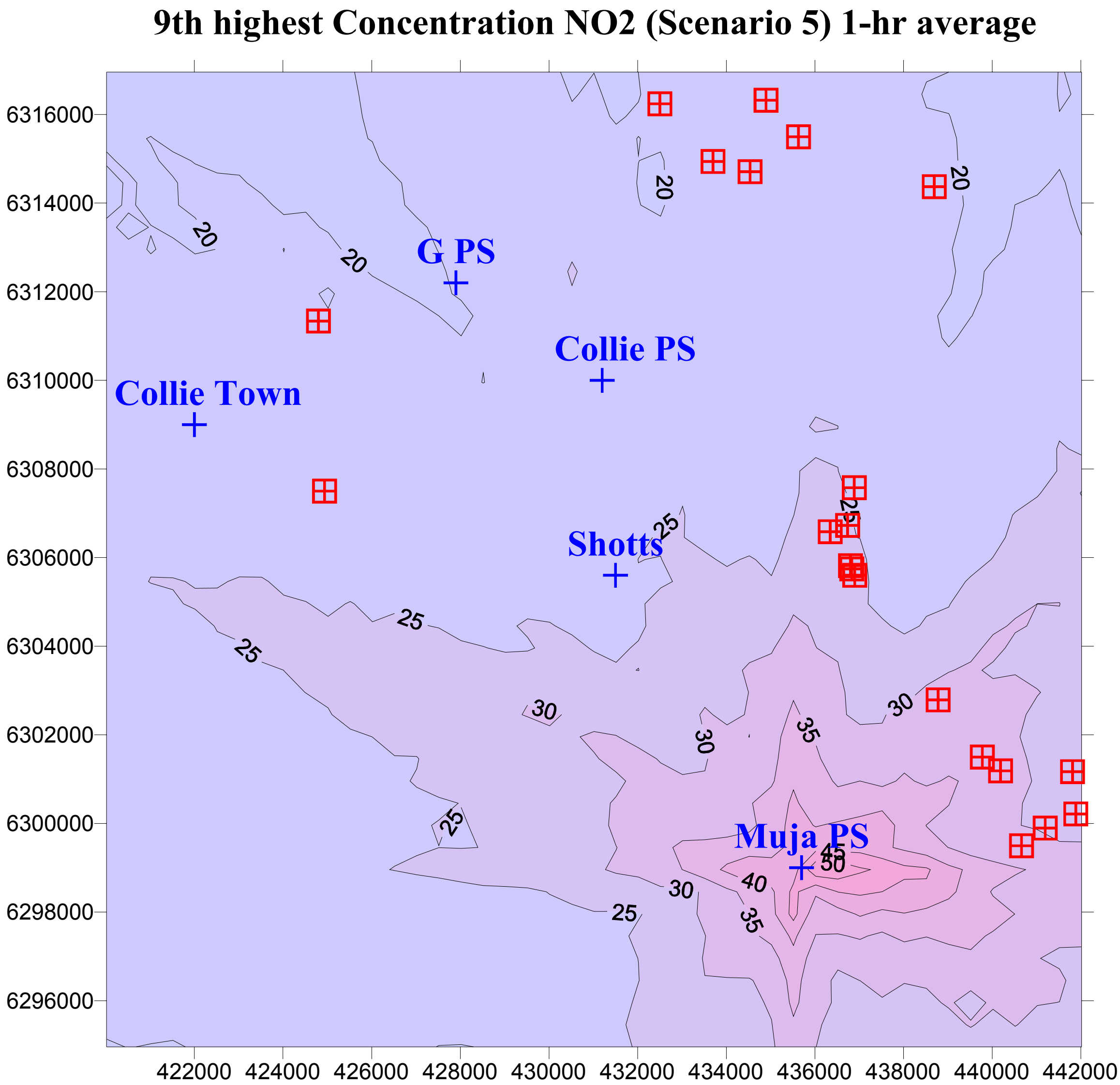

Figure F.6 For Scenario 5 (Muja A, B, Muja C, D, Collie A, B, and Worsley), contours of *9th-highest* hourly-averaged concentration of NO_2 (ppb) modelled by TAPM for 2001. Red window symbol denotes buildings. G PS denotes the location of the proposed Griffin station at Bluewaters.

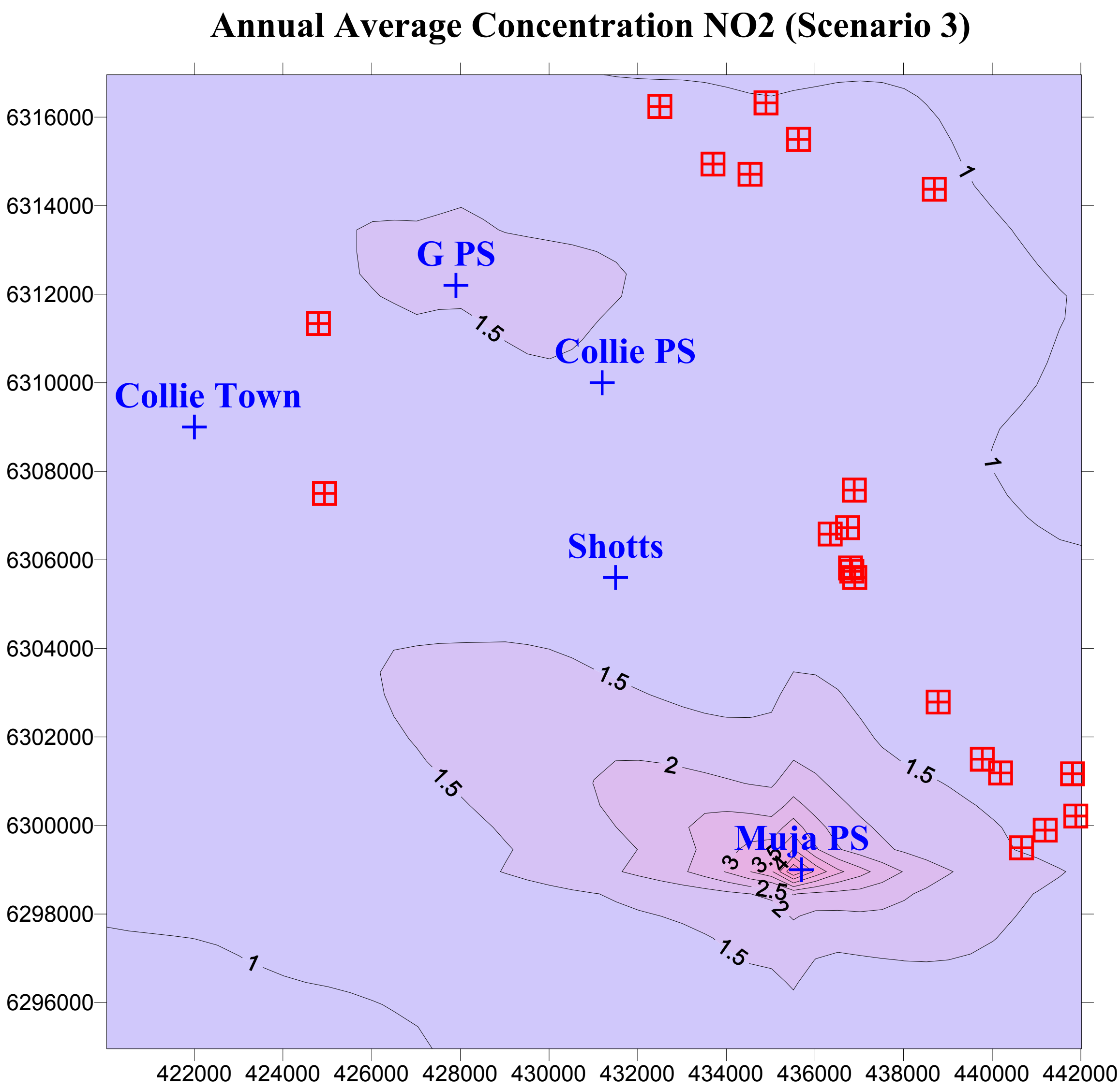

Figure F.7 For Scenario 3 (Muja A, B, Muja C, D, Collie A, B, Worsley and Bluewaters I), contours of annual-averaged concentration of NO_2 (ppb) modelled by TAPM for 2001. Red window symbol denotes buildings. G PS denotes the location of the proposed Griffin station at Bluewaters.

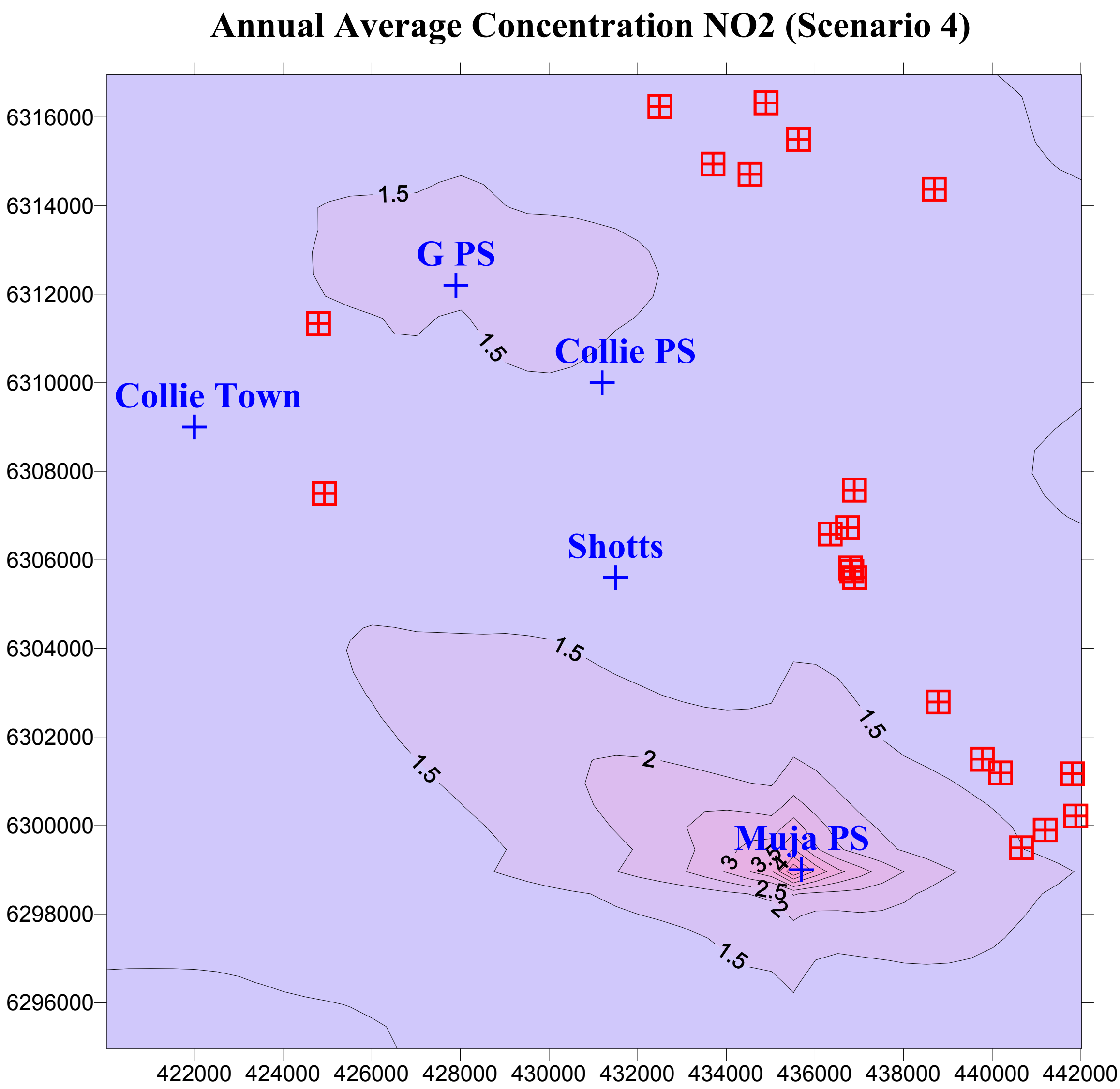

Figure F.8 For Scenario 4 (Muja A, B, Muja C, D, Collie A, B, Worsley, and Bluewaters I + II), contours of annual-averaged concentration of NO_2 (ppb) modelled by TAPM for 2001. Red window symbol denotes buildings. G PS denotes the location of the proposed Griffin station at Bluewaters.

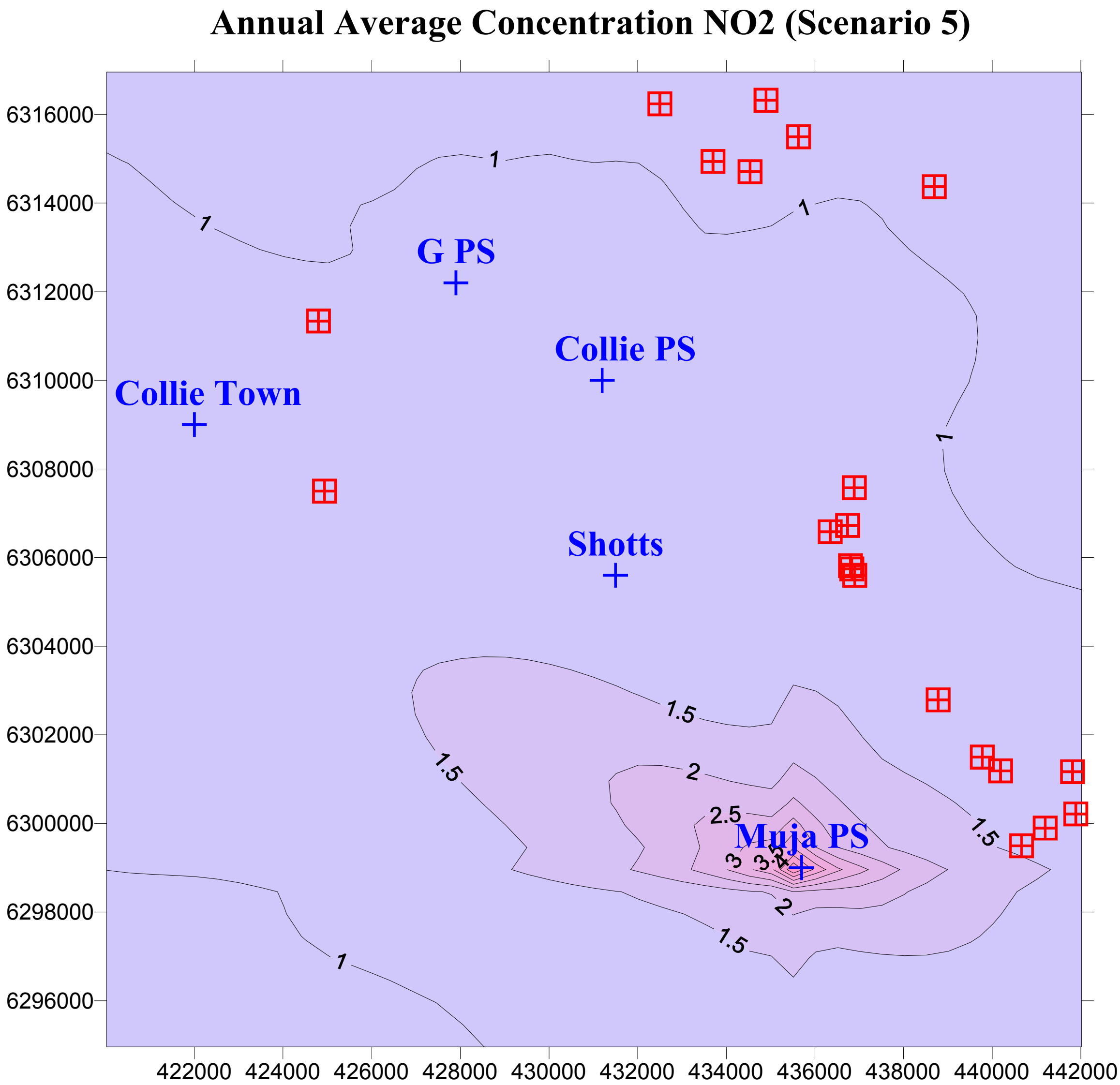

Figure F.9 For Scenario 5 (Muja A, B, Muja C, D, Collie A, B, and Worsley), contours of annual-averaged concentration of NO_2 (ppb) modelled by TAPM for 2001. Red window symbol denotes buildings. G PS denotes the location of the proposed Griffin station at Bluewaters.

Appendix G Contour plots for TAPM O_3 concentrations

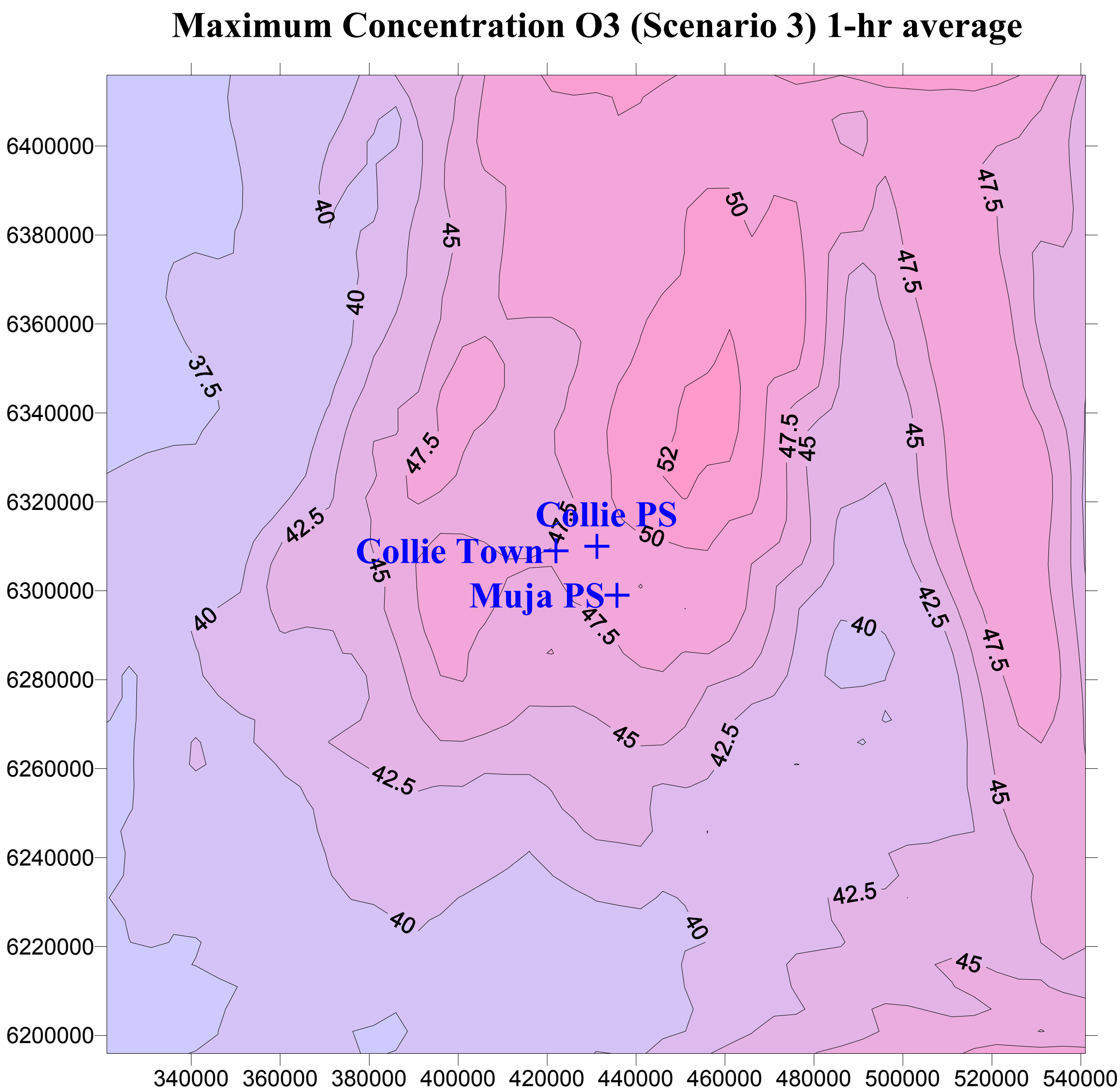

Figure G.1 For Scenario 3 (Muja A, B, Muja C, D, Collie A, B, Worsley and Bluewaters I), contours of *highest* hourly-averaged concentration of O_3 (ppb) modelled by TAPM for 2001.

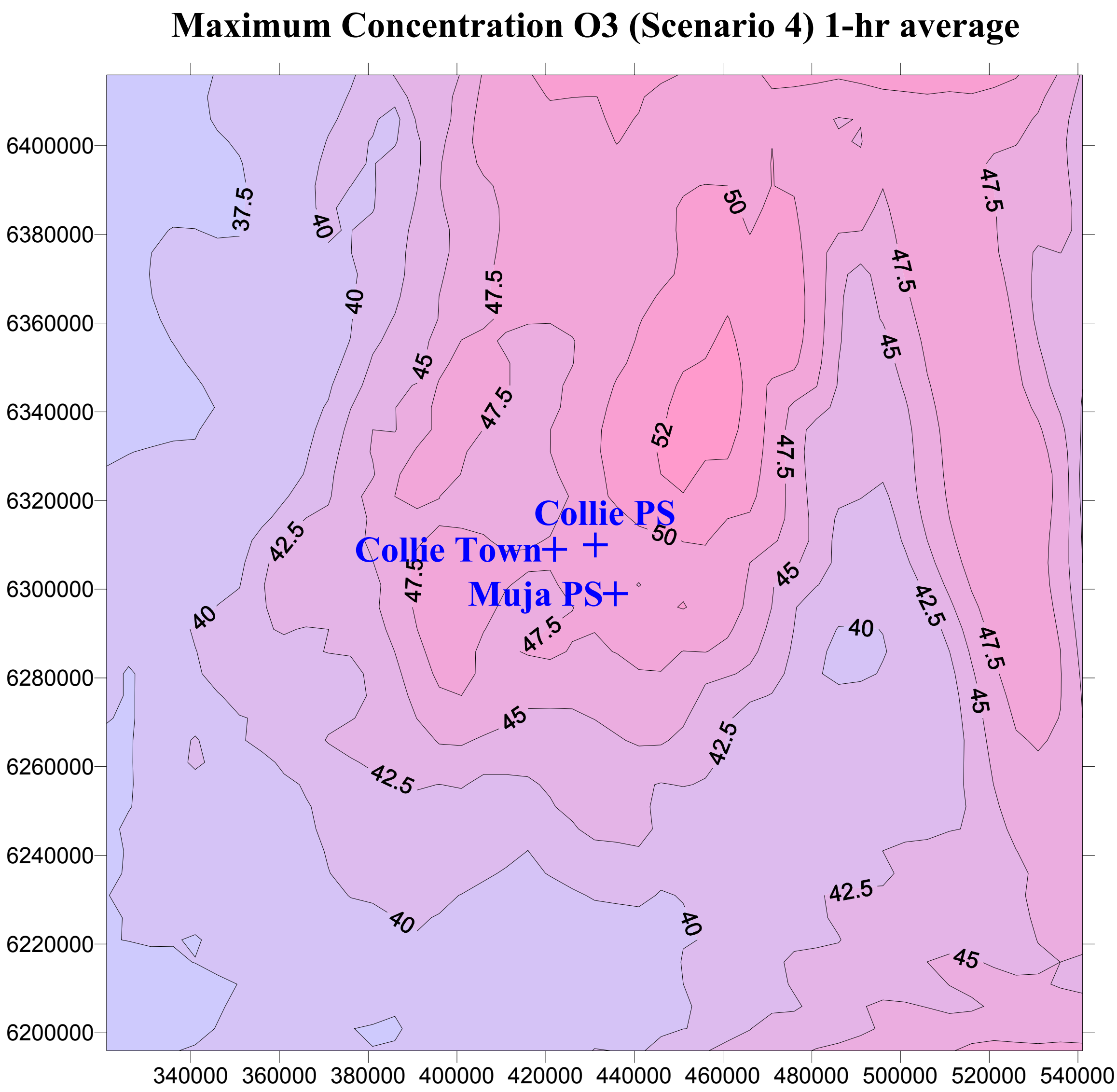

Figure G.2 For Scenario 4 (Muja A, B, Muja C, D, Collie A, B, Worsley, and Bluewaters I + II), contours of *highest* hourly-averaged concentration of O_3 (ppb) modelled by TAPM for 2001.

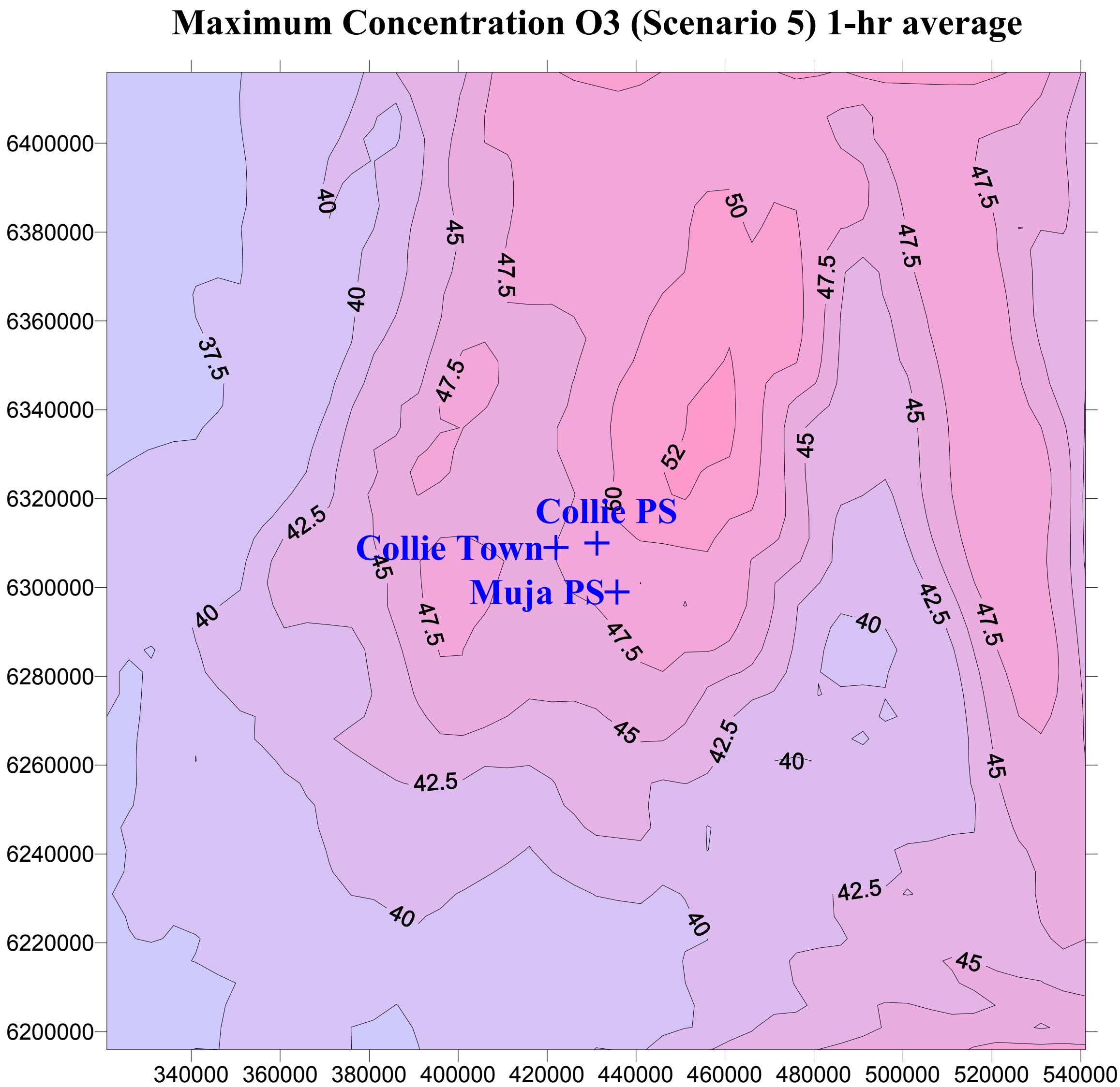

Figure G.3 For Scenario 5 (Muja A, B, Muja C, D, Collie A, B, and Worsley), contours of *highest* hourly-averaged concentration of O_3 (ppb) modelled by TAPM for 2001.

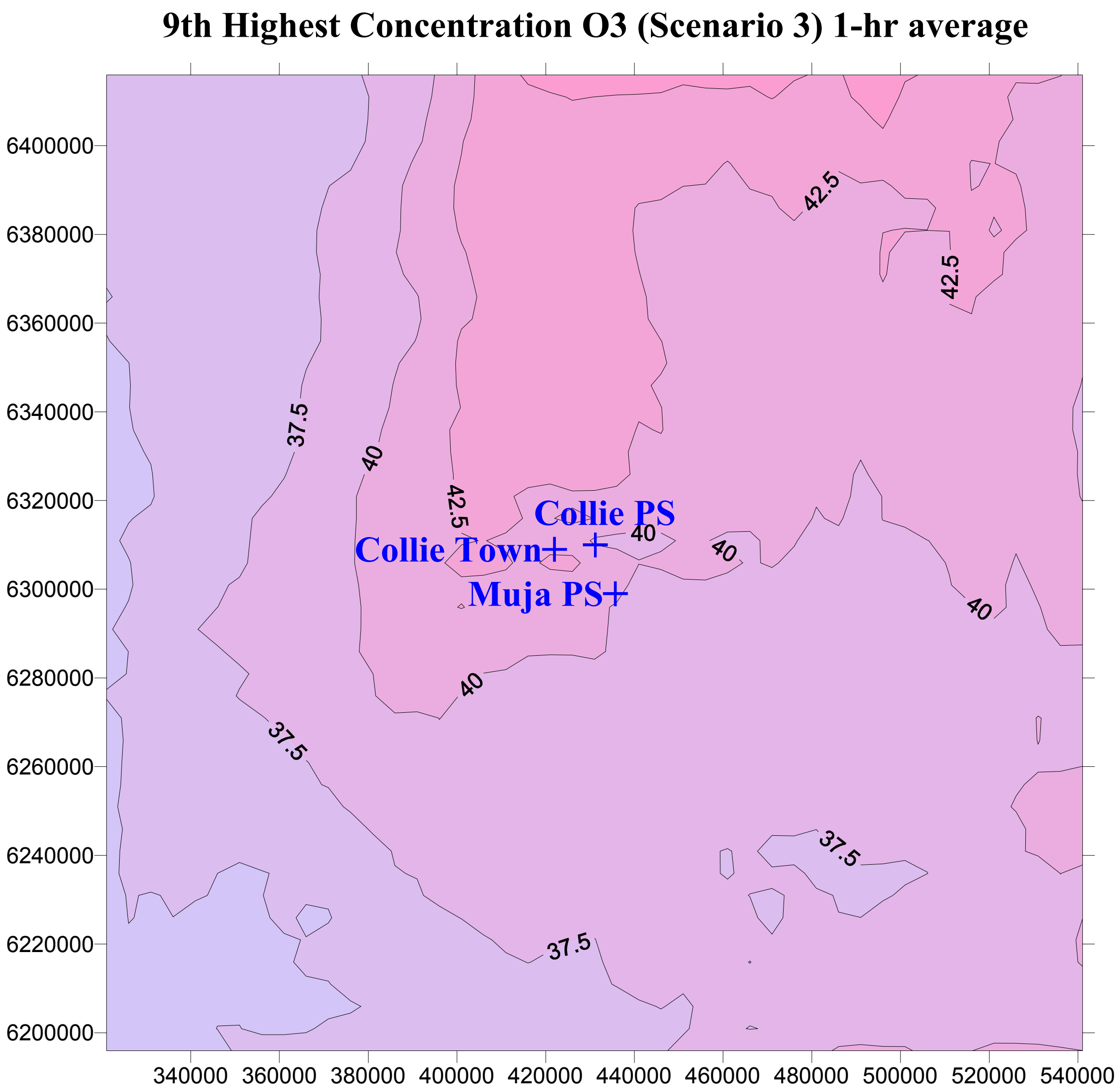

Figure G.4 For Scenario 3 (Muja A, B, Muja C, D, Collie A, B, Worsley and Bluewaters I), contours of *9th-highest* hourly-averaged concentration of O_3 (ppb) modelled by TAPM for 2001.

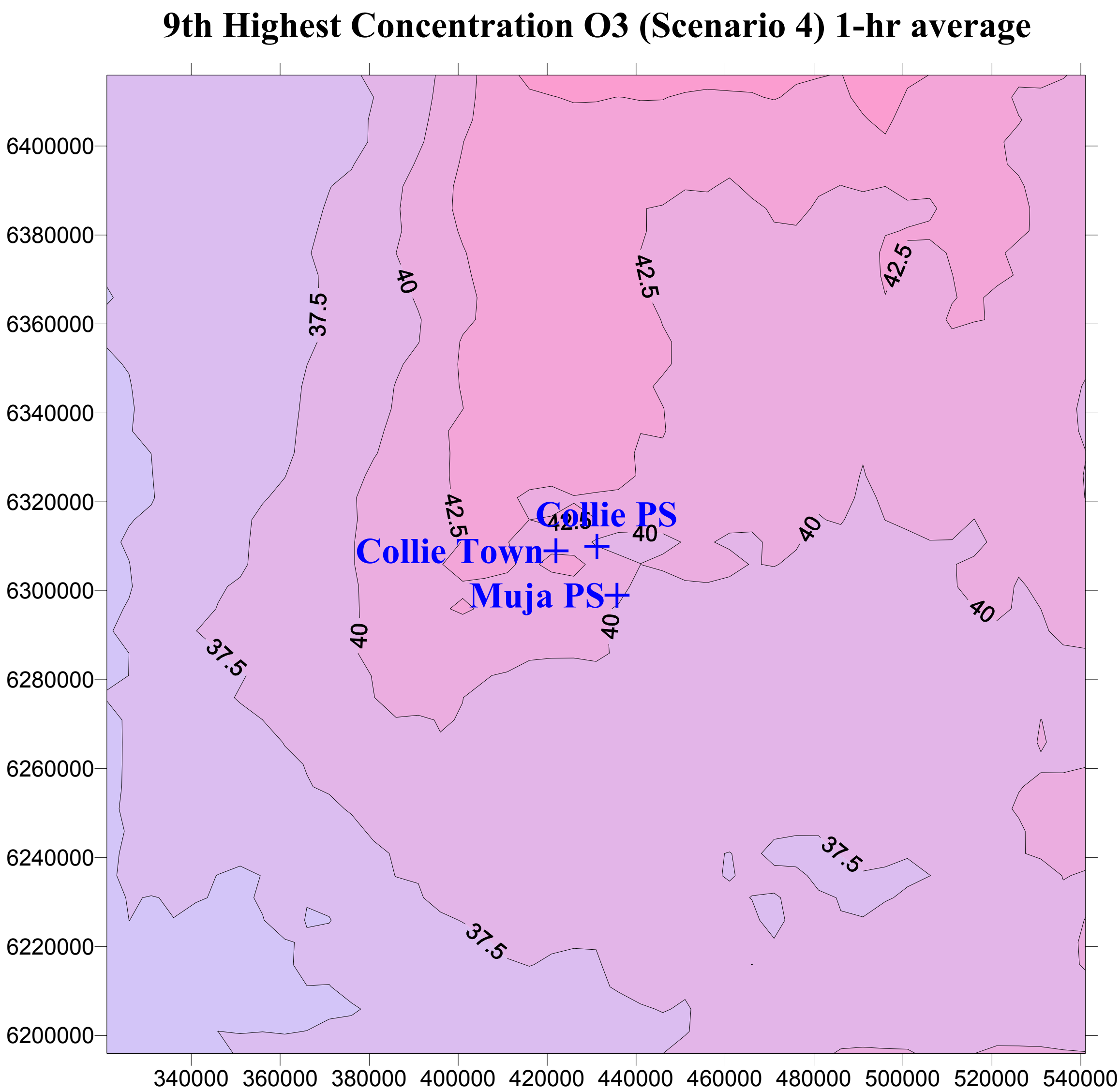

Figure G.5 For Scenario 4 (Muja A, B, Muja C, D, Collie A, B, Worsley, and Bluewaters I + II), contours of *9^th^-highest* hourly-averaged concentration of O_3 (ppb) modelled by TAPM for 2001.

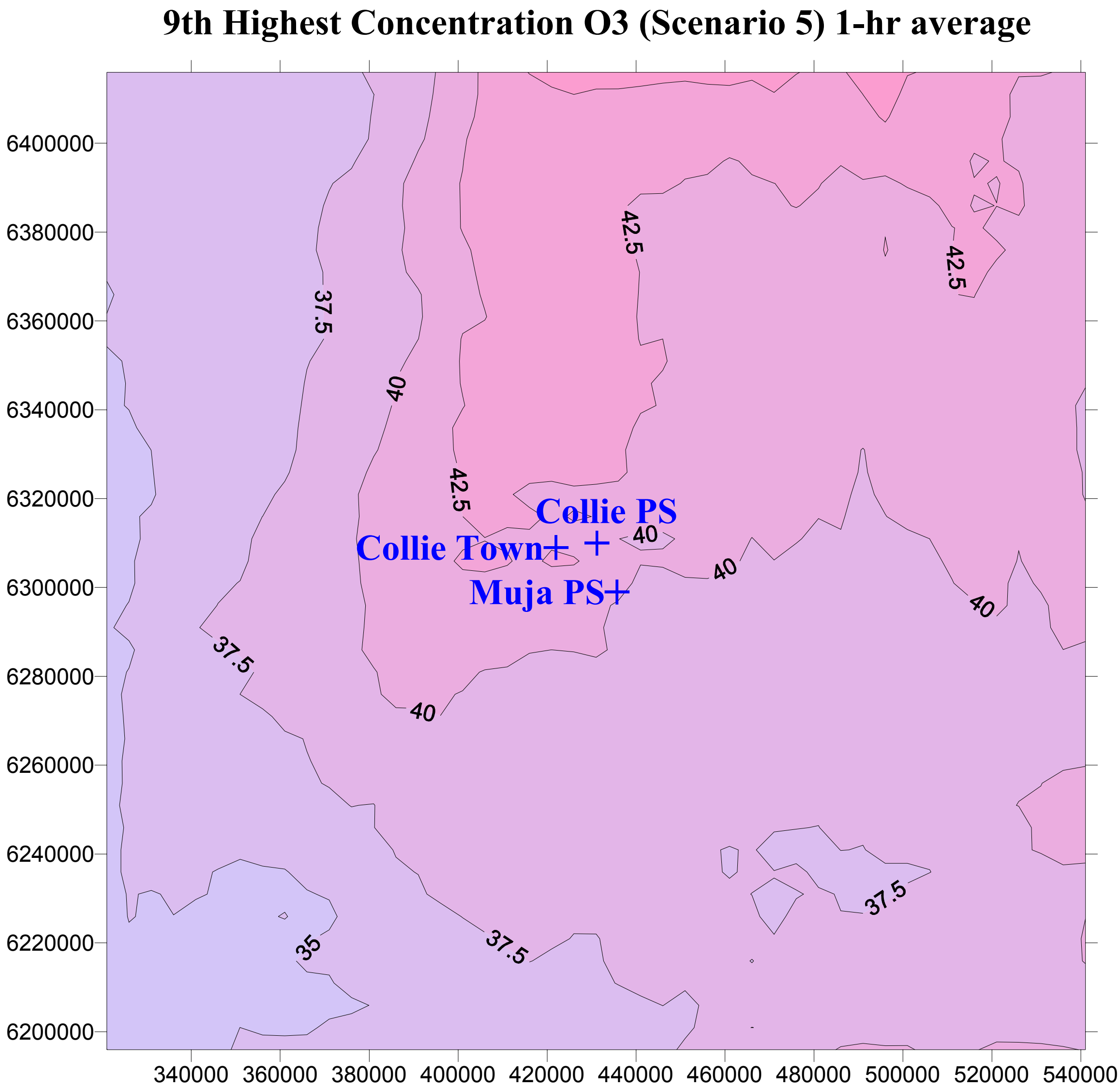

Figure G.6 For Scenario 5 (Muja A, B, Muja C, D, Collie A, B, and Worsley), contours of *9th-highest* hourly-averaged concentration of O_3 (ppb) modelled by TAPM for 2001.

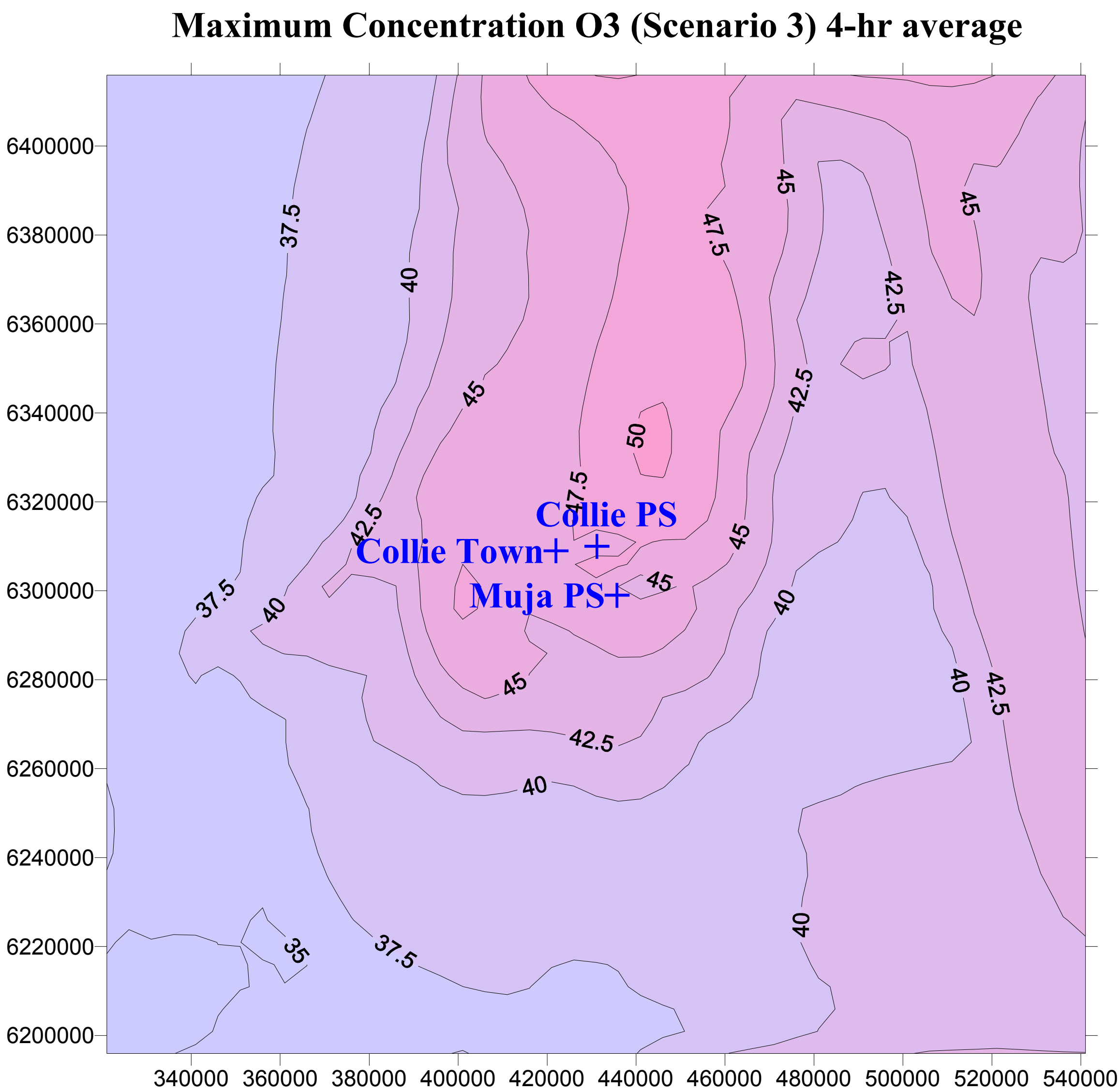

Figure G.7 For Scenario 3 (Muja A, B, Muja C, D, Collie A, B, Worsley and Bluewaters I), contours of *highest* 4-hour-averaged concentration of O_3 (ppb) modelled by TAPM for 2001.

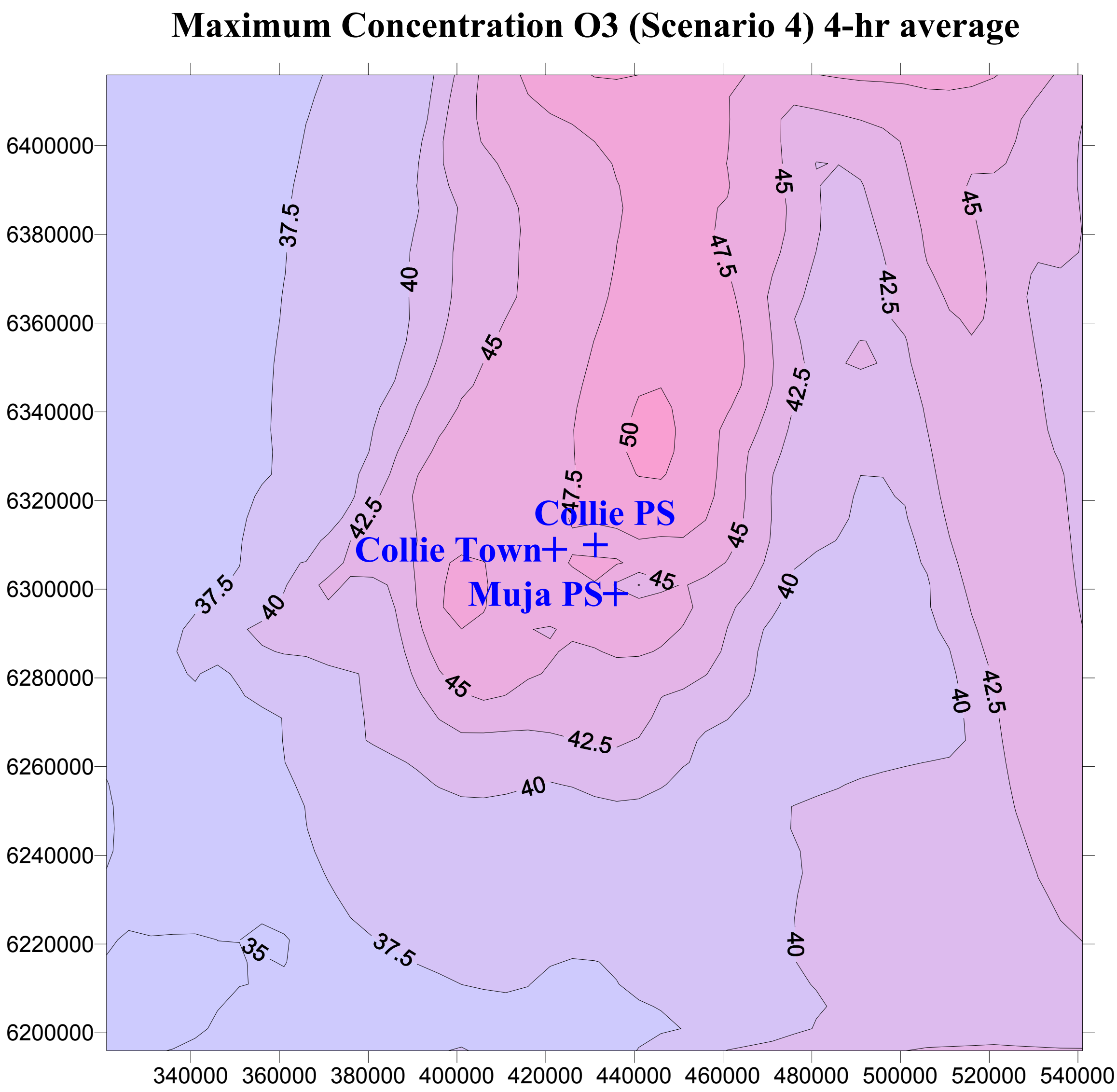

Figure G.8 For Scenario 4 (Muja A, B, Muja C, D, Collie A, B, Worsley, and Bluewaters I + II), contours of *highest* 4-hour-averaged concentration of O_3 (ppb) modelled by TAPM for 2001.

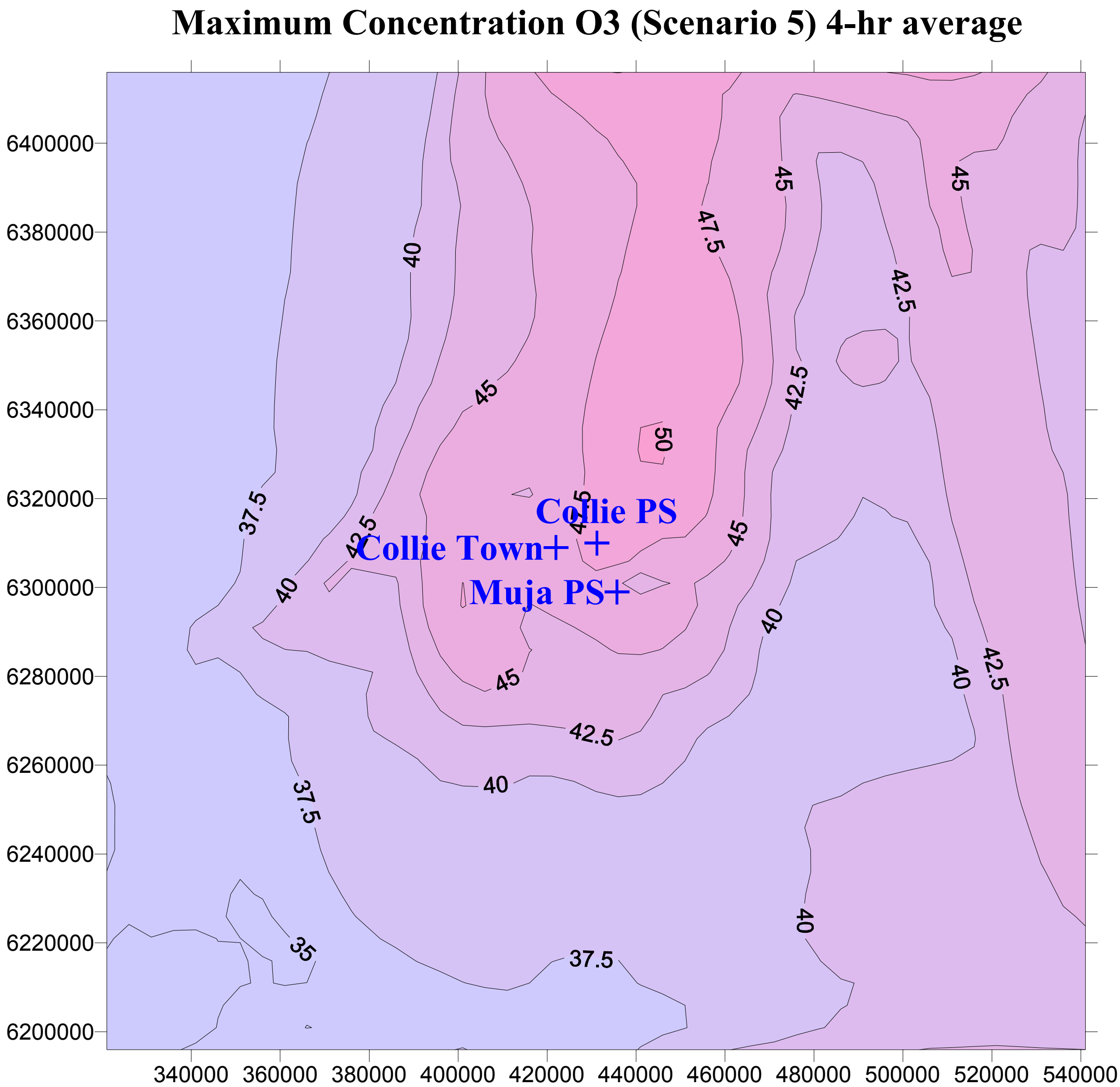

Figure G.9 For Scenario 5 (Muja A, B, Muja C, D, Collie A, B, and Worsley), contours of *highest* 4-hour-averaged concentration of O_3 (ppb) modelled by TAPM for 2001.

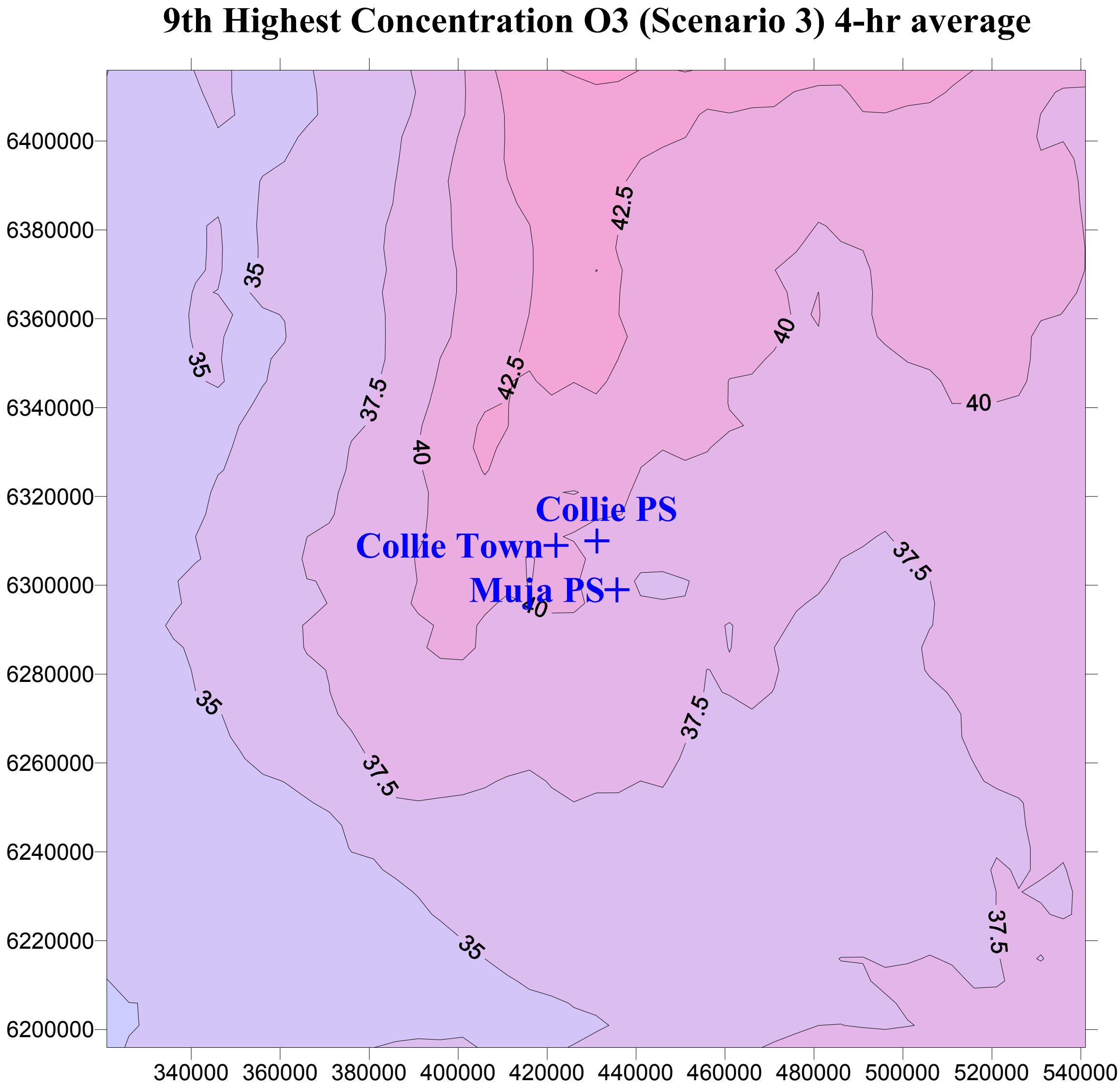

Figure G.10 For Scenario 3 (Muja A, B, Muja C, D, Collie A, B, Worsley and Bluewaters I), contours of *9th highest* 4-hour-averaged concentration of O_3 (ppb) modelled by TAPM for 2001.

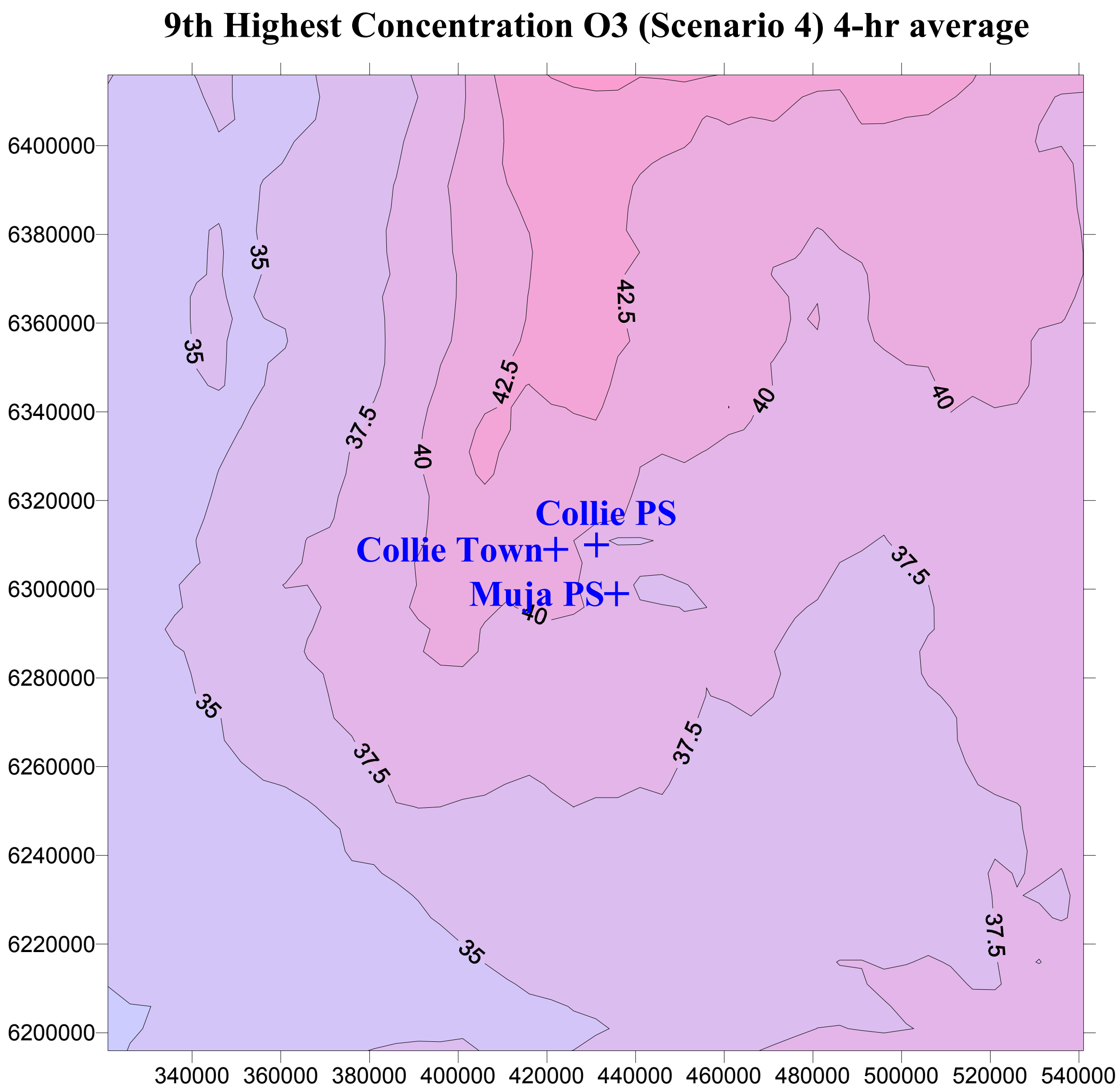

Figure G.11 For Scenario 4 (Muja A, B, Muja C, D, Collie A, B, Worsley, and Bluewaters I + II), contours of *9th highest* 4-hour-averaged concentration of O_3 (ppb) modelled by TAPM for 2001.

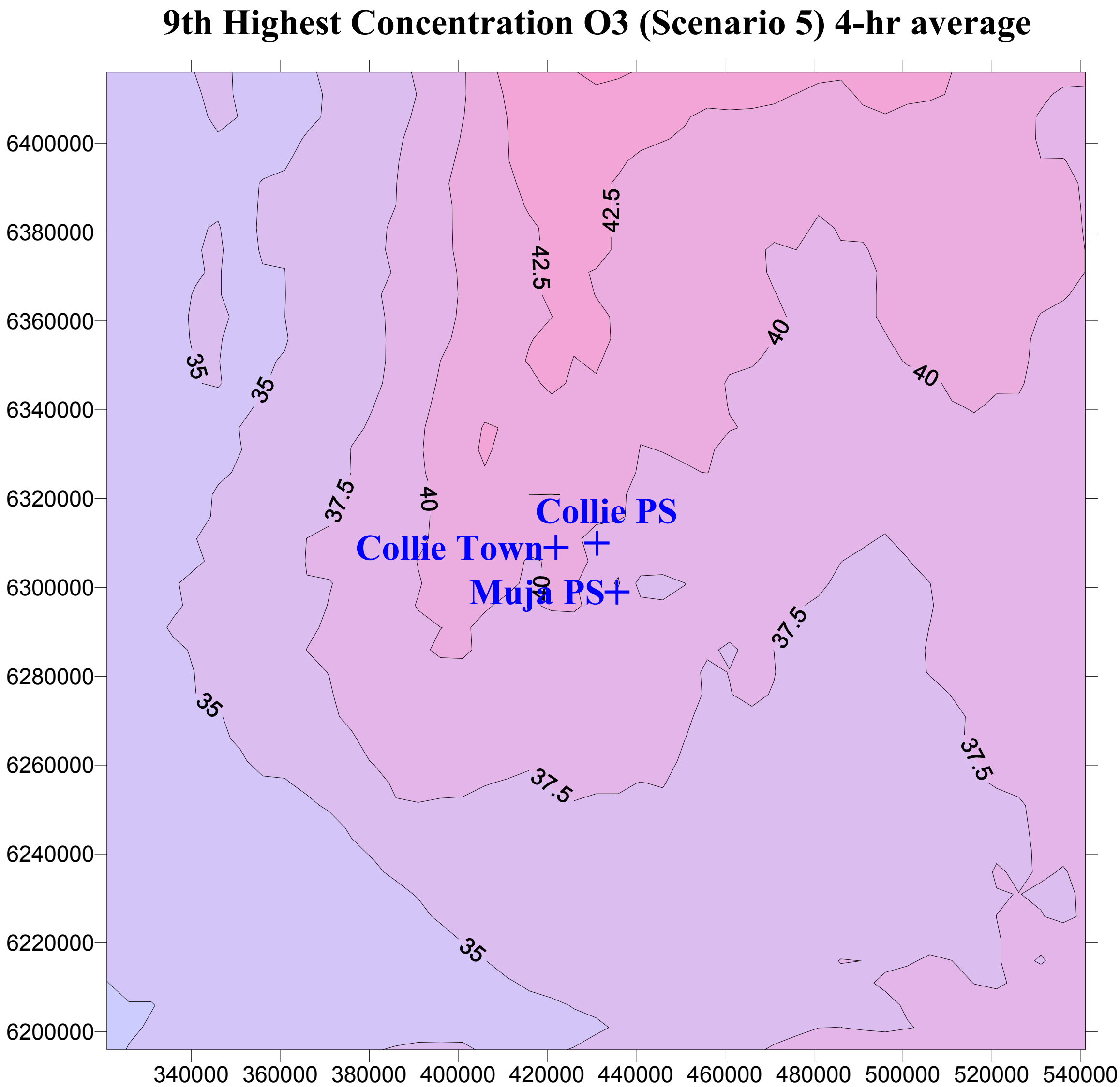

Figure G.12 For Scenario 5 (Muja A, B, Muja C, D, Collie A, B, and Worsley), contours of *9[th] highest* 4-hour-averaged concentration of O_3 (ppb) modelled by TAPM for 2001.

Appendix H Contour plots for TAPM PM_{10} concentrations

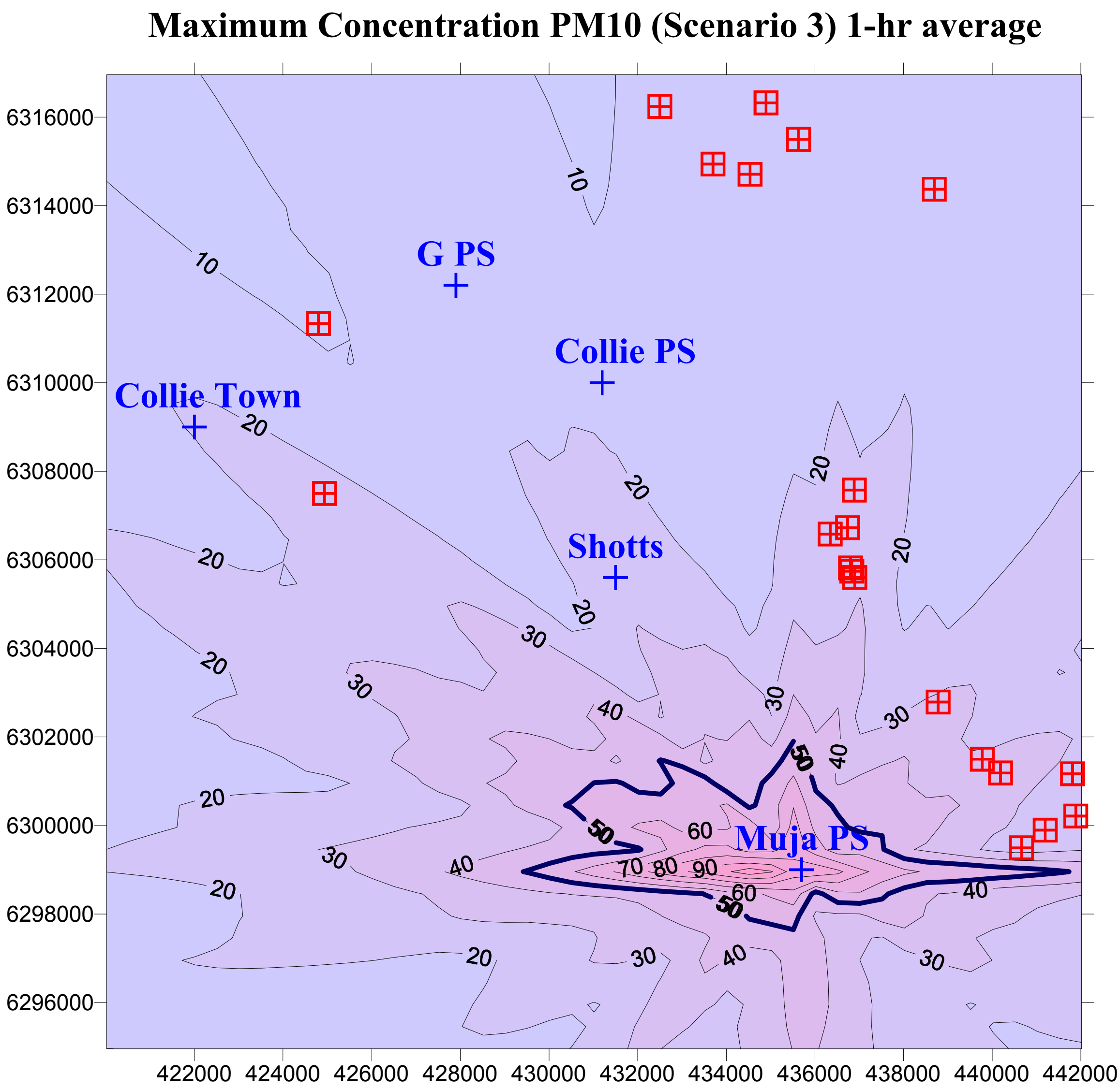

Figure H.1 For Scenario 3 (Muja A, B, Muja C, D, Collie A, B, Worsley and Bluewaters I), contours of *highest* 24-hour-averaged concentration of PM10 (µg m^{-3}) modelled by TAPM for 2001. Thick contour denotes NEPM standard (50 µg m^{-3}), red window symbol denotes buildings. G PS denotes the location of the proposed Griffin station at Bluewaters.

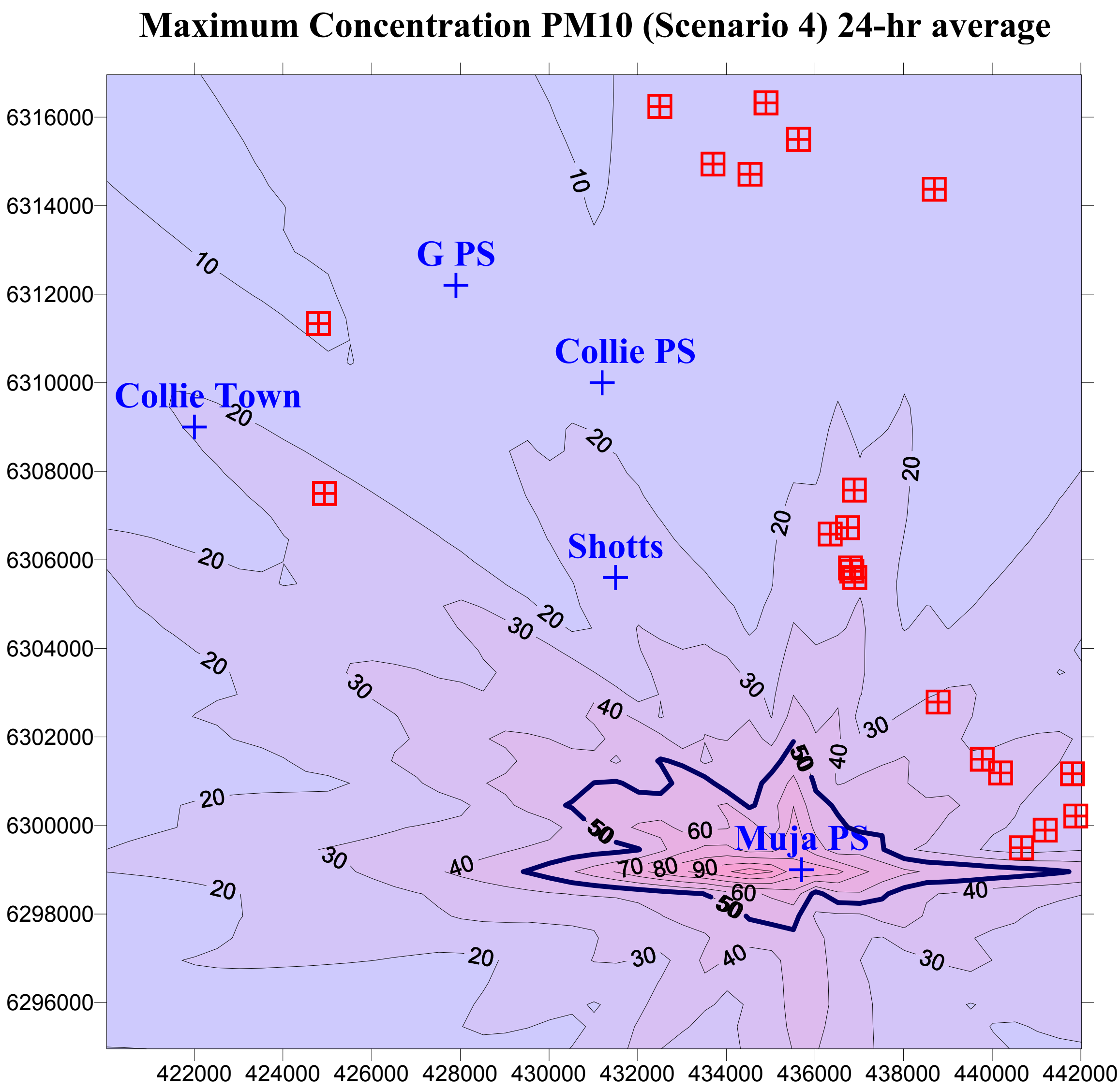

Figure H.2 For Scenario 4 (Muja A, B, Muja C, D, Collie A, B, Worsley, and Bluewaters I + II), contours of *highest* 24-hour-averaged concentration of PM10 ($\mu g\ m^{-3}$) modelled by TAPM for 2001. Thick contour denotes NEPM standard (50 $\mu g\ m^{-3}$), red window symbol denotes buildings. G PS denotes the location of the proposed Griffin station at Bluewaters.

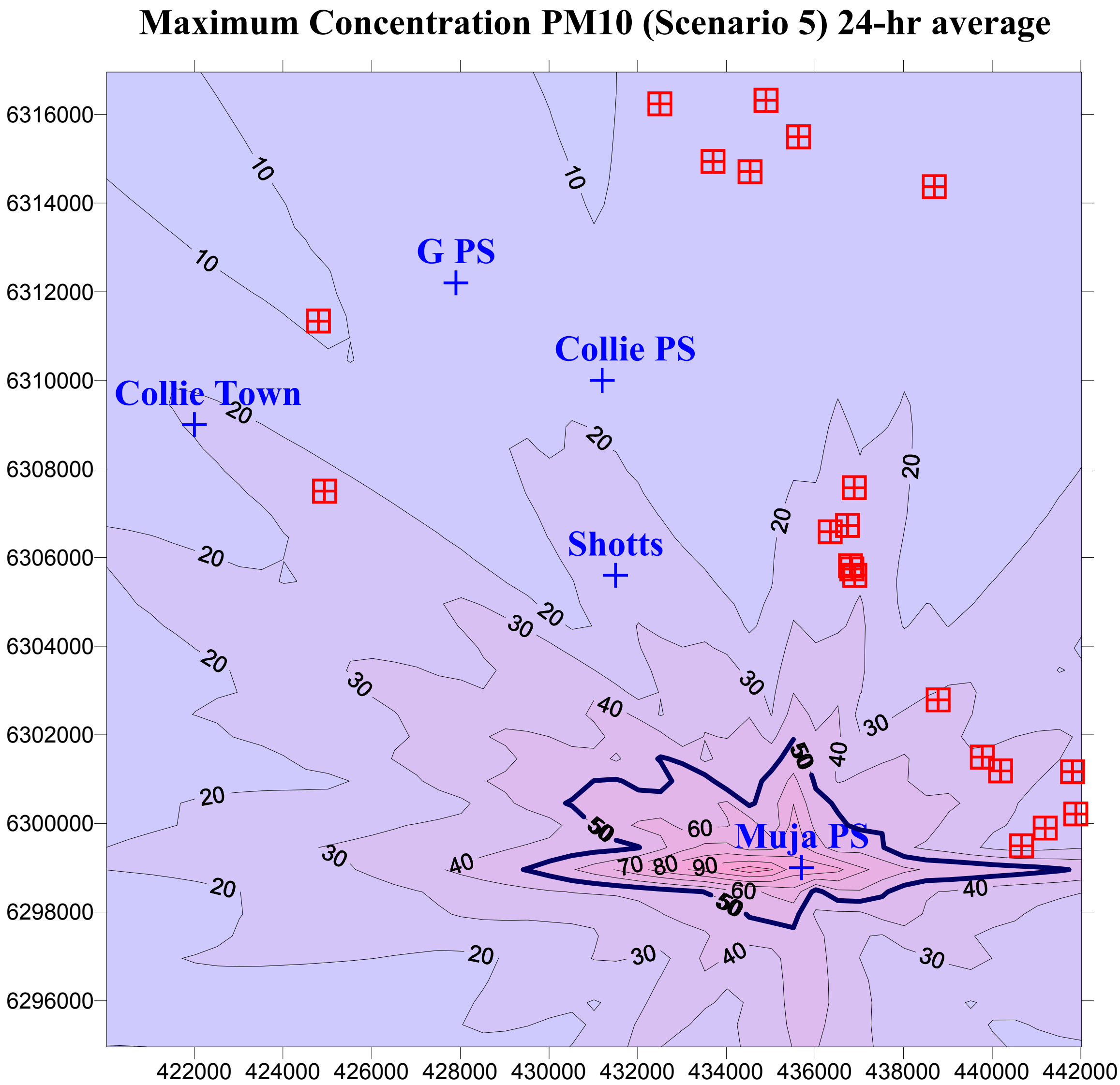

Figure H.3 For Scenario 5 (Muja A B, Muja C, D, Collie A, B, and Worsley), contours of *highest* 24-hour-averaged concentration of PM10 (μg m^{-3}) modelled by TAPM for 2001. Thick contour denotes NEPM standard (50 μg m^{-3}), red window symbol denotes buildings. G PS denotes the location of the proposed Griffin station at Bluewaters.

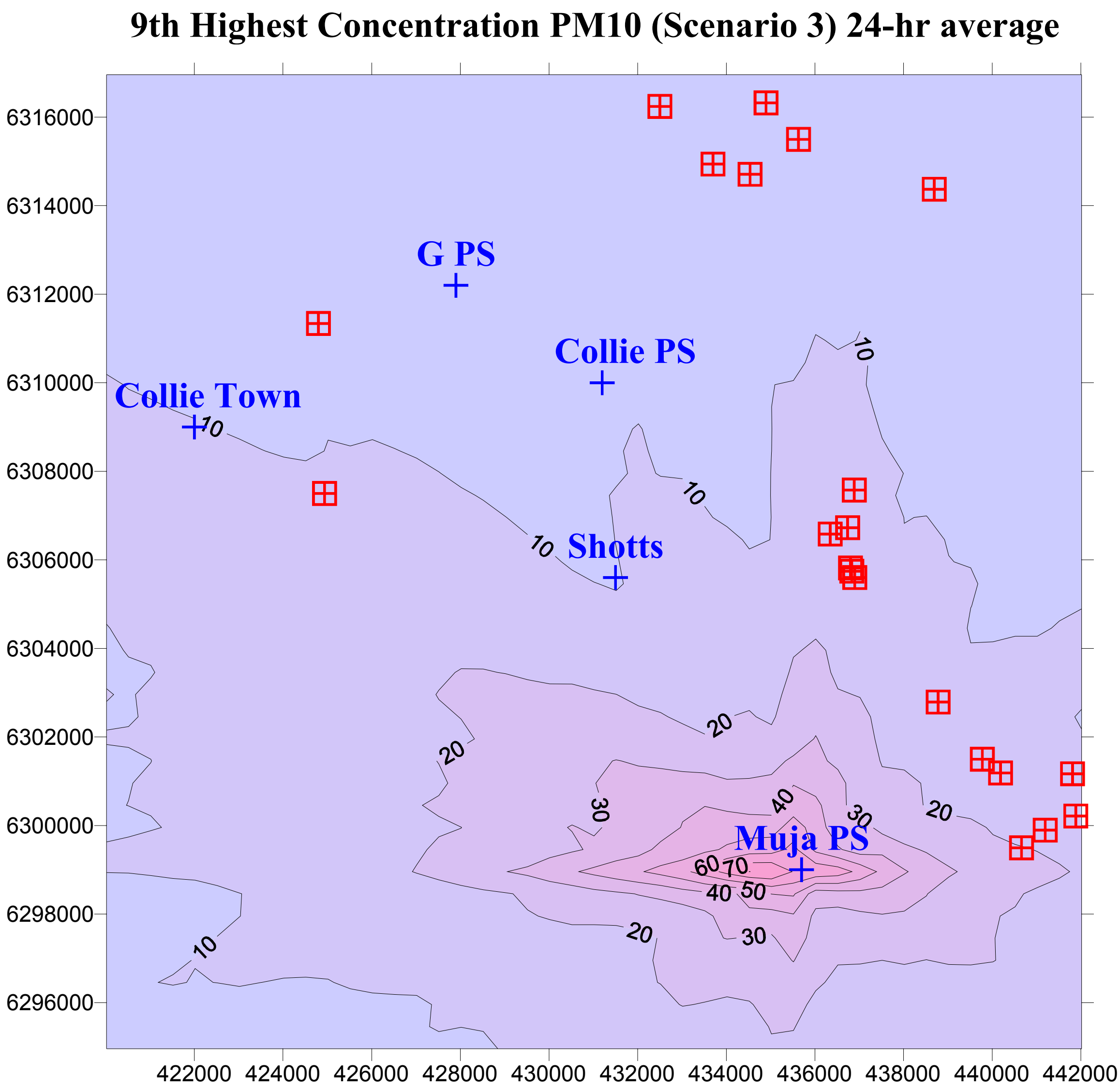

Figure H.4 For Scenario 3 (Muja A B, Muja C, D, Collie A, B, Worsley and Bluewaters I), contours of *9th highest* 24-hour-averaged concentration of PM10 (µg m^{-3}) modelled by TAPM for 2001. Thick contour denotes NEPM standard (50 µg m^{-3}), red window symbol denotes buildings. G PS denotes the location of the proposed Griffin station at Bluewaters.

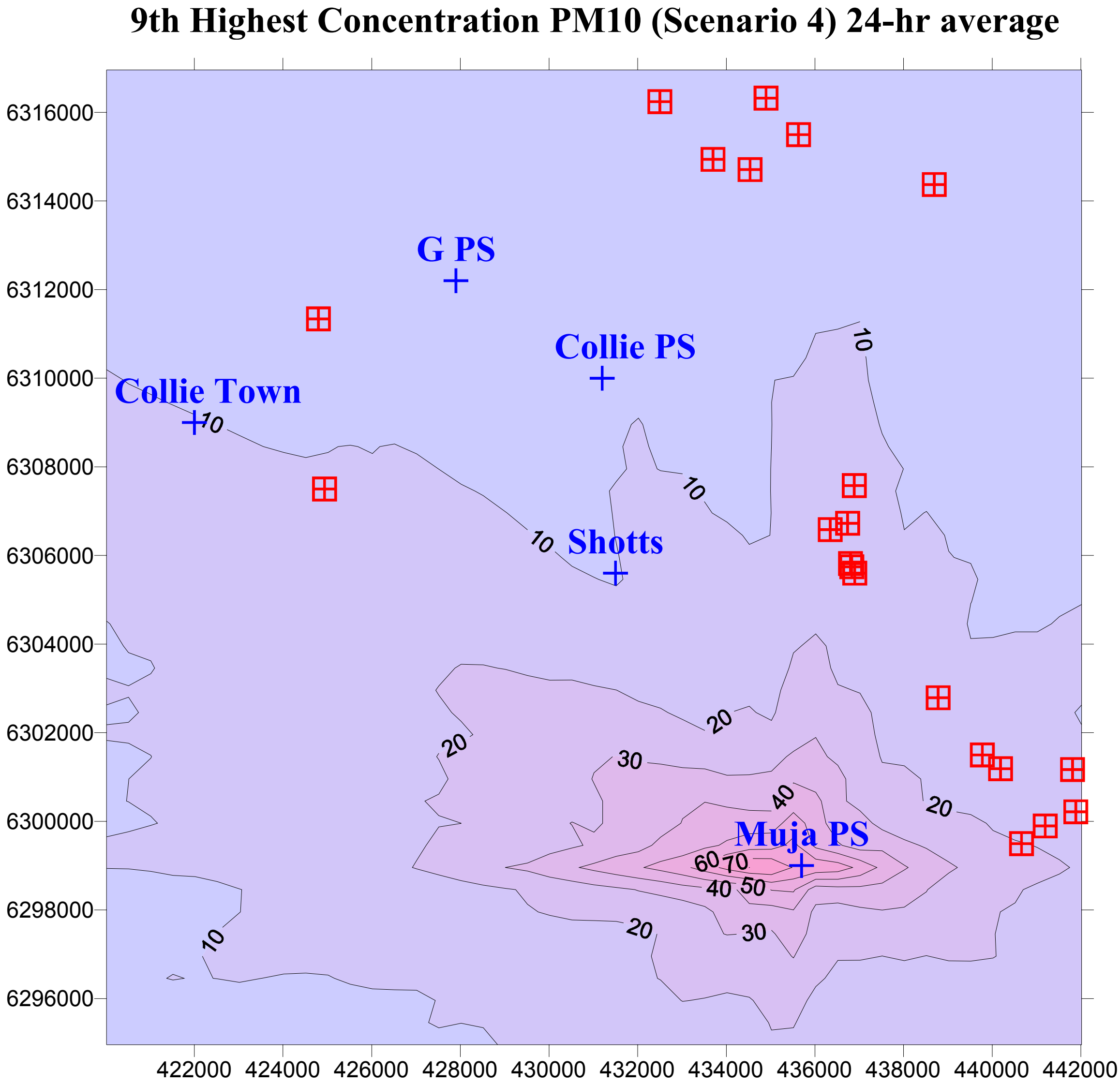

Figure H.5 For Scenario 4 (Muja A B, Muja C, D, Collie A, B, Worsley, and Bluewaters I + II), contours of *9th highest* 24-hour-averaged concentration of PM10 (µg m^{-3}) modelled by TAPM for 2001. Thick contour denotes NEPM standard (50 µg m^{-3}), red window symbol denotes buildings. G PS denotes the location of the proposed Griffin station at Bluewaters.

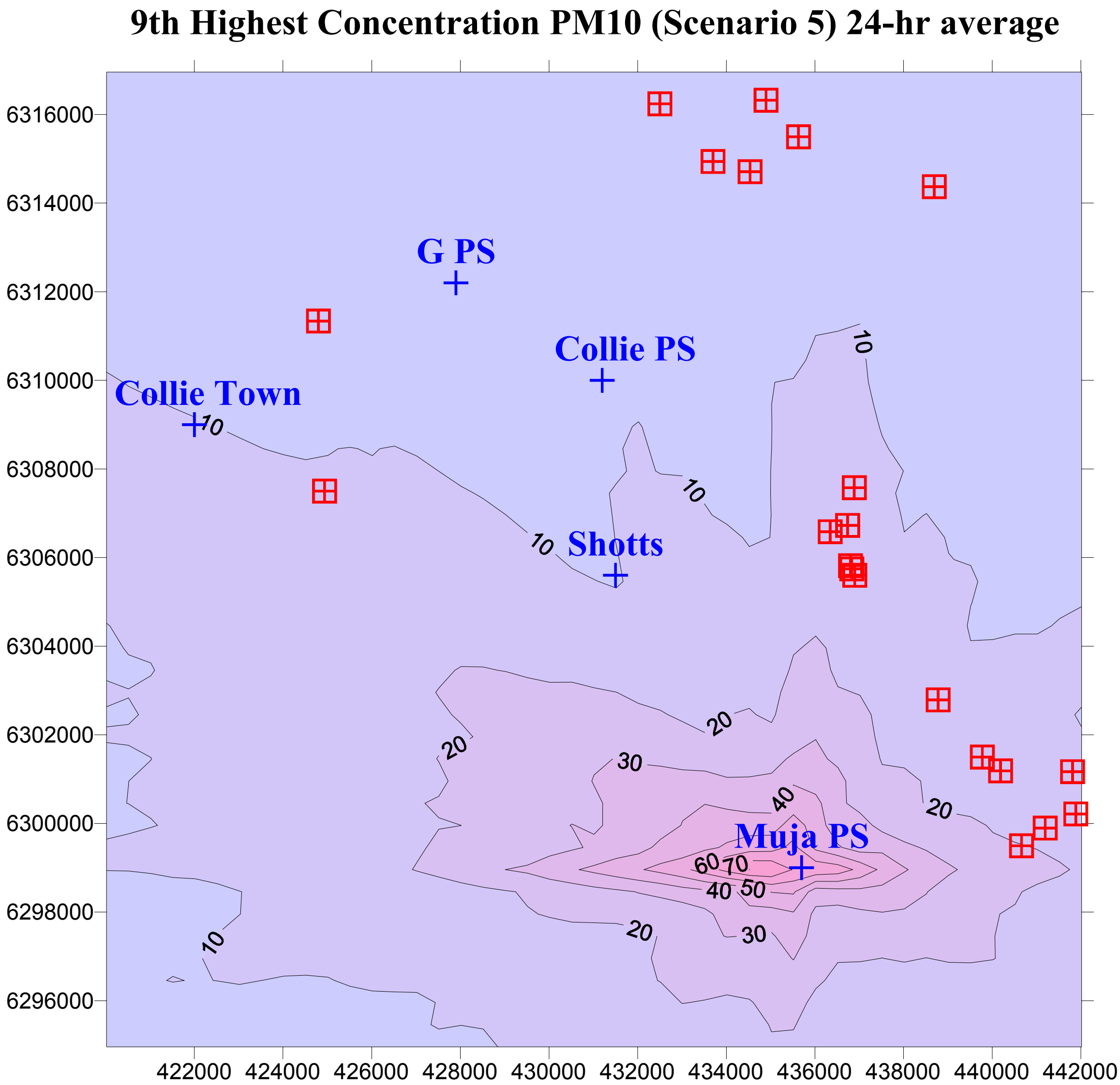

Figure H.6 For Scenario 5 (Muja A B, Muja C, D, Collie A, B, and Worsley), contours of *9th highest* 24-hour-averaged concentration of PM10 (μg m^{-3}) modelled by TAPM for 2001. Thick contour denotes NEPM standard (50 μg m^{-3}), red window symbol denotes buildings. G PS denotes the location of the proposed Griffin station at Bluewaters.

GRIFFIN ENERGY PTY LTD

Bluewaters Power Station

(Bluewaters)

Proponent's Response to Submissions

October 2004

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Summary of Submissions Received

A total of 255 submissions were received by the Environmental Protection Authority (EPA).

The submissions comprised:

- 147 pro-forma email submissions via the Bluewaters website
- 92 written pro-forma submissions
- 2 direct email submissions to the EPA.

Written submissions were received from the following:

- One private citizen
- Department of Health (DoH)
- Department of Conservation and Land Management (CALM)
- Department of Planning and Infrastructure (DPI)
- EPA Service Unit (EPASU)
- Pollution Action Network (PAN)
- Heritage Council of Western Australia (HCWA)
- Shire of Collie
- South West Development Commission (SWDC)
- Bunbury Wellington Economic Alliance (BWEA)
- Western Power Corporation (WPC)
- South West Chamber of Commerce and Industry (SWCCI)
- Department of Indigenous Affairs (DIA)
- Joint submission from the Conservation Council of WA, the Australian Conservation Foundation, WWF Australia, and Climate Action Network Australia (CCWA, ACF, WWF, CANA).

Of the submissions received there were 5 submissions totally opposed to the project (three members of the public, PAN, and CCWA, ACF, WWF, CANA), 7 submissions commented without indicating support either against or for the project (DOH, CALM, DPI, EPASU, HCWA, DIA, WPC), and 243 submissions supported the project.

Of the 239 pro-forma submissions, 72 included extra comments in the pro-forma in the space provided. Of these extra comments, only two took a position against the project, all of the remaining extra comments were in support of the proposal.

Overall the submissions received by the EPA were 95% in support of the project. In the supporting submissions the general theme was one of support as a result of the positive social and economic impacts on the town and region. The supporting submissions were also complimentary on the environmental approach adopted by Griffin Energy in proposing the project.

1 Noise

Issue 1.1 Raised by CCWA, ACF, WWF, CANA.
The Acoustic assessment provided in the Public Environmental Review (PER) has been undertaken for a power station of 150MW only, whereas Bluewaters is 200 MW.

Response The modelling for Bluewaters used noise data for a nominal 400MW unit and is therefore conservative. Refer to paragraph four on page one of the Herring Storer Environmental Acoustic Assessment.

Issue 1.2 Raised by WPC.
The noise modelling that was undertaken deals mainly with compliance at the nearest noise sensitive premises in Collie, and does not address other requirements of the *Environmental Protection (Noise) Regulations, 1997*. It is not clear from the PER document whether the proposed power station complies with the requirement to meet 60dB(A) at all undeveloped noise sensitive premises such as the nearest non-mining land, or whether cumulative noise impacts were taken into account in the modelling.

Response Part 1 – Meeting 60 dB(A) at all undeveloped premises.

The modelling carried out by Herring Storer Acoustics shows that this requirement will be met. Refer to Figures 01 and 02 of the Noise Assessment report in the PER.

Part 2 – Cumulative Noise Impact.

As Bluewaters stages I and II are effectively on the same premises, then the cumulative noise impact from both stages needs to comply with the requirements of the Regulations. As there are other industries contributing or are likely to contribute to the noise received at the neighbouring premises, noise received from both stages of Bluewaters, to comply with the Regulations, needs to be considered as not significantly contributing to the noise received at the neighbouring noise sensitive premises. To be considered as not being a significant contributor to the noise received at the neighbouring premises, noise received from Bluewaters needs to be less than 30 dB(A).

The modelling of the Bluewaters Stage I was based on noise levels from a 400MW power station. Therefore, we believe that the modelling of Bluewaters is conservative. The addition of Bluewaters Stage 2 has been subsequently modelled, and the results show that the combined noise level received at the neighbouring residential premises will comply with the requirements of the Environmental Protection (Noise) Regulation 1997 in that at the closest noise sensitive premises the cumulative noise would be 29 dB(A) under Environmental Protection Authority (EPA) standard weather conditions as described in EPA Draft Guidance for

Assessment of Environmental Factors No. 8 - Environmental Noise. There is no measurable noise impact within the town of Collie.

2 Water Usage and Disposal

Issue 2.1 Raised by DPI.
It would be sensible for the plant design to allow the use of saline water for cooling purposes.

Response Griffin Energy will keep this option under consideration, however it should be noted that the use of lower grade water for cooling will result in increased capital and running costs for the plant. The level of dissolved minerals in the water circulating through the condenser has an upper limit, beyond which mineral deposition occurs on the heat-exchange surfaces and reduces the plant efficiency. If the make-up water has a high mineral content, it can undergo fewer cycles of recirculation before being discharged. Therefore, there would be a significant increase in the amount of water demand and waste water requiring disposal.

Issue 2.2 Raised by WPC.
Cooling. In section 4.6 of the PER a wet cooling tower is specified. To what extent have other technologies such as air cooled condensers, been explored?

Response In dry-type cooling systems the heat is transferred by convection and radiation instead of evaporation as with wet towers as proposed. The major drawbacks of these systems are higher turbine back pressure, decreased turbine efficiency and higher fuel and internal power consumption rates, when compared to a typical wet cooling tower system. Also the capital costs of a dry type system are significantly higher than those for an evaporative system. This factor and excessive unit fuel and energy costs have made these towers practical only where extreme environmental conditions have necessitated their use. Dry air coolers, or hybrid type air coolers, require much more installation space and generate more noise than the proposed cooling tower.

Table 1 gives an indicative comparison between dry and evaporative cooling systems under Collie conditions.

Table 1
Comparison between Dry and Evaporative Cooling Systems

	Evaporative Cooling	Dry Condenser
Footprint area	$800m^2$	$5,000m^2$
Capital cost	$5,000,000	$19,000,000
Lost generator output	0	13.8MW
Excess CO_2 output	0	12.6t/h

3 Flora and Fauna

Issue 3.1 Raised by CCWA, ACF, WWF, CANA.
The statement in the Executive Summary of the PER that " Construction of the plant does not require… disturbance to any ecosystems" contradicts the results of the flora and fauna survey, which refers to the potential impact on Baudin's Cockatoo and Red-Tailed Black Cockatoo. These species are listed Threatened Species under the *Environment Protection and Biodiversity Conservation (EPBC) Act 1999*.

Response The flora and fauna report covered a larger area than that which will be impacted by Bluewaters. The purpose of the flora and fauna report was twofold, namely to provide information on a regional context and on site specific information. As Bluewaters is to be built on cleared agricultural land there will be no disturbance to any ecosystems.
Bluewaters was referred under the requirements of the EPBC Act and the decision handed down as required under the Act, was that the proposed action was not a controlled action (EPBC 2003/1289).

Issue 3.2 Raised by DPI.
Information on the indirect impact on fauna movements between vegetation remnants from the development of new infrastructure associated with the proposed power station needs to be provided, and could be addressed via an Operational Environmental Management Plan.

Response No major new infrastructure is required to support the proposal (see response to Issue Number 7.3). The project area is cleared grazing land on the proposed Coolangatta Industrial Estate. Griffin notes and agrees with DPI's comment that indirect impacts on fauna during operations will be dealt with in the Operations Environmental Management Plan. A Fauna Management Plan may include employee and contractor awareness training of fauna that may be encountered near the project area, and specific measures to minimise direct/indirect disturbance to fauna.

Issue 3.3 Raised by CALM.
The likely downstream impacts of the proposal regarding the clearing of forest for mining and power transmission to support the project should be clearly identified.

Response It is noted that the connection points for this project are characterised by cleared land. The coal supply for the power station will be sourced from the Ewington I coal mine. The coal mine is in the final stages of obtaining approval for its Environmental Management Plan. The mine will supply other customers besides Bluewaters. The projected life for Bluewaters and the Ewington I mine is expected to be of the order of twenty five years. The impacts of the mine development have been fully documented in the approval process for the mine. Therefore, the downstream impacts of the proposal with respect to mining have been fully documented.

Bluewaters will access the existing distribution network. It is not anticipated that additional network infrastructure is required to distribute Bluewaters produced electricity to customers. Over time it may be that the distribution network could require upgrading, however, this should be able to be accomplished within the existing network distribution corridors. Ultimately, management of environmental impacts of the distribution network is the responsibility of the network provider.

4 Atmospheric Emissions

Issue 4.1 Raised by WPC.
The total Volatile Organic Compounds (VOC) emission for Bluewaters appears to be underestimated.

Response The method for estimating VOC emissions was to pro-rata data on the NPI website for the existing Collie Power Station for the reporting year 2001-2002. Griffin Energy notes the information published on the National Pollutant Inventory (NPI) database that the amount of VOC emitted from coal fired power stations in the Collie region is insignificant when compared to biogenic sources.

Issue 4.2 Raised by WPC.
Why was the Griffin Energy 800MW South West Power Project (SWPP) excluded from air emission studies?

Response The Bluewaters proposal replaces SWPP, therefore to include SWPP would mean modelling for emissions that will never occur.

Issue 4.3 Raised by WPC.
Air modelling should include the proposed Worsley expansion.

Response It did. At the time the air modelling was undertaken the proposed expansion at Worsley had not been formally announced. Subsequent to the advice of the expansion Worsley advised that the expansion would not significantly alter the air emission profile from their facility. Griffin commissioned further air modelling which includes a conservative increase in the air emission profile for Worsley.

Issue 4.4 Raised by DoH.
There needs to be an overall development plan for Collie.

Response A development plan for Collie needs to be addressed from a broader perspective than an individual development proposal such as Bluewaters. Maintaining or improving air quality in the Collie area is of prime concern to Griffin Energy. Air emission modelling undertaken in support of the Bluewaters proposal clearly demonstrates that there is no deterioration of air quality in the Collie area attributable to Bluewaters. The modelling clearly shows the limits to be well within all accepted guidelines.

Overall planning for the Shire is the responsibility of the Shire of Collie and responsible State government authorities. Griffin Energy is committed to ongoing consultation with these and all other stakeholders to facilitate an overall development plan, and to ensure that all due processes are followed in the development of any proposal put forward by the company, including Bluewaters.

Issue 4.5 Raised by DoH.
Modelling for the estimation of short term average ground level concentration needs to be undertaken for contaminants that can have health effects following short term-duration exposures.

Response Modelling for SO_2, NO_x, PM_{10}, CO, Hg, PAH and Fluoride was undertaken. The quantities of other components of the emissions are very low and if they were modelled would produce results that are statistically meaningless. The only substance to approach any of the accepted standards is Sulphur Dioxide. In this case the modelling clearly demonstrates that Bluewaters is not a significant contributor to the Collie air shed. This is shown in Table 3 on page 25 of the PER. See also the response to Issue 4.8.

Issue 4.6 Raised by DoH.
No information has been provided on the characterisation of emissions from the present power stations or whether the substances included for consideration are representative of coal-fired emissions.

Response Table 2 on page 16 of the PER (Key Proposal Characteristics) gives an emission profile for Bluewaters. This profile is an estimation based on an operating profile similar to that expected in the proposed plant. It was prepared by engineers responsible for designing the proposed plant. It was verified by comparison with the profile of the Collie A Power Station obtained from the NPI. The emission profiles of all power stations in the Collie area are similar and vary only to the extent of the age of the plants and the technology used within the plants. Collie A Power Station was used as an analogue for Bluewaters because it is most similar in technology and pollution control equipment to that expected to be installed at Bluewaters. The emission data obtained from the NPI is data collected from the power stations themselves, using consistent methodology appropriate to the collection of such data. The data is regularly verified through stack monitoring as required under the power stations operating licences.

Issue 4.7 Raised by DoH.
The data that was used to model the relevant pollutants were derived from the National Pollutant Inventory (NPI) data. The use of this data would only enable a broad estimate of emissions to be determined which may not be accurate. Justification should be provided for not characterising the emissions.

Response Actual emission rates for each hour of the year in 2001 for SO_2 are used in the modelling for Muja and Collie power stations, obtained from Western Power. For the remaining pollutants considered (NOx, PM_{10}, CO, Hg, PAH and fluorides), hourly emission rates have also been derived by scaling the SO_2 rate each hour by the ratio of the annual NPI total emission of the pollutant under consideration and the annual SO_2 emission. In this way, important hourly variation is introduced for all pollutants. Even if measured emissions each hour of the year had been available for other parameters, the answer to the Study question (what is the impact of the proposed Bluewaters power station) would not have been any different, i.e. that Bluewaters does not significantly contribute to raising levels of NOx, PM_{10}, CO, Hg, PAH and fluorides to anywhere near guideline levels.

Issue 4.8 Raised by DoH.
The identification and characterisation of the potentially exposed population (i.e. sensitive receptors) has not been undertaken, and the modelling averaging periods of 1 hour are considered to be too long to enable the possible health effects on exposed individuals to be determined.

Response Modelling has shown that SO_2 levels are below the accepted NHMRC 10 minute average standard.
The scenarios examined and presented in Table 2 below are:

Scenario 1	Bluewaters in isolation
Scenario 2	Bluewaters stage I and II operating in tandem
Scenario 3	Muja A,B,C and D, Collie A plus proposed Collie B and Worsley (including proposed upgrade) and Bluewaters I
Scenario 4	Combined scenario 1 and 3
Scenario 5	Existing emission profile in Collie

Time averages from TAPM modelling for the proposed 200 MW power station at Bluewaters (Physick and Edwards, May 2004).

Table 2
SO_2 concentrations at Collie township in µg m^{-3}

Scenario	1	2	3	4	5
Hourly averages					
Highest	163	284	287	287	233
9^{th}-highest	108	159	168	206	117
NEPM standard	570	570	570	570	570
Short-Term averages (10 min)					
Highest	334	582	588	588	477
9^{th}-highest	221	326	344	422	240
NHMRC (250 ppb)	715	715	715	715	715
WHO 10 min average	500	500	500	500	500
UK DEFRA 15 min avg 100 ppb (max 35 exceedences)	266	266	266	266	266

Estimates of 10-minute have been made using a power law dependence of the concentration on averaging time of the form:

$$\frac{c_a}{c_m} = \left(\frac{t_a}{t_m}\right)^p , \quad (1)$$

where c_a is the concentration for an averaging time t_a, estimated from the concentration c_m for an averaging time t_m (here 1 hour), and p is the exponent. This procedure is included as an approved method in the NSW Environmental Protection Authority Modelling Guidance (NSW EPA, 2001).

Equation (1) has been derived from data for maximum annual concentrations. However, an analysis of the data given by Hibberd (1998) shows that the exponent is approximately the same for the 9^{th}-highest values.

For tall stack emissions, Katestone (1998) recommends a value of $p = 0.4$. The uncertainty in the exponent is quoted by Hibberd (1998) as ±10%, which translates to an uncertainty of about ±10% in the estimated concentrations in the above table.

Consistent with enHealth hierarchical source of information or guidelines, the most appropriate guideline for concentrations shorter than 1 hour is the NHMRC guideline of 715 µg m^{-3} (250 ppb) for 10-minute average concentrations.

The predicted, short-term SO_2 concentrations from the proposed facility are within the more conservative 10-min guideline by WHO. Whilst, the United Kingdom (UK) Department of the Environment Food and Rural Affairs (DEFRA) (http://www.defra.gov.uk/environment/airquality/aqs/so2/7.htm) guideline is exceeded by the predicted concentrations in some scenarios, it should be noted that their 24-h average (125 μg/m^3) is the same as the 24-h average by WHO, whilst their 1-h average is 350 μg/m^3, that is, higher than the 15-min average.

The maximum 1-hour average concentration of SO_2 in the Collie townsite reported by Western Power from their ambient air monitoring in the Collie area was less than 0.08 ppm. The monitoring was undertaken during the period March 1995 to April 2002.

DEFRA provides guidance that whenever the1-hour mean concentration of SO_2 exceeded 50 ppb, then it is likely that the DEFRA 15-minute guideline of 100 ppb is exceeded.

The data provided by Western Power in the Collie Power Station Expansion SER was examined using the DEFRA guidelines. The results indicate that the 15-minute average guideline could have been exceeded 12 times over the seven-year monitoring period.

Interpretation of TAPM modelling (W.L.Physick pers comm.) predicts 4 such excursions in the modelling year (2001) for existing emitters. The predicted 4 exceedences for the year 2001 are more than would be expected from examination of the actual data collected over seven years. If 2001 was considered an 'average' year then the measured data, to be consistent with the model, would have shown 28 exceedences over the seven years. This further demonstrates the conservative nature of the TAPM model.

The model output was mapped against actual measurements from the Collie Monitoring program undertaken by Western Power. The following diagram (Figure 1) shows the predicted versus actual levels for three sample locations, being Shotts townsite east of Collie, Bluewaters Farm and Collie Town. The mapping of actual versus predicted levels shows that the model has sufficient accuracy for it to be used with confidence.

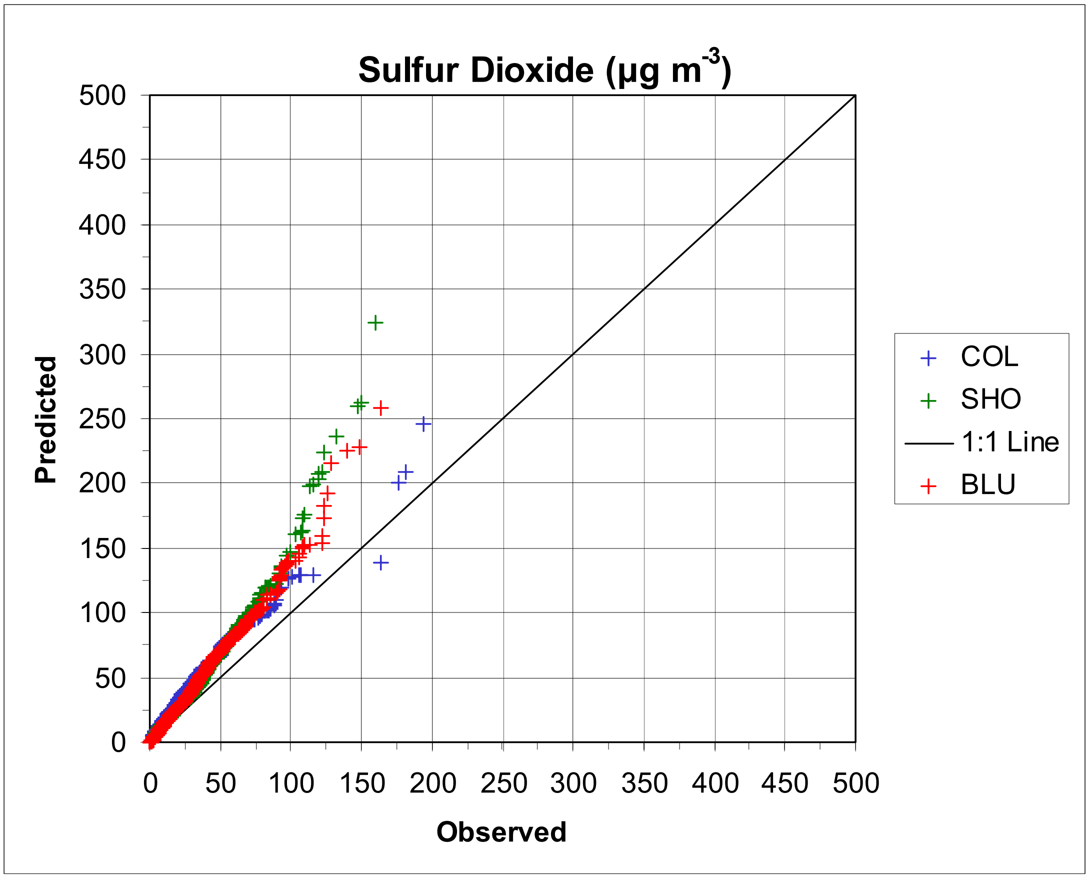


Figure 1 – Correlation of predicted vs actual SO_2 concentrations

Note: COL = Collie; SHO = Shotts; BLU= Bluewaters Farm

The results given by the model are conservative and within accepted NEPM and NHMRC standards, as shown in Table 3.

Table 3
Summary of actual and predicted levels against standards

Scenario	Bluewaters I	Existing Emitters (from TAPM model 2001 data)	Model prediction (existing plus proposed emitters)	Western Power Measured data (1995 – 2002)
Highest level (μg m^{-3})	163	233	287	230
NEPM 1 hour standard (570 μg m^{-3})	Not exceeded	Not exceeded	Not exceeded	Not exceeded
NHMRC 10 minute exposure standard (715 μg m^{-3})	Not exceeded	Not exceeded	Not exceeded	Extrapolation from data shows no exceedence
DEFRA 15 min std (286 μg m^{-3}) max 35 exceedences	Not exceeded	Exceeded 4 times/year	Exceeded 9 times/year	Exceeded 12 times in 7 years

According to the information provided with existing national standards, compliance with the one hour NEPM provides "adequate" protection for the general population. Sensitive sub-groups, such as asthmatics and sufferers from chronic heart and lung disease, have been considered in the derivation of ambient air quality guidelines. Hence compliance with the guidelines, affords protection to these groups.

Sensitive Receptors

Sensitive receptors would include hospitals, senior citizens homes and schools. Collie contains six such locations where sensitive individuals could be found. All are well within the town boundary, which has been demonstrated to have no exceedences of the NHMRC 10 minute limit. In addition there are two farm houses within 2.5 kilometres of Bluewaters. Modelling has shown that exposure levels at these locations are comparable to the levels in the town and are well within accepted limits.

As can be seen from the above analysis, the addition of Bluewaters has no impact on the predicted results for the town of Collie, thus confirming that there is no incremental health risk within the town of Collie attributable to Bluewaters emissions.

Griffin Energy is committed to continuing dialogue with the residents of Collie and will maintain an ongoing brief with the community on health and other issues relating to the power station.

Issue 4.9 Raised by DoH.

Transparent mechanisms should be used by the proponent when responding to issues raised by stakeholders in order to ensure that they are adequately addressed according to their significance.

Response The Griffin Group has been mining coal and supplying fuel to Western Australians for over 70 years, and has been a strong supporter of the local community through a range of initiatives (e.g. sponsorship and participation in the Griffin festival). The Griffin Group's commitment to maintain an open dialogue with the Collie community is ongoing.

Bluewaters is designed to maximise technological benefits, the benefits associated with the proximity of the coal source and to minimise environmental impacts. Bluewaters will be an addition to the current power supply infrastructure in the South West and as such will provide a revitalised future for the region.

To ensure that the community is aware of the proposed Bluewaters, and to inform all stakeholders about the Bluewaters project, Griffin Energy conducted extensive community consultation including:

- Press advertisements regarding the PER process state-wide
- The provision of 22,000 brochures, distributed as a newspaper insert, to residents of Bunbury and Collie
- Distributed press releases to regional and metropolitan media outlets
- Participation in the Collie Coal Taskforce
- Information posted on the company web site
- Face to face presentations with local Collie community groups including:
  - Collie Bowling Club
  - Collie Rotary Club
  - Apex Club of Collie
  - Collie Chamber of Commerce
  - Retired Mineworkers
  - Collie RSL
  - Collie High School teachers
  - Collie Tourist Information Centre
- Hosted two independently facilitated community workshops on 16 and 17 June at Collie and Bunbury respectively. Griffin management representatives were present at both these sessions. The two sessions were attended by over 36 interested parties and representatives including: Government departments, Collie Chamber of Commerce and Industry, Collie Shire Council, Western Australian Chamber of Minerals and Energy and Corporate stakeholders.
- Placed press advertisements in the Collie Mail and South West Times during the week leading up to the community workshops.

Feedback forms distributed at the community workshops included space for participants to indicate their responses to the Bluewaters proposal. In addition to the verbal questions and answers provided during the feedback sessions, these feedback forms were returned to Griffin for analysis with the following results:

- 23 registered responses were received from Collie, though numbers attending the workshop were slightly higher
- 13 registered responses were received from Bunbury
- Numbers attending the community consultation workshops indicate that less than 1% of the 22,000 residents who received the community consultation invitation brochure were interested in attending these workshops.

Supportive comments, made by those that attended, included:

- "I am glad to see this project go ahead"
- "I strongly support the Bluewaters project"
- "I am fully supportive of what Griffin Energy is proposing to do – good for Collie and the State".

Common themes for questions raised at the workshops were:

- Provision of water to supply the power station and its impact on local wetlands and the Collie River
- Griffin's strategy for dealing with greenhouse gas emissions.

Feedback collated from the consultative sessions indicated that 84% of the respondents either agreed or strongly agreed that the sessions were positive and participants were able to voice opinions, ask questions and apply the information supplied, to their issues and concerns. 11% of the respondents indicated a neutral view.

All of the questions posed at these community consultation workshops were recorded and a questions and answer document was developed.

Summary of Community Consultation Process

The community consultation workshops have provided positive feedback to the establishment of the Bluewaters Power Station. Despite some concerns about water management in the Collie Basin in the future, there was no verbal opposition to the proposed project elicited at either of the community workshops. Health concerns did not rate a mention in the community workshops; however the impact on employment opportunities was an issue that was raised in a positive sense by attendees.

Griffin remains committed to maintaining a consistent community consultation process to ensure residents and stakeholders have continuing opportunities for input and feedback on Bluewaters.

Issue 4.10 Raised by DoH.
The health risks to the community should be assessed on a cumulative and incremental basis.

Response The air emission modelling did address impacts on a cumulative and incremental basis. This is addressed in the response to Issue 4.8.

Issue 4.11 Raised by DoH.
Indirect health benefits need to be detailed so that a demonstration of employment and other benefits is shown.

Response Griffin Energy, as part of the Griffin Group is committed to equal employment opportunity and to the employment of locals.

The Griffin Coal Mining Company Pty Ltd (Griffin Coal) workforce at Collie is drawn from the following locations:

- Collie 85%
- Perth/Mandurah 2%
- Bunbury region 11%
- Donnybrook/Busselton/ Darkan 2%

It is anticipated that a similar employment profile will exist at Bluewaters in the long term. The skills required to operate Bluewaters are already present and available in the Collie area as Collie is the only town in the state where the skills are currently required.

Issue 4.12 Raised by DoH.
There is no analysis of well being vs. absence of disease in the PER.

Response Tools for this form of analysis are not fully developed and are difficult to address quantitatively. However, the response from the community provides a basis for qualitative assessment. The outcomes of the stakeholder program (see response to Issue 4.9) would indicate that the Collie community supports the project and considers that Bluewaters would provide considerable benefits to the Collie community. This suggest that the anxiety and stress in communities in controversial locations, that often lead to a heightened awareness of common health complaints and a tendency for individuals or communities to assign cause to the unwanted activities in their communities, is unlikely to be a concern in Collie. The project is welcomed because it is seen as making a positive financial and social, hence wellbeing, contribution to the Collie community.

As outlined in Sections 7.9 and 7.10 of the PER, Griffin Energy has committed to comply with all regulatory requirements regarding noise and dust, both during the construction of the facility and during the operation of the power plant. Moreover, Griffin Energy has committed to comply with emission standards and licence conditions imposed by the Department of Environment. Part of the responsible and environmentally sound management of the facility is a commitment to monitoring emissions and ambient levels to validate the predicted levels from the ambient air modelling and ensuring compliance with regulatory requirements.

Issue 4.13 Raised by DoH.
The Australian Framework for Health Risk Assessment should have been used to determine Community Health Risk from the proposal.

Response It is not entirely clear what this means. The Health Impact Assessment Guidelines published by enHealth in September 2001 and the Environmental Health Risk Assessment Guidelines (2002) were used to guide preparation of statements on Health Risk and Impact Assessment. Modelling was used to derive ground level concentration of predicted emissions; hence the exposure was assessed. The outcomes have been compared with established national air quality guidelines, the results of which show that the emissions are unlikely to pose a health risk to the community (risk characterisation). Sensitive individuals have been taken into account in the development of air quality guidelines as well as using short term averages as reference, hence the sensitive receptors identified. This is consistent with the enHealth risk assessment methodology.

Given the support for the project from the community and little or no concerns from the community, this approach is entirely consistent with national guidelines.

The Community Health Risk Workshop in Collie on December 12th 2003 was designed using the guideline as a reference. The baseline data used to provide a community health profile for the workshop was obtained from the report by Leiper, Stone and Clearwater "Epidemiology Profile for South West", produced by the South West Population Health Unit of the DoH in August 2003. The report showed that the health profile of the town of Collie is consistent with other South West towns and that the biggest impact on overall health in the South West could be gained through better diet and fitness regimes as well as controls on intake of drugs such as alcohol and smokes.

The enHealth Guidelines themselves state that they are not considered "tight" in their focus (Section 1.3 page 4). The proponents took the view that the guidelines required assessment as to the level of health risk assessment was first required. The air modelling and community consultation program was designed to meet this objective. Following the guidelines and referring to Figure 1 on page 12 of the guidelines leads to the conclusion that the health impacts from the project are negligible. The proponent believes that the intent of the guidelines was met. However Griffin Energy is committed to ongoing community stakeholder consultation and will maintain an ongoing monitoring brief with the community on health and other issues relating to the power station.

Given the analysis provided in previous responses and the level of support for the project from the town of Collie it is apparent that the real and perceived risks are acceptable to the Collie Community.

Issue 4.14 Raised by DoH.
There should be a commitment to the local communities.

Response The Griffin Group through Griffin Coal is in its 77th year of operation in the Collie area. It has supported and continues to support the community in which it operates and dedicates substantial funds each year to support local activities and groups. These include sports, cultural events (including the annual Griffin Festival), educational scholarships, community service groups and heritage preservation.

A highlight of the Collie calendar is the Griffin Festival, a week long celebration of local achievement in art, craft, literature, public speaking, music and dance. The Festival has been held every year since 1989 and enjoys a high level of participation by local schools and the artistic community.

The Griffin Continuing Education Scholarships are highly prized by the local school community.

The State's steam heritage is supported through donations of coal to the operators of steam railways. These presently include the Hotham Valley Tourist Railway, Kalgoorlie-Boulder Loop Line Railway, Pemberton Tramway, Carnarvon Tramway and miniature railways as far afield as Perth and Esperance. The Hotham Valley train normally visits Collie twice a year, coincident with the Griffin Festival and Rally Australia.

Griffin employees add to this community spirit by volunteering as members of business, schools, sporting, environmental, local government and other community groups within the South West.

With a stable workforce of 300 employees, Griffin Coal has a regular intake of apprentices and work experience students for career and training opportunities.

Griffin Coal has been instrumental in promoting and securing funding for a Centre of Excellence to research sustainable mine lakes.

Griffin Coal has also pioneered a regional salinity management scheme and established the Centre of Excellence in partnership with the DoE (formerly Waters and Rivers Commission and DEP), Water Corporation, CALM, and WA Universities. The Centre will undertake four main research streams to investigate possible options with respect to water filled mining voids. These options include bio-remediation, prediction modelling and pH neutralization.

The centre will also investigate ways to improve water quality in the Wellington Dam, one of the State's largest sources of surface water.

Griffin Energy as part of the Griffin Group will be building on the initiatives of Griffin Coal in its support of the Collie and South West communities.

Issue 4.15 Raised by a private citizen.

I am concerned about the levels of SO_2, NO_x and particulates that will be emitted from the proposed power station. The proposed emission level of 1,250mg/Nm^3 for SO_2 is six times the limit of 200mg/Nm^3 set by Directive 2001/80/EC of the European Parliament and the Council of the European Union for SO_2 emissions for new large combustion plants burning solid fuel, and thus does not represent best practice. The proponent apparently considers that they are operating in some underdeveloped third world country where the importation and use of superseded substandard equipment is acceptable.

Response The proponent has sought to adopt Best Practicable Measures to minimise atmospheric emissions from Bluewaters in accordance with EPA Guidance Statement No. 55. It is noted that, in relation to emissions of SO_2, NO_x and particulates, the EPA's view expressed in this Guidance Statement is that:

1. All relevant environmental quality standards must be met;
2. Common pollutants (including SO_2) should be controlled by proponents adopting Best Practicable Measures (BPM) to protect the environment;
3. There is a responsibility for proponents not only to minimise adverse impacts, but also to consider improving the environment through rehabilitation and offsets where practicable.

Regional air emission modelling undertaken in support of Bluewaters has demonstrated that cumulative Sulphur Dioxide levels in the surrounding community are well within accepted NEPM standards and are not predicted to have adverse impacts on local or regional air quality. (See also detailed response to Issue 4.8).

Directive 2001/80/EC was evaluated for relevance by the proponents for Bluewaters, however given the particular circumstances of the Collie region, was determined not to be relevant for the project. The EC directive was initiated to curb Sulphur Dioxide emissions in a region where the Sulphur content of coal is generally higher than that of Collie and where acid rain is an issue. The directive is more applicable to a highly industrialised region.

In contrast, the south-west of Western Australia is hardly industrialised at all, and does not suffer from problems associated with acid rain. Collie coal has a low sulphur content by global standards, and a significant part of the industrial energy in the southwest of the State comes from natural gas. Oxides of sulphur do not form and do not threaten to become an environmental problem in the Collie area. Monitoring undertaken by Western Power has indicated that effects from Sulphur Dioxide emissions from the existing coal fired power plants at Collie are negligible and almost impossible to quantify (Morris 2004, pers comm.).

Additional measures to remove oxides of sulphur consistent with Directive 2001/80/EC are commercially available and are developed to a mature stage. Such methods involve the adsorption of the oxides of sulphur either in a slurry of calcium hydroxide or calcium carbonate. However, this process has a significant environmental footprint. Emissions of carbon dioxide will be increased by 5% due to release in the process, and increased electrical power is used in the process. This would result in an extra 60,000 tpa of CO_2-e to be emitted from the Bluewaters power station.

In addition, quarrying and transport of 120,000 tonne/year of limestone would be required for the desulphurisation process. The process would also involve the consumption of a significant amount of additional water.

The use of the directive, therefore, would not be without environmental cost.

The capital cost of the project would also be increased by about 10% if this process were used. The fuel cost would then be increased by 1 or 2 percent. Other operating and maintenance costs would also increase. Tariff increases, to cover the increased costs, would make coal uncompetitive with gas as a fuel for power generation.

Therefore, taking into account:

1. Demonstration through modelling that cumulative emissions of SO_2 are predicted to be within acceptable environmental standards, and best practicable measures have been adopted by Bluewaters;
2. Vegetation monitoring by Western Power has not demonstrated any measurable impact from Sulphur Dioxide emissions from the existing Collie or Muja power stations; and
3. The additional environmental impacts (including increase in GHG emissions, water use and disposal, and land disturbance from quarrying and transport of limestone) that would be incurred from additional desulfurisation;

it is concluded that there is no net environmental benefit to be derived through the application of Directive 2001/80/EC at Bluewaters.

The overall net environmental benefit from the application of Directive 2001/80/EC at Bluewaters is less than not applying it, because of additional CO_2 emissions, loss in efficiency from Bluewaters, a requirement to find an additional disposal facility for another waste product and increased use of water through its use. This approach is consistent with the principles of Guidance Statement 55. Bluewaters will operate on the philosophy of continual improvement in its operations, and will continue to evaluate measures for improving efficiency and minimising atmospheric emissions during the lifetime of the project.

Issue 4.16 Raised by DoH.
A health risk assessment is an integral part of a health impact assessment, and a health risk assessment was not presented in the PER document. A health risk assessment should be an essential requirement

for this type of development, and the proponent should be required to undertake one for this proposal.

Response Griffin Energy has consulted further with DOH and has provided further information and clarification on the Health risk assessment for the project (see responses to previous issues in this section). DOH has agreed that sufficient work has been undertaken to be able to determine that the risk to the community in Collie is acceptable. See also the response to Issue 4.13.

Issue 4.17 Raised by DoH.
Modelling of relevant pollutants should be undertaken using averaging periods which are consistent with the expected health effects from those substances.

Response This issue is covered in the response to Issue 4.8.

Issue 4.18 Raised by DoH.
The modelling presented in the PER document suggests that emissions from existing sources have the potential to be impacting on the health of exposed individuals, and this implies that the issue surrounding power production in the area need to be considered in a holistic fashion that may require a change from existing to newer less polluting technology

Response This is a whole of Government issue and one that is not capable of being managed by a single proponent. Griffin Energy will support any proposal for a whole-of-area assessment of health impacts in the Collie region. However, it is fair to state that the Bluewaters proposal has been demonstrated, through the cumulative modelling carried out and reported in the PER and in these responses, not to have any significant impact on the health profile of Collie. Griffin Energy accepts that the closure of the older less efficient Muja plant will have a beneficial effect, however, the ultimate decision on the closure of Muja is a matter for Western Power.

Issue 4.19 Raised by DoH.
The outcomes derived from the consultation process were not attributed to the identified substances except in broad terms, and the consultation process that was undertaken appears to have added little value to the overall assessment other than to provide an opportunity for stakeholders to comment.

Response This issue is comprehensively covered in the response to Issue 4.9. Griffin Energy undertook a comprehensive consultation programme specific to the Bluewaters project. The concern raised here refers only to one particular workshop, whereas Griffin Energy as part of the Griffin Group has adopted a policy of continuos consultation with all members of the community on all aspects of existing and proposed operations. Members of the community are encouraged to raise any issues of concern at any opportunity in any forum that they feel comfortable with, so that the issue can be addressed in a positive and consultative manner.

Griffin has been part of the community for a considerable length of time and prides itself on keeping the local community informed and engaged in all aspects of operation and planned developments.

Issue 4.20 Raised by DoH.
The demographic information provided about the community identified a significant aboriginal population in the region. However, there was no obvious representation of this group on the stakeholder's consultation group.

Response Griffin Energy has a policy of ongoing consultation with all stakeholders and members of the community. To this end a presentation was made to the South West Land and Sea Council on Tuesday August 24th 2004. The main issues raised at this meeting were employment opportunities and economic impact of the proposal.

Griffin will continue to meet with representatives of all stakeholder groups to receive input and provide feedback on all existing and planned developments by the group.

Issue 4.21 Raised by DoH.
The report indicated that the model is comparable with actual data recorded by the Collie Air Quality Monitoring Network. Evidence is required to demonstrate the comparisons are appropriate for all contaminants that have been modelled.

Response The monitoring performed in Collie measured PM_{10} and SO_2. Figure 1 presented in the response to Issue 4.8 shows that the modelling is very close to measured data.

Issue 4.22 Raised by DoH.
Justification is required on the reasons for modelling some pollutants and not others, as well as the use of the NPI data over measured levels.

Details are required to explain why the consultants chose to model only SO_2, CO, Hg, PAHs, fluoride, NO_2, ozone and PM_{10}, and what the risks of these pollutants are in relation to health guideline levels

Response Actual emission rates for each hour of the year in 2001 for SO_2, used in the modelling for Muja and Collie power stations were obtained from Western Power. For the remaining pollutants considered (NOx, PM_{10}, CO, Hg, PAH and fluorides), hourly emission rates have also been derived by scaling the SO_2 rate each hour by the ratio of the annual NPI total emission of the pollutant under consideration and the annual SO_2 emission. In this way, important hourly variation is introduced for all pollutants. Even if measured emissions each hour of the year had been available, the answer to the Study question (what is the impact of the Bluewaters proposal) would not have been any different, i.e. that Bluewaters does not significantly contribute to raising levels of NOx, PM_{10}, CO, Hg, PAH and fluorides to anywhere near guideline levels.

Griffin Energy consulted with the EPASU on which substances should be modelled. Following the consultation the list of substances to be modelled was determined by Griffin Energy.

The modelling clearly demonstrated that the levels of all of the substances in the Collie town and at nearby farm residences to be well within accepted health guidelines. Refer also to the response to Issue 4.7.

Issue 4.23 Raised by DoH.
Relevant calculations should be included in the report to show that the addition of the proposed power station is of negligible risk to the population in Collie and surrounding areas.

Response This issue is covered in the response to Issue 4.8.

Issue 4.24 Raised by PAN.
The proponent has not adequately assessed the environmental health impacts of the proposed power station, particularly in relation to air pollutants such as acidic gases, heavy metals, volatile organic compounds, polycyclic aromatic compounds, and particulates, all of which are capable of causing serious human health and ecological impacts.

Response This issue is covered in the response to all of the preceding issues relating to atmospheric emissions.

Issue 4.25 Raised by PAN.
The modelling that has been undertaken indicates that the cumulative impact of the proposed power station and the existing Collie Power Station will lead to exceedences of the National Environmental Protection Measures limits for SO_2 and dust, which is unacceptable

Response This issue is covered in the response to Issue 4.8. Table 3 shows that there are no exceedences in the town of Collie. The modelling also shows NEPM standards are not exceeded at any sensitive receptor locations. Bluewaters is not predicted to result in any significant increase in emission levels received at any location. Dust monitoring undertaken by Griffin Coal has also indicated that dust levels within the town of Collie are within NEPM limits. Therefore the cumulative effect of Bluewaters on the existing situation is for no increase in exceedences of NEPM limits at any location. Any exceedences shown in the modelling are as a consequence of the existing scenario, with the exceedences occurring close to the existing emitters and remote from any existing sensitive receptors.

Issue 4.26 Raised by PAN.
The proponent has not made a convincing case in regard to emissions of volatile organic compounds, reactive organic compounds, and heavy metals which international research indicates are serious problems with

power stations burning low grade coal. Additional monitoring and analysis of existing power stations using Collie coal is required.

Response Coal is generally classified by Rank, Grade or Type**.** Grade classification of coal is a measurement of ash content. Collie coal is very low ash (approximately 6%), therefore Collie coal is considered a high grade coal. Collie coal is neither an inferior Type nor a low Ranking coal. Modelling undertaken by the CSIRO has shown that air quality at Collie will not be compromised by the Bluewaters proposal. VOC output by Bluewaters is very small when compared to the biogenic output of VOCs in the area as reported on the NPI website. Mercury was modelled in the air emission study as it is the most significant heavy metal found in Collie coal. The modelling undertaken by CSIRO indicated that annual-averaged emission levels for Mercury are three orders of magnitude smaller than the WHO Guideline value. Peterson et al (2004) found the contribution of Mercury from all Australian coal fired power stations to regional airsheds is over reported, therefore, the levels estimated in the air modelling carried out for Bluewaters by CSIRO are a conservative estimate of actual levels in the air. The levels of other heavy metals in the exhaust from Bluewaters were assessed to be so low, that any modelling results would not be meaningful or useful.

Issue 4.27 Raised by CCWA, ACF, WWF, CANA.
Insufficient research has been undertaken in Collie to determine the effect of this particular proposal, and the effect of coal mining and power generation industry in general. The community made it clear that they would like more work to be undertaken in this area and that they are uncertain about the potential impacts of this proposal.

Response This point of view is at variance to the overwhelming level of support shown by the community of Collie towards the proposal. Notwithstanding that Griffin is willing to cooperate with any overarching survey of impacts of power generation. With respect to the issue of research into health and other impacts of the proposal these have been covered in all preceding responses to Air Emission issues.

Issue 4.28 Raised by CCWA, ACF, WWF, CANA.
Although individual projects may not on their own contribute significantly to health risks, the cumulative impacts of the coal mining and power generation industry must be taken into account in assessing individual projects.

Response Cumulative impacts were taken into account in the air modelling and health impact assessment. All emission levels that are compared to standards assume the addition of Bluewaters and Collie B. Refer also to the response to Issue 4.8.

5 Greenhouse Issues

Issue 5.1 Raised by CCWA, ACF, WWF, CANA.
An assessment of geosequestration potential was not included despite the Collie Basin being identified as a potential storage site by the Cooperative Research Centre for Greenhouse Technologies (CO2CRC).

Response The Collie Basin was not identified as a potential storage site in the quoted study. In fact it is the Perth Basin that was included in the study (*Rigg et al (2001)* and *Brayshaw et al (2002)*). The Perth Basin extends from the Murchison in the North to the south coast and out to sea. The Collie basin exists within the Yilgarn Craton. In the study the Perth Basin was risked at 0.2 for potential storage sites, which means there is only a 20% chance that a suitable site exists within the basin for geosequestration. In addition the significant offshore component of the basin means the likelihood exists that a suitable site for geosequestration may only be available offshore.

Herzog (1999) has given a minimum cost for the capture of flue gases from power stations to be $US20 per tonne rising to approximately $US70 per tonne depending on the extraction process. When this cost is added to the cost of placing the gas in a suitable geosequestration location, it can be seen that the cost is prohibitive. Griffin Energy will continue to monitor the potential for geosequestration.

Notwithstanding the above, the plant layout is such that collecting CO_2 at some time in the future will be a relatively easy exercise to facilitate, should geosequestration become a viable option.

Issue 5.2 Raised by 138 private citizens.
I am concerned that coal has not received fair treatment compared with other forms of energy in selection as a fuel for electricity generation. Each fuel should be assessed on its merits and efficiencies should be sought for each fuel based on its own properties. I do not support any "penalty" or "offset" for coal to bring it into line with other energy sources with respect to Carbon emissions. To do so would impact the viability of the coal industry and the town of Collie and its surrounds and consequently have a negative impact on environmental values in the South West. This is exactly the position defined in the WA government "diversity in fuel" policy.

Response These submissions expressed a view consistent with Griffin Energy's position and State and Federal government policy. See also responses to Issue 5.11 and 5.26.

Issue 5.3 Raised by CCWA, ACF, WWF, CANA and PAN.
The Proponent should provide a Greenhouse Gas Emission Management Plan as part of the approvals process.

Response Griffin Energy has committed to preparing a Greenhouse Gas Emission Management Plan (PER commitment number 13.2). The plan will be made public (PER Section 7.8.3).

The Greenhouse Gas Emission Management Plan will comprise:

- Participation in the Commonwealth Government's *Greenhouse Challenge* Programme that focuses on continuous improvement in reducing emissions of greenhouse gases
- An inventory of GHG emissions from the Bluewaters project, and benchmarking of GHG efficiency with other comparable projects
- An action plan with specific actions to minimise emissions where practicable, and performance measures to measure progress, and
- Continued investigation of 'no regrets' and 'beyond no regrets' options for greenhouse minimisation during the life of the project.

Preparation of the plan prior to construction is consistent with the timing of similar plans for other large proposals.

Issue 5.4 Raised by Western Power Corporation.
The claim in Sections 2.5 and 3.2 of the PER document that the proposed power station would reduce the carbon intensity of electricity generated within the South West Interconnected System (SWIS) appears to be erroneous because:

- It apparently considers only WPC's electricity generation and does not take into account electricity production into the SWIS from other non-WPC sources.
- It apparently considers WPC's total electricity generation and fuel use instead of only relating specifically to the SWIS itself.
- It apparently combines generated carbon intensities with sent out-out carbon intensities, the latter which takes into account the electricity consumed within the generating facilities themselves which is not available to the SWIS.
- New generating facilities such as the proposed power station generating electricity into the SWIS would not exclusively displace the electricity generated by the older plant at Muja Power Station.

Response The implications of new power generation in carbon intensity of the SWIS were considered in the *Strategic Environmental Review – Strategic Planning for Future Power Generation* (WPC, 2002). It is noted that Scenario B presented in the SER (including 300 MW base load to be provided by coal-fired plant) predicted the SWIS carbon intensity to decrease by 2010 (see Figure 3-6 in WPC 2002).

The results presented in the Bluewaters PER were determined using data in Western Power's Annual Report. It would appear that the above concern was generated using data not available to Griffin Energy when preparing the PER.

A better way of examining Greenhouse intensity would be to examine the impact of Bluewaters on the intensity of coal fired electricity into the grid. Given that Bluewaters will have an efficiency greater than 36% and parts of the existing Muja power plant have efficiencies less than 30%, it is a given that the intensity of coal fired electricity will reduce upon the introduction of Bluewaters to the SWIS.

Whilst the Western Power statement about displacement of electricity generated by older plant at Muja is true it is not entirely relevant. The load supplied by Bluewaters will be of three kinds:

- New Load
- Load displaced from Western Power generators
- Load displaced from other generators.

New load will be taken by the new high efficiency Bluewaters plant. Western Power will always, whether Bluewaters exists or not, to the greatest extent possible reduce the capacity factor of its lowest merit plant. Other generators will do the same. The increased average efficiency of the coal-fired fleet will result in lower CO_2 emissions from coal-fired generation. If some of the load displaced from other generators had been met by a gas-fired plant, then that will involve an increase in CO_2 emissions. Such an issue depends upon commercial considerations and cannot be quantified at this stage.

The net reduction or otherwise of greenhouse intensity is always most accurately calculated in retrospect. It is noted that there is intrinsic uncertainty in projecting power generation contributions, and hence greenhouse intensity, of the SWIS. See also response to Issue 5.22.

Issue 5.5 Raised by CCWA, ACF, WWF, CANA and Western Power Corporation. There are inconsistencies in relation to the amount of Greenhouse emissions the project will produce.

Response The inconsistencies relate to the amount of coal expected to be used in the plant. The actual amount of coal used on an annual basis at a capacity factor of 80% is 700,000 tonnes per annum. The use of this amount of coal in Bluewaters will result in 1,300,000 tonnes per annum of greenhouse gas emissions based on 36% efficiency. In reality, Bluewaters is expected to achieve 36.5 – 37%.

The amount of coal used as stated in the PER is incorrect. The station is not physically capable of consuming 1,000,000 tonnes of coal per annum.

Issue 5.6 Raised by CCWA, ACF, WWF, CANA.
The Proponent should provide the Bluewaters Power Station GHG emissions per MWh.

Response Bluewaters Greenhouse intensity is predicted to be 933Kg CO_2 per MWh.

Issue 5.7 Raised by CCWA, ACF, WWF, CANA.
The proposed Bluewaters Power Station will be operated at part load (<80%), which has a lower efficiency than full load. Information on the part load efficiency of the proposed power station should be provided.

Response This submission may be confusing the terms 'capacity factor' (CF) and 'efficiency'. Bluewaters will be designed to operate at its 100% maximum continuous rating (MCR) with best plant thermal efficiency (36%). When Bluewaters is required to be operated at reduced load, because of customer demand, the plant efficiency will be only a little lower. Based on Griffin Energy's estimate of the customer demand profile Bluewaters is expected to operate at 80% capacity factor. Capacity factor refers to the ratio of the plant's actual total sent out energy (in GWh) to its design maximum sent-out capacity (in GWh) in a period of time (e.g. a calendar year). A 200MW power plant operating at 80% CF will send out about 1,402 GWh in a period of 8760 hours (a year).

Issue 5.8 Raised by CCWA, ACF, WWF, CANA.
In Section 7.8.4, the Proponent does not state that they will apply the Australian Greenhouse Office (AGO) Generator Technical Efficiency Standards to the construction of the plant. The Proponent does not state that they will enter into a Deed of Agreement with the AGO for the proposed Project.

Response The second sentence in the third paragraph on page 65 of the PER states "*Griffin Energy is committed to implementing these (AGO Technical Efficiency Standards) at Bluewaters…"*. This is also repeated in Commitment 13.3. This commitment clearly carries with it the obligation to apply the standards to both the design and the construction of Bluewaters. The commitment to sign on to the Greenhouse Challenge is in fact a commitment to enter into a Deed of Arrangement with the AGO.

Issue 5.9 Raised by CCWA, ACF, WWF, CANA and PAN.
The PER did not fulfil the requirements of the Environmental Protection Authority (EPA) Guidance Statement for Minimising Greenhouse Gas Emissions (No. 12).

Response Griffin Energy has committed to preparing a Greenhouse Gas Emission Management Plan (PER commitment number 13.2). The plan will be made public (PER Section 7.8.3). It will be consistent with the EPA Guidance Statement for Minimising Greenhouse Gas Emissions (No. 12). Preparation of the plan prior to construction is appropriate and consistent with the timing of similar plans for other large proposals. See also response to Issue 5.3.

Issue 5.10 Raised by CCWA, ACF, WWF, CANA.

Further information about the proposed initiative to supply trees to landcare groups in the southwest is required to determine whether this can be considered a carbon offset.

Response The initiative is linked to the research project that is directed towards reducing salinity levels in the Collie River. See also response to Issue number 5.11.

Issue 5.11 Raised by CCWA, ACF, WWF, CANA.
The proponent has not provided information on the level of offsets that will be applied against the project.

Response Griffin Energy is committed to participating in the Greenhouse Challenge (**www.greenhouse.gov.au/challenge**) as detailed in the PER and in the response to Issue 5.3. Griffin Energy has adopted a sustainable approach to Bluewaters and views the management of carbon dioxide as part of the project's sustainability. The project proposes best available coal fired technology appropriate to the size of the plant, complements the Griffin Group's adopted strategy for the Collie River Basin and will, therefore, contribute to the long term and ultimate rehabilitation of Wellington Dam.

Griffin Energy does not propose any formal mitigation of greenhouse gas for the project down to any arbitrary target level, as to do so will affect the economic viability of Bluewaters, however, the commitment to the Greenhouse Challenge means that the potential offsets, detailed below, will be evaluated as part of an ongoing management plan aimed at reducing greenhouse gases over the life of the project.

The imposition of arbitrary sequestration targets on Bluewaters will have the effect of disadvantaging the project and the State, contrary to the terms detailed in the Premiers letter of 8th Oct, 2003 to the Chamber of Commerce and Industry WA on the subject.

Griffin's Commitments

Technologies that can reduce coal emissions are potentially of great benefit to Australia's economy and environment (Commonwealth of Australia, 2004). Griffin Energy is committed to a range of measures to mitigate emissions of greenhouse gases (GHG), including:

- Adoption of state-of-the-art plant technology appropriate to the scale of the project, with proven greenhouse efficiency benefits, using the AGO Technical Efficiency guidelines in design and operational management;
- A strong corporate commitment to the *Greenhouse Challenge* Programme to further characterise GHG emissions, benchmark GHG intensity against other comparable generation plants, and continually identify practicable opportunities for emissions management;

- Preparation and implementation of a publicly available Greenhouse Management Strategy, to the satisfaction of the Environmental Protection Authority (EPA).

The following offsets will be considered in the development of a Greenhouse Management Strategy for Bluewaters:

1. Sequestration Research on Minilya Station
2. Tree planting on Joanna Downs agricultural property
3. 80MW Wind Power at Emu Downs
4. Collie Catchment recovery program
5. Retirement and Replacement of Muja A/B
6. Research into fly ash use
7. Diversion of East Collie River
8. Purchase of carbon credits
9. Tree plantation
10. Mine Rehabilitation at Griffin Coal sites.

Specifically each of the offsets is described as follows:

1 Sequestration Research on Minilya Station

Minilya Station is a property owned by W.R. Carpenter Agriculture Pty Ltd (WRCA), a member of the Griffin Group. Changed management practices on Minilya Station North of Carnarvon have resulted in an increased vegetative cover on the pastoral property. This project involves the CSIRO measuring and validating a methodology for quantifying Carbon sequestration on Minilya.

There is significant potential for sequestration in rangelands. This project is a two-year research project with an ongoing monitoring component, once the initial research project has quantified the extent of carbon sequestration and validated the ongoing measurement approach.

Using the definitions provided in the Environmental Protection Authority Preliminary Position statement No.9 “Environmental Offsets”, this option would initially be designated as a secondary offset, however subject to the research proposal results could be redesignated a primary offset.

2 Tree planting on Joanna Downs agricultural property

Joanna Downs is also an agriculture property owned by WRCA in the Mid West region of WA. This project calls for the planting of 2,000Ha of trees on the property to fulfil the following objectives.

- Salinity control
- Erosion control
- Shelter belts
- Direct sequestration of greenhouse gases for Bluewaters

- Potential economic gain from oil mallee plantation.

Using the definitions provided in the Environmental Protection Authority Preliminary Position statement No.9 "Environmental Offsets" this option would be designated as a primary offset.

3 **80MW Wind Power at Emu Downs**

Emu Downs is another property owned by WRCA in the Shire of Dandaragan. The wind profile on the property makes it very attractive for wind generated electricity. The development of a wind farm on the property has been investigated for some time. The project is nearing formal commencement.

Using the definitions provided in the Environmental Protection Authority Preliminary Position statement No.9 "Environmental Offsets" this option would be designated as a primary offset.

4 **Collie River Catchment recovery program**

Griffin Energy has been investigating the potential for catchment recovery in the Collie River for some time. The project involves tree planting in the upper catchment of the Collie River and investigation of the potential for drawing down the saline near surface aquifers, in certain parts of the catchment, through pumping.

Using the definitions provided in the Environmental Protection Authority Preliminary Position statement No.9 "Environmental Offsets", this option would initially be designated as a secondary offset, however, subject to the project results, could be redesignated a primary offset for vegetation cover and secondary for the added environmental benefit of improving environmental values in the Collie River.

5 **Retirement and Replacement of Muja A/B**

Muja A and B are scheduled for closure. Using Bluewaters as a direct replacement for Muja A and B results in an immediate net saving of up to 214,000 tonnes per annum of Carbon Dioxide.

Using the definitions provided in the Environmental Protection Authority Preliminary Position statement No.9 "Environmental Offsets" this option is a primary offset.

6 **Research into fly ash use**

Fly-ash has potential for re-use. The most common form of re-use is in cement manufacture. Unfortunately in WA the full potential has not been realised due to the cost of transporting the fly-ash to a suitable market

In addition to use in cement manufacture, flyash has potential in a number of other areas, for example in the production of

Cenosperes and Zeolites. Research is required to fully understand the properties of Collie fly-ash and to commercialise these opportunities.

Using the definitions provided in the Environmental Protection Authority Preliminary Position statement No.9 "Environmental Offsets" this option would initially be designated as a secondary offset, however, subject to the research results and successful commercialisation, could be redesignated a primary offset.

7 Diversion of East Collie River

Diversion of the East Collie river into a disused mine void has been proposed as a means of returning Wellington Dam to potable condition. Currently Wellington Dam is too saline for it to be used as a source of drinking water and its use is restricted to pasture irrigation and in a limited sense to "shandying" with other water sources to increase the total water supply to the state's water system.

The sustainable yield of Wellington Dam is approximately 85Gl per annum. The scheme to divert the East Collie River into a disused mining void involves diverting the first flush of water coming down the River each winter until the water quality has reached a level whereby it can be allowed to flow into Wellington Dam. It is estimated that by the diverting early flushes of high salinity river flows over two years Wellington Dam would approach potable condition.

Griffin Energy initiated and paid for the initial studies that have proved the scheme up to a point where it has been adopted by the Collie Catchment Recovery Team as its preferred option with the DoE considering a trial in 2005. Griffin Coal is providing the disused mine voids and additional support for the project.

Using the definitions provided in the Environmental Protection Authority Preliminary Position statement No.9 "Environmental Offsets" this option would be designated as a secondary offset.

8 Purchase of carbon credits

Direct purchase of credits involves an established Carbon trading market and direct purchase of credits. Whilst there is no established market in Australia at the current time, this may change. Currently Carbon trades are being made in the range of \$1.00 per tonne CO_2 equivalent up to \$15 per tonne.

Using the definitions provided in the Environmental Protection Authority Preliminary Position statement No.9 "Environmental Offsets" this option would be designated as a primary offset.

9 Tree Plantation

Planting trees in a plantation involves committing to planting sufficient trees to sequester an equivalent amount of carbon output that is required to be offset.

In a report to Western Power, Greenhouse Gas Primary Offsets for Coal Generation – Bidders Discussion Paper, prepared by SKM Consultants in August 2004, the cost of tree planting as a sequestration option is detailed. Using the data provided in the report the area required for full offset sequestration for Bluewaters would be 240,000 hectares for a commercial plantation and 90,000 hectares for a non harvested plantation. The lifetime cost of a commercial plantation to the project would be $960 million and for a non harvested plantation $316 million. Clearly these costs make carbon offsets using this option impractical as they render the project uneconomic.

Using the definitions provided in the Environmental Protection Authority Preliminary Position statement No.9 "Environmental Offsets" this option would be designated as a primary offset.

10 Mine Rehabilitation (tree plantation on Griffin owned land)
Griffin Coal has rehabilitated several areas using Tasmanian Blue Gums. The Carbon sequestered through these trees can be applied as a bankable credit against Griffin Energy's power proposals. There are currently 250Ha of rehabilitated mine areas giving a credit of 112,500 tonnes in the ground with an annual credit of 11,250 tonnes per annum.

Using the definitions provided in the Environmental Protection Authority Preliminary Position statement No.9 "Environmental Offsets" this option would be designated as a primary offset.

Issue 5.12 Raised by CCWA, ACF, WWF, CANA.
The sub-critical technology proposed for the Bluewaters Power Station is "old technology" and is less efficient than super-critical technology. As Griffin Energy has stated that a 200 MW station is too small to use super-critical technology and the Bluewaters Power Station is the first of three 200 MW power stations, then it should investigate the option of constructing a larger generator that can utilise more efficient technology. Griffin is a contributor to CRC for coal in Sustainable Development and consequently supports R&D in a broad range of clean coal technologies.

Response The 200 MW unit size proposed by Griffin Energy is not within the typical commercially supported size range for supercritical coal fired technology, therefore, there is no commercial basis for it to be anything other than a sub-critical plant.

The 200 MW unit size is an appropriate size for the reliability of the South West Interconnected System. The minimum Reserve Margin for the SWIS is 304 MW (Western Power 2003); this is set by the sent-out capacity of the largest unit of the system being the Collie Power Station Unit. 200 MW represents the approximate 2 year load growth under average conditions. The Bluewaters generator size matches the Unit size at Muja C & D and Kwinana C and is an appropriate fit for the proposed 240 MW retirement of Muja A&B.

Conventional pulverised coal fired power stations are Rankine cycle plants (closed steam / water circuit for working fluid) and are described as either subcritical or supercritical units. The term supercritical describes steam conditions above the steam triple point at 22 MPa. Raising steam conditions into the supercritical area with elevated pressure and temperatures improves the Rankine cycle efficiency [advanced supercritical plant are currently up to 30 MPa and 600°C]. At supercritical steam conditions there is no density differential between the water and steam phases and this requires a "once through boiler" design.

The steam cycle to subcritical conditions (typically a maximum of 180 bar, 540°C / 560°C reheat), boiler design and operation is simplified, but overall efficiency is limited to about 36 - 37% (net generation, and HHV). However a modern subcritical technology power station will share the same design advance of current state of the art steam turbine isentropic efficiency similar to supercritical plant.

A significant limitation for supercritical plant is the minimum unit size. Currently the minimum standard commercially available unit size supported by manufacturers (Siemens, Alstom, Foster Wheeler, Babcock & Wilcox etc) is approximately 400 MW. This reflects the trend in developed countries to very large unit sizes of 800 – 1000 MW with 600 – 800 MW plants becoming the norm. The largest supercritical coal-fired boiler in operation is 1300MW. The trend in commercial development of supercritical plant is within Organisation for Economic Development (OECD) countries where environmental compliance, high fuel cost and electricity charges foster the plant investment in leading edge technologies. The grid sizes for these countries are encouraging new investment in increasingly larger unit sizes to achieve economies of scale. With increasingly larger Unit sizes the capital costs for incremental improvements in performance are more easily realised.

This is also born out in the Australian experience with Supercritical power station developments on the east coast, summarised in Table 4 below.

Table 4

Australian Supercritical experience

	Callide C	**Millmerran**	**Tarong North**	**Kogan Creek**
Main Steam Pressure	25 MPa	24.2 MPa	25 MPa	25 MPa
Main Steam	566°C	565.5°C	566°C	540°C

Temperature				
Reheat Temperature	566°C	595°C	566°C	560°C
Nominal Net Output	2 x 400 MW	2 x 400 MW	1 x 425 MW	1 x 750 MW

The Queensland supercritical power plant, Callide C, Millmerran, Tarong North, and Kogan Creek, have all been designed for a continuous overload operation with 2 High Pressure (HP) feed water heaters out of service and have historically operated in overload due to high demand. The overload operation increases the nominal 400 MW output to approximately 450 MW but at the expense of a higher heat rate (lower efficiency). The most efficient plant operation is with all feed heaters in service.

The following table illustrates the increasing size of supercritical power station units in China.

Table 5
Supercritical Power Station Units in China

Project	Province	Capacity (MW)	Manufacturer	Commissioning date
Shidongkou No. 2 Power Plant	Shanghai	2×600	Boiler:Sulzer Turbine:ABB	1992.06 1992.12
HuanengNanjingPower Plant	Jiangsu	2×300	Russia	1994.03 1994.01
Panshan Power Plant	Tianjin	2×500	Russia	1996
Yimin Power Plant	Inner Mongolia	2×500	Russia	1998.04 1999.08
Houshi Power Plant	Fujian	6×600	Mitsubishi	1999.12 2000.07 2001.10
Suizhong Power Plant	Liaoning	2×800	Russia	2000.06 2000.01
Waigaoqiao Power Plant	Shanghai	2×900	Boiler: Alstom Turbine: Simens	Under construction
Huaneng Qinbei Power Plant	Henan	2×600	Boiler:Dongfang Turbine: Harbin	Designed
CRP Changshu Power Plant	Jiangsu	2×600	Boiler: Harbin Turbine:Dongfang	Under construction

It is important to note that currently there are no standard commercial supercritical plants offered in the size 300 – 350 MW by major equipment manufacturers; this may change if the market for “small” machines increases. However, below 350 MW it is expected that subcritical technology will prevail.

A supercritical plant less than 350 – 400 MW would carry a premium for a one off design cost and may have financing issues for proven design / performance. This situation is unlikely to change in the short term unless there is sufficient market demand for supercritical plant in the 300 – 400 MW size range.

There are practical limitations on the boiler and steam turbines that will limit the minimum supercritical unit sizes to 250 – 350 MW. Below these unit sizes, the efficiency advantages of the supercritical cycle can not be realised due to effects of scale such as high blade path losses in the HP turbines. The effect of both steam leakage and blade inefficiencies can be reduced by the adoption of a larger unit size, so that the leakage paths become proportionally smaller and the blade heights higher.

As unit size increases, the incremental cost of efficiency enhancements becomes economic. The typical cycle enhancements that may be included with increasingly larger units are as follows.

- High temperature materials for advanced supercritical and ultra supercritical cycles for boiler and steam turbine
- Increasing the number of feed water heaters to optimise heat recovery
- Double reheat cycle
- Reducing the condenser vacuum conditions with reduced approach temperatures on the cooling water system and heat rejection technology.
- Large steam turbines minimise the gland steam, seal and blade tip losses
- HP turbine efficiency increases with size of HP blading
- High efficiency low pressure blading
- Variable speed drives of auxiliary plant.

This issue was addressed in section 3.3.3 of the Public Environmental Review.

Issue 5.13 Raised by CCWA, ACF, WWF, CANA.
The Proponent should provide evidence that a critical assessment of options and plant optimisation has been conducted prior to the selection of the fuel and final plant configuration.

Response The plant configuration has been developed by one of the most highly successful and respected power plant developers and manufacturers, with a capability and knowledge of virtually all plant technologies currently available. See also response to Issue 5.12.

Issue 5.14 Raised by CCWA, ACF, WWF, CANA
There should be discussion on the use of biomass and Combined Heat and Power (CHP).

Response CHP and Biomass co-firing technologies do have lower greenhouse gas intensity than the conventional coal fire technology, due to the high overall energy efficiency of CHP and the renewable nature of the biomass.

Given Bluewaters will be constructed on an industrial estate, the potential for CHP exists when heat intensive industry relocates to the industrial estate. See also response to Issue 5.13.

With respect to biomass co-firing, the biomass contribution is typically less than 5% of the overall fuel input (dependent upon the specific nature of biomass). Again, in general co-firing does not require a significant redesign of the plant, and should suitable and economic biomass sources become available, the potential for biomass co-firing is retained for Bluewaters in the future.

Issue 5.15 Raised by CCWA, ACF, WWF, CANA.
The potential to use "low-emission" coal technologies, such as Integrated Drying Gasification Combined Cycle (IDGCC), Mechanical Thermal Expression (MTE) or dewatering technologies should be assessed.

Response IDGCC is a development of the gasification process intended specifically for the use with high moisture, low rank lignite coals. This is not applicable for the Griffin Energy proposed sub-bituminous coal. The technology is not commercial. There is only a 5 MW pilot scale gasification plant at the Morwell Coal Gasification Development Facility.

Emerging technologies such as Integrated Gasification Combined Cycle (IGCC), IDGCC and MTE are not yet commercially well proven.
In respect of IGCC and IDGCC technology, the gasification technologies have had little entrance using coal as a fuel primarily due to the solid content, as opposed to gasification processes on liquid rich fuels (e.g. oil refinery by products). On an international basis, there are a handful of coal-based gasification plants as outlined below:

- Pinon Pine IGCC Power Project
- Tampa Electric IGCC Project
- Wabash River Coal Gasification Repowering Project

In respect of these gasification projects, the following should be noted:

- the projects are heavily funded by the US Department of Energy

- the projects are IGCC projects only, as opposed to IDGCC
- they are not yet sufficiently proven for commercial application

In respect of MTE (and other similar dewatering concepts), the research is targeting high moisture coals (greater than around 50%), and especially coals with a propensity to hold moisture, such as lignite. In general, the dewatering technologies reduce moisture levels to around 30% which is still greater than the Ewington coal deposit fuel properties. On this basis, these technologies are not physically or technically appropriate for the Bluewaters project.

Issue 5.16 Raised by CCWA, ACF, WWF, CANA.
The potential to apply "low-emission" coal technologies as a pilot or research plant in order to contribute to research being undertaken to lower emissions from coal use should be examined.

Response The Griffin Group through Griffin Coal is a contributor to the CRC for Coal in Sustainable Development and therefore supports a range of R&D projects that have the ultimate aim of improving the technologies available to coal fired power generation. Griffin Energy believes that support of this kind is more appropriate than attempting research and development activities on a sole risk basis. By supporting collective R&D efforts more resources can be applied to specific problems and issues that require resolution across the industry.

While Bluewaters will use so-called 'conventional technology', it will nevertheless utilize modern, state-of the-art equipment and components. The 4 x 60 MW Muja A & B units were commissioned in 1965, and use equipment that is now well over 40 years old in design terms. In those 40 years there have been improvements in the design and efficiency of the energy intensive, so-called "conventional technology" plant items such as electric motors, fans, pumps and, in particular, steam cycle (higher conditions and reheat cycle), steam turbine and generator. In addition, the increase in size from the 60 MW units at Muja, to the 200 MW unit proposed initially for Bluewaters would in itself result in an increase in efficiency even if nothing else was changed.

Nevertheless, because conventional technology is mature, the efficiency gains made over the past 40 years are, as CCWA, ACF, WWF, CANA have pointed out, relatively modest. Consistent with expectations, further gains in efficiency from conventional technology would come at significantly increased cost. As a result, what is now state-of-the-art represents a balance between what is theoretically achievable and what is practical and affordable.

While not explicitly, CCWA, ACF, WWF, CANA in effect raise an issue here that is a perpetual challenge to industry and governments; that is, the challenge of bringing first-of a-kind or non-conventional technology to maturity. This is an issue that requires more than CCWA, ACF, WWF, CANA lobbying, more than the political will of the Western

Australian Government, and more than the resources of the power industry. Dr David Brockway, Chief Executive Officer of The Cooperative Research Centre For Clean Power From Lignite, in his submission to the Victorian Government's Greenhouse Challenge for Energy in August 2003 puts it this way:

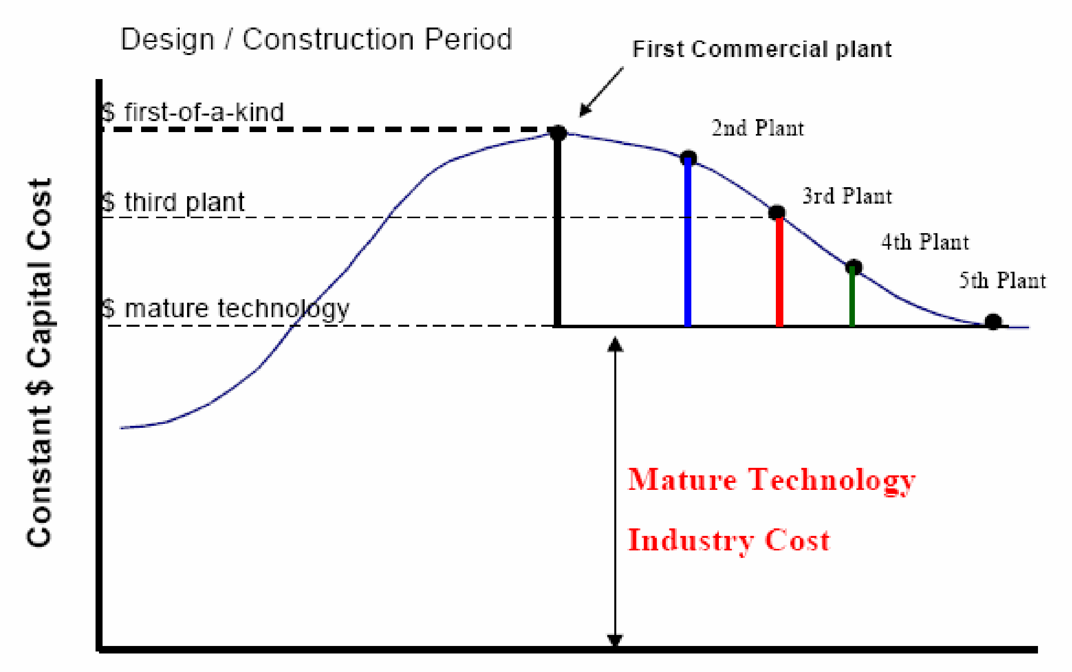
"*It is well known in many industries involving large capital-intensive plant that the first-of-a-kind have a relatively high capital cost and initially, at least, suffer from low availability. It is only after several installations and a number of years of operational experience that sufficient developments have progressed for the technology to be mature, with substantially reduced capital and operating costs. Clearly any Independent Power Producer [IPP] operating in a competitive market will be extremely reluctant to disadvantage itself relative to its competitors by accepting the additional costs that its competitors will not suffer and from which its competitors may in fact benefit in the future.*

This difficulty is compounded by the fact that IPPs are seldom in a position to fund construction of a new plant from internal sources. Almost invariably power station projects involve substantial debt funding with funds raised from financial institutions. These institutions are similarly very risk-averse. They are simply not prepared to provide loan funds that are at risk when applied to economically and technically uncertain investments for the first-of-a-kind plant.

The issue is further compounded by the fact that, due to the high capital intensity of the power generation industry, many Independent Power Producers (IPPs) are heavily leveraged already. Hence, additional loan funds come at a premium (if available) and further increase the real cost of new plant (and therefore their position in a competitive market).

It is abundantly clear that under the existing world power generation industry's structure, financial institutions will play a determining role in the implementation of large-scale advanced cycle technologies."

Dr Brockway's submission illustrates this issue with the following diagram.



The obvious question that must be addressed is: who provides the risk capital to bring the non-conventional, significantly more efficient, advanced cycles to maturity?

Our view is that it requires more than the "determining role' of financial institutions. It requires the collective and collaborative efforts of government, industry, the CCWA, ACF, WWF, CANA's of this world, and the financial institutions. This issue is therefore much bigger than the Bluewaters proposal.

In summary, in the context of converting coal to electricity at the 200 MW scale, all the non-conventional technology options available are simply not yet "bankable" (considered too risky for lenders). This is because they are not yet fully proven and/or not yet commercially mature technologies.

It is agreed that both CHP (cogeneration) and biomass co-firing have lower greenhouse gas intensities than the Bluewaters proposal and are reasonably mature technologies.

However, CHP requires a host or consumer for the heat. While Bluewaters will be constructed on an industrial estate, and the potential to sell heat may exist in the future, it does not exist now. For the project to proceed it requires a robust expectation of its revenue streams. This will typically be provided in the form of the Electricity Sales Agreement (or Power Purchase Agreement) and Steam Sales/Purchase Agreement. For this reason, CHP projects are either developed after or in parallel to the development of the host industry.

Biomass co-firing is a real opportunity, provided that a source of suitable biomass is available. However, it is limited to 5 – 10% of the overall heat input. An issue with biomass is that it is not a commodity fuel and its price is uncertain. It can have a negative value for someone who has to pay to dispose of it but this can quickly change once a commitment to, say co-firing, is made. There is then a risk that its value will attract opportunists, leading to destructive harvesting of forestry resource.

IGCC is considered a developing technology in the worldwide electricity utility industry. Existing projects with project costs reported in the public domain are demonstration projects that typically have pricing that is "first of a kind". There are few examples of IGCC plants that are coal fired and operated for electricity generation only.

The following table lists current coal fired demonstration plants. These have all received significant subsidies for research development funding.

Table 6

Commercial Scale Coal / Petroleum Coke Based IGCC Power Plants

PLANT NAME	PLANT LOCATION	OUTPUT (MWe)	FEEDSTOCK	GASIFIER TYPE	POWER ISLAND	OPERATION STATUS
U.S. IGCC PLANTS						
Texaco Cool Water	Daggett, CA, USA	125	Bituminous Coal (1,000 tpd)	Texaco	CCGT – GE 7FE	1984 - 1988
Dow Chemical/Destec LGTI Project	Plaquemine, LA, USA	160	Subbituminous Coal (2200 tpd)	E-Gas (formerly Destec)	CCGT – Westinghouse 501	1987 – 1995
Tampa Electric Polk Plant	Polk County, FL, USA	250	Bituminous Coal (2200 tpd)	ChevronTexaco	CCGT – GE 7FA	1996 - Present
PSI Energy/Global Energy Wabash River Plant	West Terre Haute, IN, USA	262	Bituminous Coal and Petroleum Coke (2544 tpd)	E-Gas (formerly Destec)	CCGT – GE 7FA	1995 - Present
FOREIGN IGCC PLANTS						
NUON/Demkolec/ Willem-Alexander	Buggenum, The Netherlands	253	Bituminous Coal	Shell	CCGT – Siemens V94.2	1994 - Present
ELCOGAS/ Puertollano	Puertollano, Spain	298	Coal and Petroleum Coke (2500 tpd)	Prenflo®	CCGT – Siemens V94.3	1998 - Present

CCGT – Combined Cycle Gas Turbine, tpd – short tons per day

(Source: "Major Environmental Aspects of Gasification Based Power Generation Technologies", Final Report Dec 2002 NETL Table 1-4)

Most current gasification developments are associated with Refinery industries where there are issues with the disposal of refinery bottoms. A list of international IGCC projects currently operating or under construction are provided in Table 7.

Table 7
Global IGCC Plants

Facility	Commercial Operation Date	MW	Application	Gasifier
SCE Cool Water USEA	1984	120	Power/Coal	Texaco – O_2
LGTI – USA	1987	160	Cogen/Coal	Destec – O_2
Demkolec	1994	250	Power/Coal	Shell – O_2
PSI/Global – USA	1995	260	Repower/Coal	Destec – O_2
Tampa Electric – USA	1995	260	Power/Coal	Texaco – O_2
Texaco El Dorado – USA	1995	40	Cogen/Pet Coke	Texaco – O_2
SUV Czech	1996	360	Cogen/Coal	ZUV – O_2
Schwarze Pumpe – Germany	1996	40	Power/Methanol Lignite	Noell – O_2
Shell Pemis – Netherlands	1997	120	Cogen/H_2//Oil	Shell – O_2
Puertollano – Spain	1998	320	Power/Coal/Pet Coke	Prenflow – O_2
Sierra Pacific – USA	1998	100	Power/Coal	KRW – Air
ISAB – Italy	1999	500	Power/H_2/Oil	Texaco – O_2
API – Italy	2000	250	Power/H_2/Oil	Texaco – O_2
Motiva – Delaware	2000	240	Repower/Pet Coke	Texaco – O_2
Sarlux/Enron – Italy	2000	550	Cogen/H_2/Oil	Texaco – O_2
Exxon – Singapore	2000	180	Cogen/H_2/Oil	Texaco – O_2
Fife – Scotland	2001	120	Power/Sludge	BGL – O_2
EDF/Total Gonfreville	2003	400	Power/H_2/Cogen/Oil	Texaco – O_2
Fife Electric – Scotland	2003	400	Power/Coal/RDF	BGL – O_2
Nihon Sekiyu – Japan	2004	350	Power/Oil	Texaco – O_2
Citgo Lake Charles	2005	500	Cogen/Pet Coke	Texaco – O_2
PIEMSA	2006	800	Power/H_2/Oil	Texaco – O_2

Source: General Electric

IGCC costs are still highly variable as the IGCC technologies are still not considered to be commercially proven by Utility companies. Current studies have costs ranging from US$1,100 to US$1,700 /kW. Current studies show significant pricing differences between the three primary gasification technologies. (Texaco Quench, E Gas, Shell Gasifiers). This illustrates that IGCC is not a mature technology with consistent costs. It is important to recognise that lower construction costs are typically associated with low plant efficiency. Economies of scale are being applied to large scale IGCC to reduce the capital cost; hence size of plant in the Australian context needs to be considered.

A significant impact on the IGCC costs will be any requirement for redundancy of the gasification plant to ensure that the IGCC plant availability remains similar to competing clean coal technologies. The plant size of the studies is trending to large plant in the 800+ MW size range.

Griffin Energy requires non-recourse financing to fund Bluewaters. Financial institutions do not consider that the capital costs are mature. Firm prices are not yet being offered by EPC contractors. Financial institutions consider that there is not enough plant experience for risks to be fully understood and managed. O&M costs are relatively predictable with operating information from demonstration plants. There is a significant penalty for refractory O&M. Life cycle costs are not currently competitive with other technologies.

IGCC reliability suffers from still being a "first of a kind" plant with the power plant not always operating when it is needed. The start up times for IGCC are very long compared with other coal based technologies due to extensive preheating of refractory in the gasifiers. Inspection and maintenance access to the gasification plant is slow during forced outages due to the large amount of refractory requiring cooling.

Financial risk hedges have not been adequate to date. Guarantees and warranties on a plant are still difficult to manage with an affordable single performance wrap as there are many contractors in the supply chain. IGCC is still vulnerable to regulatory changes for CO_2 emissions and carbon taxes. However IGCC is probably better able to hedge this with higher plant efficiency (when mature) and the potential for lower costs of CO_2 capture. Plant costs are reducing and as the technology matures the cost of electricity for a merchant plant will be competitive with other technologies.

The current economic status of IGCC has been assessed in the USA in the Final Environmental Impact Statement for the "Elm Road Generating Station" Public Service Commission of Wisconsin Department of Natural Resources, Docket 05-CE-130, Date Issued July 2003, which notes that "*there is little historical information to determine the estimated IGCC cost and the 2011 operation date is too far into the future to develop a more reliable estimate with increased price certainty. IGCC technology has been demonstrated commercially at only two sites within the US both for a nominal 250MW size plant. The cost for one of those plants, the Wabash River Plant in Indiana was US$417 million for a 262 MW facility (in 1995 dollars) or US$1,591/kW*".

Issue 5.17 Raised by CCWA, ACF, WWF, CANA.
The potential use of biomass instead of coal and the potential application of biomass co-firing should be addressed.

Response Use of biomass on its own to provide sufficient energy for a 200MW power station is currently unrealistic. The Western Power trial plant at Narrogin is a 2MW plant (1/100th the size of Bluewaters) and is reliant on Commonwealth subsidies to make it viable.

It is doubtful that sufficient tonnages of biomass would be available at economic prices to make a 200MW biomass plant viable.

Biomass co-firing is possible up to about 5%, however, the availability of sufficient quality, reliable supply is not guaranteed. The option for biomass co-firing will be kept open and should it become technically and economically possible, will be pursued. See also response to Issue 5.14.

Issue 5.18 Raised by CCWA, ACF, WWF, CANA.
All fuel options and technologies, such as cogeneration opportunities should be examined.

Response Refer to response to Issue 5.16 and 5.17.

Issue 5.19 Raised by CCWA, ACF, WWF, CANA
Information about Collie coal should be presented to establish whether the thermal efficiency of Bluewaters is World's Best Practice.

Response Thermal efficiency is related more to the plant selected than the coal properties. The Bluewaters project has selected the most appropriate technology for a coal fired plant of the scale proposed.

Issue 5.20 Raised by CCWA, ACF, WWF, CANA.
The proposed development would breach the objectives of the United Nations Framework Convention on Climate Change (UNFCCC).

Response Meeting the objectives of the UNFCCC is a matter for the Commonwealth Government and is not an issue for the proponents of Bluewaters. Notwithstanding this, Griffin Energy has committed to the development of a Greenhouse Gas Management Plan as detailed in the response to Issue 5.3.

Issue 5.21 Raised by Western Power Corporation.
The average sent-out carbon intensity of electricity generation into the SWIS in 2003/2004 was 870kg of CO_2 per MWh. Using information provided in the PER document, and assuming that 5.5% of the electricity generated by the proposed power station will be used internally, the Bluewaters Power Station would have a sent out carbon intensity of about 925kg of CO_2 per MWh, thus making it appear unlikely that it would significantly reduce the sent-out carbon intensity of electricity generation of the SWIS.

Response The issue, as detailed, highlights the difficulty in accounting for greenhouse contributions from various sources into a network such as the

SWIS, especially when some producers may be claiming credits from non-electricity generating initiatives.
Notwithstanding the above, it is clear that the introduction of Bluewaters into the system will reduce the Greenhouse intensity of coal fired electricity produced in the Collie region due to the better efficiencies used by Bluewaters when compared to the aging Muja fleet. The exact reduction is difficult to quantify as it will be a calculation that will be reliant upon the production profile of Bluewaters and all of the other coal fired plants being available at the time of calculation.

The calculated sent out intensity of Bluewaters is 933kg of CO_2 per MWh.

This concern is also addressed in the response to Issue 5.4.

Issue 5.22 Raised by DPI.
Additional Investment in carbon sequestration such as tree farming should be strongly encouraged.

Response Griffin Energy is considering many options for carbon management. The options are detailed in the response to Issue 5.11.

Issue 5.23 Raised by a private citizen.
Given that the proponent is proposing to burn coal to produce electricity instead of cleaner and more efficient natural gas, I thought that they would consider making a commitment to implement some form of greenhouse gas reduction strategy such as tree planting.

Response Griffin Energy is considering many options for carbon management. The options are detailed in the response to Issue 5.11.

Issue 5.24 Raised by PAN.
More acceptable options for power generation in the south-west are available. And sustainable energy systems based on cogeneration, renewables and energy conservation should be considered.

Response This issue is addressed in the responses to Issues 5.14, 5.15, 5.16 and 5.18.

Issue 5.25 Raised by a private citizen.
There should be no demand for offsets placed on this project by the EPA. Offsets are contrary to the Federal government position as defined by the AGO Technical Efficiency Guidelines and contrary to the State Government diversity in fuel policy. The EPA approach to condition setting and commitment seeking should be in line with state government policy.

Response Griffin agrees that policy should be consistent across all arms of government.

6 Liquid and Solid Waste Disposal

Issue 6.1 Raised by CALM.
If the chosen method for flyash disposal is to be supported, additional technical justification is required.

The PER does not demonstrate the merits of the chosen method for flyash disposal by comparing the relative risks and benefits with alternative techniques.

It is not apparent whether flyash will be disposed of into backfilled pits or out of pit overburden dumps.

Response The issue of flyash disposal raises the following questions:

- *What is the composition, acidity, and heavy metal composition of the flyash*
- *What will be the impact on the composition of the flyash if the mine voids become acidic*
- *If the mine voids that are filled with flyash do become acidic, what happens to the acidic water run-off*
- *Can the flyash be fixed in place in "a clay stabilised form" as indicated on page 54 of the PER document*
- *Proposals for flyash disposal should be verified as the most appropriate disposal technique and benchmarked*
- *What are the risks relating to the selected disposal method and can the risks be quantified*

The concept of coal fired power station ash disposal into coal mine voids is not unique in Australia, having been successfully utilised at Mt Piper Power Station (NSW) for over 10 years, Bayswater Power Station and more recently Wallerwang Power Station (NSW). Utilisation of coal mine voids for disposal of coal combustion products is common practice in the United States.

The ash disposal method proposed for Bluewaters utilises a dry emplacement technique above the water table similar to Mt Piper Power Station near Lithgow in the central west of NSW. Like Collie coal ash, the ash produced at Mt Piper generates an acidic leachate when mixed with water. The Mt Piper ash storage area is also located within Sydney water catchment area and hence environmentally sensitive. Water added to the ash for conditioning purposes is kept to a minimum (<15%) and leachate to the groundwater has not become an issue. The ash storage site has been progressively capped with soil and revegetated.

In the absence of fly ash sales, the utilisation of flyash for mine backfill purposes alleviates the need to excavate a separate site for ash disposal.

Coal and Ash Composition

Combustion of blended Ewington coal, deemed typical of customer supply quality, in a Boiler Simulation Furnace at ACIRL produced fly ash with the chemical composition detailed in Table 8.

Table 8
Ewington Coal and Flyash Composition

	Coal % as received	Laboratory Ash
Ash	11.6	
Sulphur	0.41	
Ash Analysis		**% of ash**
SiO_2		64.6
Al_2O_3		25.6
Fe_2O_3		6.24
CaO		0.61
MgO		0.65
Na_2O		0.24
K_2O		0.52
TiO_2		1.75
Mn_3O_4		0.10
SO_3		0.34
P_2O_5		0.07
Loss on Ignition		-
Trace Metals		**µg/g of air dried coal**
Arsenic		0.62
Mercury		0.02
Selenium		0.01
Cadmium		<0.02
Lead		18
Boron		<5
Zinc		15
Antimony		0.2
Beryllium		1.4
Fluorine		50
Chlorine		0.03

Acidity of flyash itself is not generally measured, however, when the flyash from Collie coal is mixed with water an acidic aqueous phase is typically produced.

Acidic leachate has the potential to mobilise metallic species from the ash and surrounding materials. Fly ash leaching tests indicate the presence of manganese, cadmium and chromium in quantities above the drinking water standard. Trace metals in the Ewington coal blend are regarded as low in comparison to other Australian and U.S. coals.

Ground water monitoring

Fly ash has the capacity to hold up to 30% moisture. It is proposed to add approximately 15% water for dust suppression and to facilitate handling. The ash therefore, has additional moisture holding capacity to accommodate water ingress before saturation and leaching. Rainfall ingress would be minimised by rolling and grading the working face of the laid down ash and progressive capping with stored topsoil and revegetation. Since the fly ash bed will be kept above the groundwater table, the potential for leachate will be minimised.

An earlier request for strategic advice was made to the EPA regarding the South West Power Project proposal for a coal fired plant in the Collie region. The response (Bulletin 1090) required the commitment by Griffin to prepare and implement an operation phase environmental management plan to monitor groundwater quality to ensure potential impacts from the power station are managed. Griffin's Environmental Management Plan for the Ewington I mine details the groundwater monitoring program including the construction of several new multipiezometers and dewatering installations around the mine site. Along with existing local and regional State and Griffin owned piezometer network, the monitoring program will provide substantial data for groundwater flow modelling.

Sampling of runoff, local water courses and wetlands is also proposed. The sampling program will commence prior to mining and power station development in order to establish baseline conditions. Annual assessments and reporting on water resource management and mining impacts will be made. The sampling program will target species known to emanate from coal ash leachate such as sulphate and strontium as well as discharge water quality parameters defined in the Collie Coal Basin Water Resources Management Strategy (1988) and trace metals of concern.

Acidic Mine Water Interaction with Fly Ash

Coal mine voids are often left open after mining, resulting in ground and surface water influx forming a void lake. Interaction of water and air results in oxidation of the void surfaces from Collie coal open cut mines and the production of acidic mine void lakes.

Closure of open cut mines in the Collie region has left a number of acidic mine void lakes. The acidic water restricts the potential for recreational or aquatic re-use and poses an environmental hazard through seepage and overflow. pH amelioration has proved difficult due to the strong buffering capacity of the water constituents. The proposal to utilise flyash to assist in back filling the mined areas will reduce the volume of any remaining void thereby reducing the amount of acidic mine water. The flyash disposal zone will be kept above the ground water level hence, provided the water level in any remaining void is kept at or below groundwater level, acidic void water will not contact the flyash directly. If acidic mine void water were to contact the flyash bed the potential for leaching of metallic species does exist.

Fixation of Flyash

The interaction of flyash with the over / inter burden claystones has not been established at this stage. Some clays have cationic exchange properties that have potential to fix metals in place thereby limiting their environmental availability. A literature search is currently underway to establish historical work on Collie coal flyash interactions with other materials. There have been previous studies on interactions of fly ash with mineral sand waste, red mud from bauxite mining and soil for soil improvement purposes.

Ash Disposal Practices

Historically combustion products from coal fired power stations are pumped as low density slurries to custom built lined disposal areas. This method requires considerable water resources, poses disposal area water management and leaching problems and increases the space required for disposal. Rehabilitation of the disposal area is also delayed until surface waters are removed and the ash bed dries out. More recently dense phase slurries or paste disposal methods are utilised, reducing both the water requirements, leaching propensity and volume necessary for disposal as well as speeding up the rehabilitation process. Dry disposal methods are the other alternative. The operating cost is generally considered greater, however the water management and leaching issues are reduced. Griffin Coal already has the equipment for laying down and carting the ash through mine site operations as well as the disposal site and infrastructure for operations.

Ash Disposal Summary

The proposal to dispose flyash back into the mine was initially proposed by Griffin Energy in the Strategic Environmental Review for the South West Power Project. In its report (Bulletin 1090) on the proposal the EPA made the following statement "*The EPA considers that further investigation may be required to demonstrate the effectiveness of disposing of overburden above the water table in preventing groundwater pollution. The EPA encourages Griffin Energy to pursue its research efforts towards finding a beneficial use for the flyash that does not have any significant impact on the environment, such as in cement manufacture or similar uses.*

The EPA considers that a commitment by the proponent to prepare and implement an Operations Phase Environmental Management Plan to monitor groundwater quality to ensure that potential impacts from the power station on groundwater quality are managed would be capable of adequately dealing with this issue."

Griffin Energy will cooperate with the operator of the coal mine (Griffin Coal) to ensure that this commitment is fulfilled. Flyash management will be a component of the Operational Phase Waste Management Plan referred to in Commitment 10 in Table 9 of the PER document. The plan will include a groundwater monitoring program which will be agreed in consultation with the mine operator, DoE and other stakeholders.

Issue 6.2 Raised by CALM.
The regulatory framework that would allow the disposal of flyash within the mine lease located within a State Forest needs to be determined.

Response The Ewington I mine will be subject to closure criteria. The criteria will be established in consultation with stakeholders including CALM. The mine will be returned to the custody of CALM when the closure criteria have been met after rehabilitation. The flyash incorporation will be a component of the closure plan. A closure plan for the mine is currently in preparation by Griffin Coal as part of the Environmental Management plan for the mine. Flyash disposal back into the mine is current accepted practice in many coal mines in Australia and around the world.

The Collie Coal (Griffin) Agreement Act 1979 provides for activities associated with the mining of coal to be carried on within the mining leases subject to the Act. The return of flyash is an initiative associated with the expansion of activities and increased production as specified in the Agreement Act.

Issue 6.3 Raised by CCWA, ACF, WWF, CANA.
There is no indication of what investigations have been undertaken or planned with respect to developing markets for alternative uses for flyash.

Response ***Current market for flyash in WA***

Approximately 10%, or ca 50,000 tonnes, of the fly-ash from Collie coal being used for power generation is effectively utilised. There is only one company currently exploiting the commercial use of this ash, with about 5%, or 25,000 to 30,000 tonnes used in cement blends and the rest in bulk fills, including road base applications.

Technically, the use of fly-ash in cement and many bulk fills has many advantages. Depending on the application, concrete structures may take as much as 10 – 30% fly-ash to improve the setting time, water consumption and mechanical strength.

However, use of fly-ash in WA is severely impeded by the relatively high transport cost to bring the "low-value" ash to the major markets near Perth.

The use of fly-ash in bulk fills is seasonal and dependent on the opportunities for utilisation projects that become available from time to time.

In using fly-ash from Western Power utilities at Collie A and Muja power stations, a quality standard is imposed by the company taking it, that is, the unburnt carbon content needs to be less than 3% and the particle size is such that 80% passing the 45μm sieve. While this standard is used as the reason to reject the rest (ca 90%) of the ash, it is more a commercial decision (to keep the price of fly-ash low) rather than a technical issue. Note that the industry standard is 6% unburnt carbon and 70% passing 45μm.

Future potential for growth in this market

Reliable figures indicated that the amount of fly-ash utilised in cement and other construction work was only 1,500 tonnes in 1992 and increased to about 50,000 tonnes in 2003. Although the potential market for fly-ash utilisation in cement is much greater than it is, the future growth may be slow, primarily due to the transport cost. Potential fly-ash marketers will need further commercial incentives to increase fly-ash intake, such as large construction projects, cement price, and specific (technical) requirements of the concrete work.

Other low-value markets for fly-ash include mine backfills, soil stabilisation, engineered fills, roads, and barrier materials. However, these options have not been fully explored in WA. Again, this is due to the transport costs and locally available project opportunities for the fly-ash to be utilised.

Technically, if one assumes that all cement takes 10% fly-ash, it is possible for all WA fly-ash to be utilised. However, the current low values of fly-ash means that it is uneconomic to transport it more than 100 to 150 km.

A potential exists for the majority, if not all, of the fly-ash produced to be utilised in agricultural applications in the south west region of the state. However, the direct use of fly-ash in agriculture is faced with legislative and public perception barriers and requires further research to prove the application.

Potential for value-adding flyash

Clearly, the transport costs (or the low values of fly-ash in the present form of utilisation) are the key barrier to wide spread utilisation of fly-ash in WA (and in Australia in general, due to our low population density). The future growth of fly-ash utilisation relies on value-adding (so that the fly-ash can be transported over greater distances). The following are several potential options identified in WA.

Zeolite for agricultural applications has the potential to utilise a significant proportion of fly-ash produced in WA in the long term. Processed hydro-thermally zeolite from fly-ash contains no or little undesirable trace elements and heavy metals, thus overcoming the legislative and public perception barriers. Fly-ash zeolite can improve the efficiency of fertilisers and water by holding them in its micro pore structures and only releasing them when the plant requires them, thus improving the economic and environmental performance of the agricultural industry. Fly-ash zeolite can also be used in the residential market for potting mix for gardens and flower beds. The price of such zeolite is estimated to be from several hundred dollars to over $1000 per tonne, depending on the application.

Manufacturing of aggregates from coal ash (including bottom ash) is another option with potential. The supply of natural aggregates for construction work is decreasing nationwide, pushing up the price (and cost). This offers a great opportunity for coal ash aggregates.

Cenosphere is a very high value product that could be easily derived from fly-ash, valued at $1,000 - $2,000 per tonne. Although the yield of cenospheres is generally low (a few percent at best), its high value encourages its commercial exploitation. The good economic return from cenospheres can also help other utilisation options, for example, by subsidising the transport cost.

Masonry is yet another (though small) option feasible in WA, including pave blocks (more likely) and bricks (less likely for residential houses).

Another value-adding option is to make geo-polymers from coal ash. There are significant mechanical and structure performance questions to be answered before its realisation. There are significant research activities at Melbourne University looking into geo-polymers making from a range of feedstocks, including fly-ash.

Timeline for realisation of value adding opportunities

There are probably two timelines for realisation of the above value-adding opportunities, one being technical and the other commercial. The latter one is more difficult to estimate than the former. The zeolite option is estimated to take about 3-5 years to develop a commercially feasible manufacturing process, based on good science and engineering research which is currently being undertaken at Curtin’s Centre for Fuels and Energy.

It will probably take slightly less time (3–4 years) for aggregate manufacturing process to be developed. However, in the longer term, in 10–15 years, fly-ash aggregates have the potential to displace natural aggregates.

Cenospheres from WA power stations can be readily harvested and marketed. However, this option has not been exploited commercially.

Likewise, masonry making from fly-ash has little technical barrier but has not been exploited commercially, due largely to the lack of a developed market. In any event the market is considered to be quite small in WA.

Research activities supporting value-adding potential

Curtin's Centre for Fuels and Energy is undertaking research into zeolite and aggregate manufacturing, funded by CCSD. However, the progress of the research has been limited affected by the low levels of funding.

The hydro-thermal treatment of fly-ash to produce zeolite is currently under investigation at Curtin. The process mixes fly-ash with a caustic solution and subjects the slurry to a temperature in the range between 70 to 180 ^{o}C for a certain time (expected to be from a couple of days up to a week or so), for the zeolite crystals to grow from the silica and alumina elements within the ash. The impurities in the coal ash are not thought to be a problem as the aim is agricultural uses of the zeolite. Obviously, the ratio of ash/caustic solution, the processing temperature and "curing" time are the key subjects of the current research, together with the characterisation of both the ash (the feedstock) and the zeolite (product) produced. It is difficult to give a realistic estimate of the processing cost but the simplicity of the process ensures relatively low costs of manufacturing. Collie coal ash has been identified to be suitable for zeolite making.

A new Task which has recently been approved by the CCSD is to undertake research into aggregate manufacturing from coal ash. One of the intended processes is to mix coal ash with waste coal (as the fuel) with or without lime additive, agglomerate the mix into granules and fire (sinter) the granules at a high temperature (between 800–1000^{o}C). This will produce the aggregates. An alternative is to blend the coal ash with a caustic solution, with or without lime additive, granulate the blend into particles of desired sizes, and then steam-cure the granules at ca. 200–400^{o}C for a certain amount of time. Again, the blending ratios, the use of lime additive, the temperature and time for firing or curing and process optimisation are the subjects of the current research effort.

Issue 6.4 Raised by CALM.
CALM should be included as an advising agency with respect to Commitment 10 in the PER.

Response Griffin Energy agrees and will work towards this being done.

Issue 6.5 Raised by DoH.
The on-site wastewater system for the treatment and disposal of sewage will require the Department's approval, and a concept plan of the system

will need to be submitted to the Department for consideration. The volume of wastewater generated by construction workers during the peak construction period needs to be taken into consideration in the design of the proposed system.

Response The Wastewater treatment plant approval will be a component of the building approval received from the Shire of Collie. Griffin Energy will be making all appropriate applications for the project as required. Where the Health Department or any other government authority or agency is required to be involved in the approval process this will be done.

No particular effluent disposal system has as yet been selected by the proponents at this early stage of project development, but all relevant information will be included within the Local Government Report to the DoH at the time of submission of the appropriate application. It is probable that an existing and approved off the shelf system (e.g. Biomax) as has been used at other Griffin sites is likely to be adopted.

Issue 6.6 Raised by DoH.
The ability of the soil and the adequacy of the area for effluent disposal should be demonstrated if disposal by soil absorption is proposed.

Response This will be done in consultation with the Shire of Collie and other stakeholders. The subject site has various soil types from deep sands to various clays, gravels and rock within its confines, many of which will be well suited to the absorption of effluent wastes if that method is the preferred and approved choice.

Issue 6.7 Raised by PAN.
The discharge of contaminated cooling and washing water into the ocean off Australind will raise water pollution issues given that this water will contain elevated levels of residual pollutants such as heavy metals.

Response The discharge water will not contain elevated levels of pollutants. As discussed in the PER the proposal is to utilise the existing Collie Power Station ocean discharge line. This issue is fully covered in the response to Issue No. 9.2.

Issue 6.8 Raised by WPC.
Use of the existing saline pipeline does not take into account that future local power generation supply water quality is likely to be significantly different, with attendant impact on pipeline capacity availability.

Response WPC provided in-principle approval for the use of the saline pipeline in its letter to Griffin Energy dated 6 February 2004. The proponent will continue to work with WPC regarding saline water disposal and other water issues. Griffin Energy is confident of having the facility available for Bluewaters' operation.

Issue 6.9 Raised by WPC.

Some type of groundwater/leachate monitoring would be required in order to gauge the effect of disposing of flyash by mixing it with overburden and returning it to the Ewington mine.

Response This is indeed proposed. The final monitoring program for Ewington mine is overseen by the Collie Coal Mines Environment Committee (CCMEC) thus ensuring that relevant stakeholders such as CALM are included in the design of the monitoring program and assessment of results. See also response to Issue No. 6.4.

Issue 6.10 Raised by WPC.
Since the use of the Collie Power Station wastewater pipeline has not been confirmed, the proponent should consider alternative methods of disposal more fully.

Response WPC provided approval in principle for the use of the saline pipeline in its letter to Griffin Energy dated 6 February 2004 The proponent will continue to work with WPC regarding saline water disposal and other water issues. Griffin Energy is confident of having the disposal facility available for Bluewaters' operation. See also response to Issue 6.8.

Issue 6.11 Raised by WPC.
Further detailed discussion is required in relation to the on-site evaporation pond referred to in the PER document given that it could have a significant impact on the local environment.

Response No on-site evaporation pond is proposed for Bluewaters. Refer to response to Issue 6.10.

Issue 6.12 Raised by WPC.
It is stated that the existing Collie Power station Saline water pipeline will be used for saline water disposal. In the absence of confirmation of this means of disposal, alternatives for saline water disposal should be addressed in more detail.

Response Griffin Energy has agreement in Principle from Western Power for the use of the pipeline. The arrangements for the use of the line are the subject of commercial negotiations. Refer also to Responses to Issues 6.10 and 6.11. Griffin Energy is confident that the ocean disposal facility will be available for the power stations operation.

Issue 6.13 Raised by EPASU.
Additional detailed information is required in respect to marine environmental impact especially with respect to the following points:
- Dilution factors
- Background water quality
- Cumulative discharge concentrations
- Flowrate
- Dilution zones
- Toxicant concentrations

- Comparisons with Guidelines

Response **Wastewater Dilution**

The wastewater dilution figures presented in Table 8 of the PER are a simple dilution calculation that does not take into consideration the natural, or background, concentration of the listed substances in the receiving environment.

Table 9 (below) presents concentration values for background water quality, based on the values quoted in Department of Environmental Protection (DEP) licence 6637/4, McAlpine et al (in press) and discharge site reference values, and for the predicted water quality of the cumulative wastewater discharge.

Table 9
Existing background water quality and proposed cumulative discharge concentrations

Parameter	Background (Western Australian coastal waters)[1]	Background (Perth coastal waters)[2]	Background Water Quality in vicinity of Discharge Location[3]	Predicted cumulative discharge: Collie A plus Bluewaters[4]
PH	8.2		8.4 – 8.5	7.3
mg/L				
Dissolved oxygen	7		6 – 7	8.1
TDS	34,500		32,600 – 33,100	1,500
TSS	10			23
µg/L				
Phosphate-P	10			2
Nitrate-N	20			550
Cadmium	0.1	0.0045	<0.2 – 0.3	<10
Calcium	400,000			231,000
Chloride	19,000,000			1,732,000
Chromium (III)	0.05	0.2	<10 – 11	20
Copper	3	0.085	<0.005 – 6	30
Iron	10			300
Lead	0.03	<0.019	<5 – 15	10
Magnesium	1,400,000			91,000
Mercury (total)	0.05	0.0004	<0.1 – <0.2	<3
Nickel	2			75
Potassium	280,000			29,000
Silica	6,000			78,000
Sodium	10,500,000			815,000
Sulphate	2,450,000			244,000
Zinc	10	0.502	<2 – 10	67
L/s				
Flowrate	92.5*			92.5

* design capacity
1 taken from licence number 6637/4
2 McAlpine et al (in press)
3 Western Pacific reference site values
4 Bluewaters PER

Background values used in this assessment have been adopted in the following order of priority: McAlpine et al (in press), discharge site reference data (URS 2003), DEP Licence 3367/4. The data presented in Table 9, and actual in-pipeline wastewater toxicant concentrations measured to fulfil the environmental licensing conditions (Table 10), are then compared to ANZECC/ARMCANZ (2000) water quality guidelines and DoE Environmental Quality Objectives at the point of discharge and at the edge of the zone of initial dilution (ZID) (Tables 10 and 11 and subsequent discussion), based on 1 in 100 dilution at the edge of the ZID in seawater at background concentrations.

Flowrate of Combined Effluent

The flow rate of the combined effluent has been nominally set at 92.5L/sec, which is the original design flow rate for a 600 MW power station. The pumping rate for the Collie A 300 MW Power Station is 43 L/sec (155 m^3/hr) but flow is intermittent and the average flow is approximately 21 L/sec (based on data for a three month in 2001 – 2002 [URS 2003]).

This allows for approximately a four-fold increase in volume within present design and licence parameters.

Initial dilution zone

The zone of initial dilution (to achieve a minimum dilution of 1 in 100 throughout the water column) has been modelled under assumed worst case conditions (winter). The flow rate modelled was 92.5 L/sec, which is the nominal discharge rate for the combined effluent (the actual rate may be less). The salinity of the discharge water used in the modelling was 5,000 mg/L, which is a conservative value, the actual discharge salinity being typically less than 2,500 mg/L and hence more buoyant.

The modelled zone of initial dilution was calculated to be an area 15 m in width and 92 m in length (an area of 1,380 m^2). The length is a function of diffuser length, which is also 92 m. Modelled dilution throughout the water column at the edge of this zone will exceed 190:1 (Figure 8-1, Collie Power Station Expansion, Strategic Environmental Review. Sinclair Knight Merz, June 2002).

The modelling indicates that a dilution of 1 in 100, both horizontally and vertically, will be achieved within four metres of the diffuser under the above conditions (SKM 2002).

For the purposes of the present assessment a dilution factor of 1 in 100 was applied in calculating contaminant concentration and physical characteristic of the discharge at the edge of a dilution zone extending 7.5 m on either side of the diffuser.

Background seawater, physical parameters and toxicant concentrations

A revised calculation for dilution of toxicants, based on receiving water background concentrations, is presented in Table 10.

Values for the combined effluent are based on weekly operational data for two three-month periods of operation of the Collie A Power Station in 2000 and 2001-2002. The data are the 95th percentile values of data taken from the input to the seawater discharge pipeline. As noted above, it is not anticipated that the combined effluent will differ markedly in concentration, rather it is the volume of effluent that will increase.

Table 10
Comparison of Mixing Zone Concentrations to ANZECC Toxicant Guidelines

Parameter (concentrations expressed in µg/L)	Background water quality[1]	Combined Effluent (95th percentile of 26 samples)[2]	100-fold dilution	ANZECC 99% species protection	ANZECC 80% species protection
Cadmium	0.0045	<1	0.014	0.7	36
Chromium	0.2 (total)	<2 (total)	0.218 (total)	7.7 (CR^{III})	90.6 (CR^{III})
Cobalt	0.013	<50	0.512	0.005	150
Copper	0.085	<20	0.284	0.3	8
Lead	<0.019[2]	<3	0.049	2.2	12
Mercury (total)	0.0004	<0.1	0.0014	0.1 (Inorg.)	1.4 (Inorg.)
Nickel	2[3]	<30	2.28	7	560
Zinc	0.502	90	1.397	7	43

1 McAlpine et al (in press)
2 assumed to be the maximum value for the purpose of calculation
3 taken from licence number 6637/4
ID insufficient information available to derive a reliable guideline

Calculation for physical characteristics at the edge of the ZID, based on the discharge conditions and receiving water background concentrations set out in Table 9, is presented in Table 11.

Table 11
Physical conditions at the edge of the ZID

Parameter (concentrations expressed in mg/L)	Background water quality	Predicted quality of combined effluent	Concentration following 100-fold dilution	ANZECC Guideline (Southern Western Australian Coastal Waters)
pH	8.2	7.3	-	8.0 – 8.4
Dissolved Oxygen (mg/L)	7	8.1	-	>90% sat.
TDS	34,500	<2,500	34,180	N/G
TSS	10	<50	10.4	N/G
Nitrate-N (µg/L)	20	<5	19.85	5
Phosphate-P (µg/L)	10	<5	9.95	5
Sulphate (mg/L)	2450	<250	2428	10,000

N/G No guideline

COMPARISON WITH ANZECC/ARMCANZ (2000) GUIDELINES TO ASSESS IN-PIPELINE AND DIFFUSED DISCHARGE

WATER QUALITY IN RELATION TO THE VALUE OF ECOSYSTEM HEALTH

Comparison of in-pipeline combined effluent concentrations with ANZECC/ARMCANZ (2000) 80% species protection guidelines:

Based on Collie A Power Station monitoring data (Table 10), with one exception the 95th percentile in-pipeline concentrations of all metal toxicants, including cadmium and mercury, in the combined effluent meet the ANZECC 80% species protection guideline.

The exception to the above being zinc, which on six of the 26 sampling dates exceeded the guideline concentration of 43 µg/L. Evaluation over a longer time frame would be required to assess whether such occurrences occur on an ongoing basis, as four of the exceedances occurred over a single four week period.

Comparison of in-pipeline combined effluent concentrations with ANZECC/ARMCANZ (2000) 95-99% species protection guidelines:

All metal concentrations in the combined effluent, other than cobalt, meet the relevant ANZECC/ARMCANZ 99% species protection guideline at the edge of the ZID (Table 10).

From the available data, it would be possible that the concentration of cobalt exceeds the 99% species protection guideline. However, the concentration indicated may simply be a reflection of the high detection level used in the analysis of this metal (no concentration has ever exceeded the 20 and 50 µg/L detection levels used at various times in this monitoring program).

At all times the cobalt concentration has met the 95% species protection guideline concentration of 1 µg/L.

COMPARISON WITH GUIDELINES FOR OTHER "SOCIAL USE OBJECTIVES"

EQO 1: Maintenance of Ecosystem Integrity

As noted above, the physical and chemical parameters of the combined effluent will meet the requirements for maintenance of ecosystem integrity at the boundary of the ZID.

The concentration of cobalt meets the 95% species protection guideline but could exceed the 99% species protection guideline level, the uncertainty being due to the high level of detection used in analysing for this metal. Analysis at a lower level of detection would be required to further assess the possible influence of this metal.

EQO 2: Maintenance of Aquatic Life for Human Consumption

The concentrations of the identified metallic toxicants will not adversely impact on the maintenance of aquatic life for human consumption.

Analysis of mussels from the discharge site (URS 2003) have shown no evidence of exceedance of the nominated guidelines or standards for metals in seafood (molluscs).

Total arsenic concentration in both reference (Cockburn Sound commercially produced mussels) and impact site mussels have exceeded the inorganic arsenic concentration Environmental Quality Standard, however, no speciation into organic and inorganic arsenic in mussels has been undertaken.

EQO 3: Maintenance of Aquaculture

The requirements for physical stressors (pH and dissolved oxygen) will be met.

For the protection of wild fish stocks (refer to ANZECC/ARMCANZ [2000] guidelines section 4.4.1) the concentration guidelines for the identified toxicants present in the effluent (nitrate-nitrogen, cadmium, chromium, copper, lead, mercury and zinc) will be met within the ZID at four metres horizontal and vertical from the diffuser, based on existing modelling.

EQO 4: Maintenance of Primary Contact Recreation Values

The biological indicators for primary contact recreation will continue to be met.

The guideline pH range of 5 - 9 encompasses the in-pipeline pH of 7.3 for the combined effluent.

Water clarity will not be impacted, TSS will increase only marginally.

The concentrations of known potential toxins in the combined effluent (refer to PER) will not exceed the environmental quality guidelines for primary contact recreation.

EQO 5: Maintenance of Secondary Contact Recreation Values

The biological indicators for secondary contact recreation will continue to be met.

The guideline pH range of 5 - 9 encompasses the in-pipeline pH of 7.3 for the combined effluent. The actual pH is expected to be close to background at the edge of the ZID.

EQO 6: Maintenance of Aesthetic Values

All visual indicators of aesthetic quality will continue to be met.

The guideline concentration of copper and zinc (as fish tainting substances) of 1,000 µg/L and 5,000 µg/L, respectively, is higher than the in-pipeline concentration of copper and zinc (<20 µg/L and 90 µg/L, respectively) in the combined effluent.

EQO 7: Maintenance of Industrial Water Supply Values

Water supply at the boundary of the ZID would be suitable for industrial water supply, however the discharge site is offshore and is highly unlikely to ever be considered for industrial water supply.

7 Social and Heritage Issues

Issue 7.1 Raised by DoH.
The discussion of social issues appears to be general and commentary rather than supported by assessment when considering issues such as the requirement for a construction and operations workforce, and the potential impacts on the Shire and Region.

Response The Shire of Collie in its submission to the EPA made the following comments with respect to Social and Community Issues:

"*The township of Collie is extremely well serviced with community infrastructure including medical, schools, business and commercial, and social and leisure facilities. The town is able to cope with an industrial expansion of this magnitude and will not require Government assistance towards the provision of additional infrastructure. The Collie community is welcoming and accepting of its industrial base and would be only too pleased to see its expansion in major projects such as the proposed Bluewaters power station project.*"

The Council also made the following comments with respect to the economic impact of the project:

"The Council has a good economic reason to fully support the Bluewaters power station project. The project will not only provide employment (during construction and late operational) but will also provide opportunities for local businesses to supply goods and materials. Collie has a vibrant light industrial sector that may well grasp the many opportunities that will inevitably arise. The purchasing power of the additional workforce will also help to stimulate and provide additional business opportunities within the general retail sector."

With respect to employment opportunities Collie Shire's submission states:

"There will be obvious benefits to the Collie district through the development of the proposed power station. The construction phase will employ skilled tradespersons and their associated trades' assistants and once completed, there will be a need for on-going management and support staff. The Council will be welcoming of all employment aspects associated with the project."

In addition Griffin Energy commissioned a report on Economic and Social Impacts of Bluewaters from ACIL Tasman. The report summary states:

"*The Bluewaters Power Station represents a considerable boost to the economy, particularly that of the South West. It also adds to the social sustainability of the South West in the form of job creation, long term employment opportunities, training and development opportunities, greater use of social infrastructure and the general long term well being of the community".*

Issue 7.2 Raised by DPI.
The proximity of Special Residential areas should be given more detailed consideration, particularly in relation to the impact of the proposed development and buffer zone requirements.

Response For the purposes of the noise and emission modelling carried out in support of the project no distinction was made between the Special Residential areas and other residential areas of the towns. The closest noise receptor is at the town's eastern limits, a Special Residential zone. Modelling and assessments were made on this basis. Bluewaters meets the separation distances proposed in the EPA draft guideline No. 3 on Separation distances (see response to Issue 7.6).

Issue 7.3 Raised by DPI.
Additional information is required on infrastructure requirements including potential electricity lines, conveyor belts and haul roads, the upgrading of roads for construction and operational workforce, as well as the impact on transportation infrastructure in general.

Response As stated in the PER, Bluewaters will maximise the use of existing infrastructure and requires no new infrastructure to support it (Section 3.3.1). No new electrical distribution lines are required except for the interconnection to the SWIS grid. The actual interconnection is yet to be specified by WPC, however, will not require clearing of any native or remnant vegetation.

The existing road transport network was sufficient for the construction of Collie A and will be sufficient for Bluewaters which is smaller than Collie A. Coal supply will be the responsibility of Griffin Coal and will be covered in the Environmental Management Plan for the Ewington I Mine. The ACIL Tasman report, Economic and social impacts of Bluewaters, details the positive impacts in more detail.

Issue 7.4 Raised by DPI.
There is no actual commitment by Griffin Energy to try to obtain its work force as much as possible from the local area as well as to ensure that these positions are on a long term basis.

Response The Griffin Coal workforce at Collie is drawn from the following areas;

• Collie	85%
• Perth/Mandurah	2%
• Bunbury region	11%
• Donnybrook/Busselton/ Darkan	2%

It is anticipated that a similar employment profile will exist at Bluewaters in the long term. The skills required to operate Bluewaters are already present and available in the Collie area.

Issue 7.5 Raised by Shire of Collie, SWCCI and BWEA.
The project will benefit the region economically by maintaining employment opportunities and provide for long term jobs. Population drift to the larger centres will be reduced and, in accordance with the State Governments priority, sustainability of an important small town and community can be better assured.

Response This supports Griffin Energy's position. A more detailed analysis of the impact of the proposal is contained in the report prepared by ACIL Tasman on the Economic and social impacts of Bluewaters.

Issue 7.6 Raised by DPI.
Mechanisms to establish and maintain buffers to the plant are not adequately addressed.

The PER document does not specify the land area requirements, associated buffer zone requirements, and buffer zone management measures to minimise off-site impacts.

Response Bluewaters needs to be considered in its full and proper context. That is, as a primary land use within the proposed Coolangatta Industrial Estate (Coolangatta).

Coolangatta comprises 490ha and is contained wholly within Lot 8 Wellington Location 796 Boys Home Road and is owned in fee simple by W.R. Carpenter Agriculture Pty Ltd, a member of the Griffin Group of companies of this Bluewaters will comprise less than 3%.

The positioning of Bluewaters in the north-east corner of Coolangatta means that it is located 3.5km from the nearest sensitive land use. This conforms to the EPA's Draft Guidance for the Assessment of Environmental Factors – Separation Distances between Industrial and Sensitive Land Uses guidelines which states *"4.4.2 General guidance is* *required on separation distances in the absence of site specific technical studies, OR An estimation of the area that could be subject to land use conflicts."*

"Where a separation under consideration is less than in the table, it is recommended that a new project does not proceed in the absence of site-specific investigations and a report demonstrating that the separation distance will meet acceptability criteria and that enforceable management techniques will be applied to ensure an appropriates environmental outcome."

The PER prepared for Bluewaters included site-specific investigations that demonstrated that the lesser distance to the nearest sensitive landuse, being a rural residence 3.5km to the west of the proposed power station, would not be adversely impacted. The environmental assessment carried out for Coolangatta also considered the issues. The conclusion from both studies was that there will be no impact on the nearest sensitive landuse and therefore, there are sufficient buffers in place.

In effect Coolangatta contains, within it, sufficient buffer to meet the concerns raised in the above issue. In addition, the requirement for any further industrial proposals on Coolangatta to undergo formal environmental assessment under Part IV of the Environmental Protection Act, will ensure that buffers for all industries within Coolangatta are considered and maintained at the time each specific proposal is proposed.

Issue 7.7 Raised by DPI.
The PER document does not specify the land area requirements, associated buffer zone requirements, and buffer zone management measures to minimise off-site impacts.

Response Table 2 on page 16 of the PER (Key Proposal Characteristics) specified the land requirement. The Maximum total area required is 15 hectares. The maximum facility footprint is 350 metres by 150 metres. The nearest sensitive location is a farmhouse 3.5 km to the west. Noise and air modelling demonstrate that this residence will not be impacted by the proposal. Bluewaters meets the separation distance suggested in EPA draft Guidance Statement No.3 – Separation Distances between Industry and Sensitive Locations. See also response to Issue 7.6.

Issue 7.8 Raised by 153 individuals, Shire of Collie, BWEA and SWCCI.
Bluewaters will make significant contribution towards a sustainable future for Collie and the South West.

Response Griffin Energy agrees that Bluewaters will be a positive contribution to Collie and the South West. This is further detailed in the ACIL Tasman report.

Issue 7.9 Raised by 134 individual submissions, Shire of Collie, BWEA and SWCCI.

Bluewaters is a positive investment both socially and economically and is also environmentally responsible.

Response This supports Griffin Energy's position. A more detailed analysis of the impact of the proposal is contained in the report prepared by ACIL Tasman on the Economic and social impacts of Bluewaters.

Issue 7.10 Raised by DIA and Shire of Collie.
The proponent should fully explore Indigenous and Archaeological issues associated with the development and will be required to seek approval from the Minister for Indigenous Affairs should any Aboriginal sites be discovered during construction.

Response Griffin Energy has fully explored Indigenous and Archaeological issues associated with the development. Copies of applicable Ethnographic and Archaeological reports were supplied to the DIA covering the site chosen for the power station. In a letter to the EPA dated 22 June 2004 the DIA stated "*The DIA is satisfied that Aboriginal Heritage surveys have been undertaken within the proposed project area*". However in the event that any items or sites of significance are discovered at the site the DIA and any other appropriate authority will be notified.
Commitment number 16 in the PER covers this issue.

8 Other Issues

Issue 8.1 Raised by WPC.
It is not correct to imply that Bluewaters will provide capacity for the aging Muja Power Units. Western Power has in place an Asset Replacement Program to manage its portfolio of generation plant and under this program Cockburn 2 gained approval on the basis that Muja A/B would be decommissioned.

Response The Minister for Energy on 5^{th} August announced that the Cockburn 2 proposal by Western Power would not proceed. Given that at some stage Muja A & B will be required to be decommissioned, Bluewaters remains an option to replace the Muja A/B capacity.

Issue 8.2 Raised by WPC.
Is the South West Power Project (SWPP) still being considered along with Bluewaters?

Response No – The Bluewaters program replaces the SWPP.

Issue 8.3 Raised by WPC.
The role of Bluewaters in the Western Power, Power Procurement Process (PPP) should be clarified.

Response Bluewaters is a merchant plant. In combination with the proposed Bluewaters II it has been offered as an option to Western Power for the PPP. Notwithstanding the outcome of the PPP, Bluewaters is planned to proceed.

Issue 8.4 Raised by DPI.
Will the coal resource be available from the approved capacity of the mine?

Response Bluewaters will require approximately 700,000 tonnes of coal per annum (not 1 million tonnes per annum as stated in the PER) for the life of the station (25 years) to operate at an 80% capacity factor. Ewington I mine has an annual mining rate of 3 million tonnes per annum for 25 years. Griffin Coal has reserves in place for 100 years at current mining rates. Refer also to the response to Issue 5.5.

Issue 8.5 Raised by CCWA, ACF, WWF, CANA.

The plant is not justified. Energy demand is not growing at a rate that will require both the PPP 300MW and Bluewaters 200MW within the same timeframe.

Response The following graph of power demand using information provided by Western Power clearly demonstrates a demand for power. The PPP program is not sufficient to cover off the increased demand.

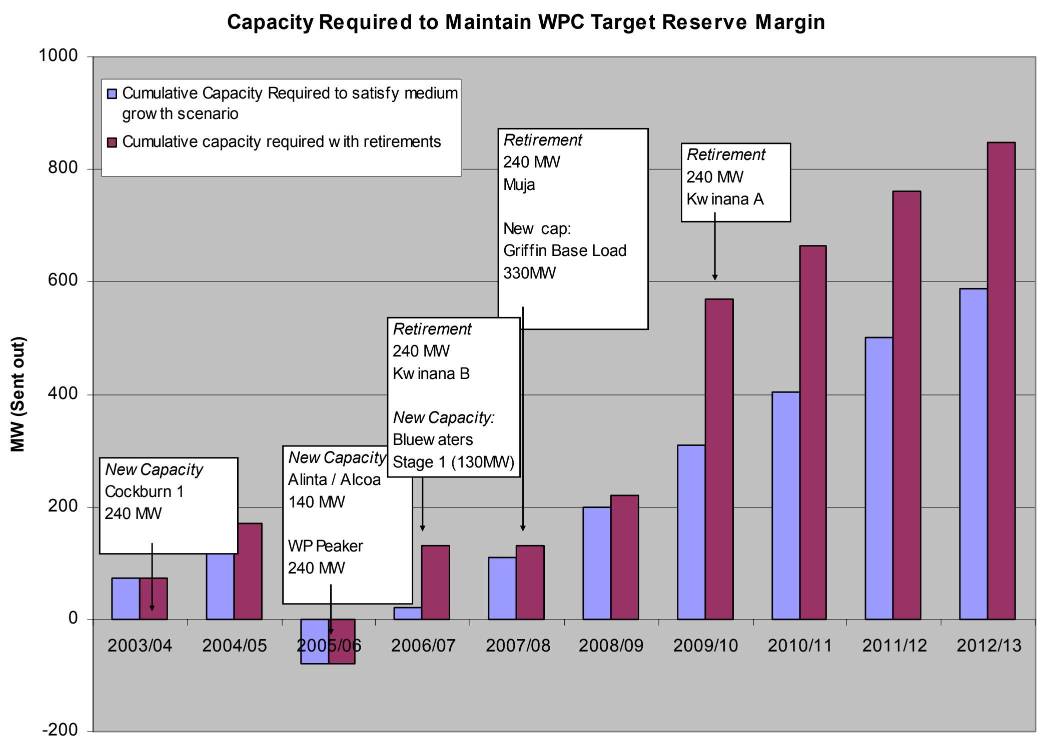


Figure 2 – Capacity Required to Maintain WPC Target Reserve Margin

Issue 8.6 Raised by CCWA, ACF, WWF, CANA.
The Proponent should release a supplementary PER addressing the deficiencies of the original PER, which should be made available for public comment.

Response Griffin Energy has followed due process in preparing and presenting the PER for public review. The preceding scoping document and the PER were reviewed by the EPA prior to release to the public for review. There is a considerable amount of support for the project in the Collie area and the greater South West. Griffin Energy is responding to all issues raised in submissions. The responses are available for public scrutiny. There is no justification for a supplementary PER.

Issue 8.7 Raised by CCWA, ACF, WWF, CANA.
The proponent should justify the use of Griffin Coal as the fuel for Bluewaters.

Response Bluewaters, as proposed by Griffin Energy, is a sustainable solution to delivering necessary base to medium load power to meet energy demands in Western Australia's south west region. This response provides detail on the rationale for the selection of coal as a viable energy source for the Bluewaters Project.

This information is supplementary to that already provided in the PER released for public comment in May 2004.

Consistency with Contemporary Government Policy

Commonwealth Government Policy
On 15 June 2004 the Prime Minister of Australia released the White Paper *Securing Australia's Energy Future,* which defines the long-term policy framework for the production and use of energy in Australia (Commonwealth of Australia, 2004). The Energy White Paper sets out a comprehensive and integrated approach to meeting the government's energy objectives of prosperity, security and sustainability.

As outlined in the White Paper, coal which produced 78 % of Australian electricity in 2000-01, will remain the main energy source for electricity generation despite substantial growth in natural gas and renewables (Commonwealth of Australia 2004, p.37). It is noted that Australia is well endowed with vast reserves of coal that are relatively easy to mine and located close to energy load centres. As a result, our nation is the world's fourth largest producer and largest exporter of coal (IEA 2003, cited in Commonwealth of Australia 2004).

Bluewaters is fully consistent with the objectives and strategies delivered by the Prime Minister in the White Paper. A stated aim of the Australian Government is to "…provide consumers with reliable supplies of competitively priced energy, ensure an appropriate return to the community for the development of its depletable resources, and meet environmental and social objectives (Commonwealth of Australia 2004, p.51).

Consumers and energy-intensive industries will continue to require competitively priced and reliable energy supplies. In June 2001, the Council of Australian Governments (COAG) agreed on national energy policy objectives to guide future energy policy decision-making by jurisdictions. Consistent with agreed COAG objectives, a competitive national energy market is important for longer-term energy security, enhanced energy efficiency, increased greenhouse gas abatement and progressive commercialisation of renewable and low-emission technologies. Therefore, the implementation of the Griffin Bluewaters Project is in accordance with this long-term transition of energy reform.

State Government Policy
The Government of Western Australia has in place a Policy Statement *Fuel Diversity in Power Generation* (Government of Western Australia, 2004).

Through this Project, Griffin endorses the objectives set in this Policy, including facilitation of the sustainable supply of reliable, competitively priced electricity. The proposed development of the Bluewaters Project is fully consistent with the fundamental principles of the Fuel Diversity Policy including:

- Competition;
- Fairness and Consistency;
- Environmental Sustainability;
- Security of Supply;
- Robust and Adaptable Fuel Industries; and
- Employment.

In addition, the development of the Bluewaters Project is consistent with the intent of the *Western Australian Energy Policy,* with one of its stated aims to "…encourage and supplement where appropriate investment in energy infrastructure to provide for reliable and sustainable energy supply" (Office of Energy, 2002).

Security of Supply
The use of existing Collie coal represents a relatively cheap and reliable power source to existing and new customers in the region. Black and brown coal accounts for around 55 per cent of the identified fossil fuel energy resources of the State and will last for around 1,200 years at the current level of production (Office of Energy, 2004). According to the latest annual *Energy Western Australia* report (Office of Energy 2003), of the total 6.1 million tonnes (or 120 PJ) of coal production in 2000-'01, over 80 % was used for power generation.

There is an obvious need to maintain diversity in fuel supply for the State, as the Dampier to Bunbury natural gas pipeline is operating at maximum capacity. This was demonstrated in early 2004 when the south west region experienced widespread power restrictions which cut electricity consumption.

Acceptance by the Local Community
Griffin Coal has mined coal in the region for over 75 years, and owns and operates the Muja and Ewington II open cut mines. This industry has been an integral element of the local economy and livelihood in the Collie region for many years, and is accepted as an important means of maintaining economic and social viability of the town in the future.

In summary, Collie is accepted by the social and business community as a place for coal mining and power generation for the foreseeable future. The Bluewaters Project can be implemented with evident benefits of using under-utilised local infrastructure, further maintaining the commercial viability of the area.

Environmental Performance
The replacement of ageing units with new state-of-the-art technology will improve environmental performance and reduce electricity generation costs on the SWIS (Office of Energy, 2003). Bluewaters offers advantages over existing old coal-fired power stations in terms of higher thermal efficiencies and lower CO_2 emissions per GJ of energy produced.

The site of the proposed Bluewaters Project is represented by existing cleared grazing land, and will be built within the proposed Coolangatta Industrial Estate. Field surveys for terrestrial vegetation confirmed that no species of threatened flora were located in the project area, and the overall condition of remnant vegetation is very poor (Maunsell, 2003). Therefore the proposal does not pose an adverse threat to existing ecological values of the surrounding environment.

The project design incorporates state-of-the-art technology for plants of this size, including a high efficiency combustion process and highly advanced process controls. Mine mouth electricity generation is very efficient in terms of energy utilisation, and cumulative air emissions from existing and new sources have been modelled to show that there is negligible health risk. In summary, the improved environmental performance of the highly efficient Bluewaters Project is considered acceptable in providing a sustainable solution to meet growing energy demands of the SWIS.

Renewable Energy Constraints
Whilst windpower and solar power are attractive from an emissions perspective, the reality is that these technologies have not developed to the point of being able to produce large quantities of electricity in the economies of scale required to satisfy demand. Two major factors

severely constrain renewable energy, namely availability and area required to produce large amounts of electricity. For example the availability of windpower is 33% compared to 95% offered by coal-fired power generation. The area required for windpower generation is 12 ha/MW compared with 0.3 ha/MW for coal-fired power plants. Most importantly, however, is that typically windpower plants provide up to 20 MW of capacity, which is significantly less than current demand. Coal-fired power generation easily meets demand typically providing between 120 - 2000 MW. Furthermore, Western Power (2002) concluded that "wind energy technologies came closest to providing a cost competitive renewable energy source, however, there were technical and commercial constraints upon the use of windpower", for example, wind generators operate intermittently and "are not able to reliably produce their rated output when required to meet demand" (Western Power 2002).

Issue 8.8 Raised by CCWA, ACF, WWF, CANA.
Data regarding the moisture and energy content and price of coal should be presented to verify the statement that "Collie coal is an efficient, available and comparatively inexpensive local source of energy".

Response The price of the coal is commercial in confidence and not relevant to the Environmental Review process. However, the availability of Collie coal is a matter of record by virtue of the stated reserves.

Collie coal is a comparatively inexpensive source of energy for electricity production purposes. By comparison wind and solar sources, while considered cost free, require much higher capital cost equipment to convert the energy source to electricity. Furthermore, wind and solar electricity generators must be fully backed up by other, (usually thermal) generators, for periods when the wind and solar insolation is not available in order to meet the reliability and availability requirements of electricity customers. The requirement to back up those supplies automatically renders them more expensive than Collie coal because of the capital and other fixed costs of both the renewable and thermal generators. Other renewable energy sources are not available locally in the scale required for the Bluewaters Project.

Issue 8.9 Raised by CCWA, ACF, WWF, CANA.
The proponent should clarify whether or not it has a policy to full replace Muja A and B power stations when they are retired.

Response The ultimate decision regarding the replacement of Muja A and B is a matter for Western Power.

Issue 9.10 Raised by DPI.
Section 2.6, Table 1 in the PER does not refer to planning documents or legislation.

Response Table 12 is an amended Table of applicable legislation.

Table 12
Applicable Legislation

Applicable Legislation - State
Department of Indigenous Affairs • *Aboriginal Heritage Act, 1972 - 1980* Scope: Protects aboriginal sites **Department of Agriculture** • *Agriculture and Related Resources Protection Act, 1976* Scope: Management of pests and weeds **Local Government Authority** • *Bush Fires Act, 1974* Scope: Fire safety **Department of Conservation and Land Management** • *Conservation and Land Management Act, 1984* Scope: Protection and management of national, marine, conservation and regional parks, State forests, and timber, nature, and marine nature reserves. • *Wildlife Conservation Act, 1950* Scope: Protection of rare and endangered flora and fauna. **Environmental Protection Authority - Department of Environment** • *Environmental Protection Act, 1986* Scope: The EPA was established as in independent authority with the broad objective of protecting the State's environment. **Department of Industry and Resources** • *Explosives and Dangerous Goods Act, 1961 - 1986* Scope: Regulates the manufacture, use and storage of explosives and dangerous goods. **Department of Health** • *Health Act, 1911* Scope: Regulation for the protection of public health. **Native Title Tribunal** • *Native Title Act, 1993* Scope: Deals with aboriginal claims for native title to land. **WA Planning Commission** • *State Planning Commission Act, 1976* Scope: Controls the State's land development. **Water and Rivers Commission (now DoE)** • *Waterways Conservation Act, 1976* Scope: Conservation and management of waters and the associated land and environment. **Department for Planning and Infrastructure** • *Town Planning and Development Act 1928* Scope: Legislative framework for the preparation of Local Town Planning Schemes and Amendment to Schemes. **Shire of Collie** • *Shire of Collie Town Planning Scheme Number One* Scope: Zoning of land, classification of land uses and development control provisions to assess new land developments.
Applicable Legislation – Commonwealth
Department of Environment and Heritage • *Environment Protection and Biodiversity Conservation Act, 1999 (EPBC Act)* Scope: Protects matters of national environmental significance, including National Heritage Places.

Issue 8.11 Raised by DPI.
An explanation of the statutory processes and the role of the PER in seeking approval of the development of Bluewaters is required, especially with respect to the Coolangatta Industrial Estate.

Response The role and purpose of the PER is detailed in Sections 2.1 and 2.4 of the PER. With respect to Coolangatta, the rezoning process is the responsibility of the landowner (WRCA). Once they have been successful in rezoning the land, Griffin Energy will negotiate a lease with the owners, and then submit a Development Application to the Shire of Collie.

Issue 8.12 Raised by CCWA, ACF, WWF, CANA and PAN.
The PER does not meet the requirements of the EPA's Guidelines for Preparing a Public Environmental review, as it does not provide a description of legal framework, including existing zoning and environmental approvals and decision making authorities.

Response Griffin Energy followed due process in preparing the PER. The scoping document was accepted by the EPA and the PER was approved for public circulation. If the PER did not meet the requirements it is unlikely that the PER would have been approved for circulation by the EPA. Legal framework, legislation and decision-making authorities are covered in Section 2 of the PER.

Issue 8.13 Raised by CCWA, ACF, WWF, CANA.
The potential for building a bigger plant to take advantage of CHP or super-critical technologies should be examined

Response The CHP process is widely used in densely-populated cities in cold climates. It features the distribution from the power plant of hot water at less than 100° C for domestic heating and hot water. The process substitutes energy from a low-temperature heat source for this purpose in place of high-grade energy (electricity, or natural gas). Conditions for the application of CHP do not exist at Collie.

The sale of steam to industrial customers is a different consideration; the steam is bled from the turbine at appropriate conditions causing a reduction in the electric power output. Cycle efficiency is increased, but steam must be priced appropriately in recognition of its energy content and the foregone electrical energy. Currently there are no industrial demands for steam in the vicinity of the project but these may arise when the adjacent industrial estate is developed.

See also the response on size and super-critical technology (Issue 5.12).

Issue 8.14 Raised by 111 private citizens.
I support Bluewaters Power Station because the project represents a commitment by Griffin Energy to the town of Collie and the South West and I believe it will contribute to a sustainable future for the town and region.

Response Griffin Energy agrees with the point of view expressed. In fact this view was consistent with the feedback received by Griffin Energy during the public consultation period.

Issue 8.15 Raised by 134 private citizens.
WA needs this new coal-fired power station to protect us from power shortages such as those that occurred on 18 February 2004. We cannot rely on gas for power generation as it is supplied through a single pipeline. We need a balanced fuel supply and coal has to be part of the mix. Power shortages as a result of the very risky approach of too much reliance on a single source of fuel should not be tolerated.

Response Griffin Energy agrees with the point of view expressed. In fact this view was consistent with the feedback received by Griffin Energy during the public consultation period, and supported by research carried out by the Australian Research Group on behalf of Griffin Energy.

Issue 8.16 Raised by 133 private citizens.
Bluewaters will ensure that industry will have access to low cost power which in turn will foster economic growth and prosperity in the South West.

Response Fostering economic growth in Collie and the surrounding regions is one of Griffin Energy's motivations for proposing the power station.

Issue 8.17 Raised by 121 private citizens.
I believe Bluewaters will accelerate the necessary and ultimate closure of older power plants, resulting in a net positive environmental benefit to Western Australia. A new Bluewaters power station will reduce the greenhouse intensity across the South West Interconnected System .

Response Griffin Energy agrees with the point of view.

Issue 8.18 Raised by a private citizen.
There is little question that the proposal is soundly balanced and geared towards enhancing Collie, The South West and WA through improved efficiencies that will increase rural employment, not only maintain but improve local environmental conditions, It is considered win/win by ensuring that WA wins with better guarantees to security of supply, the environment wins with a proposal to desalinate waterways and the proposal is ultimately profitable which will ensure that supply is continuous and plant is upgraded – insurance that what is environmentally positive today remains that way.

Response Griffin Energy agrees with the point of view.

Issue 8.19 Raised by a private citizen.
Natural gas is a premium transportation fuel, and its use for base load power generation here and overseas is a deplorable short term policy which is likely to see the resource plundered to exhaustion within the lifetime of those currently permitting it. We should be conserving

natural gas for what it is needed for, and using coal for what it is good for.

Response Griffin Energy agrees with the point of view.

Issue 8.20 Raised by a private citizen.
Griffin Energy have provided extensive consultation to the Collie community and have demonstrated the environmental benefits of modern coal fired power stations. Collie people look forward to Griffin Coal building this Power station, allowing them to continue their excellent relationship with the local community and South-West. With 100 years of Coal reserves this is clearly a sustainable choice in power generation without being dependent on a troublesome pipeline. We look forward to industries that would be attracted by such infrastructure.

Response Safeguarding the future of Collie is a strong motivation for Griffin Energy.

Issue 8.21 Raised by 49 private citizens.
The following points of view were forwarded to the EPA during the public review period of the PER. Griffin Energy acknowledges the support and agrees with all the sentiments expressed by these private citizens.

- With New technology that your company has available this should be an automatic choice for a PowerStation in Collie, good luck.
- I also believe the greater ability to sell gas overseas compared to WA coal is of huge importance to our state. Why use a product that can produce an income for the state if it is not necessary to use it locally. As shown recently with the gas emission near Dongara there is a lot of pollution that occurs with gas at points other than point of burn.
- My main concern is the reliance on one pipeline supplying gas from the north west.
- The state needs to think strategically to minimise the possibility of loss of the gas pipeline due to whatever reason. Coal can be stored and disruption to supply minimised.
- WA needs this power station to avoid debacles such as happened on February 18 this year.
- Would be good to see a group that has operated in the local area for such a long time take a new step into an industry in need. I feel that the company will carry on with its brilliant efforts and considerations and make a new path for power generation. Also continuing its support to the local community with jobs, sponsorships, education etc which it seems to pride itself.

- Griffin Coal is showing more leadership than the current government in that it is addressing the power demand and shortfall as well as ensuring the long term development of industries and the benefit the proposed power station will have on our state.

- My dad has worked there for 22 years and I hope it will employ more local people.

- About time someone is forward thinking and realises that gas is not the ideal solution to our electricity woes. I believe the gas pipeline is a sitting target for terrorist activity, given WA's strategic position and involvement with US military.

- I am pleased to see that someone is paying attention to our power requirements in WA.

- I strongly believe this is a step in the right direction, as gas produced in Western Australia is more valuable as an export commodity.

- The continuing negativity towards coal as a power source. People are not getting the full facts on the comparisons between coal and gas and the effects on the environment.

- A new coal fired power station in Collie will be an important contribution to sustaining the future for the town of Collie.

- I believe this project should proceed as it will ensure the viability of the region and provide low cost power for the region. Ultimately, it will lead to the closure of less efficient, higher greenhouse gas emitting plants.

- Greenhouse emissions from the million or so megawatt hours that will be produced each year by this privately funded power station, dwarf into insignificance compared with the several orders of magnitude higher emissions from east coast coal fired power stations. There can be no compelling reason to deprive the Collie region of its livelihood on the grounds of national greenhouse issues while Queensland and other states continue to build mega power stations to enhance their energy export industries.

- I was extremely annoyed at the power fiasco in February and my family and I have little faith in the existing power set-up (both political and electrical) in Western Australia. We definitely need to have a more-than-adequate power-supply system if we are to be able to cope with an ever-increasing demand for power and if we are to be able to fend off disaster should either a terrorist attack or an act of God render existing power-generating facilities inoperable. And both of the latter are entirely possible.

- As a small business owner in the Collie area, I can only see good in any proposal that will help guarantee the economic future of the area.

- The Collie Visitor Centre Management Committee does have some concerns regarding dust levels; however we believe that with the appropriate environmental practices in place and diligent monitoring of weather conditions, this can be overcome. The Visitor Centre also recognises that industrial tourism is becoming increasingly popular and would expect to see Bluewaters supporting the Visitor Centre and Shire of Collie's drive to promote tourism by making tours available of both the mine and the power station. We see this as an excellent opportunity to both entertain, but more importantly educate the public in the award winning environmental practices that coal mining in Collie achieves. We feel that tours of both the mine and the proposed Blue Waters Power Station, with its advanced technology will achieve that end.

- In the past there have been many sacrifices for Collie Mine Workers and the community to make coal more competitive in price and availability, resulting in loss of jobs and income for our Town, not to forget the social impact on workers and their families of the 24 hours, 7 days a week operation. That's why in my opinion the Collie Community deserves to get another Coal-fired Power Station and Industrial Park. We need a future (jobs) for us and our children, we need to grow.

- Attracting other industries and down streaming in the Coolangatta Industrial Park will also be an important economic spin-off, which will be jumpstarted by the Bluewaters Power Station project.

- It is imperative there be a balance in the fuel sources used to generate electricity in WA & this can only be achieved with any degree of security in the short to medium term by assuring the Bluewaters Project goes ahead.

- Why should our state import fuel to fire power plants when we have an abundance of coal in the SW, which is readily available? Using coal as an option will help to ensure the long-term viability of coal mining in Collie which in turn will support the existing community and infrastructure of the town and surrounding area.

- I do not want to be forced into year after year power shortage panics as happened last summer when electricity, etc had to be cut or people threatened with fines if caught using their power.

- My business (both patrons and employees) whom are members of the Collie community, wholeheartedly support Griffin Coal in their endeavour to build the Blue Waters Power Station. The town needs the economic benefits that will be a flow on from the attraction of new businesses to the region. Due to the cleaner New Collie Coal, we believe that Coal is well placed to be both competitive and an environmentally sustainable product that the State needs. The Collie community welcomes new industry and has the infrastructure within the town to cope with an increase in population. We believe the State cannot continue with it's reliance on the gas industry due to its unreliability to continue supply. It is the right of all residents and business operators in W.A. to receive a reliable and cheap power source.

- Successful industrial proposals such as the Bluewater proposal have the potential to create wealth in the region and thus the ability to help manage environmental issues in the Collie region such as salinity and vegetation clearing.

- I believe gas is too valuable resource to be used in fixed plant. High carbon fuels such as coal should be used as energy sources for the likes of larger power stations where scales of economy can be implemented to recover pollutants and green house gasses.

- Western Australia has vast resources of coal which can be utilised to provide a reliable, sustainable, and economic source of fuel for the generation of electricity in the State.

- I have worked in the Energy & Resource sector for nearly 30 years and had experience with all 4(four) types of fuels used for power generation. Nuclear has to be ruled out because of Western Australia's non-nuclear policy so that leaves coal, gas & oil. Oil must be ruled as its price and supply is regulated by a cartel that can upset the world's balance with a turn of a valve. So that leaves Gas & Coal. I agree on the surface gas is a "cleaner" fuel by producing less carbon dioxide per TJ of energy released but "invisible" leaks from its systems damage the ozone layer in 26 times greater than produced by coal as the latter does not do damage in its "raw" form. Equally gas reserves are no where near in the amount of coal and even if they were, wouldn't it be more prudent to use it for EXPORT & HOME DOMESTIC HEATING, (i.e. to replace wood-burning appliances, by legislation if necessary). Low-rank coal, as produced locally in the Collie coalfields, is ideal for power generation as it does not form clinker on the fire-grate when burnt thereby making "ash" disposal easier and in most cases able to be used as by-product(s). With advent of "CLEAN COAL" power stations and state-of-the-art technology in removing SOx & NOx as well as complete combustion control and electrostatic dust precipitators, constituents that could cause acid rain and fugitive dust, respectively, are nullified. All in all there is only one fuel source for the proposed "Blue Waters" & Collie "B" power stations and that is COAL.

- There needs to be a balance between gas and coal based power. To make this work properly the Management of Western Power would appear to need some sorting out, and the coal unions will need to be more responsible than they have been in the past.

- The use of Collie Coal by the Griffin Group is a sensible use of an energy source that can only be utilised in Western Australia.

- Too many of the judgements and comments made about Collie Coal are based on historical image of coal as a dirty industry leading to and black smoke producing industries. Modern technology ensures that the industry is now operating in a very clean and efficient manner.
- In addition the Griffin Group of companies have looked at this proposal in a holistic fashion that incorporates renewable energy (wind power) and a desire to increase tree planting and reduce salt levels within the East Collie River.
- The proposal should be strongly supported by West Australians.

- Griffin Coal has a long history of stable supply to many industries in Western Australia.
- Coal needs to be given a fair chance.
- Coal is a sensible fuel for power generation. Gas should be reserved for high value industries (petrochemical etc).
- Let us use the fuel 'coal' that we have in our back yard not gas from the north.
- This is a more viable option than gas fired plant.
- Collie Need diverse industries.
- Coal is the most reliable fuel for a Base Load station. Gas relies on only one supply source.
- There is plenty of coal, gas supply is uncertain and easier to sabotage. Coal emission is getting cleaner.
- I would like to see a stable future for the coal industry for our sake and my kids and their kid's sake. I support the new Collie Coal 100%.
- It is silly to use gas for power generation when gas has so many other valuable uses. Coal is suited mainly for power generation and should be use of first choice.
- I believe natural gas should not be used for new power generation because this has export potential, whereas coal doesn't.
- Using Collie coal will be better because of no methane.
- We need to use more coal to keep people in jobs.
- Coal the only way to go.
- I think it's the best that could happen for the future of coal and Collie.
- Security for my family and the town of Collie.

- The use of coal as a power supply has my full support.
- I totally support the use of Collie coal in power supply.
- I believe that a new base load coal power station is necessary to make up shortfall in supply at present and for future growth with other sources to top up on peak demand.

9 Glossary

ACF	The Australian Conservation Council
AGO	Australian Greenhouse Office
ANZECC	Australian and New Zealand Environment and Conservation Council
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
BPM	Best Practicable Measure
BWEA	Bunbury Wellington Economic Alliance
CANA	Climate Action Network
CALM	Department of Conservation and Land Management
CCMEC	Collie Coal Mines Environment Committee
CCSD	Cooperative Research Centre for Coal in Sustainable Development
CCWA	Conservation Council of WA
CHP	Combined Heat and Power
CO	Carbon Monoxide
COAG	Council of Australian Governments
CO2CRC	Cooperative Research Centre for Greenhouse Technologies
CRC	Cooperative Research Centre
CSIRO	Commonwealth Scientific and Industrial Research Organisation
dB	Decibel
dB(A)	Decibel A weighted
DEFRA	Department of Environment Food and Rural Affairs
DEP	Department of Environmental Protection
DIA	Department of Indigenous Affairs
DoH	Department of Health
DPI	Department of Planning and Infrastructure
EC	European Commission
EPA	Environmental Protection Authority
EPASU	EPA Service Unit
EPBC	Environment Protection and Biodiversity Conservation
EQO	Environmental Quality Objective
g	Grams
GHG	Greenhouse Gases

GJ	Gigajoule
ha	Hectare
HCWA	Heritage Council of Western Australia
Hg	Mercury
HP	High Pressure
IDGCC	Integrated Drying Gasification Combined Cycle
IEA	International Energy Agency
IGCC	Integrated Gasification Combined Cycle
IPP	Independent Power Producer
kg	kilogram
L/sec	Litres per second
m^2	Square metres
m^3	Cubic metre
Mg/Nm^3	Milligrams per normal cubic metre
MPa	Mega Pascal
MTE	Mechanical Thermal Expression
MW	Megawatt
MWh	Mega Watt hour
NEPM	National Environment Protection measure
NHMRC	National Health and Medical research Council
NO_2	Nitrogen Dioxide
NO_x	Nitrous Oxides
NPI	National Pollutant Inventory
NSW	New South Wales
OECD	Organisation of Economic Cooperation and Development
PAN	Pollution Action Network
PAH	Polycyclic Aromatic Hydrocarbon
PER	Public Environmental Review
PM_{10}	Particulate matter less than 10 microns
PPP	Power Procurement Process
R&D	Research and Development
SKM	Sinclair Knight Merz
SO_2	Sulphur Dioxide
SOx	Oxides of Sulphur
SWCCI	South West Chamber of Commerce and Industry

SWDC	South West Development Commission
SWIS	South West Interconnected System
SWPP	South West Power Project
TAPM	The Air Pollution Model
tpd	Short (US) tons per day
t/h	Tonnes per hour
UNFCCC	United Nations Framework Convention on Climate Change
US$	United States Dollar
VOC	Volatile Organic Compounds
WA	Western Australia
WHO	World Health Organisation
WPC	Western Power Corporation
WRC	Waters and Rivers Commission
WRCA	W.R. Carpenter Agriculture Pty Ltd
WWF	WWF Australia
ZID	Zone of Initial Dilution
$	Australian Dollar
$\mu g\ m^{-3}$	Micro grams per cubic metre
^oC	Degrees centrigrade
µg/L	micrograms per Litre

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