5 December 2008

Silver Spirit Partners
Level 25, Chifley Tower
2 Chifley Square
Sydney NSW 2000

Attention: David Goodrich

Dear David,

Subject: Moruya East Village – Groundwater Issues

Thank you for providing me with a copy of a letter to the Department of Planning (DoP) from the Department of Water & Energy (DWE) dated 5 June 2008. This letter provides a response to the groundwater issues raised by DWE.

In attempting to provide appropriate response to these issues, I have made numerous attempts to speak directly with the relevant person in DWE with a view to identifying the form of analysis they expect. On every occasion, the relevant person has not been available because of other commitments, or I have been referred back to DoP.

Based on advice from DoP, an assessment of groundwater conditions has been undertaken in line with the requirements of *The NSW Groundwater Quality Protection Policy* (1998).

1. Proposed Development on the Floodplain

Some of DWE's concerns appear to be based on a misunderstanding of the information shown on the Landscape Masterplan and the wording in Section 3.9 of the *Water Cycle Management and Flooding Report* prepared by Evans & Peck (June 2007).

The Landscape Masterplan shows a series of ephemeral wetlands which reflect current locations of inundation/ponding within the floodplain. In some instances (e.g. the small open water areas to the east of the Stage 1 Project Application) areas of the floodplain are currently subject to high densities of the environmental weed Spiny Rush (*Juncus acutus*). To control this weed it was proposed to undertake discrete, shallow excavations, sufficient to substantially remove the weed and reduce high associated soil borne weed seed loads (the species seeds prolifically). These areas would then be reinstated with locally endemic marsh species and managed as small ephemeral wetlands, similar to those already occurring within the floodplain. The areas of open water shown on the Landscape Masterplan were intended to be indicative of areas where treatment of Spiny Rush would be undertaken.

In view of concerns expressed by other agencies, control of Spiny Rush will not be carried out by excavation. No additional open water areas will be created on the floodplain.

2. Existing Groundwater Regime

In order to assess the hydrogeology of the locality and the use of groundwater, a search of the DWE groundwater bore database has been undertaken. The location of the identified bores (shown in red) in relation to the site (outlined in black) are shown on Figure 1 attached at the end of this letter . Relevant details of the identified bores are contained in Tables 1 and 2 (also attached at

the end of this letter). None of the bores are located in an area that is influenced by surface runoff or groundwater drainage from the site. Only one bore (105412) is located in the catchment which drains past the development area.

As shown on Figure 1 and the tables, the bores within 1 km of the boundaries of the site come from three different landscape units reflecting their position in the landscape and the underlying geology:

- **Floodplain Zone** – represented by Bores 109379 – 109382 inclusive. These bores, which are located close to the Moruya River, were only drilled to about 3 m deep and encountered silty sand with some shells. Although there is no record of the yield of these bores, it is likely that the groundwater in this locality is in direct connection with the river and to be at an elevation of about 1 m AHD.
- **Lower Slopes** – represented by Bores 102194 and 58347 which are located at elevations between 5 and 10 m AHD. The bore logs indicate that the geology on the lower slopes comprises sandy clay infill deposits overlying decomposed granite with hard granite at depths greater than 15 m. The water table in these areas is at an elevation of about of 2 - 4 m AHD. No yields are recorded for these bores.
- **Mid Slopes -** represented by four bores for which there are bore details (100212, 103864, 105412 and 105555). These bores are located at elevations of 20-30 m AHD and typically encounter a layer of decomposed granite between 5 and 25 m thick. All except bore 105412 (located to the south of the site) have water tables in the range of 6 – 12 m below ground level in decomposed granite. Yields of 0.6 to 1.0 L/s are recorded for these bores. Bore 105412, which is located about 600 m south of the south-western corner of the site was drilled to a total of 92 m but only encountered water within the granite at a depth of 51 m. The very low yield of 0.01 L/s for this bore is indicative of the water being derived from fractures in the granite.

The data from the bores indicates that the groundwater regime on the site is likely to be characterised by:

- Water tables in the range of 2-4 m AHD (approximately the same as the ground surface) in the low lying swampy area (as represented by the groundwater regime on the "Lower Slopes" above).
- Water tables in the range of 6 - 12 m below surface level on the mid slope areas on which the development will be located.

The only beneficial use of any groundwater draining from the area of the development is the maintenance of the swamp ecosystem located in the lower areas of the site, which will not be developed and will be managed as open space areas.

3. Groundwater Vulnerability

Based on the geology identified from the bores described above, the main threats to groundwater flow and quality are associated with the proposed urban development on the slopes draining to the low lying wetland. The potential risks to the groundwater system have been taken into account in the design of the development and its associated stormwater drainage systems:

- Full reticulated sewerage will be provided throughout the development. On-site sewerage systems are not proposed. In addition, there will be no industrial activities. Accordingly, there are no significant sources of pollution that could affect groundwater.
- All stormwater will be treated by a range of systems including the rain gardens and bio-retention swales. Accordingly, water that drains to the groundwater or via the stormwater drainage system, will have received an appropriate level of treatment.
- The stormwater drainage system incorporates a range of infiltration systems to maintain water for groundwater recharge throughout the development, comprising:

- Approximately 50% of the area within the development zone will be maintained as pervious surfaces;
- 198 rain garden areas totalling about 4,500 m^2. All runoff from roads will be directed into these rain gardens to provide water for street trees;
- Maintenance of 20 m wide riparian zones along the two main drainage lines within the southern development precinct.

On the basis of these features, the development gives rise to minimal risk of groundwater pollution. While the development can be expected to have a minor effect on groundwater recharge, it will not have any effect on the wetland ecosystems into which all stormwater drainage will discharge. Accordingly, Level 1 protection is required in accordance with *The NSW Groundwater Quality Protection Policy* (1998).

4. Assessment of Issues

Responses to the specific groundwater issues identified by DWE are set out below:

1. No open water areas will be created on the lowland area. Accordingly, no licence is required.
2. The nature of the development (no significant pollutant sources and treatment of all stormwater) gives rise to low vulnerability to pollution of groundwater.
3. The provision of a large proportion of pervious surfaces together with the infiltration systems will assist in maintaining the groundwater regime under the development area. While there is likely to be some reduction in groundwater recharge, this will not have any effect on the wetland ecosystems because any loss of groundwater will be compensated for by increased surface runoff into the wetland area immediately adjoining the development.
4. All stormwater draining from the site, whether contributing to groundwater recharge or surface runoff, will be subject to treatment. The stormwater treatment analysis in the *Water Cycle and Flooding Report* indicates that the proposed systems will provide a reduction in the average annual pollution loads compared to existing conditions. Accordingly, the proposed development can be expected to reduce any pollutants conveyed to the groundwater system.
5. A large low lying wetland/swamp area is located immediately west of the development. Based on the observed persistent inflow to the area during recent drought conditions, the hydrologic regime of this low lying area is sustained primarily by inflow from the contributing creeks (catchment areas of 122 ha and 540 ha). The proposed development may reduce groundwater recharge flows in the immediate area of the development, but as a result of a corresponding increase in surface runoff, will not have any significant impact on the total volume of water to sustain the wetland.

Yours faithfully
EVANS & PECK PTY LTD

Dr Steve Perrens
Principal

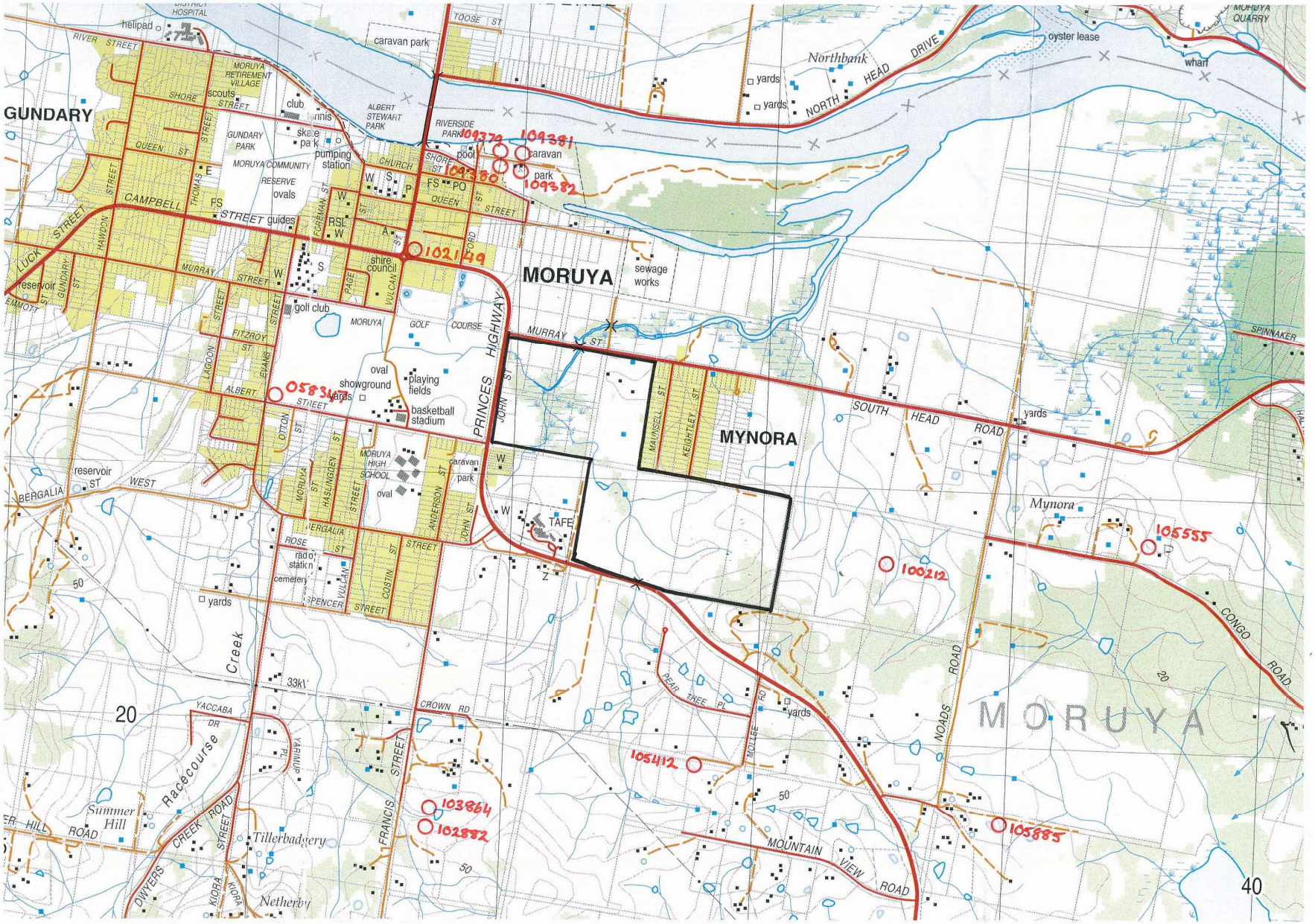

Figure 1: Locations of Groundwater Bores

GROUNDWATER BORE DATA: EAST MORUYA

Table 1 - Geology Summary	Floodplain				Lower Slope		Mid Slope					
Bore Number (GW)	**109379**	**109380**	**109381**	**109382**	**102149^**	**058347^**	**100212^**	**102882**	**103864**	**105412^**	**105555**	**105885**
Elevation (approx) (m AHD)	**3**	**3**	**3**	**3**	**6**	**9**	**20**	**30**	**30**	**30**	**30**	**30**
Yield (L/s)	-	-	-	-	-	-	0.6	1	1.2	0.01	0.75	-
Salinity (mg/L)	-	-	-	-	-	-	Good	-	100	-	-	-
Water Bearing Zone												
Top (m)	-	-	-	-	2.5	6.4	6	-	9	51	10.6	-
Bottom (m)	-	-	-	-	3.5	7.7	8	-	36	58	27.4	-
Range of Topsoil (Layer 1)	0 to 2.2	0 to 3.2	0 to 3.2	0 to 3.2	0 to 5 *	0 to 0.3 **	0 to 1	-	0 to 1	0 to 0.9	0 to 0.9	-
Range of Decomp. Granite (Layer 2)					5 to 14.7 *	0.3 to 7.6 **	1 to 8	-	1 to 6	0.9 to 25.9	0.9 to 8.5	-
Range of Hard Granite (Layer 3)					14.7 to 35.8	7.6 to 83.8	8 to 12	-	6 to 36	25.9 to 86.5	8.5 to 31.7	-

**** The division between layer 1 and layer 2 is unclear. See Table 2 - Bore Information for given data***

***** The division between layer 1 and layer 2 is unclear. The 'clay water supply' was assumed to be decomposed granite. See Table 2 - Bore Information for given data***

^ Closest bores to the site

Table 2 - Bore Information	Floodplain				Lower Slope		Mid Slope					
Groundwater Number (GW)	**109379**	**109380**	**109381**	**109382**	**102149**	**58347**	**100212**	**102882**	**103864**	**105412**	**105555**	**105885**
Yield (L/s)	-		-	-	-	-	0.6	1	1.2	0.01	0.75	-
Salinity (mg/L)	-		-	-	-	-	Good	-	100	-	-	-
Water Bearing Zone												
Top (m)	-		-	-	2.5	6.4	6	-	9	51	10.6	-
Bottom (m)	-		-	-	3.5	7.7	8	-	36	58	27.4	-
Layer 1												
Thickness (m)	2	1	0.6	0.3	1.3	0.3	1	-	1	0.9	0.9	-
Material	Silty Sand (some sea shells)	Silty Sand	Silty Sand	Silty Sand	Clay/Gravel Fill	Topsoil	Black Soils	-	Topsoil & Clay	Topsoil/ Sand/ Clay	Sandy Topsoil	-
Layer 2												
Thickness (m)	1.2	2.2	2.6	2.9	3.7	7.3	5		5	25	7.6	-
Material	Silty Sand (trace of sea shells)	Silty Sand	Silty Sand (some sea shells)	Silty Sand (some sea shells)	Sandy Clay - Clay and Sand	Clay Water Supply	Decomposed Granite		Decomp. Granite	Decomp. Granite	Decomp. Granite	-
Layer 3												
Thickness (m)					9.7	76.2	2		30	32.1	18.9	-
Material					Decomp. Granite	Granite	Sand		Granite	Granite	White Granite	-
Layer 4												
Thickness (m)					21.1		4			28.5	4.3	-
Material					Hard Blue Granite		Granite			Hard Blue Granite	Blue Granite	-