Geotechnical Assessment of E6 Transport Corridor

Network and Asset Planning

E6 Transport Corridor

Report No: MW 91-01-08-1

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EXECUTIVE SUMMARY

Key Points

1. This study provides a geotechnical assessment in support of the planning study for the proposed E6 transport corridor

2. The task comprised of a desktop study of available information and kerbside site inspections.

3. Three primary geological units are contained within the E6 corridor,
a) Quaternary age River Alluvium (soils derived from adjacent rock)
b) Quaternary age Newer Volcanics (Basalt)
c) Silurian age Sediments (Mudstone, siltstone and sandstone)

4. Slightly weathered to fresh, high to very high strength, "non rippable" basalt is exposed at natural surface level in many areas of the proposed E6 corridor. Substantial cut excavations will likely require "blasting".

5. A substantial area of landfill underlies the E6 corridor between Metropolitan Ring Road and McKimmies Rd and warrants further investigation of its contents and ground conditions.

6. The current proposed E6 corridor traverses through a substantial part of the southern section of Work Authority 393 (Hanson Construction Materials – Wollert Quarry)

7. Cut excavations in Silurian sediments should be generally rippable, except where metamorphosed to hornfels (Boral Wollert Quarry, nr southern end Bindts Road).

8. Suitable Type A/B fill sources should be generally available in close proximity to the proposed E6 corridor.

9. Suitable foundation conditions should be intersected at most structure sites apart from the Darebin Creek – Metropolitan Ring Road area where soft wet soils may be encountered.

10. Brief site inspections have indicated that some soils within the proposed E6 corridor are of low to moderate dispersion potential and may be prone to rilling and sheet erosion.

11. Cut batter slope design will depend largely on the site geology and the road alignment geometry.

12. From a geotechnical perspective, no major impediments exist in regard to the construction of the E6 corridor apart from the common presence of near surface, high to very high strength, basalt (including basalt boulders) and possibly the above mentioned large landfill area.

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1. INTRODUCTION

At the request of VicRoads Network and Asset Planning (Ms Joan Gilmer), a study has been undertaken to identify and review the geotechnical aspects which may affect the proposed E6 corridor between Mill Park and the Hume Freeway near Beveridge (refer Locality Plan Appendix A).

The E6 proposed corridor travels north from the Metropolitan Ring Road along a "previously reserved" alignment to Epping. Beyond Findon Road, the proposed transport corridor continues in a northerly direction and roughly parallels Bindts Road and Epping Road before deviating to the north-west in the vicinity of Grants Road and ultimately connecting with the Hume Freeway near Donovans Lane.

The proposed E6 transport corridor traverses mainly flat lying to gently undulating terrain for much of its length, however to the north of Donnybrook Road the prevailing terrain is "undulating to hilly" in character. Significant changes in topographic relief often reflect changes in the rock and soil types and the structural geological features.

The southern section of the E6 transport corridor to Bindts Road is adjacent to substantial residential and industrial development, while the transport corridor to the north of Bindts Road mainly traverses farmland and agricultural use beyond this point. Some scattered remnants of original vegetation remain intact in the northern section in close proximity to the proposed transport corridor. Drainage lines in the area of the proposed transport corridor while prominent generally have low to moderate gradients.

The objective of the study was to provide background information regarding the geology and geomorphology of the proposed transport corridor and to identify any constraints and their potential effect on the construction of the proposed E6 transport corridor.

The geotechnical assessment has been mostly a desktop study consisting of:

- collating existing borehole data from internet databases (The Department of Primary Industry's "GeoVic") and the Sinclair Knight Merz database / Victorian Water Resources Data Warehouse
- review of the EPA's priority sites register for contaminated sites
- review of aerial photographs from 1966 and 1984 and of recent satellite images (i.e. Google Earth) to identify potential contaminated sites such as landfills
- phone conversations with councils
- discussions with operating quarries in close proximity to the proposed transport corridor
- brief site visits along the proposed transport corridor were conducted where access was possible from public roads.

2. GEOLOGY AND GEOMORPHOLOGY

The Geological Survey of Victoria maps (1:250,000 Melbourne Sheet SJ55-5, Ed 2, May 1997, 1:63,360 Yan Yean sheet, part 7922 Zone 55, rev. 1981) and the Department of Primary Industry's Geomorphological Units maps for the Port Phillip and Westernport Catchment Management region (available online from dpi.vic.gov.au) show that the geology of the E6 transport corridor is relatively straight forward with Quaternary Newer Basalt (Qvn) being encountered over the much of the study area. Major basalt flows have occurred down the ancient flood plains of the Merri Creek, Darebin Creek and Plenty River, and typically these flows are 15m-30m in thickness with basalt flows in excess of 40-50m reportedly in some of the southern areas of the transport corridor (refer Geological Plans Appendix B).

Scattered outcrops of Silurian, interbedded shale, mudstone and greywacke (Sud) are visible in very close proximity to the proposed transport corridor, these often represent that remnant peaks of the older Silurian landform day-lighting through the basalt flows. In the vicinity of Findon and Bindts Road the Silurian sediments have been metamorphosed to a hornfels; this rock is currently extracted and crushed for aggregate and crushed rock products at the Boral Wollert quarry.

Significant areas of Quaternary river alluvium (Qra) are present around some of the major waterways adjacent to the proposed transport corridor, in particular the Darebin Creek area. These river alluvium deposits consist primarily of sand, silt and clay, but may contain minor amounts of gravel. The alluvium is commonly moderately sorted and only poorly consolidated.

2.1 Newer Basalt

Along the proposed E6 transport corridor, slightly weathered to fresh basalt cobbles and boulders (in excess of 1m diameter in some areas) are commonly present at the surface, particularly away from natural drainage lines. Stony rises (elevated remnant areas of slightly weathered to fresh, high to extremely high strength, basalt) are also common over extended areas (refer site photos Appendix C). Typically, the topsoil (where present) and residual red-brown clay is commonly less than 1m thick, except where adjacent to natural drainage lines and waterways. In the latter instance, a much deeper weathering profile is evident, with up to several metres of dark grey to black basaltic clays and weathered rock. The soils derived from the weathering of the basalt are typically of very low California Bearing Ratio (CBR) strength (1-2%) when wet, highly plastic and have a high potential to shrink and swell in response to any changes in the moisture regime.

The basalt rock encountered along the transport corridor is typically a dark to light grey, coarsely to finely vesicular olivine basalt.

2.2 Silurian Siltstone/Sandstone

The Silurian sediments where exposed in close proximity to the transport corridor are usually extremely to distinctly weathered and of low to very low strength. The dominant structure in the Silurian sediments is approximately north-south with the Merriang Syncline being visible near

the intersection of Epping Rd and Grants Road. The soils derived from the weathering of the Silurian sediments are typically stiff to very stiff clays and silty clays.

These residual clays are likely to be of low to medium strength and of low moderate dispersion potential. The soils will likely be prone to erosion where the gradients of drainage lines exceed 3%.

A thin formation known as the Mt Phillipa Member (Sum) consisting of a micaeous, fossiliferous sandstone crosses the E6 transport corridor approximately 1.5Km south of Grants Rd.

3. GROUNDWATER

3.1 Surface Water

There are a number of small creeks and rivers flowing in a southerly direction in close proximity to the transport corridor, including Merri Creek, Darebin Creek, Findon's Creek and Plenty River. An appropriate level of water quality monitoring and surface runoff control should be undertaken during the construction phase to ensure that any impact on major waterways and drainage lines is minimised.

3.2 Groundwater, Springs and Groundwater Bores

The Newer Volcanics aquifer is typically a fractured rock aquifer, which is primarily recharged through the areas of basalt rock outcrop. The hydraulic conductivity of the aquifer can be highly variable and dependent on the degree of joint interconnection and development of fracture patterns.

The bore information compiled in this report was obtained through the Department of Primary Industry's GeoVic database and the Sinclair Knight Merz database / Victorian Water Resources Data Warehouse website by the Department of Sustainability and Environment.

A number of groundwater bores (approximately 60 in total) are registered within the immediate vicinity of the proposed E6 transport corridor (refer borehole location plans Appendix D & E). Most of these bores are classified as being suitable for domestic and stock use with several being DSE investigation bores for groundwater quality monitoring. The standing water levels in these groundwater bores vary considerably with a range in water depth of 0m and 50m with an approximate average value of 14 m.

The boreholes in which groundwater was encountered at the natural surface level (0m) are 68805, 68808, 68813 (Merriang Rd north of Donnybrook Rd), 68807 (Merriang Rd south of Donnybrook Rd) and 144491 (Merriang Rd north of Bridge Inn Rd).

As such, it is likely that other areas of the proposed E6 transport corridor will encounter groundwater at levels close to the existing natural surface level depending on the surrounding head and recharge capacity.

The groundwater chemistry associated with the identified groundwater bores shows total suspended solids (TSS) ranging from 1600 to 5900 mg/L (average 4000) and chloride levels ranging from 500 to 2700 (average 1700) mg/L. Electrical conductivities range from 2400 to

9200 µS/cm, with an average value of 6000 µS/cm.

Inspection of the available areas of the proposed E6 transport corridor has not indicated any obvious presence of springs. However the presence of springs should not be discounted particularly in the existing drainage lines. If present, localized springs may have the capacity to recharge quickly due to some of the prominent surrounding hills.

3.3 Salinity

Information provided by the Department of Sustainability and Environment (DSE) identifies a likely presence of salinity discharge lines within the northern part of the proposed E6 transport corridor. These areas are principally confined to drainage lines.

Most of the typical indicators of salt affected areas, i.e. salt resistant vegetation (spiny rush etc) or scorched areas were not visually apparent in the inspected areas of the transport corridor. However, the prolonged dry conditions experienced in recent years within the area and many other parts of Victoria may well have masked their presence. Under normal conditions, the contrast between those areas which are salt affected and those which are not would likely be more pronounced.

It would be prudent to ensure that construction works do not significantly modify the hydrological balance and/or cause enlargement of saline discharge areas or any groundwater to reappear at another location. Any salinity issues can be successfully managed by ensuring surface water is used or managed within the source area rather than allowing surface runoff to migrate to areas of impeded drainage and consequently elevates groundwater levels downstream. Increased surface runoff within the transport corridor will have the potential to impact significantly on erosion problems and water quality.

The protection of remnant native vegetation and dense planting of new vegetation would decrease any possible impacts in run-off prone areas. Other measures to minimise any potential groundwater impacts include:

- Maintain overland flow paths by the provision of waterway structures (culverts and bridges) at existing watercourses and drainage lines.

- Maintain subsurface flow paths by provision of appropriate subsurface drainage.

4. GEOTECHNICAL ASPECTS

While it is anticipated that most of the earthworks along the proposed E6 transport corridor will likely involve only low cut and fill (i.e. < 1-2m), it should be noted that high to extremely high strength, slightly weathered to fresh basalt is present at the natural surface level in many areas (for site photos, refer Appendix C). As such, any subsurface excavations (even shallow drainage lines) will likely encounter substantial quantities of “non-rippable” basalt which will require either the use of a rock breaker or blasting to affect excavation. If blasting of the basalt rock is required along the southern sections of the proposed E6 transport corridor, appropriate design of rock blast patterns and containment would be required. Close monitoring of ground vibrations and air blast vibrations would also be highly desirable during construction, given the close proximity of houses abutting the road reservation.

Avoiding cut and drainage excavations in these basalt areas as far as practical and maintaining the transport corridor on low fill will considerably reduce the costs associated with the construction of the road. Alternatively, where cut excavation is unavoidable, then consideration should be given to extracting sizeable quantities of basalt which can be potentially processed as lesser quality pavement materials (Class 3 & 4 crushed rock) for the E6 road. In this way, the additional costs associated with excavation can be mitigated to some degree. Care should be exercised in the design of proposed road cuts in this instance, to ensure they are well above the prevailing groundwater table at the time of excavation otherwise additional drainage costs may be incurred.

In regard to the far northern section of the proposed E6 transport corridor, cut excavations in this area are likely to be sited in Silurian sediments. On the basis of the observation of the existing cut exposures along Epping/Merriang Road, it is judged that these cuts will be generally rippable with a large dozer (Caterpillar D10 dozer or equivalent). The stability of cut excavations in the Silurian sediments may be a potential issue depending on the adopted cut batter height and batter orientation. A comprehensive defect and cut stability analysis should be undertaken at a later stage once the horizontal and vertical geometry of the proposed road is more fully established.

In regard to bridge and culvert foundation conditions along the proposed E6 transport corridor, given the common presence of very high strength, near surface, basalt in combination with limited thickness of very low strength soils; it is likely that spread footings or large diameter bored piles would be the preferred foundation type for at-grade structures. However, elevated structures (i.e. grade separated overpasses) are more likely to adopt either pre-bored or driven piles as the preferred foundation option.

It is judged on the basis of visual observation of most structure sites that foundation conditions will be generally conducive to the construction of the normally used structure types without significant cost increase.

5. LANDFILL AREAS AND EXISTING QUARRIES

Along the proposed E6 transport corridor, several substantial land fill areas are known to exist, the largest of these sites is located on the E6 transport corridor between McKimmies Rd and the Metropolitan Ring Road.

Known as the “GB Landfill”, it is located at the former site of the Boral Bundoora Quarry which until its closure in the late 1980’s was a reasonably large source of crushed rock and aggregates. At the time of its closure as an operating quarry, the depth of extraction had exceeded 40m in the deeper areas of the quarry. While some consolidation of the landfill will have occurred over time, it is likely that the construction of a major road across the landfill area will require significant additional design and incur appreciable additional construction costs.

The readily available information in regard to the “GB Landfill” and the materials placed is insufficient at this stage to make a full assessment of the likely issues and impacts. It is recommended that a more comprehensive investigation and assessment be made in the near future.

Two other known prior landfills occur to the east and west of the proposed E6 transport corridor in the vicinity of Morang Road, both of these landfills are located at least 200m from the transport corridor and as such will likely have negligible impact on the proposed road.

In a number of areas along the southern sections of the proposed E6 transport corridor, sound mounds have been placed at the rear of residential properties. While it is presumed that these mounds contain no contaminated landfill components, the contents of the sound mounds should be assessed in more detail.

In terms of potential future landfill sites, currently the exhausted parts of the Hanson Wollert quarry located in Bridge Inn Road to the east of the proposed E6 transport corridor are utilised as a repository for landfill. It is likely that future exhausted areas of the quarry close to Merriang Rd and Bindts Roads will be utilised in the same way in the longer term. Similarly, some of the exhausted areas of the Boral Wollert quarry (off Findon's Road in Epping) are also a future potential landfill site.

In its present form, the proposed E6 transport corridor will significantly impact on the southern section of Work Authority 393 (Hanson Construction Materials – Wollert Quarry), particularly the part of the work authority on the south side of Bridge Inn Rd. The degree of impact will largely depend on the timing of the construction of the proposed E6 transport corridor. If Hanson Construction Materials have extracted and backfilled the area prior to the construction then VicRoads may well incur considerable additional costs in construction of a road across an extensive new land fill area.

6. ANTICIPATED FOUNDATION CONDITIONS AT STRUCTURES

In regard to bridge and culvert foundation conditions along the proposed E6 transport corridor, given the common presence of very high strength, near surface, basalt in combination with limited thickness of very low strength soils; it is likely that spread footings or large diameter bored piles would be the preferred foundation type for at-grade structures. However, elevated structures (i.e. grade separated overpasses) are more likely to adopt either pre-bored or driven piles as the preferred foundation option.

It is judged on the basis of visual observation of most structure sites that foundation conditions will be generally conducive to the construction of the normally used structure types without significant cost increase.

However, the foundation conditions for the construction of bridges/culverts at Darebin Creek and Merri Creek may be less favourable with considerable depths of soft weak soils likely within the immediate floodplain areas.

7. SOURCES OF EMBANKMENT FILL AND PAVEMENT MATERIALS

With respect to potential sources of fill, the proposed E6 transport corridor is unlikely to readily generate the large quantities of Type A and B fill required due to the poor quality and very low strength of the near surface basaltic clays present over much of the transport corridor. In addition, the obvious presence of near surface, slightly weathered to fresh, very high strength basalt and basalt boulders will further limit the potential to obtain embankment fill materials. As such, it is likely that there will be a significant shortfall of readily available fill materials along the proposed E6 transport corridor.

However given the close proximity of a number of well established quarries and future quarry prospects to the transport corridor, it is likely that suitable overburden materials meeting the Type A and B fill requirements will be readily obtained without a significant cost increase. Those quarries are:

- Hanson Wollert quarry (Bridge Inn Rd Wollert)
- Boral Wollert quarry (Findon's Rd Epping)
- Mountain View quarry (Donnybrook Rd Donnybrook)
- Northern Quarries (Cooper St Epping)

Collectively the above quarries are also capable of providing all the necessary pavement materials (crushed rock and sealing aggregates) for flexible pavement construction.

It is also likely that the outcrops of Silurian sediments immediately to the east and present along the northern section of the proposed E6 transport corridor will also potentially provide a large quantity of ripped soft rock suitable for both Type A and B fill materials.

8. APPENDICES

Appendix A - Locality Map

Appendix B - Geological Maps

Appendix C - Site Photos

Appendix D - Overview Maps – Borehole Locations from GeoVic Database

Appendix E - Overview Maps – Borehole Locations from Victorian Water Resources Data Warehouse / Sinclair Knight Merz Database

Appendix F1 - Aerial Photographs 1984

Appendix F2 - Aerial Photographs 1966