HMVS Cerberus infilling project – product and methodology risk review

Prepared by the Professional Divers Group following consultation with engineers, product suppliers and marine contractors

Task/outcome: Infilling and encasement of the internal components of the wreck of the HMVS Cerberus to prevent any further collapse and breakup of the site with the aim of the infilling support solution to provide stabilisation of the site for 30+ year option.

Concrete infilling	Comments	Risk
Constructability	Concrete can be pumped from shore. Proven product and placement method in a submerged marine environment.	Low
	No large marine plant (barges) required on site and for numerous mobilisation and demobilisation of marine plant during weather delays and for ongoing loading of product (1,700 cubic metres)	Low
	Methodology of placement of concrete and self-levelling properties will best allow for 100% filling of the voids of the site	Low
	Placement will be from the bottom up encasing all components within the wreck during the filling process with the ability to monitor between pours to ensure 100% fill	Low
	Concrete can be placed from all existing penetrations within the hull to allow void filling of all areas	Low
Durability & strength	Product has good compressive and tensile strength (32mpa)	Low
	Resistant to abrasion and scouring from sand. Other mass concrete structures within Port Phillip Bay have well exceeded 30 years and some have been in place for over 100 years with no indication of short or long term failure. (No 2 West Channel “Tuckey” and Breakwater Pier).	Low
	Tensile strength and adhesion to wreck components will assist in strengthening the site from future collapse.	Low
	Concrete will create an alkaline environment and have a passivating effect on iron, slowing the corrosion rate	Low
	Resistant to water ingression and prevention of ongoing corrosion of internal components.	Low
Environmental	Can be contained and managed with correct methodology for placement. Overflow can be pumped into a containment bag for later removal.	Low
	Once cured has no environmental effect on surrounding areas and immediate site impacts will be negligible and return to current state within 6 – 9 months.	Low
Pricing	Price point with shore pumping makes this the most cost effective and low risk option for long term stabilisation of the site. Product quantities have been calculated and product loss will be minimal and as an option has little scope for variation.	Low

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Cemented sand infilling	Comments	Risk
Constructability	Cemented sand due to distance cannot be pumped from shore. Proven product and placement method in a submerged marine environment. Requires localised mixing and pumping from a barge located at the Cerberus site	Medium
	Large marine plant (barges) required on site and numerous mobilisation and demobilisation of marine plant during weather delays and for ongoing loading of product (1,700 cubic metres of cement and sand requiring mixing for pumping on site). Option for obtaining local sand from around the site for use but will require approvals and may not be suitable for design.	Medium
	Methodology of placement of cemented sand infilling allows for 100% filling of the voids of the site.	Low
	Placement will be from the bottom up encasing all components within the wreck during the filling process with the ability to monitor between pours to ensure 100% fill.	Low
	Cemented sand can be placed from all existing penetrations within the hull to allow void filling of all areas without cutting new penetrations.	Low
Durability & strength	Product has low compressive and tensile strength (5-10mpa).	Medium
	Less resistant to abrasion and scouring from sand than concrete and loss of material exposed to the elements is expected over time and may require remediation over time.	Medium
	Low tensile strength and adhesion to wreck components reducing the intent of preventing the site from future failure.	Medium
	Less resistant to water ingression and ongoing corrosion of internal components may cause future corrosion and expansion of iron and localised failure of cemented sand	High
Environmental	Can be contained and managed with correct methodology for placement. Overflow can be pumped into a containment bag for later removal.	Low
	Once cured has no environmental effect on surrounding areas and immediate site impacts will be negligible and return to current state within 6 – 9 months.	Low
Pricing	Although this will be the lowest cost for materials, barge cost and duration for placement makes this a more expensive option for a less durable result with the possibility of ongoing remediation required. Product quantities have been calculated and product loss although likely product cost is low and should be allowed for in works and as an option has little scope for variation.	High

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Epoxy grout infilling	Comments	Risk
Constructability	Epoxy grout due to distance cannot be pumped from shore. Proven product and placement method in a submerged marine environment. Requires localised mixing and pumping from a barge located at the Cerberus site	Medium
	Large marine plant (barges) required on site and numerous mobilisation and demobilisation of marine plant during weather delays and for ongoing loading of product (1,700 cubic metres of two part epoxy requiring mixing for pumping on site).	Medium
	Methodology of placement of epoxy infilling allows for 100% filling of the voids of the site.	Low
	Volume of epoxy grout required will need extensive lead time for manufacture and delivery in the quantities required and is likely an imported (not local) product	Medium
	Placement will be from the bottom up encasing all components within the wreck during the filling process with the ability to monitor between pours to ensure 100% fill.	Low
	Epoxy grout can be placed from all existing penetrations within the hull to allow void filling of all areas without cutting new penetrations.	Low
Durability & strength	Product has excellent compressive and tensile strength (100mpa)	Low
	Resistant to abrasion and scouring from sand.	Low
	Tensile strength and adhesion to wreck components will assist in strengthening the site from future collapse.	Low
	Resistant to water ingression and anti-corrosion properties will assist in the prevention of ongoing corrosion of internal components.	Low
Environmental	Requires a large amount of product on site that in its two parts are a hazardous substance and any spillage prior to mixing have an environmental risk that may be difficult to contain	High
	Can be contained and managed with correct methodology for placement. Does not mix with and will simply displace water not requiring containment of water displaced/overflow.	Low
	Once cured has no environmental effect on surrounding areas and immediate site impacts will be negligible and return to current state within 6 – 9 months.	Low
Pricing	This will be the most expensive option of infilling requiring marine plant for placement and a high cost product. Although product quantities have been calculated and product loss will be minimal any increase in product quantities due to its high cost per litre will be significant.	High

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Various foam infilling	Comments	Risk
Constructability	Foam due to distance and product behaviour cannot be pumped from shore. Requires localised mixing and pumping from a barge located at the Cerberus site	Medium
	Un proven product in these quantities for placement in a submerged marine environment.	High
	Large marine plant (barges) required on site and numerous mobilisation and demobilisation of marine plant during weather delays and for ongoing loading of product (1,700 cubic metres of foam required for pumping on site).	Medium
	Methodology of placement of foam infilling is undetermined for 100% filling of the voids of the site. Product reaction with salt water during curing is undetermined.	High
	Placement will be from the top down and its ability to ensure encasing all components within the wreck during the filling process is unknown. Product key into the lower hull structure and filling all voids is unknown.	High
	Placement of foam likely requires further infilling penetrations to ensure 100% void filling and therefore impact to the site and more than likely access to the site internally for port installation	High
Durability & strength	Product has low compressive and tensile strength (varies between products 1-10mpa compressive).	High
	Low resistance to abrasion and scouring from sand and loss of material exposed to the elements is expected over time and may require future remediation.	Medium
	Low tensile strength and adhesion to wreck components is poor.	Medium
	Products investigated have low resistance to water ingression and ongoing corrosion of internal components may cause future corrosion and expansion of iron and localised failure of the foam.	High
	Foam products resistant to fuels and oils to be selected, foams affected by hydrocarbons if exposed to a fuel/oil spill (high boating area) will be affected & possibly require remediation. Compatibility of foam to a range of possible chemical exposures possible in the marine environment need to be clearly understood.	High
	Foam products resistant to UV to be selected, foams affected by UV need to be considered or methodology to cap and cover foam at deck penetrations.	Medium
	Non-flammable foam product required to be selected, most foams although non-flammable will be affected by fire and if occurs will requiring possible remediation.	High
	Foam products investigated generally have a density of around 15kg per cubic metre. Foam infilling	High

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	of 1,700 cubic metres will provide a buoyant force of 1,675 ton of upward lift when fully submerged. This upward force and the heavy top structure above water has a significant risk of the site rolling over as the foam has little bond strength to the remaining bottom structure.	
Environmental	Containment requires sound methodology for placement and significant works to form up and seal upper hull penetrations. High probability of spillage of product during placement as product is buoyant, requires large floating boom and retrieval vessel for any spilt foam.	High
	Products in two parts prior to mixing are hazardous materials and any spillage will be extremely hazardous to the localised and possibly even wider environment creating significant environmental and project risk. Methodology needs to ensure no spillage of materials is possible.	High
	Once cured has no environmental effect on surrounding areas and immediate site impacts will be negligible and return to current state within 6 – 9 months. Clean up of areas on external hull inside containment booms undetermined. Products investigated generally contain and will release traces of hazardous materials such as formaldehyde unless contained.	High
Pricing	Depending on foam infilling product selected, barge cost and duration for placement makes this a more expensive option for a less durable result with the possibility of ongoing remediation required. Although product quantities have been calculated, product placement and containment for this application is unproven and product loss cannot be determined. Increase in cost for product is possible.	High

Budget estimates for the infilling works as listed below.

Concrete infilling	$0.6 - 0.7M
Cemented sand infilling	$1.6 – 1.7M
Epoxy grout infilling	$11.5 - 12M
Foam infilling	$1.4 – 1.5M