Memorandum

To:	Gravity vs Pumped MCA Workshop Participants	**Date:**	16 July 2015
From:	David Heiler	**Beca Ref:**	3384543
Copy:		**Opus Ref:**	3C1262.00
Subject:	Dudley Creek MCA for Pumping versus Gravity		

1 Overview

This memo presents an evaluation of pumped vs gravity conveyance for downstream options being considered for the Dudley Creek Flood Remediation Project.

Pumped conveyance involves pumping flows along the bypass corridor through a pressure pipeline. Gravity conveyance relies on the hydraulic grade available between the inlet and outlet of the bypass to convey flows by gravity through a larger gravity pipeline.

The evaluation was undertaken using a subset of criteria used for evaluating the downstream corridors. Relevant Criteria are presented in Section 2 of this memo. The evaluation was undertaken at a workshop on 15 July 2015 that involved the following participants:

- Ramon Strong – CCC Land Drainage Manager
- Graham Harrington – CCC Senior Surface Water Planner
- Tom Parsons – CCC Land Drainage Recovery Programme manager – Technical
- Martin Smith – CCC Dudley Creek Project Manager
- David Gardiner – Beca/Opus Downstream Design Manager
- Tony Gordon – Beca/Opus Upstream Design Manager
- David Heiler - Beca/Opus Project Team Leader
- Kate Purton - Beca/Opus Hydraulic Design
- Graham Levy - Beca/Opus Hydraulic Design Lead

2 Relevant Criteria

The following criteria from the main corridor selection MCA were considered relevant to the evaluation of pumped vs gravity conveyance:

D1 – Vulnerability

D2 – Hydraulic performance / opportunity

C1 – Whole of life cost

E4 – Community impact (social)

E5 – Construction

S1 – Long term hydraulic sustainability

The following sections provide further detail on these criteria:

2.1 Flood Hazard Reduction

	Outcome	Criteria	Definition	Measurement
FLOOD REDUCTION	The degree to which the project provides mitigation of the flood risk	D1 – Vulnerability	Reliability of the option including any residual flood risk - design	The degree of robustness of the option and consequence of failure during a flood event
		D2 – Hydraulic performance / opportunity	Flood risk reduction over and above the primary objective of flood risk reduction in the Flockton St area	Ability of the option to reduce flood risk in other areas

Note that the project needs to meet the primary objective (flood risk reduction in the Flockton Street area). This means accepting that the options presented can meet the objective, otherwise they would not be assessed.

D1 is about how reliable the on-going 'operation' of the option is.

While there might be minor changes to the design options, it is to be assumed that no further optimisation would occur to the extent that it would change the outcomes

2.2 Cost

	Outcome	Criteria	Definition	Measurement
COST	The capital and ongoing costs of the project	C1 – Whole of life cost	Whole of life costs including operation, maintenance and renewals, earthquake related costs and risks	Whole of life cost estimate

The lowest cost option is to be seen as the preferred option under this criteria.

- Whole of Life Cost
  - Cost to construct
  - Cost to operate
  - Maintenance requirements – this captures the ability to maintain as this comes at a cost
  - Capital renewals (e.g. replacement of pumps and electrics at say 15 years)
  - Earthquake related costs (resilience assessment)
  - Implementation of health and safety requirements.

The whole of life assessment includes an assessment of the ability of the option to maintain service following a future earthquake event and an assessment of the estimated costs associated with rebuilding the asset following a future earthquake event.

If there are other aspects of property acquisition that are not necessarily financially compensated for then these are captured elsewhere – e.g. social impacts, disruption during construction.

There is an indirect cost of ongoing flooding to properties if there is a delay in delivering the project due to legal challenge and extended land access negotiations. This will be reported separately from the capital cost of the scheme as it is not a direct cost to CCC. The cost and risk of this will be evaluated under the timeframe risk criteria (R2).

2.3 Environment

	Outcome	Criteria	Definition	Measurement
ENVIRONMENT	The health and wellbeing of the community has been considered	E4 – Community impact (social)	The option provides for peoples wellbeing and sense of community Note this includes recreation	Qualitative assessment of impact – quality of life, community cohesion, recreations, health & wellbeing. There was no specific question in the MCA over pumped vs gravity. This was assessed based on experience of the Tay St Drain PS and other infrastructure projects in ChCh.
	Temporary effects from construction are managed	E5 – Construction	Effects of constructing the option including the natural environment, traffic, pedestrians, noise, disruption to public and services, health and safety risks, damage to other assets, access to private property.	The degree of adverse effect from construction activities

It is the degree of the adverse effect even with appropriate mitigation in place (i.e. we can't do something that has totally unacceptable effects) that is being assessed. The timeframe over which the impact is assessed will vary for each of the criteria. When the option assessment is undertaken the timeframe used for each criteria will need to be documented.

Consideration of the criteria excludes cost to implement mitigation and cost of property acquisition.

2.4 Long Term Hydraulic Sustainability

	Outcome	Criteria	Definition	Measurement
LONG TERM SUSTAINBILITY	The project is considered sustainable in the long term	S1 - Long term hydraulic sustainability	Ability to future proof the solution for climate change, to meet demands for increased levels of service and to cope with over design event (> 50 yr ARI) flows	Qualitative assessment of the ability of the option to adapt to meet changing hydraulic needs

While a short term solution might meet the current flooding issue it could preclude future opportunities or even the means to address future adverse effects (e.g. climate change). This is not about the cost of enabling a future proofed solution, or the cost to fix something if a future natural hazard was to occur, but the ability to come along at a later date and provide additional benefit. By long term we mean 50+ years based on the life of the asset.

The resilience to damage in a future natural hazard (particularly earthquake) has been factored into the whole of life analysis (C1). This includes consideration of the cost to repair damage and the current earthquake risk profile for Canterbury.

3 Scoring

3.1 Scoring System

The same scoring system as used for the corridor MCA has been used for evaluating pumped vs gravity.

The scoring system is: **All scoring of the Options against the Criteria are to be scored on a 0 to 100 scale.** Where 0 = very low or a real or hypothetical least preferred option (worst outcome / completely fails the criteria, strong negative effects) 25 = low 50 = moderately meets the criteria (adequate, neutral) 75= high 100 = very high or a real or hypothetical most preferred option (best outcome / completely meets the criteria such that it is an ideal level of performance, strong positive effects) Scoring should be in units of no less than 5.

3.2 Scores

Table 3.1 presents the raw scores agreed on at the workshop. Justification for raw scores provided.

Table 3.2 presents the analysis of MCA scores using raw MCA scores from the workshop and the relative weightings agreed at the MCA corridor workshop on 14 July 2015. As we are considering a subset of the overall weightings, the weighting percentages have been scaled so that they sum to 100%.

The weightings and raw MCA scores have been used to calculate a final score for each criteria and option. These have been summed to provide a total score for pumped and gravity conveyance for each corridor option.

Table 3.1 Raw MCA Scores and Justification

	Pumped Conveyance			Gravity Conveyance			Justification
Option	A	B (long)	C	A	B (long)	C	
D1 – Vulnerability							
Outlet	*60*	*60*	*60*	*60*	*50*	*50*	Gravity outlet adequate. Pump outlet marginally better at self flushing.
Inlet	*45*	*45*	*45*	*50*	*50*	*50*	More potential for pumped inlet blockage due to pump start/stop operation
Pipeline	*60*	*60*	*60*	*55*	*50*	*50*	Pumped line less reliant on maintenance. Gravity for A less vulnerable that B or C
Siphon (if any)	-	*35*	-	-	*25*	-	Applies to B only. Pumped siphon less vulnerable than gravity.
Pump Station	*40*	*40*	*40*	-	-	-	Applies to pumped options only. Gravity lines do not rely on pump station.
Agreed overall score (not weighted average)	40	40	40	50	45	50	On balance, gravity conveyance has been assessed as being less vulnerable than pumped conveyance due to pumped's reliance on a pump station
D2 – Hydraulic performance	55	55	55	50	50	50	Potential for pump to draw water level down lower in creek during smaller events, resulting in slightly less flood risk during smaller events
C1 – Whole of life cost	45	25	55	65	45	65	Raw MCA scores from Whole of Life Analysis. Refer separate Whole of Life memo (doc ref 10923376)
E4 – Community impact	40	40	40	50	50	50	On-going disruption associated with operating and maintaining pump station and generator in residential environment
E5 – Construction	40	40	40	50	50	50	Pumped and gravity pipeline construction effects considered equal. Greater disruption associated with construction of a pump station
S1 – Long term hydraulic sustainability	50	50	50	55	55	55	Gravity lines cope with greater than design event flows better than pumped lines. Gravity lines can be pumped in the future to meet increased flows whereas pumped lines are limited by flow velocity and headloss within smaller diameter pipelines. The key point is ensuring that gravity pipelines are selected so that they can be used as pressure lines in the future.

Table 3.2 Analysis of MCA Scores

Option	Adjusted Weightings from MCA	Pumped Conveyance						Gravity Conveyance					
		A		B		C		A		B		C	
		Raw	Final	Raw	Final	Raw	Final	Raw	Final	Raw	Final	Raw	Final
D1 – Vulnerability													
• *Outlet*		*60*		*60*		*60*		*60*		*50*		*50*	
• *Inlet*		*45*		*45*		*45*		*50*		*50*		*50*	
• *Pipeline*		*60*		*60*		*60*		*55*		*50*		*50*	
• *Siphon (if any)*		-		*35*		-		-		*25*		-	
• *Pump Station*		*40*		*40*		*40*		-		-		-	
Overall score	30%	40	12	40	12	40	12	50	15	45	13	50	15
D2 – Hydraulic performance	18%	55	10	55	10	55	10	50	9	50	9	50	9
C1 – Whole of life cost	11%	45	5	25	3	55	6	65	7	45	5	65	7
E4 – Community impact	11%	40	4	40	4	40	4	50	6	50	6	50	6
E5 – Construction	4%	40	1	40	1	40	1	50	2	50	2	50	2
S1 – Long term hydraulic sustainability	26%	50	13	50	13	50	14	55	14	55	14	55	14
Total	100%		**46**		**44**		**47**		**53**		**49**		**53**

4 Recommendation

The MCA process for evaluating pumped vs gravity conveyance has identified that gravity conveyance is preferred for all downstream corridor options. Gravity conveyance is therefore recommended.

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