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Lean Earthworks

Mrs Katarina Fidler & Mr Shane Betts,
Carillion Infrastructure





Presentation

1. Business Improvement strategy in Carillion Infrastructure:

- Lean Sigma on M6 Guards Mill
- Lean Sigma in company strategy
- Successes and barriers
- Lessons learnt so far

2. Lean Earthworks case study





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M6 Guards Mill scope of works





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Lean Sigma on M6 Guards Mill

£4.77m **3% net benefit**

on £120m construction budget over 2.5 years

- £1m total investment
- 27 Lean Sigma projects
- Target costed pilot scheme/Dedicated improvement team on site





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Lean Sigma in company strategy

Building on M6 success...

Business Improvement strategy focused on operational excellence:

- Focus on target areas
- Full ownership by Business Units
- Centralised reporting and governance
- Centralised Lessons Learnt process





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Capturing Lessons Learnt

Lessons Learnt Submissions

ROMS

Process Improvement

Evidence Coordinators

Best Practice / Lessons Learned

Evidence Champion

KNOWLEDGE BANK

Adoption of Best Practice

EVIDENCE

Bid Submissions

Continuous Improvement

Continuous Improvement





Successes and Barriers

Cultural Barriers

Business Improvement strategy focused on operational excellence:

1. “It’s extra overhead – can’t afford it...”
2. “It’s all just good project management...”
3. “Every project is different...”





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Successes and Barriers

People...Pace...Passion

1. Advocates with operational gravitas
2. Senior management buy in and commitment
3. Resilient Lean Sigma resources





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Lessons Learnt so far

People...Pace...Passion

1. Operational ownership is a must
2. Do not underestimate engineer's passion for problem solving
3. Suitability of commercial models





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M6 Extension – Carlisle to Guards Mill

Application of Lean Sigma to Earthworks Logistics & Efficiency





Earthworks Efficiency Project

Quad of Aims



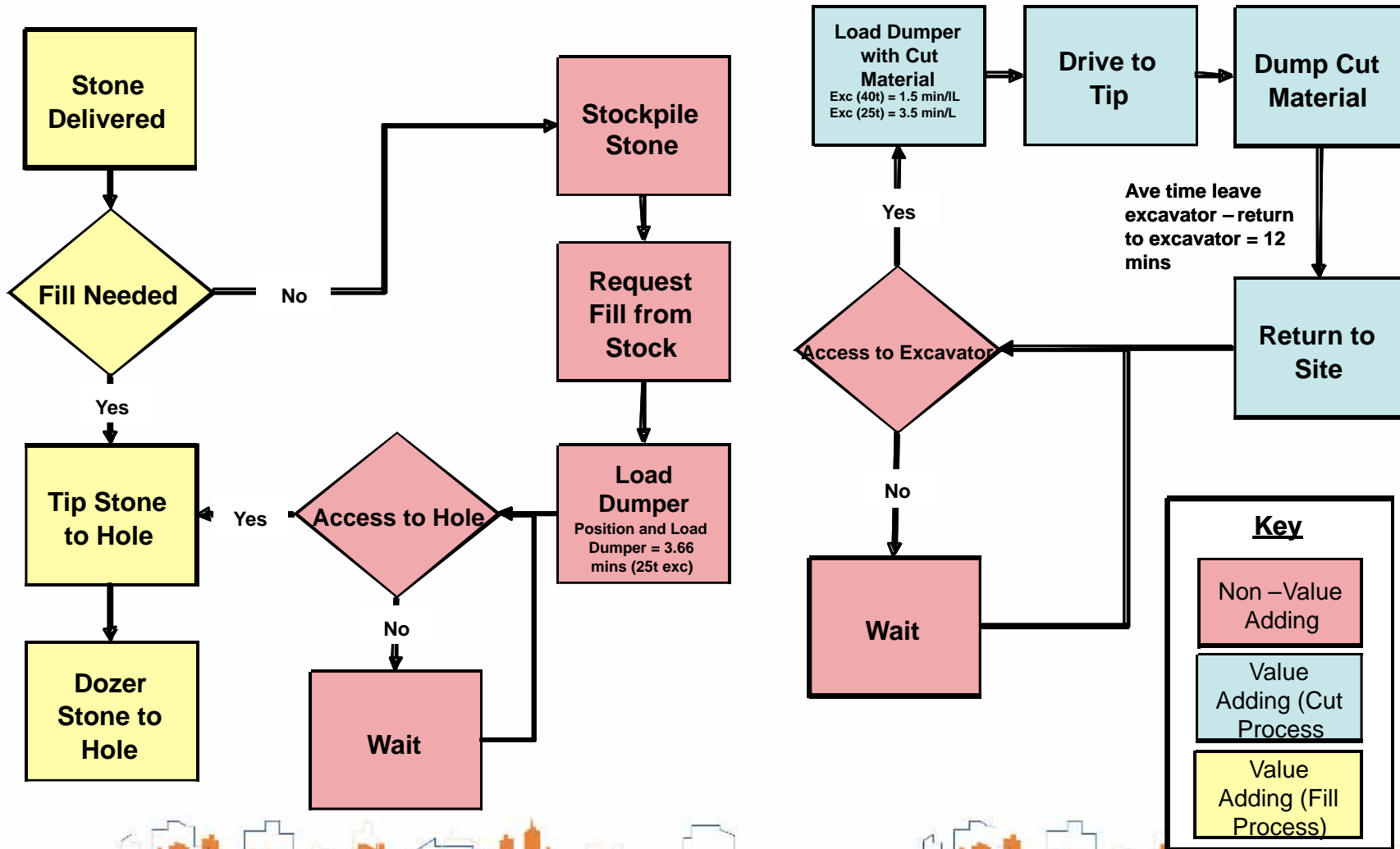
<p>Purpose</p> <ul style="list-style-type: none">• To improve efficiency of earthworks movements in terms of cost per cubic meter• Increase equipment utilisation• Optimise labour resource	<p>Stakeholder Benefits</p> <ul style="list-style-type: none">• Deliver to Program• Reduced Labour Cost• Reduced Plant Hire
<p>Deliverables</p> <ul style="list-style-type: none">• Improved employee satisfaction• Best Practice Guide• Procedures for ongoing controls and Monitoring• Improved Safety	<p>Success Criteria</p> <ul style="list-style-type: none">• 10% reduction on target cost• Achieved Compliance• Improved Plant Utilisation• Reduced Labour Costs

Define





Debog (620 – 1400) High Level Process Map





Opportunity for Improvement

Based on 170 cubes per hour from work study calcs

Cubes Lost/Day

Total Cost

Double handling

Dumpers used to move stock (approx 2hrs/day)

340 @ £1.45

Additional plant (1 x 25 tonne excavator)

Restricted Access for Plant/Deliveries

Excavator waiting for Dumper (approx 50mins/day)

£4089

Additional Waiting Time

Waiting for replacement Plant

????

Waiting for Documentation

340 @

£493

£1.45

????

Waiting for Engineer

Unforeseen Ground Conditions

????

Smaller loads

????

Deviation

Rework

£1314

Other (e.g. 1000 cubes dig)

????

Total Estimated Efficiency Loss

£19,896

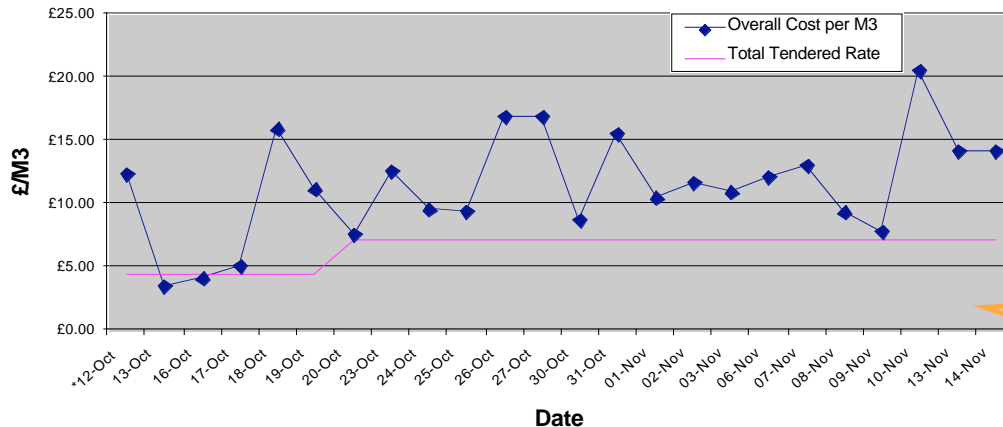
Opportunity = £1m





Current Performance...Daily Cost per Meter Cubed

Overall Cost/M3 4950 - 5600 (Debog)



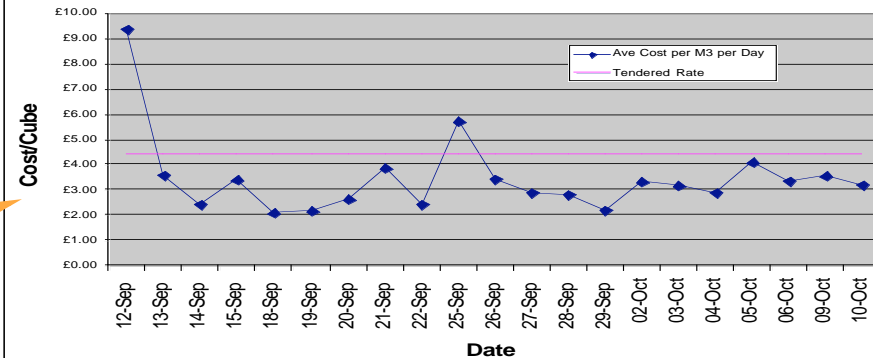
- Location NB6
- Combined Fill and Cut
Daily cost per cubic metre
minus Tendered Value

- Average Observed Performance = £11.42/Metre Cubed
- Tendered Rate = £7.21/Metre Cubed

- Location NB3
- Combined Fill and Cut
Daily cost per cubic metre
minus Tendered Value

- Average Observed Performance = £3.08/Metre Cubed
- Tendered Rate = £4.421/Metre Cubed

Overall Cost/M3 620 - 1120 (Debog)





Measure Phase Conclusions

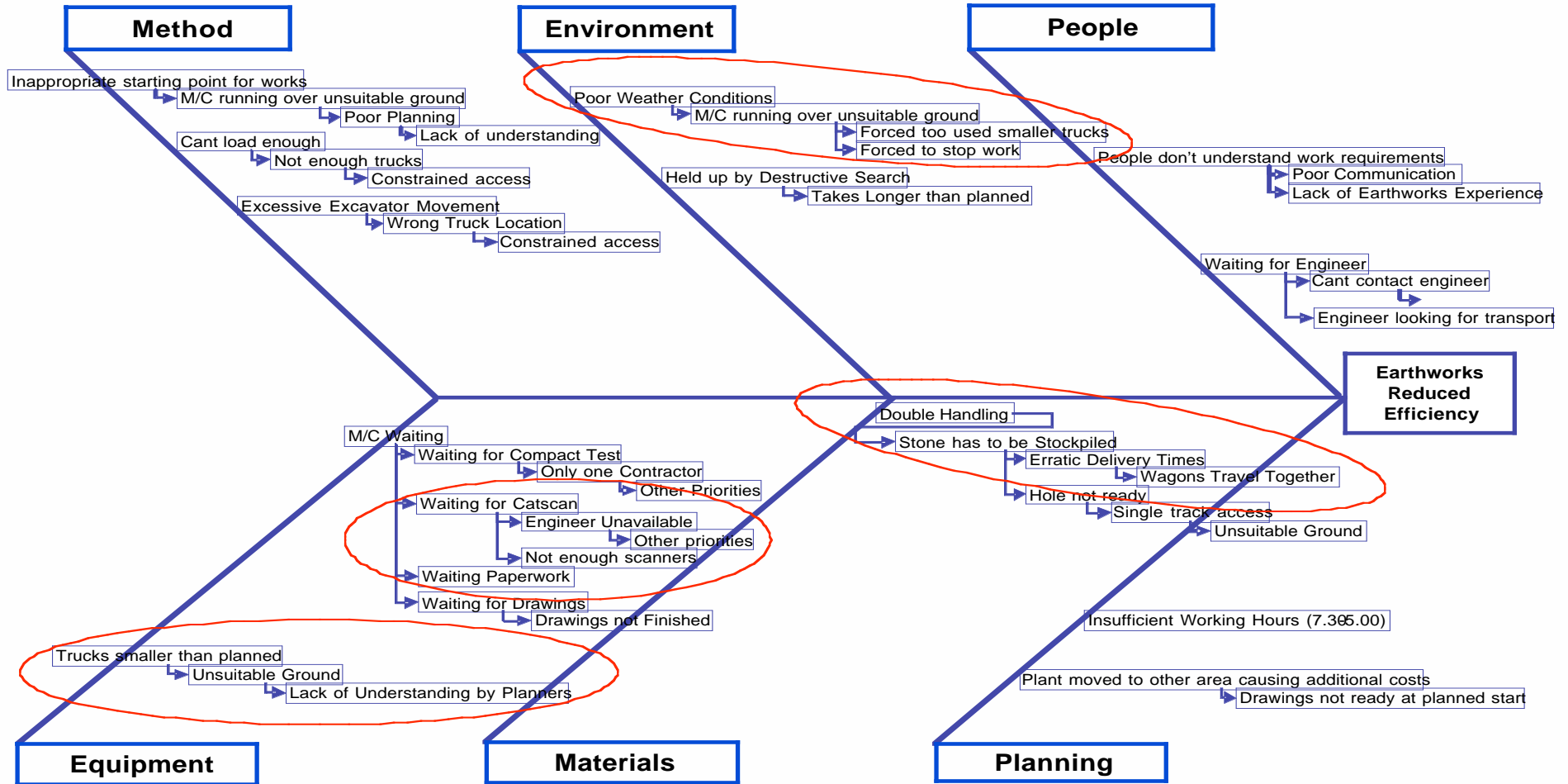


- **Stockpiling requires double handling and therefore reduces capacity and additional plant**
 - Erratic deliveries from quarry
 - Called off greater than capacity
- **Inefficiencies exist which reduces potential output**
 - Restricted access to and from tip
 - Restricted access to excavation
 - Waiting for Wagons
- **Unforeseen ground conditions force a change to normal working practice**
 - Wrong Plant Size
 - Additional work e.g. deeper excavation
- **Non-Conformance**
 - Abandoned work and rework
- **Unplanned waiting time yet to be measured**
 - Plant breakdown time
 - Documentation etc





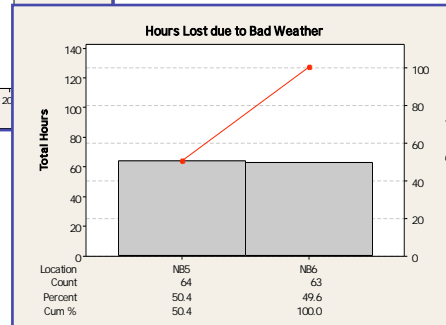
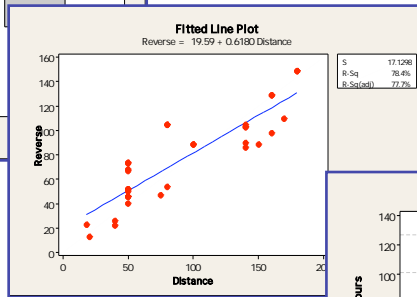
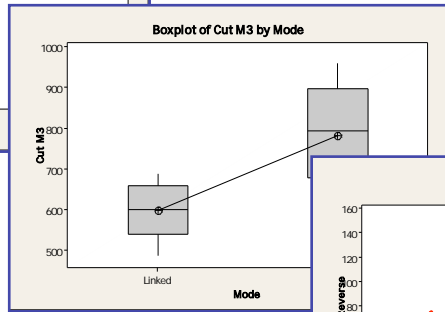
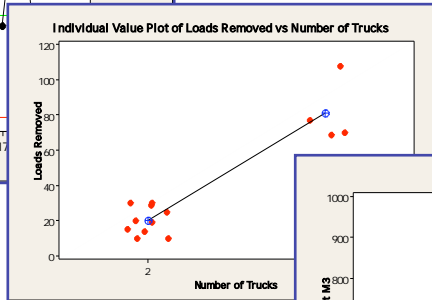
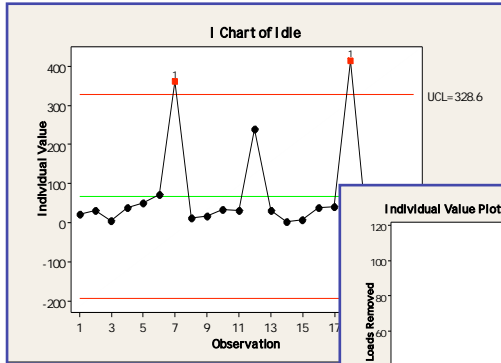
Cause and Effect Diagram





Earthworks Efficiency Project Analysis of Data

Process Outputs:
Variation in the inputs
will impact on these



• Number of Removal Wagons

• Excavator waiting time

• Work Methods

• Reversing Distances

• Plant Cycle Times

• Weather Conditions

• ETC

• Daily Volumes

• Labour Costs

• Plant Hire Costs

• Cost per M3

• Daily Progress

Process inputs: These are the critical inputs which needed to be addressed. They affect productivity and cost





Analyse Phase Conclusions

Overproduction

Waiting

Movement

Process

Inventory

Motion

Defects

- **Number of resources employed is critical**
 - Balance with
- **Parallel working possible**
 - Alternate Work
- **Using ADT dump possible**
 - Haul Routes
- **Minimise distance to nearest passing**
 - Lay bys
 - Turning Circle

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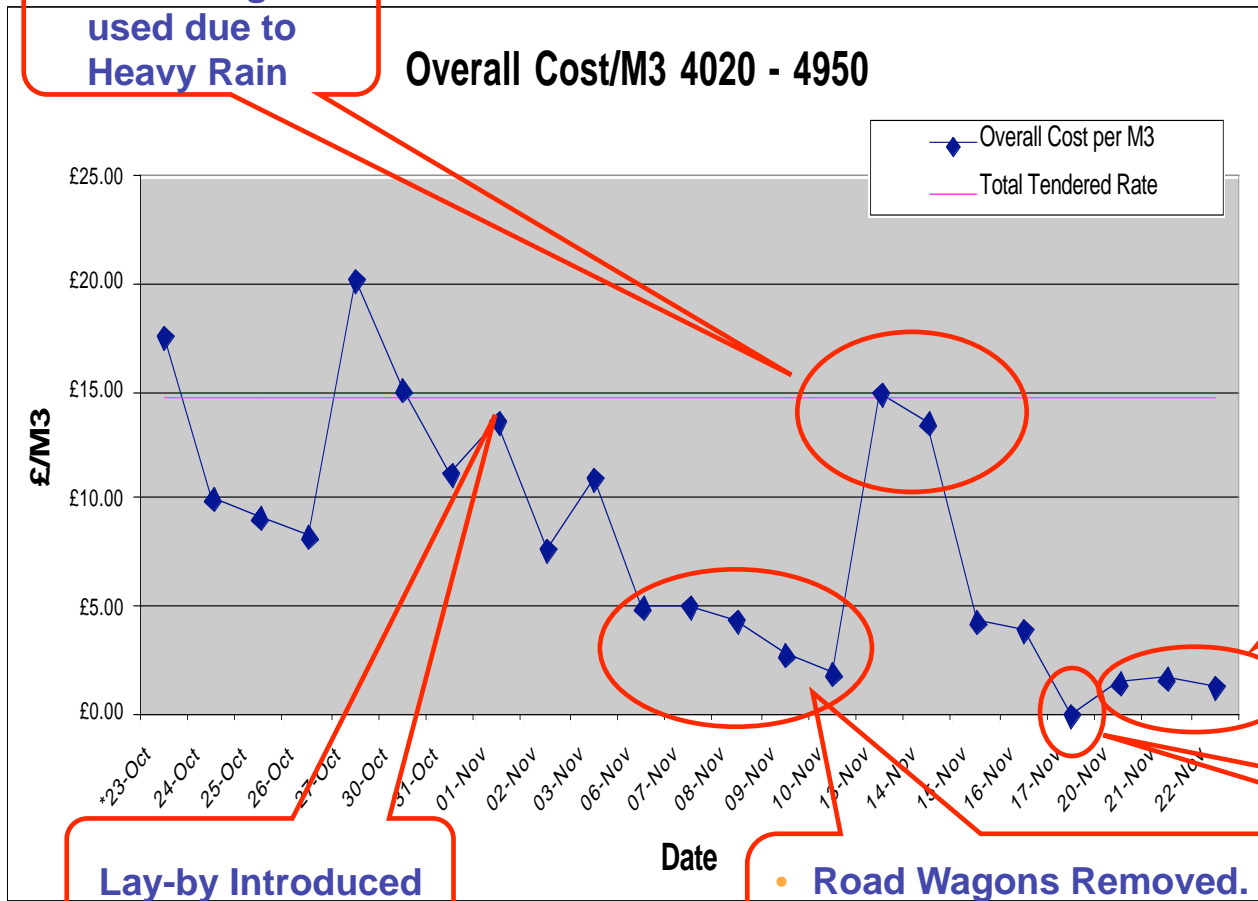




Performance Improvements... ...Daily Cost per Meter Cubed

- Road Wagons used due to Heavy Rain

Overall Cost/M3 4020 - 4950



- Location NB5
- Combined Fill and Cut Daily cost per cubic meter versus Tendered Value

- Road Wagons Removed.
- Deposit Cut Material to Landscape (1 Dumper)

Lay-by Introduced

- Road Wagons Removed.
- Deposit Cut Material to Landscape (2 Dumpers)

No Earthworks due to Weather



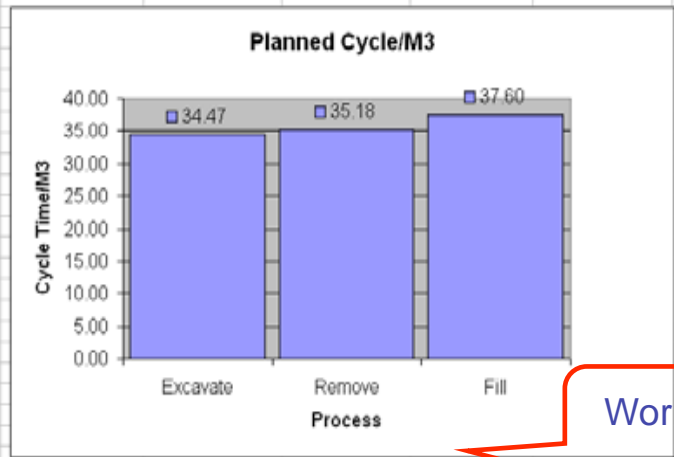


Improve Phase Work Flow Planning Sheet

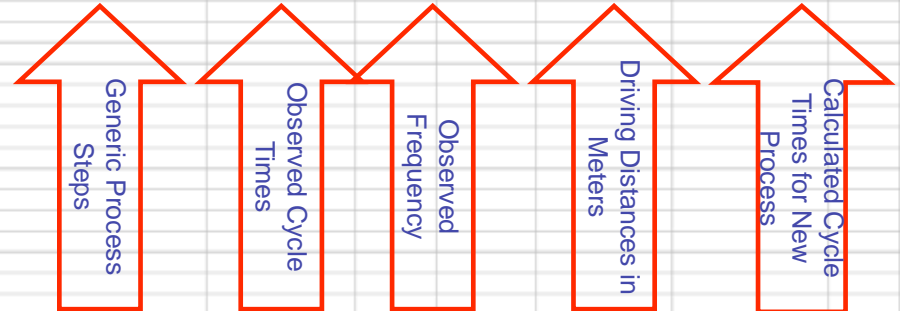
Enter Plant and Labour Requirements



Process Step	Standard Time	Frequency	Complexity	Distance (meters)	Estimated Cycle Time	Process	No of Plant	M3/Cycle	Cycle/Load	Planned Cycle/M3
Excavation						Excavate	1	1.5	250.50	34.47
Wait for Wagon to Position	0.7	0.2		140	19.6	Remove	7	7.5	263.03	35.18
Excavate and Load	21	1	1.1		23.1	Fill	1	7.5	292.00	37.60
Reposition Digger	30	0.3			9					
Wait for Fill cycle to complete	34.4	0			0					
				Total:	51.7					
Remove Material						Excavate	40	16.29	9	506.61
Drive to Turning Point	0.3	1		850	255	Remove	40	16.29	9	2666.61
Turn Vehicle	25	1			25	Fill	40	16.29	9	506.61
Reverse to Excavator	0.7	1		150	105					
Wait to be Loaded	21	1	5		105					
Exit Site	0.3	1		1000	300					
Drive to Deposition Site	0.04	1		6720	268.8	Excavate	940	752	£0.54	£0.67
Drive to Turnig Point	0.3	1		500	150	Remove	921	737	£2.90	£3.62
Turn Vehicle	25	1			25	Fill	862	689	£0.59	£0.74
Deposit Load	67	1			67					
Exit Site	0.3	1		500	150					
Drive to Site	0.09	1		4400	396					
				Total:	1846.8					
Deposit Fill Material										
Drive to Turning Point	0.3	1		850	255					
Turn Vehicle	31	1			31					
Reverse to Deposition Point	0.7	1		150	105					
Deposit Load	67	1			67					
				Total:	458					
Compact Fill Material										
Wait for Wagon to deposit	67	1			67					
Push Stone to Hole	200	1			200					
Exit to Allow Access to Wagon	0.3	1		50	15					
				Total:	282					



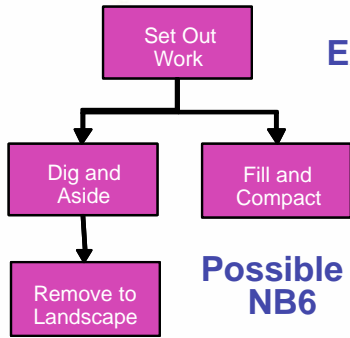
Work Balance Table



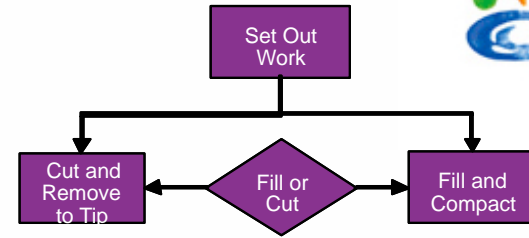
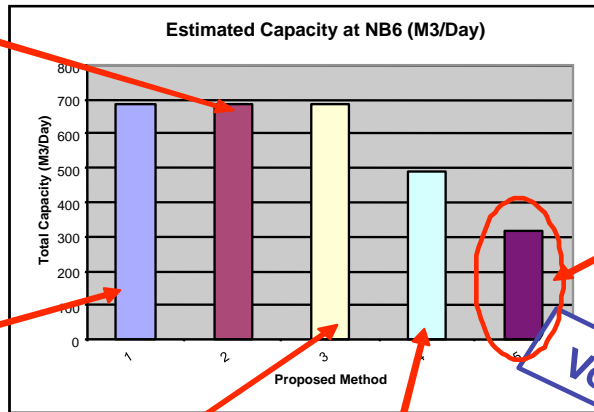
Improve



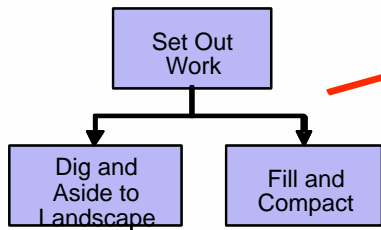
Examples of Different Workflows and their estimated outputs/cost at NB6



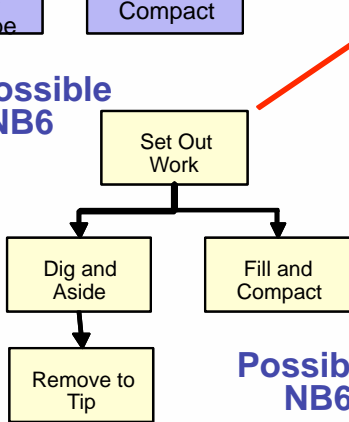
Possible at NB6



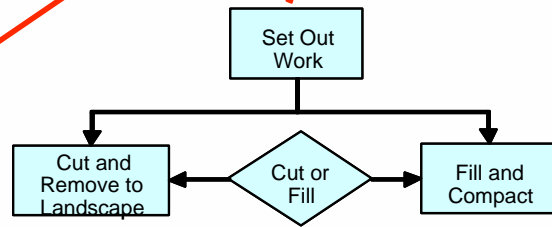
Adopted Method



Not Possible at NB6

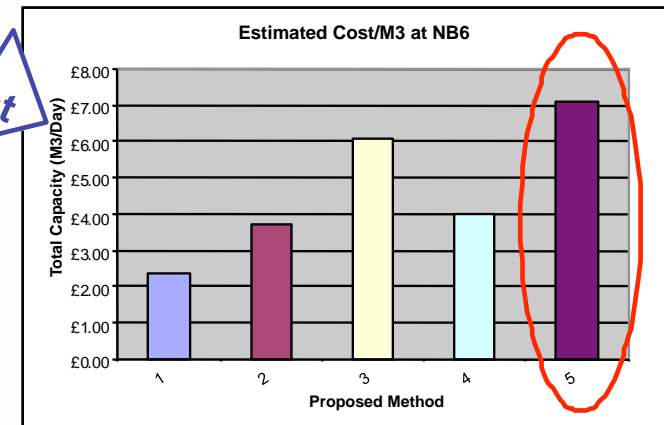


Possible at NB6



Possible at NB6

Volume Cost





Workshops

- Identified all Cut and Fill site with minimum haul routes to the Deposition Site.
- Input information into Work Planning toolkit.
- Identified best method of working.





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Earthworks Efficiency Project Benefits

- **Earthworks activity is near complete**
- **Total estimated projected savings are £1.56m**
- **Awareness has been raised resulting in many additional improvements to the Earthworks Processes**
 - Alternative deposition sites
 - 130,000 M3 of Recycled Material (VOSA site) reducing imported fill
 - Reconditioning of high moisture content material for recycling to reduce the qty of imported fill
- **Organisation of 160,000 vehicle movements has resulted in no complaints of dirty roads**





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“The cultural spin offs from the process improvement activity employed at M6 Guards Mill are significant. Everyone expects to be challenged; doing it better tomorrow than we did it today is how we do things around here.”

Chris Hayton, Project Director





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Q&A

