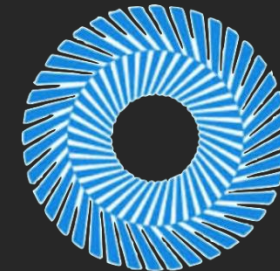




When the Speed Limit Breaks the Timetable:

Simulating South Africa's Braamfontein Rail Depot at End-State

Cecil Lourens
Senior Simulation Engineer

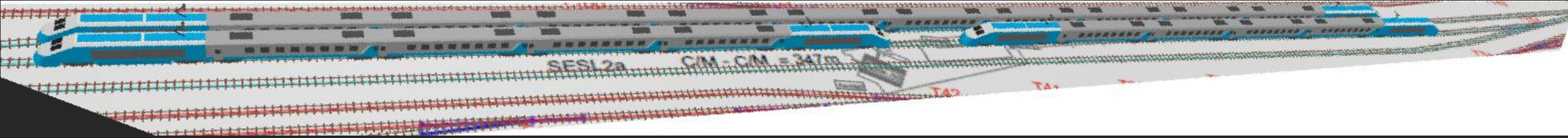


prasa
PASSENGER RAIL AGENCY
OF SOUTH AFRICA

AGENDA

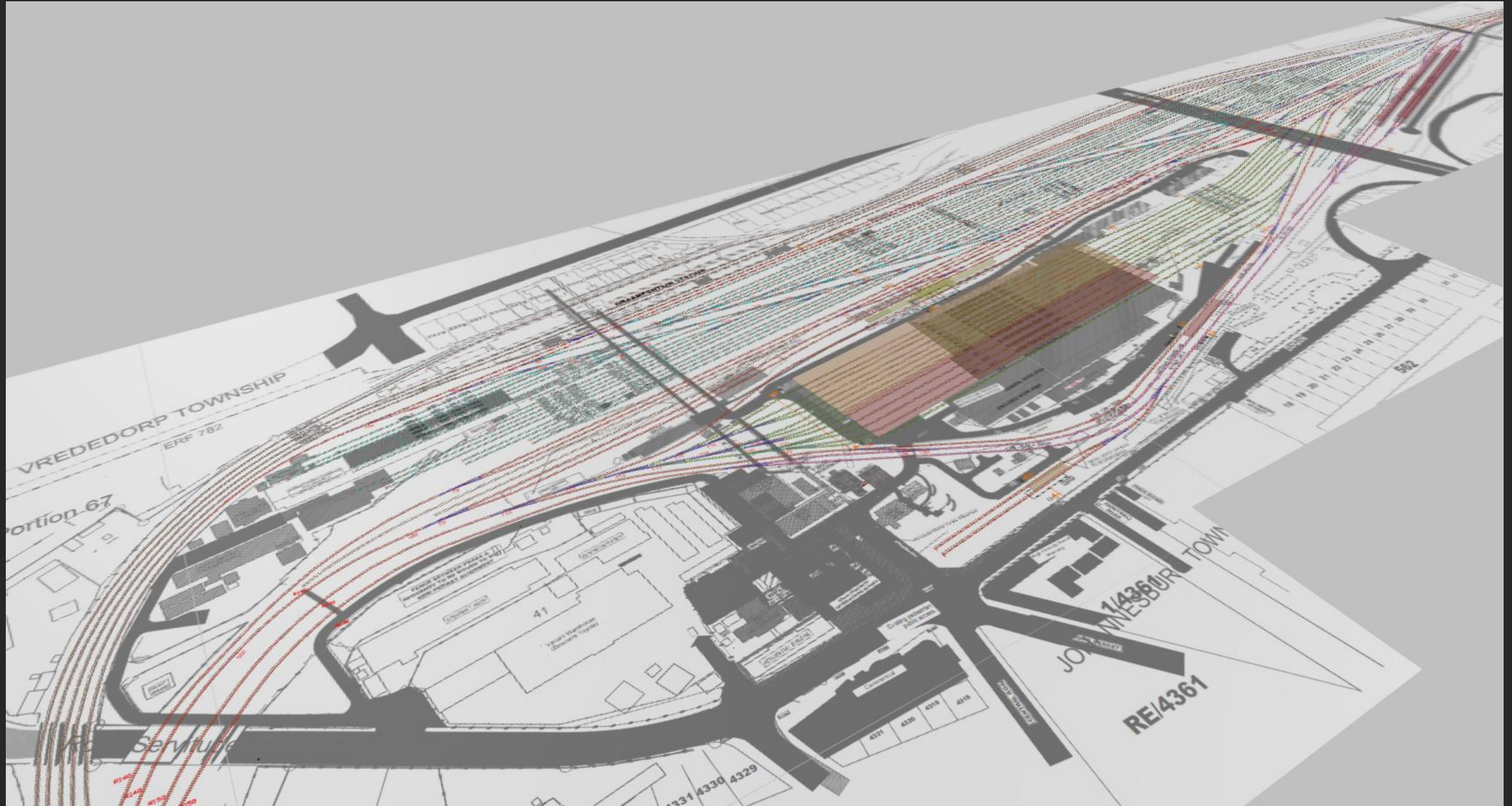
- ❑ Background / Overview
- ❑ Advantages of using the Anylogic RAIL LIBRARY
- ❑ Simulation Concepts
- ❑ Results and Conclusions

OVERVIEW - Trains

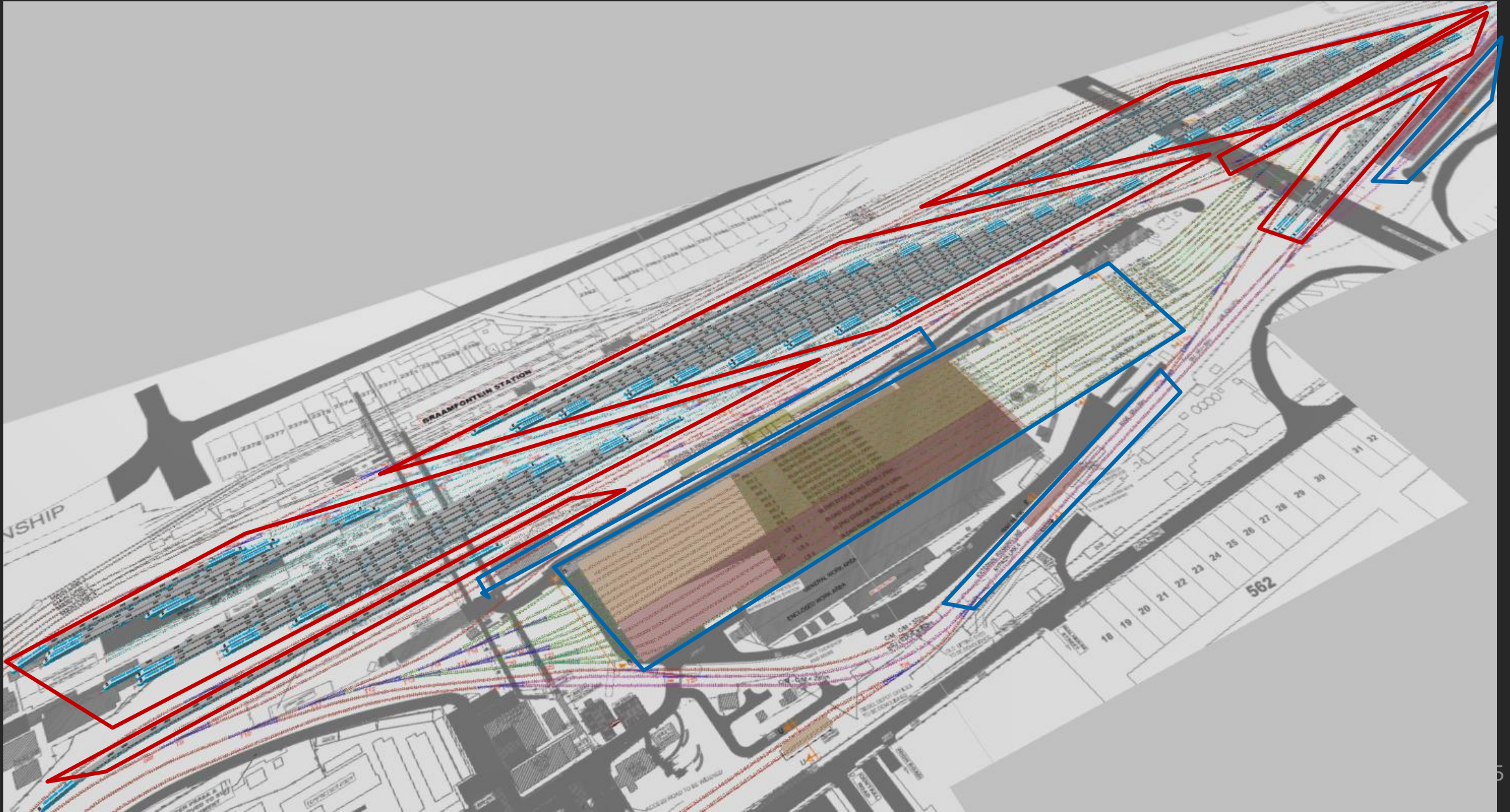


- ❑ Fleet: 324 EMU's ; 93 in this Yard (EMU = Electric Multiple Unit)
- ❑ Loco on both sides – drive any direction
- ❑ Long and Short trains
- ❑ No need to combine / split trains : no Shunting
- ❑ Speed Restrictions

OVERVIEW - Yard



OVERVIEW - Yard



OVERVIEW – Operational Schedule

DAY 1:					
		04:00 - 06:00 Dispatch	08:00 - 10:00 Receipt	14:00 - 16:00 Dispatch	19:00 - 22:00 Receipt
2 EMU	Target	41	28	28	41
	Actual	0	0	0	0
1 EMU	Target	0	26	26	0
	Actual	0	0	0	0
Time Complete		0:00	0:00	0:00	0:00

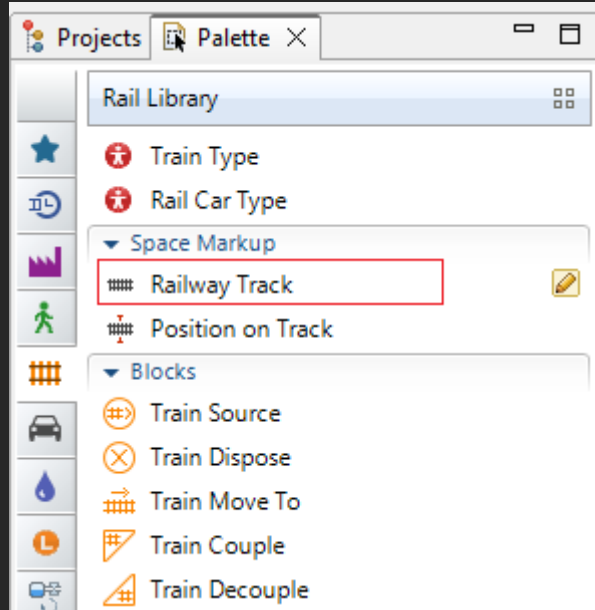
- ❑ Morning Peak
- ❑ Afternoon Peak
- ❑ No maintenance train movement in yard during Receipt /
Dispatch Cycles

OVERVIEW - Maintenance

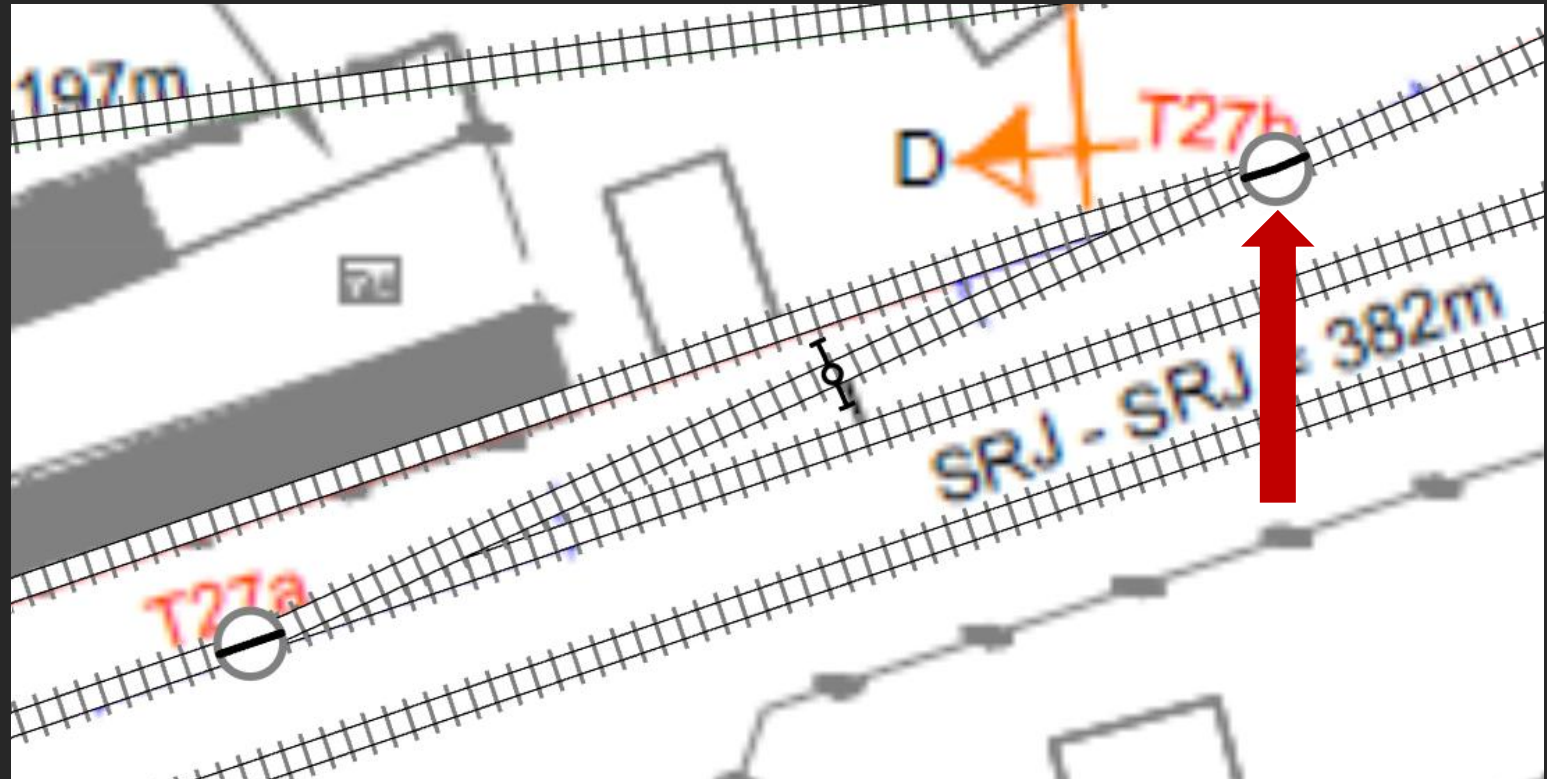
Yard	Target (per day)
Int. Cleaning	2
Con. Em. Toilet	9
Ext. Washing	21
Running Shed	3
Lifting Shed	1 in 4 days
Wheel Lathe	1 in 2 days

- ❑ Daily Maintenance Targets (Fleet)
- ❑ Maintenance train-movements outside peak periods ONLY
- ❑ Some facilities have parallel services

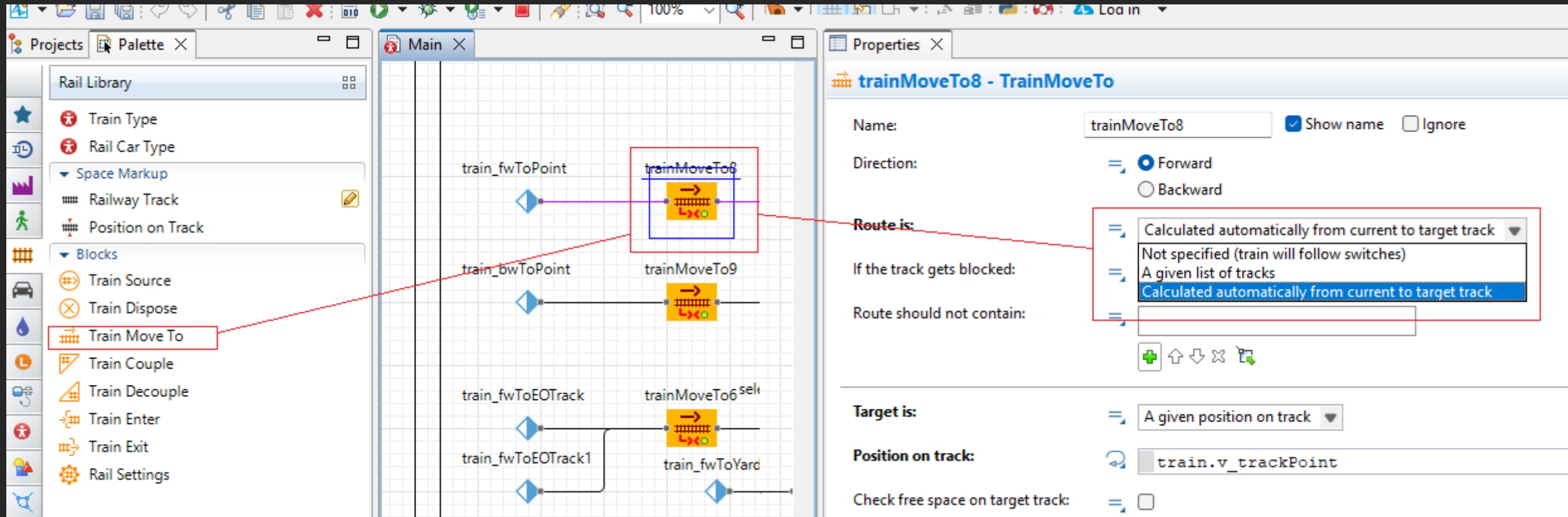
ANYLOGIC – Railway Track / -Switch



- ❑ Switches
- ❑ Reserve and (Automatic) Clear Tracks
- ❑ Interlock-System: Real Live



ANYLOGIC – Train MoveTo Logic Block



The screenshot displays the ANYLOGIC software interface, specifically the configuration for the **Train MoveTo** logic block. The interface is divided into three main sections: a left-hand **Rail Library**, a central **Main** workspace, and a right-hand **Properties** panel.

Rail Library: The **Blocks** section contains various logic blocks. The **Train Move To** block is highlighted with a red box, and a red line connects it to the corresponding block in the main workspace.

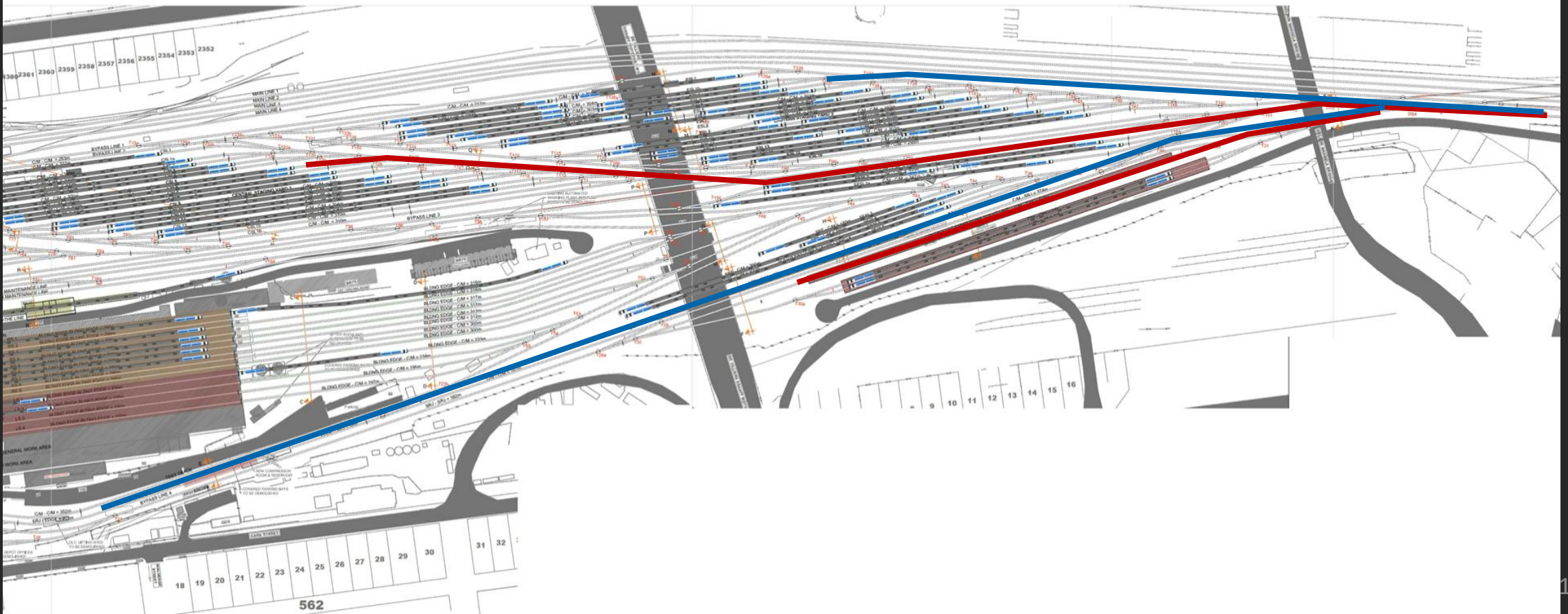
Main Workspace: The workspace shows a track layout with several logic blocks. The **trainMoveTo8** block is highlighted with a red box, and a red line connects it to the Properties panel. Other blocks visible include **train_fwToPoint**, **train_bwToPoint**, **trainMoveTo9**, **train_fwToEOTrack**, **train_fwToEOTrack1**, **trainMoveTo6 self**, and **train_fwToYard**.

Properties Panel: The panel is titled **trainMoveTo8 - TrainMoveTo**. It contains the following configuration options:

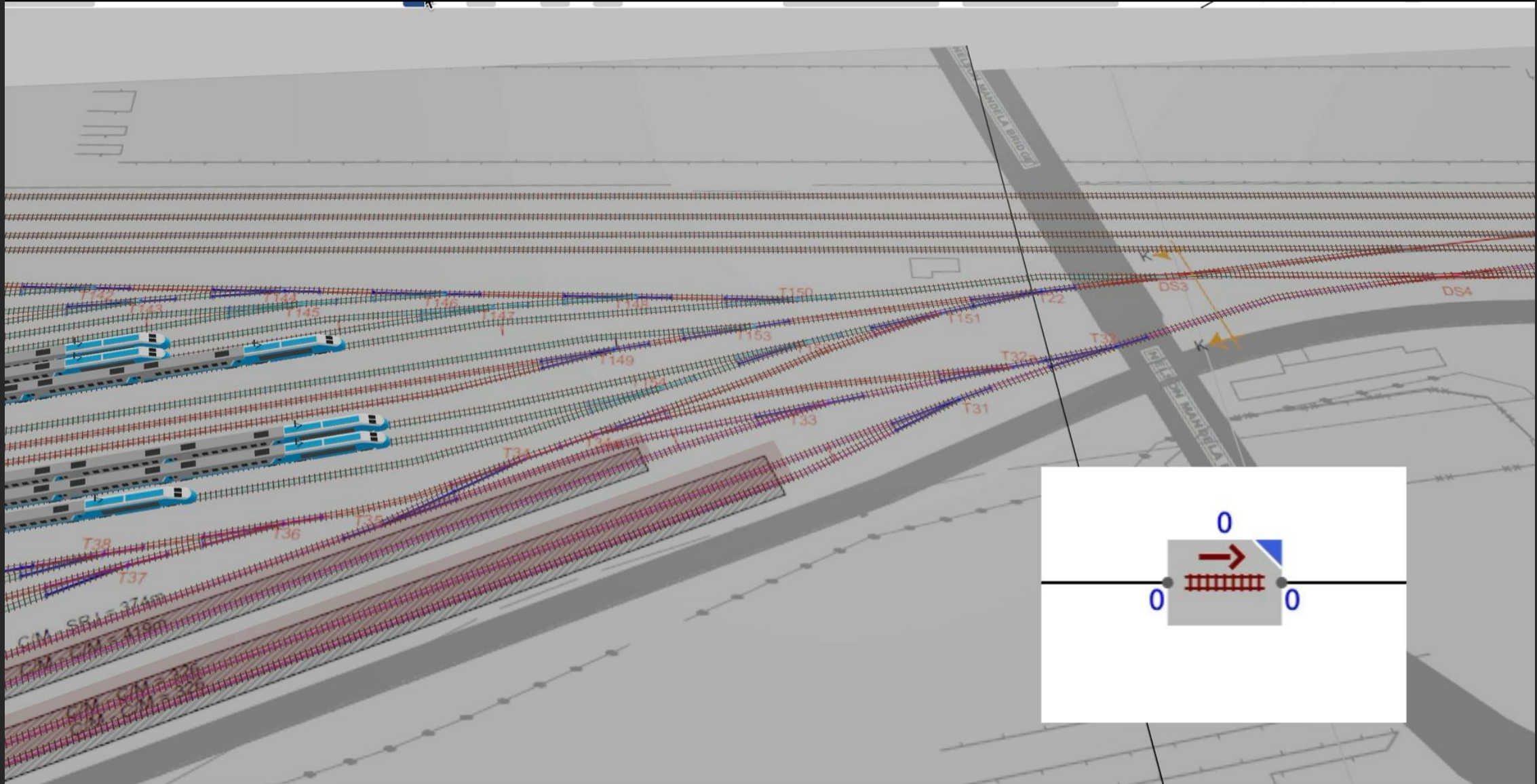
- Name:** `trainMoveTo8` (with ☒ Show name and ☐ Ignore).
- Direction:** ☒ Forward, ☐ Backward.
- Route is:** A dropdown menu with the following options:
 - Calculated automatically from current to target track (selected)
 - Not specified (train will follow switches)
 - A given list of tracks
 - Calculated automatically from current to target track
- If the track gets blocked:** A dropdown menu with the following options:
 - Not specified (train will follow switches)
 - A given list of tracks
 - Calculated automatically from current to target track
- Route should not contain:** A text input field.
- Target is:** A dropdown menu with the following options:
 - A given position on track (selected)
- Position on track:** A text input field containing `train.v_trackPoint`.
- Check free space on target track:** ☐.



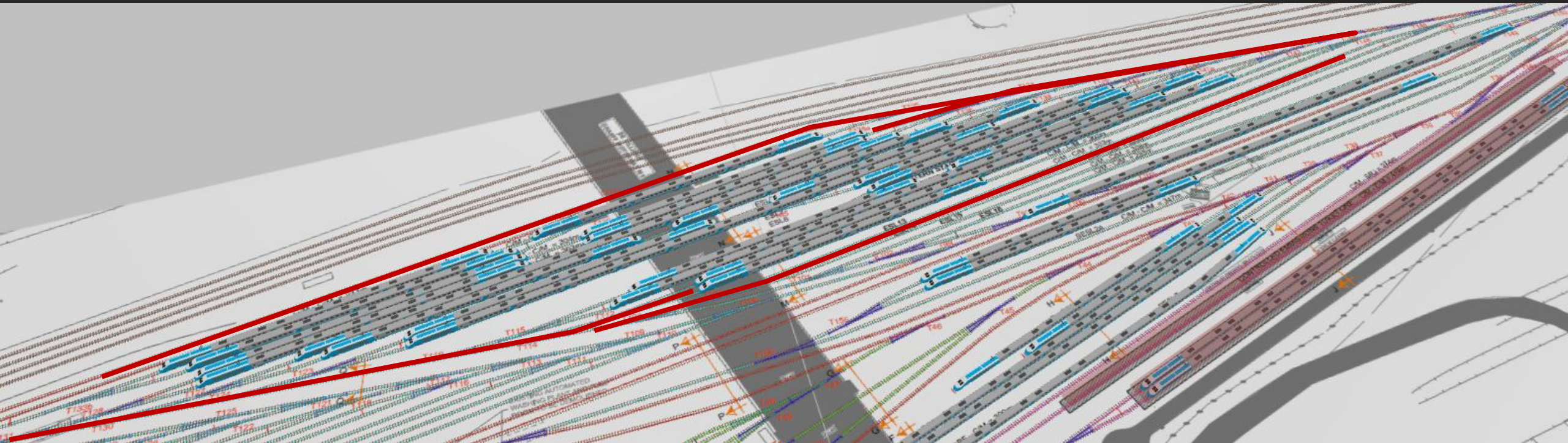
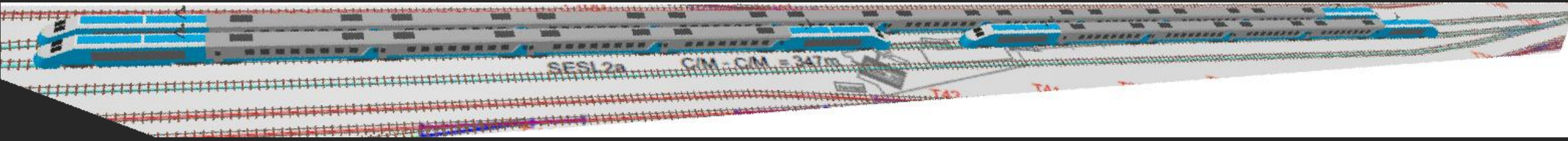
ANYLOGIC – Tracks Manages Reservations



ANYLOGIC – MoveTo Manages Switching



SIMULATION – Short Trains Blocks Access



SIMULATION – Routing Table (DataBase)

Projects x Palette

ElwatiniNew_v22_AC [cloud]

- Main
- MaintTask
- MaintTrack
- PaxEndLoco
- PaxLoco
- PaxWagon
- StageTrack
- Task
- Train
- Simulation: Main
- Run Configuration: Main
- Database
 - destinations
 - maintenance
 - points
 - routes
 - routing_table
 - setup6_w
 - switches
- Resources

	from_db	dest	route_id	priority	westwards
1	E	WS	1	2	✓
2	E	WS	2	3	✓
3	E	CS	3	1	✓
4	E	CS	4	2	✓
5	E	ES	5	1	✓
6	E	ES	6	2	✓
7	E	SES	7	1	✓
8	E	SE	8	2	✓
9	W	WS	9	1	
10	W	WS	10	2	
11	W	CS	11	1	
12	W	CS	12	2	
13	W	ES	13	1	
14	W	ES	14	2	
15	W	SES	15	1	
16	W	SE	16	1	
17	WS	E	17	2	
18	WS	E	18	3	
19	WS	W	19	1	
20	WS	RS	20	1	
21	WS	LS	21	1	
22	WS	WASH	22	1	
23	WS	WASH	23	2	

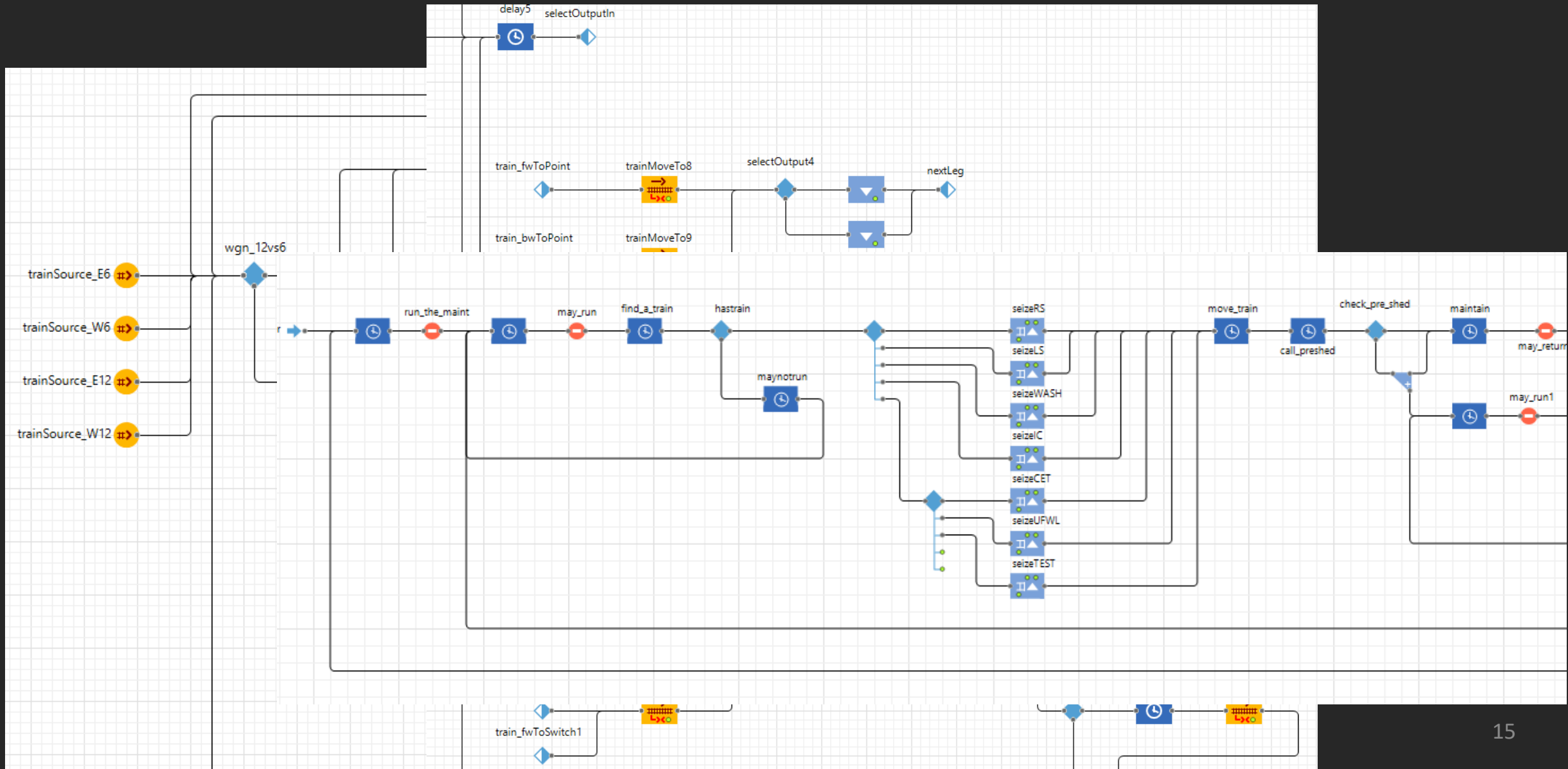
Projects x Palette

ElwatiniNew_v22_AC [cloud]

- Main
- MaintTask
- MaintTrack
- PaxEndLoco
- PaxLoco
- PaxWagon
- StageTrack
- Task
- Train
- Simulation: Main
- Run Configuration: Main
- Database
 - destinations
 - maintenance
 - points
 - routes
 - routing_table
 - setup6_w
 - switches
- Resources

	route_id	switch_db	order_db
351	17	ds3c	16
352	17	tE	17
353	17	cont	18
354	18	pt	1
355	18	t84	2
356	18	t89	3
357	18	t93	4
358	18	t95	5
359	18	t96	6
360	18	t97	7
361	18	t98	8
362	18	t103	9
363	18	r	10
364	18	t89	11
365	18	t84	12
366	18	t78	13
367	18	t80	14
368	18	t72	15
369	18	t65	16
370	18	t69	17
371	18	t67	18
372	18	t63	19
373	18	t59	20
374	18	t56b	21
375	18	t56a	22
376	18	t56	23
377	18	ds2	24
378	18	r	25
379	18	ds2	26
380	18	t56	27

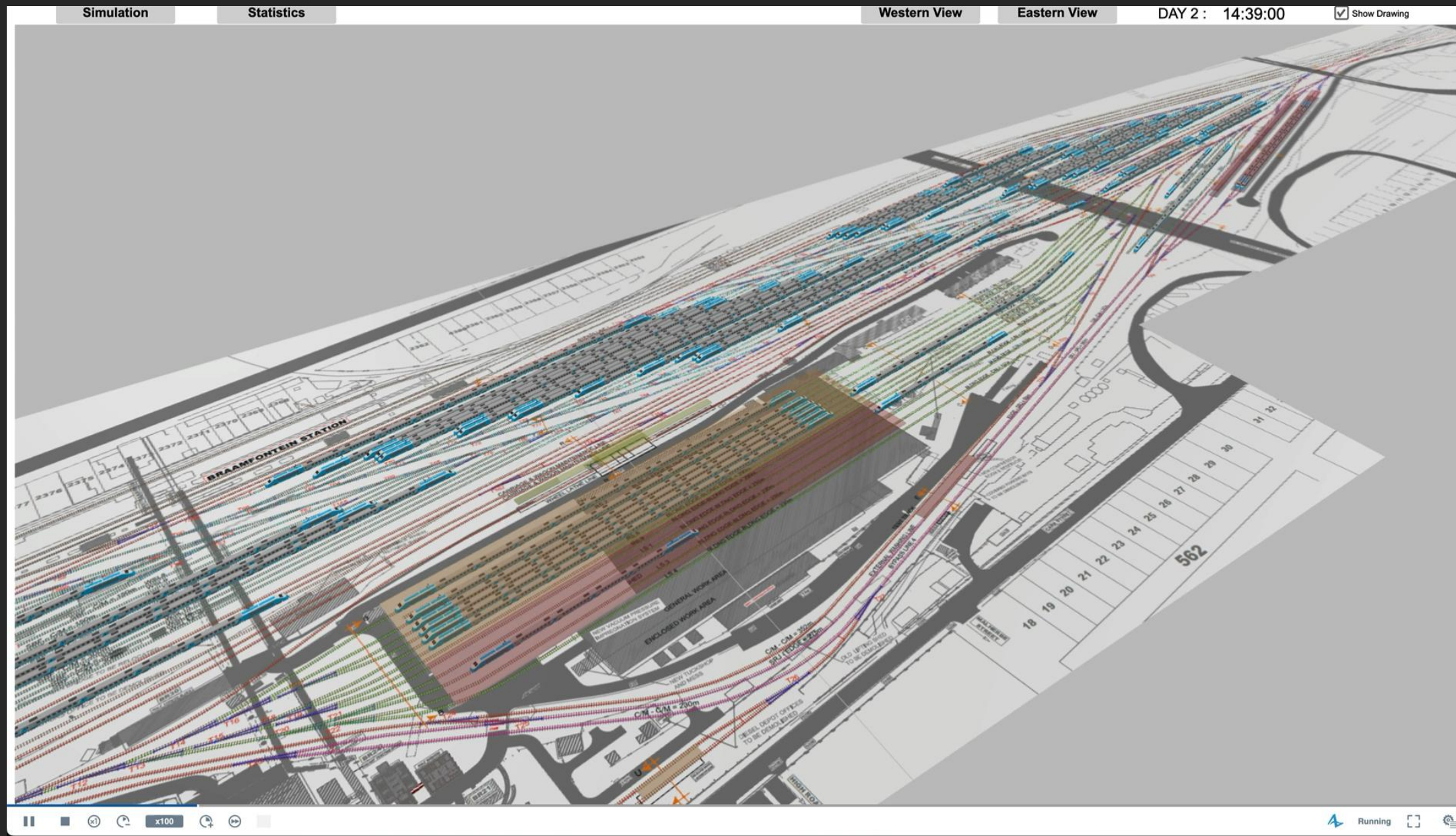
SIMULATION – Logic



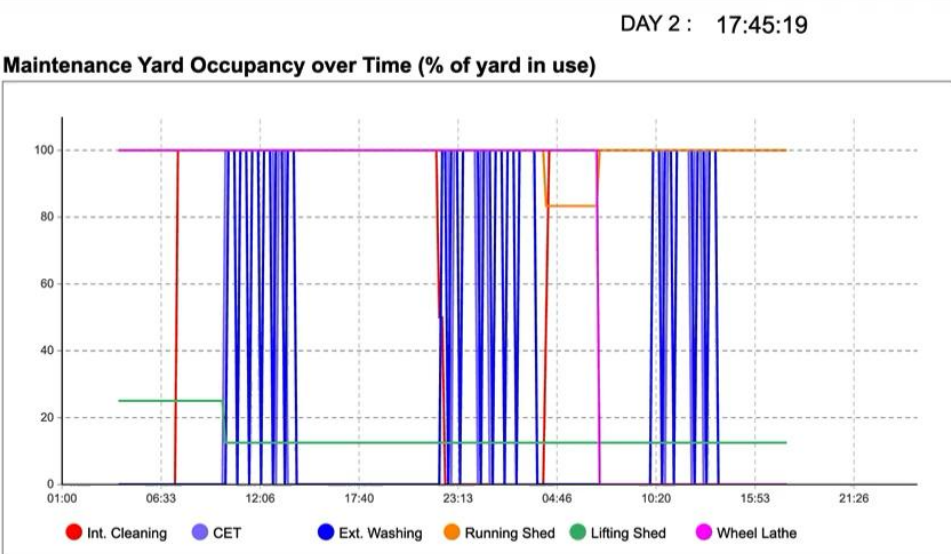
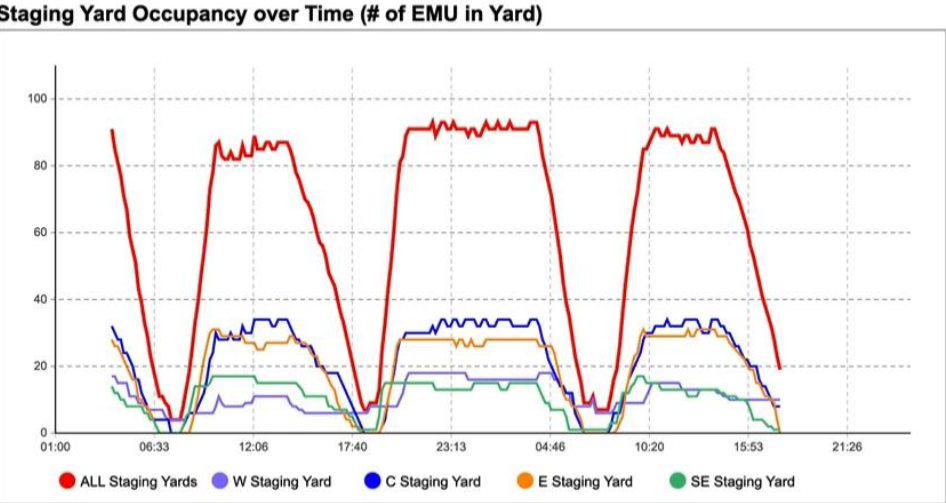
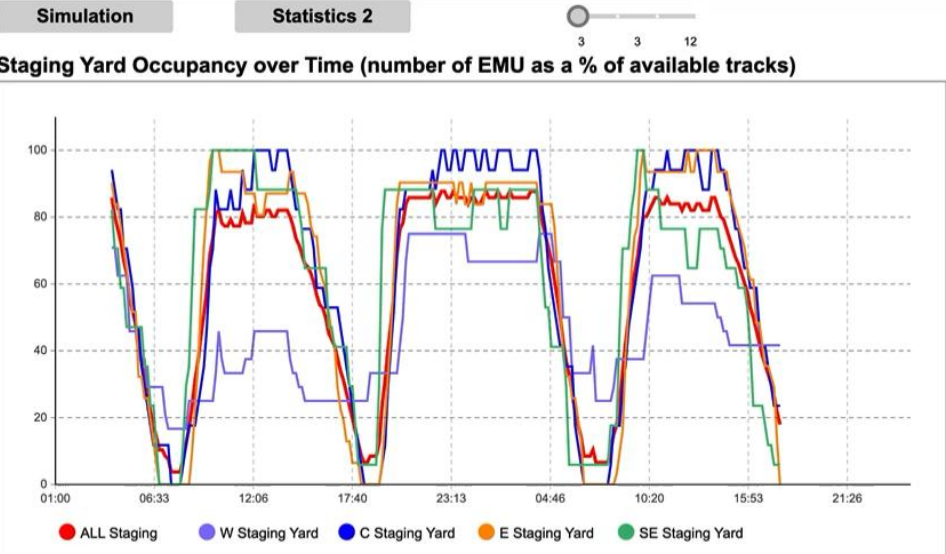




RESULTS – Train Departures



RESULTS – Statistics Collection



Maintenance Statistics

Yard	Target (per day)	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6
Int. Cleaning	2	2	2	0	0	0	0
Con. Em. Toilet	9	9	5	0	0	0	0
Ext. Washing	21	15	6	0	0	0	0
Running Shed	3	3	3	0	0	0	0
Lifting Shed	1 in 4 days	0	0	0	0	0	0
Wheel Lathe	1 in 2 days	0	0	0	0	0	0

Latent Capacity Estimation (based on 12 continuous simulated days)

	# Tracks	Track Hours Capacity	Track Hours Occupied	Track Hours Available
Wheel Lathe	1	48.0	27.0	21.0
Running Shed	6	288.0	106.52	181.48000000000002
Lifting Shed	4	192.0	6.0	186.0

RESULTS – Operational Schedules (15 km/h)

DAY 4:

		04:00 - 06:00 Dispatch	08:00 - 10:00 Receipt	14:00 - 16:00 Dispatch	19:00 - 22:00 Receipt
2 EMU	Target	41	28	28	41
	Actual	39	27	27	39
1 EMU	Target	0	26	26	0
	Actual	0	26	26	0
Time Complete		2:39	2:00	4:01	1:35

DAY 5:

		04:00 - 06:00 Dispatch	08:00 - 10:00 Receipt	14:00 - 16:00 Dispatch	19:00 - 22:00 Receipt
2 EMU	Target	41	28	28	41
	Actual	39	28	27	38
1 EMU	Target	0	26	26	0
	Actual	0	26	26	0
Time Complete		2:32	2:00	4:09	1:35

DAY 6:

		04:00 - 06:00 Dispatch	08:00 - 10:00 Receipt	14:00 - 16:00 Dispatch	19:00 - 22:00 Receipt
2 EMU	Target	41	28	28	41
	Actual	38	29	26	35
1 EMU	Target	0	26	26	0
	Actual	0	23	23	0
Time Complete		2:23	2:02	4:29	1:18

RESULTS – Maintenance (15 km/h)

Maintenance Statistics

Yard	Target (per day)	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6
Int. Cleaning	2	2	2	2	2	2	2
Con. Em. Toilet	9	9	9	9	9	9	9
Ext. Washing	21	15	15	15	15	15	15
Running Shed	3	3	3	3	3	3	3
Lifting Shed	1 in 4 days	0	0	0	1	0	0
Wheel Lathe	1 in 2 days	0	1	0	1	0	1

RESULTS – Operational Schedules (15 – 30 km/h)

DAY 4:

		04:00 - 06:00 Dispatch	08:00 - 10:00 Receipt	14:00 - 16:00 Dispatch
2 EMU	Target	41	28	28
	Actual	39	27	27
1 EMU	Target	0	26	26
	Actual	0	26	26
Time Complete		2:39	2:00	4:01

DAY 5:

		04:00 - 06:00 Dispatch	08:00 - 10:00 Receipt	14:00 - 16:00 Dispatch
2 EMU	Target	41	28	28
	Actual	39	28	27
1 EMU	Target	0	26	26
	Actual	0	26	26
Time Complete		2:32	2:00	4:09

DAY 6:

		04:00 - 06:00 Dispatch	08:00 - 10:00 Receipt	14:00 - 16:00 Dispatch
2 EMU	Target	41	28	28
	Actual	38	29	26
1 EMU	Target	0	26	26
	Actual	0	23	23
Time Complete		2:23	2:02	4:29

DAY 4:

		04:00 - 06:00 Dispatch	08:00 - 10:00 Receipt	14:00 - 16:00 Dispatch	19:00 - 22:00 Receipt
2 EMU	Target	41	28	28	41
	Actual	40	28	28	40
1 EMU	Target	0	26	26	0
	Actual	0	26	26	0
Time Complete		1:47	1:53	2:18	1:26

DAY 5:

		04:00 - 06:00 Dispatch	08:00 - 10:00 Receipt	14:00 - 16:00 Dispatch	19:00 - 22:00 Receipt
2 EMU	Target	41	28	28	41
	Actual	41	28	28	41
1 EMU	Target	0	26	26	0
	Actual	0	26	26	0
Time Complete		1:47	1:51	2:18	1:32

DAY 6:

		04:00 - 06:00 Dispatch	08:00 - 10:00 Receipt	14:00 - 16:00 Dispatch	19:00 - 22:00 Receipt
2 EMU	Target	41	28	28	41
	Actual	40	28	28	40
1 EMU	Target	0	26	26	0
	Actual	0	26	26	0
Time Complete		1:58	1:49	2:16	1:29

RESULTS – Maintenance (15 – 30 km/h)

Maintenance Statistics

Yard	Target (per day)	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6
Int. Cleaning	2	2	2	2	2	2	2
Con. Em. Toilet	9	9	9	9	9	9	9

Maintenance Statistics

E	Yard	Target (per day)	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6
R	Int. Cleaning	2	2	2	2	2	2	2
Li	Con. Em. Toilet	9	9	9	9	9	9	9
W	Ext. Washing	21	20	20	20	20	20	20
	Running Shed	3	3	3	3	3	3	3
	Lifting Shed	1 in 4 days	0	0	0	1	0	0
	Wheel Lathe	1 in 2 days	0	1	0	1	0	1

SUMMARY

Simulation

Statistics

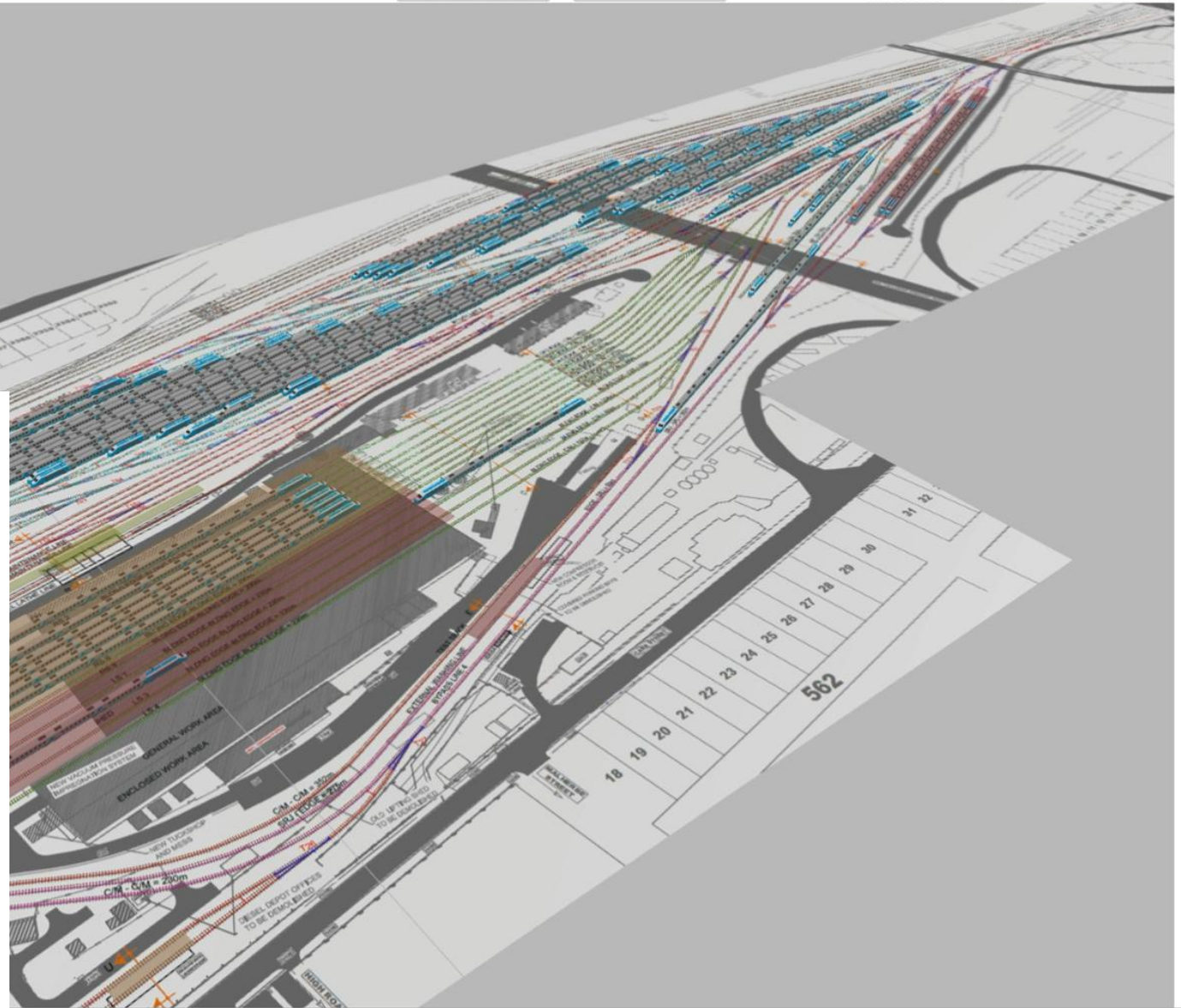
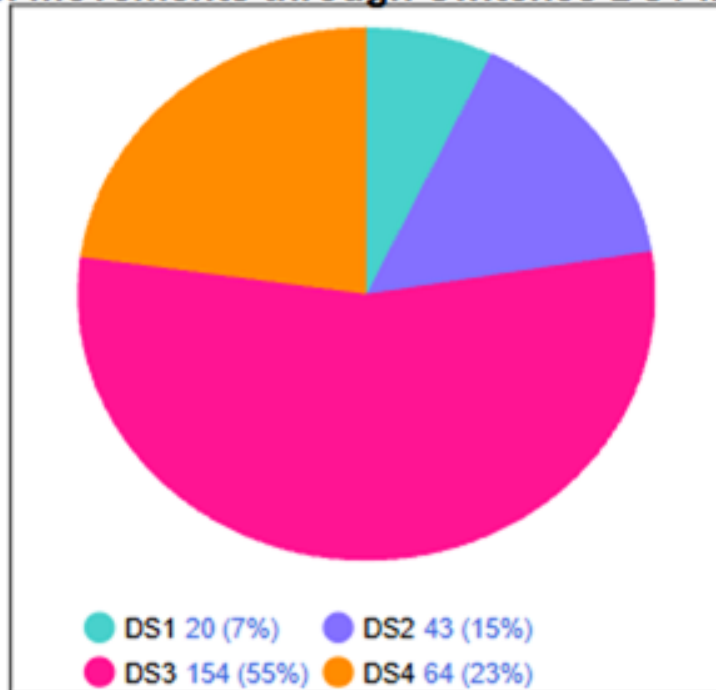
Western View

Eastern View

DAY 2 : 11:58:33

☒ Show Drawing

Train movements through Switches DS1 .. DS4



CONCLUSIONS & RECOMMENDATIONS

- ❑ Speed Limit (15 km/h) breaks the Timetable
- ❑ Variable Speed in Yards
- ❑ Parallel Switches allow multiple outgoing routes
- ❑ Queue Trains on outgoing tracks



Thank you!
Q&A

cecil@bluestallion.co.za