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**INNOVATION IN MOTION**  
**8 - 11 June 2025**

*The Leading Event in Africa for Supply Chain Professionals*  
**47<sup>th</sup> ANNUAL CONFERENCE**  
Century City Conference Centre, Cape Town

# Digital Twins and Demand Driven Model Adaptation

Gerrit Zaayman

# Agenda

- Manufacturing and Supply Chain Challenges
- The “Intelligent” Supply Chain Game
- What is a “real” Digital Twin?
- Q&A

# Today's Manufacturing & Supply Chain Challenges



Manufacturing has become the **response buffer** for supply chains as companies become leaner and the order behavior of the market changes



Customers demand increased **product variety and configurability** with **smaller minimum order quantities**, and **shorter product life cycles** requiring manufacturing agility



Facilities are handling **increasingly complex operations** with semi-flexible manufacturing resources to increase manufacturing agility also dealing with **more complex supply chains**



End customers are demanding **shorter lead times** and increased transparency into the supply chain performance with **predictable delivery times**



Adapting to the VUCA world as global **variability** and **uncertainty** has increased while supply chains became more **complex** and available information more **ambiguous**.

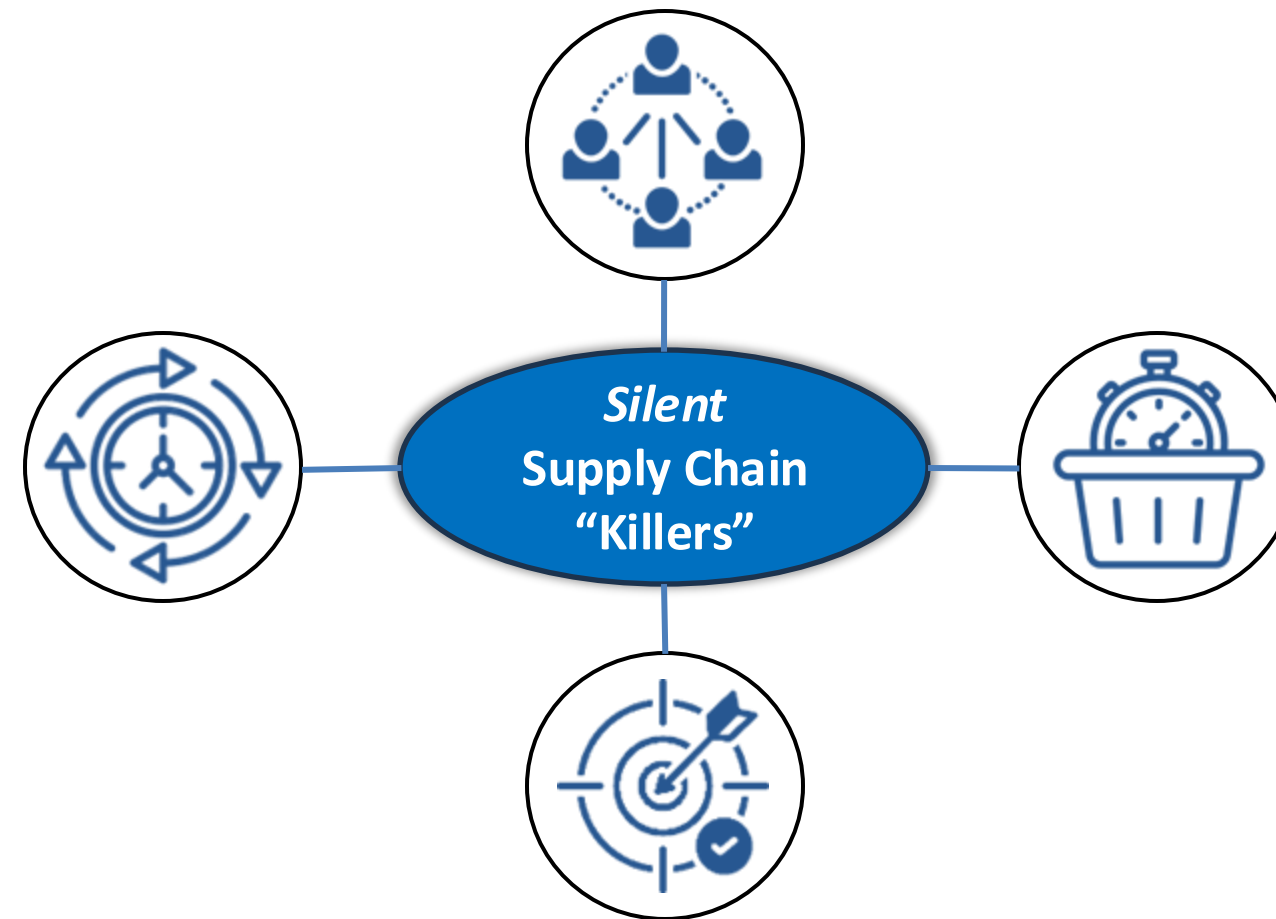
# The *Silent* Supply Chain “Killers”

## Planning in Organizational Silos

- Production unit specific
- Function specific
- Synchronization through meetings

## Time Phased Business Planning

- Time horizon specific
- Different software applications
- Different constraint models



## Scheduling in Time Buckets

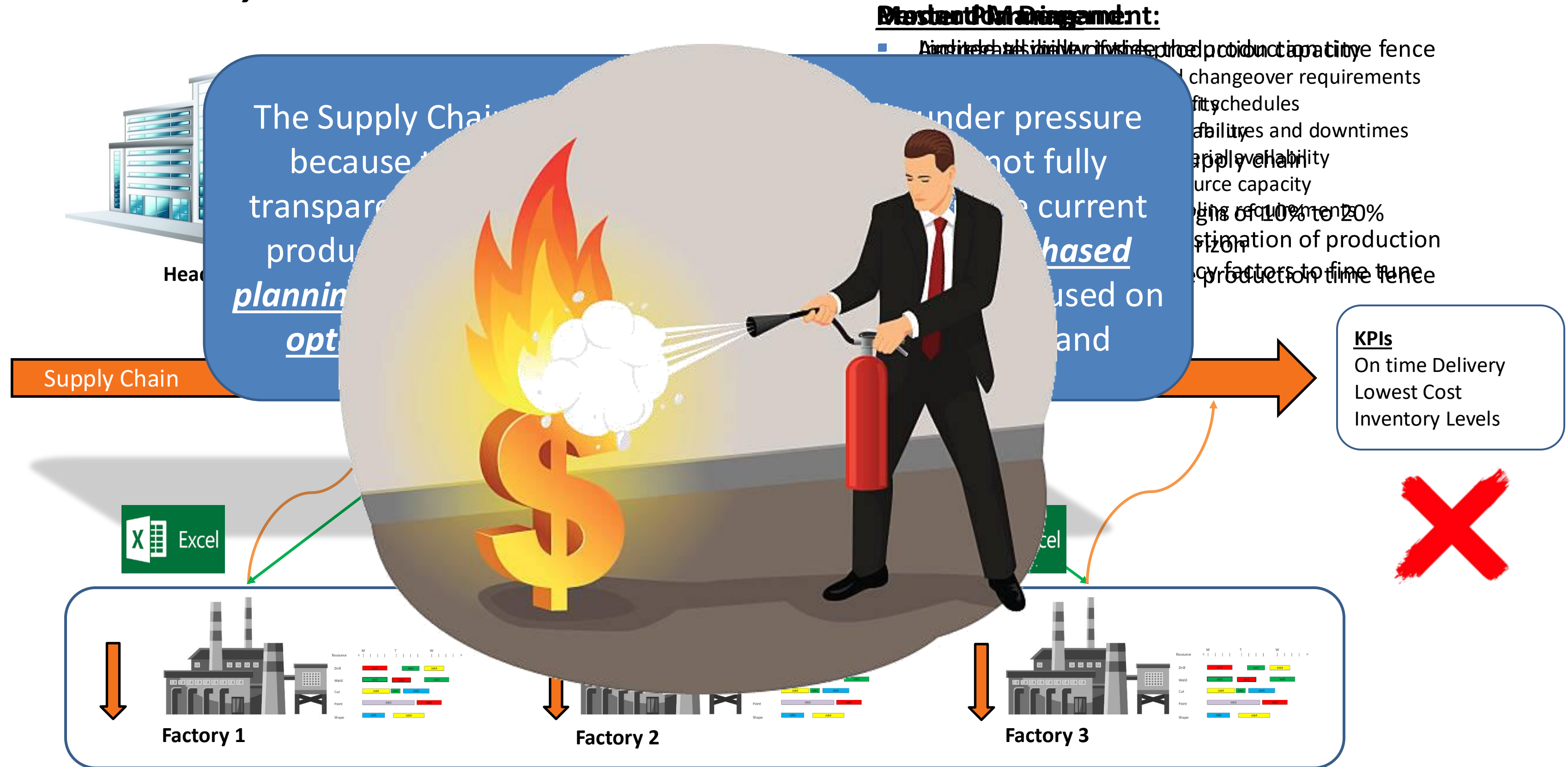
- Typically, in weekly time buckets
- Starting the system empty
- Resources calendar-based capacity

## Optimizing to Single Objective Functions

- Ignoring competing objectives
- Multiple KPIs for “optimal” performance
- Flow-based versus cost-based objectives

# The Planning and Scheduling Challenge

## Current Reality



# Imagine.....

## An “*enterprise system*” that.....

1. Represents your **end-to-end** manufacturing supply chain
2. Runs the supply chain across **all time horizons** and **all supply chain functions** on a **continuous timeline** in a **single constraint model** of the process
3. Allows you to **make changes** to the processes, business rules and decision logic and perform detailed “what-if” analysis
4. Contains **dynamic dashboards** and reports with key business KPIs and process specific results for **detailed analysis supporting all stakeholders**
5. Provides full **3D visualization** of the supply chain for presentation and validation
6. Provides a **platform** that accurately **replicates the end-to-end process behavior** for business optimization based on agreed KPIs and performance metrics

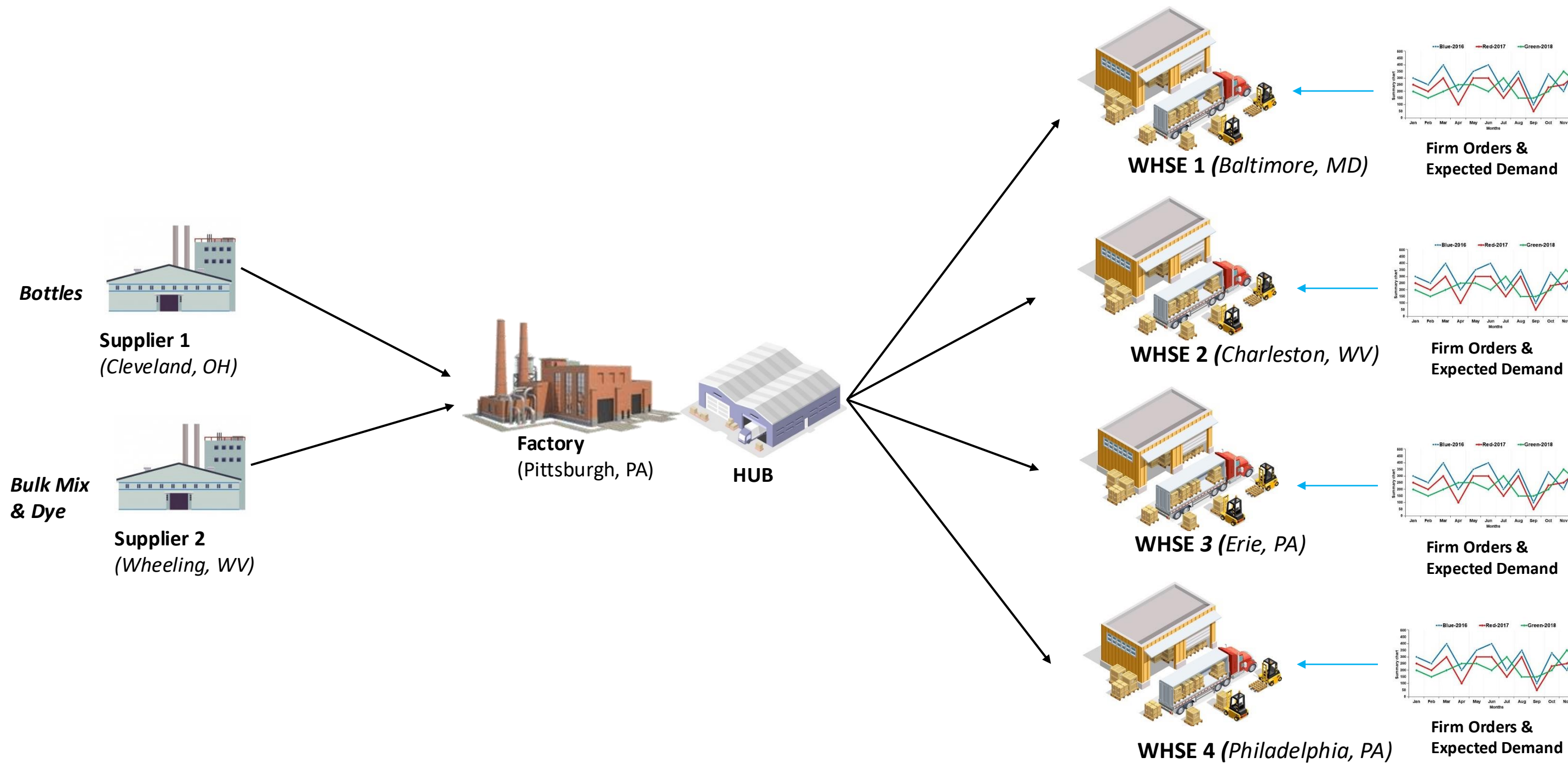
# The “Intelligent” Supply Chain Game

- Let's visualize this new *“enterprise system”* as if it is a computer game?
- This is *game changing* so please bear with me for the next 30 min....
  - The game will entail a lot of detail
  - I will be going fast to cover all the use cases
  - It might even feel somewhat repetitive
  - It might also be hard to follow all the game results
- So *please hang in there*, at the end you will clearly see what is possible with this new *Intelligent Digital Twin* technology to take your business to the *next level*

# The Intelligent Supply Chain “*Game*” Concepts

- The game will consist of **4 levels** of progression
  - 2 levels in the operational timeframe
  - 1 level in the S&OP timeframe (“what-if” tactical)
  - 1 level in the Future Business Planning timeframe (“what-if” strategical)
- Each level will have a **specific business challenge** to complete
- Some levels might require **adjustments in game setting** to improve business performance (Gross profit)
- Evaluate the supply chain performance
  - Production Schedules
  - Inventory positions and cost
  - Resource utilization and cost
  - Warehouse utilization
  - Constraint analysis
  - Delivery performance
  - Sales revenue
  - ***Gross profit***

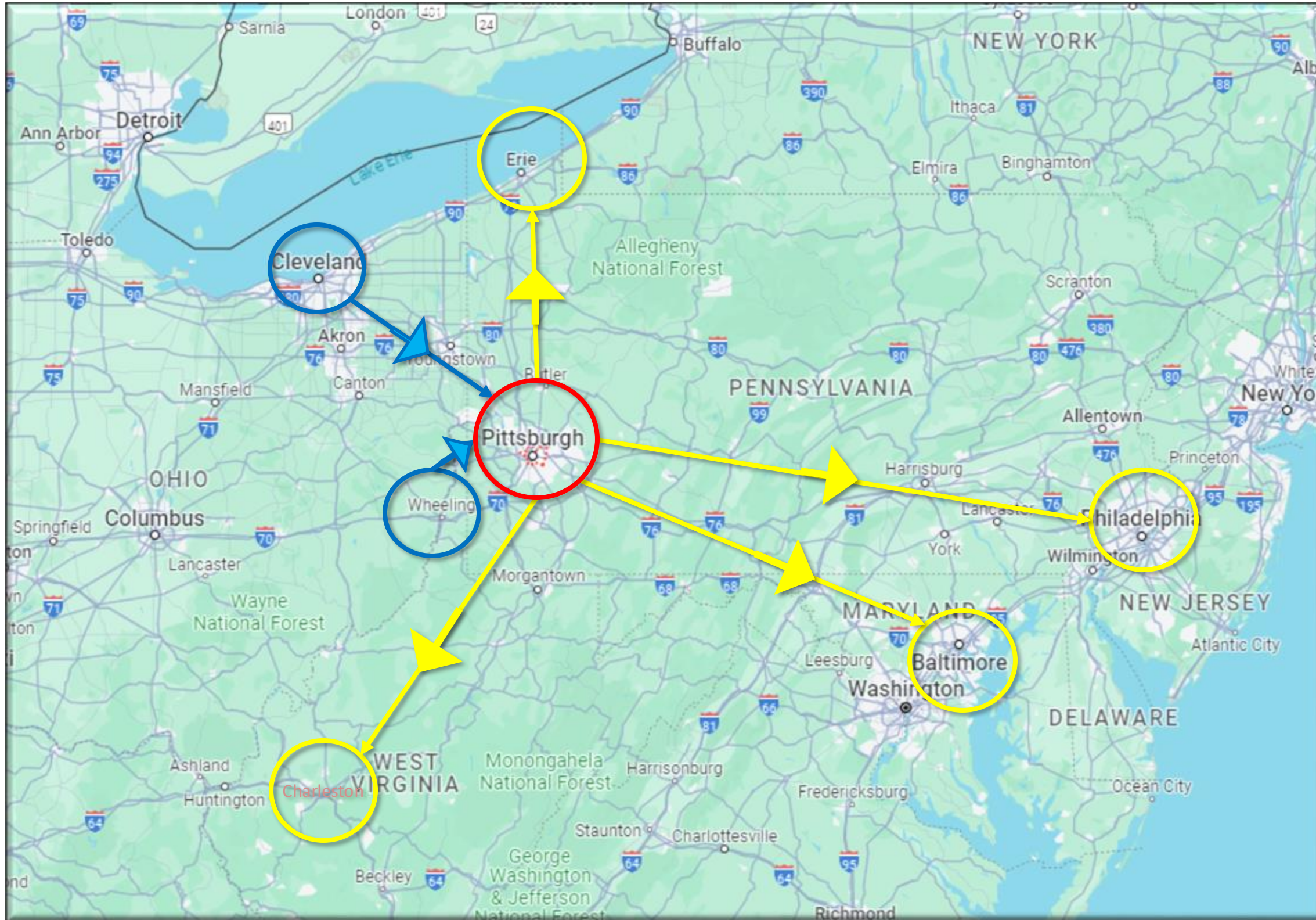
# Game Configuration: Bottling Supply Chain



## Products:

- **4 Colors**
  - Red
  - Yellow
  - Green
  - Blue
- **1 package Types**
  - Bottles
- **4 Sizes**
  - 100ml
  - 250ml
  - 400ml
  - 500ml
  - 1000ml

# Supply Chain Map View



- Factory & Hub (1)
- Warehouses (4)
- Suppliers (2)

# Game Configuration: Factory Layout

The Filling & Packing schedule is then used to create the **mixing orders and schedule** to optimize flow through the storage tanks

Sales orders are for **filled and packed bottles** and placed on Filling & Packing creating the filling schedule first



Factory  
(Pittsburgh, PA)



Supplier Trucks



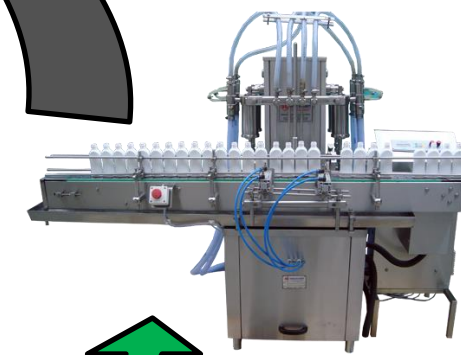
Receiving & QA



Mixers



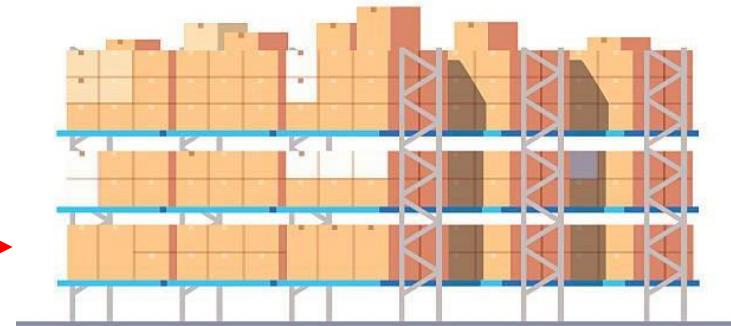
Storage Tanks



Filling and Packing



Skilled labor



Finished Goods Inventory



Picking and Loading



Warehouse Trucks



ComponentOrdersSink

Sewickley

Osborne

Haysville

# Game Level 1 (operational)

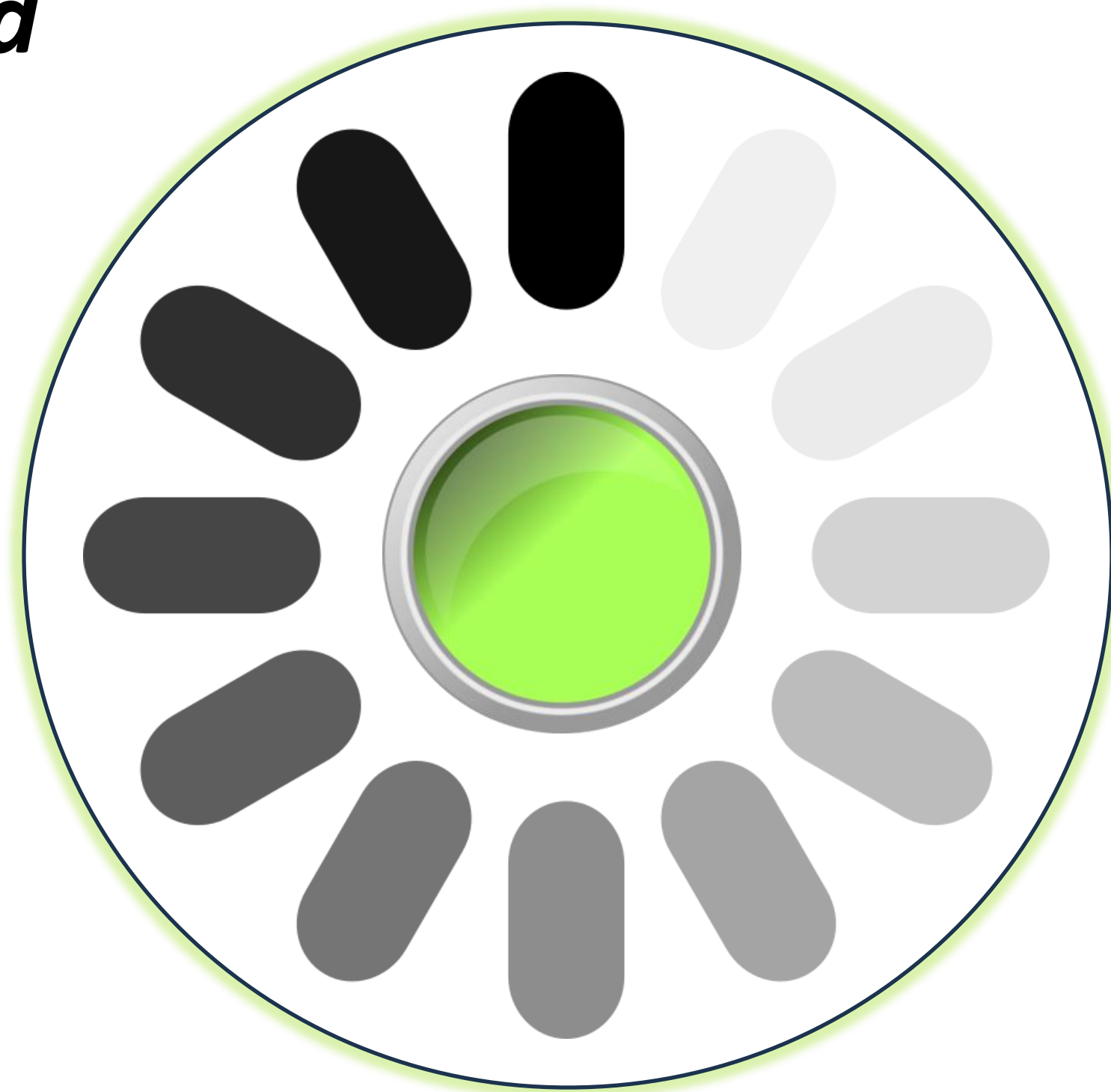
- The Level 1 challenge: Traditional MRP base case
  - Sales orders for all products with 25% day to day variation
  - Demand spike of 20% in week 3
  - Reorder point/reorder quantity replenishment policy for RM & FG
  - Run the operations very lean and cost effective
  - Run the game for 30 days

➤ Stating the 26<sup>th</sup> of January 2025

Analyze & understand the business performance of the base case using a standard ***Reorder point/reorder quantity*** replenishment method

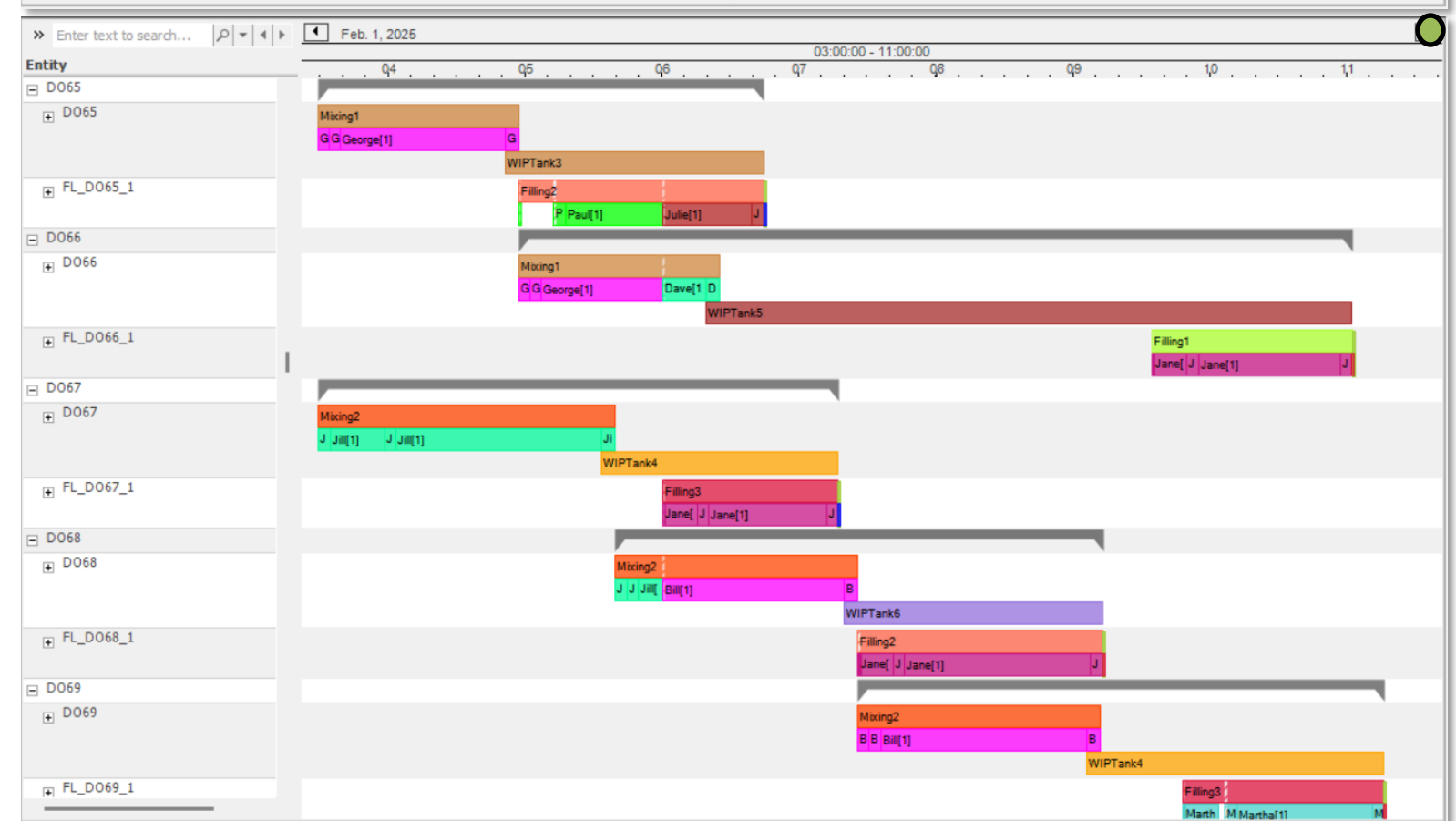
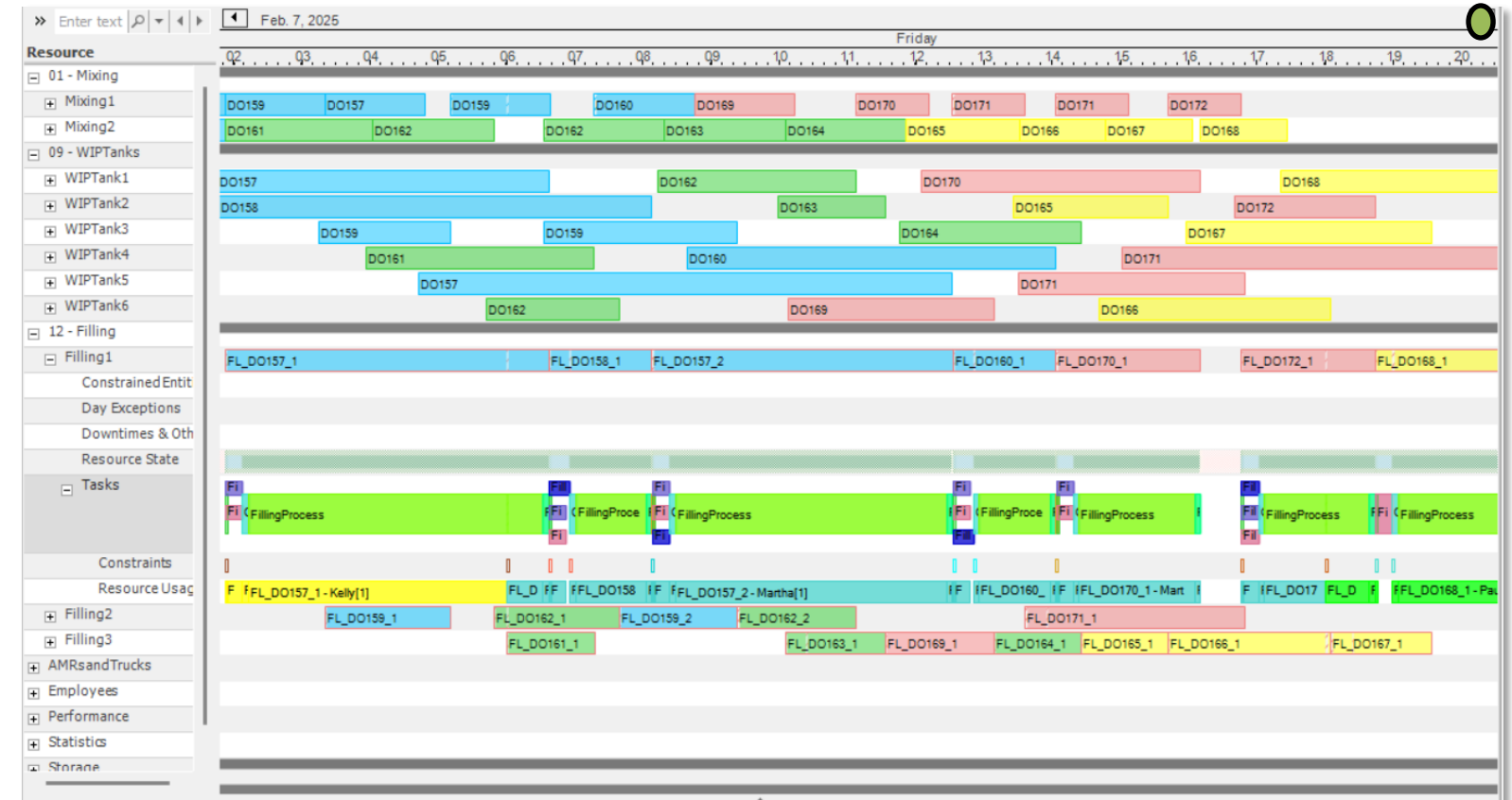
# Level 1

*Run Completed*

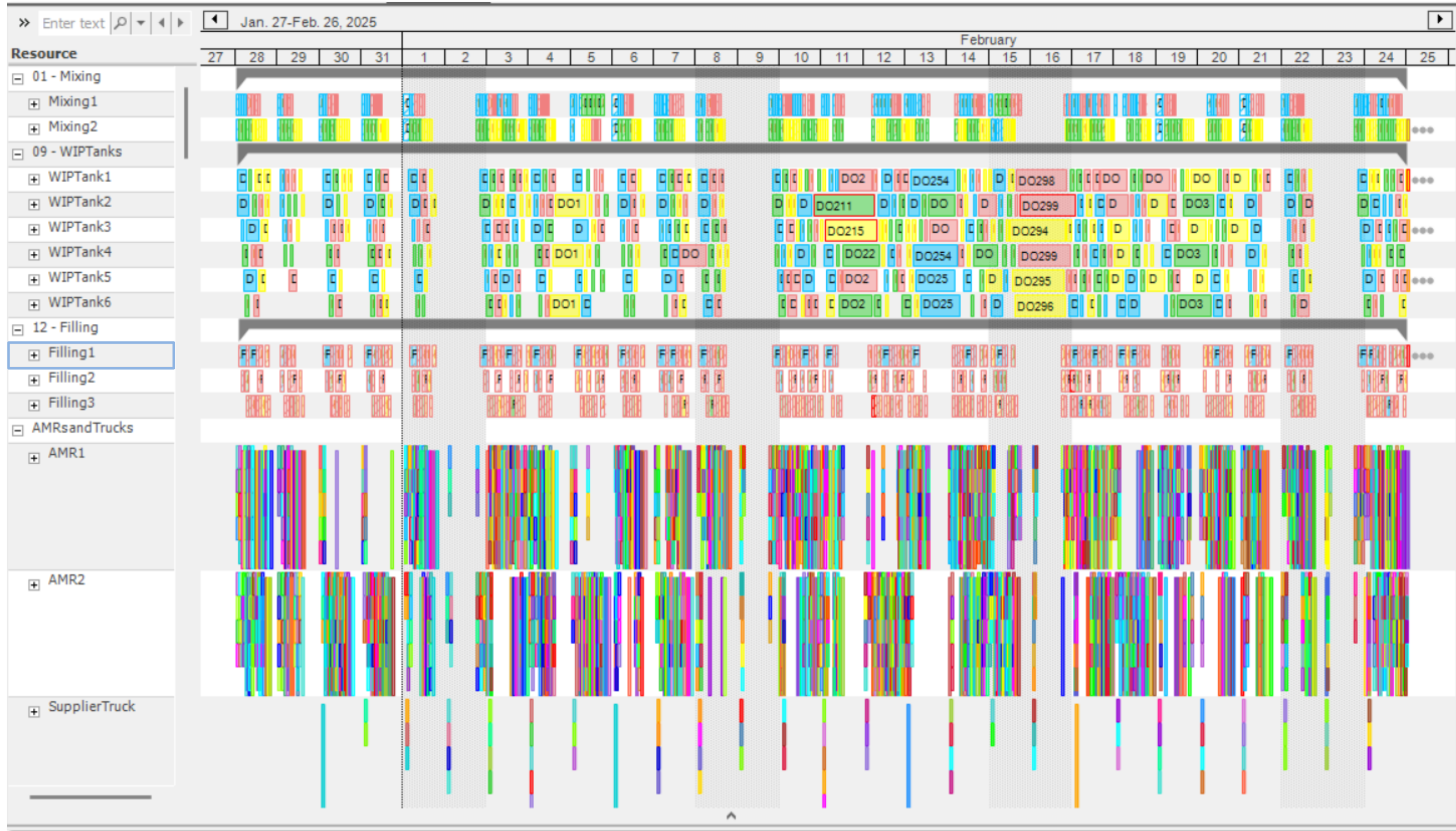


Start Game

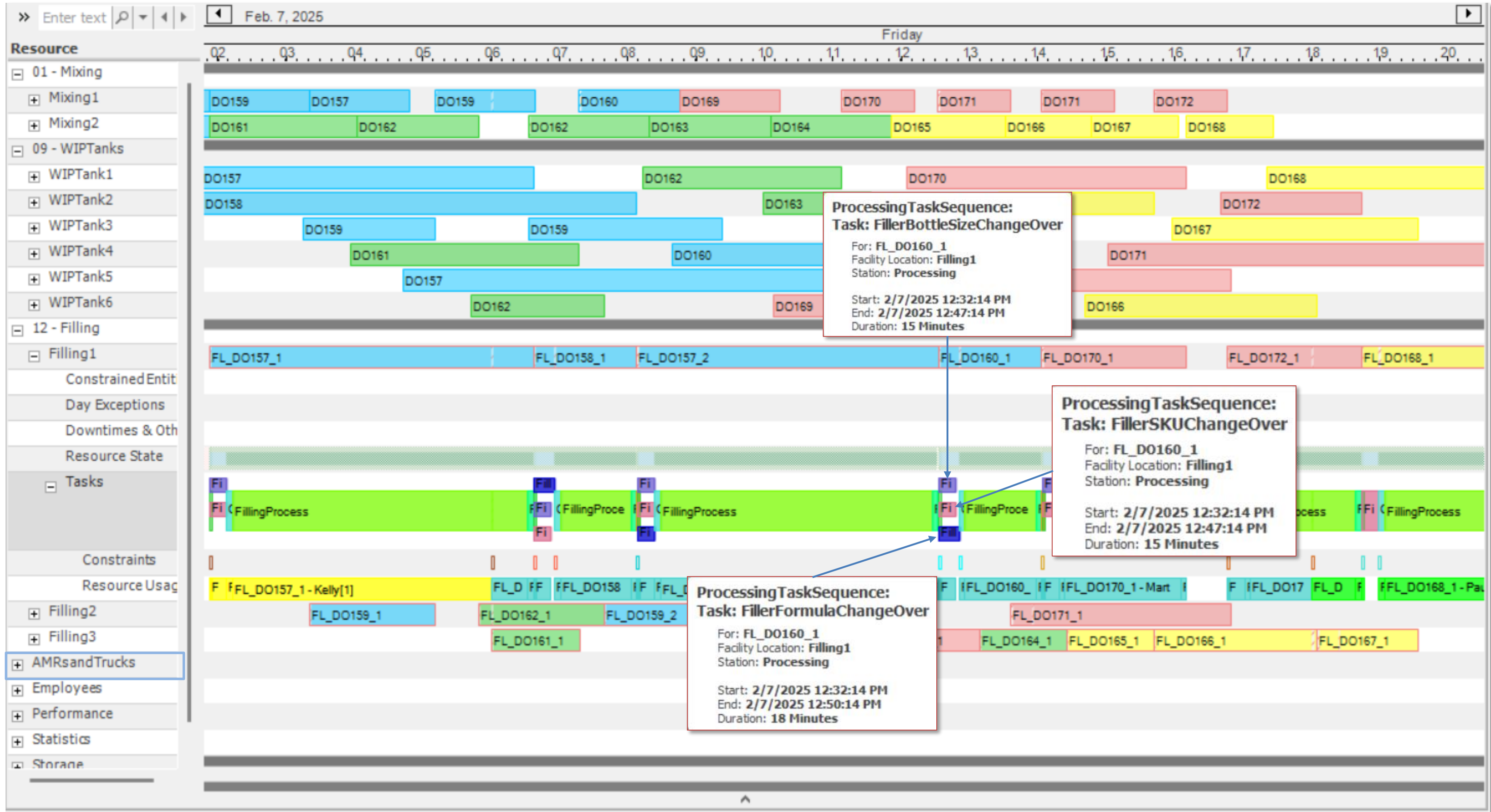
# Level 1 Results: Gantt charts



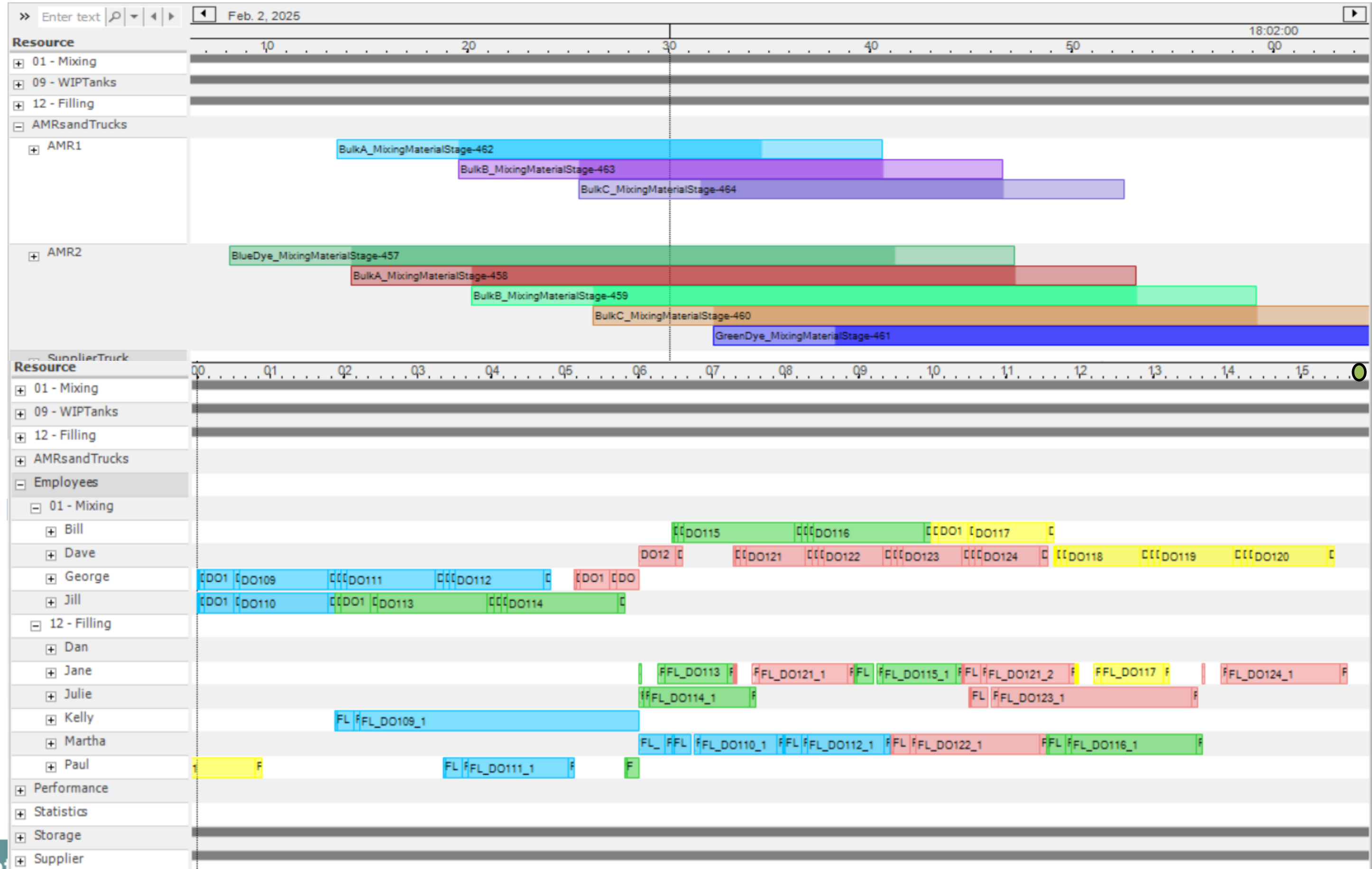
# Level 1 Results: Gantt charts



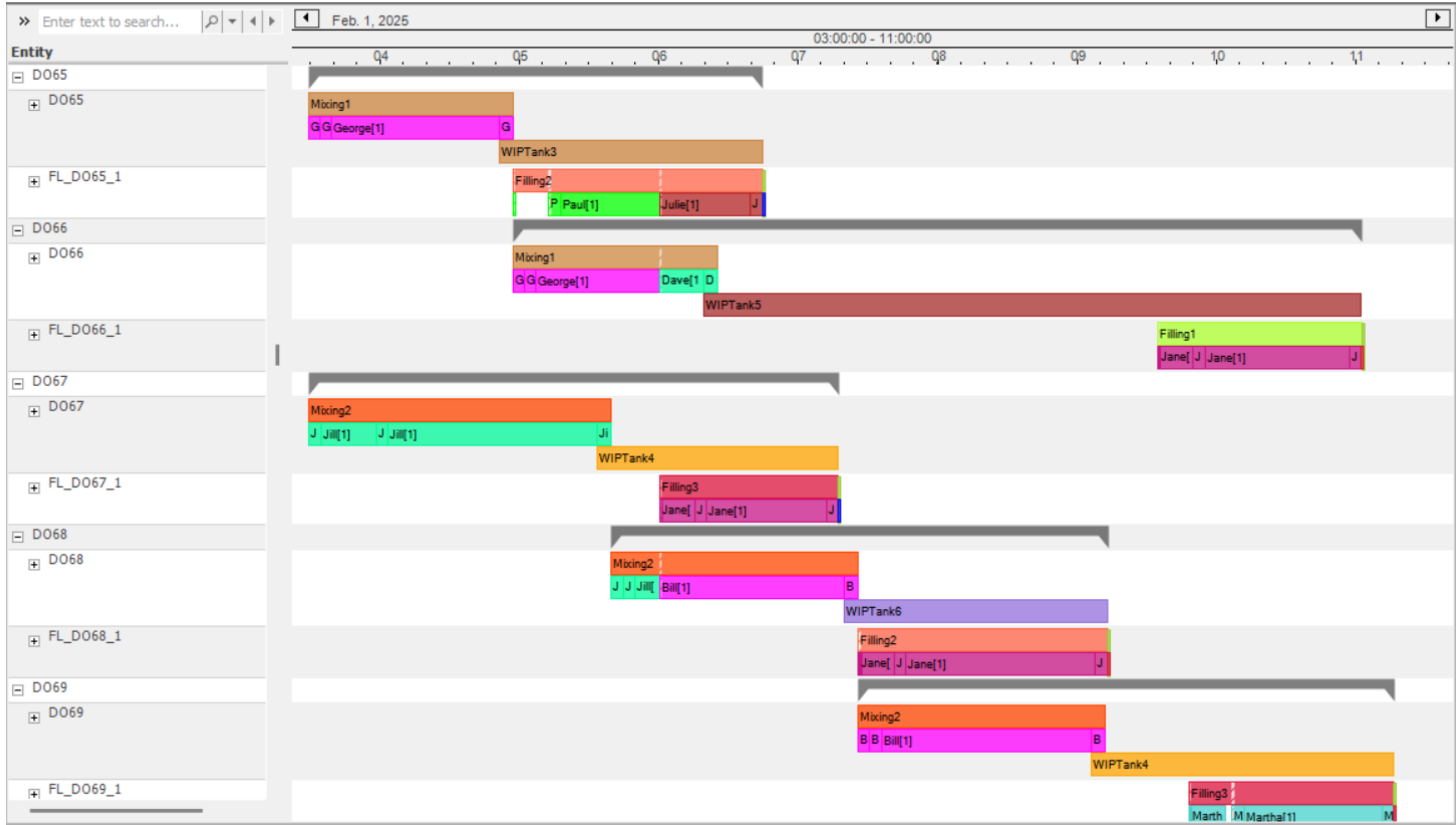
# Level 1 Results: Gantt charts



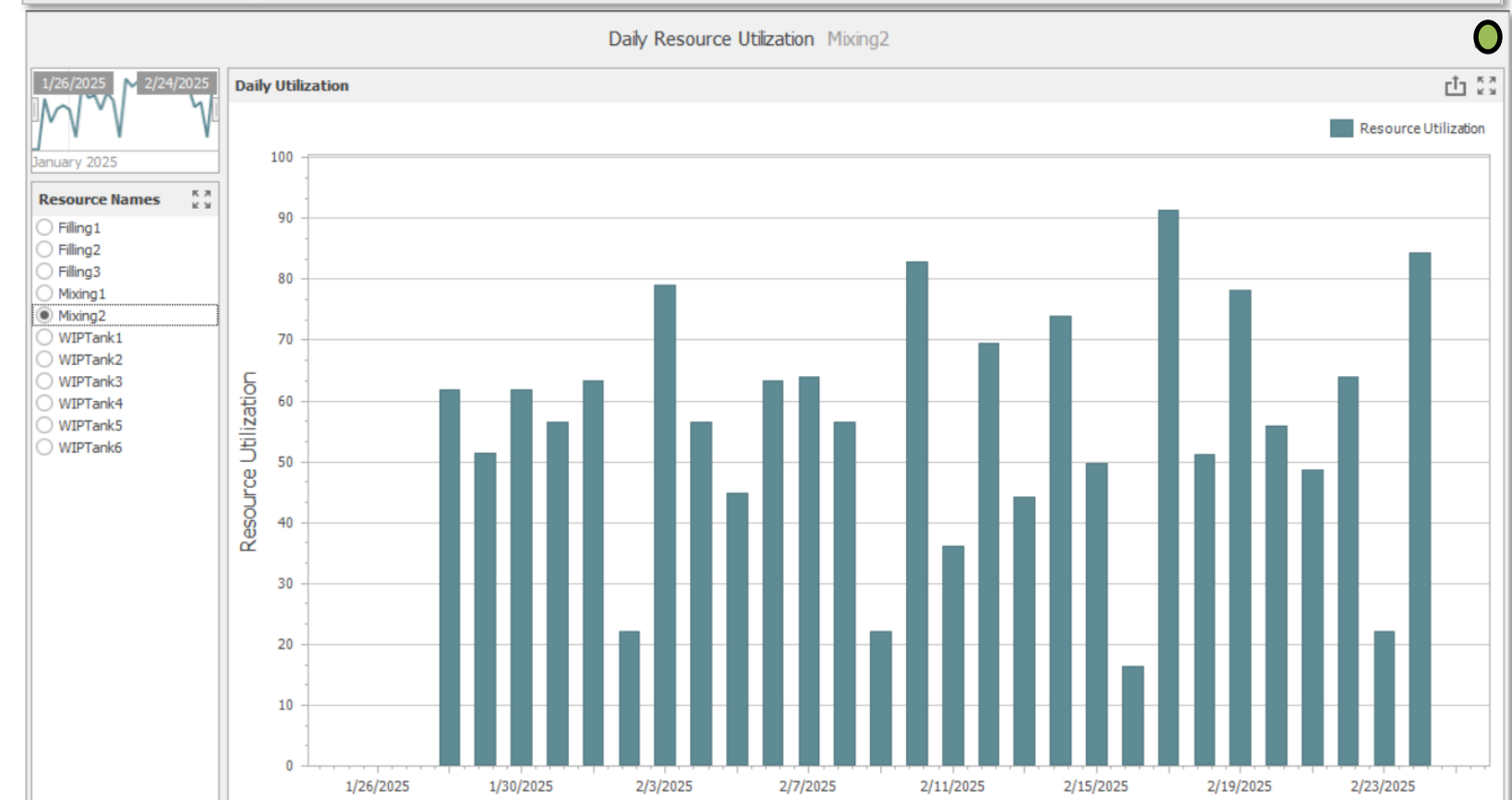
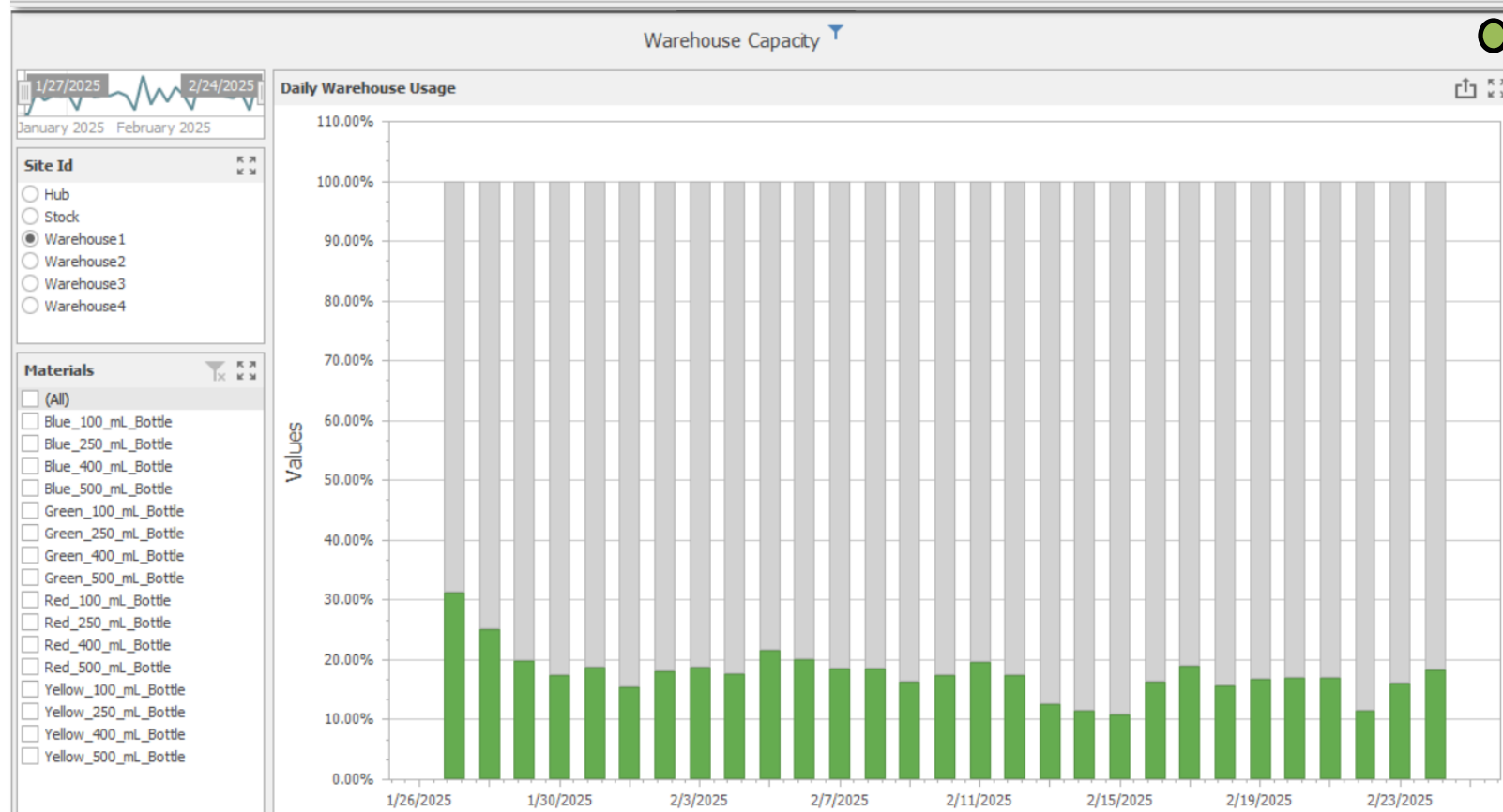
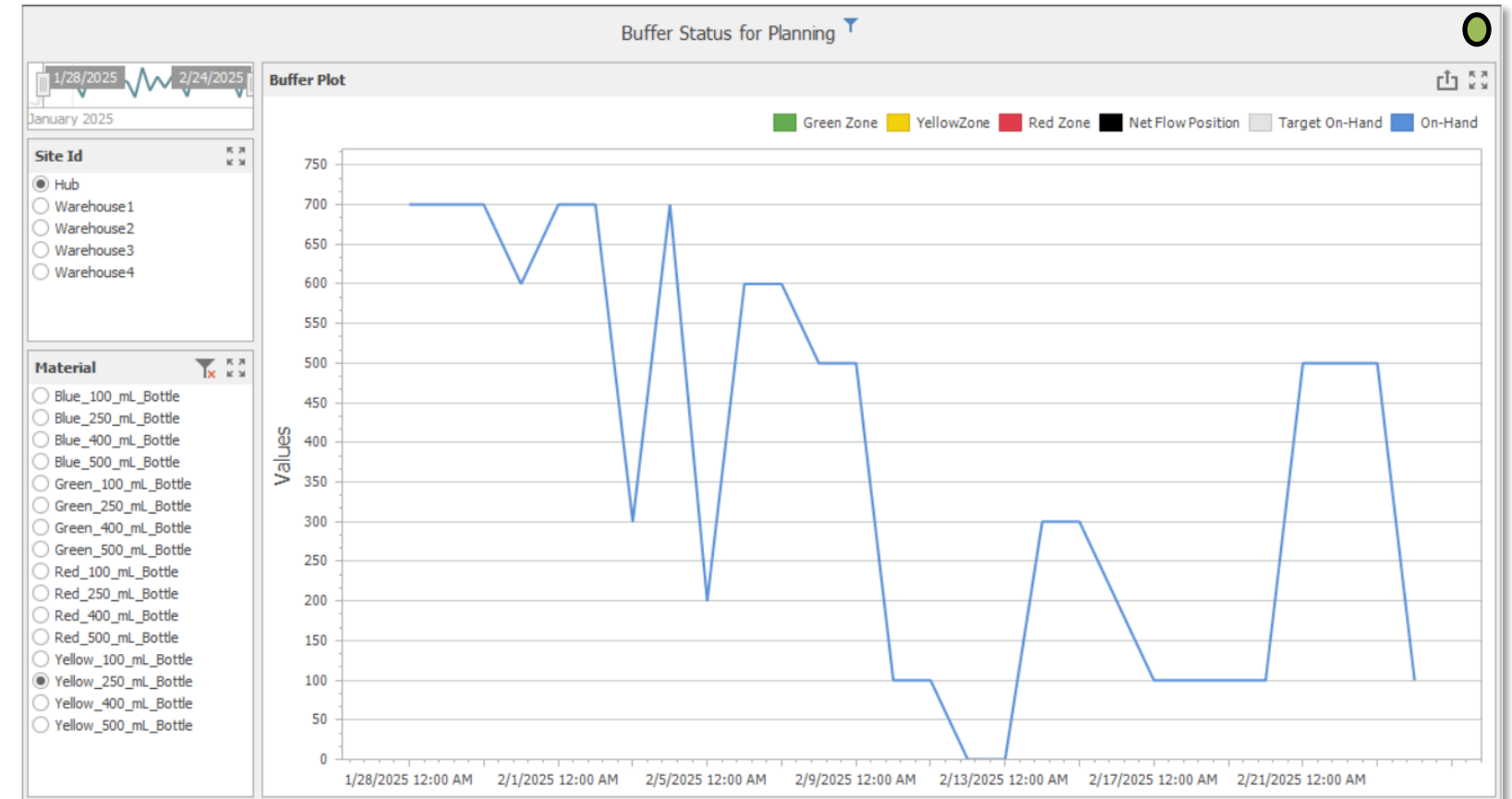
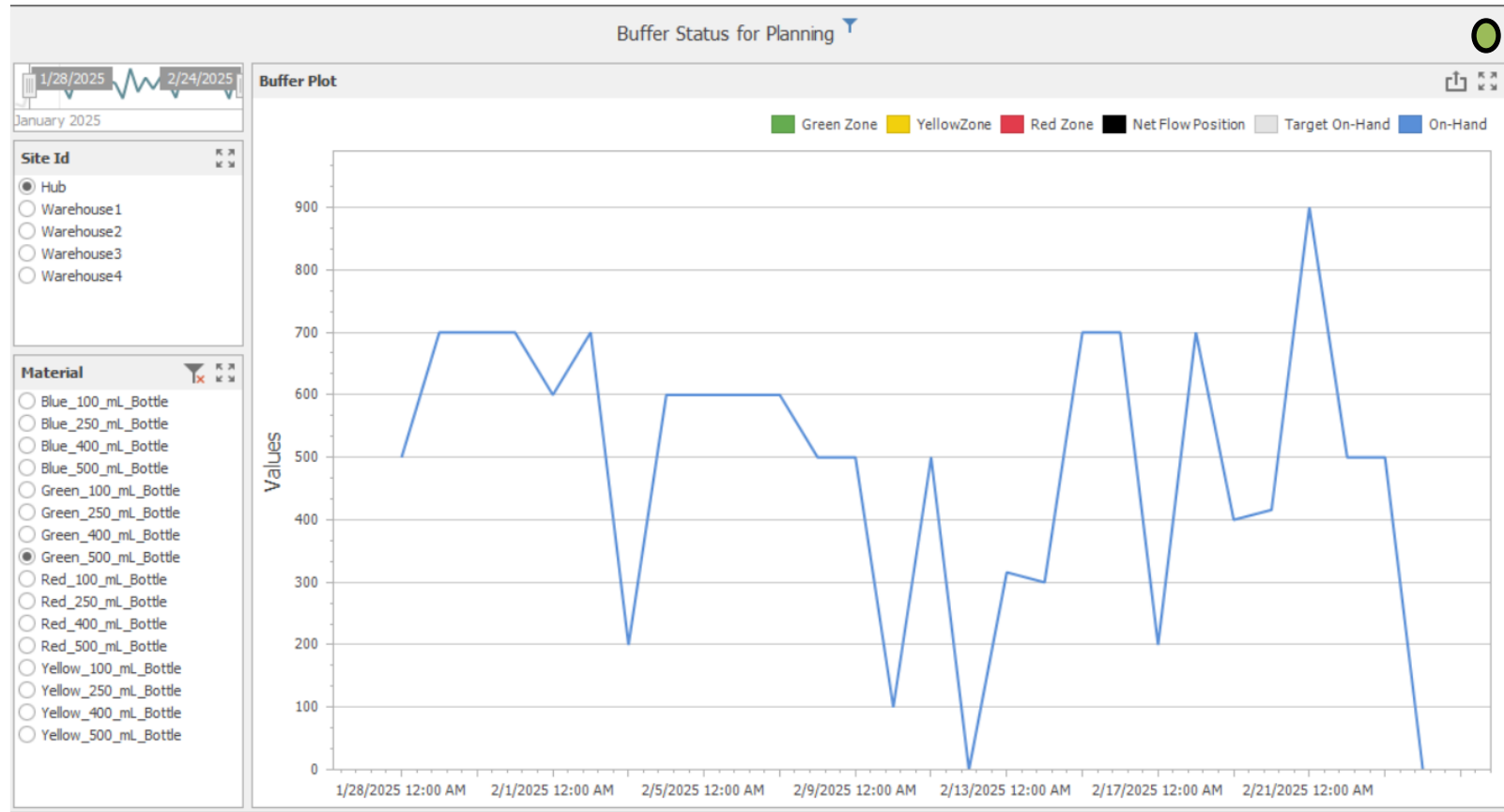
# Level 1 Results: Gantt charts



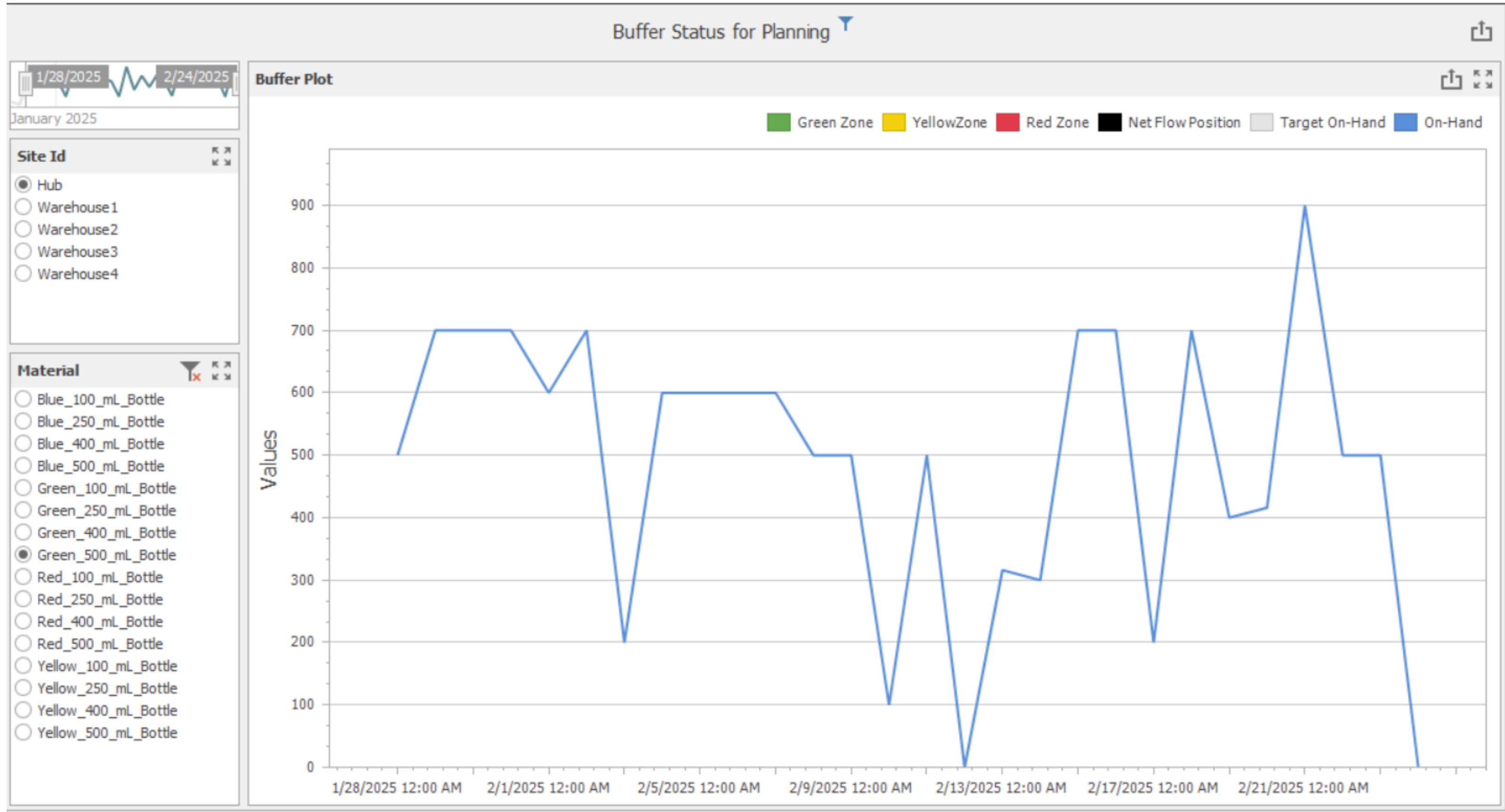
# Level 1 Results: Gantt charts



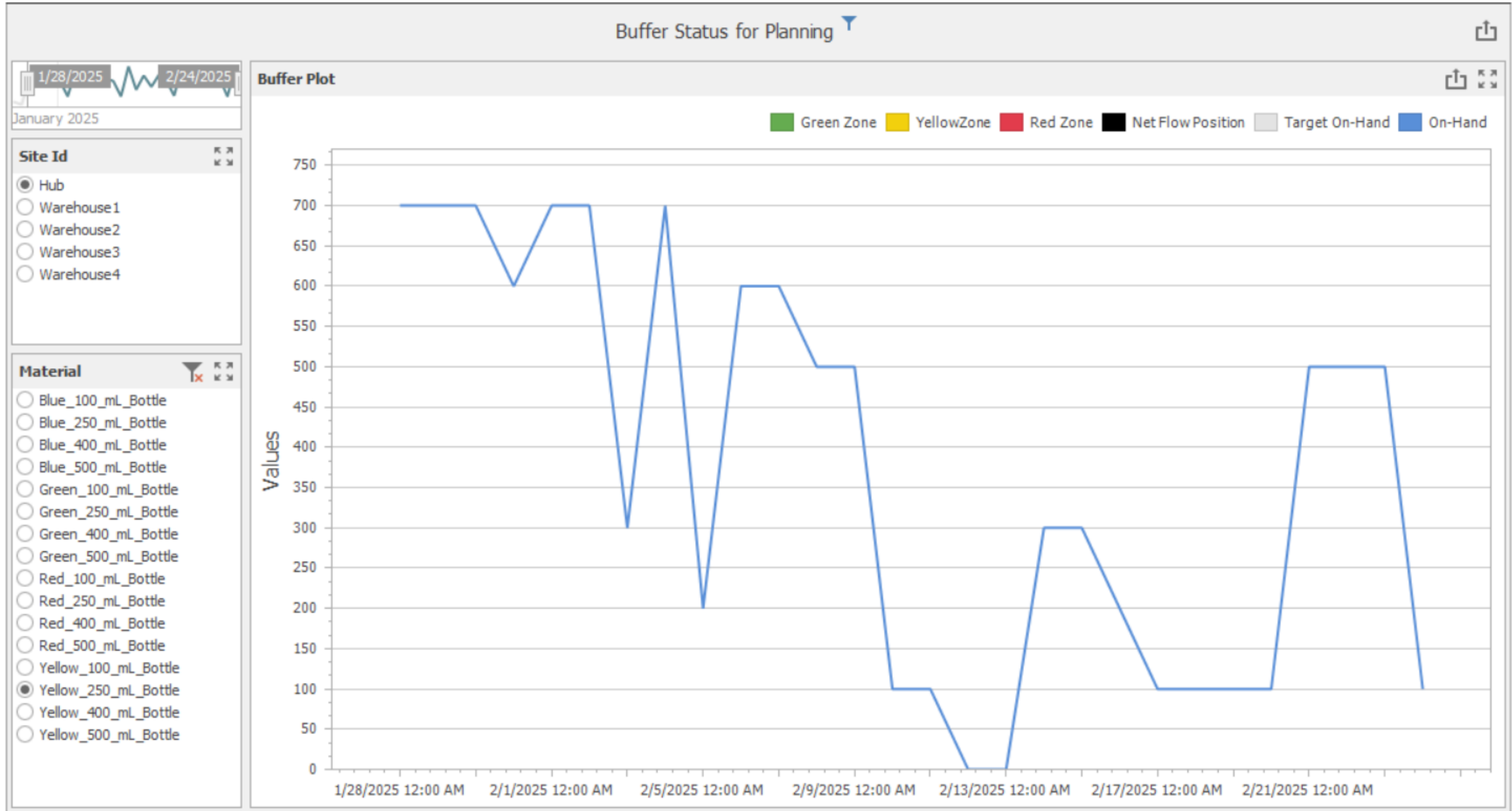
# Level 1 Results: Inventory and Utilization Dashboards



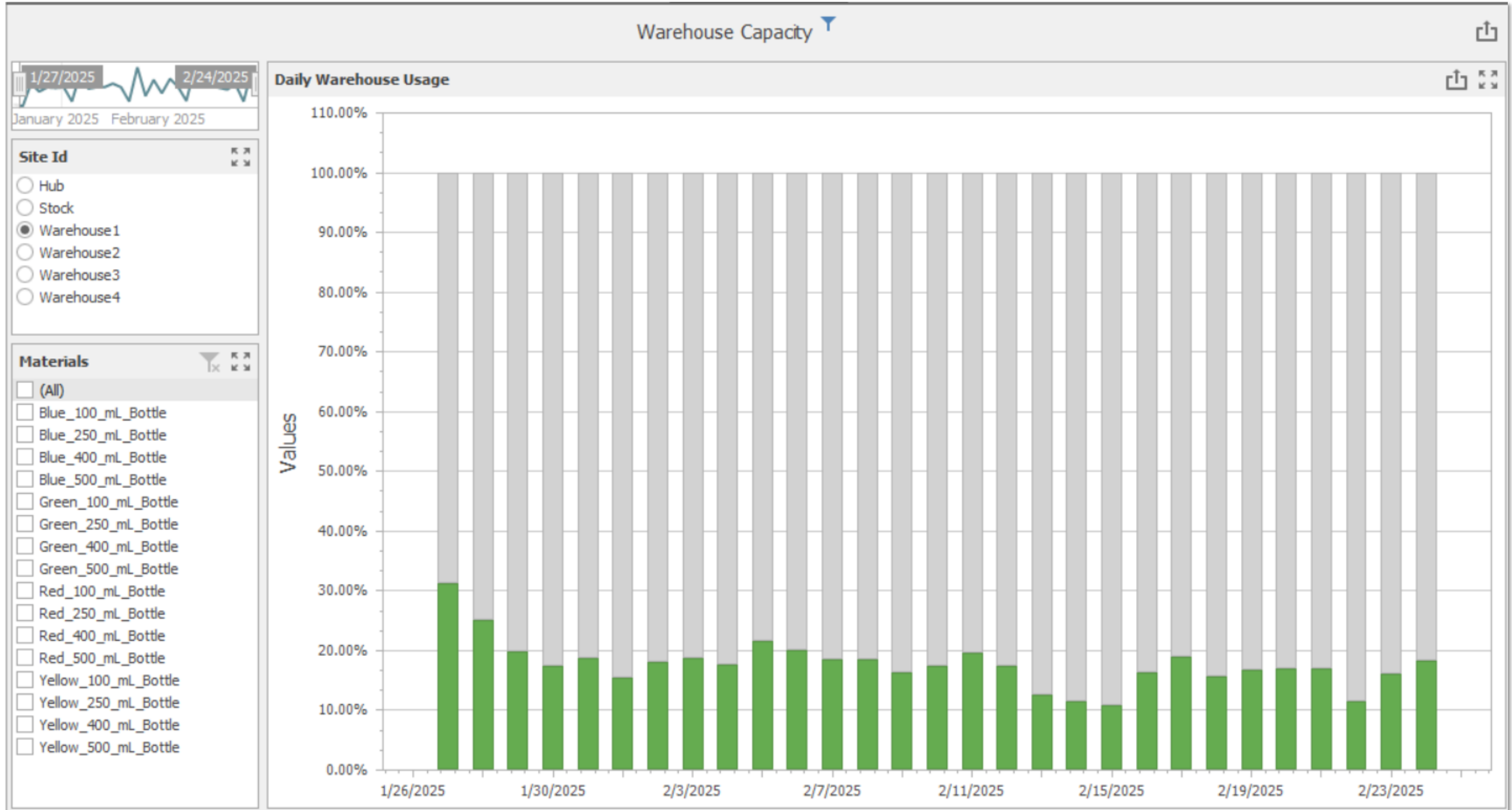
# Level 1 Results: Buffer status for the Green 500ml bottle



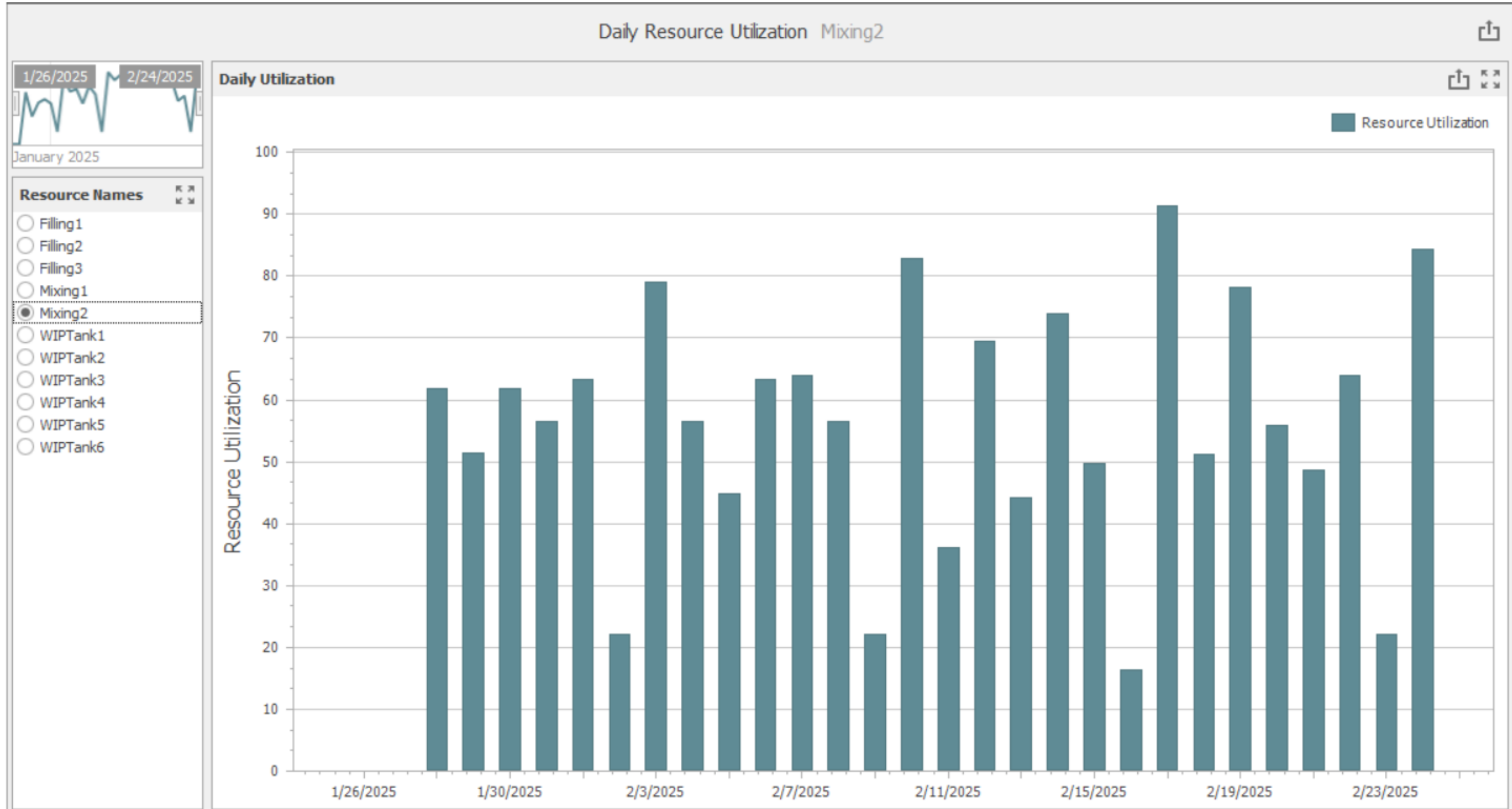
# Level 1 Results: Buffer status for the Yellow 250ml bottle



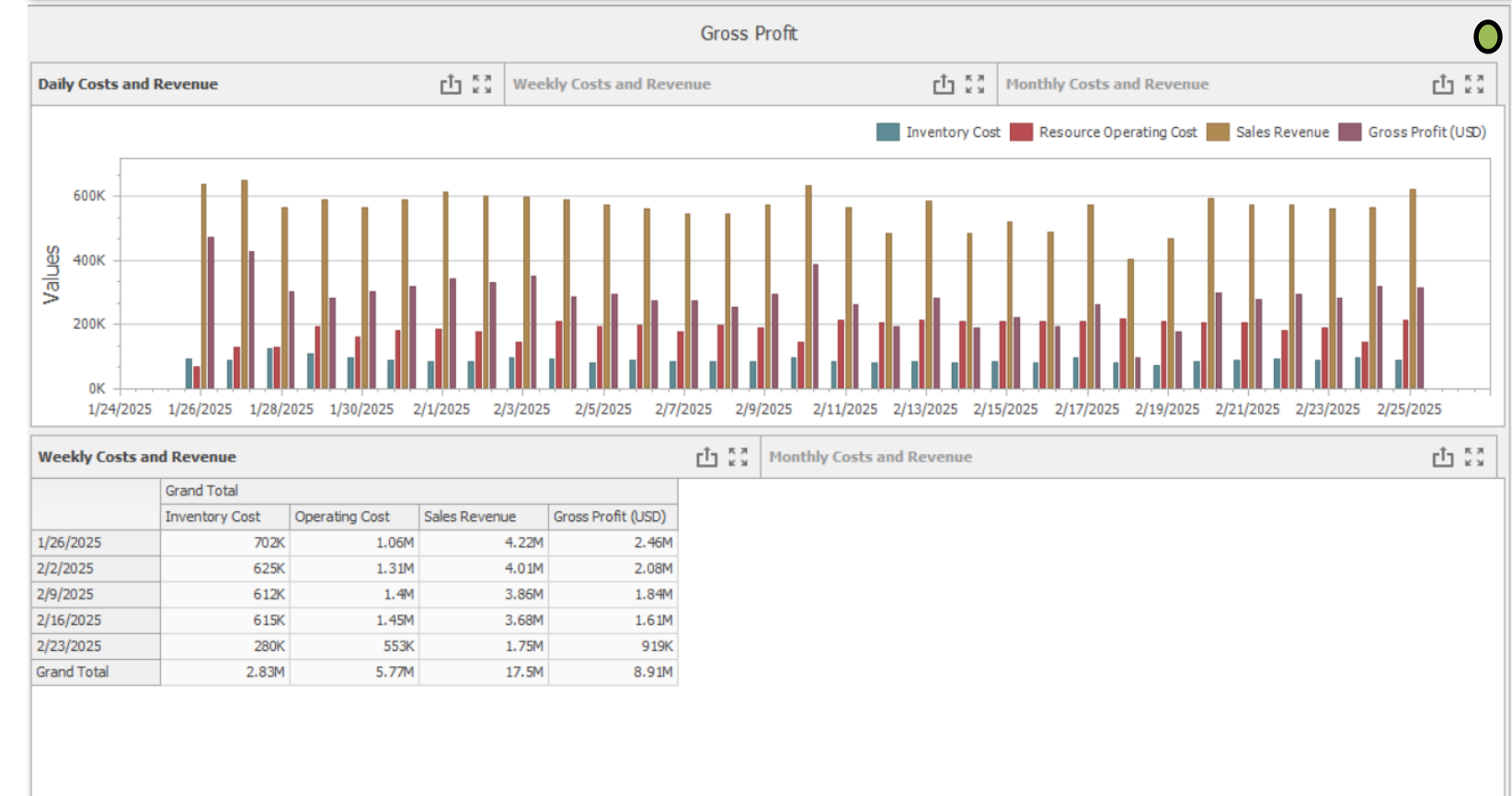
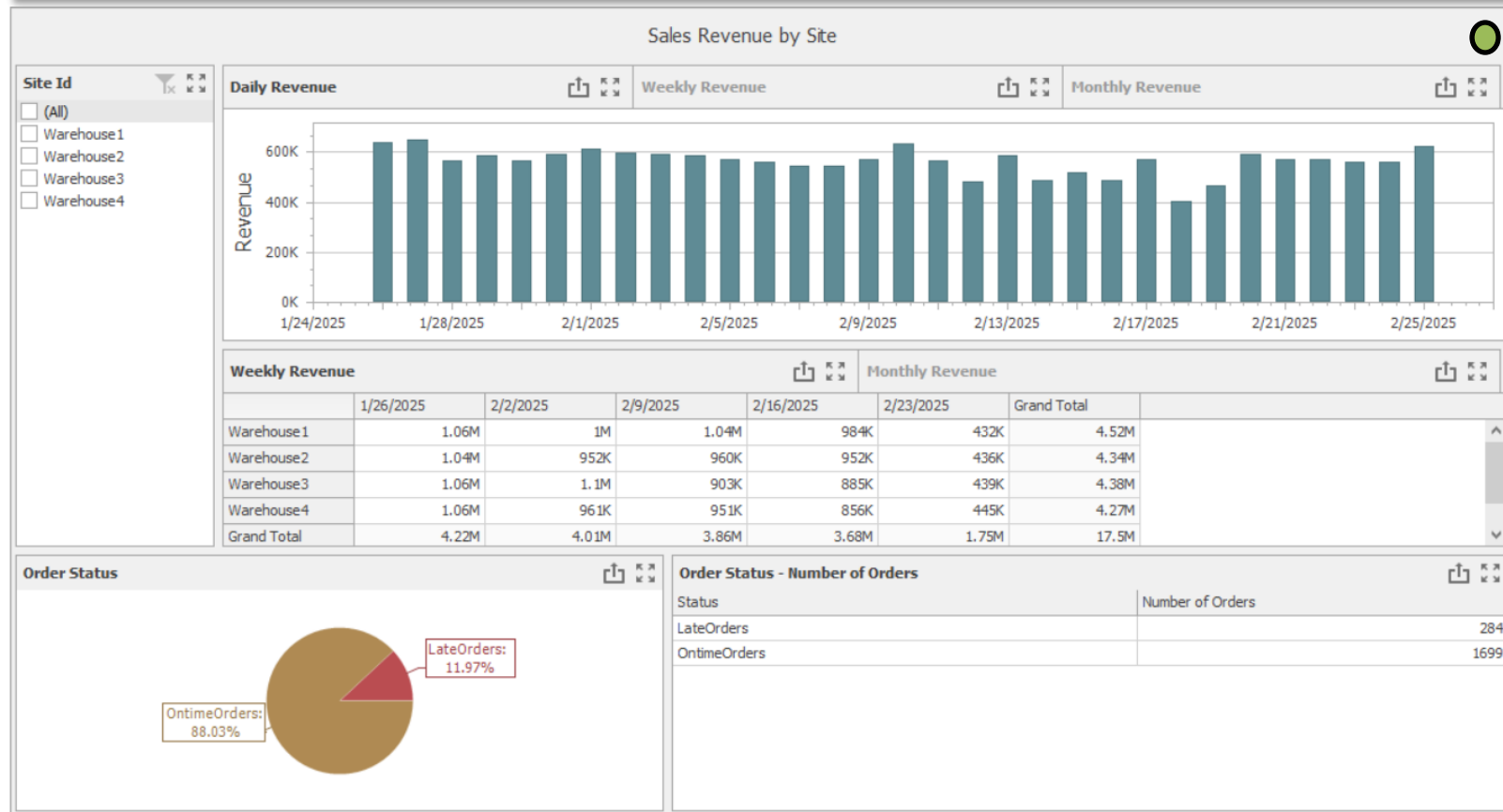
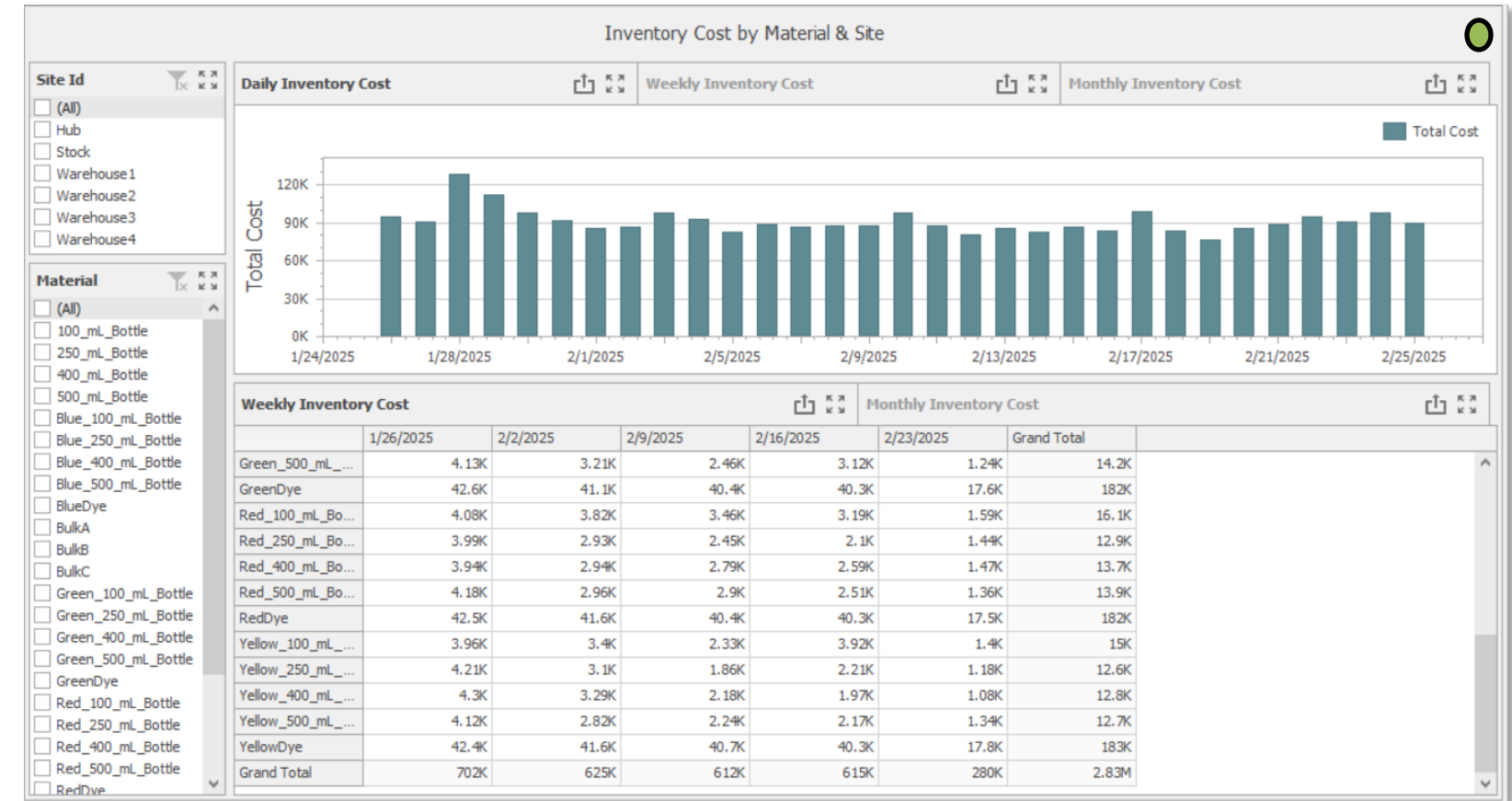
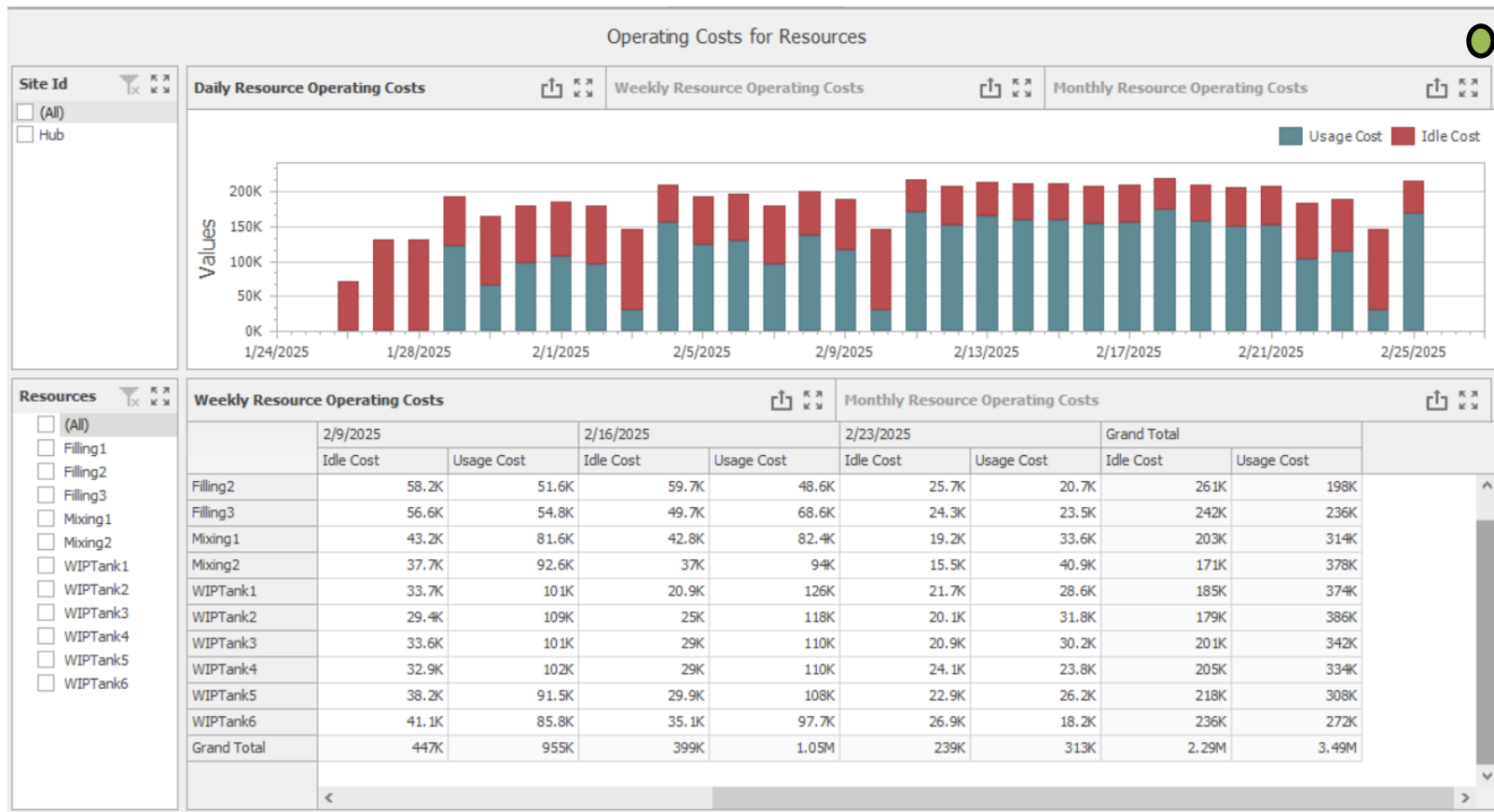
# Level 1 Results: Warehouse 1 capacity



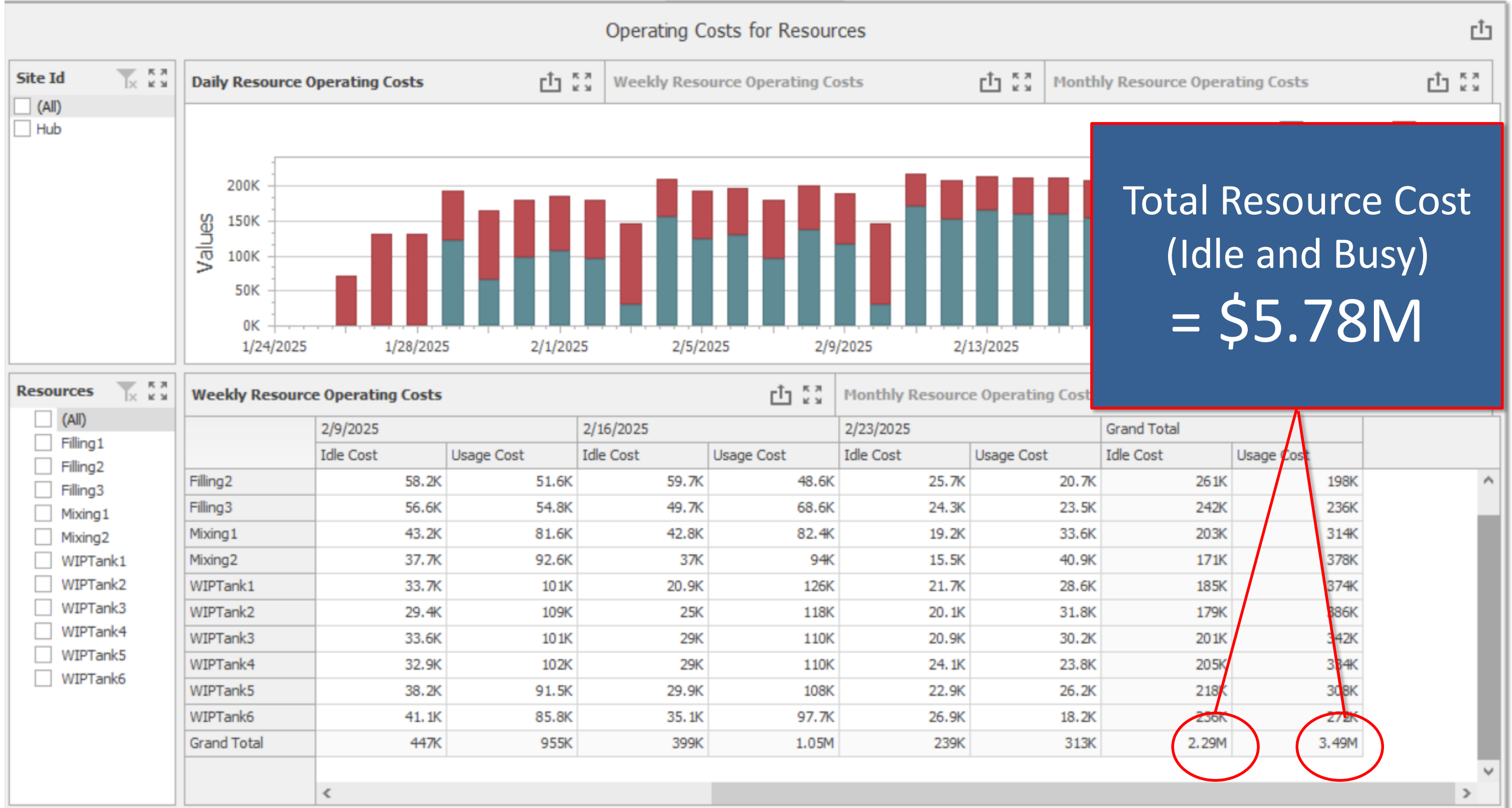
# Level 1 Results: Daily recourse utilization for Mixer 2



# Level 1 Results: Financial and Service Level Dashboards

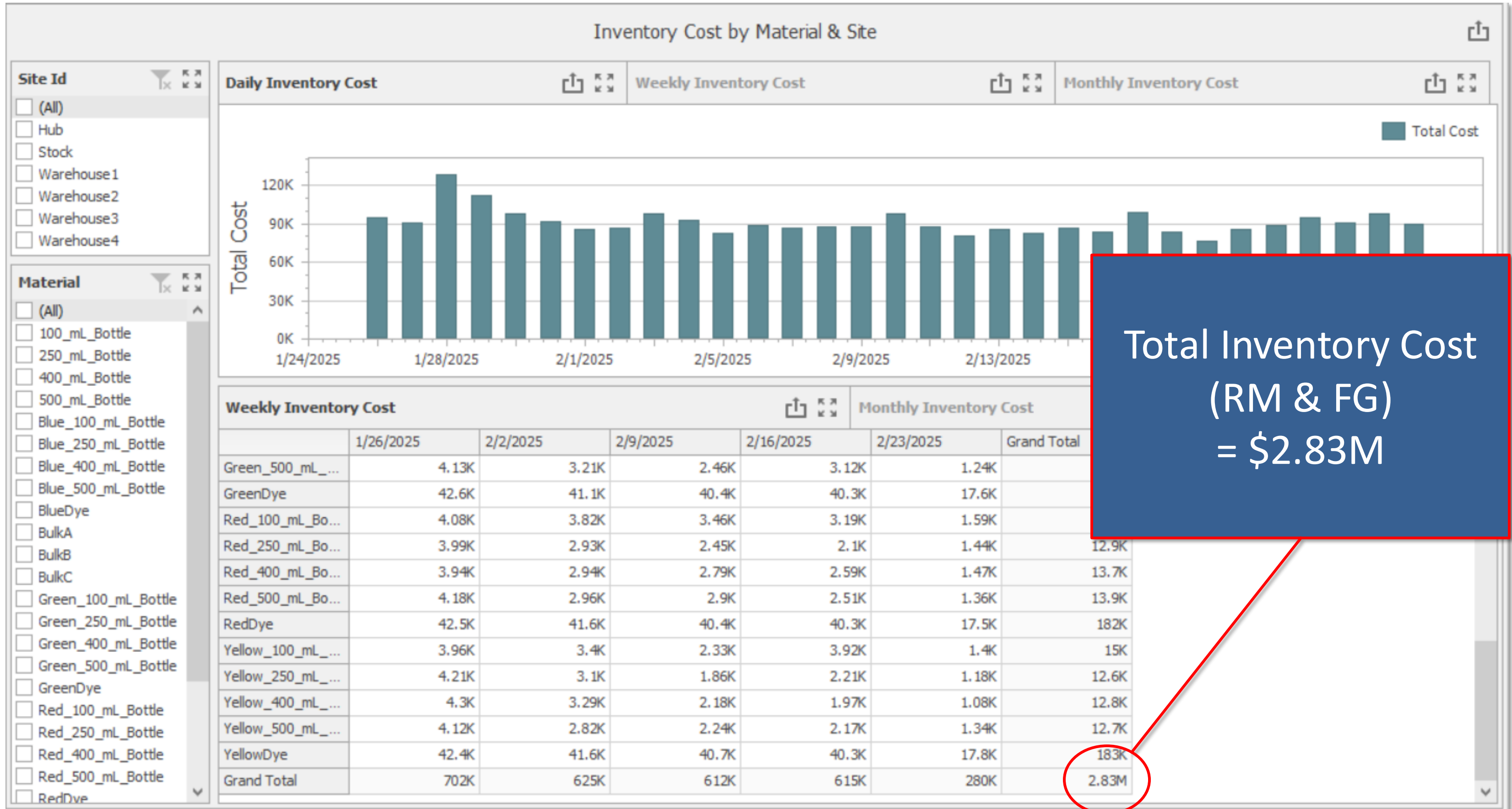


# Level 1 Results: Resource cost



Total Resource Cost (Idle and Busy) = \$5.78M

# 1 Level 1 Results: Inventory cost



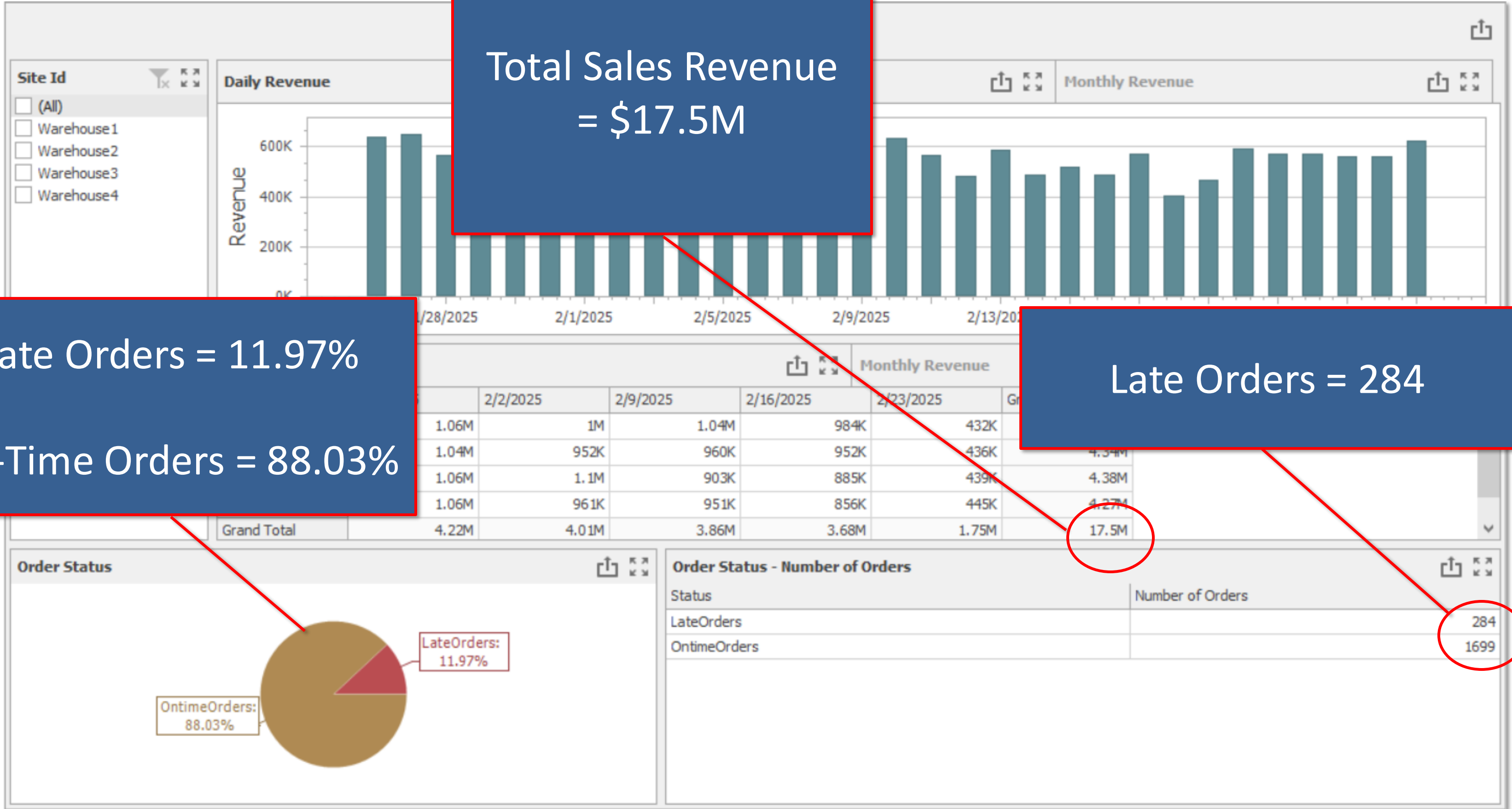
1

# Level 1 Results: Revenue and service level

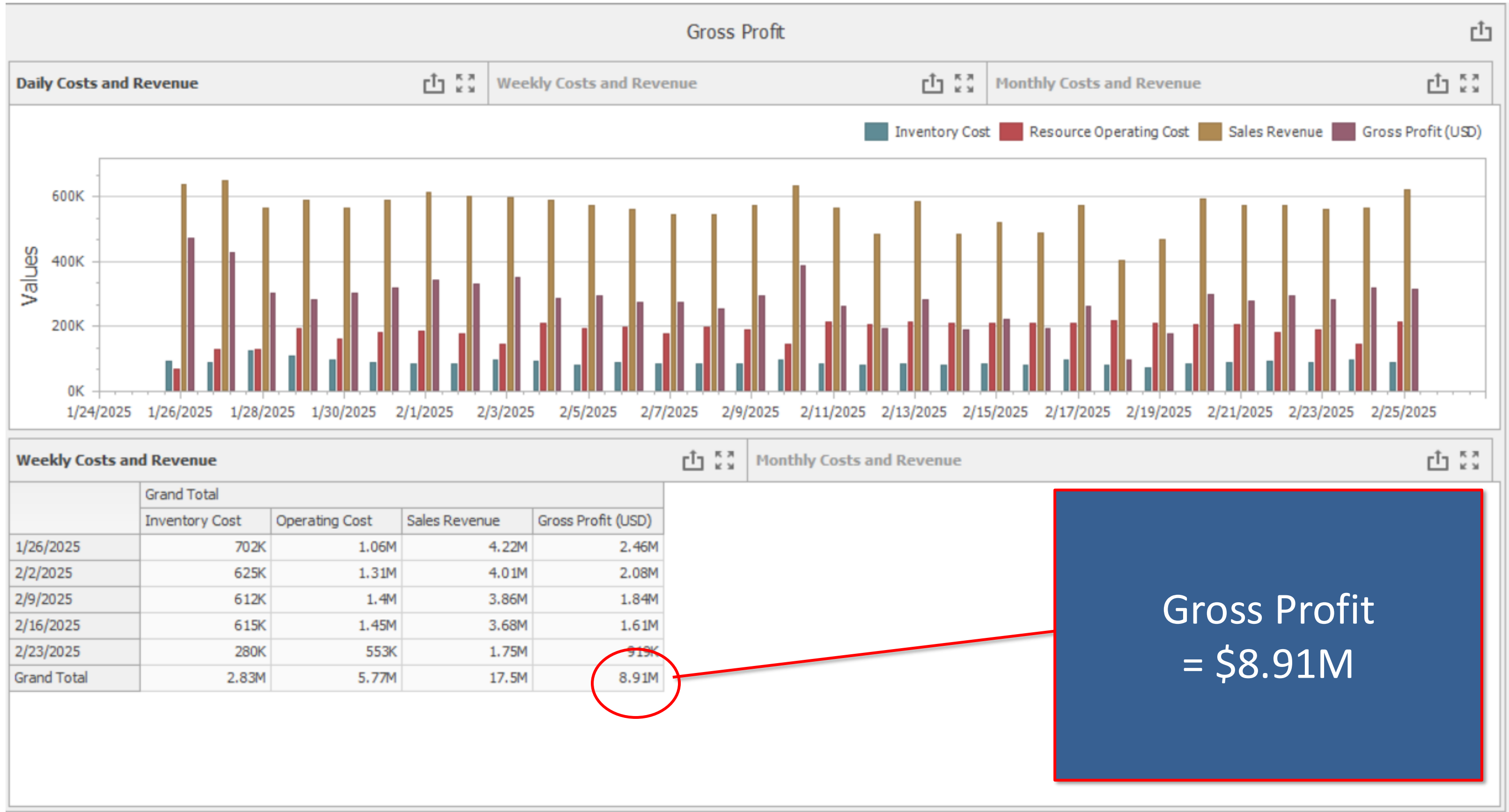
Total Sales Revenue = \$17.5M

Late Orders = 11.97%  
On-Time Orders = 88.03%

Late Orders = 284



# Level 1 Results: Gross profit



# Game Level 2 (operational)

- The **Level 2** challenge: *Operational Demand Driven (DDMRP)*
  - Sales orders for all products with 25% day-to-day variation
  - Demand spike of 20% in week 3
  - **Implement DDMRP replenishment policy for all RM and FG**
  - Run the game for 30 days

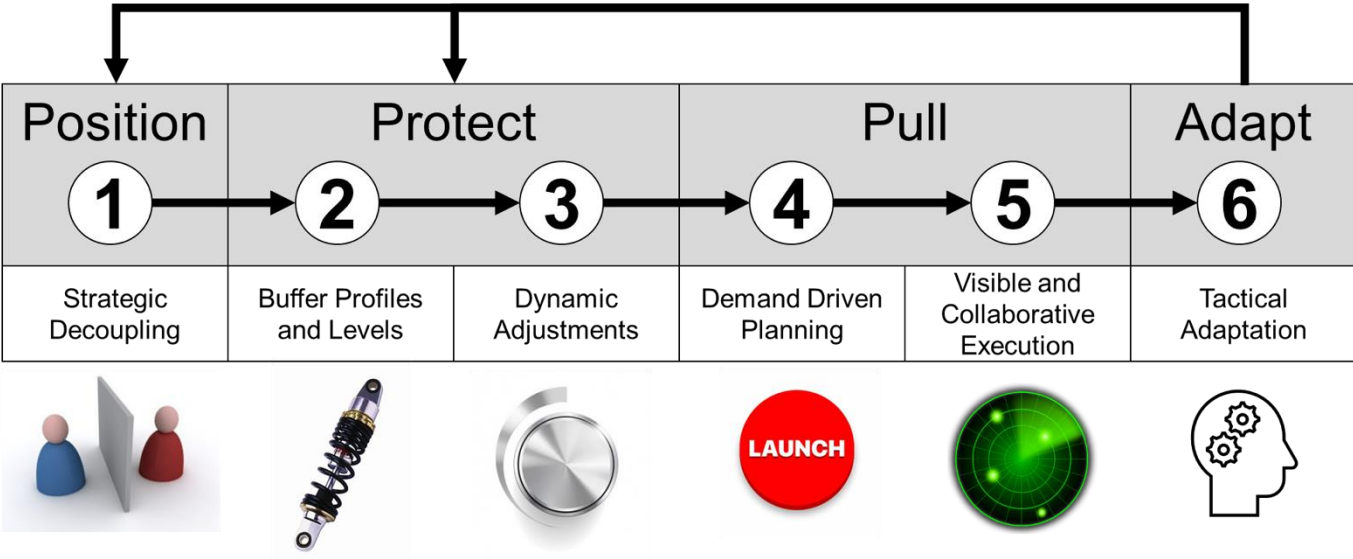
➤ Starting the 26th of January 2025

Analyze & understand the impact and difference in business performance using the **DDMRP methodology** to manage the flow of material

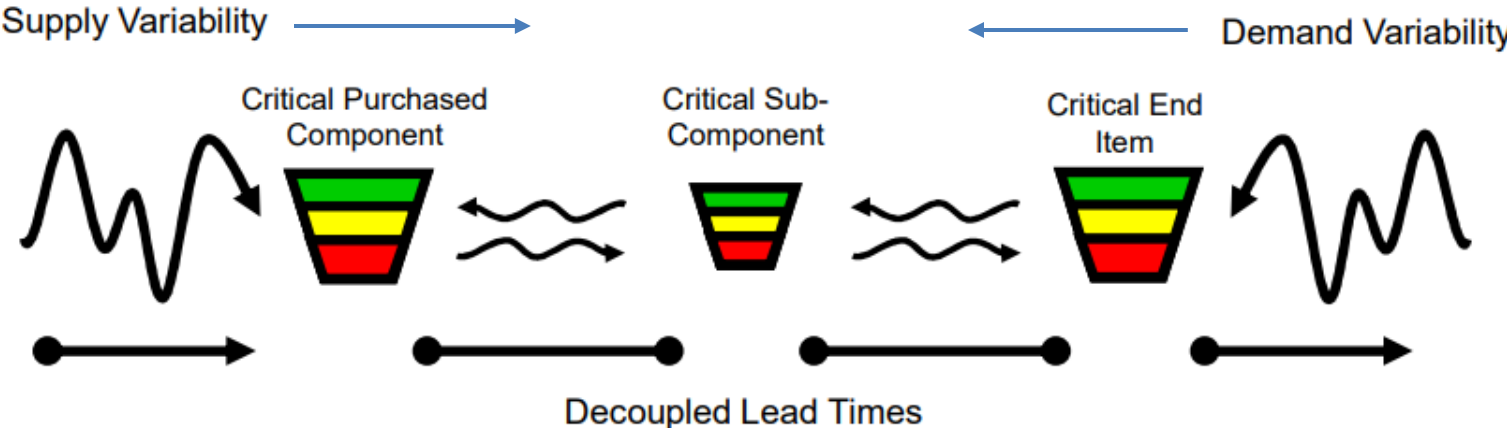
# What is DDMRP?

► DDMRP is the strategic positioning and sizing of decoupling buffer stocks to manage customer lead times while reducing the impact of variability and improving overall *FLOW* of product and information through the network (end-to-end)

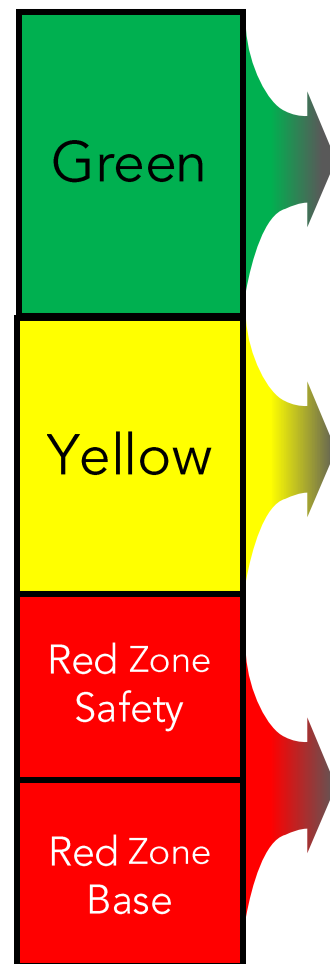
► There are six components to DDMRP:



► DDMRP eliminates the overall bullwhip effect by enabling synchronized FLOW of material and information across the supply chain to meet demand



# DDMRP Buffer Zone Size Calculation



Determines supply order generation frequency and size  
 Max value of :

- Minimum Order Quantity = MOQ value
- Desired or imposed Order Cycle = # of days x ADU
- Calculated =  $LTF \times ADU \times DLT$

The heart of the demand coverage in the buffer

- $ADU \times DLT$

The embedded safety in the buffer

- Red Zone Base =  $LTF \times ADU \times DLT$
- Red Zone Safety = Red Zone Base x VF
- Total Red Zone = Red Zone Base + Red Zone Safety

## Buffer Calculation Variables

ADU - Average Daily Usage  
 DLT - Decoupled Lead Time  
 MOQ - Minimum Order Quantity  
 VF - Variability Factor  
 LTF - Lead Time Factor

### LTF - Lead Time Factor

0.20 – 0.40

Long Lead Time

0.41 – 0.60

Medium Lead Time

0.61 – 1.00

Short Lead Time

### VF - Variability Factor

0.20 – 0.40

Low Variability

0.41 – 0.60

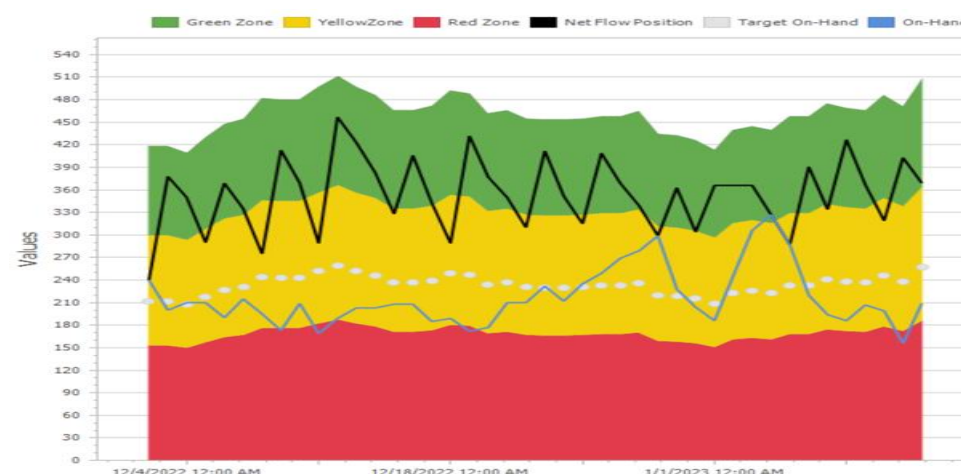
Medium Variability

0.61 – 1.00

High Variability

## Adjustment Factors

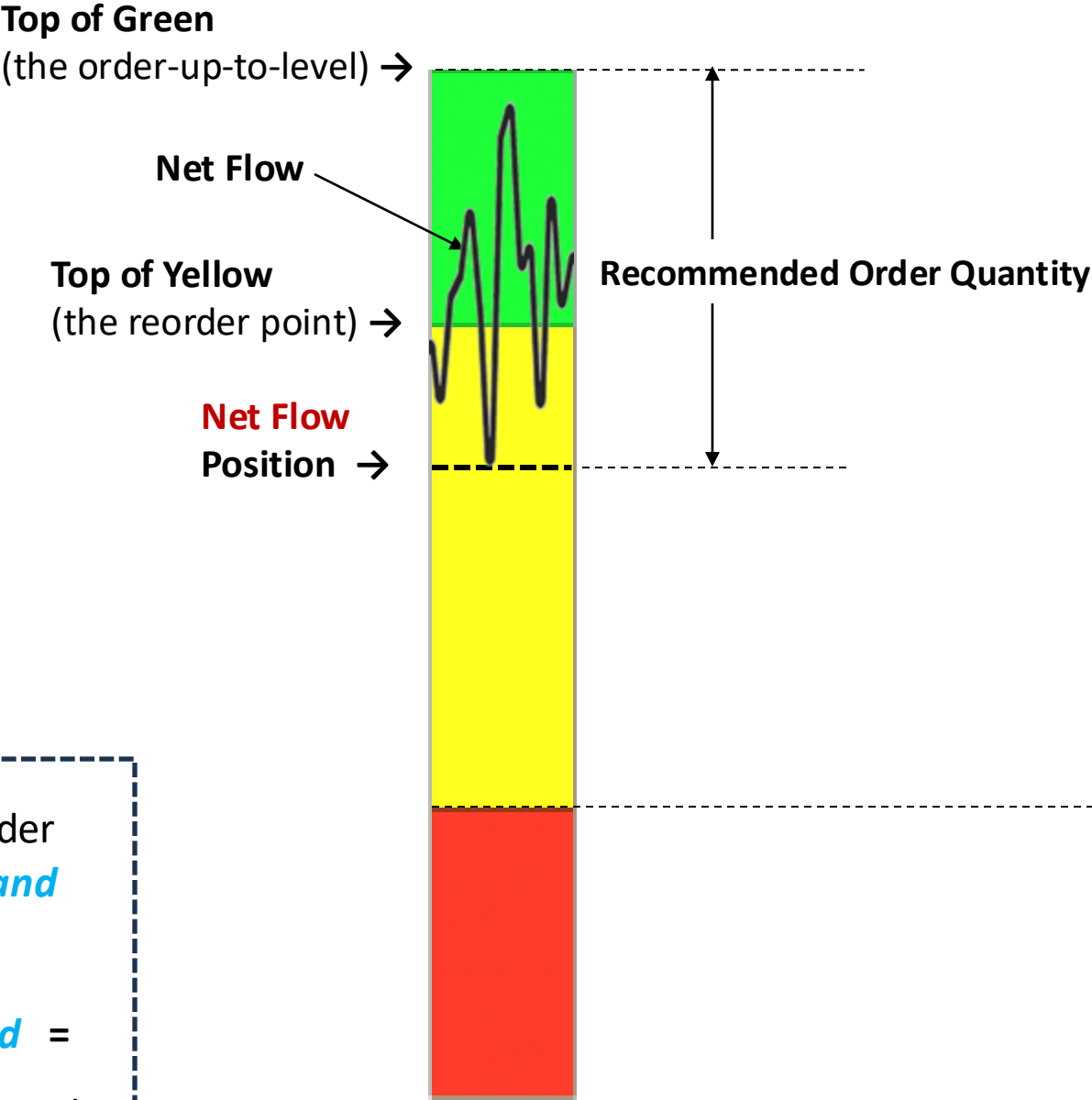
1. Demand (DAF)
2. Zone (ZAF)
3. Lead time (LAF)



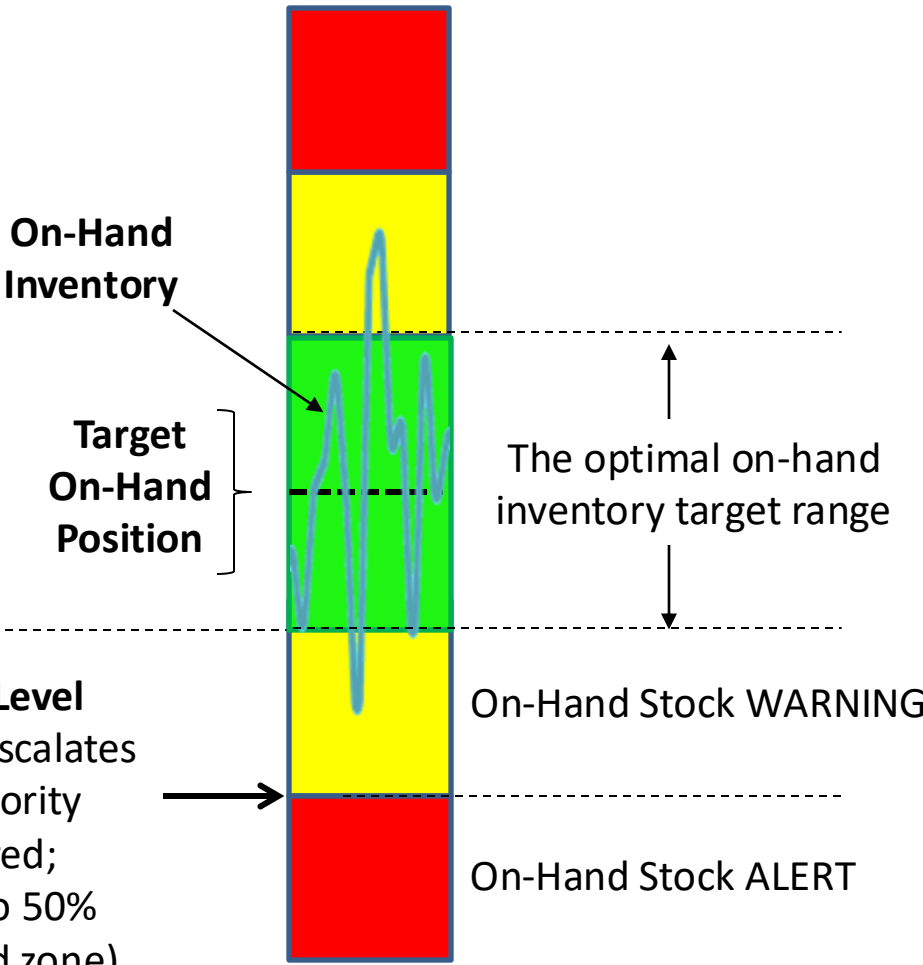
Buffer zone sizes and Net Flow are dynamically adjusted as the ADU is updated.

# DDMRP Planning and Execution Indicators

## Buffer Zones for Planning



## Buffer Run Chart for Execution Tracking



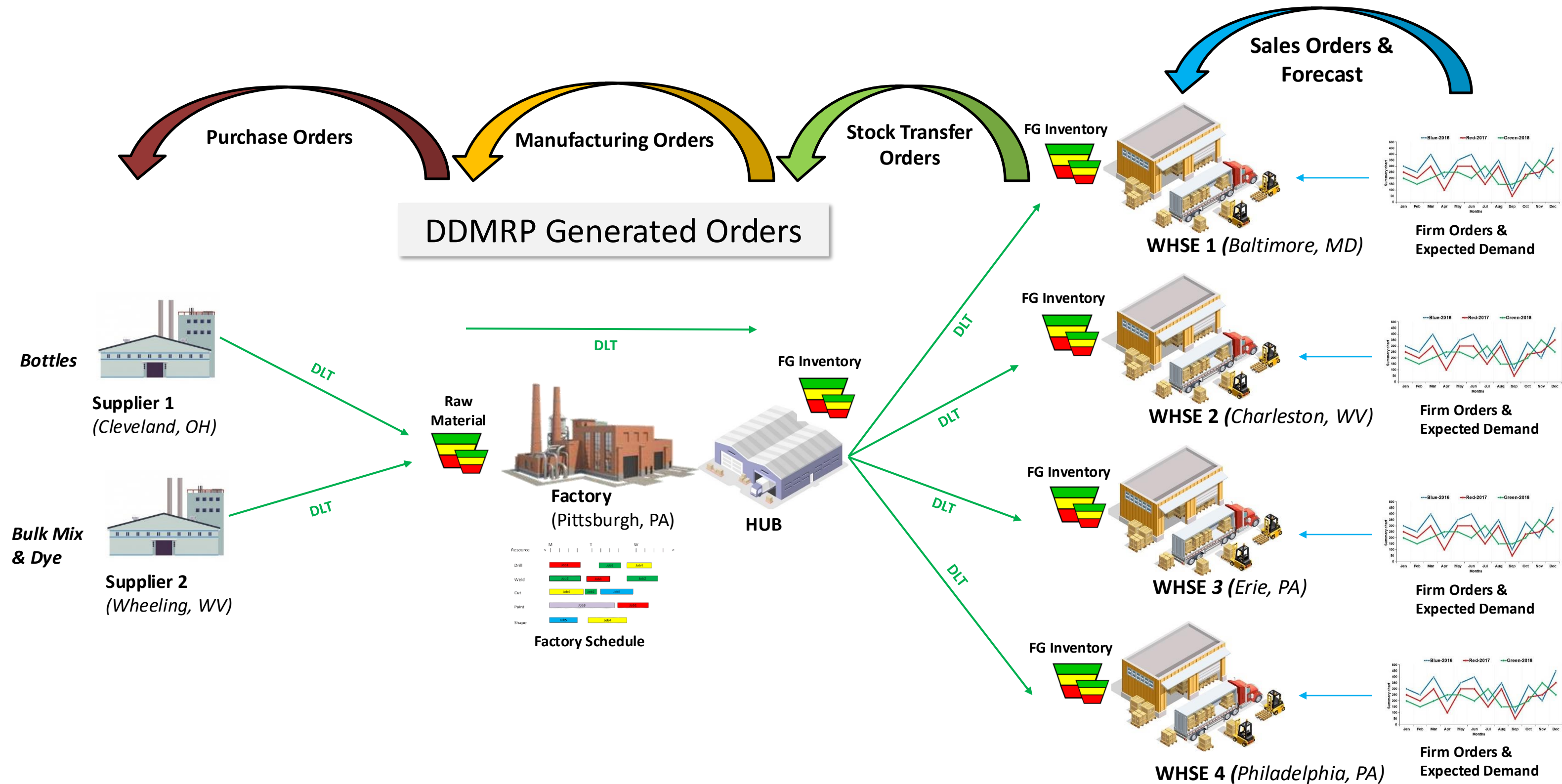
### Calculations (daily review)

$$\text{Net Flow} = \text{On-hand} + \text{On-order} - \text{Qualified sales order demand}$$

↓

$$\text{Qualified sales order demand} = \text{Orders past due} + \text{Orders due today} + \text{Qualified Order Spikes}$$

# Game Configuration: DDMRP Replenishment



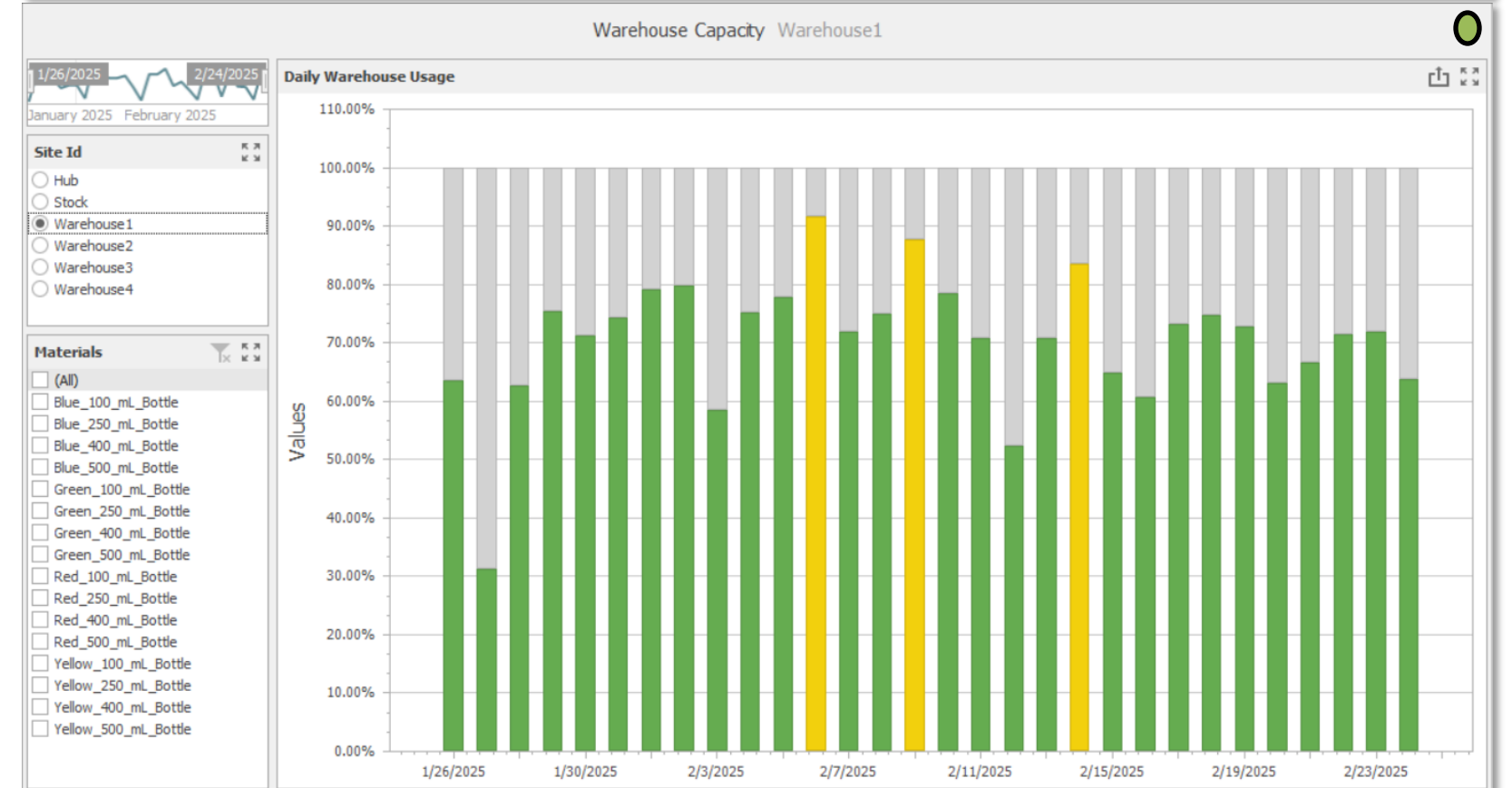
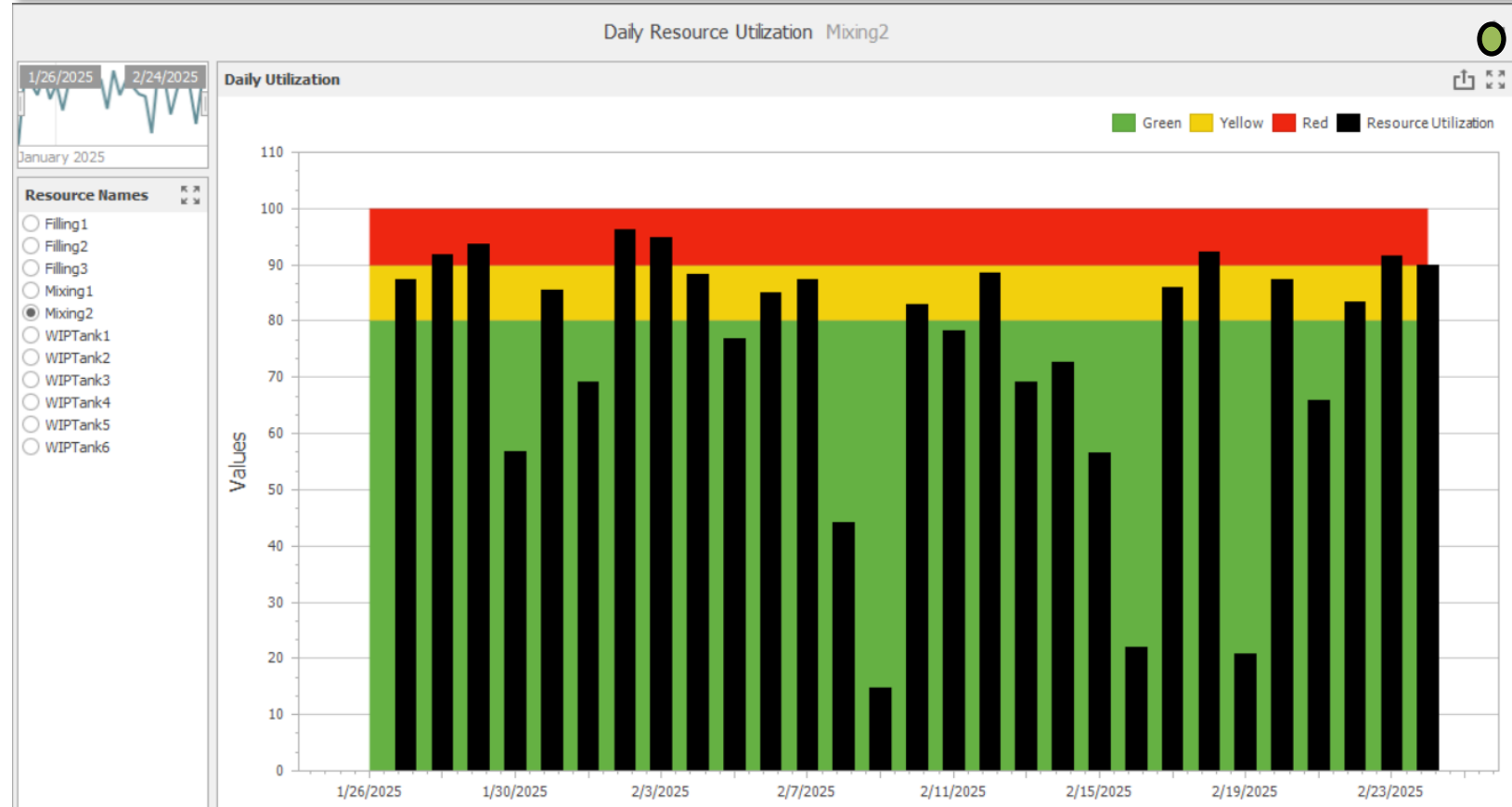
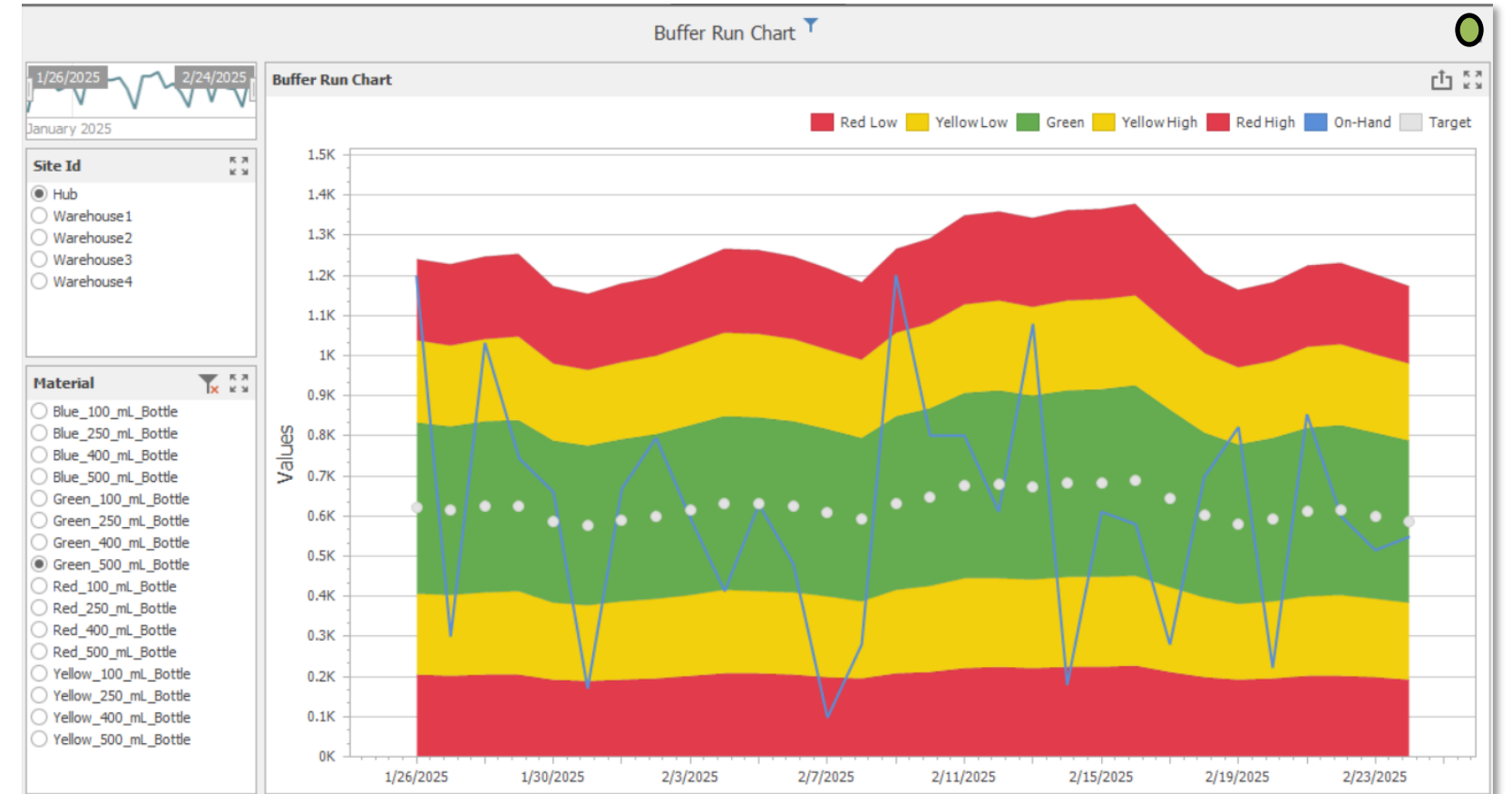
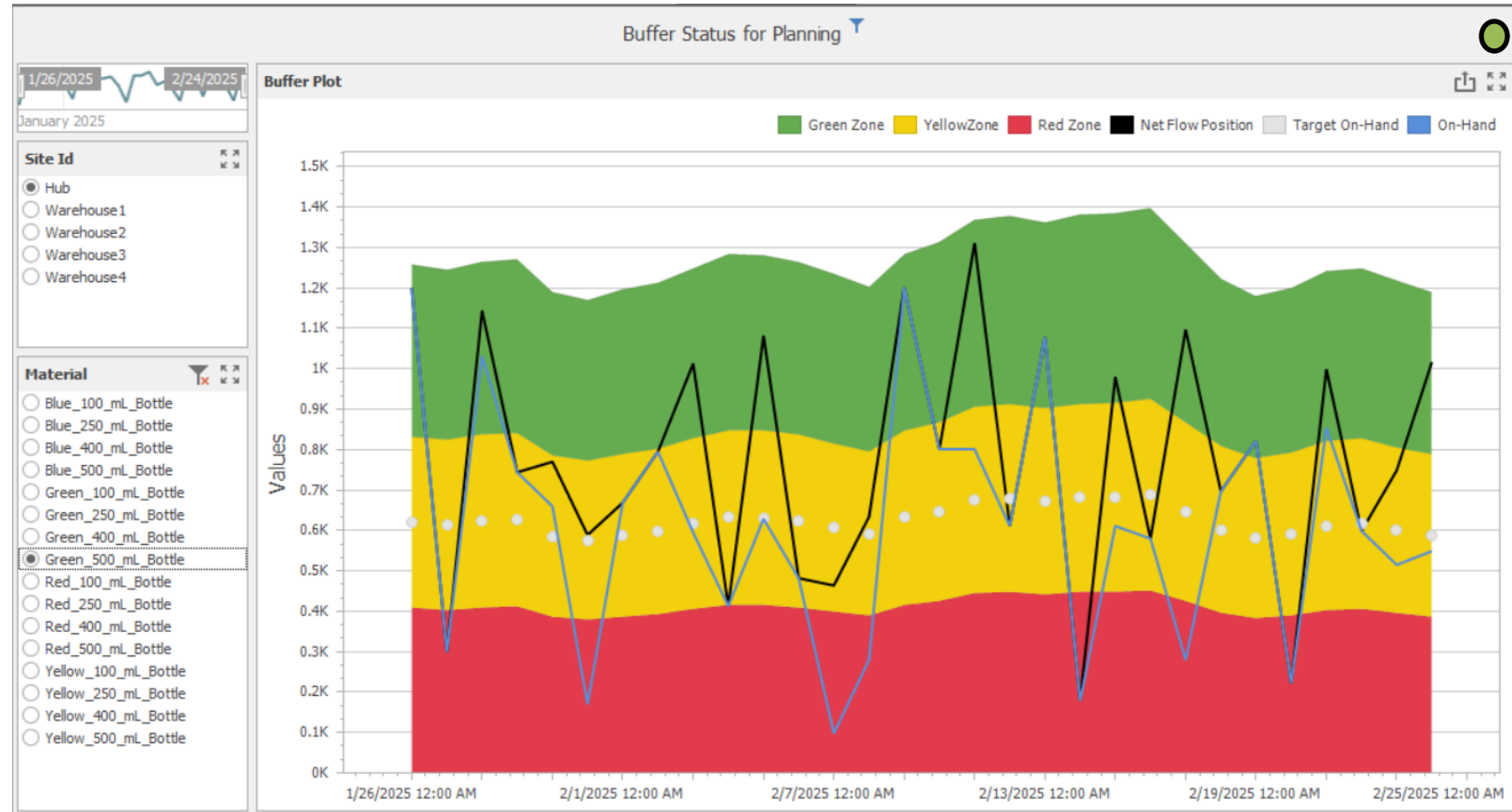
# Level 2

## *Run Completed*

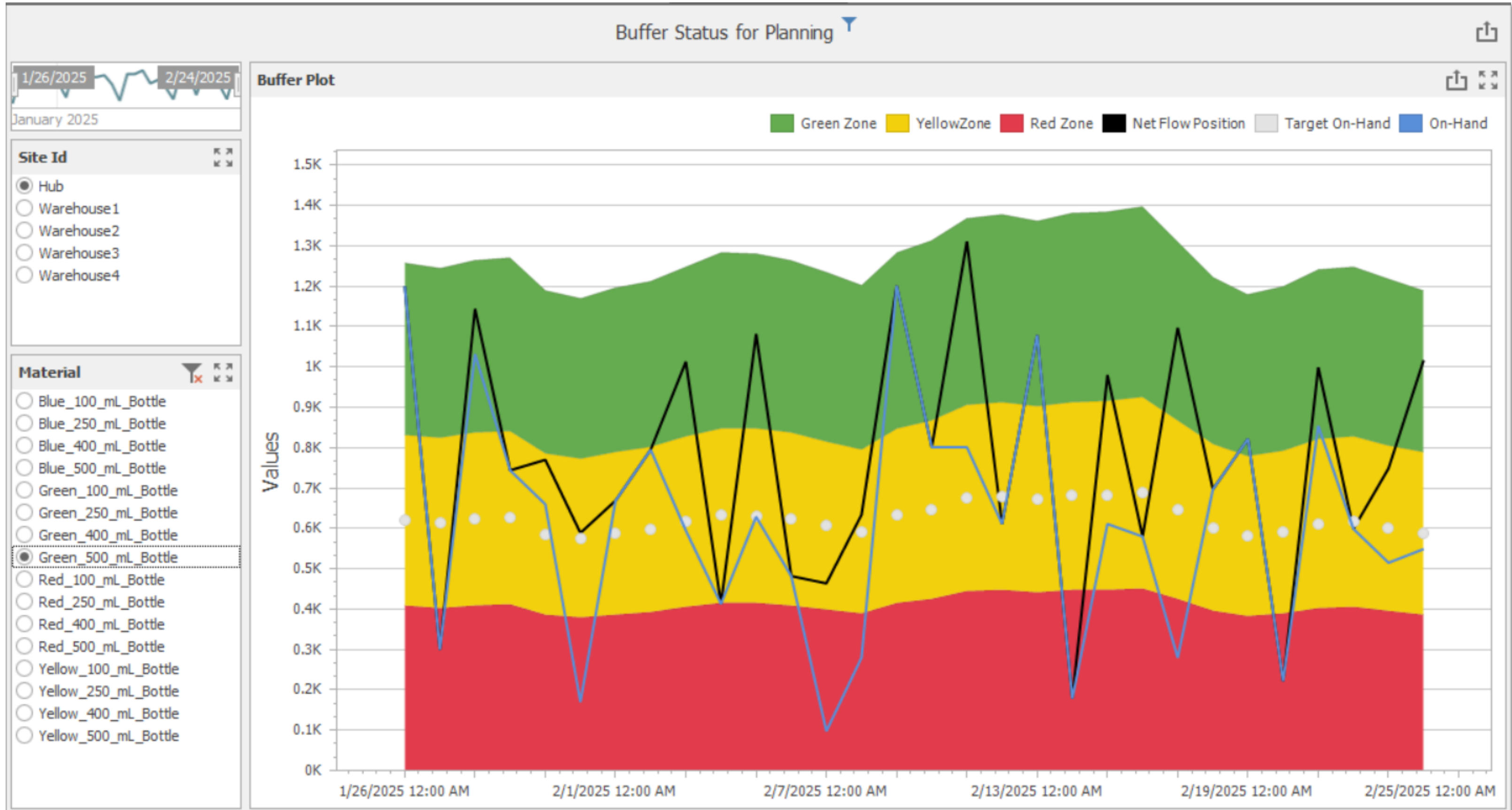


Start Game

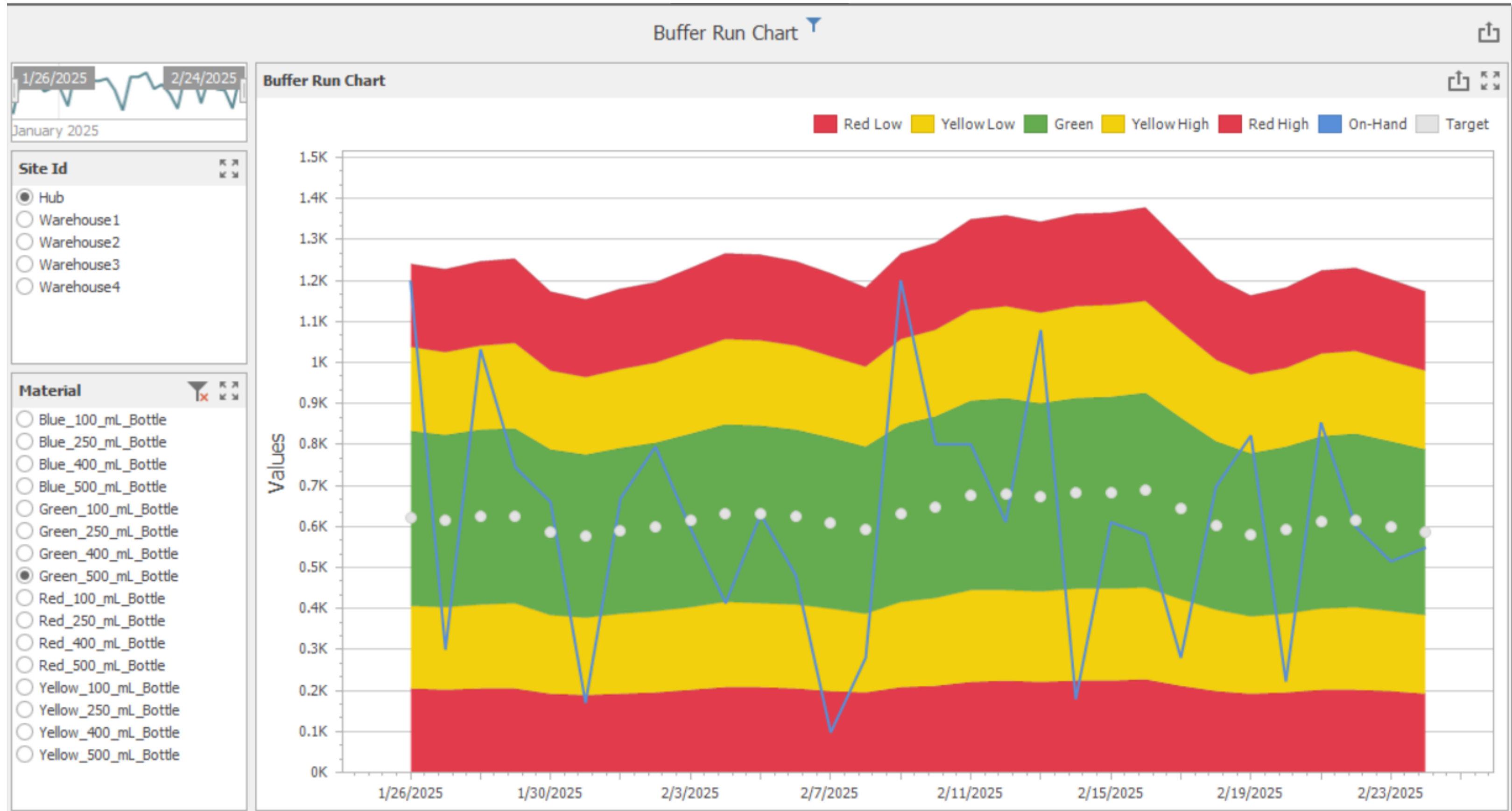
# Level 2 Results: Inventory and Utilization Dashboards



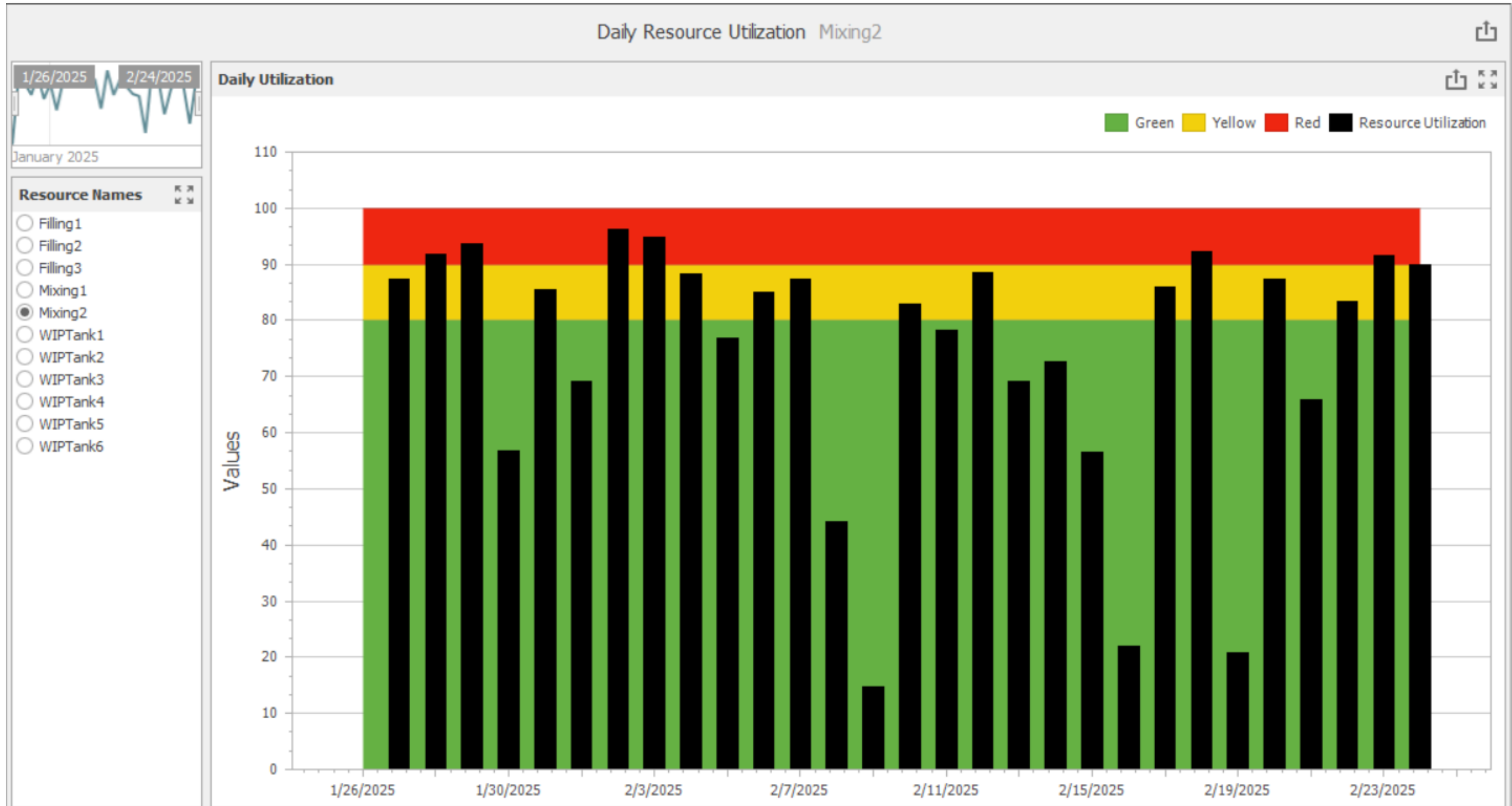
# Level 2 Results: Buffer status for Green 500ml bottle



# Level 2 Results: Buffer run chart for Green 500ml bottle



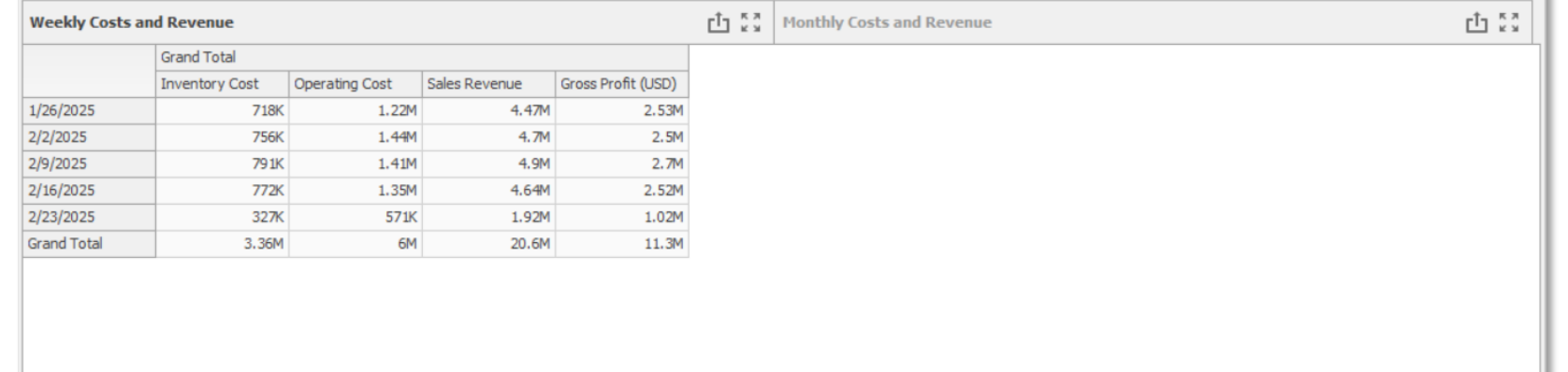
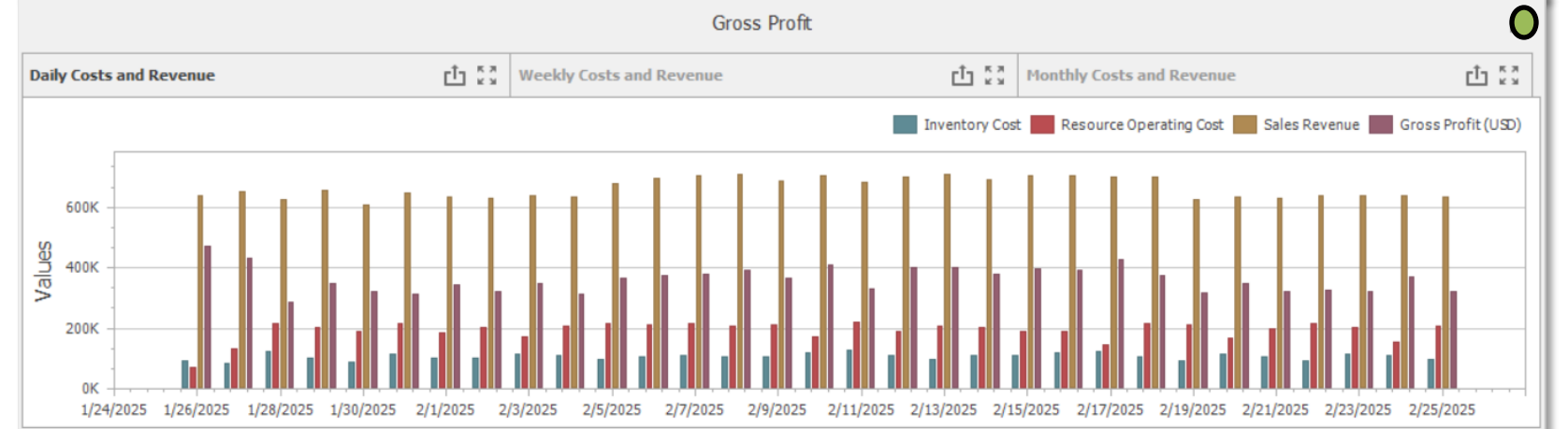
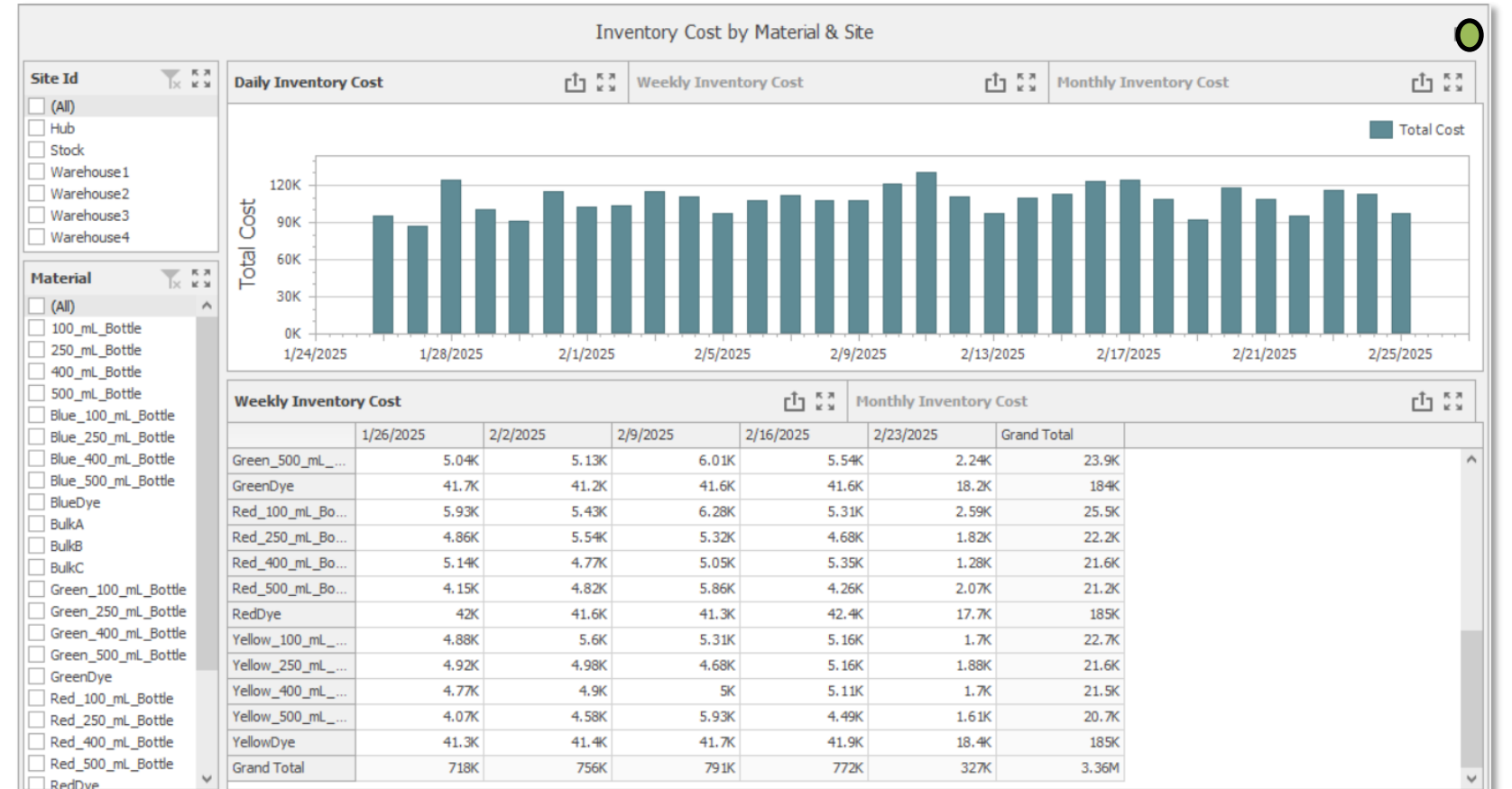
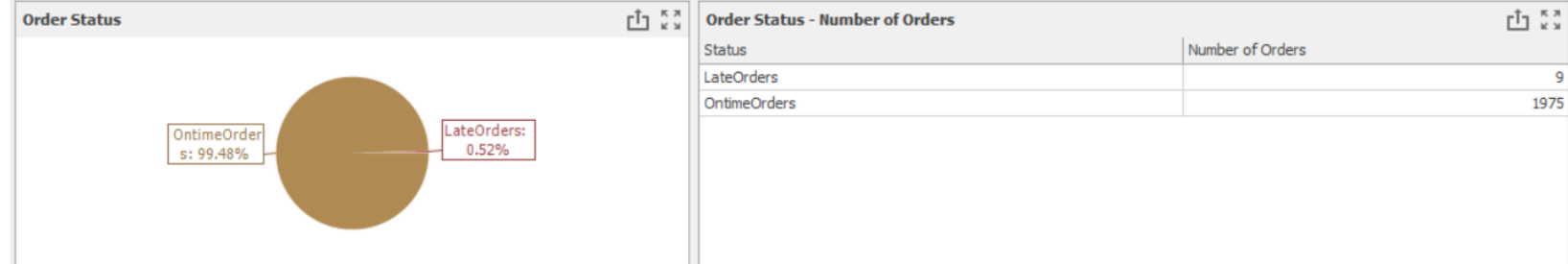
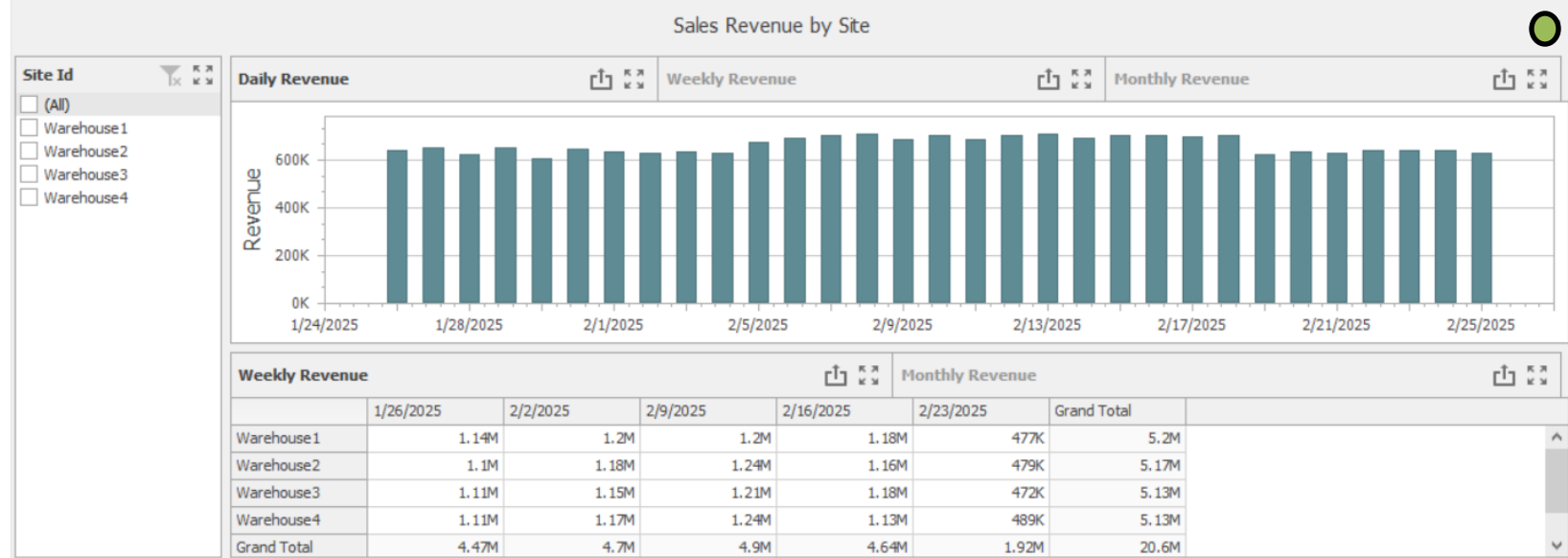
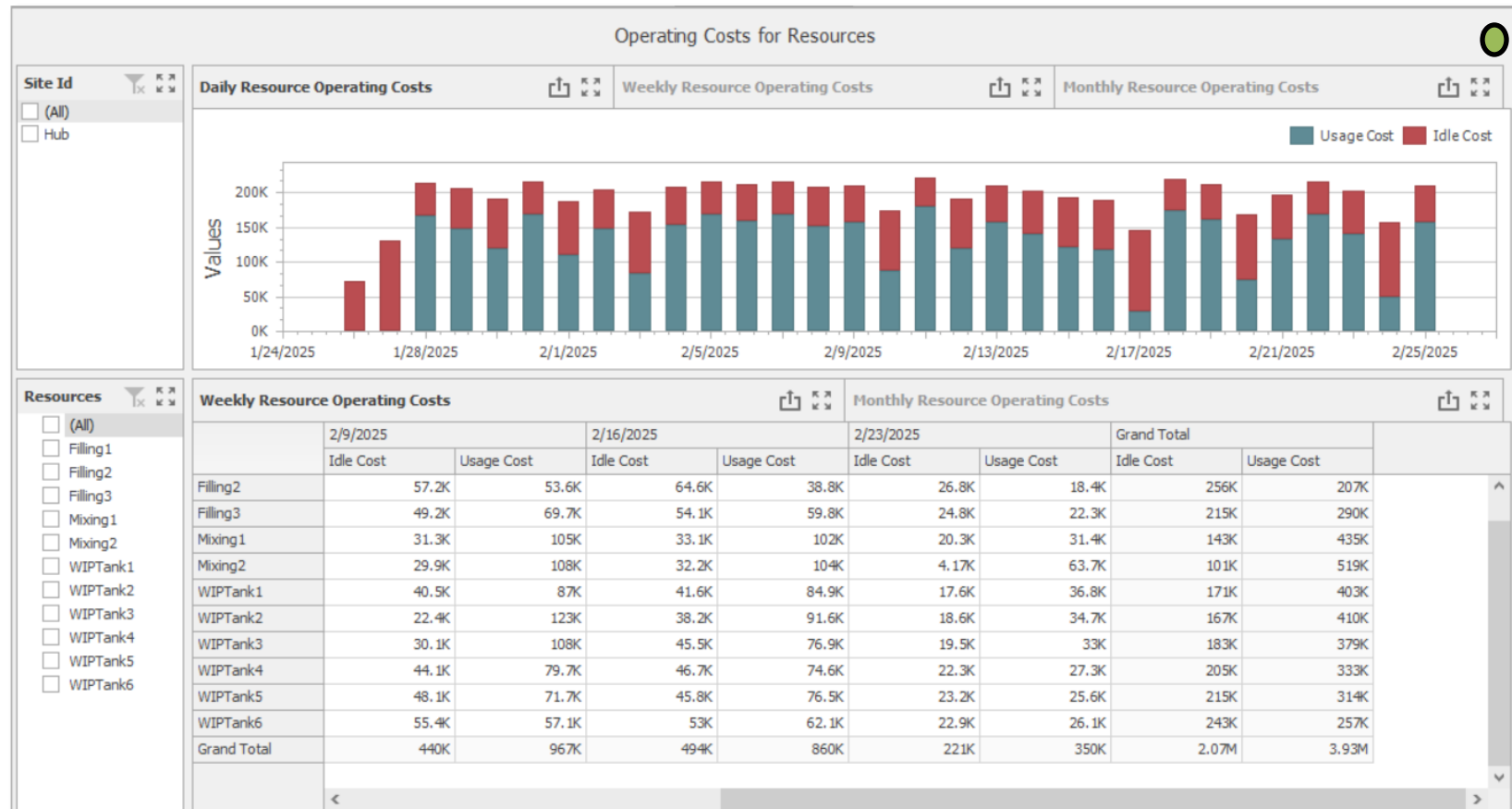
## Level 2 Results: Resource utilization for Mixer 2



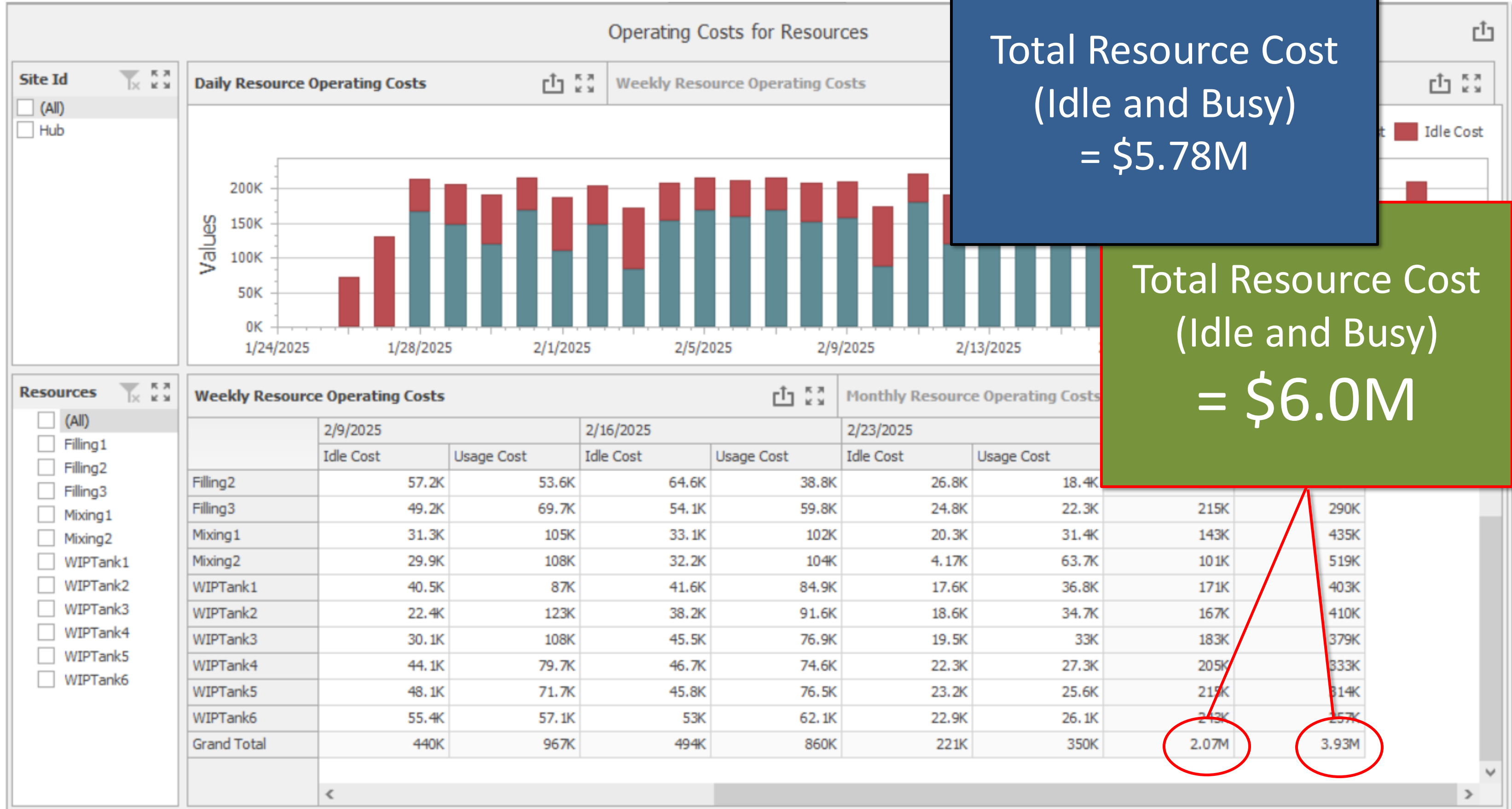
# Level 2 Results: Warehouse 1 capacity



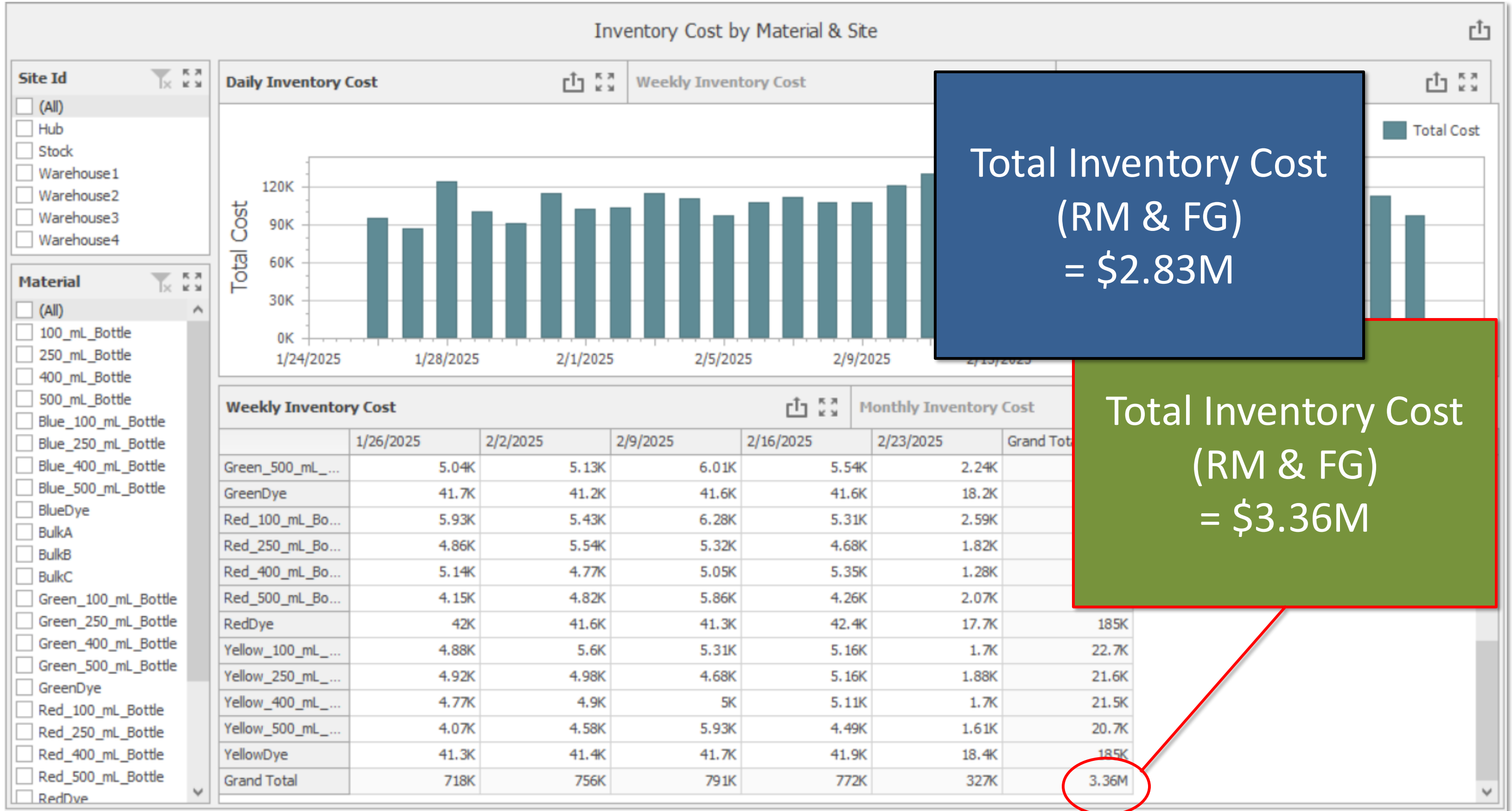
# Level 2 Results: Financial and Service Level Dashboards



# Level 2 Results: Resource cost



# Level 2 Results: Inventory cost



2

# Level 2 Results: Revenue and service level

Total Sales Revenue = \$17.5M

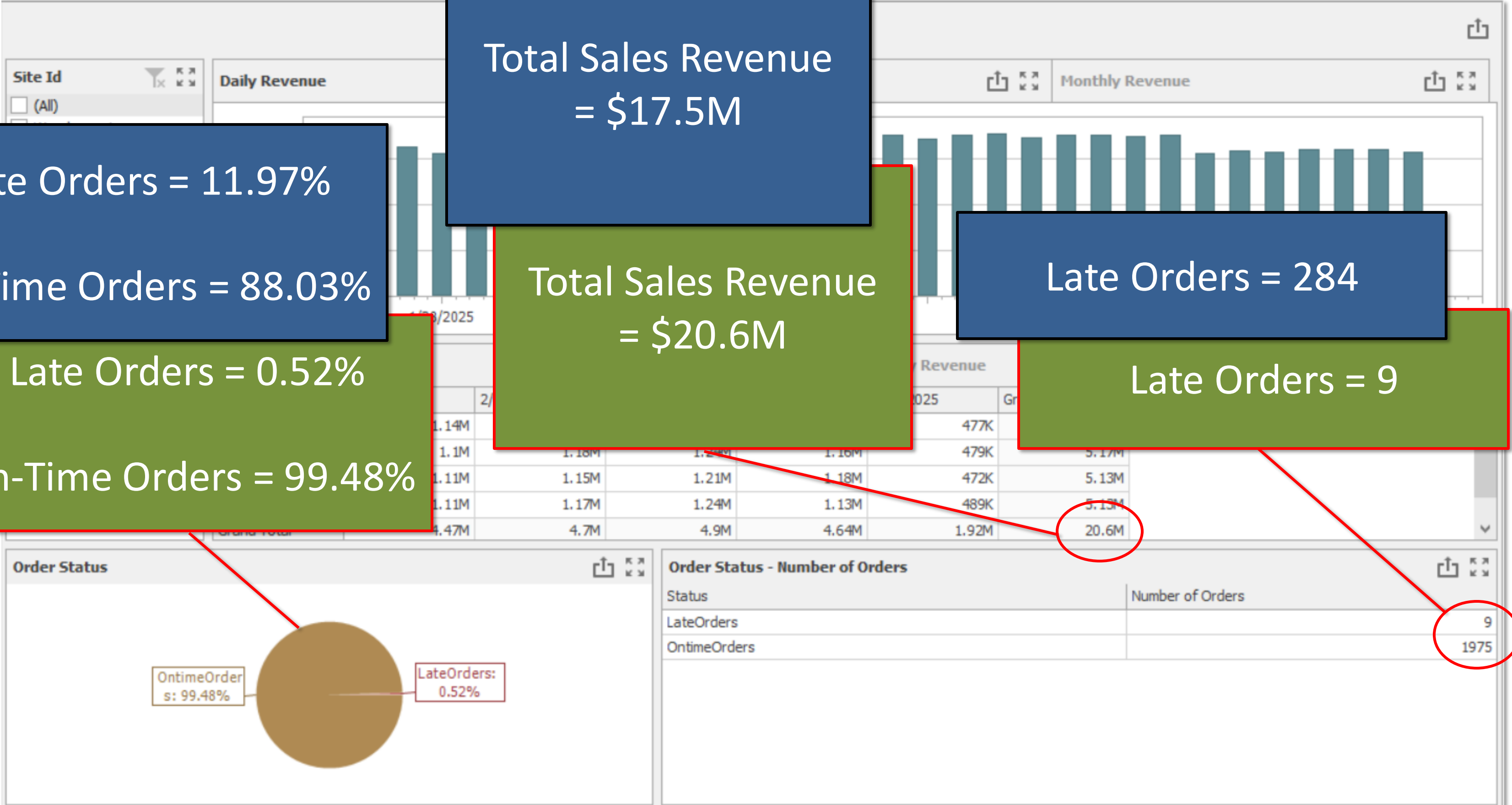
Late Orders = 11.97%  
On-Time Orders = 88.03%

Total Sales Revenue = \$20.6M

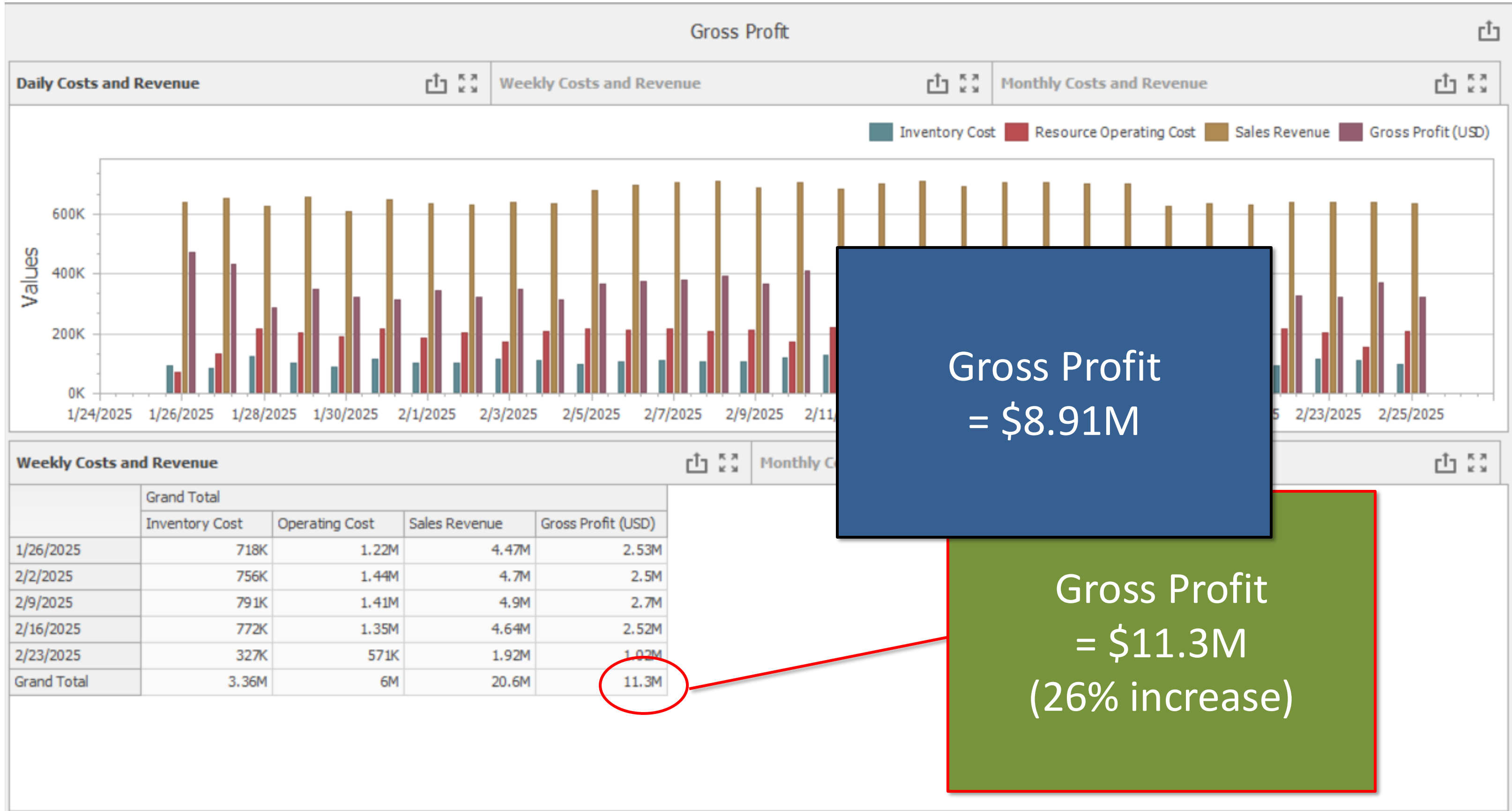
Late Orders = 284

Late Orders = 0.52%  
On-Time Orders = 99.48%

Late Orders = 9



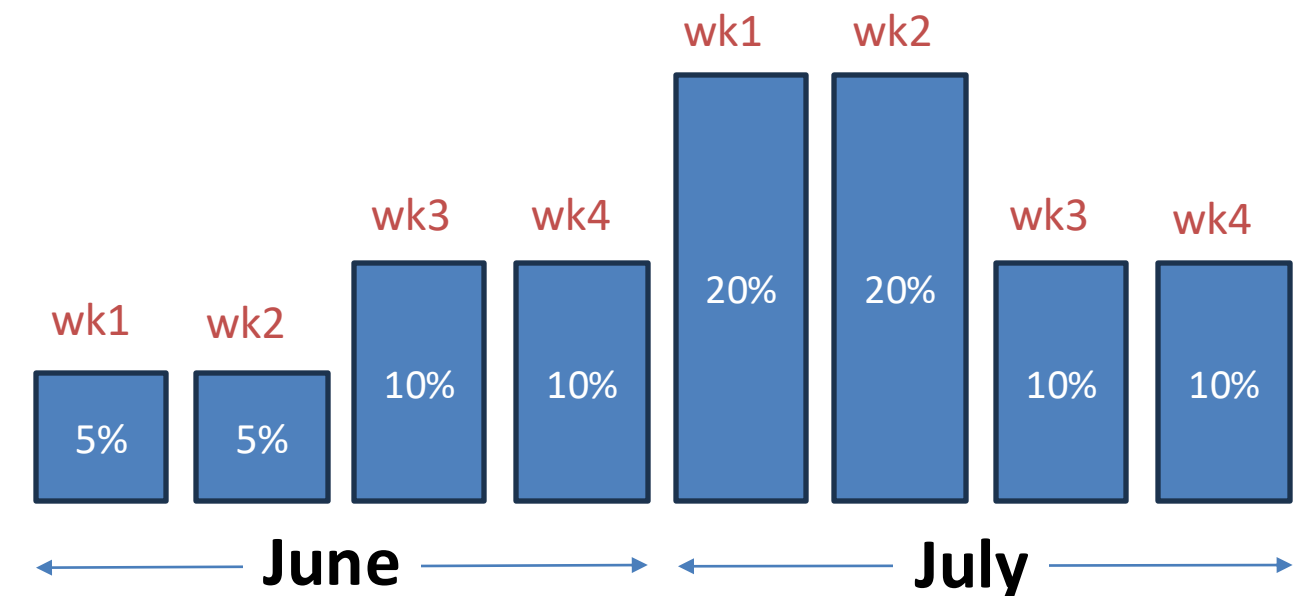
# Level 2 Results: Gross profit



# Game Level 3 (Tactical S&OP)

## ■ The Level 3 challenge: Adaptive S&OP

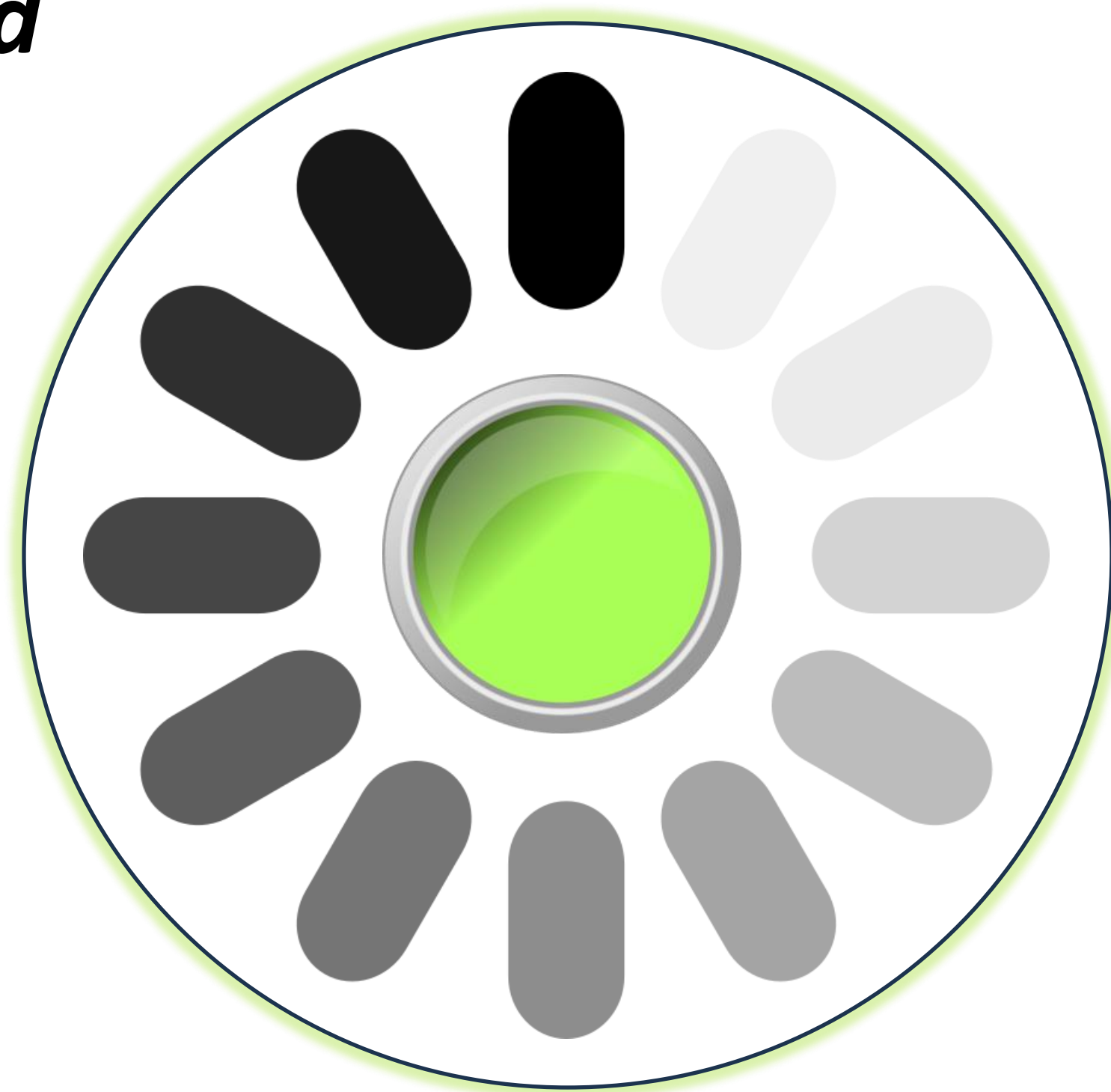
- Strategic planning starting with Level 2 configuration (DDMRP)
- Ongoing 25% day-to-day variation in demand across the whole period
- Evaluate the business impact of the expected **2025 winter lift** in demand
  - First 2 weeks in June = 5% increase
  - Second 2 weeks in June = 10% increase
  - First 2 weeks in July = 20% increase
  - Second 2 weeks in July = 10% increase
- Run the game for 220 days (7.3 month)
  - Starting the 26th of January 2025
  - Ending late September 2025



Analyze and improve the impact of the expected **2025 winter lift** in demand on the overall business performance

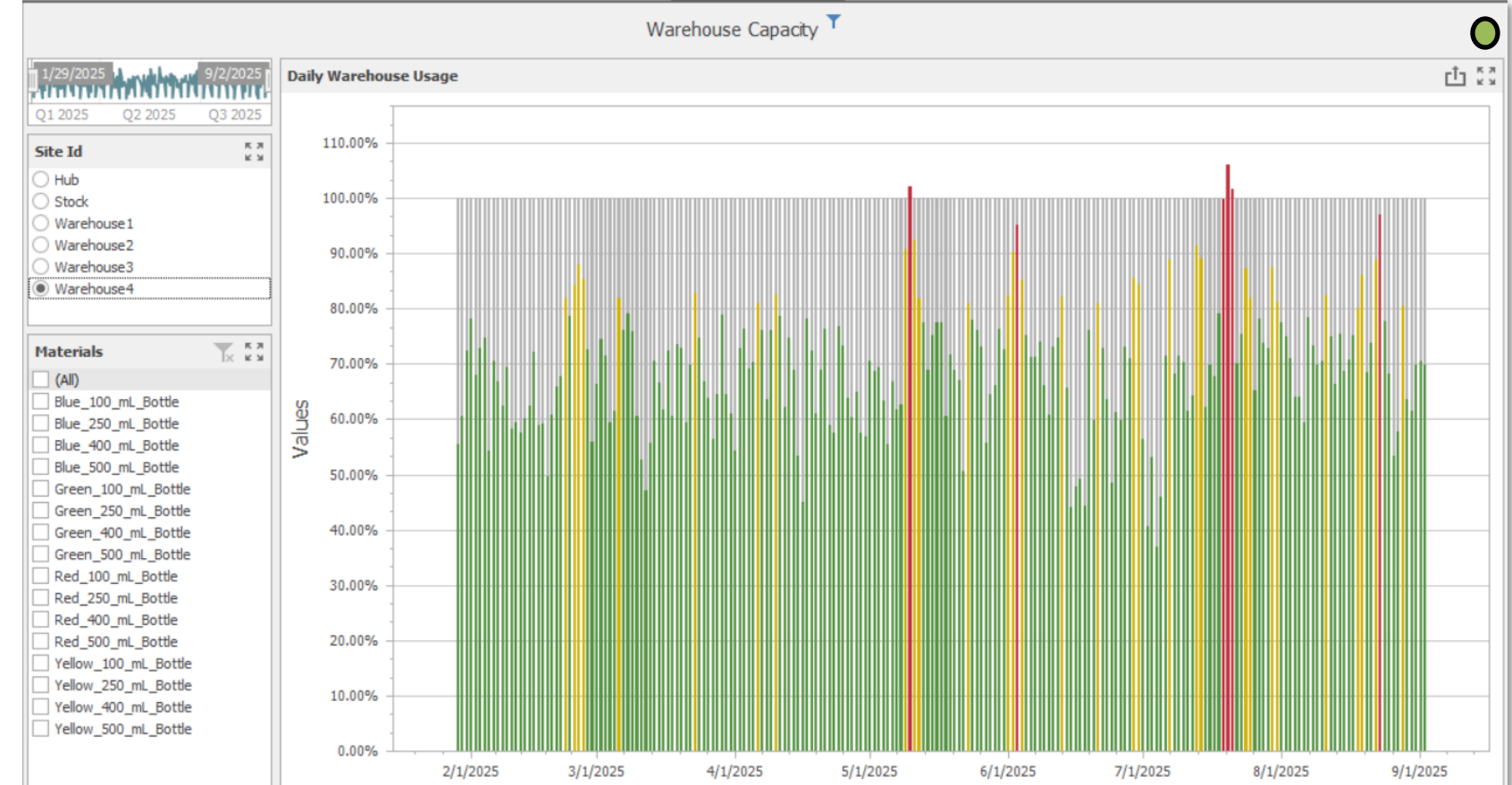
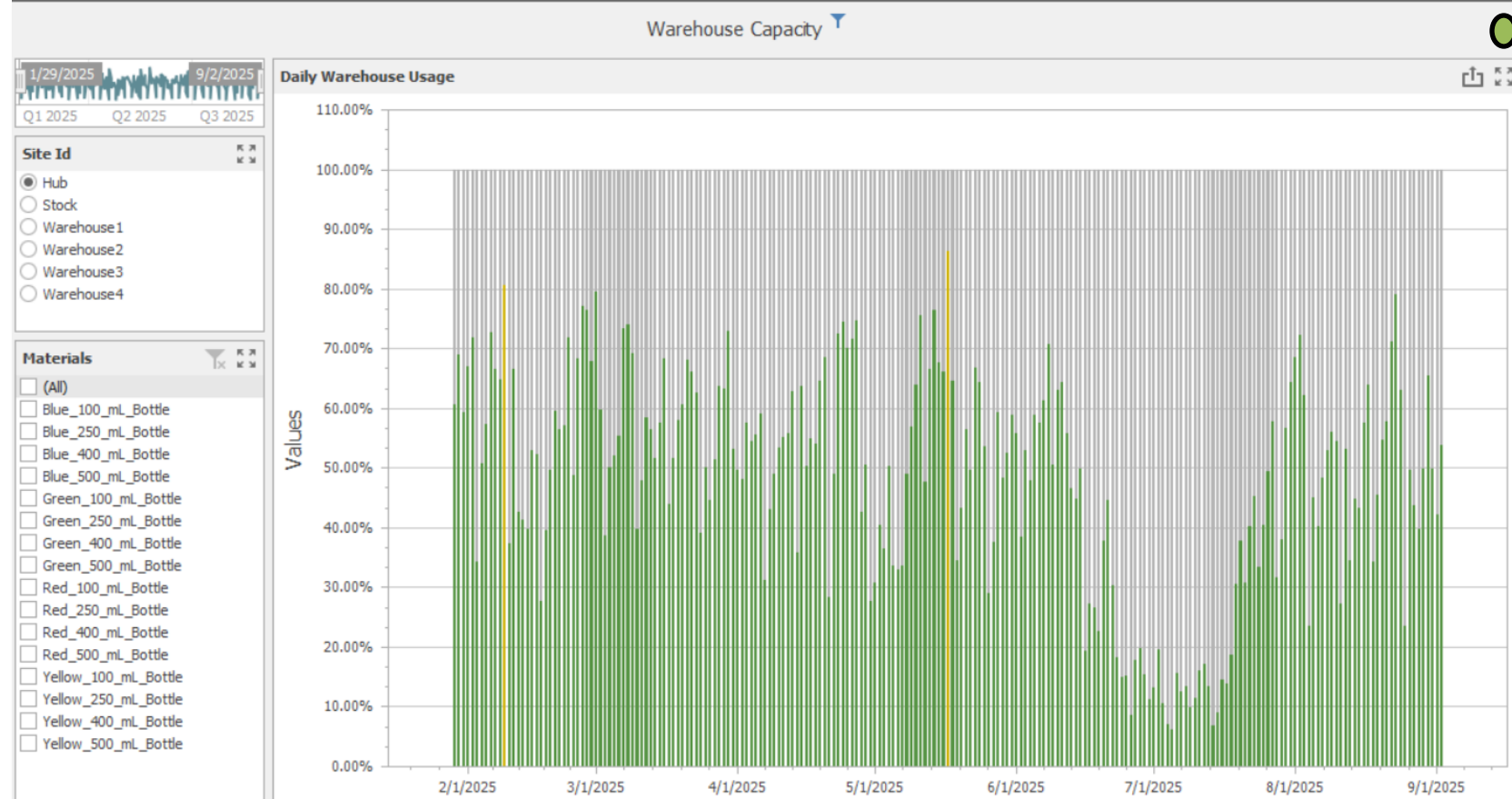
# Level 3

## *Run Completed*



Start Game

# Level 3 Results: Gantt Charts and Inventory Dashboards



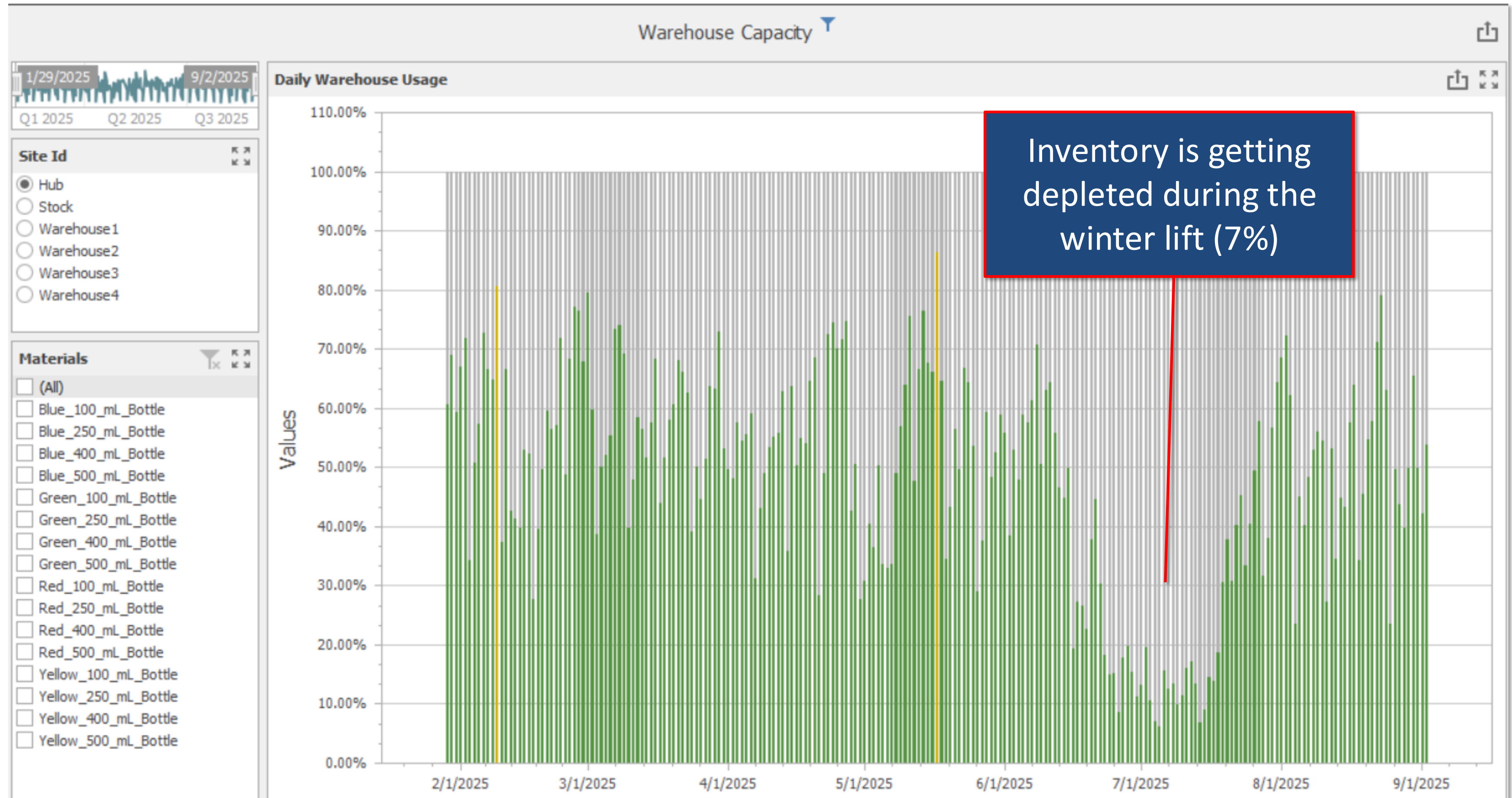
# Level 3 Results – Gantt chart



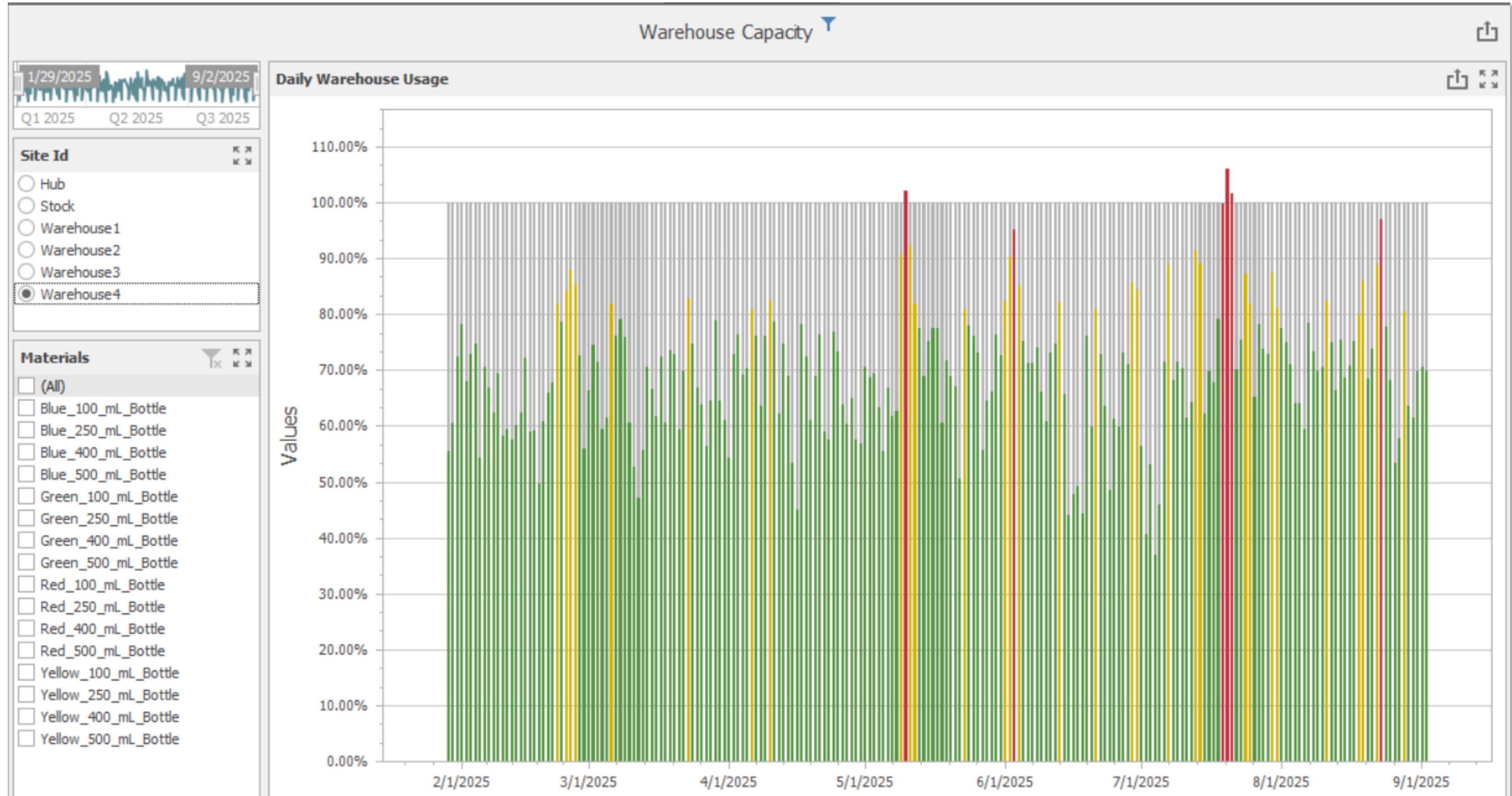
# Level 3 Results – Gantt chart for June & July



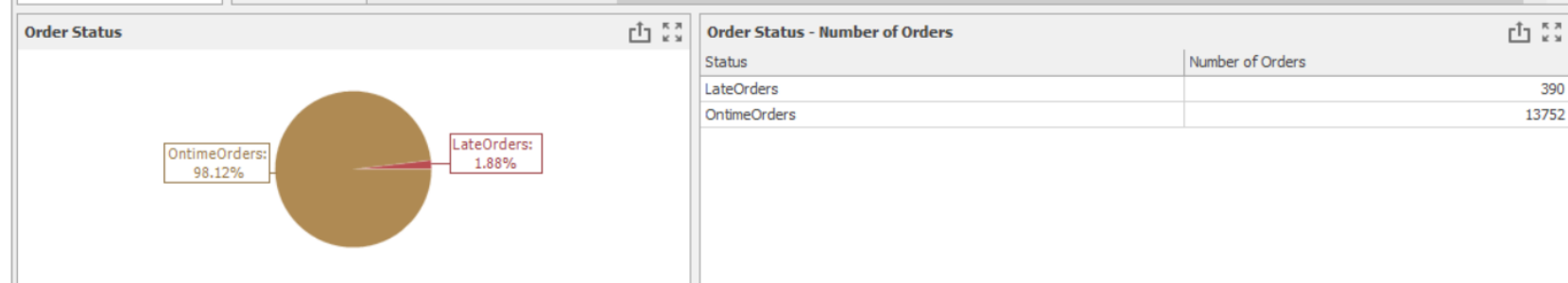
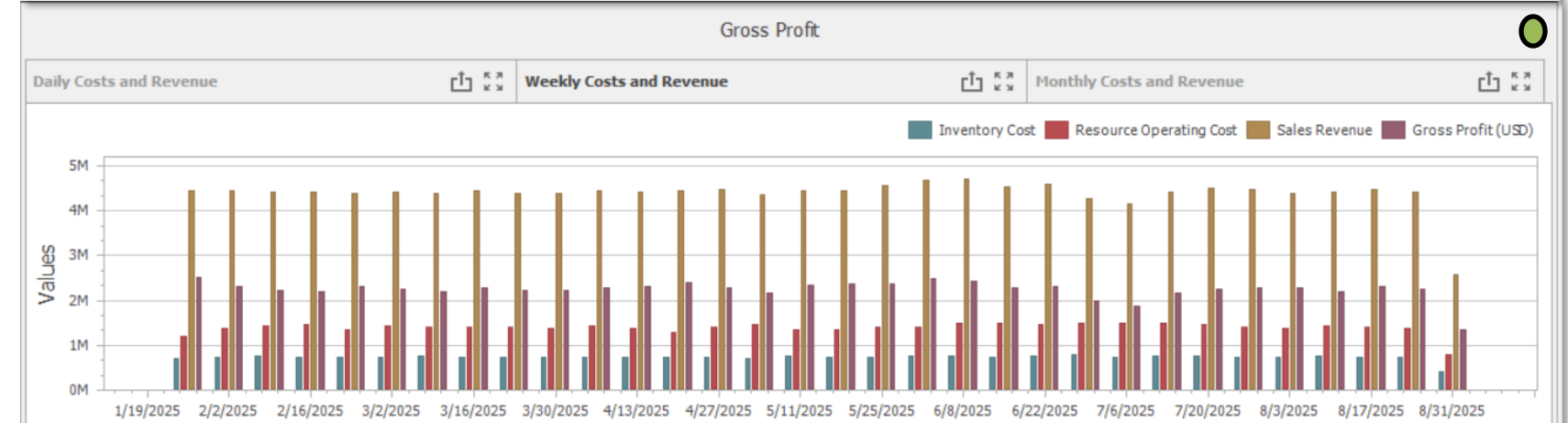
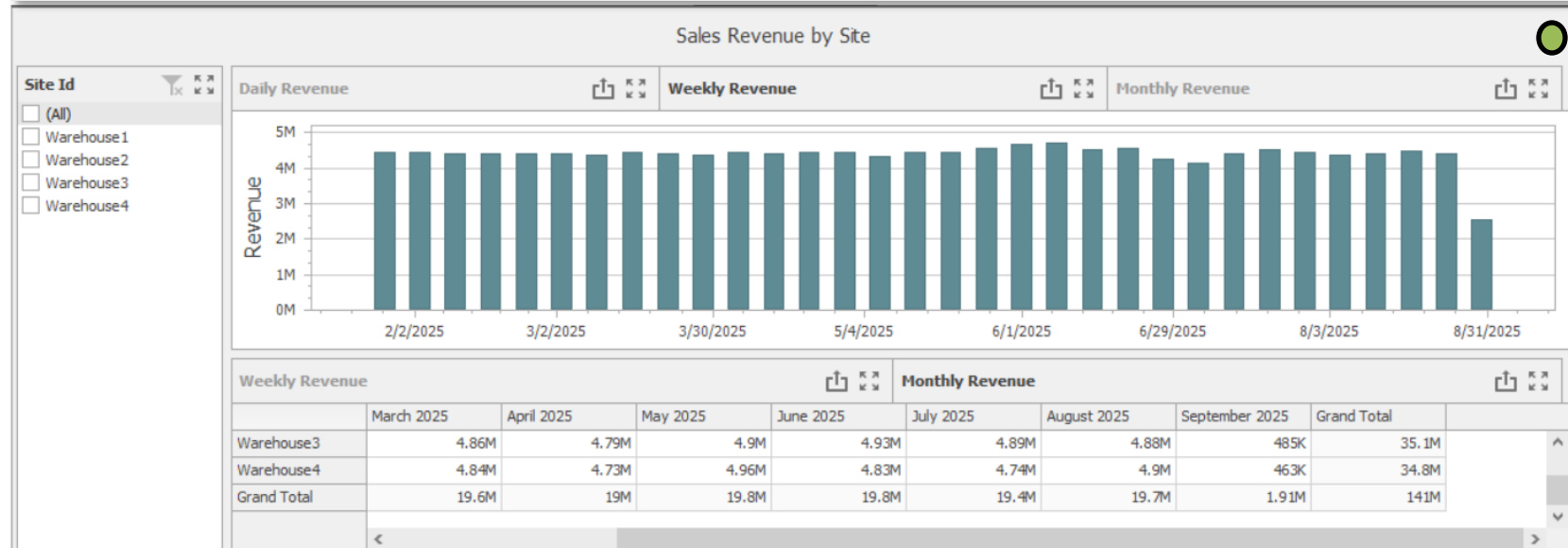
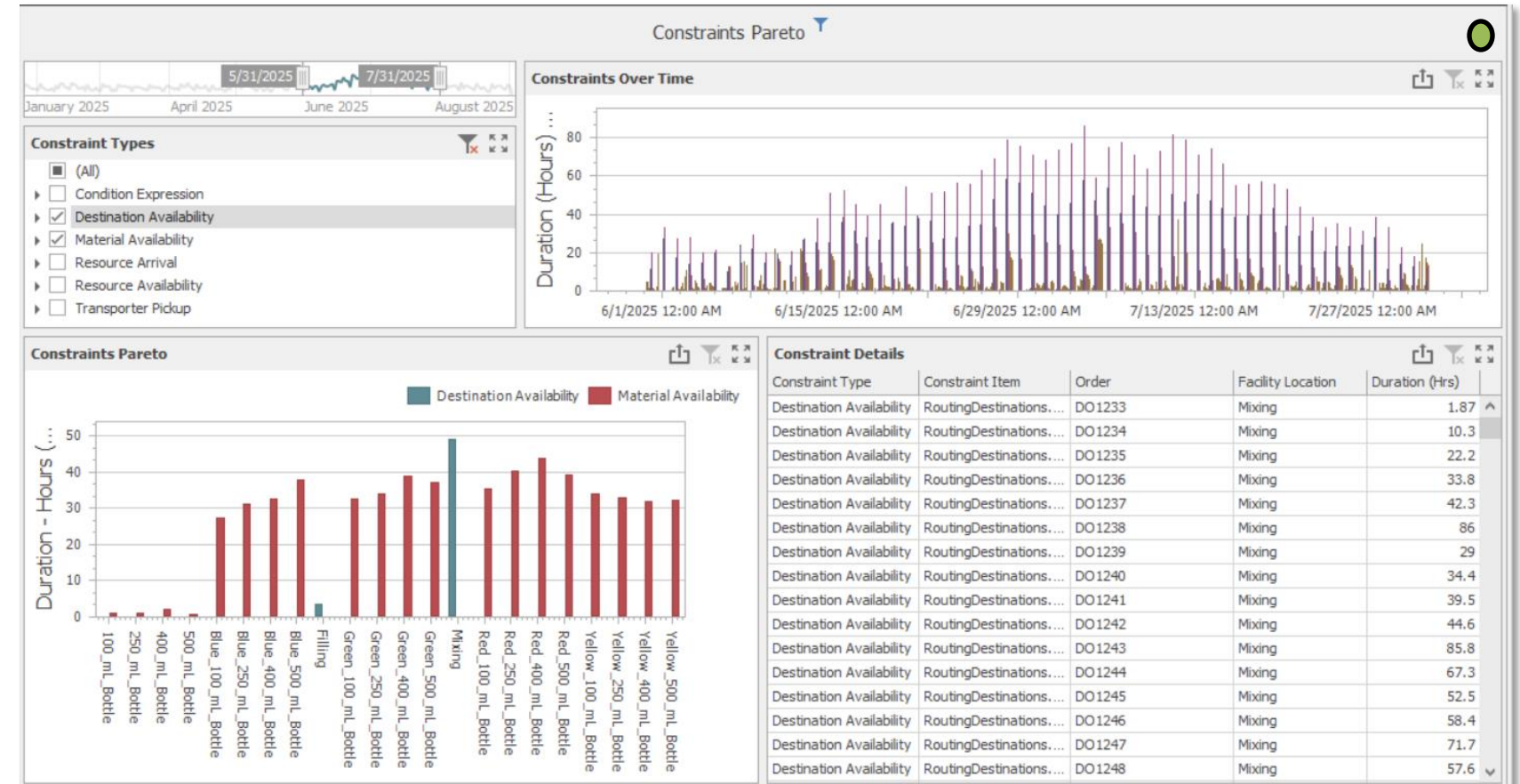
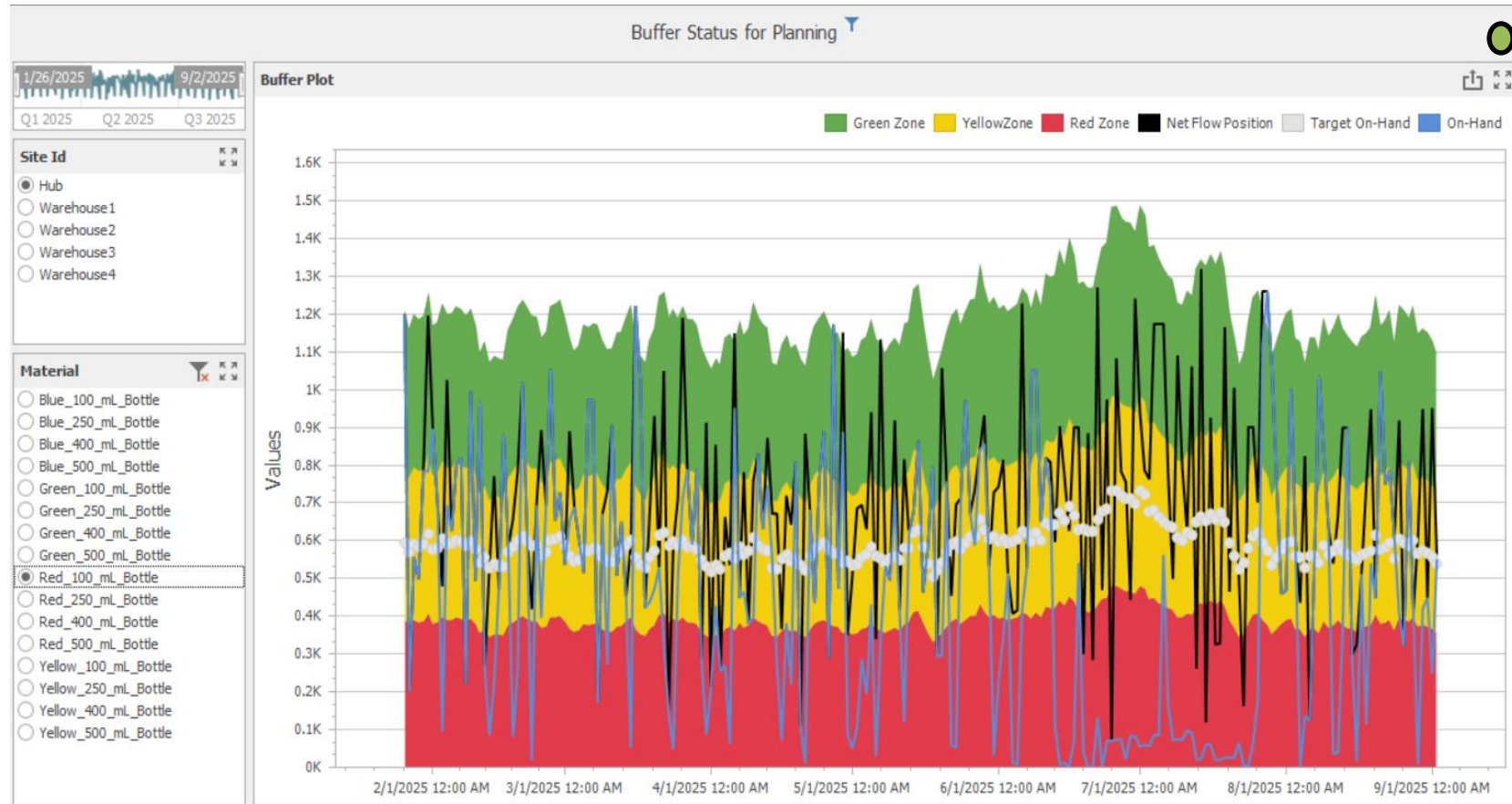
# Level 3 Results – Factory HUB capacity



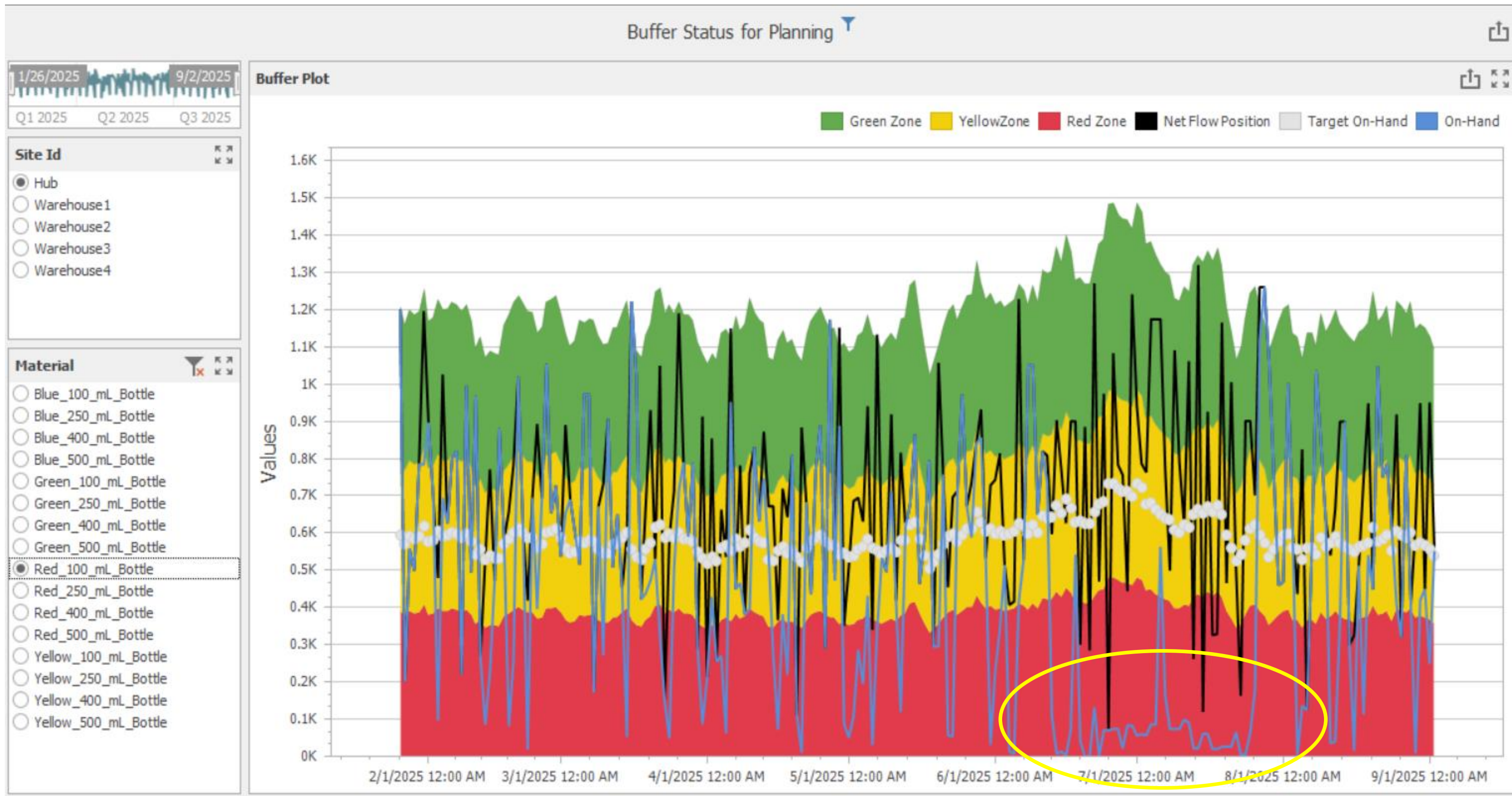
# Level 3 Results – Distribution Warehouse #4 capacity



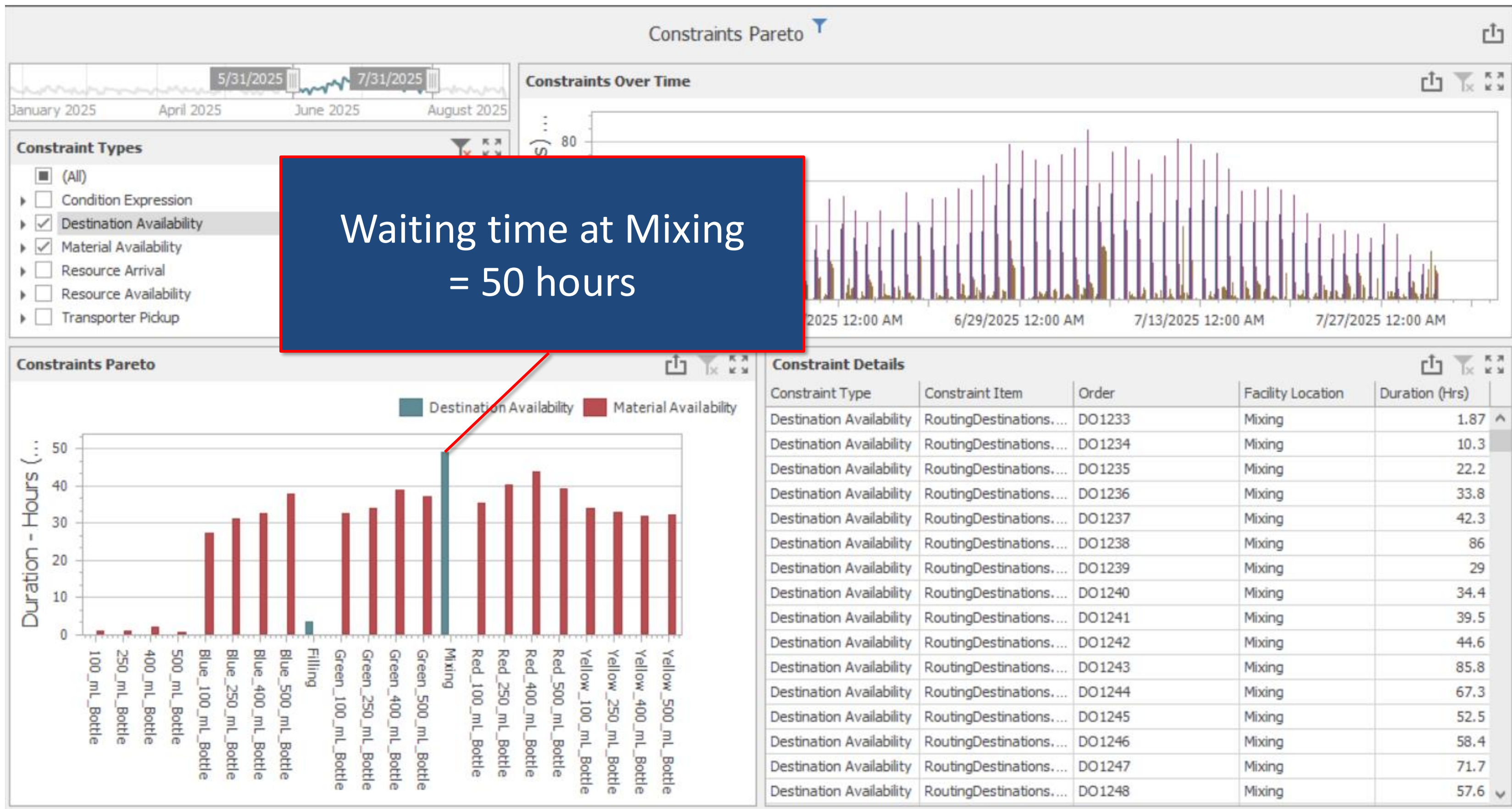
# Level 3 Results: Inventory, Constraint and Financial Dashboards



# Level 3 Results – Inventory Red 100ml bottle

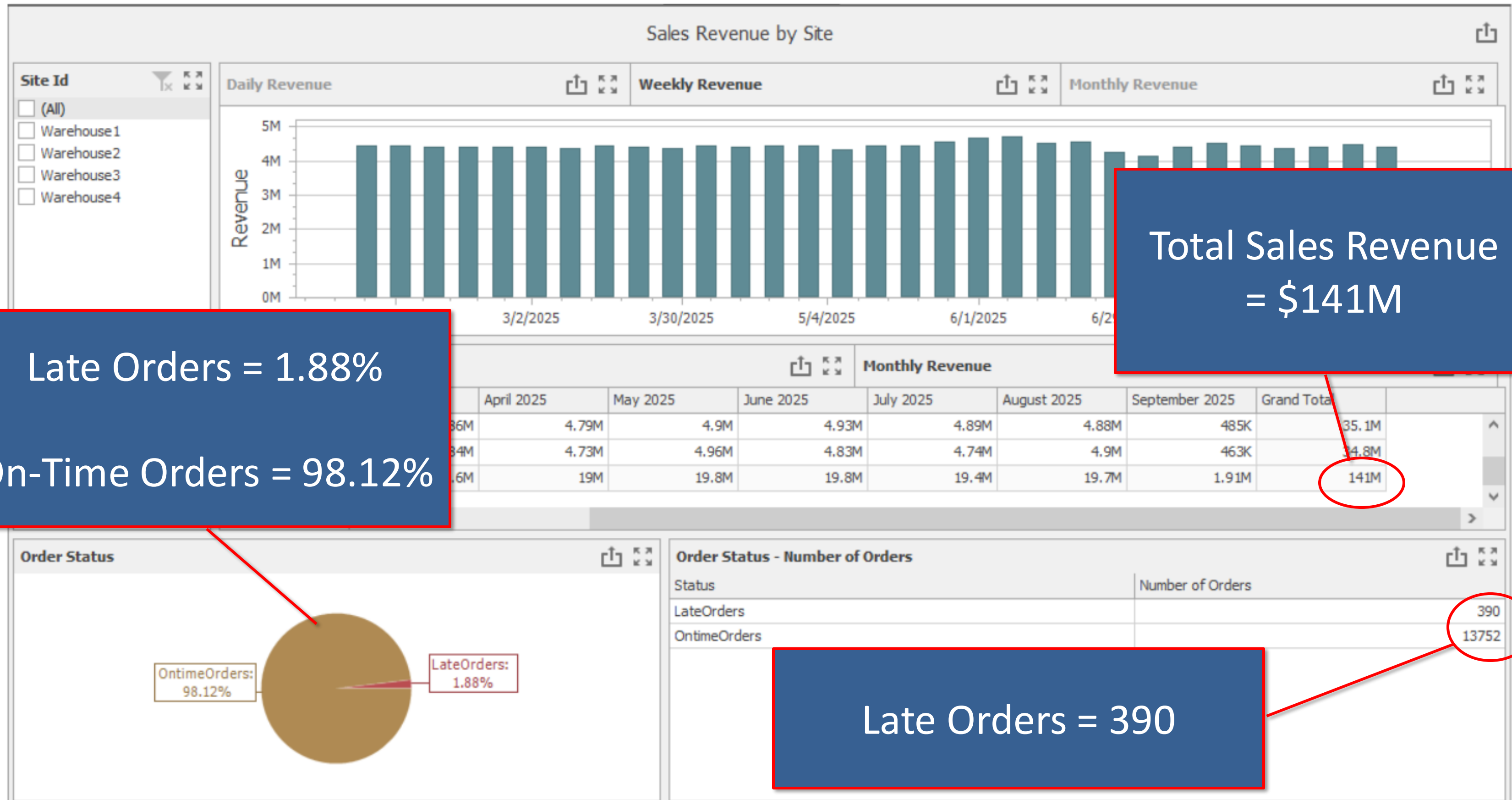


# 3 Level 3 Results – Key Constraints

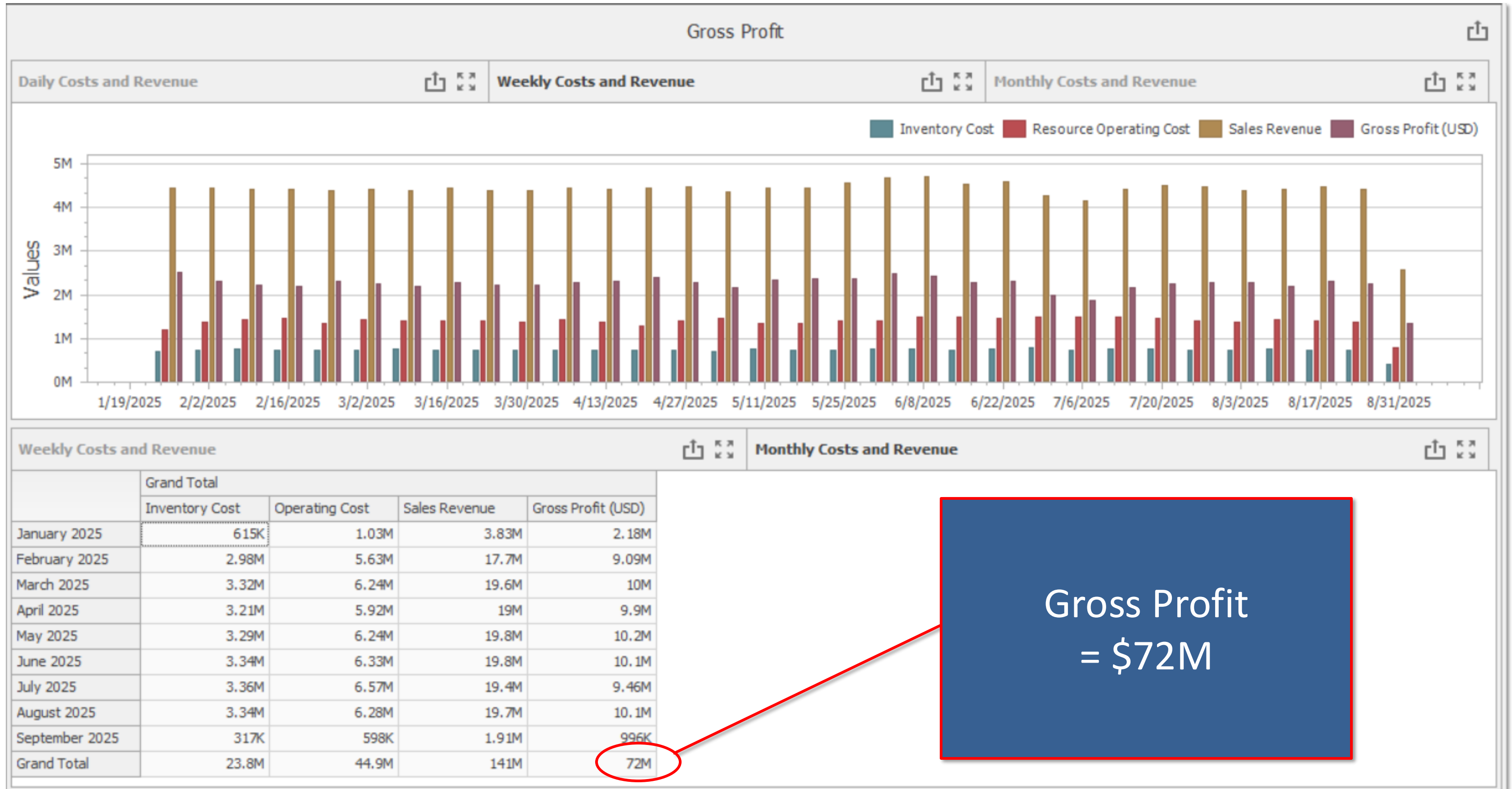


# 3

## Level 3 Results – Revenue and Service Levels



# 3 Level 3 Results – Gross Profit



## 3

## Impact of the Winter Lift

- Congested factory for 6 to 8-week period
- Almost deplete the stock in the HUB – down to 7%
- Resulting in 390 late orders
- Gross profit of \$72M

**What can we do to improve performance?**

# Game Level 3 Adjustments

## ■ Adjustment Strategy

- Demand Adjustment Factor to build ahead
  - All 4 warehouses = 10% adjustment to build ahead
  - Adjustment Factor set for May only
- Add Sunday shifts to increase capacity in the factory
  - Extra shifts for all of June and July

Demand	Planned Adjustment Factors	Buffer Profiles	Average Daily Usage	Decoupled Lead Times	Buffer Zone Sizes	Qualified Spike Demand	
	Inventory Name	Start Date	End Date	Demand Adjustment Factor	Red Zone Adjustment Factor	Yellow Zone Adjustment Factor	G
1	Blue_100_mL_Bottle_Warehouse1	5/1/2025 12:00:00 AM	6/1/2025 12:00:00 AM	1.1	1	1	
2	Blue_250_mL_Bottle_Warehouse1	5/1/2025 12:00:00 AM	6/1/2025 12:00:00 AM	1.1	1	1	
3	Blue_400_mL_Bottle_Warehouse1	5/1/2025 12:00:00 AM	6/1/2025 12:00:00 AM	1.1	1	1	
4	Blue_500_mL_Bottle_Warehouse1	5/1/2025 12:00:00 AM	6/1/2025 12:00:00 AM	1.1	1	1	
5	Green_100_mL_Bottle_Warehouse1	5/1/2025 12:00:00 AM	6/1/2025 12:00:00 AM	1.1	1	1	
6	Green_250_mL_Bottle_Warehouse1	5/1/2025 12:00:00 AM	6/1/2025 12:00:00 AM	1.1	1	1	
7	Green_400_mL_Bottle_Warehouse1	5/1/2025 12:00:00 AM	6/1/2025 12:00:00 AM	1.1	1	1	
8	Green_500_mL_Bottle_Warehouse1	5/1/2025 12:00:00 AM	6/1/2025 12:00:00 AM	1.1	1	1	
9	Yellow_100_mL_Bottle_Warehouse1	5/1/2025 12:00:00 AM	6/1/2025 12:00:00 AM	1.1	1	1	
10	Yellow_250_mL_Bottle_Warehouse1	5/1/2025 12:00:00 AM	6/1/2025 12:00:00 AM	1.1	1	1	
11	Yellow_400_mL_Bottle_Warehouse1	5/1/2025 12:00:00 AM	6/1/2025 12:00:00 AM	1.1	1	1	

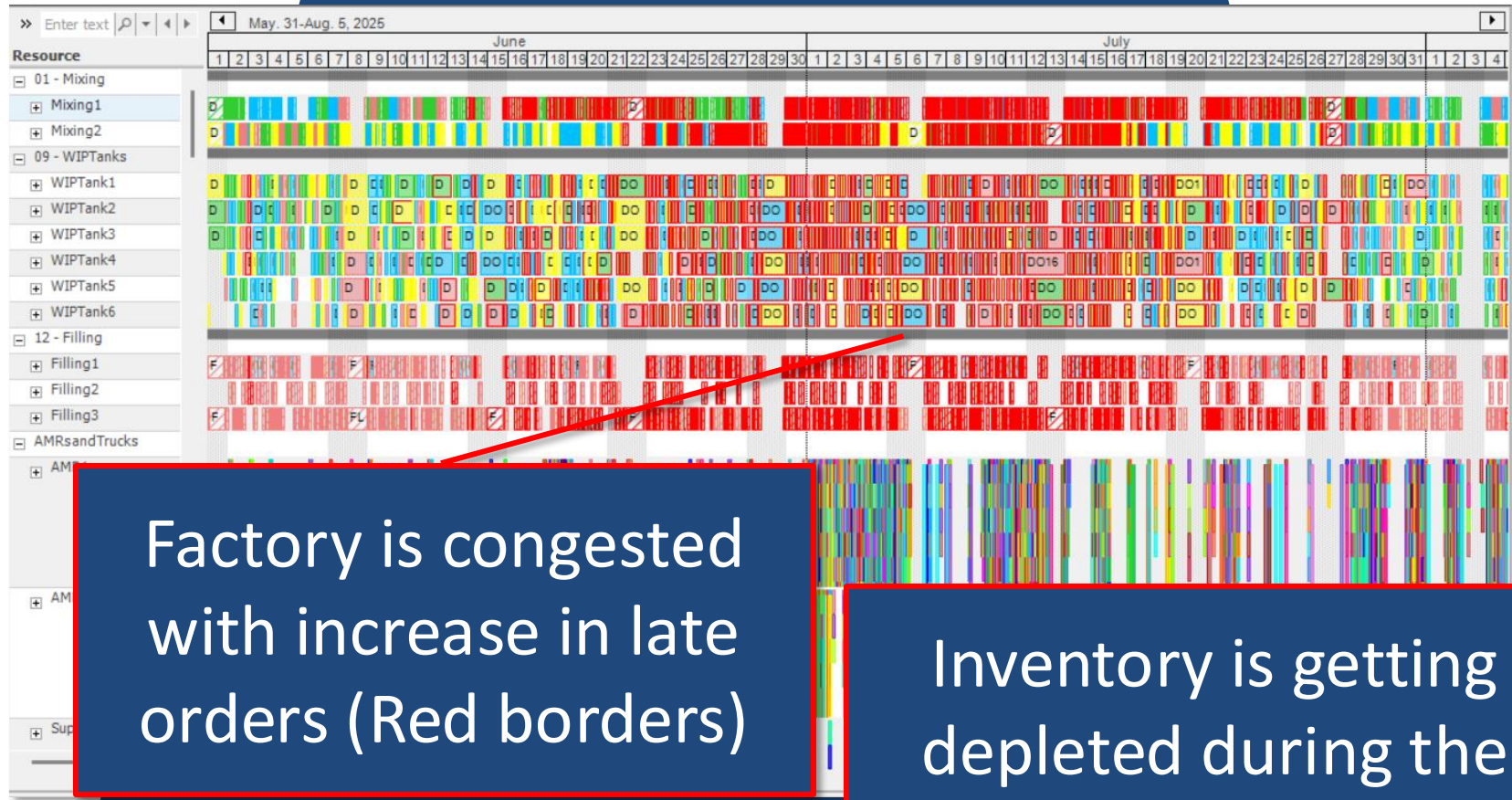
# Level 3 Adjustments

## *Run Completed*



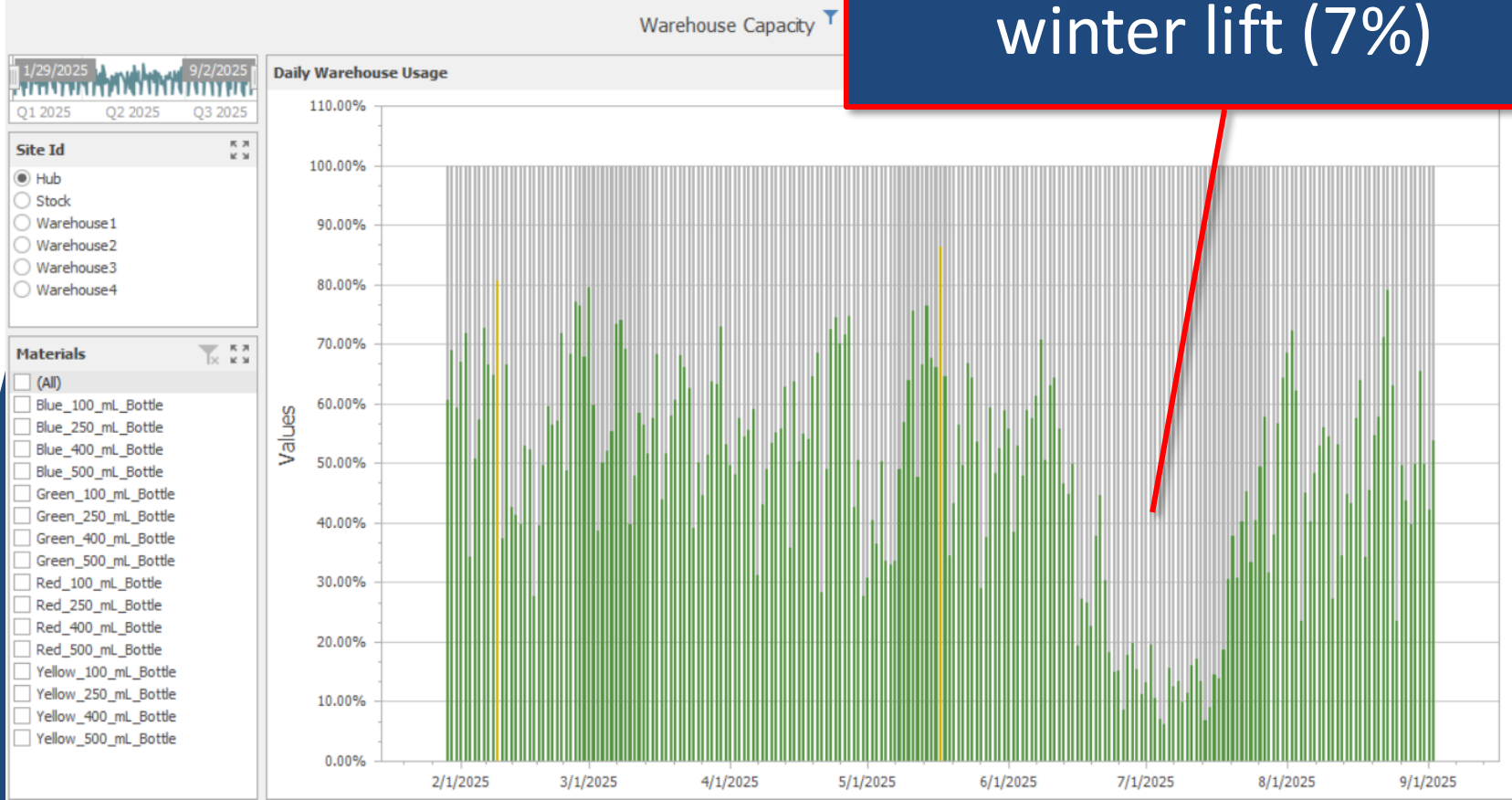
Start Game

# Base Level Results



Factory is congested with increase in late orders (Red borders)

Inventory is getting depleted during the winter lift (7%)

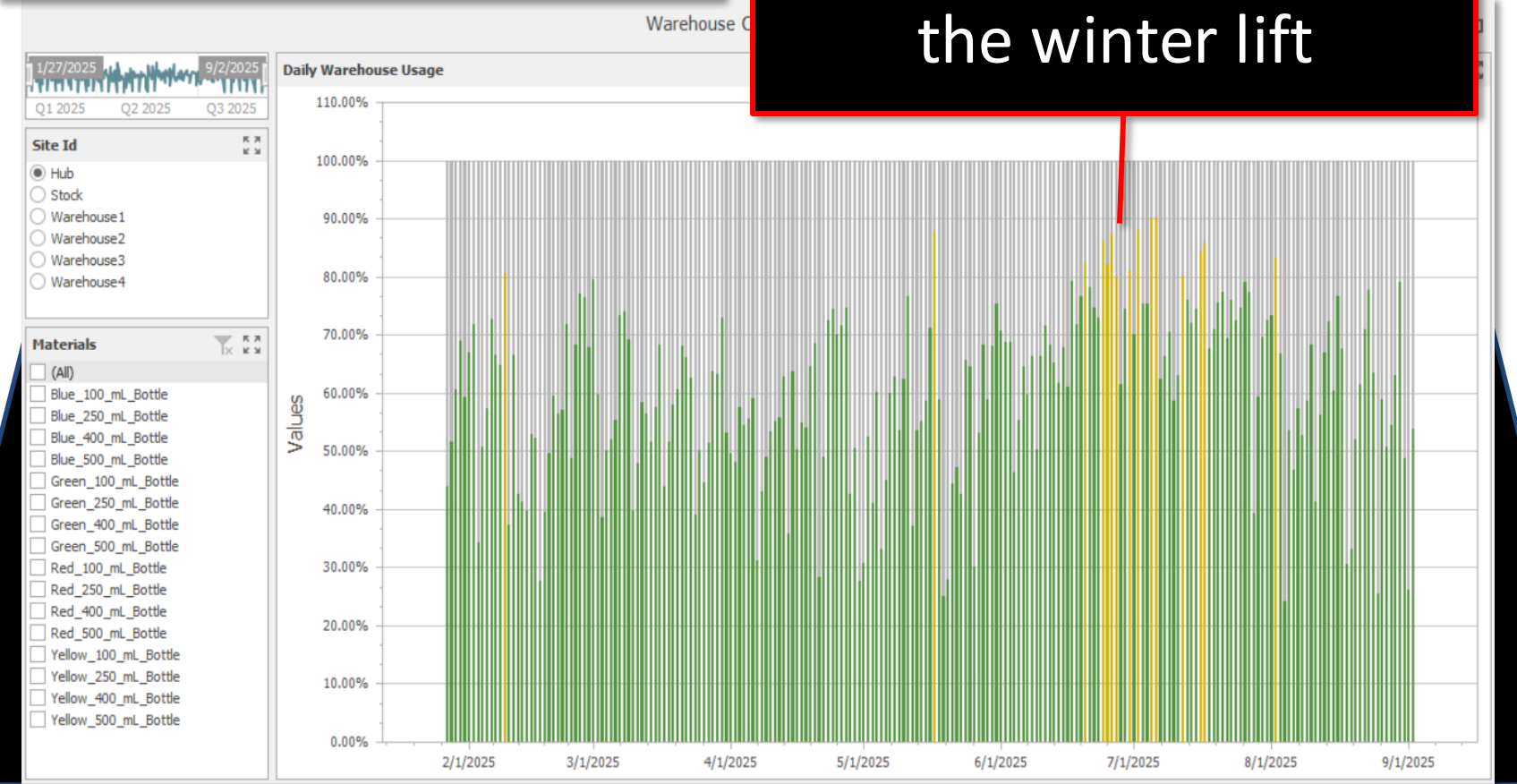


# Adjustment Results

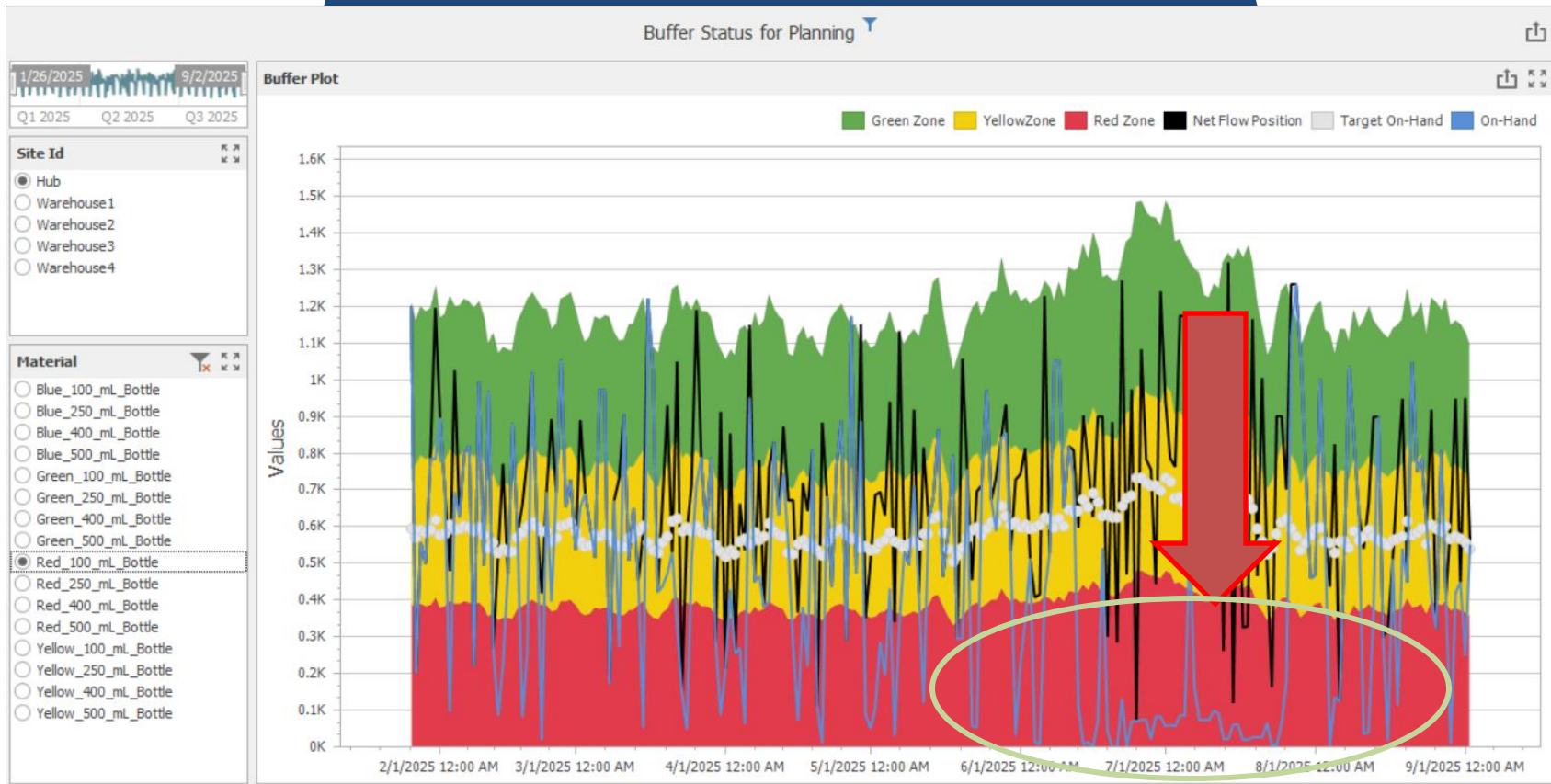


Almost no congestion in the factory during the wintertime

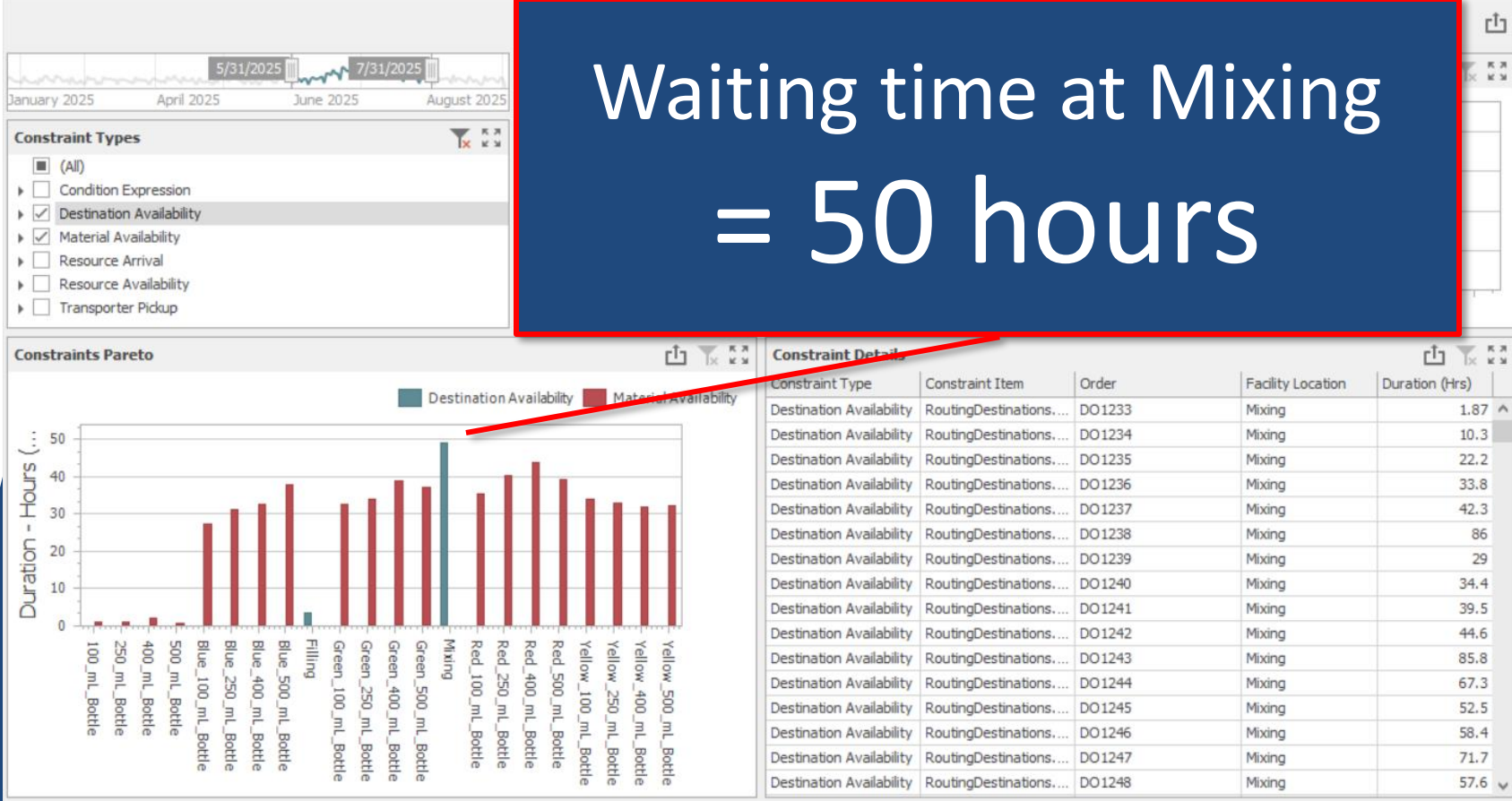
Inventory levels well managed to cope with the winter lift



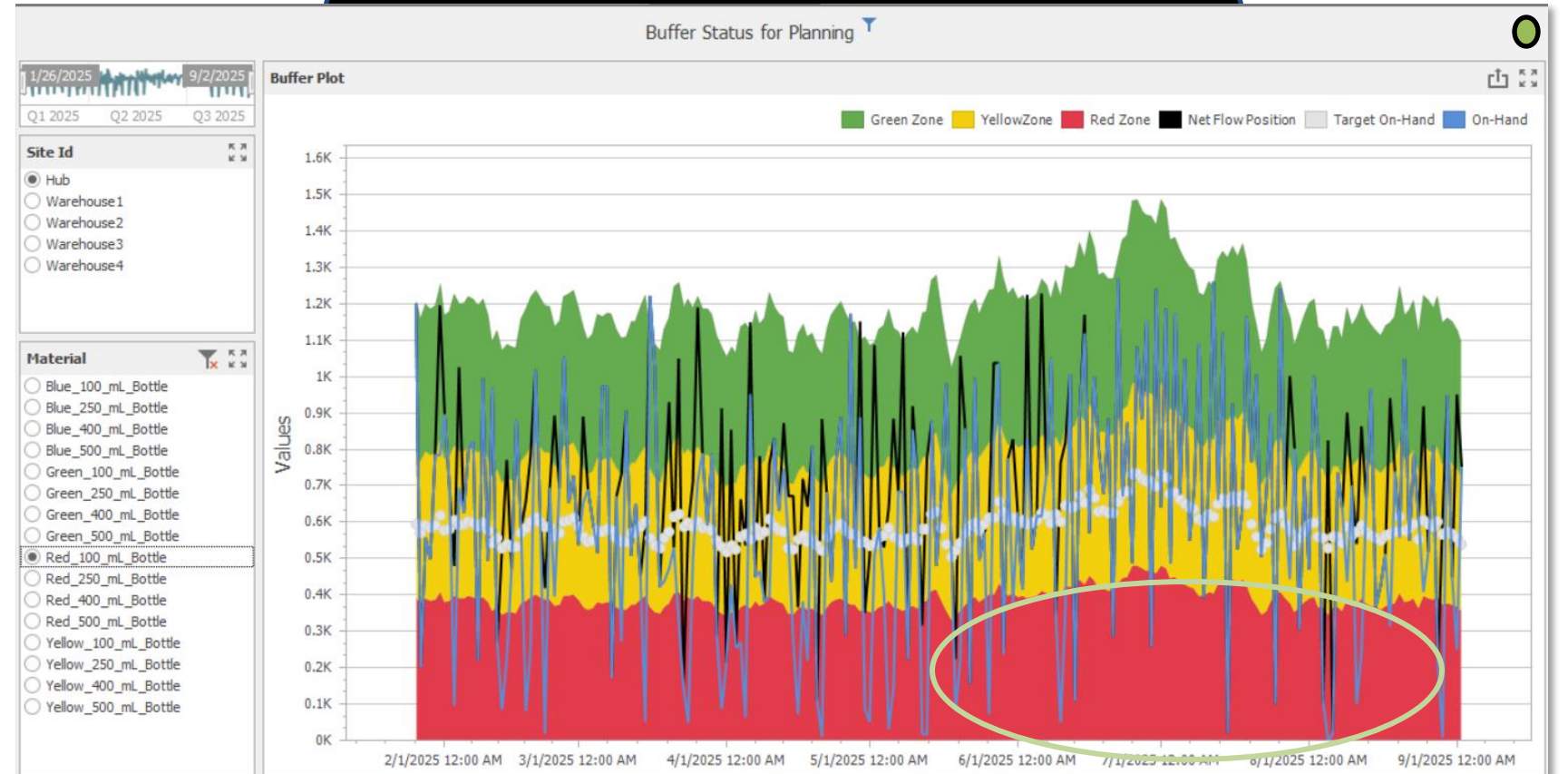
# Base Level Results



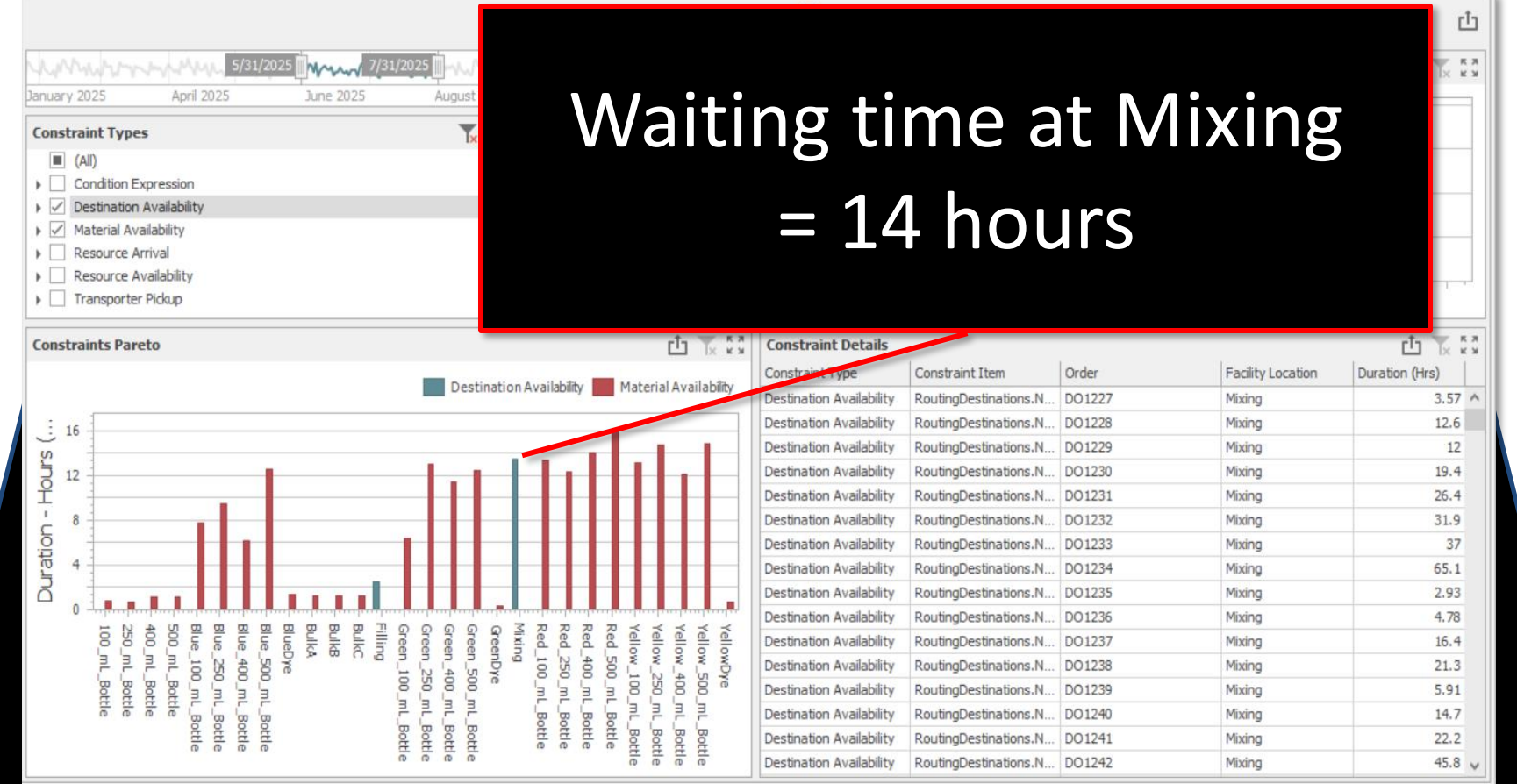
**Waiting time at Mixing = 50 hours**



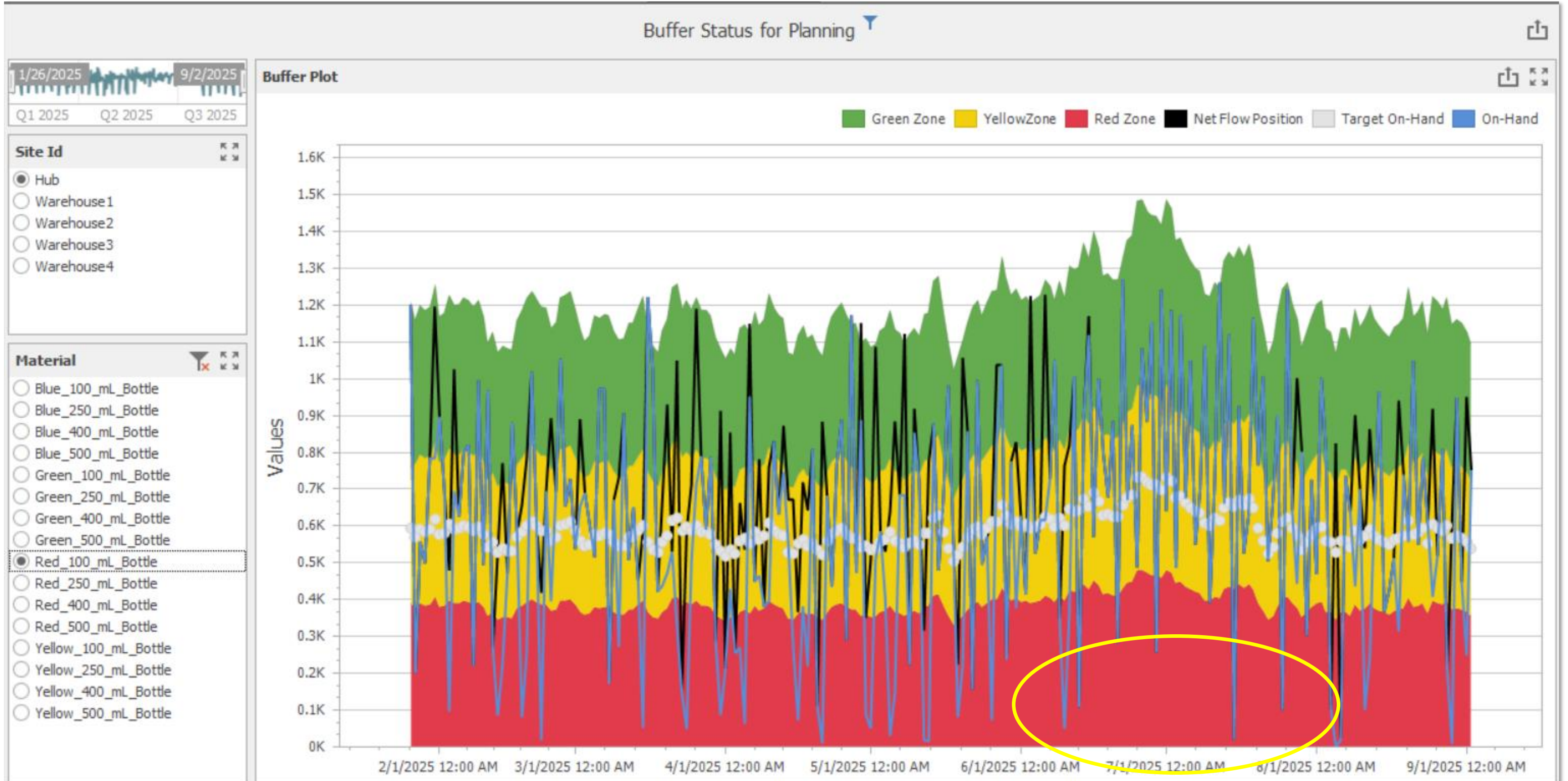
# Adjustment Results



**Waiting time at Mixing = 14 hours**



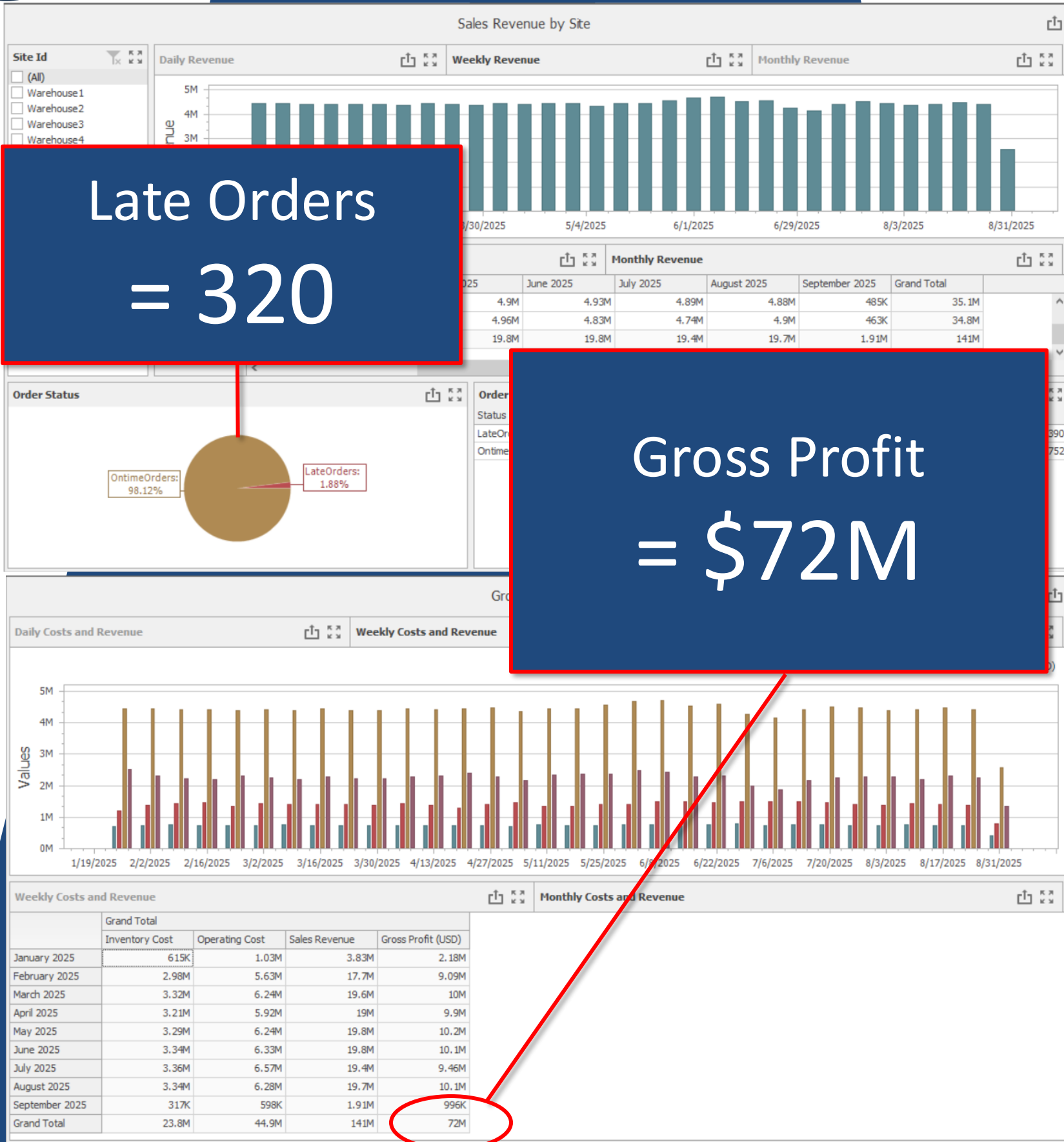
# Level 3 Results – Winter Adjustment



# Base Level Results

Late Orders  
= 320

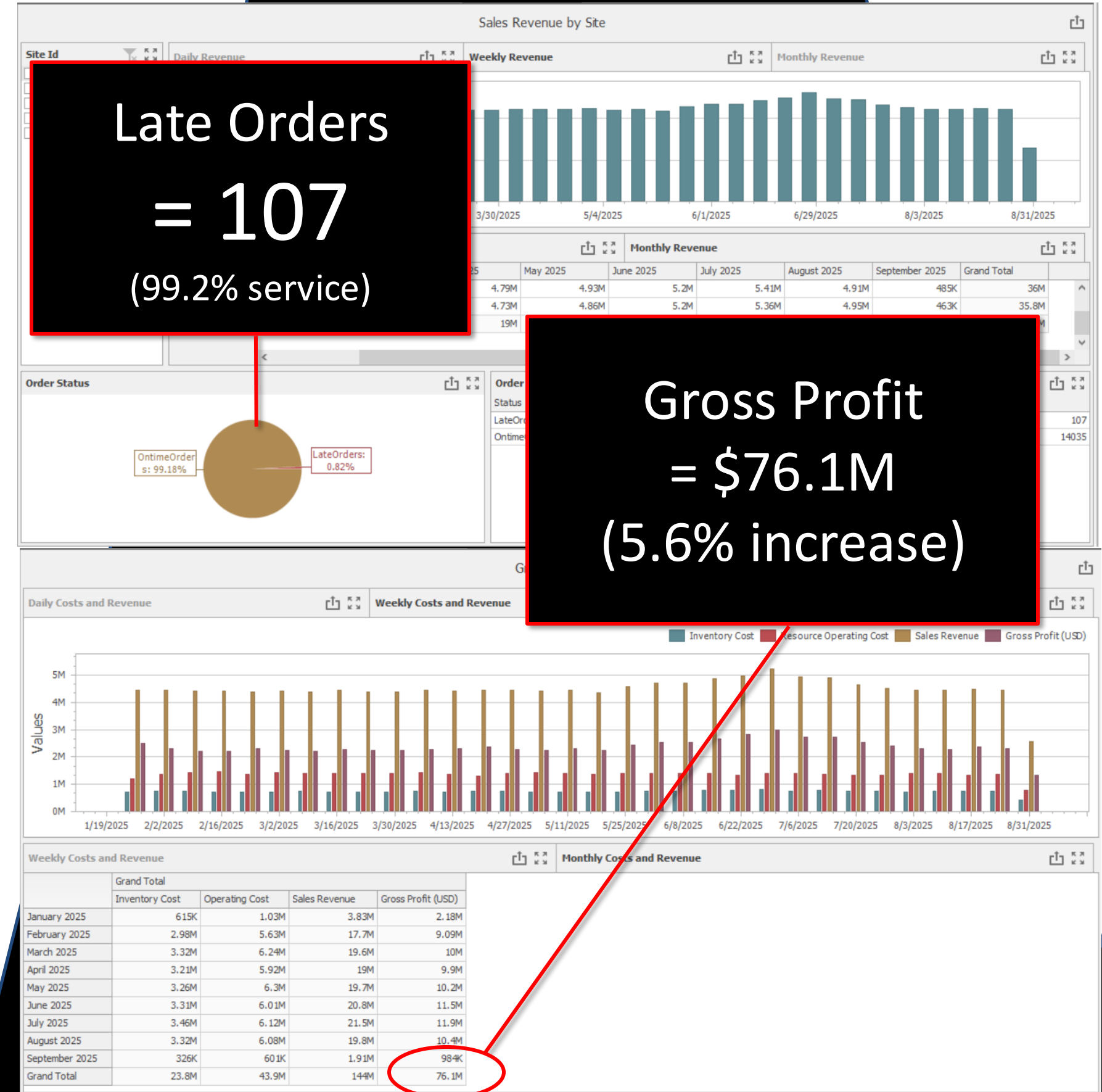
Gross Profit  
= \$72M



# Adjustments Results

Late Orders  
= 107  
(99.2% service)

Gross Profit  
= \$76.1M  
(5.6% increase)



# Game Level 4 (What-if Strategical)

## ■ The Level 4 challenge: Adaptive S&OP

- Strategic planning starting with Level 3 configuration
  - **Winter lift** for 2025 and 2026 as per Level 3 challenge
  - New product introduction **starting year 2** (January 2026) with **1-liter bottle for all products**
- Run the game for **565 days** (18+ month)
  - Starting the 26th of **January 2025**
  - Ending late **August 2026**
- Analyze the **impact of the new product introduction** on key KPIs to answer specific management questions.....

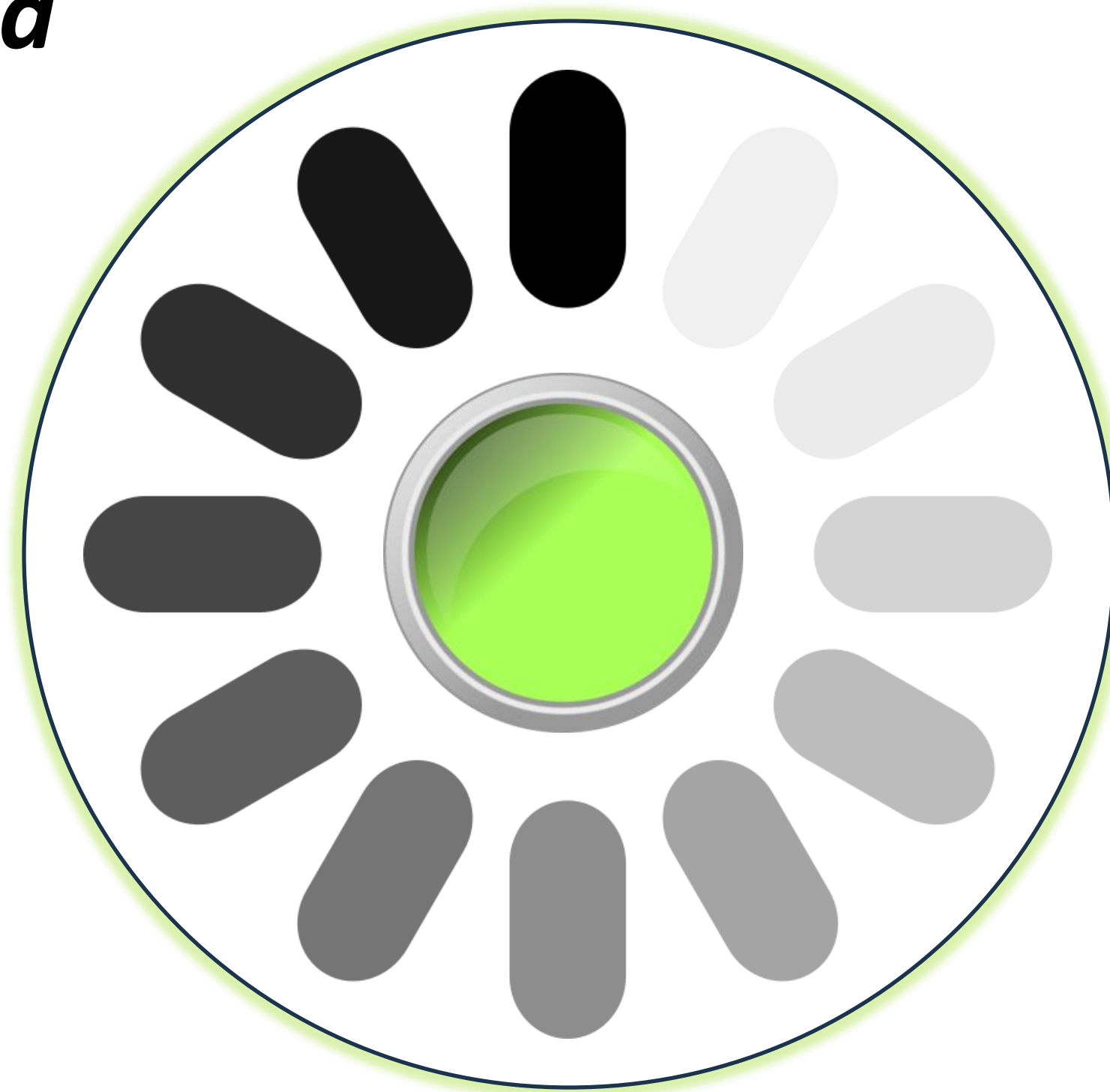
**Key Management Question:** How many markets can we serve to test the new product without having to do investment in new infrastructure or negatively impact our current business?

(Market is by Warehouses #1, #2, #3 and #4)

- Gross Profit
- Utilization (flexibility to respond)
- Customer service

Level 4

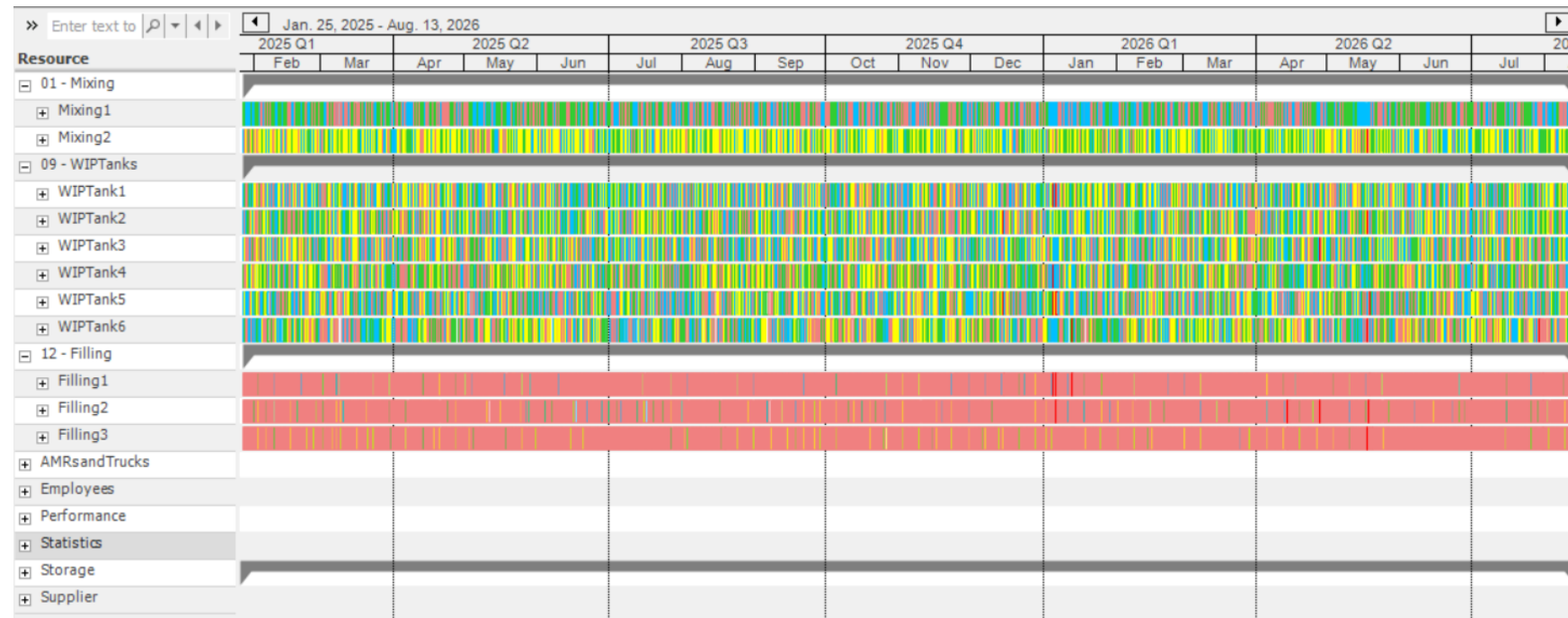
***Run Completed***



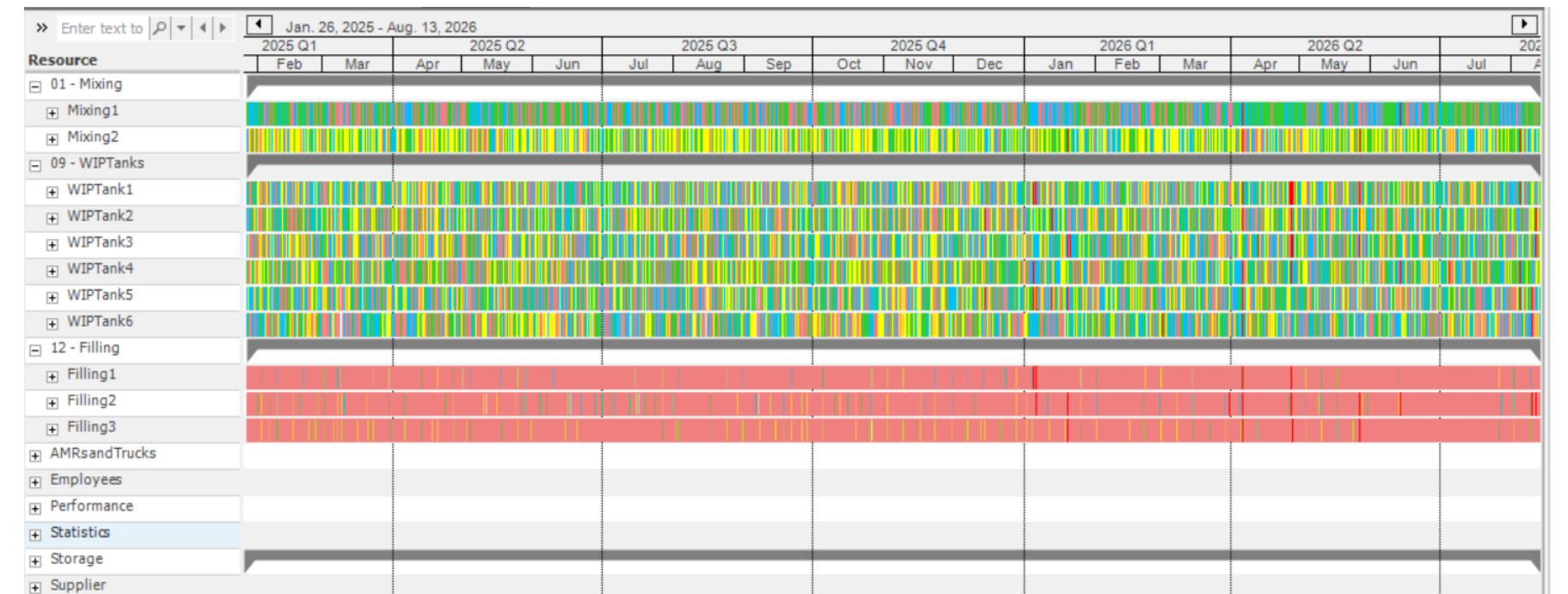
**Start Game**

# Gantt Charts for Production

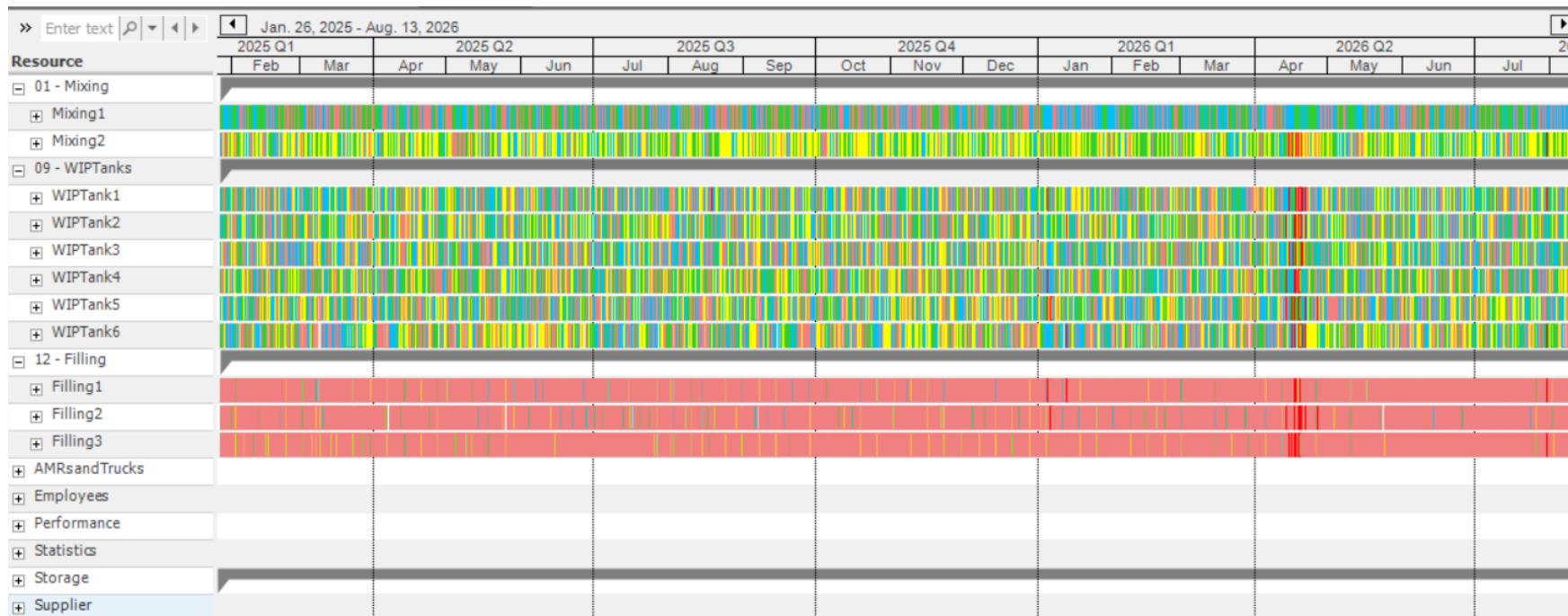
## 1 Warehouse/Market



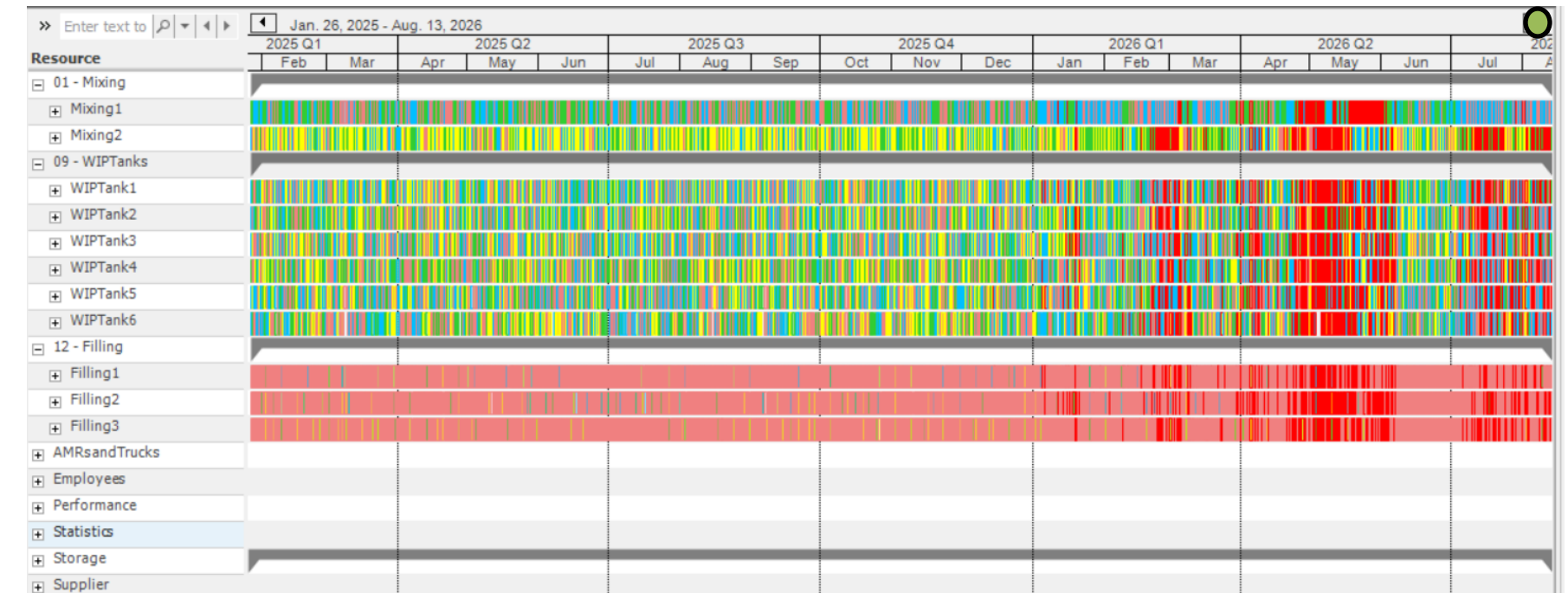
## 2 Warehouses/Markets



## 3 Warehouses/Markets



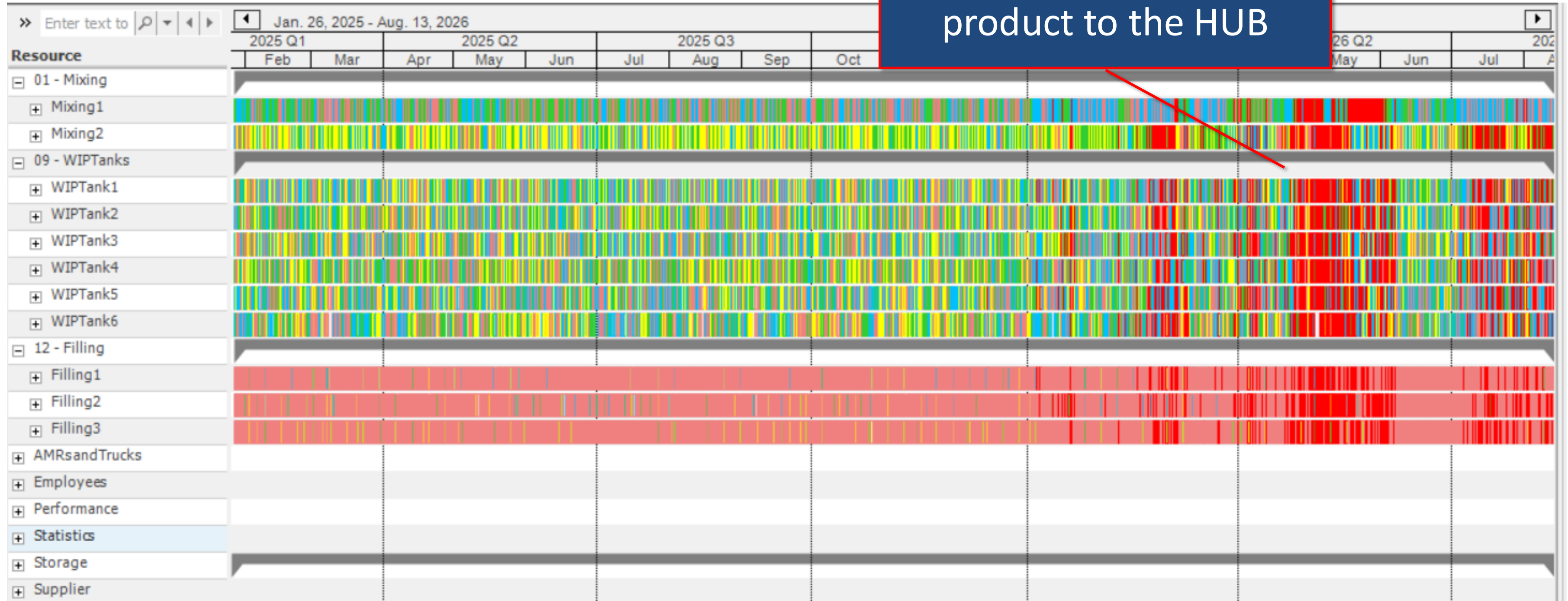
## 4 Warehouses/Markets



# 4

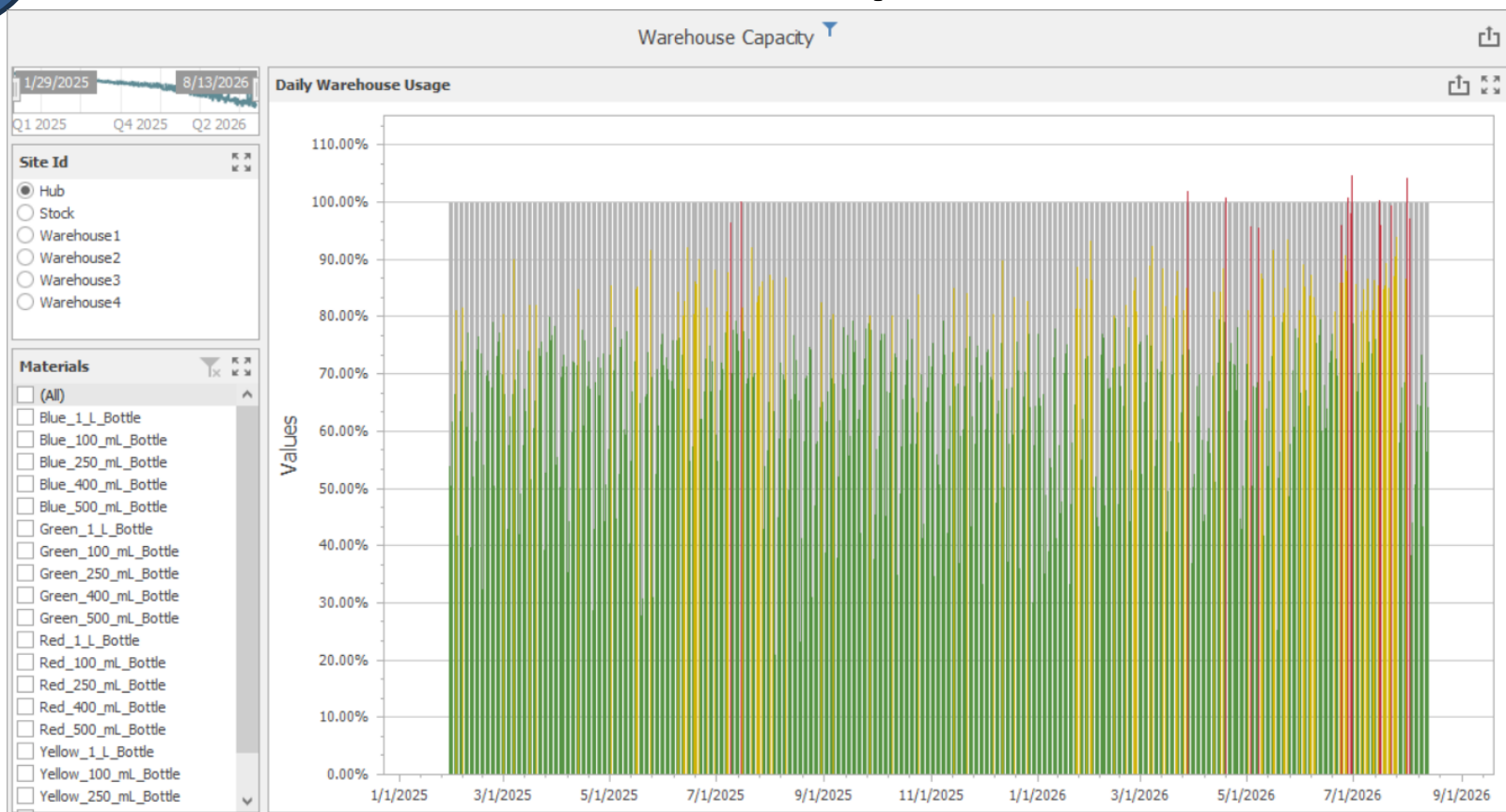
## Level 4 Results – 4 Warehouses/Markets added

Factory is very congested struggling to deliver product to the HUB

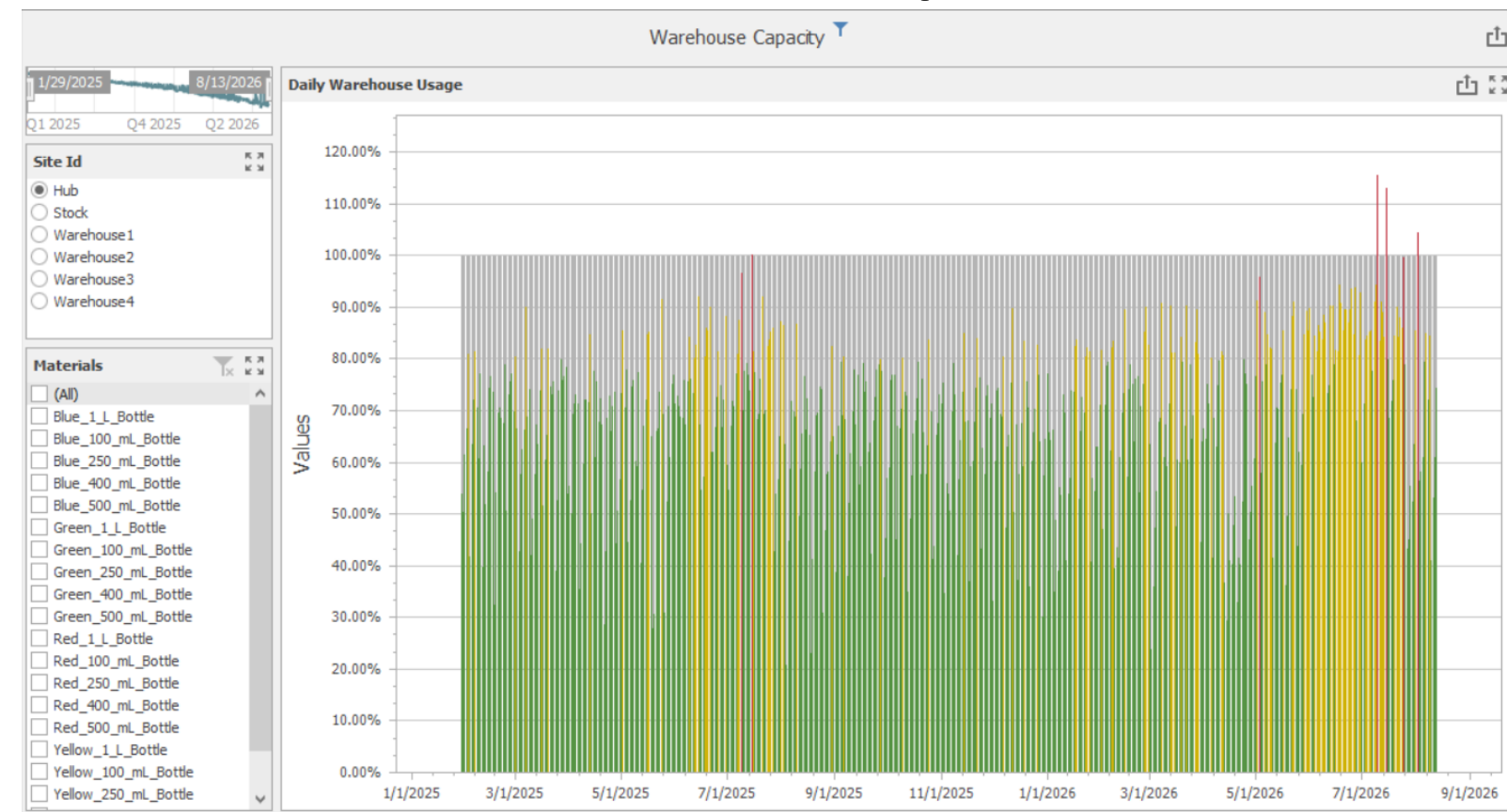


# Inventory at the HUB

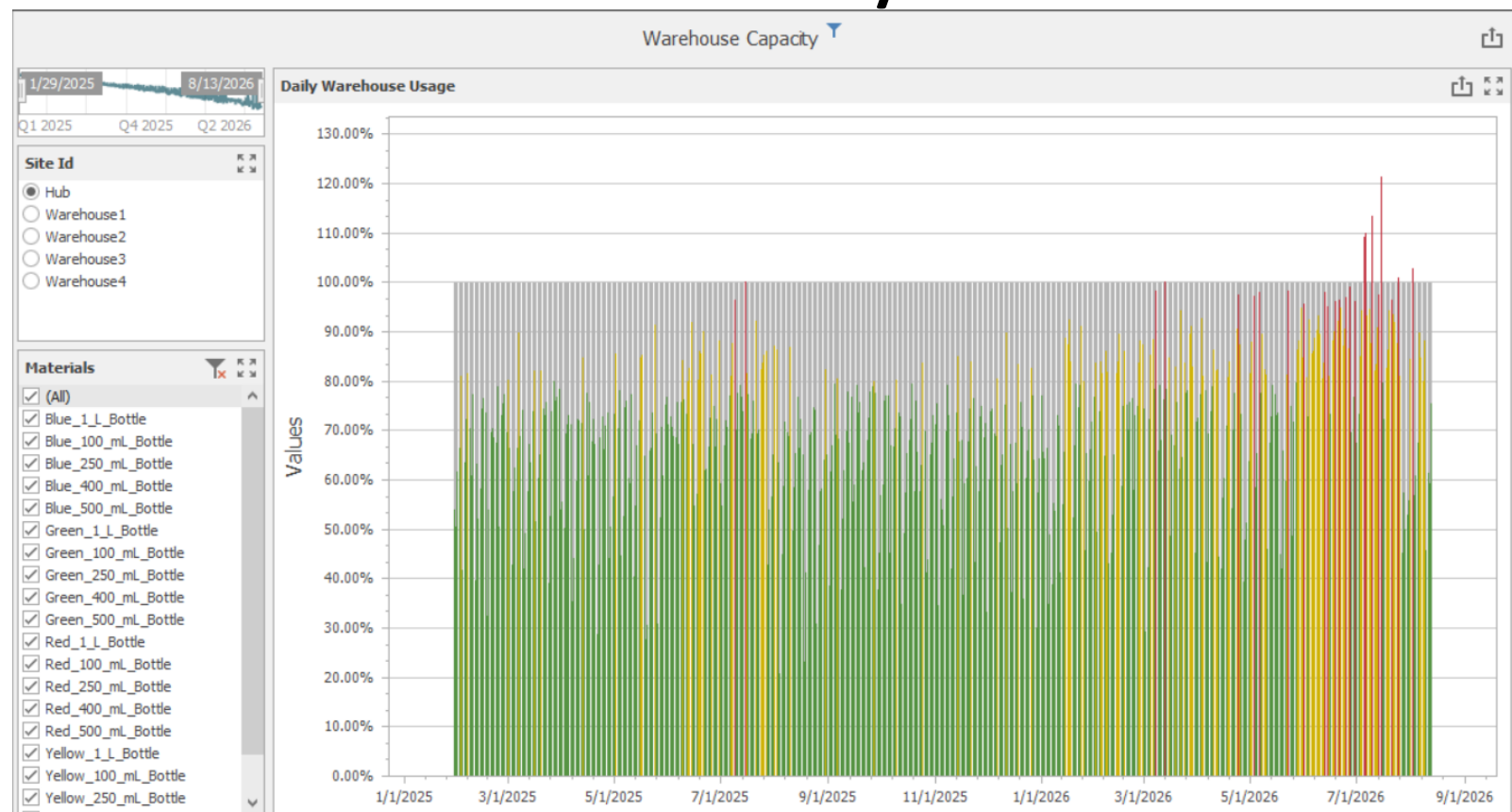
## 1 Warehouse/Market



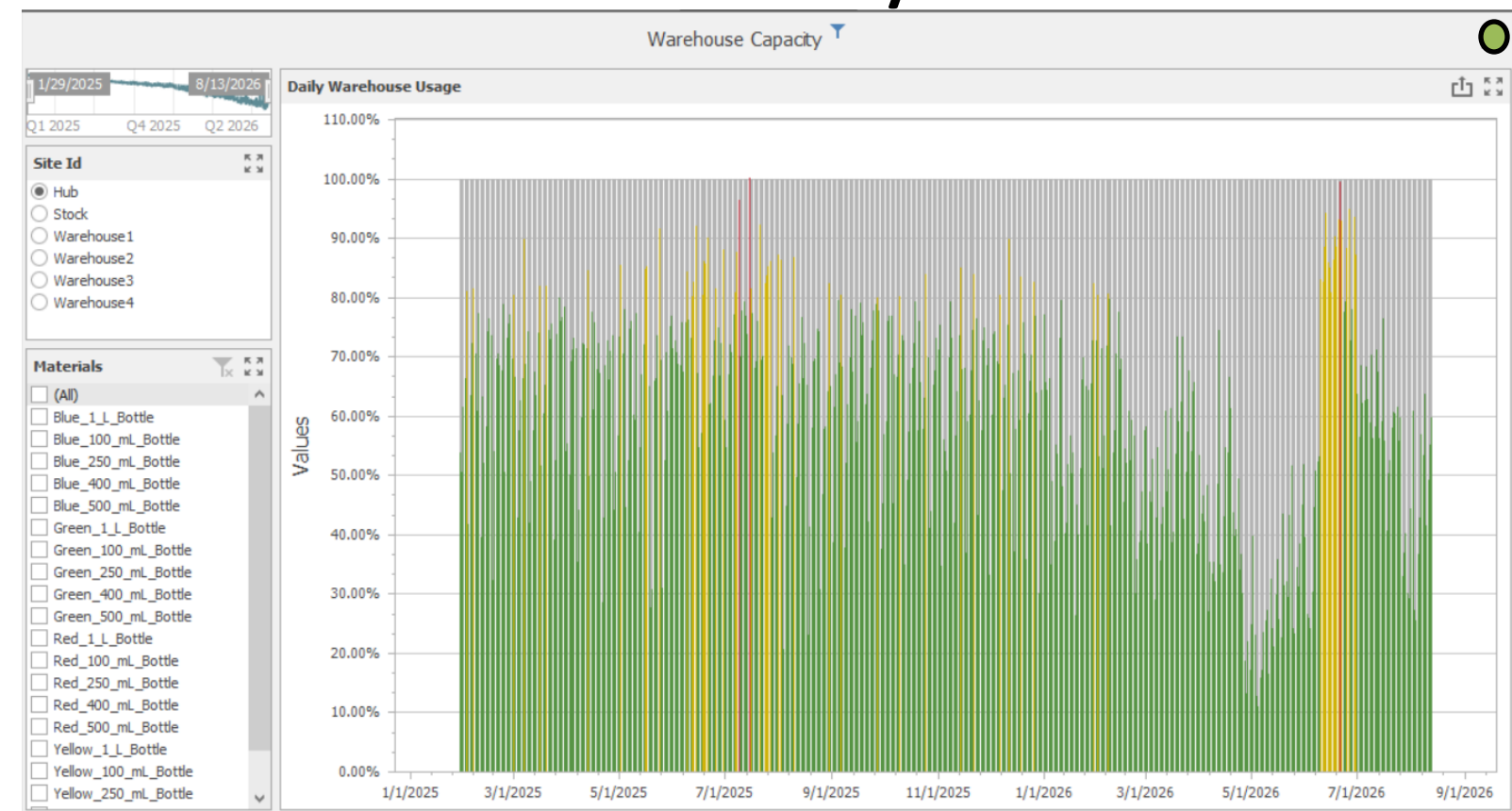
## 2 Warehouses/Markets



## 3 Warehouses/Markets



## 4 Warehouses/Markets

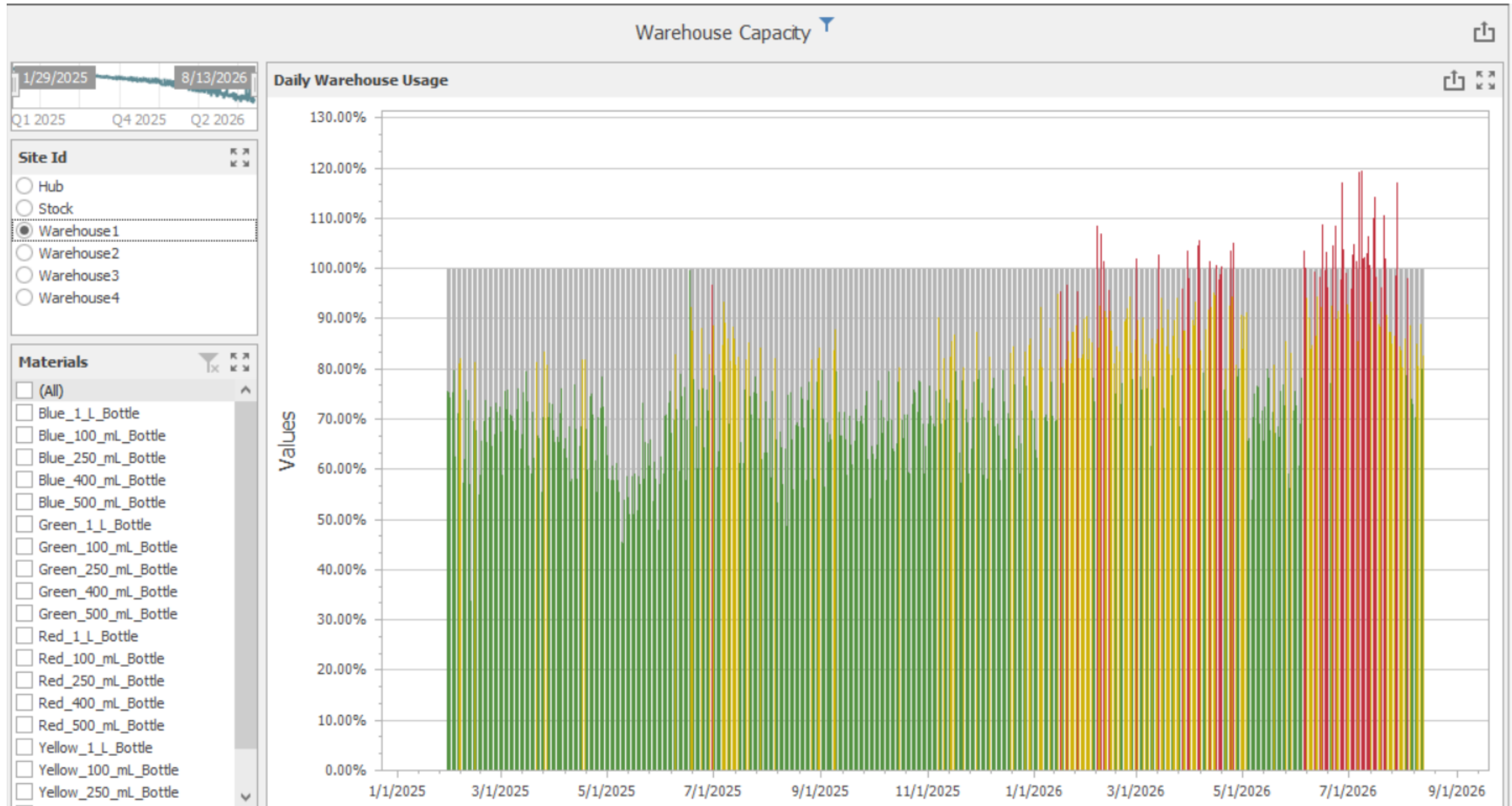


## Level 4 Results – 4 Warehouses/Markets added

Factory cannot produce enough product to serve demand at the HUB

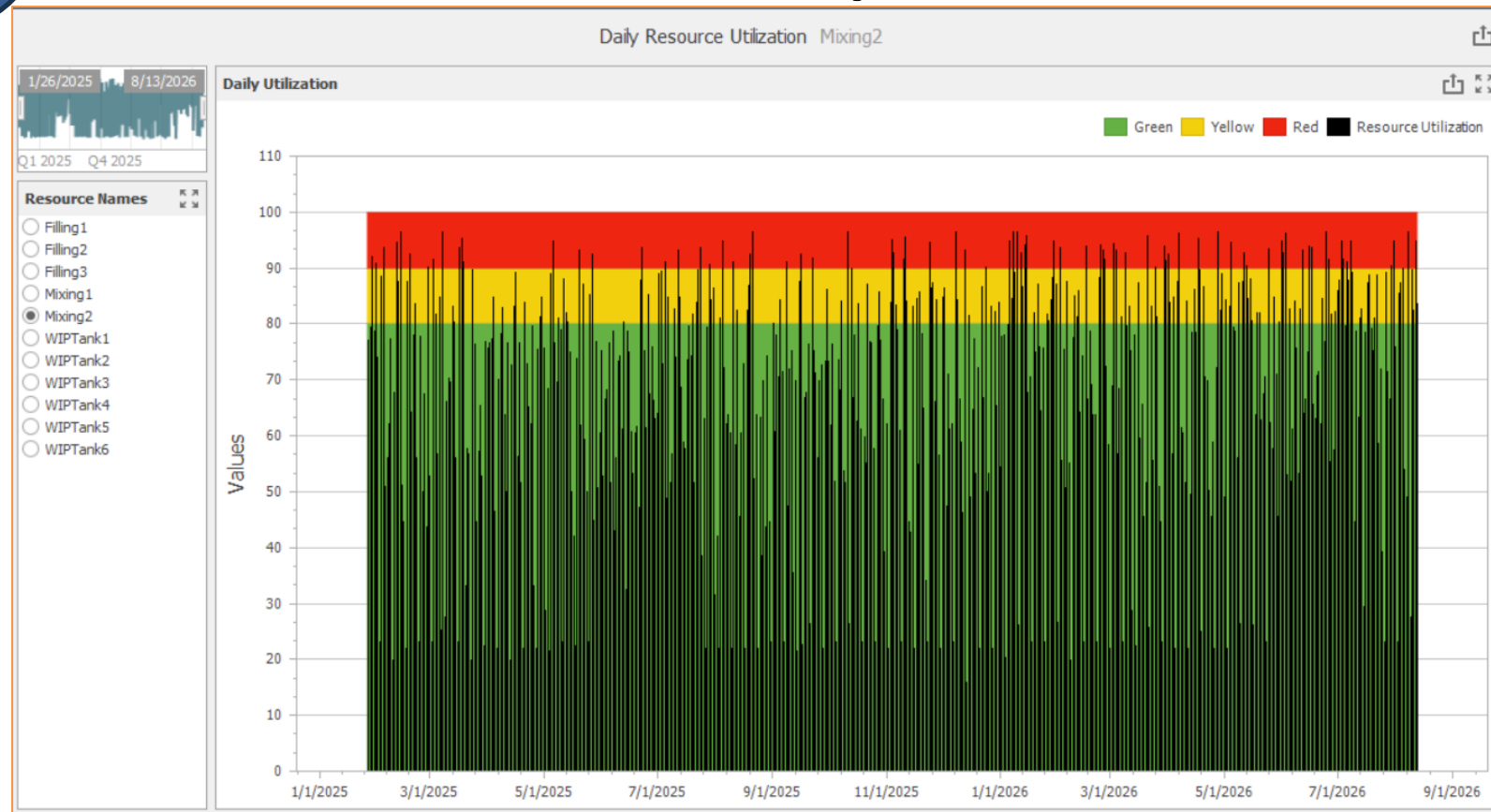


# Warehouse #1 Total Inventory

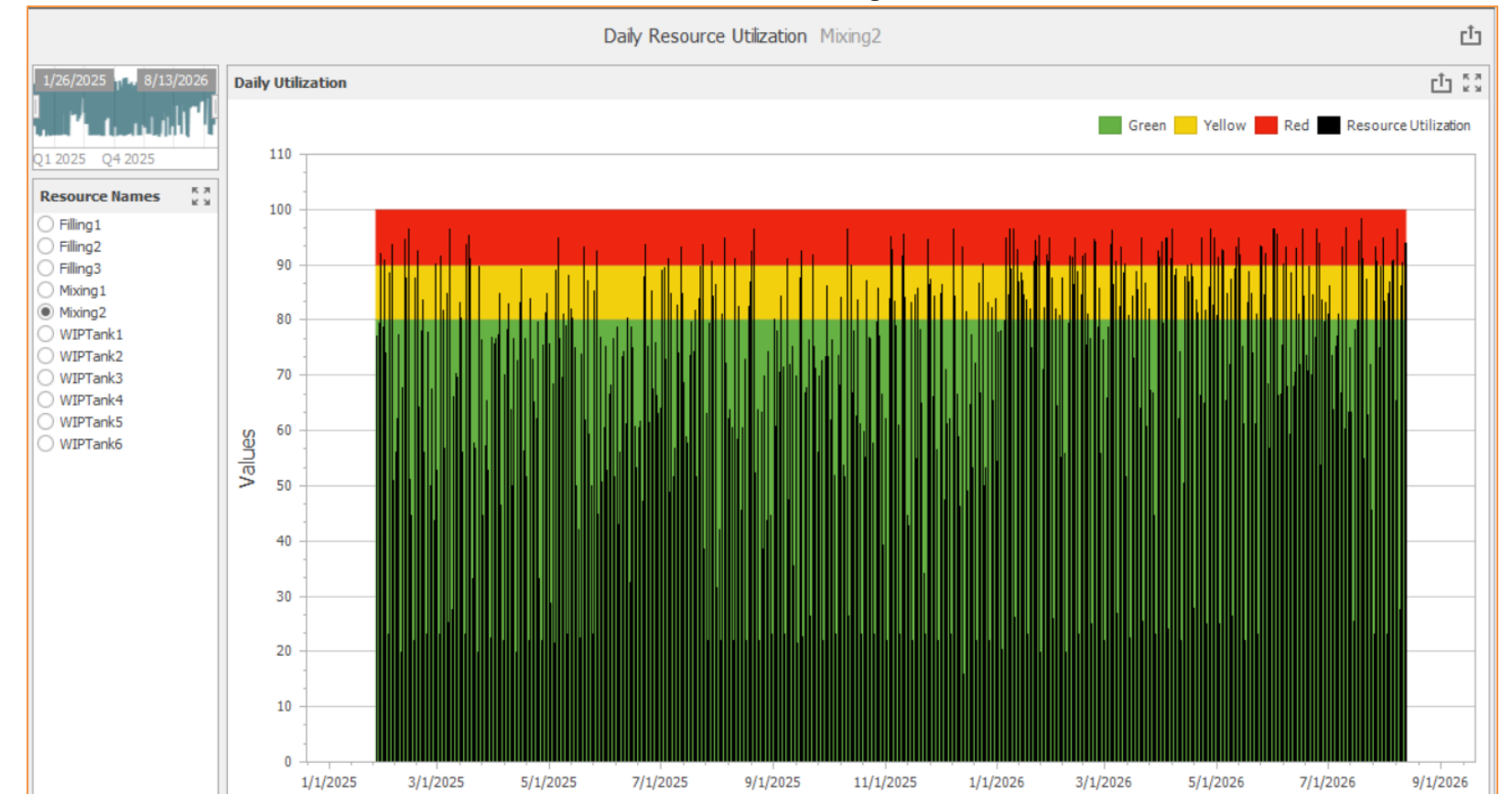


# Mixer 2 Utilization

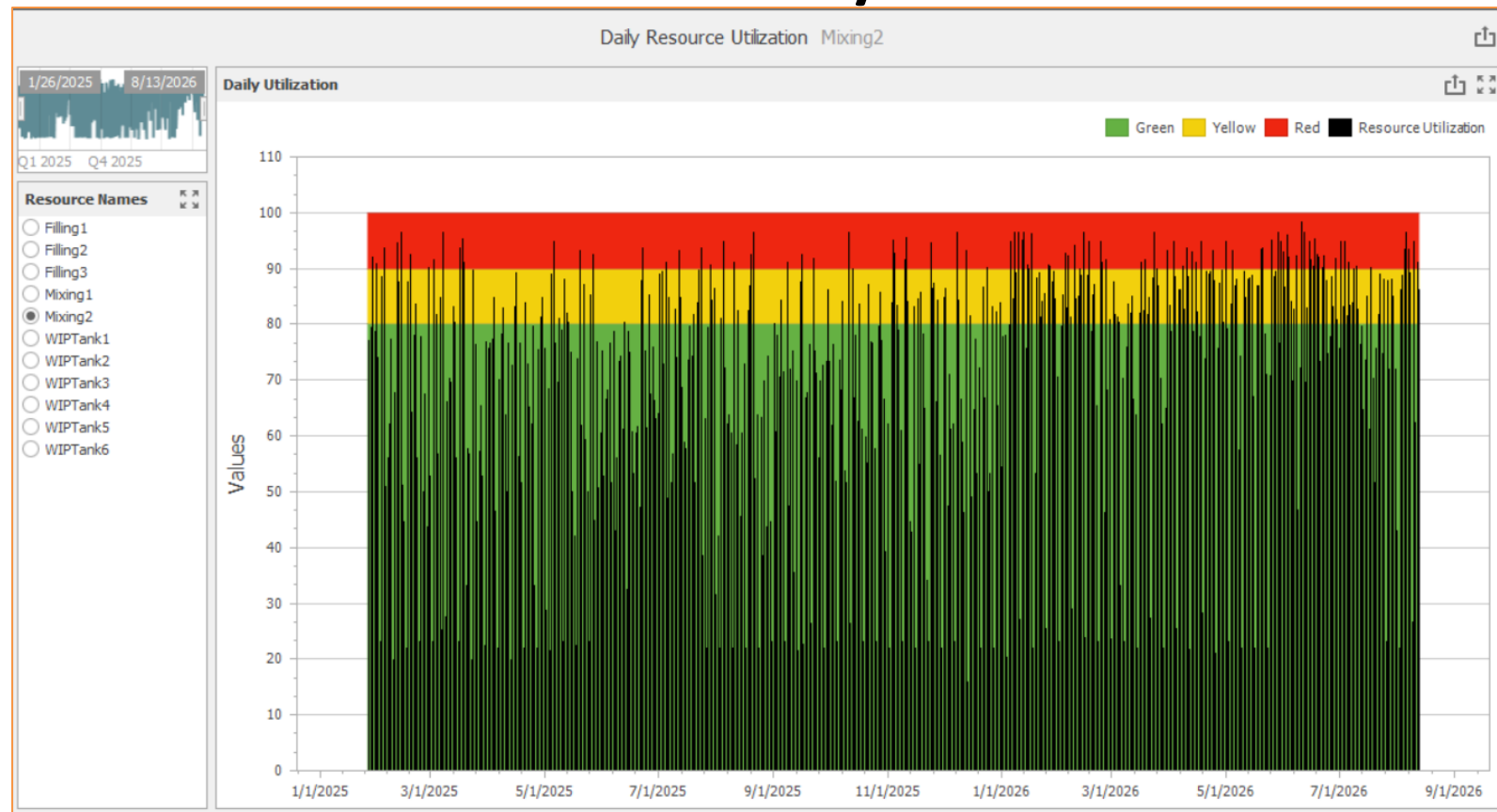
## 1 Warehouse/Market



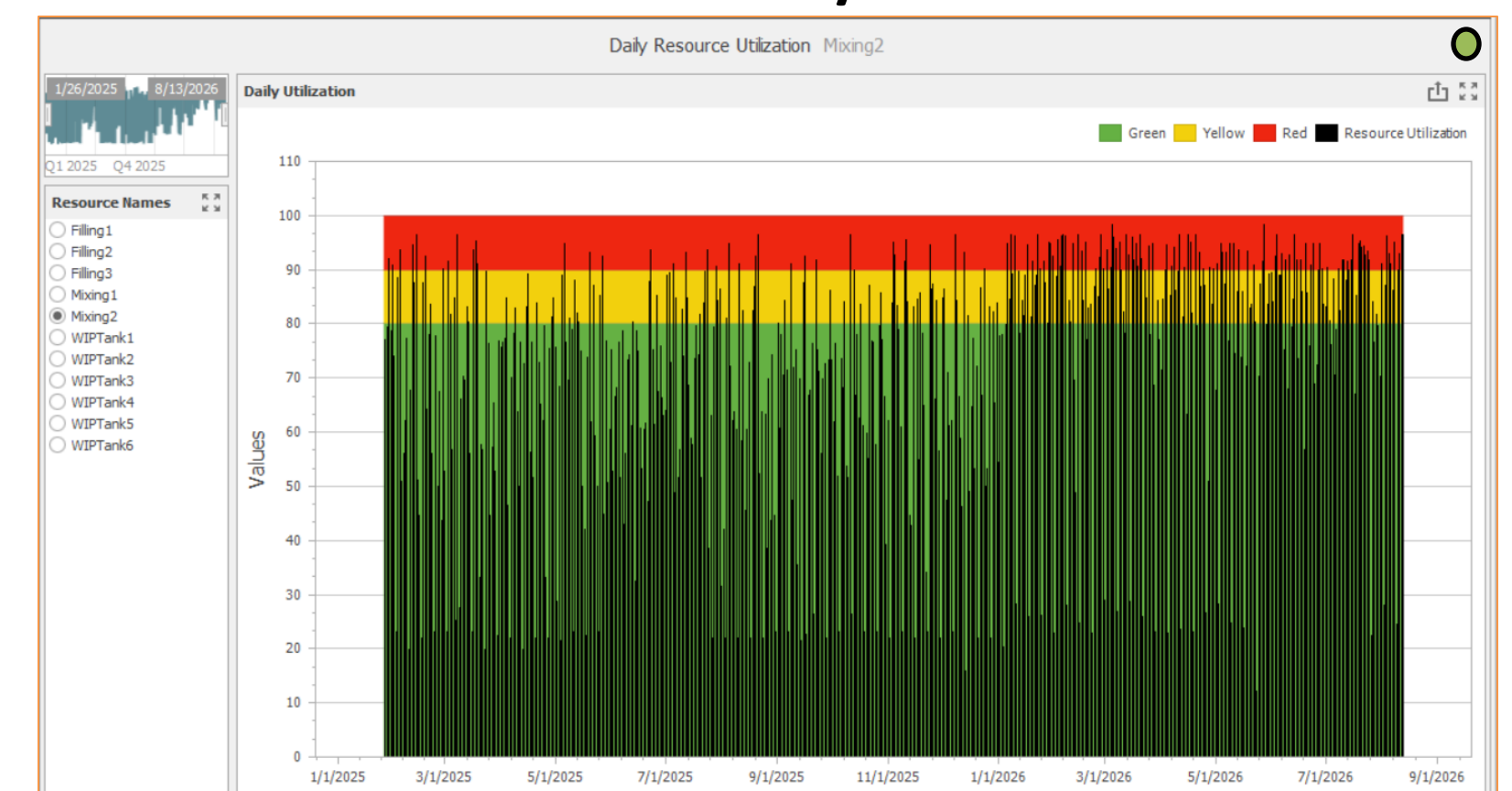
## 2 Warehouses/Markets



## 3 Warehouses/Markets

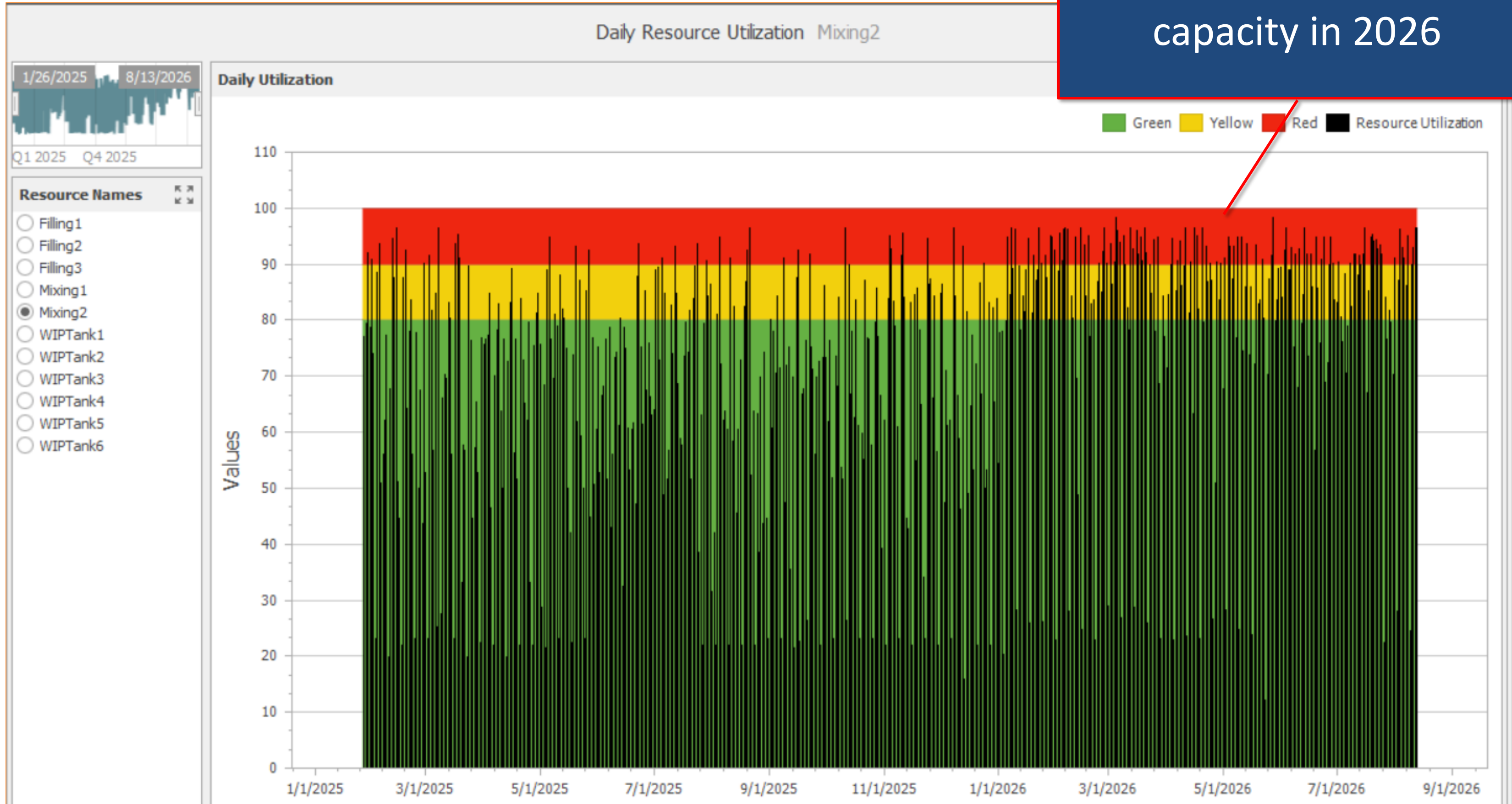


## 4 Warehouses/Markets



## Level 4 Results – Mixer 2 Utilization with 4 Warehouses

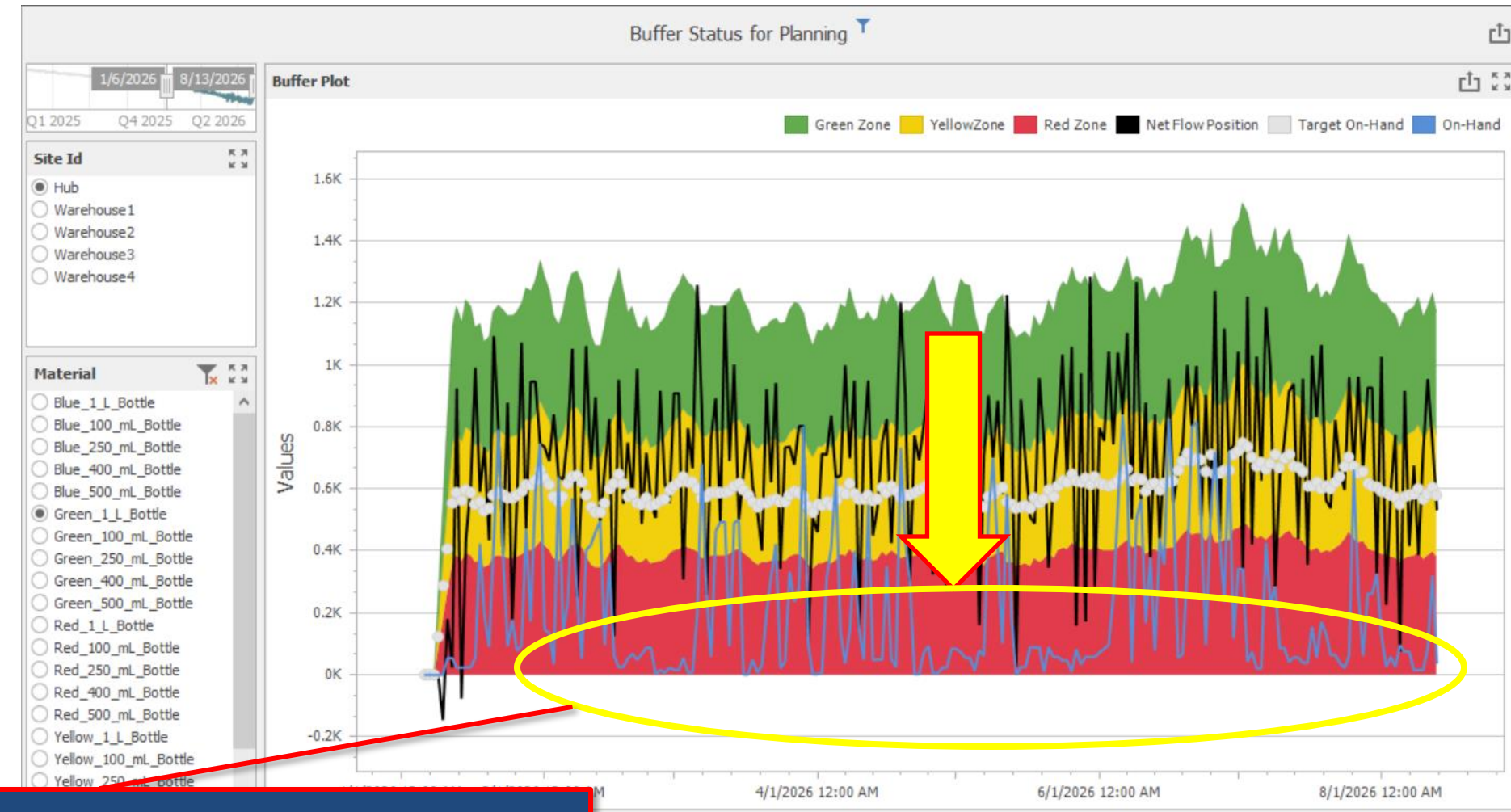
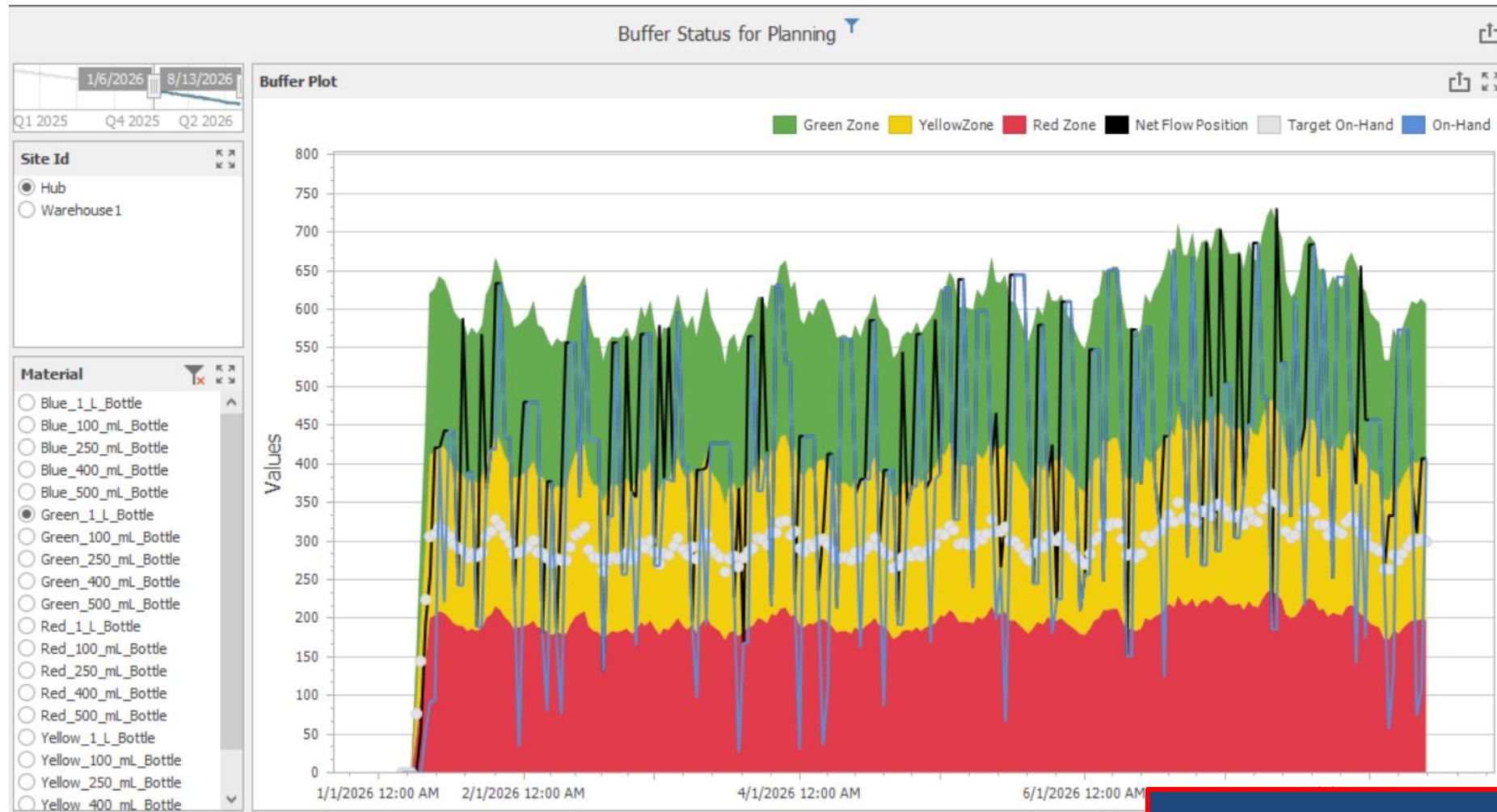
Mixers running near full capacity in 2026



# Green 1 liter Bottle at the HUB

## 1 Warehouse/Market

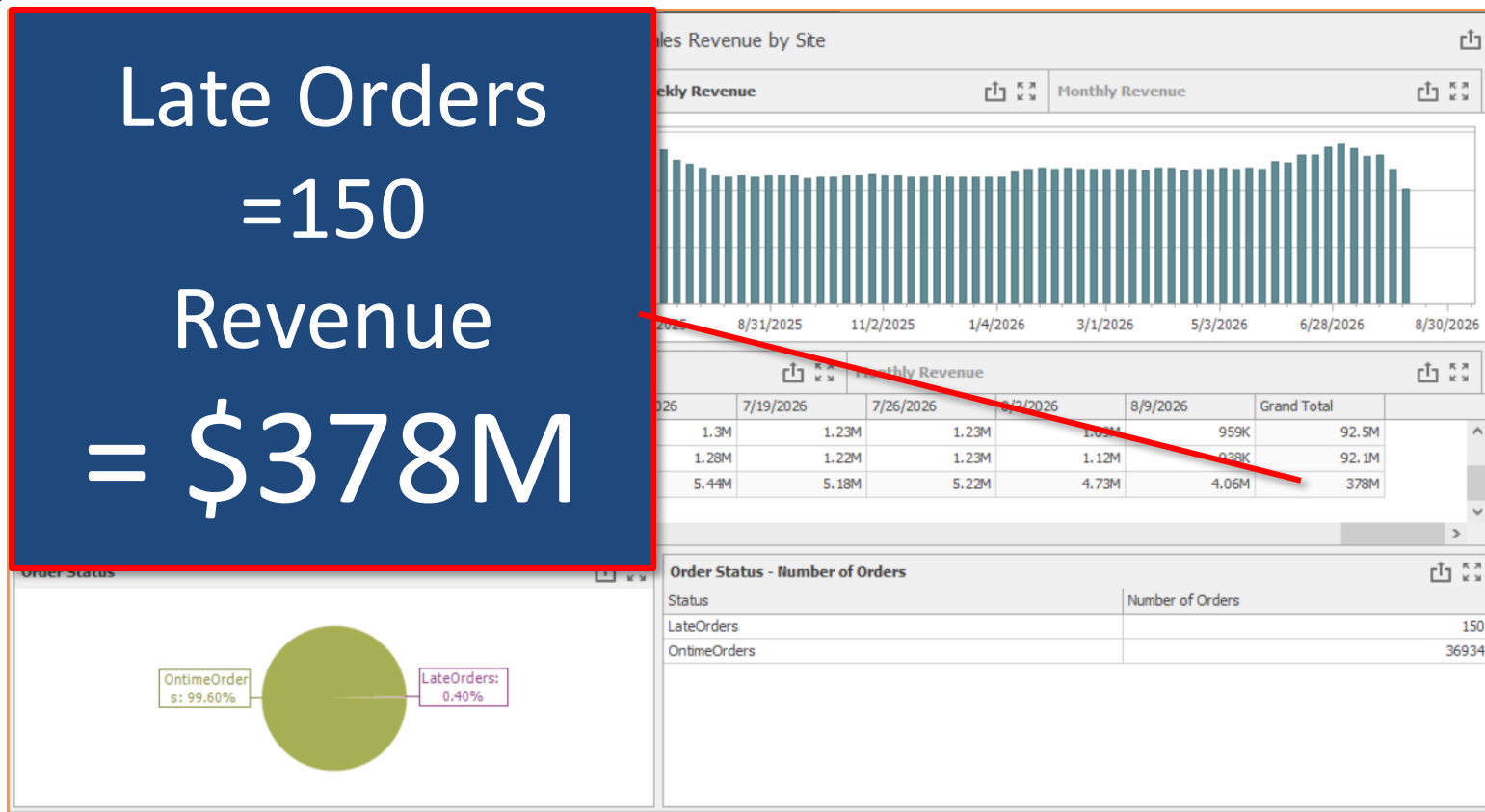
## 4 Warehouses/Markets



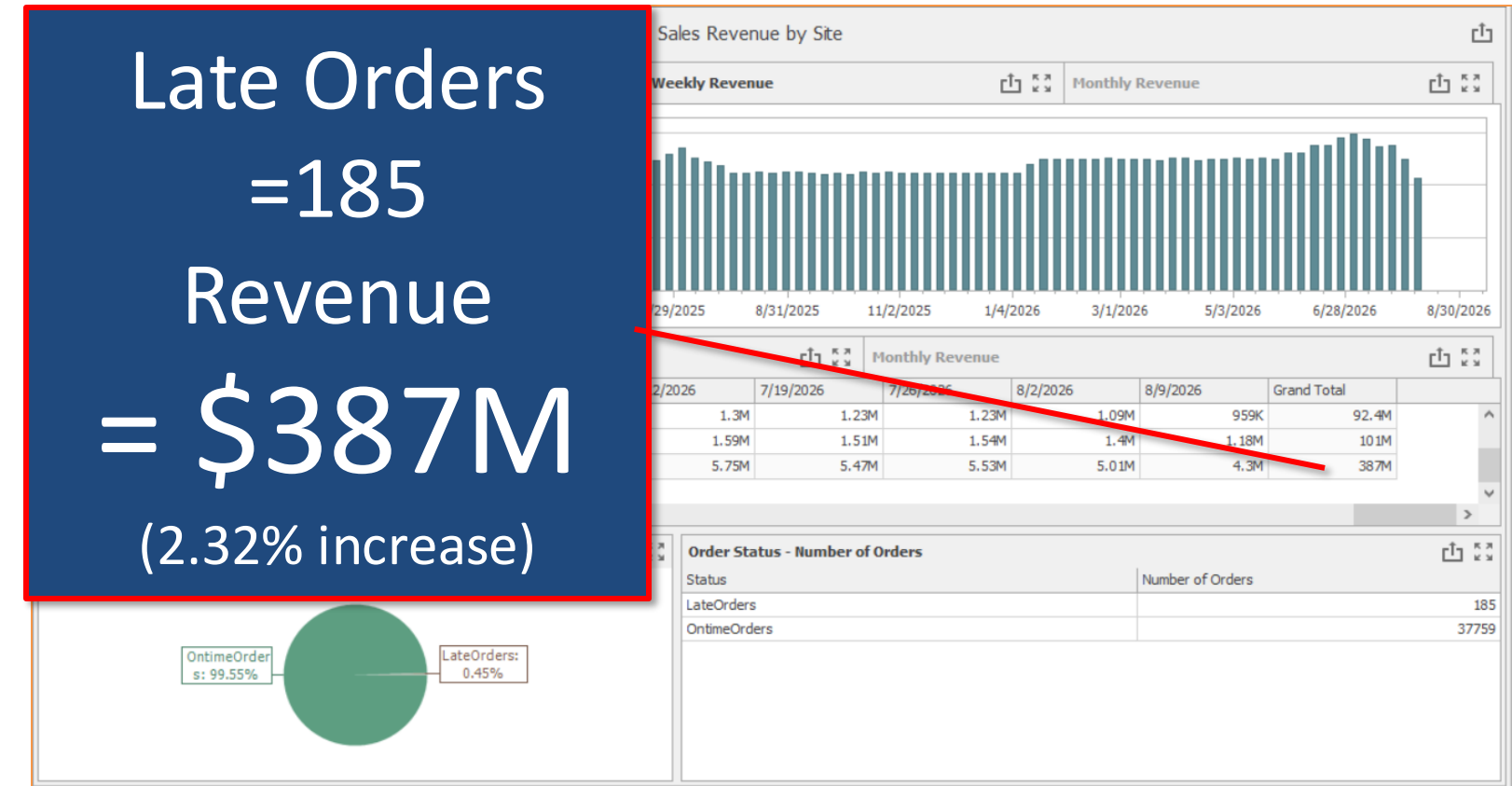
Inventory in the HUB cannot keep up with demand as the factory does not have sufficient capacity

# Revenue and Service Level

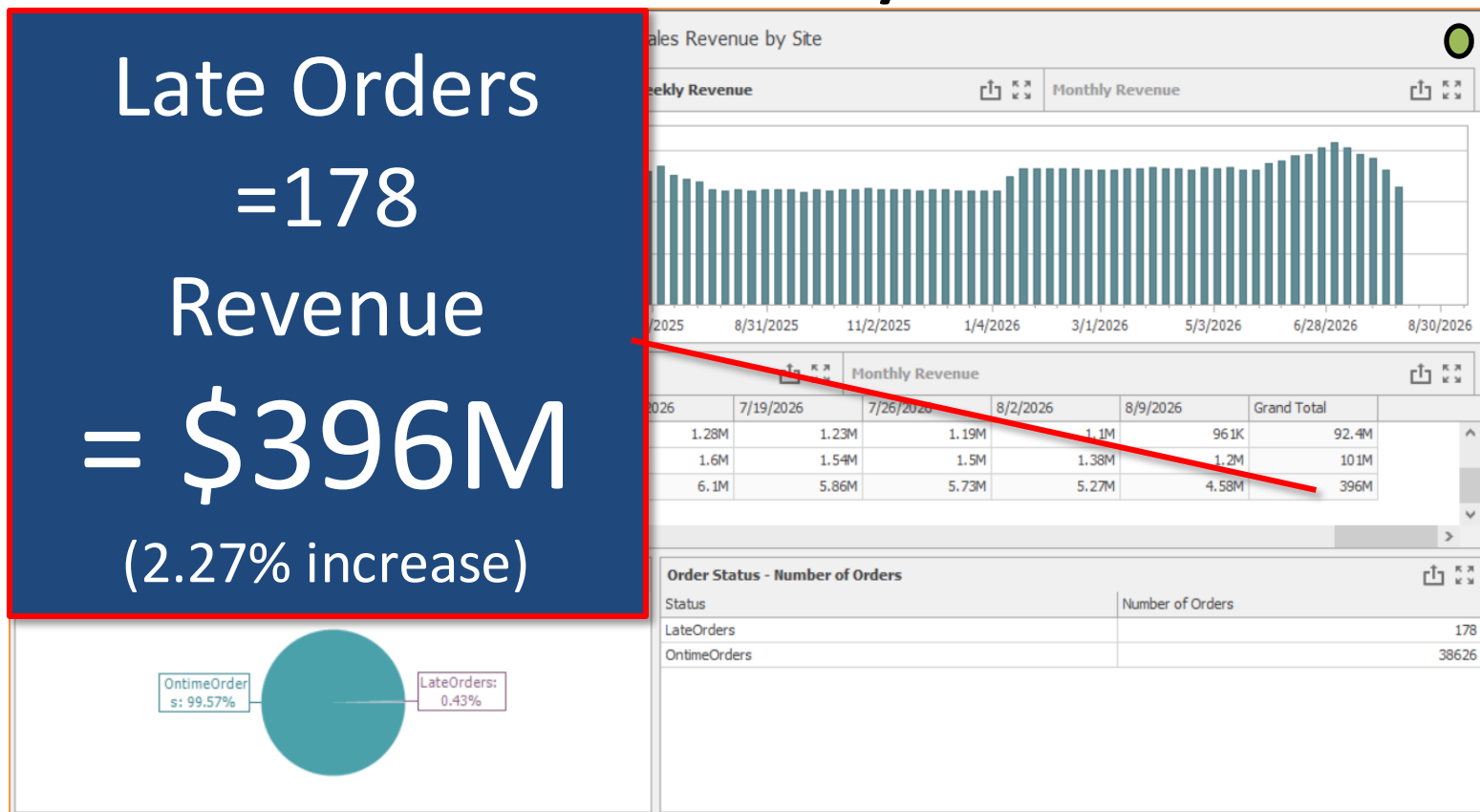
## 1 Warehouse/Market



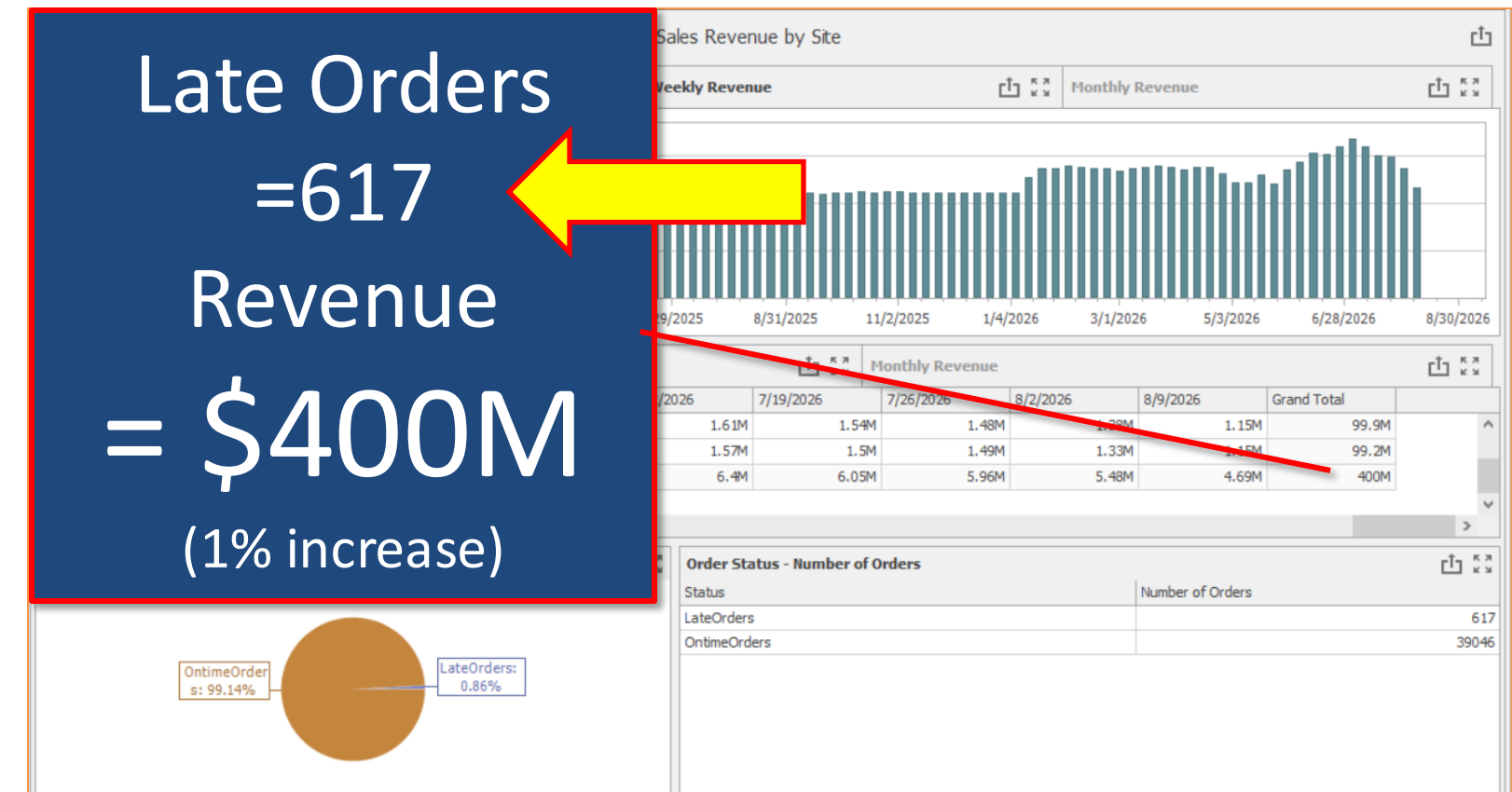
## 2 Warehouses/Markets



## 3 Warehouses/Markets

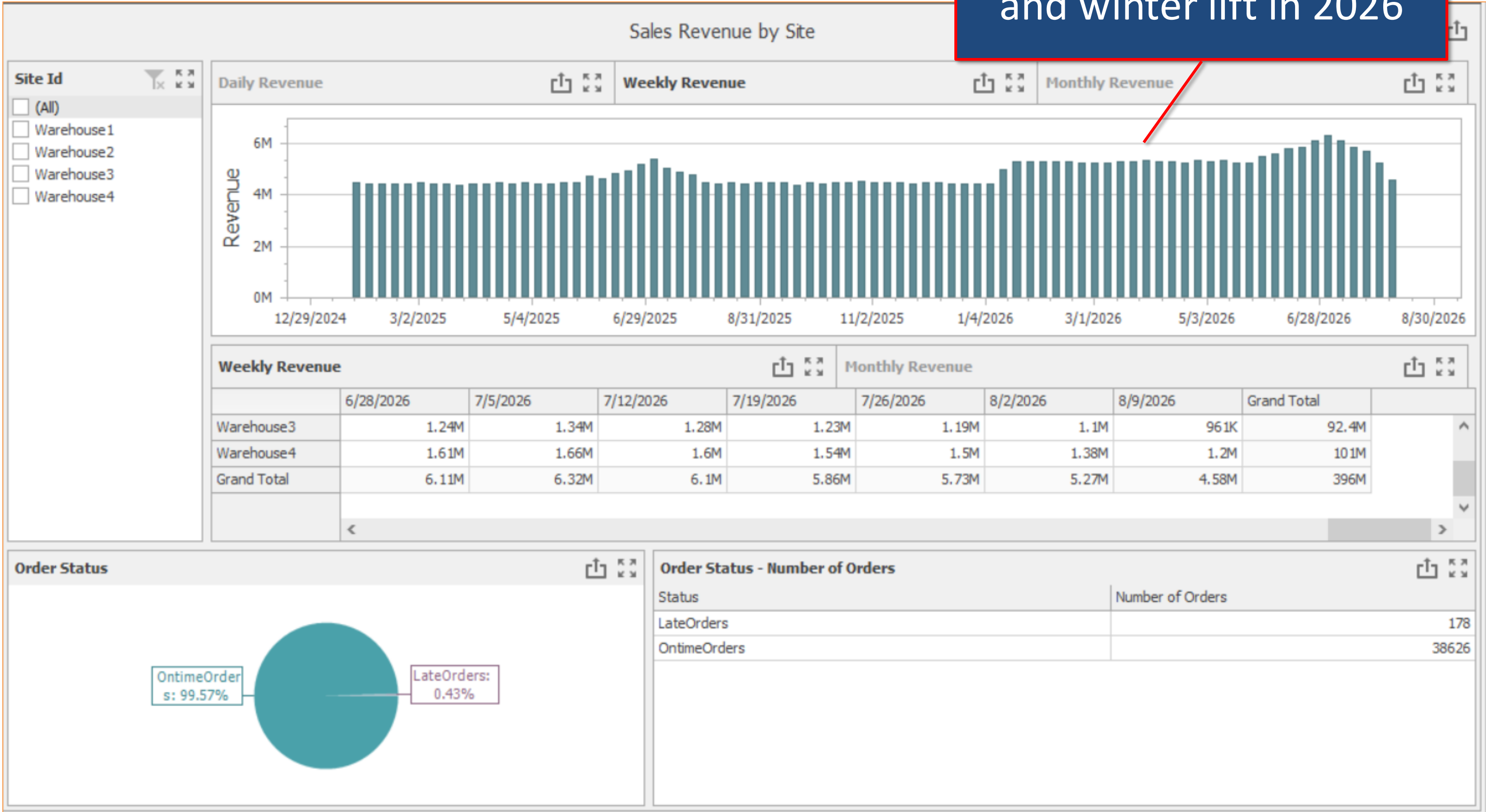


## 4 Warehouses/Markets



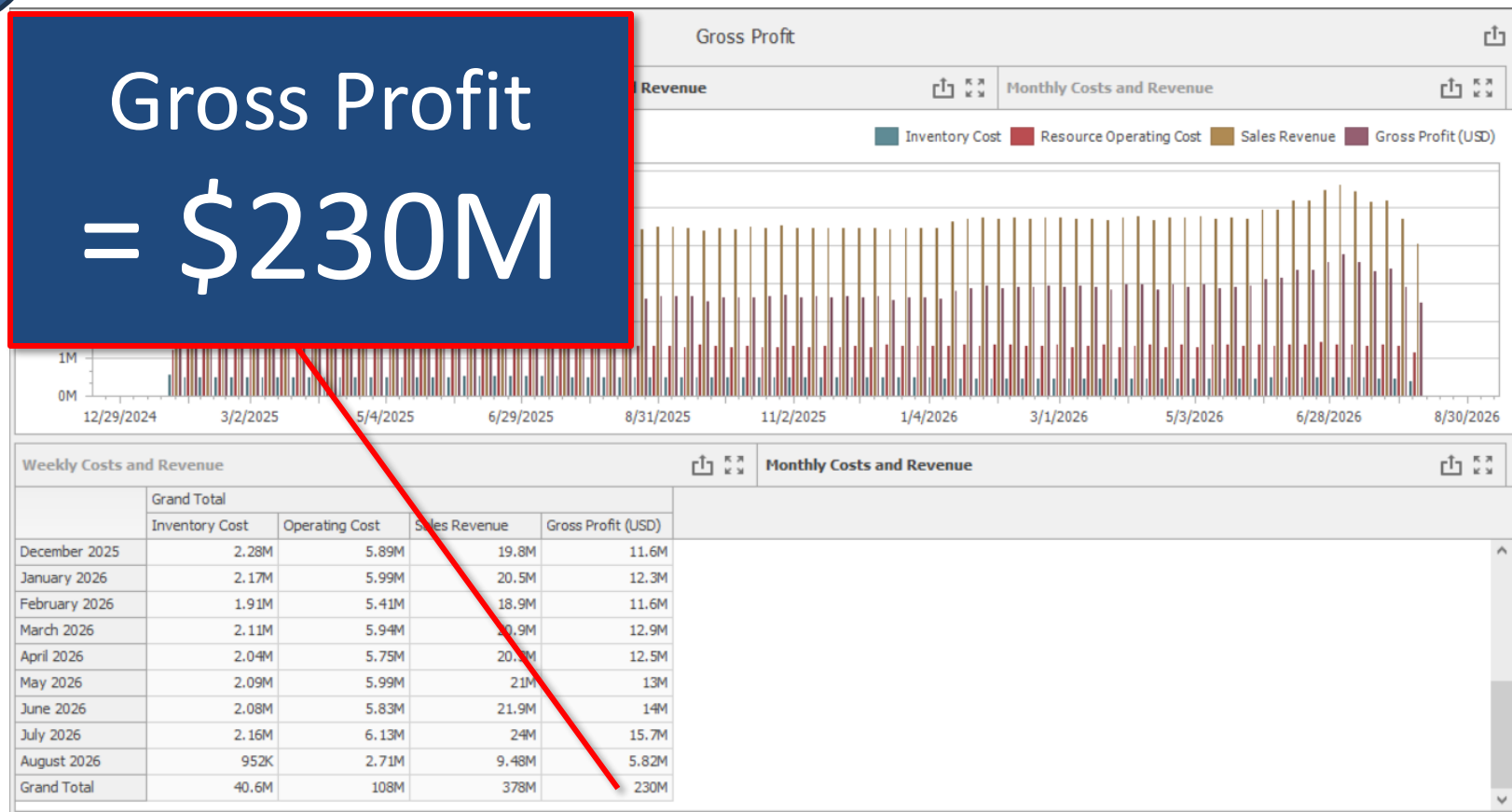
# Level 5 Results – Revenue and Service Level

New SKU introduction and winter lift in 2026

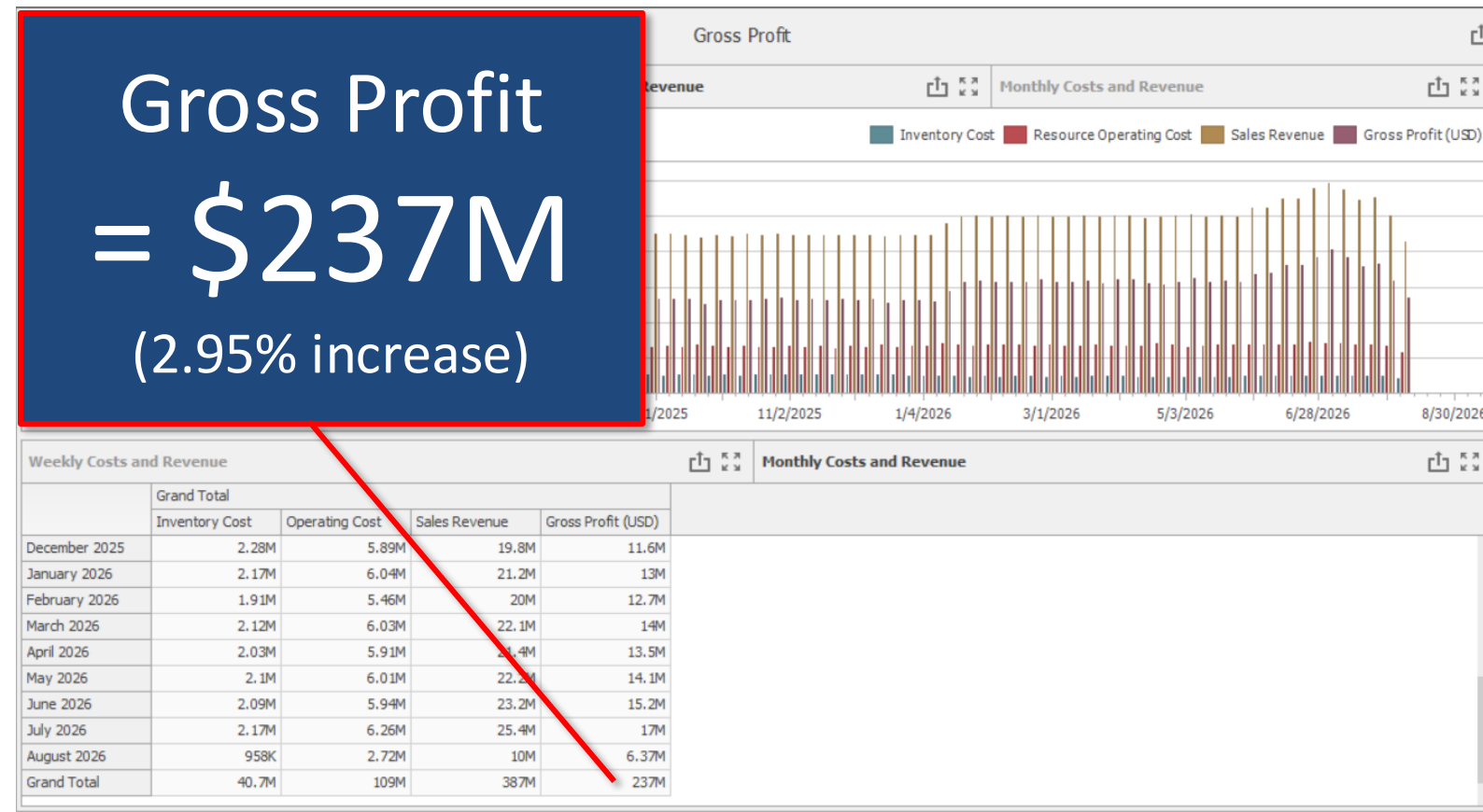


# Gross Profit

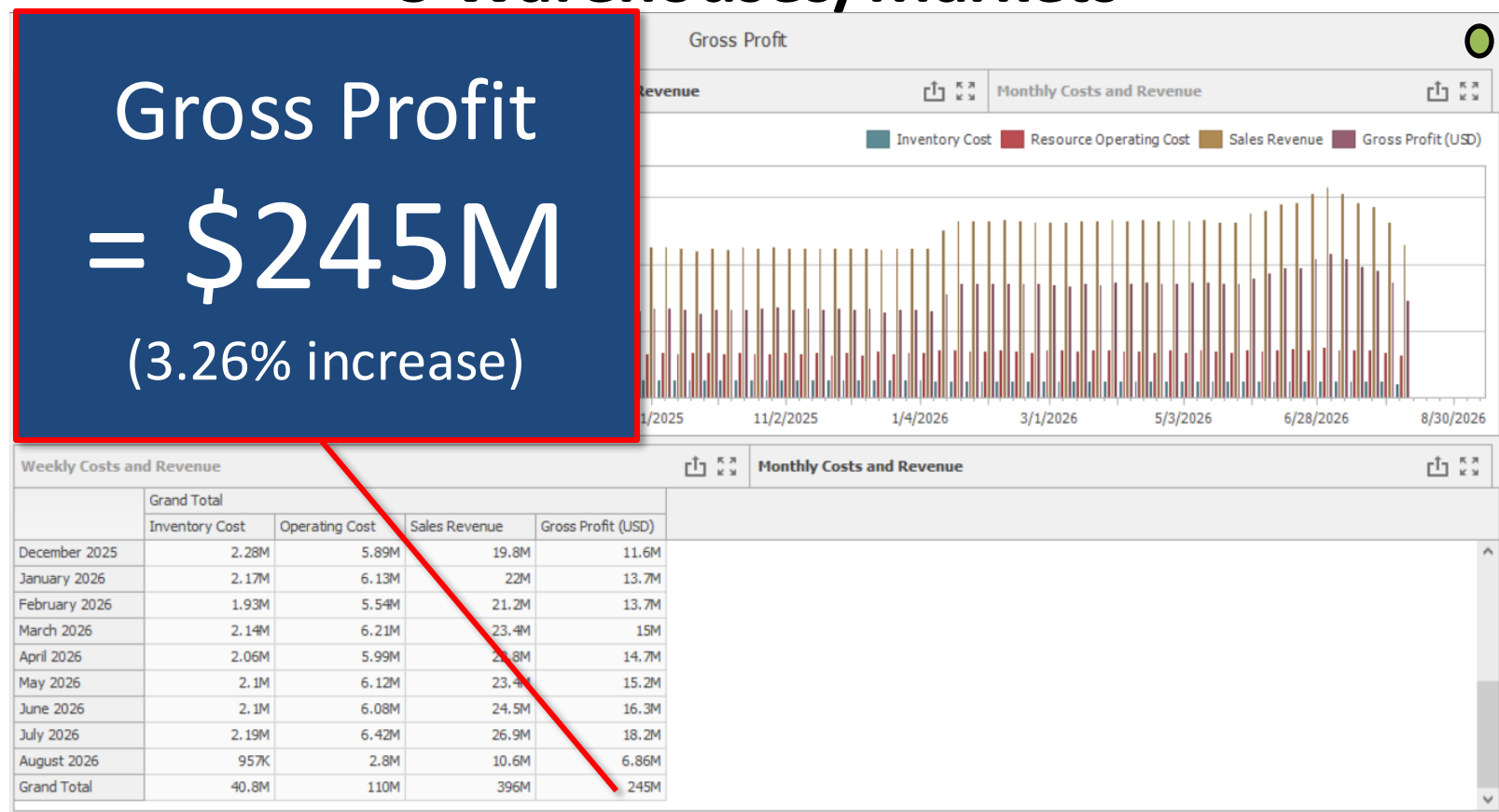
## 1 Warehouse/Market



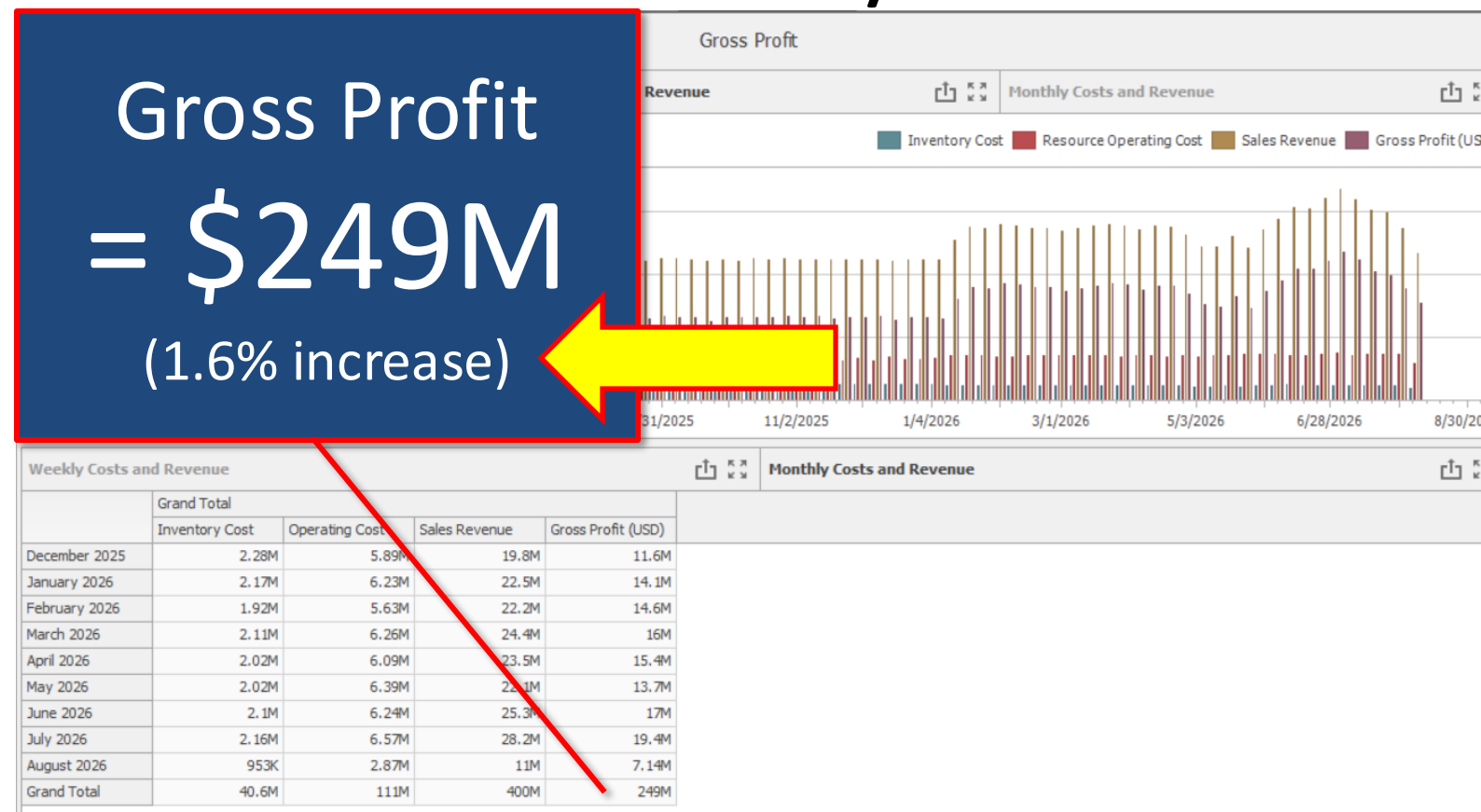
## 2 Warehouses/Markets



## 3 Warehouses/Markets

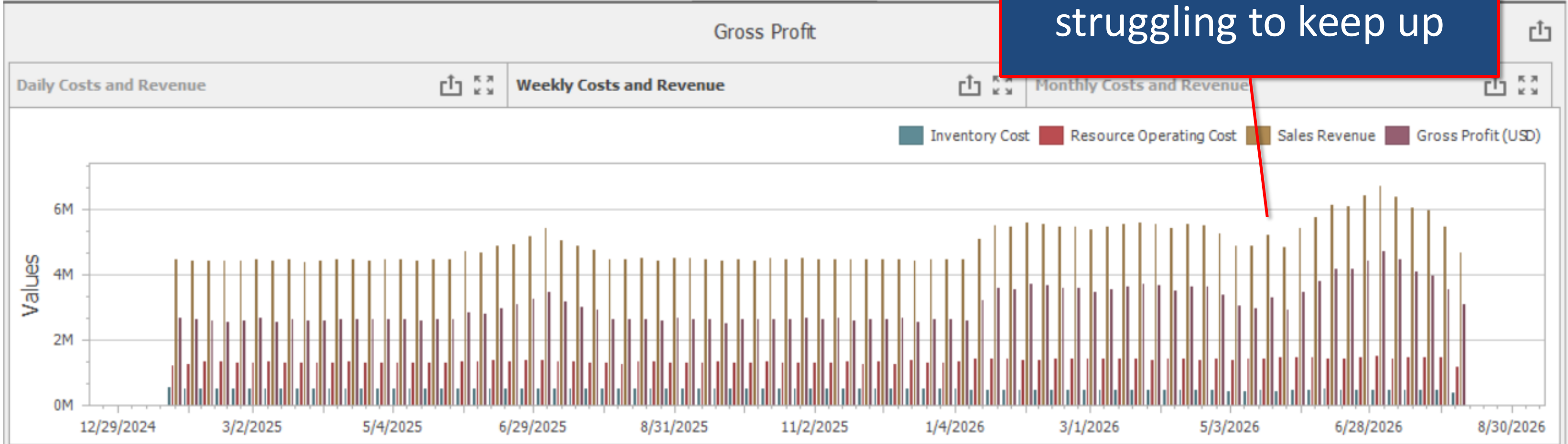


## 4 Warehouses/Markets



# Level 5 Results – Gross Profit

The supply chain is struggling to keep up

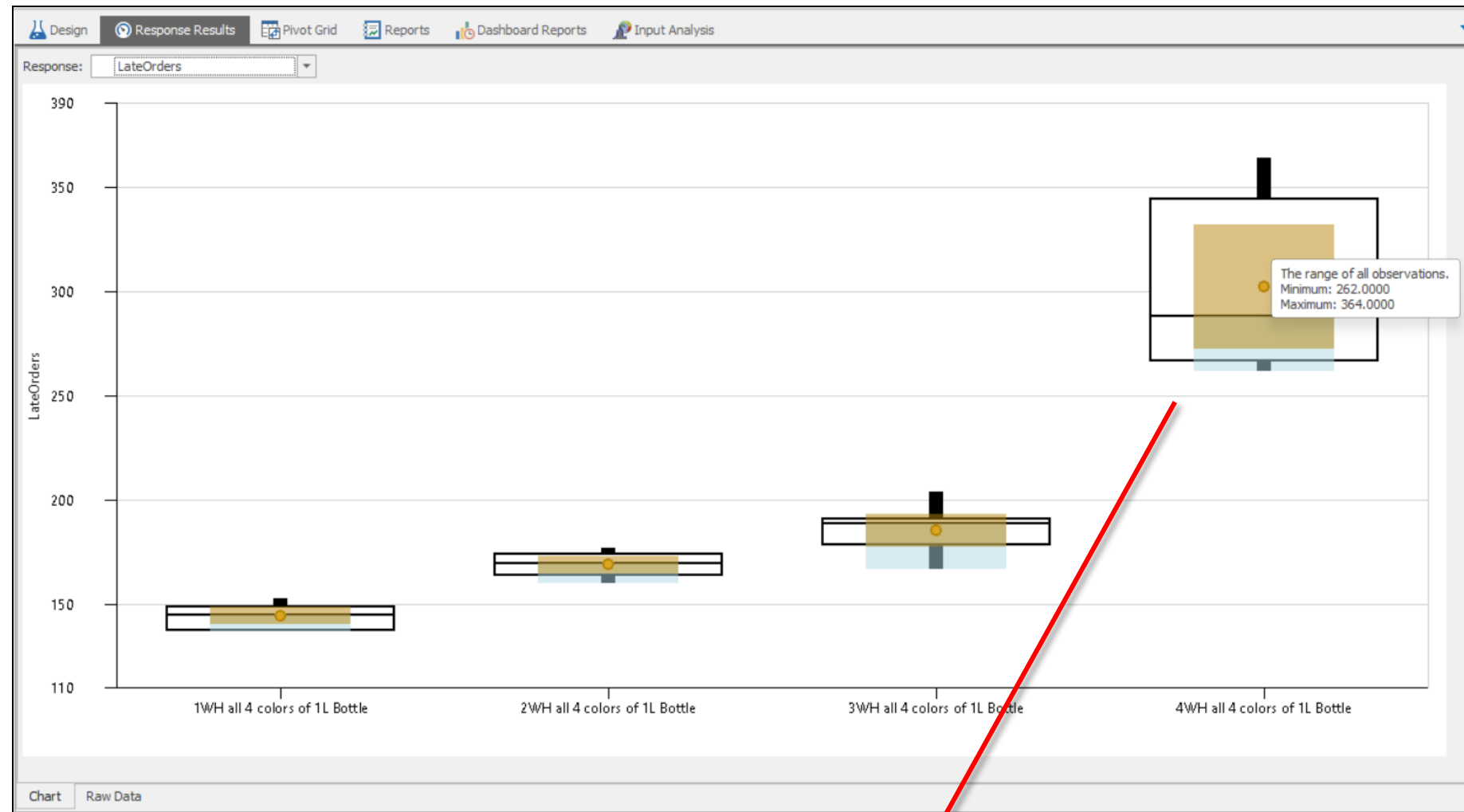


	Grand Total			
	Inventory Cost	Operating Cost	Sales Revenue	Gross Profit (USD)
December 2025	2.28M	5.89M	19.8M	11.6M
January 2026	2.17M	6.23M	22.5M	14.1M
February 2026	1.92M	5.63M	22.2M	14.6M
March 2026	2.11M	6.26M	24.4M	16M
April 2026	2.02M	6.09M	23.5M	15.4M
May 2026	2.02M	6.39M	22.1M	13.7M
June 2026	2.1M	6.24M	25.3M	17M
July 2026	2.16M	6.57M	28.2M	19.4M
August 2026	953K	2.87M	11M	7.14M
Grand Total	40.6M	111M	400M	249M

# Statistical Analysis

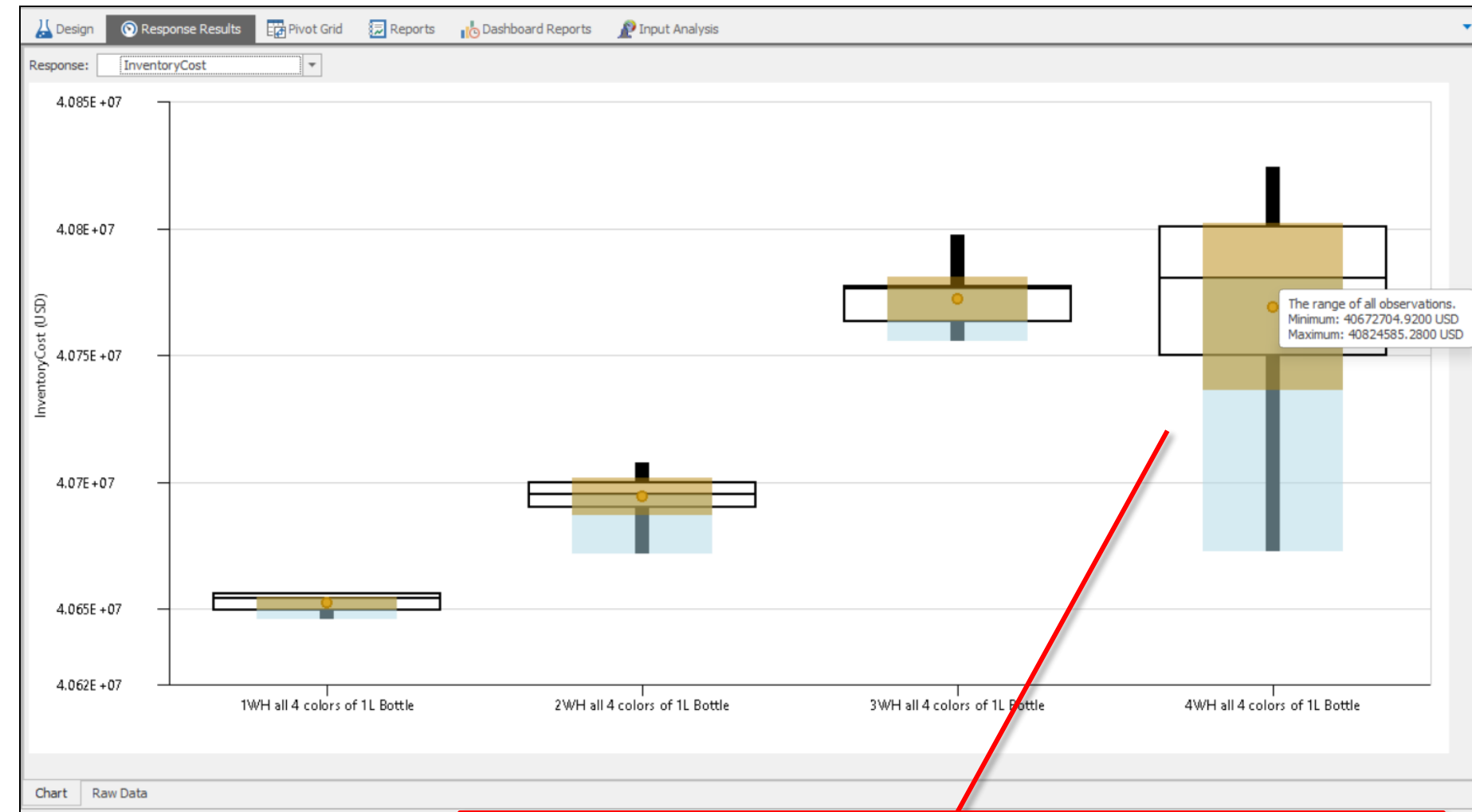
*Run the Game multiple times with variation to evaluate the system responses*

## Late Orders



System is becoming more unpredictable in delivery performance

## Inventory Cost



Inventory are varying more as the systems is struggling to respond to demand

## 4

# Summary and Recommendation

- Introducing the new 1-liter bottle into **2 markets** seems very **possible** within the capacity of the current factory and supporting network
- Introducing the **third** market seems to put the network **on the edge**
- The **fourth** market will push the network into **instability** and exceed all current capacity, negatively impacting all products

## Recommendation to Management

- To test the market response to the new product it will be best to **introduce it to just 2 markets** for the initial launch and then **extend it to a third** based on market response
- Introducing the 1-liter bottle to **all 4 markets** at once will put the **whole network at risk** including the current product supply

# What did we learn from the *Game*,..... if this was real?

- Evaluate any business option or key decisions such as business rules, detail decision logic, changes in processes and resourcing.
- Fully understand the end-to-end supply chain impact from raw material supply through manufacturing and distribution
- The business can make informed decisions about all aspects of their operations and infrastructure to optimize performance and ROI

## But wait.....

This can be done today!

# What is a Process Digital Twin ?

**Process Digital Twins** can be deployed **offline** and/or **online** to be used for design, analysis & decision support (**predictive**) as well as for planning, scheduling & execution management (**prescriptive**) applications



## **Digital Twin**

- A detailed **data generated and driven**, object oriented, discrete event simulation model
- **Accurately replicates** the process to design, predict and prescribe process performance



## **Process**

- **Industry agnostic** Process Digital Twins to meet the specific business requirement
- Processes include **manufacturing, warehousing and end-to-end supply chain** operations



## **Adaptive**

- **Generated and driven by enterprise data** including sources such ERP, MES and IoT
- Digital Twin models **automatically adapt** to the changes in enterprise data



## **Intelligent**

- **Embedded AI** for making intelligent, complex and optimized decisions
- Generate **synthetic training data** for training and testing NN agents

# Intelligent Adaptive Process Digital Twin

## *Key Deliverables*

- **Knowledge base** capturing the detailed process flows, business rules and decision logic in a comprehensive simulation model of the process
- **Performance benchmark** to evaluate any business transformation changes or performance improvement initiatives to determine and validate ROI
- **Control tower** that provides global visibility for decision-making and end-to-end process synchronization, scheduling and orchestration
- **Digital reference model** of the “current status” that accurately replicates the process behavior for ongoing and future analysis – “*digital replica*”

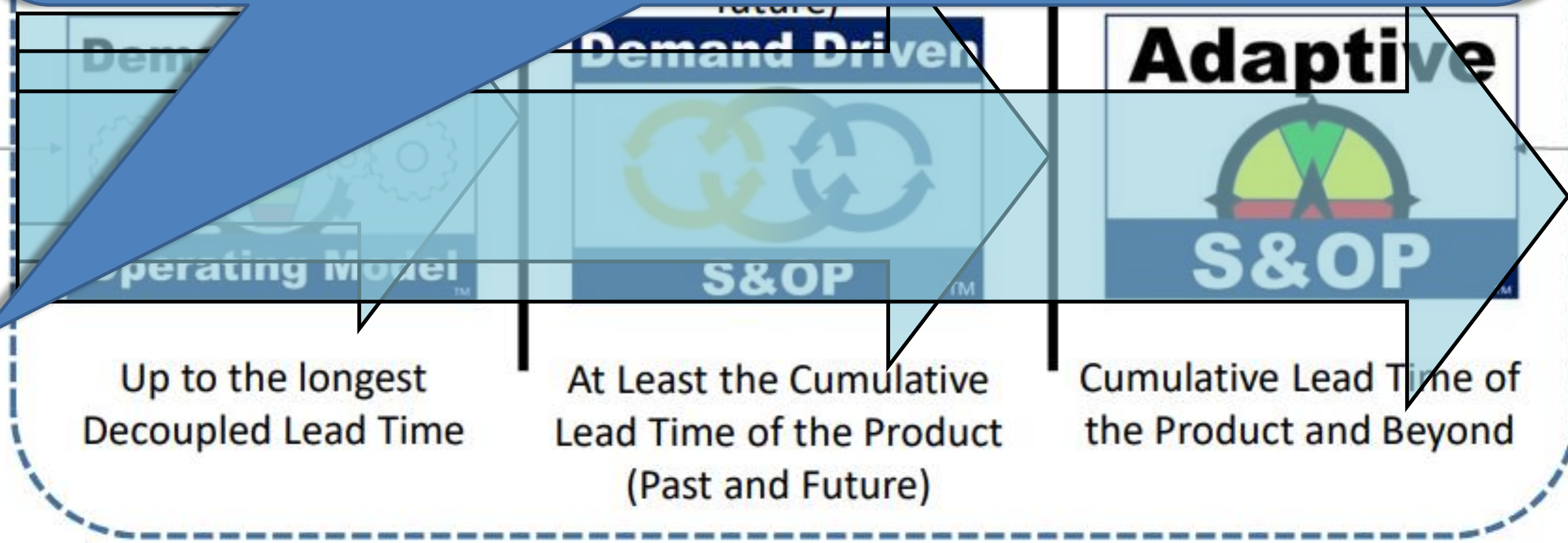
# Effective Digital Twins Enable the DDAE Model

Actual Demand & Forecast



Process Digital Twin

One single supply chain model across all time horizons and all organizational functions/silos executing on a continuous rolling timeline with a unified constraint model of the end-to-end process concurrently evaluating product mix, demand, resource and material availability while focused on optimizing the flow of material to fulfill actual demand



DDI Certified



Market Driven Innovation

# Want to learn more about Digital Twins?

**Please visit our booth in the exhibit area.**

***Simio & 4Sight***

**Booth #S37**

# Questions?

