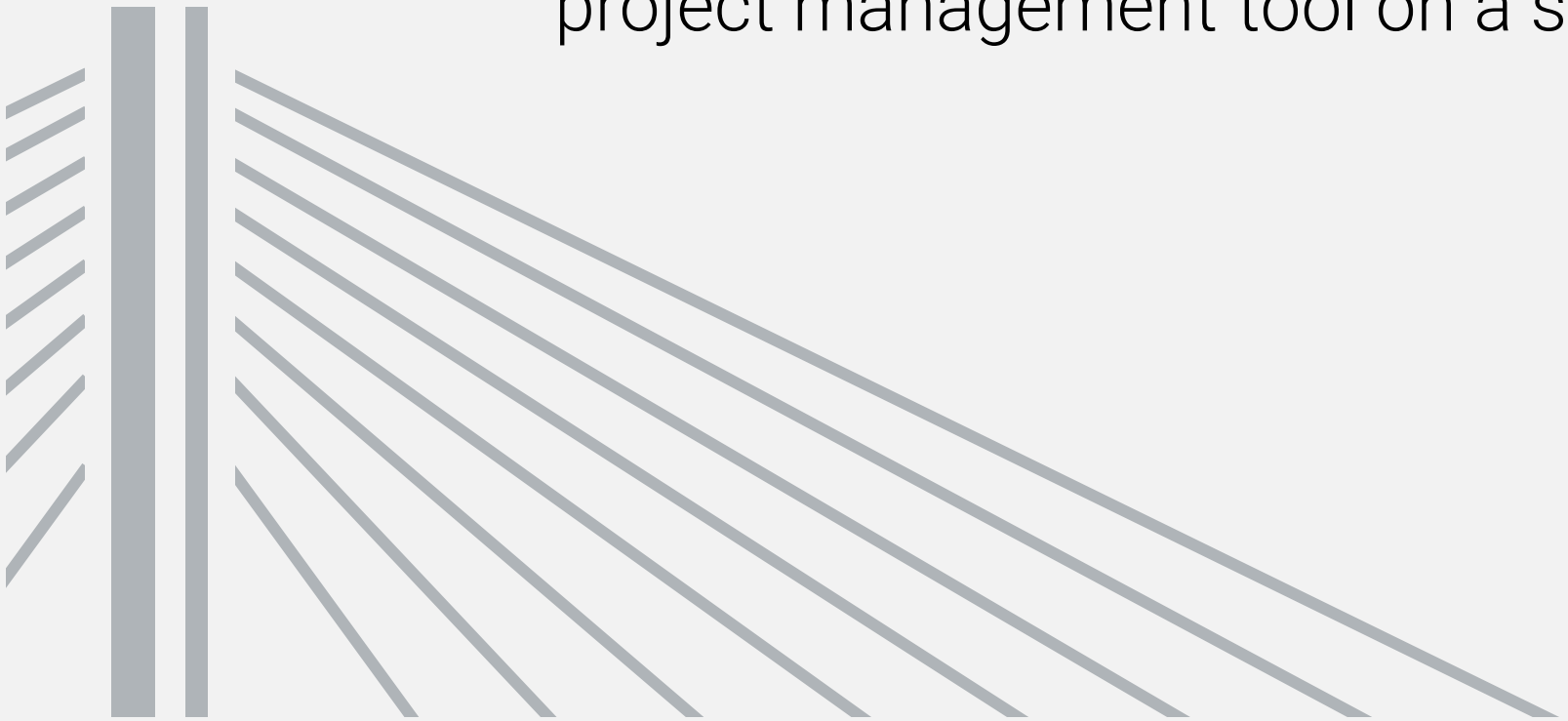
Linear Scheduling 101

How to create your most-valuable
project management tool on a single page.



GritCityLabs

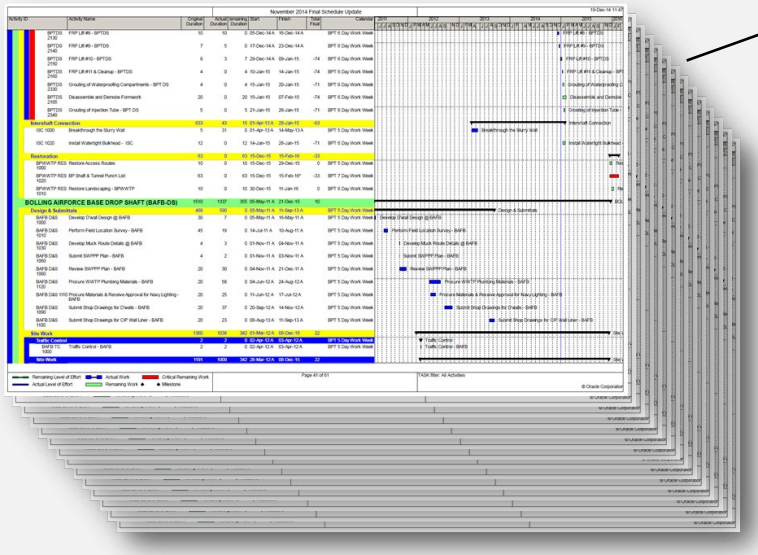
The problem with Gantt charts on major projects:

"Our schedule has 2,638 activities on 61 pages."

"This doesn't reflect how our linear activities actually work."

"Am I supposed to be able to read this?"

"My boss doesn't want to see all of that detail."



"I can't tell where the work crews will be located. How can we spot conflicts before they happen?"

"Our schedule was supposed to be a planning tool, but it feels like it's mostly a payment tool."

We've been there. Major projects is what we do.

This guide was originally created in 2017 by two construction managers who needed a better way to communicate complex schedules with their project teams.

James Wonneberg, PE

- Construction management of major projects since 2008, including:
  - 2008-2011: Brightwater Conveyance Project (Woodinville, WA)
  - 2011-2016: DC Clean Rivers Project (District of Columbia)
  - 2016-2019: Alaskan Way Viaduct Replacement Program (Seattle, WA)
  - 2019-Present: I-405 Widening & Express Toll Lanes Project (Bellevue, WA)
- Pioneered the use of dynamic Excel graphics that redraw automatically with links to contractors' Primavera P6 schedules.

Ron Drake, PE – in remembrance

- Led complex infrastructure projects for over 40 years, including:
  - 1990-1993: Metro Red Line (Los Angeles, CA)
  - 1993-1998: Tri-Met Westside Light Rail (Portland, OR)
  - 2005-2007: Brightwater Conveyance Project (Woodinville, WA)
  - 2014-2019: LA Metro Regional Connector (Los Angeles, CA)
  - 2019-2022: PM/CM Practice Lead
- Made linear scheduling a cornerstone of his project management approach for decades.

What We Believe:

We believe that the vast majority of people that work on these projects really do want to know what's in that huge schedule with thousands of activities.

They want to know the master plan. They want to see the big picture and understand the relationships between activities. They want to know about the deadlines that their crew must meet. But our industry lacks the tools to communicate that information in a way that the entire team can understand.

We believe that if you make your schedule beautiful, your team will use it!

If you place a good-looking linear schedule on the table in any project office or jobsite trailer, people will go out of their way to look at it, pick it up, and study it. Then they will ask questions, and give you valuable feedback about how the work will *actually* be built.

(But if you don't make your schedule beautiful, it will be ignored and forgotten like all the rest.)

What We Believe: CONTINUED

We believe that schedules should fit on one page.

The moment you have to flip the page to see the rest of your sequence of work, you've lost the relationships between activities. This is not to say that we don't create multiple sheets; in fact we do it all the time to "zoom in" and "zoom out" on our projects. But each sheet should tell the whole story of what you are trying to communicate.

We believe that adding a simple graphic of what you're building makes your schedule information 10x more useful and effective.

Most people are visual learners, and schedule data doesn't sink in unless they can visualize the major work elements and the spatial relationships between them. A one-page illustration of scope of work and schedule becomes a very useful "talking paper" that helps you quickly explain your entire project to anyone, anywhere. And your team members will undoubtedly start sketching right on top of it for all sorts of problem solving, alternatives, and what-if-scenarios. This is when the magic happens – increasing the chances of your team delivering a winning project.

What the Industry is Saying:

"As engineers and contractors, we are taught to break down complex projects into fundamental simpler pieces. Linear schedules are great tools that help us break down complex P6 schedules to help communicate to all team members our plan for success."

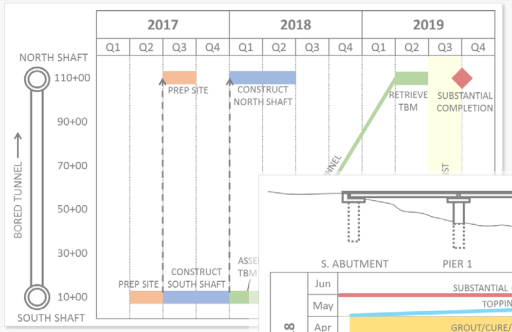
-Fernando De Leon, Project Director at Shimmick Construction

"The linear scheduling method really helps to visualize a project's schedule. It makes it possible to not only account for time but also space constraints."

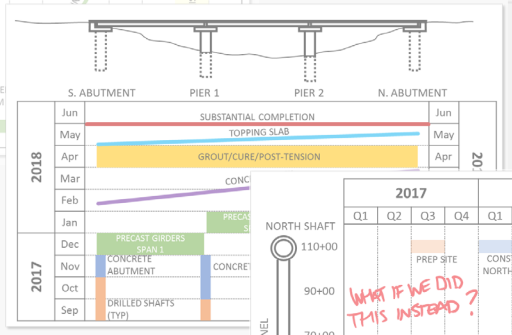
-Lisa Mori, Tunnel Engineer at Jay Dee Contractors

Coming Up:

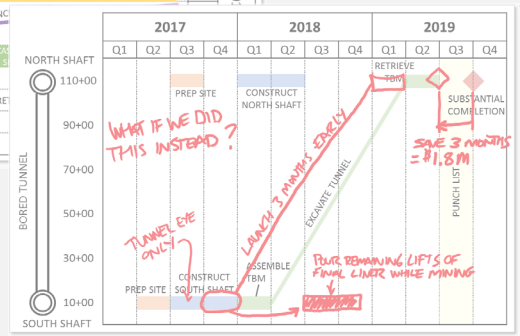
This guide will walk you through the fundamentals of a linear schedule, give you the vision for how it can be applied, and show you how to put it to work as your project evolves. Along the way you'll hear from more industry leaders about how they're using linear scheduling to execute their own challenging projects.



Part 1: The Basics



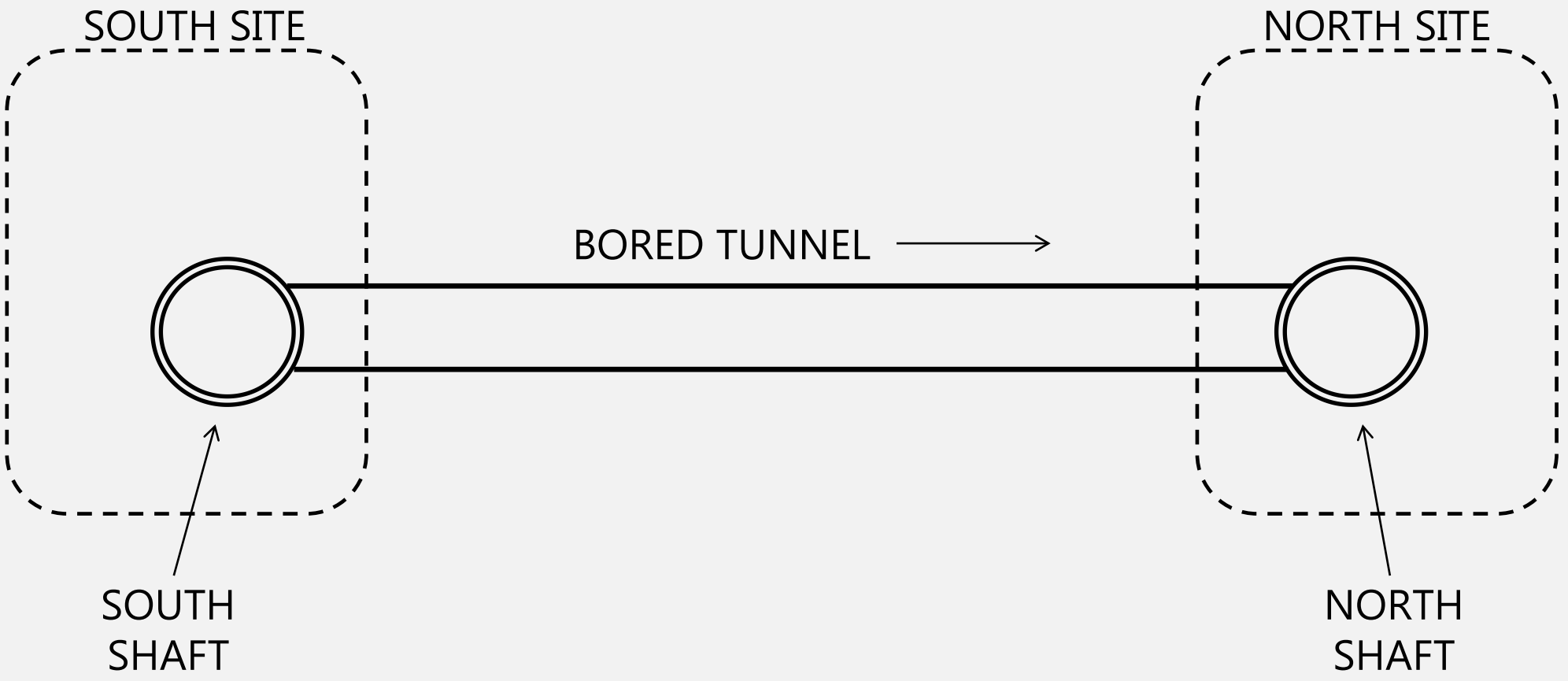
Part 2: Example Projects



Part 3: Adapting to Schedule Changes

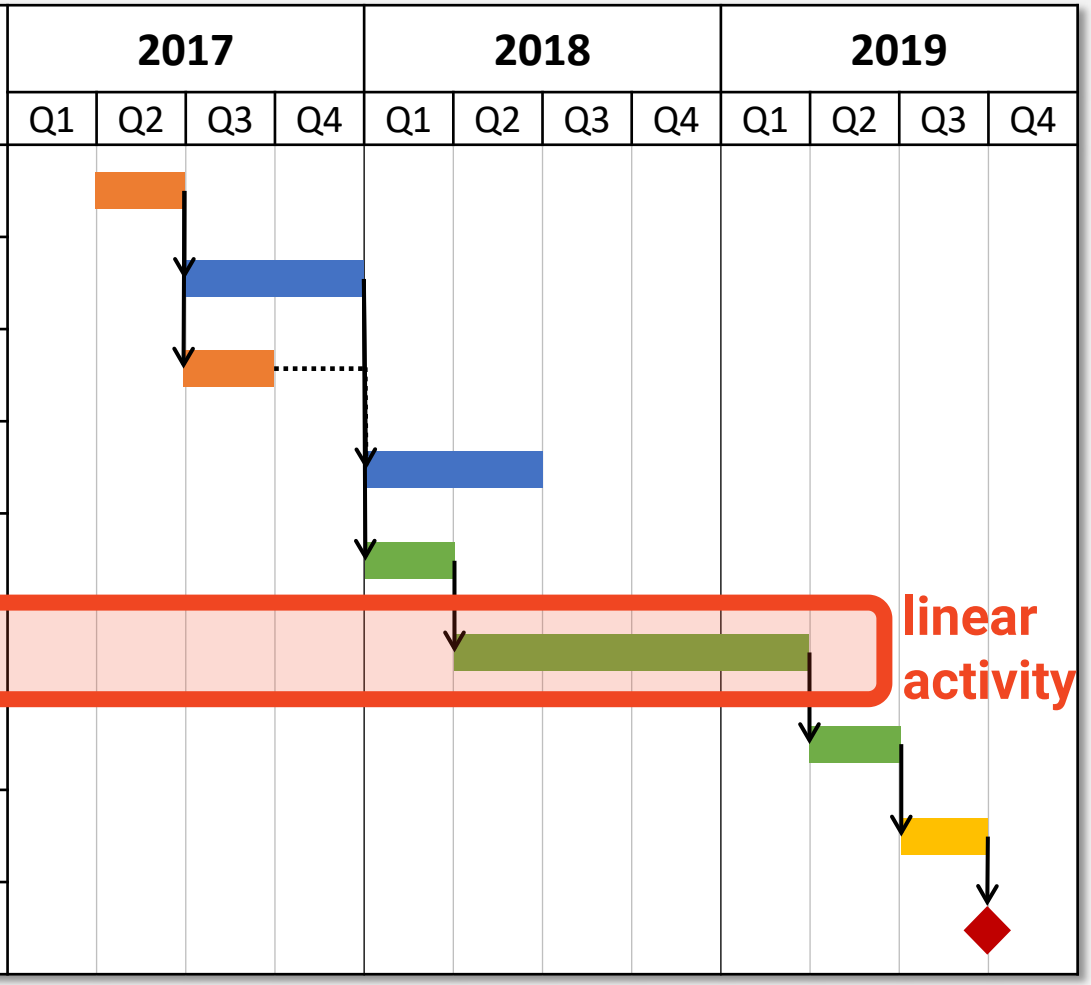
1 The Basics

Tunnel Project Example:

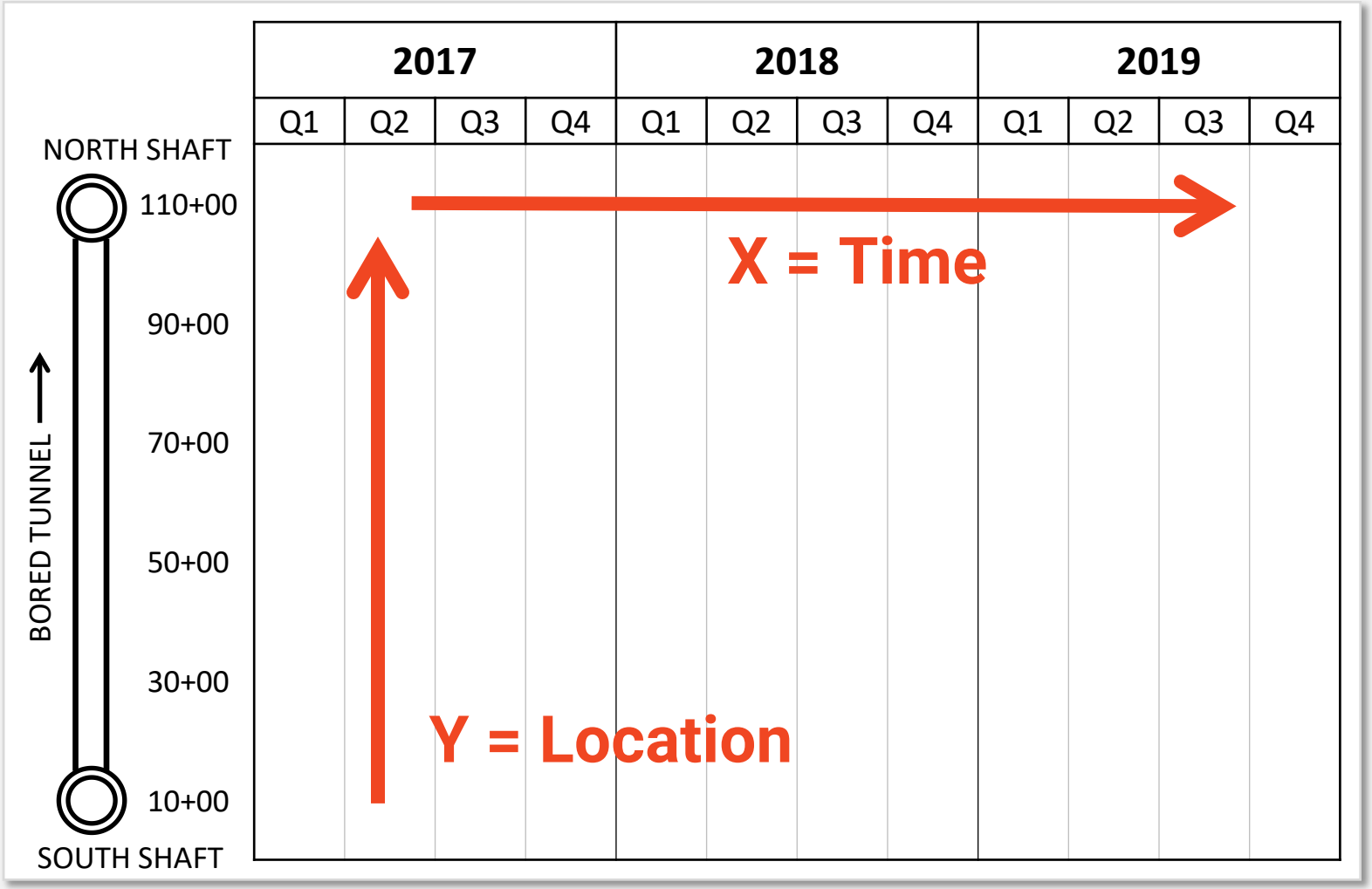


Simplified Gantt Chart:

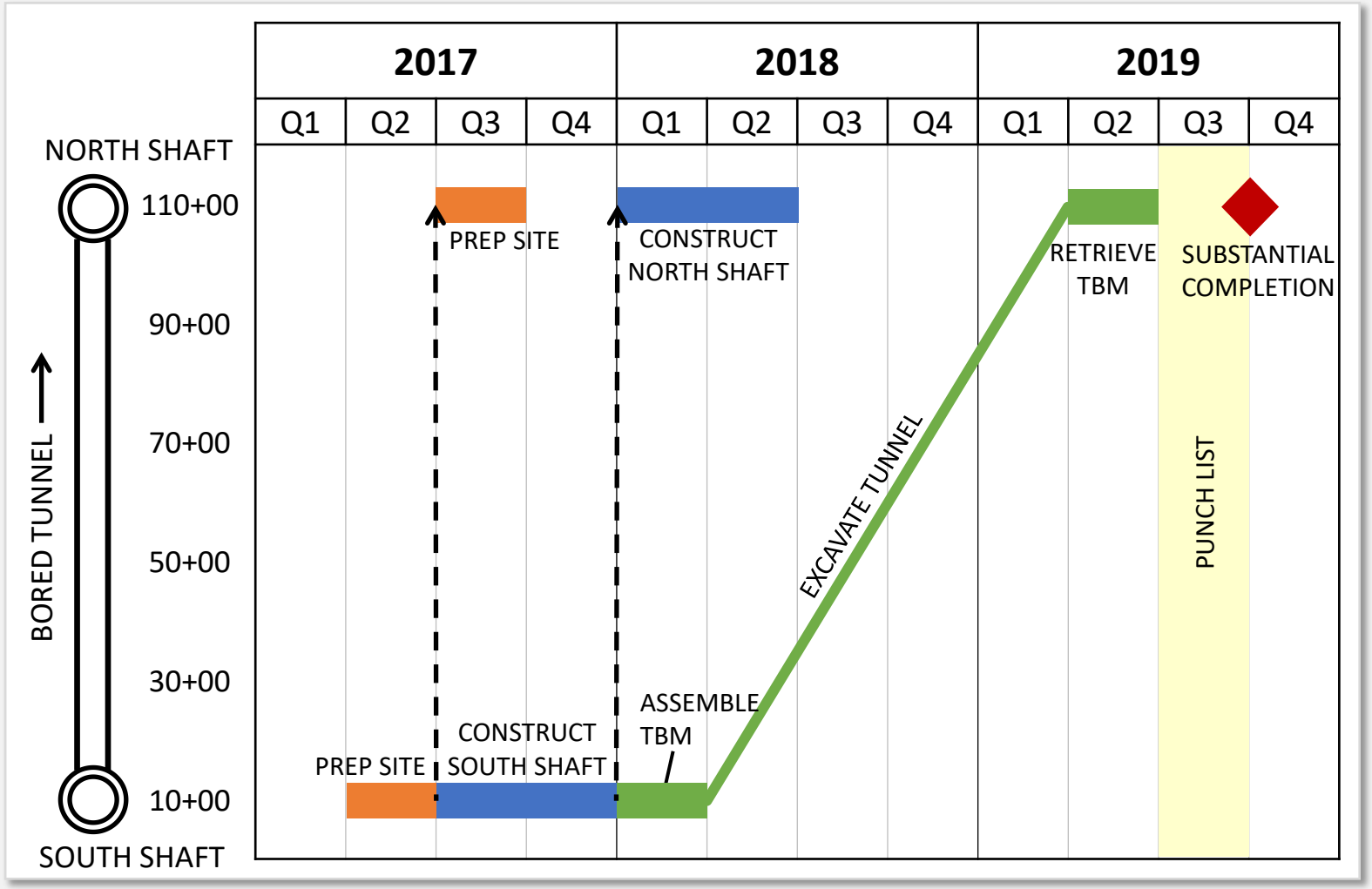
ACTIVITY	START DATE	FINISH DATE
PREPARE SOUTH SITE	1-Apr-17	30-Jun-17
CONSTRUCT SOUTH SHAFT	1-Jul-17	31-Dec-17
PREPARE NORTH SITE	1-Jul-17	30-Sep-17
CONSTRUCT NORTH SHAFT	1-Jan-18	30-Jun-18
ASSEMBLE TBM	1-Jan-18	31-Mar-18
EXCAVATE TUNNEL	1-Apr-18	31-Mar-19
RETRIEVE TBM	1-Apr-19	30-Jun-19
PUNCH LIST	1-Jul-19	30-Sep-19
SUBSTANTIAL COMPLETION		30-Sep-19



Page Setup for Linear Schedule:



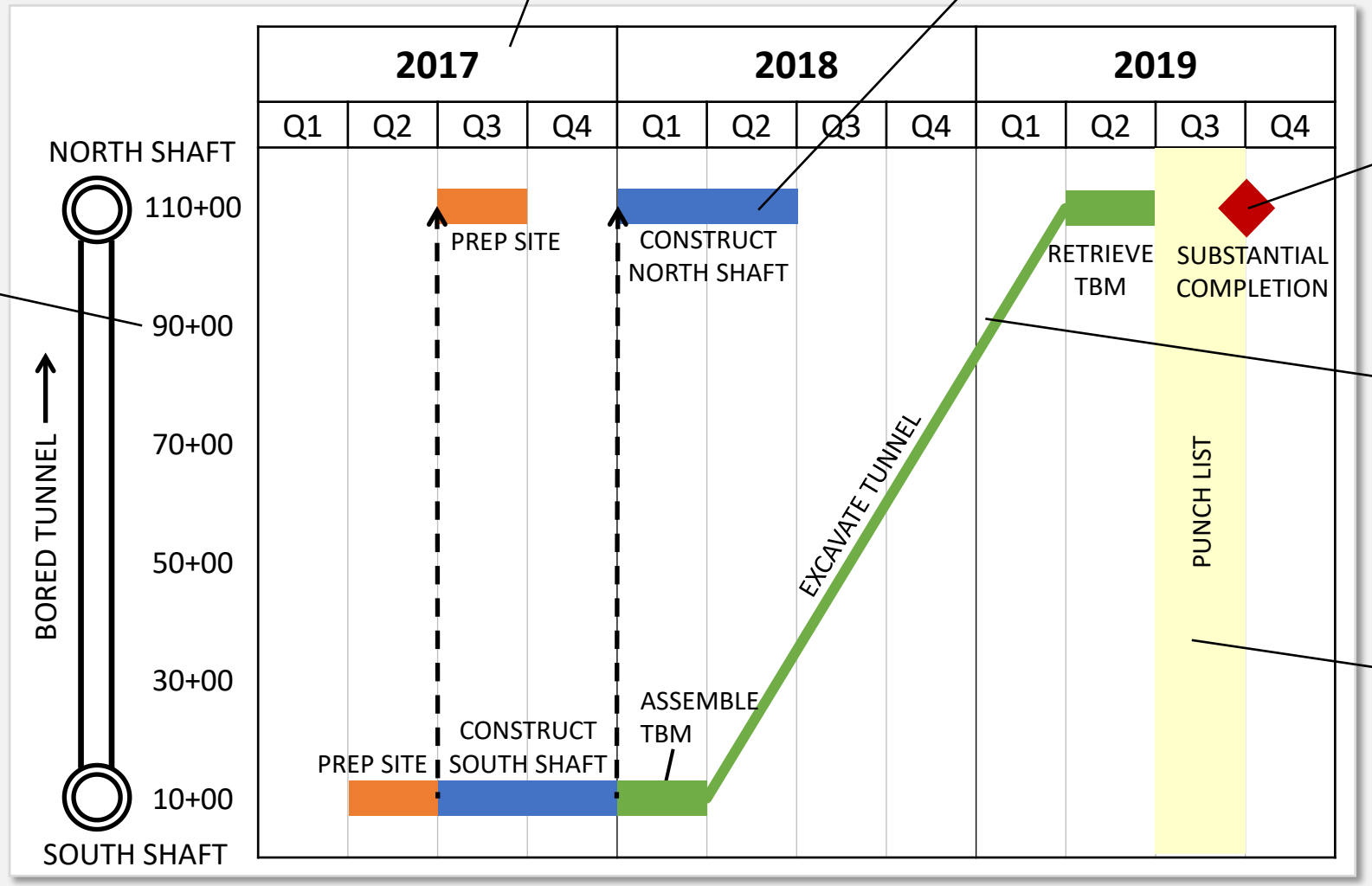
Linear Schedule:



Terminology:

Timescale

Bar Activity (work at a single location)



Location Axis (distance units or stationing along project alignment)

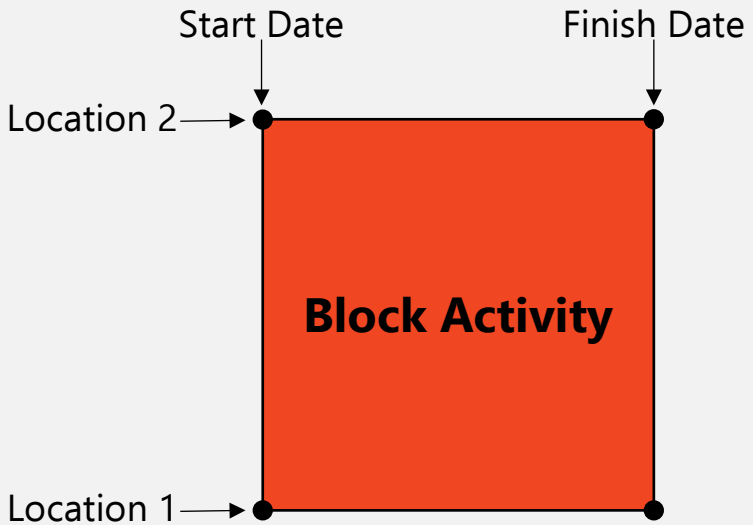
Milestone (deadline or major event)

Linear Activity (work that moves from Point A to Point B over time)

Block Activity (work over a given space for a period of time)

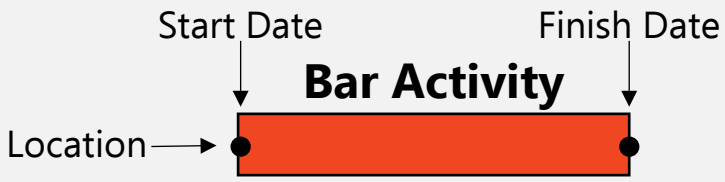
Primary Types of Activities:

Work that moves from Point A to Point B over time

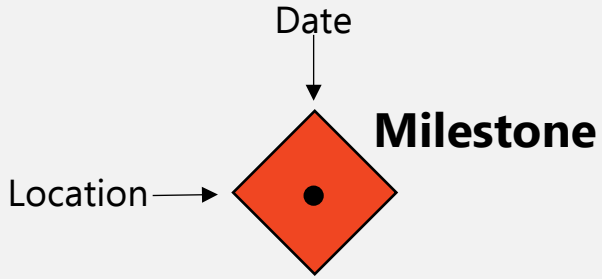


Work over a given space for a period of time

Primary Types of Activities: CONTINUED



Work at a single location



Deadline or major event

What do the colors mean?

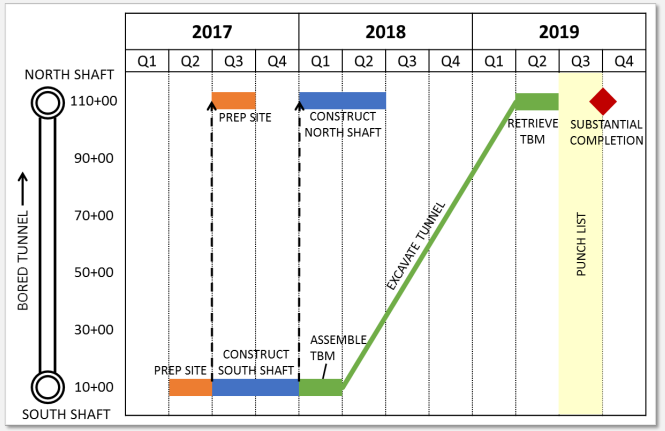
Short Answer: Whatever you like.

Better Answer:

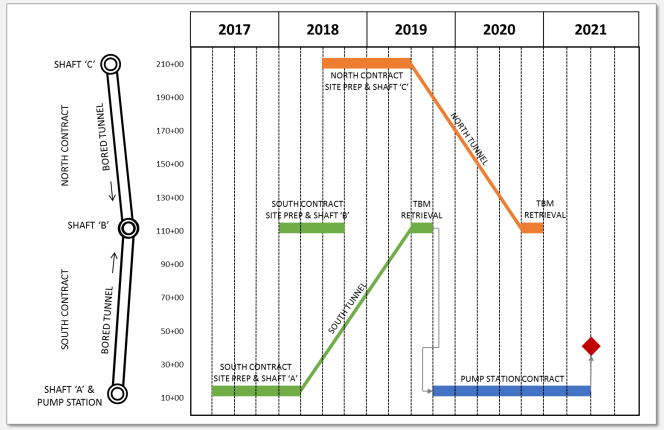
We usually assign one color to each major type of work (similar to layers in a CADD drawing). This makes it easy to see how your crews and equipment will move through the project over time.

Or, when illustrating a large program with multiple contracts, we often assign one color to each contract. This helps everyone see how all of the contracts work together to complete the program. It also highlights the interfaces (i.e. touch points) that will require coordination to make sure everything goes smoothly.

Color is a good thing. Be creative, and don't hold back!



or



Advantages of a Linear Schedule:

"Are we OK with three cranes or do we need to add a fourth? I can just look down a specific month on the linear schedule and see right away how many crews or spreads we will have working and at what locations. All on one page. That is convenient compared to long P6 schedules."

-Brett Zernich, Project Manager at Traylor Bros.

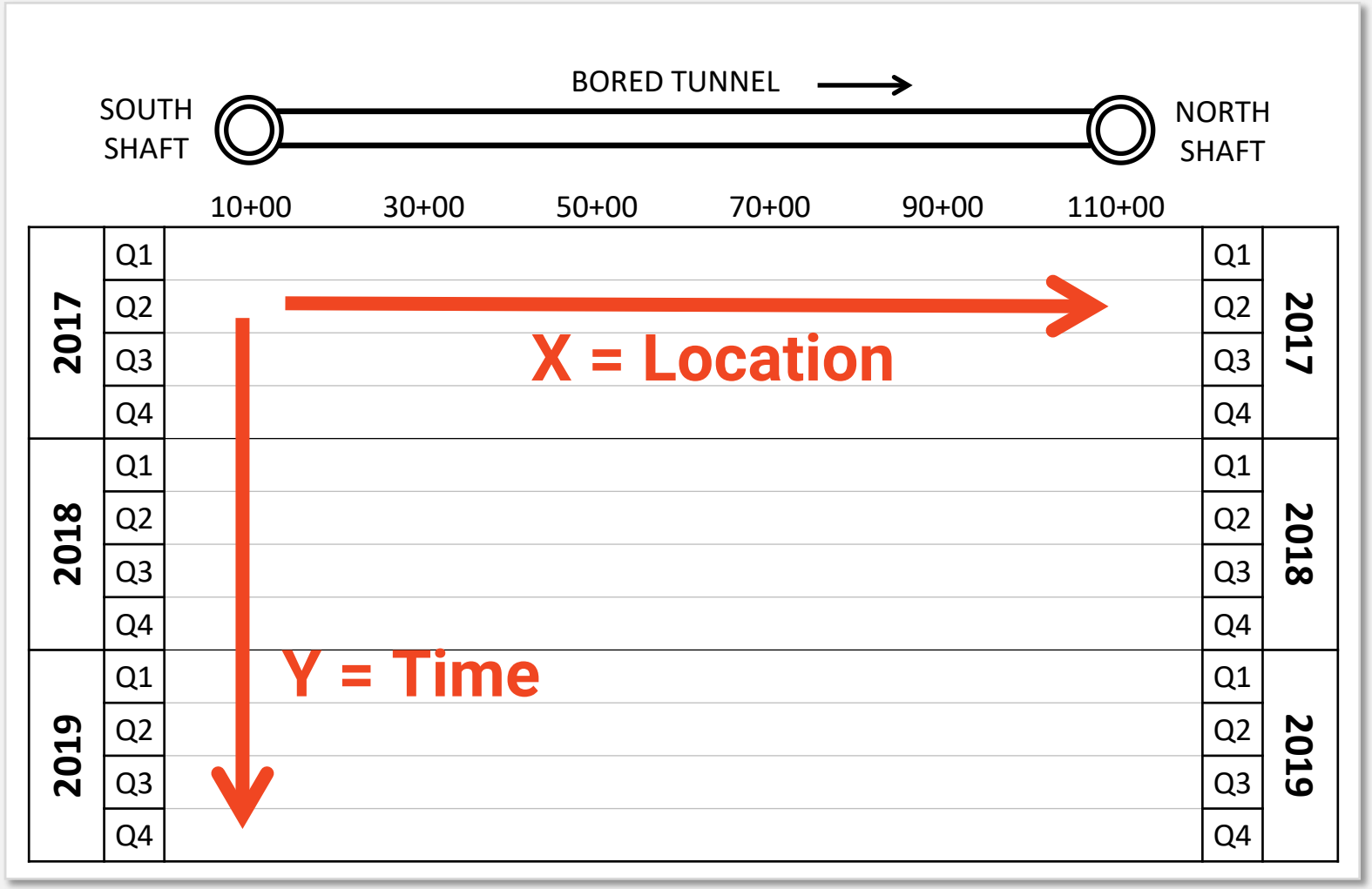
"The linear schedule update is one email that I actually look forward to receiving each month. It provides a concise and useful snapshot of otherwise complex project and program schedules."

-Rafael Castro, Principal at JCK Underground

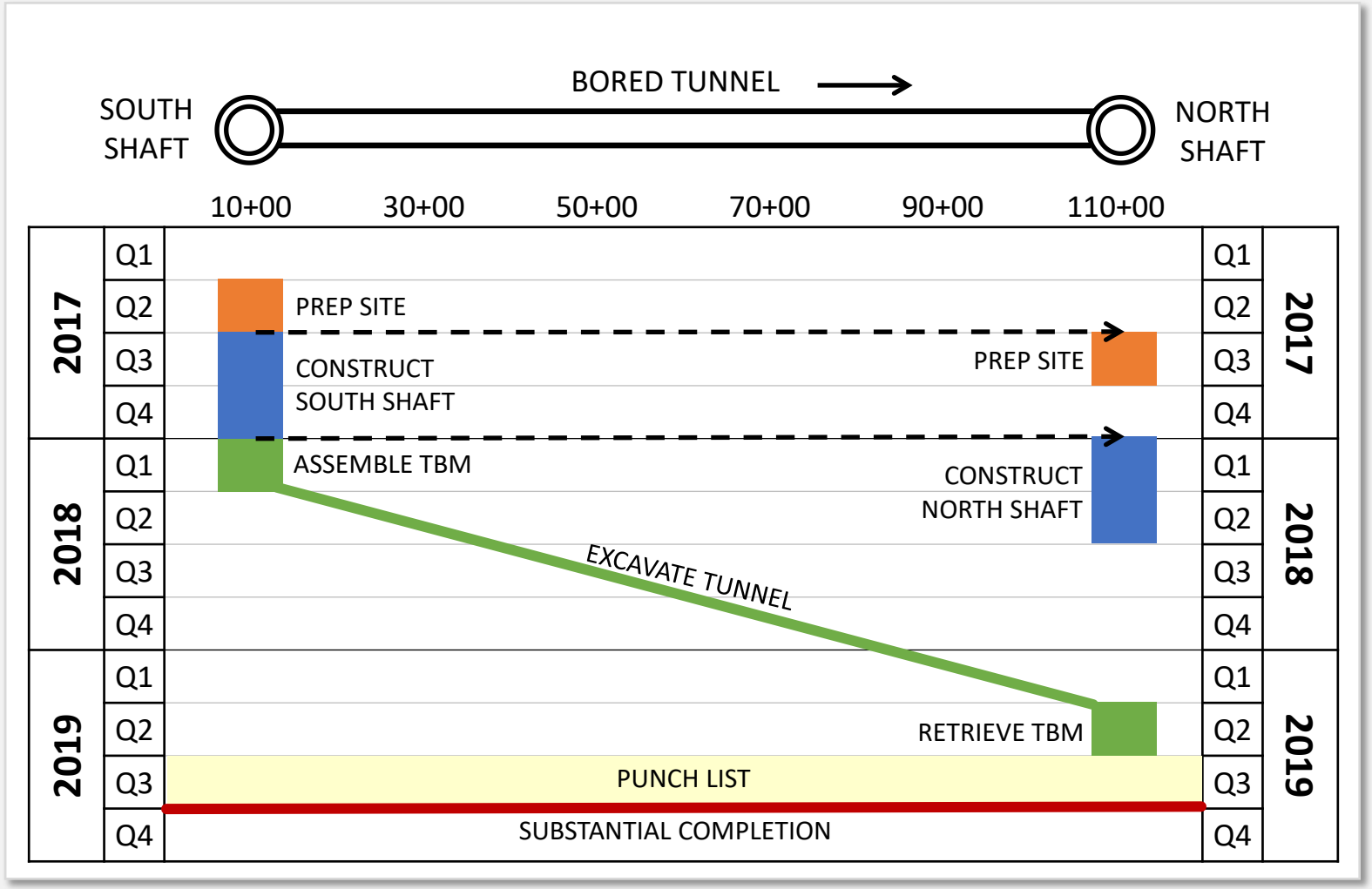
"Linear schedules have been essential to communicating inter-project and inter-agency construction relationships."

-Brian Smith, Program Controls Manager at Mott MacDonald

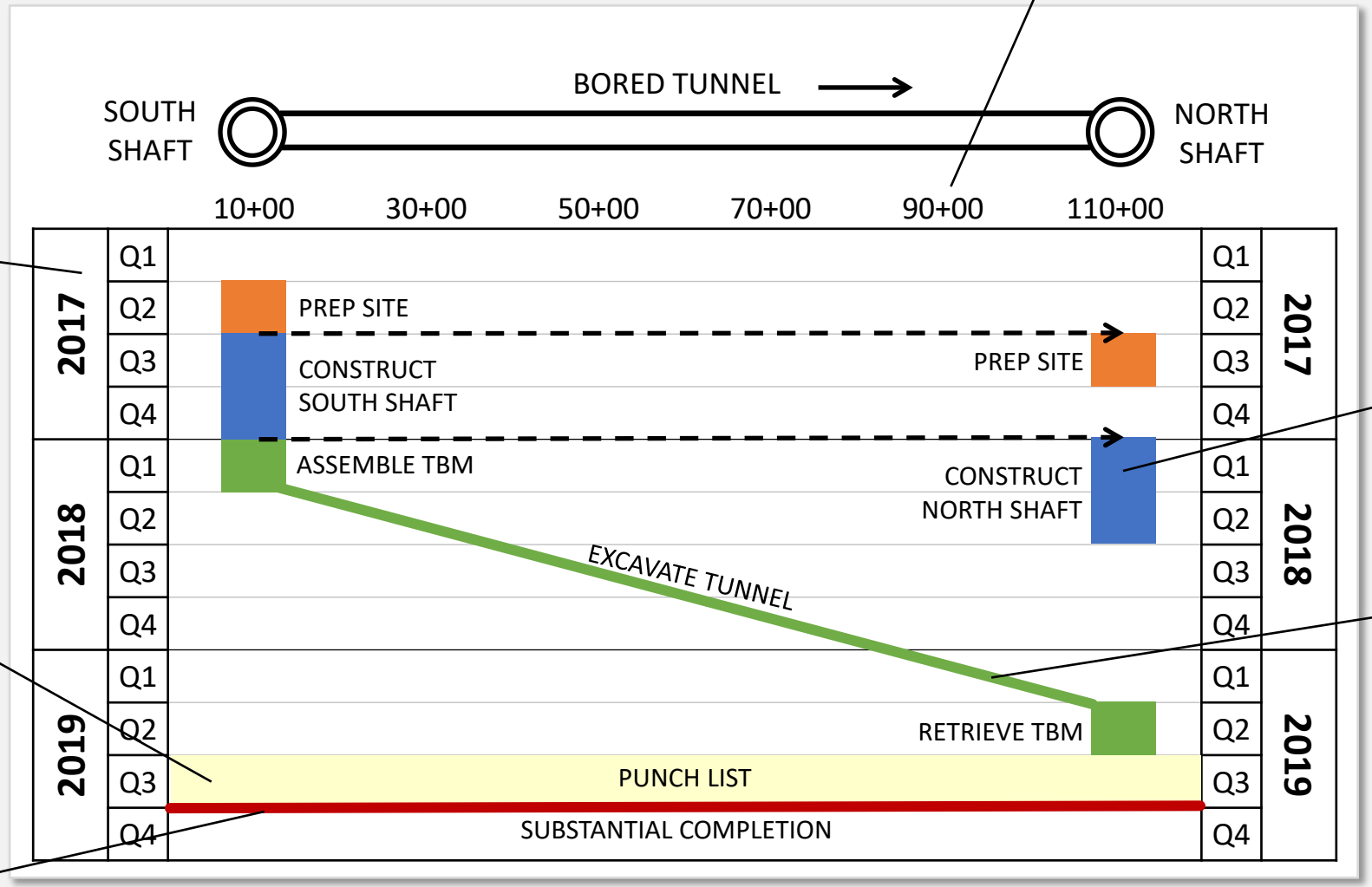
Alternate Page Setup: Time on Vertical Axis

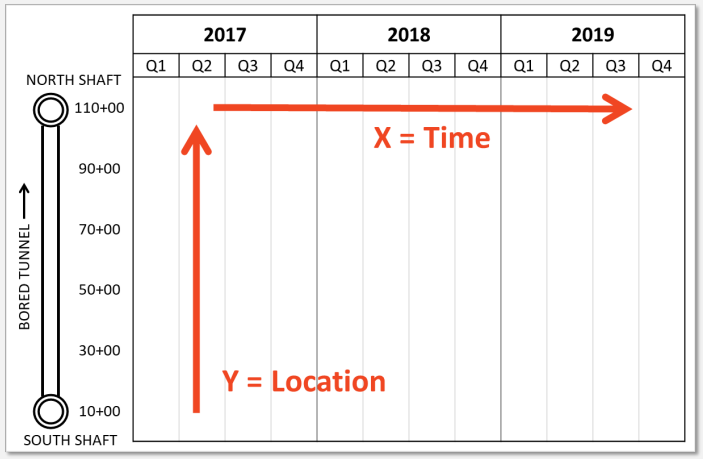


Linear Schedule: Time on Vertical Axis



Same Terminology:

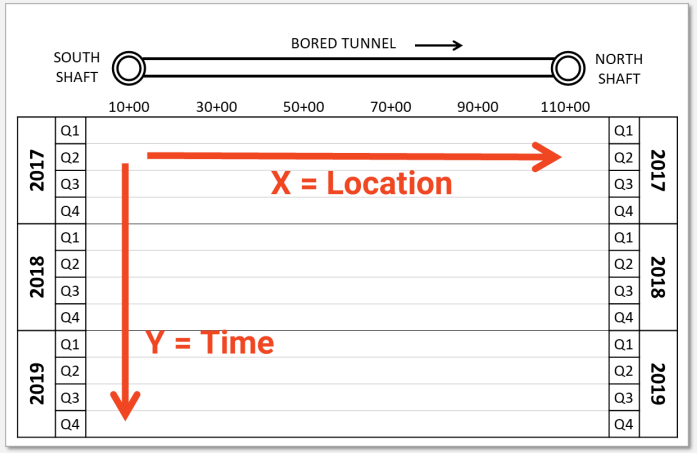




Time from Left to Right:

- ✓ Easiest to read for general audiences (the way we normally read schedules)
- ✓ Expanded timescale accommodates more-detailed schedule activities and labels
- ✓ Differences in linear production rates are more obvious

vs.



Time on Vertical Axis:

Also called a Time-Chainage Diagram

- ✓ Keeps the drawing horizontal (the way we normally read plan & profile drawings)
- ✓ Can illustrate the sequence in the same direction that the work is constructed (i.e. top-down or bottom-up)

Which format to choose? Here's our $0.02:

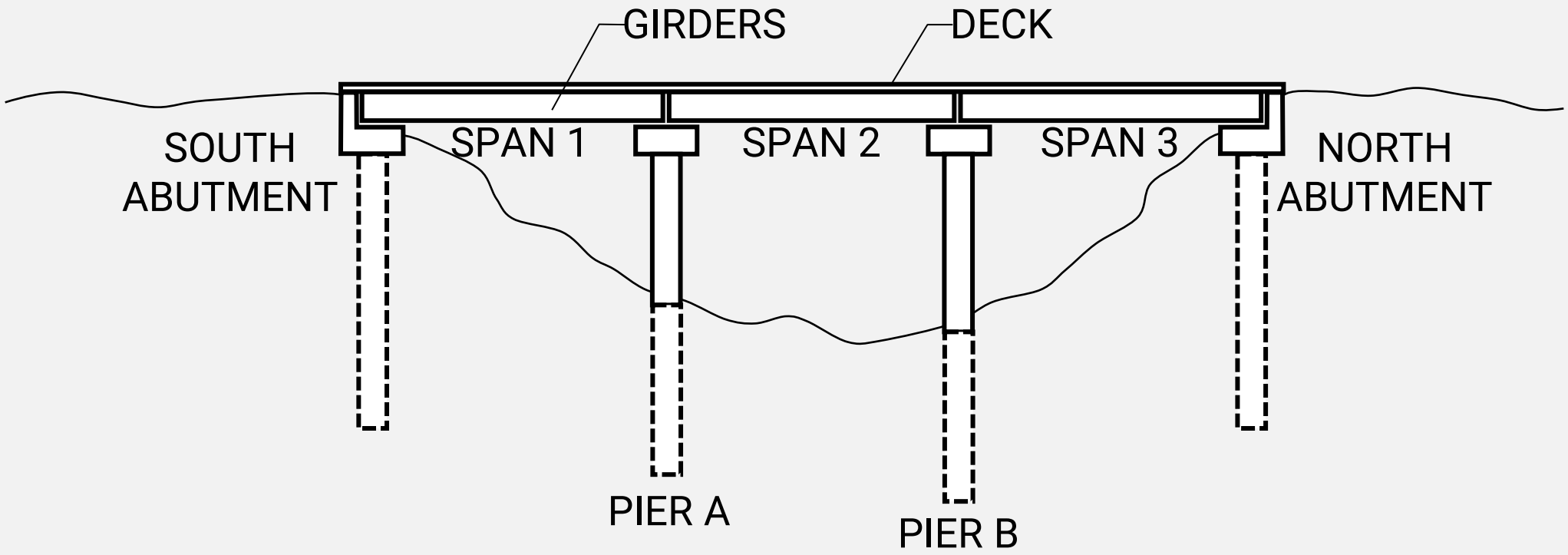
People that have never seen a linear schedule before usually find it easiest to read time from left to right. When meeting with executives, third party stakeholders or the Mayor, you need to bring them up to speed quick. So we plot time from left to right whenever possible.

However, certain industries and regions have been plotting time on the vertical axis for decades. In that case, stick with the format that your target audience wants to see.

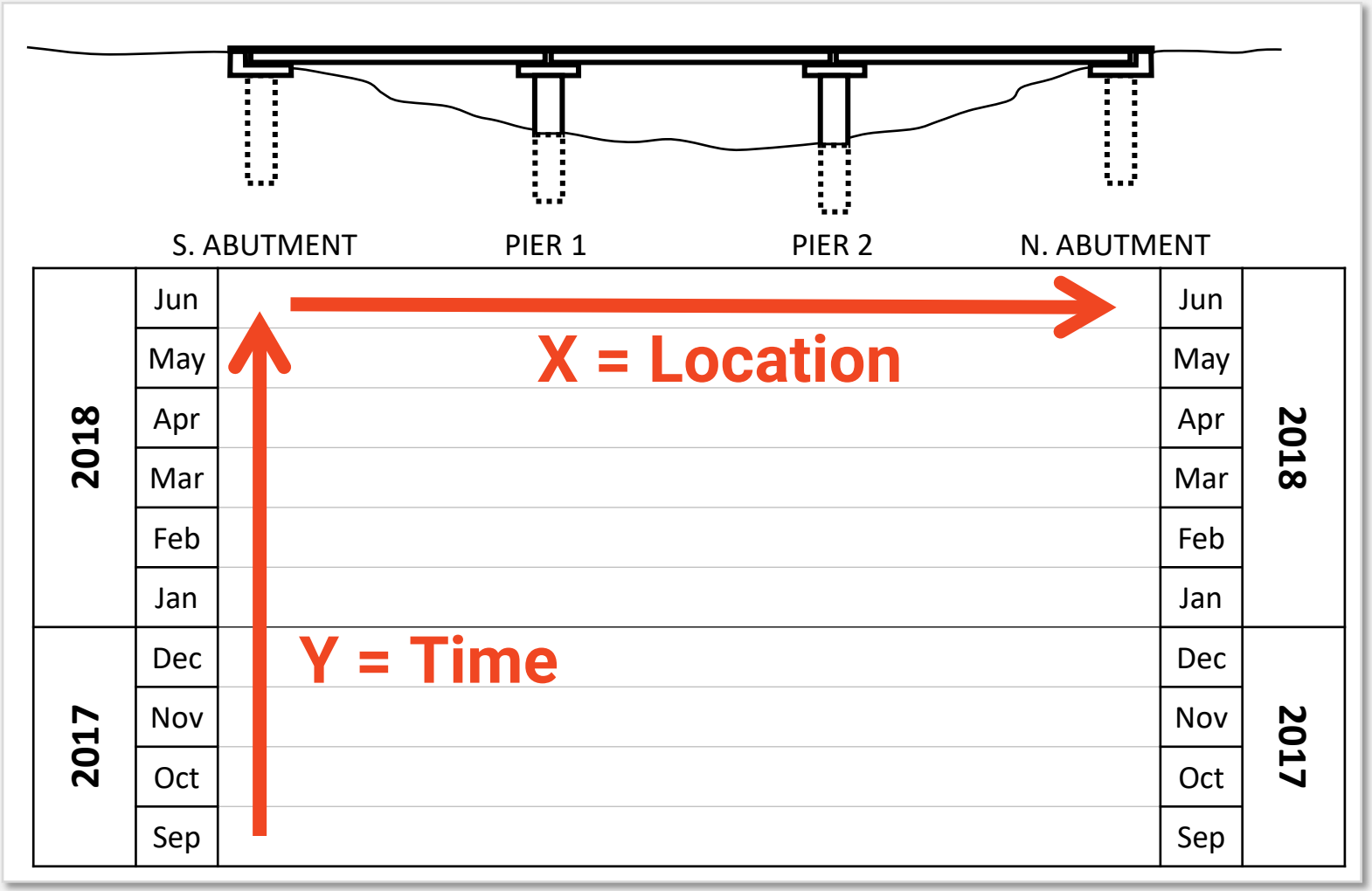
(Either way, your linear schedule is sure to communicate your plan far better than that stack of Gantt charts ever could.)

2 Example Projects

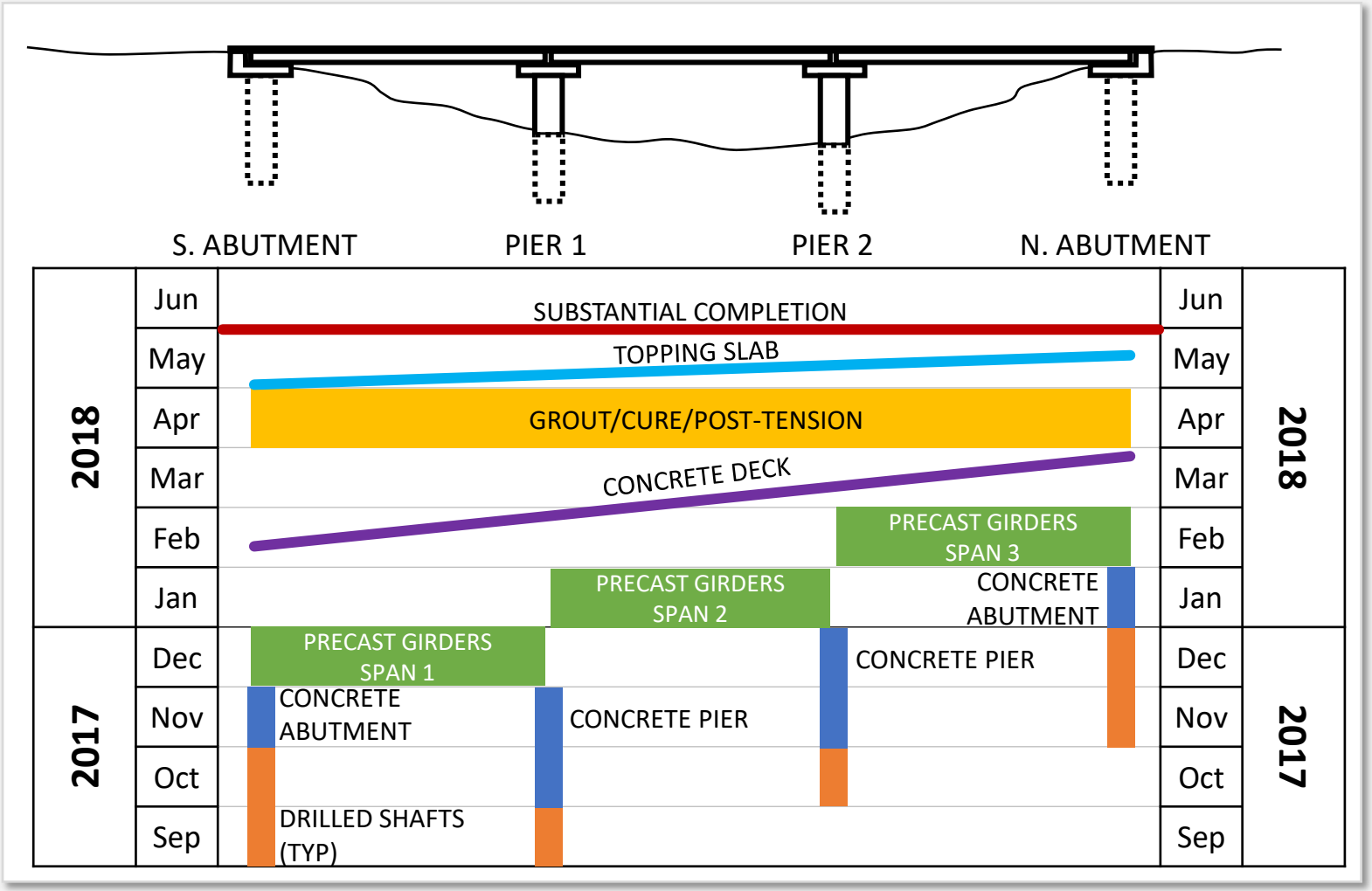
Bridge Project Example:



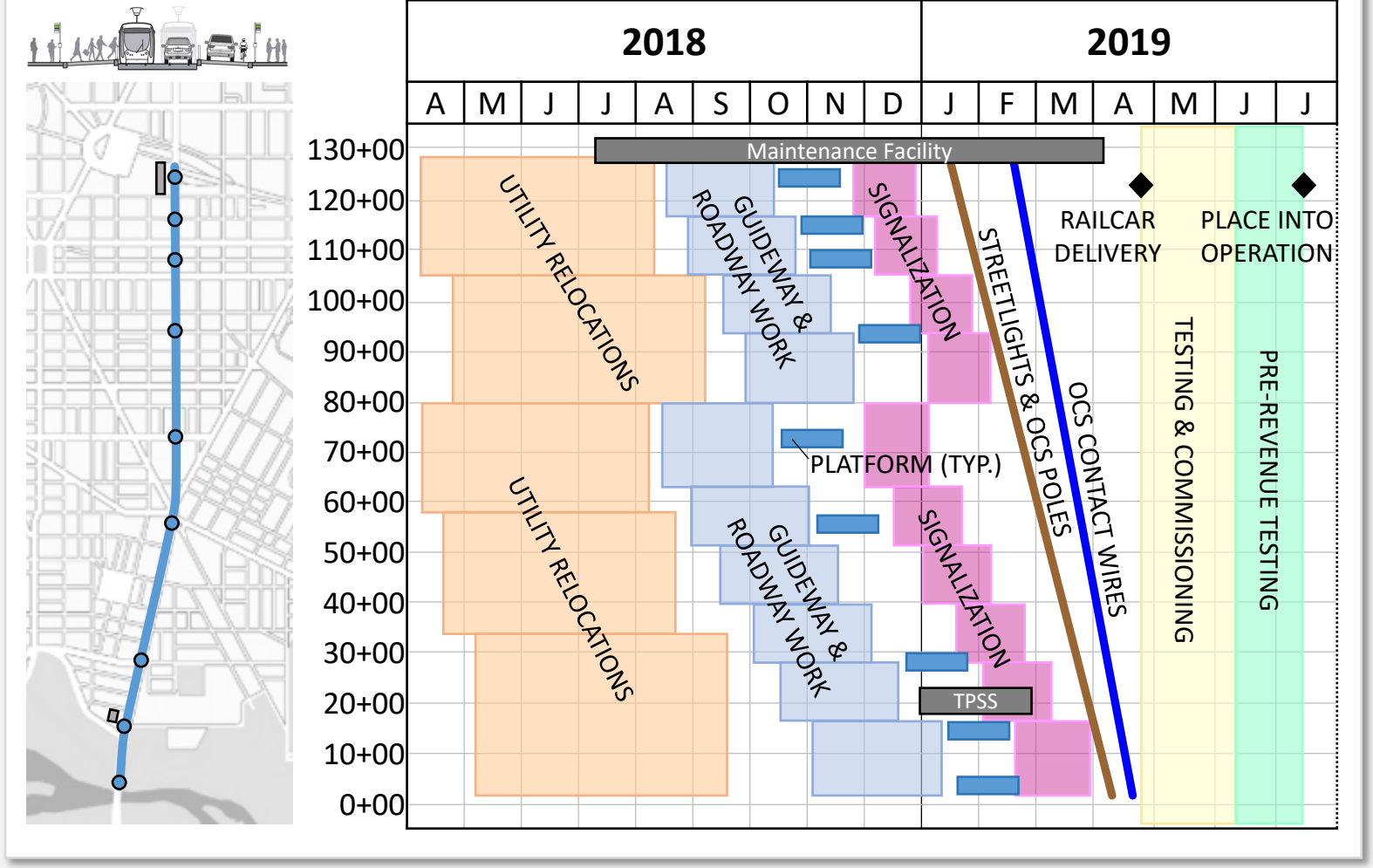
Page Setup:


S. ABUTMENT
PIER 1
PIER 2
N. ABUTMENT
2018
Jun
May
Apr
Mar
Feb
Jan
2017
Dec
Nov
Oct
Sep
X = Location
Y = Time

Linear Schedule:



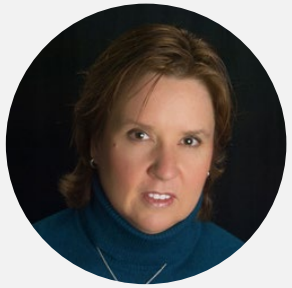
Streetcar Project:



Industry Perspectives:

"The intuitive format of a linear schedule helps us transform detailed CPM schedules from overwhelming to understanding."

-Brian Ellingson, Schedule Engineering Supervisor at Sound Transit



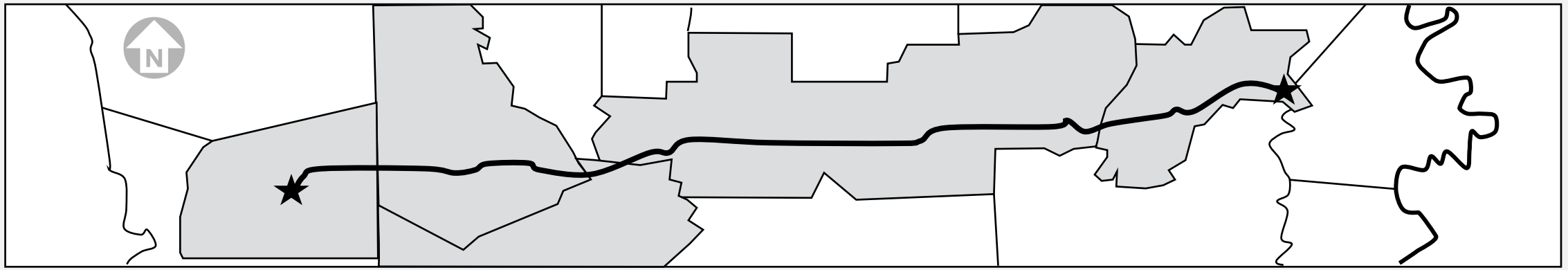
"Linear scheduling provides a graphic display of how crews and equipment move through the project over time. This 1) helps contractors depict their plan to construct the work and 2) allows for constructability analysis of the schedule that may be lost by Gantt Chart review only."

-Amy Heine, Principal at Hirschmugl, Heine & Associates

"Our linear schedule was extremely helpful on the floating bridge project. We used it to manage the job and communicate with the public."

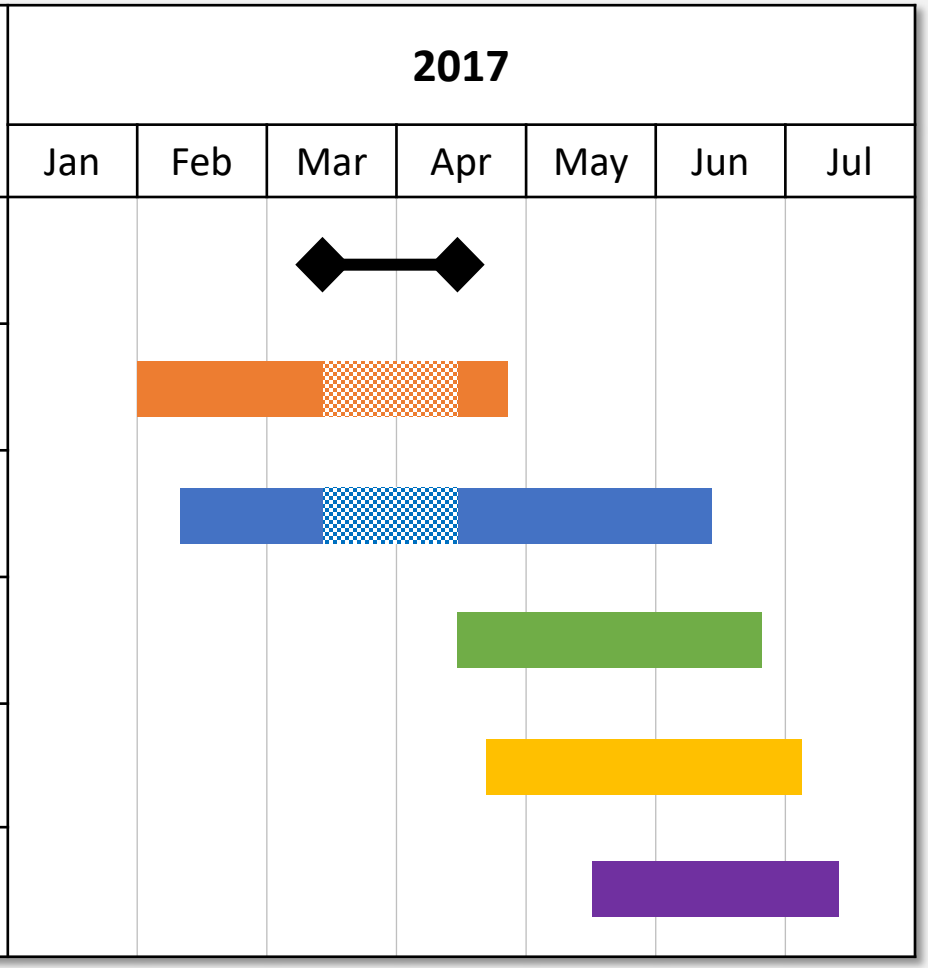
-Walter Tarr, Principal at Polaris Project Controls

Pipeline Project Example:

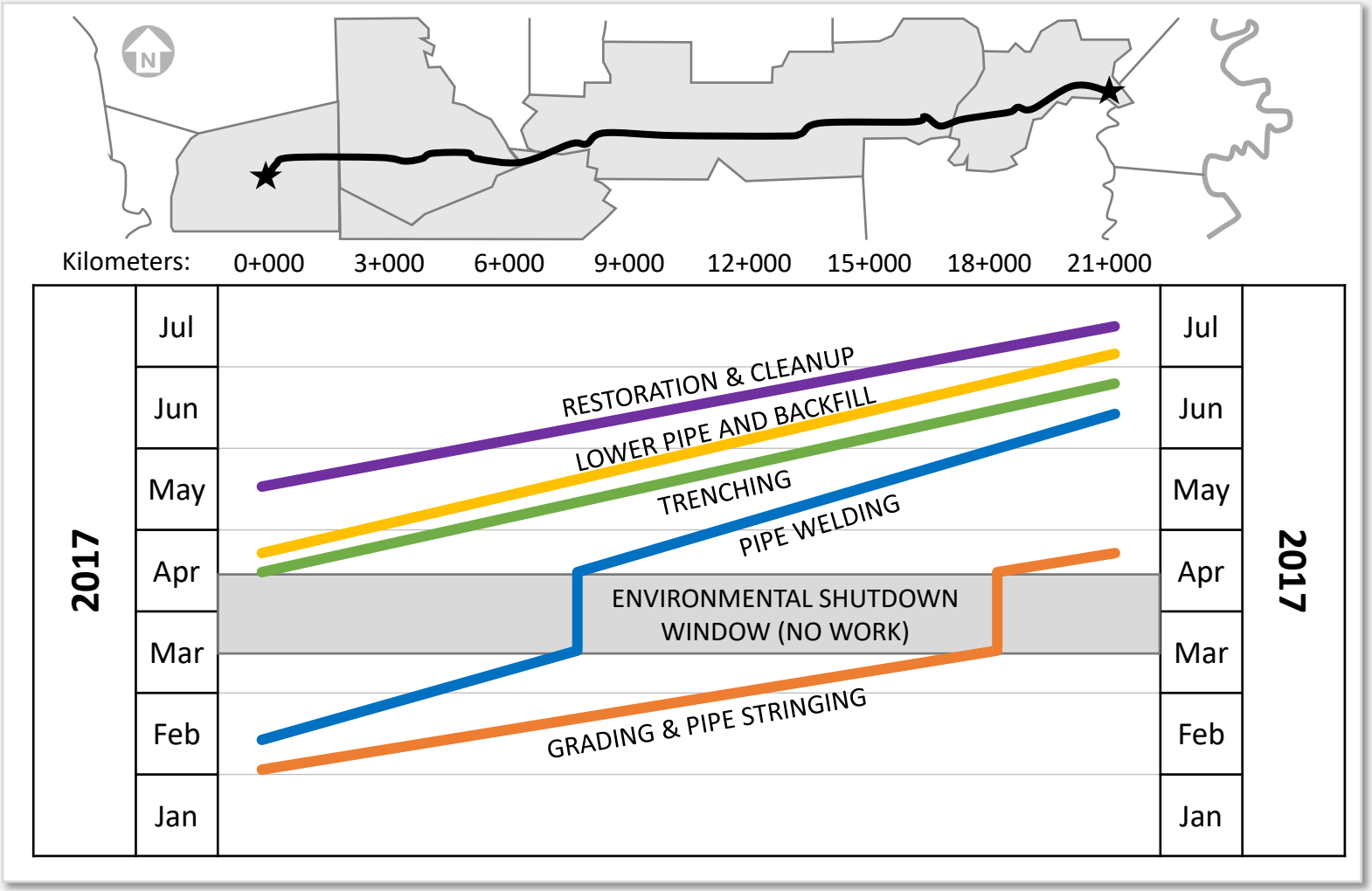


Gantt Chart for Pipeline Project:

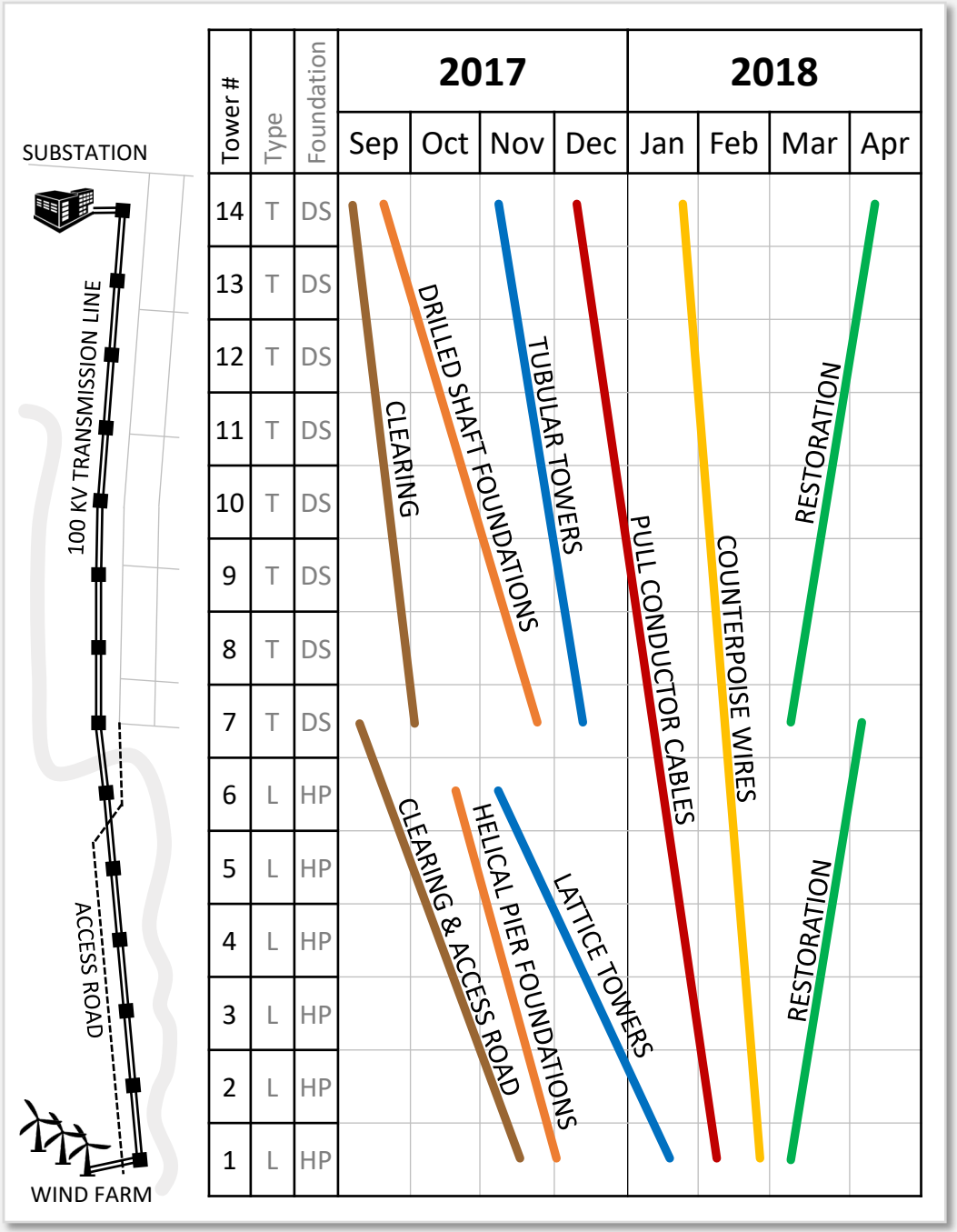
ACTIVITY	START DATE	FINISH DATE
ENVIRONMENTAL SHUTDOWN WINDOW (NO WORK)	15-Mar-17	15-Apr-17
GRADING & PIPE STRINGING	1-Feb-17	24-Apr-17
PIPE WELDING	9-Feb-17	11-Jun-17
TRENCHING	16-Apr-17	26-Jun-17
LOWER PIPE & BACKFILL	23-Apr-17	3-Jul-17
RESTORATION & CLEANUP	16-May-17	13-Jul-17



Linear Schedule for Pipeline Project:



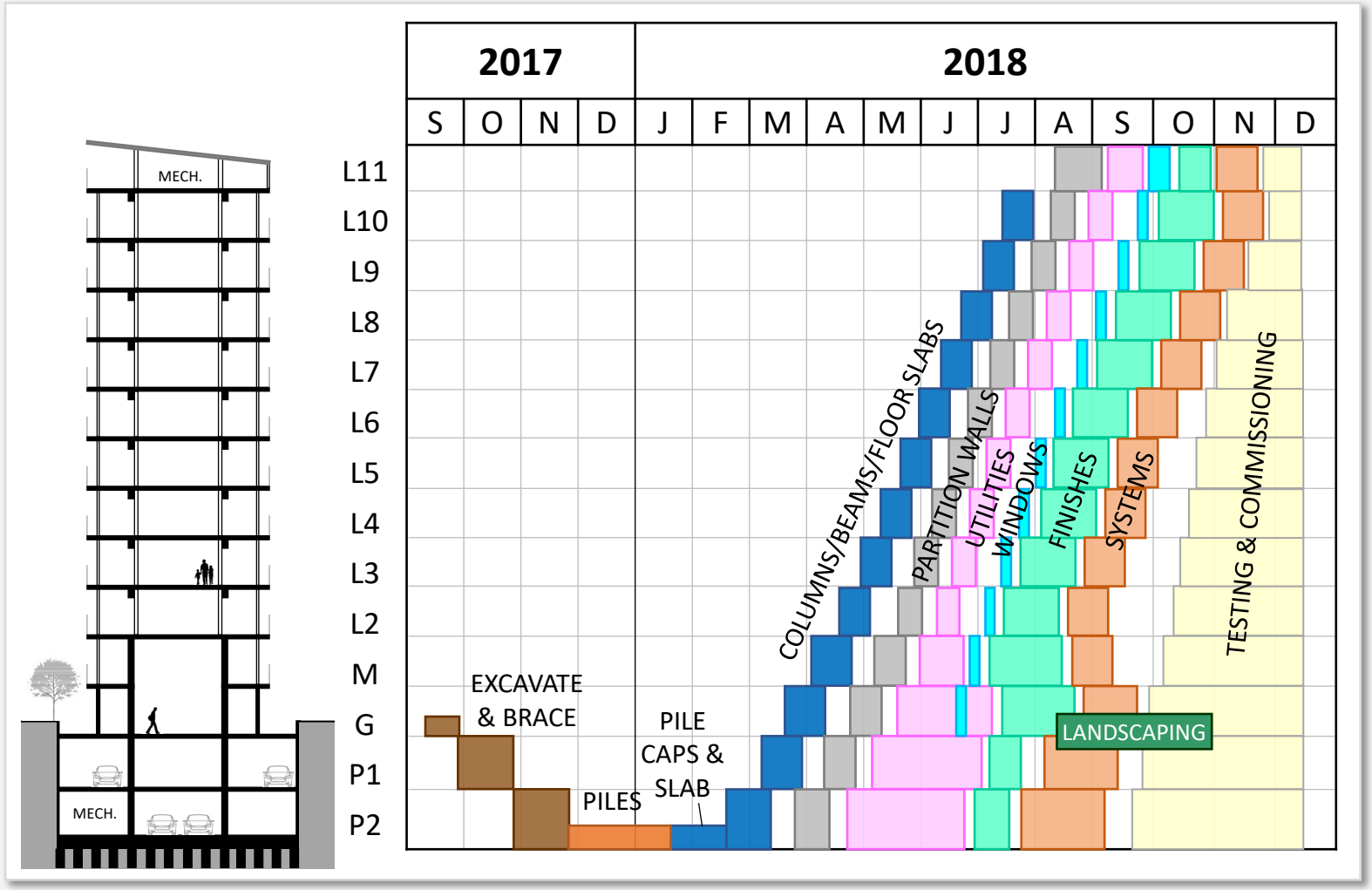
Transmission Line Project:



So far these examples have all been infrastructure projects.

This method works for vertical construction too.

High Rise Building Project:

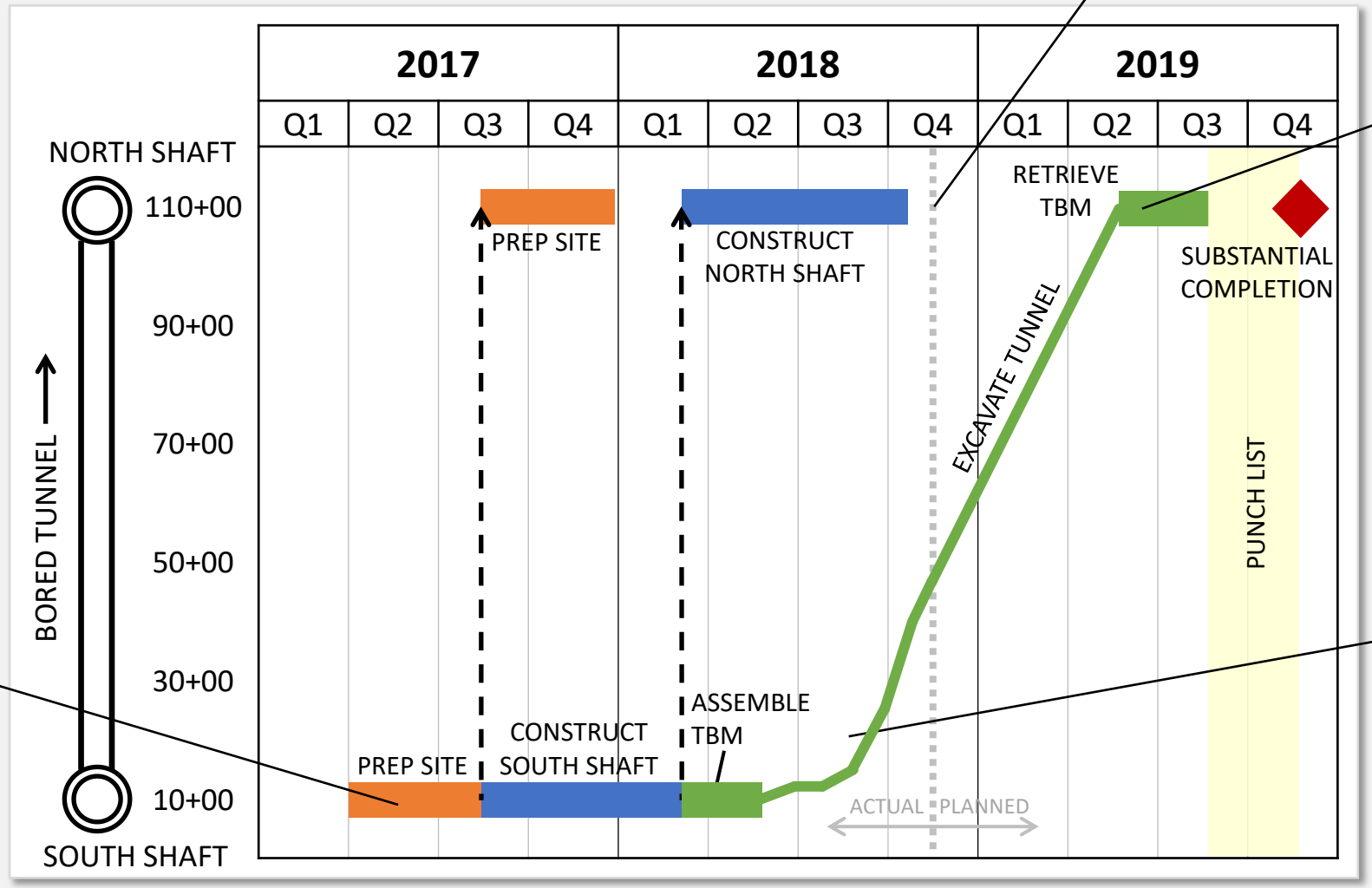


3 Adapting to Schedule Changes

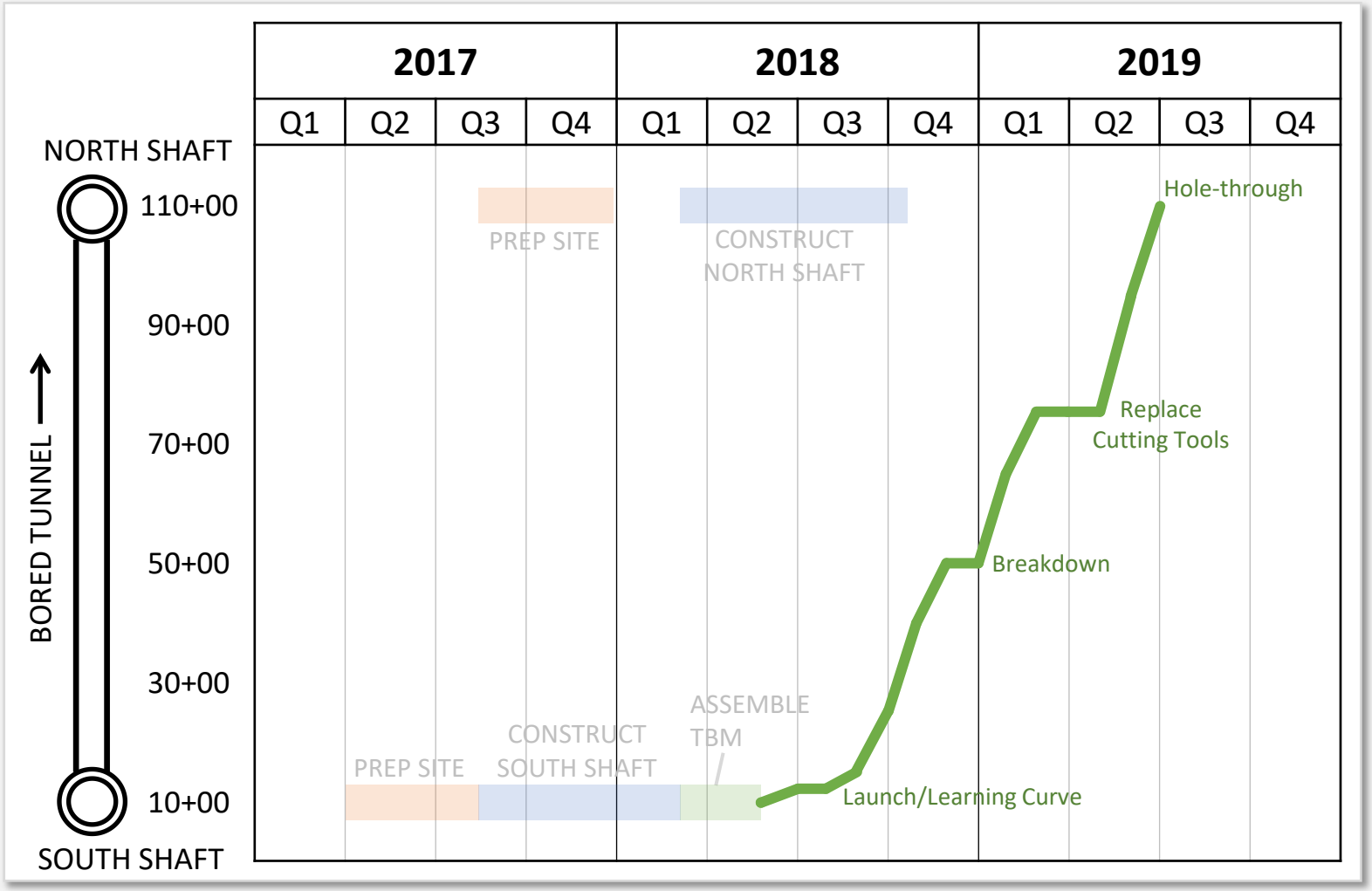
"Everybody has a plan 'til they get punched in the mouth."

- Mike Tyson

Updating a Linear Schedule:



Plotting Actual Progress for Linear Activities:



Date	Location
31-May-18	10+00
30-Jun-18	12+50
31-Jul-18	12+50
31-Aug-18	14+74
30-Sep-18	25+31
31-Oct-18	42+00
30-Nov-18	50+07
31-Dec-18	50+07
31-Jan-19	63+87
28-Feb-19	76+03
31-Mar-19	76+03
30-Apr-19	76+03
31-May-19	94+46
30-Jun-19	110+00

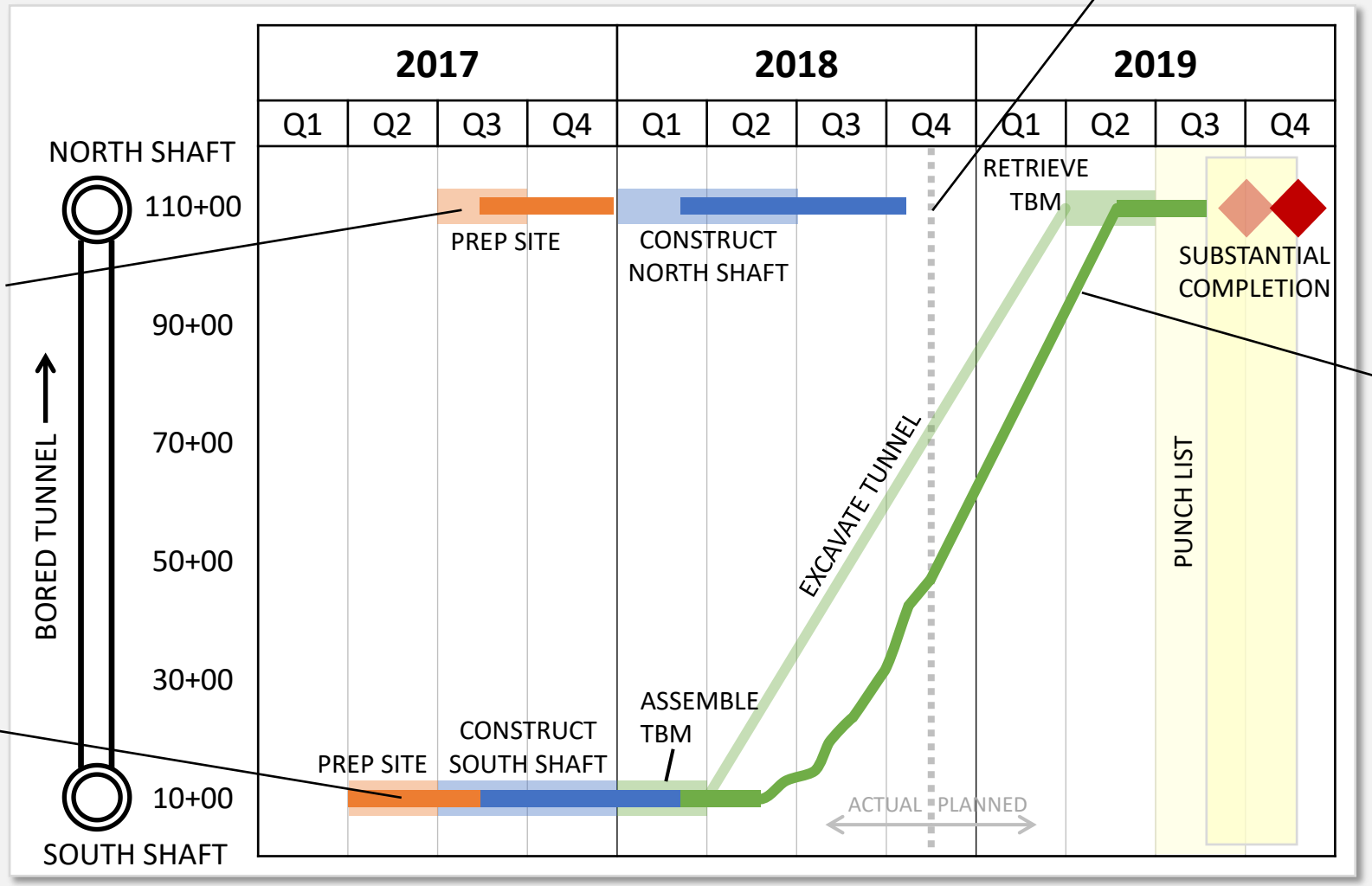
Comparison to Baseline:

Add a Data Date Line

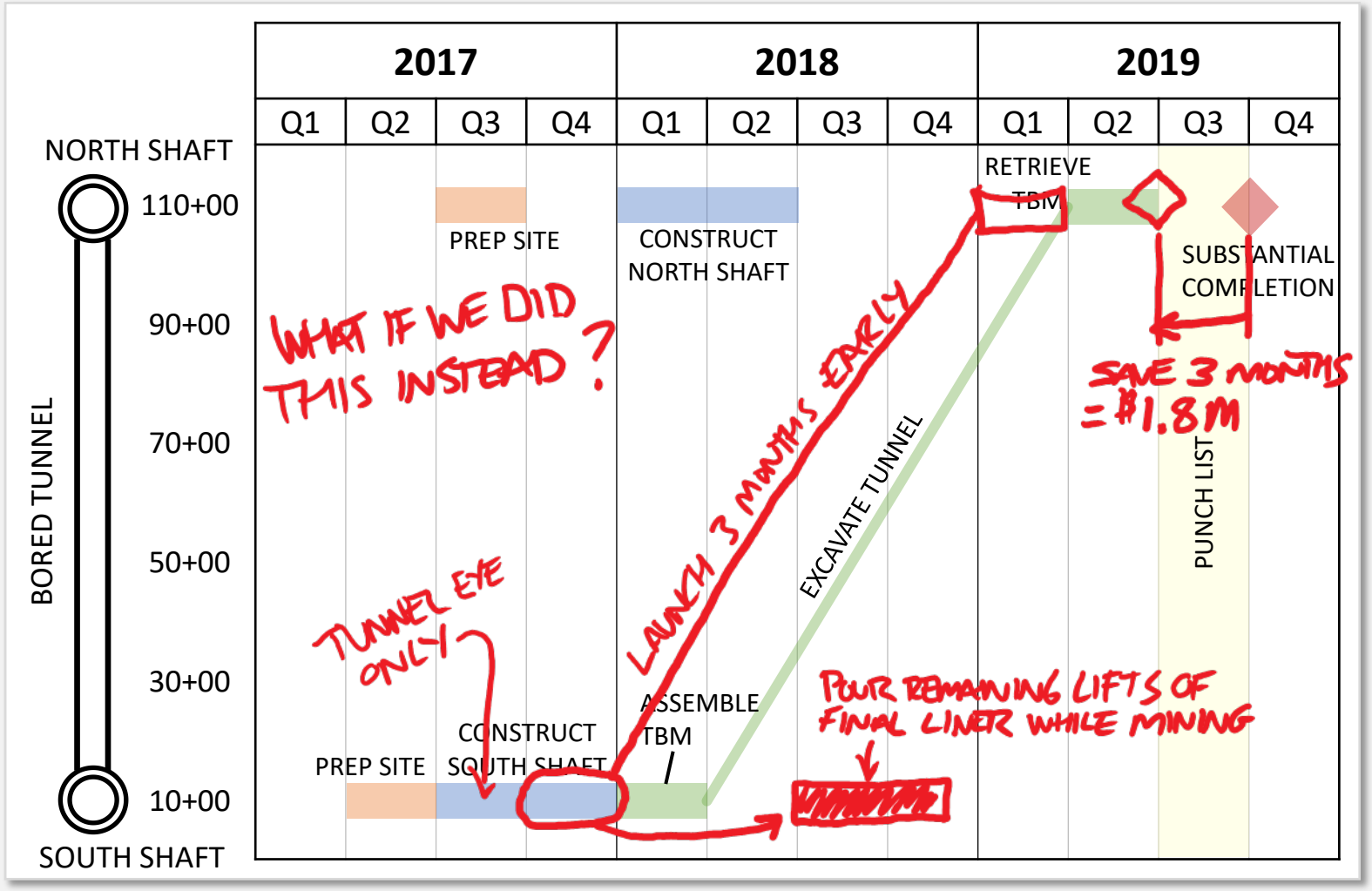
Show Baseline Activities as a Faded Background Layer

Overlay Actual Progress To-Date

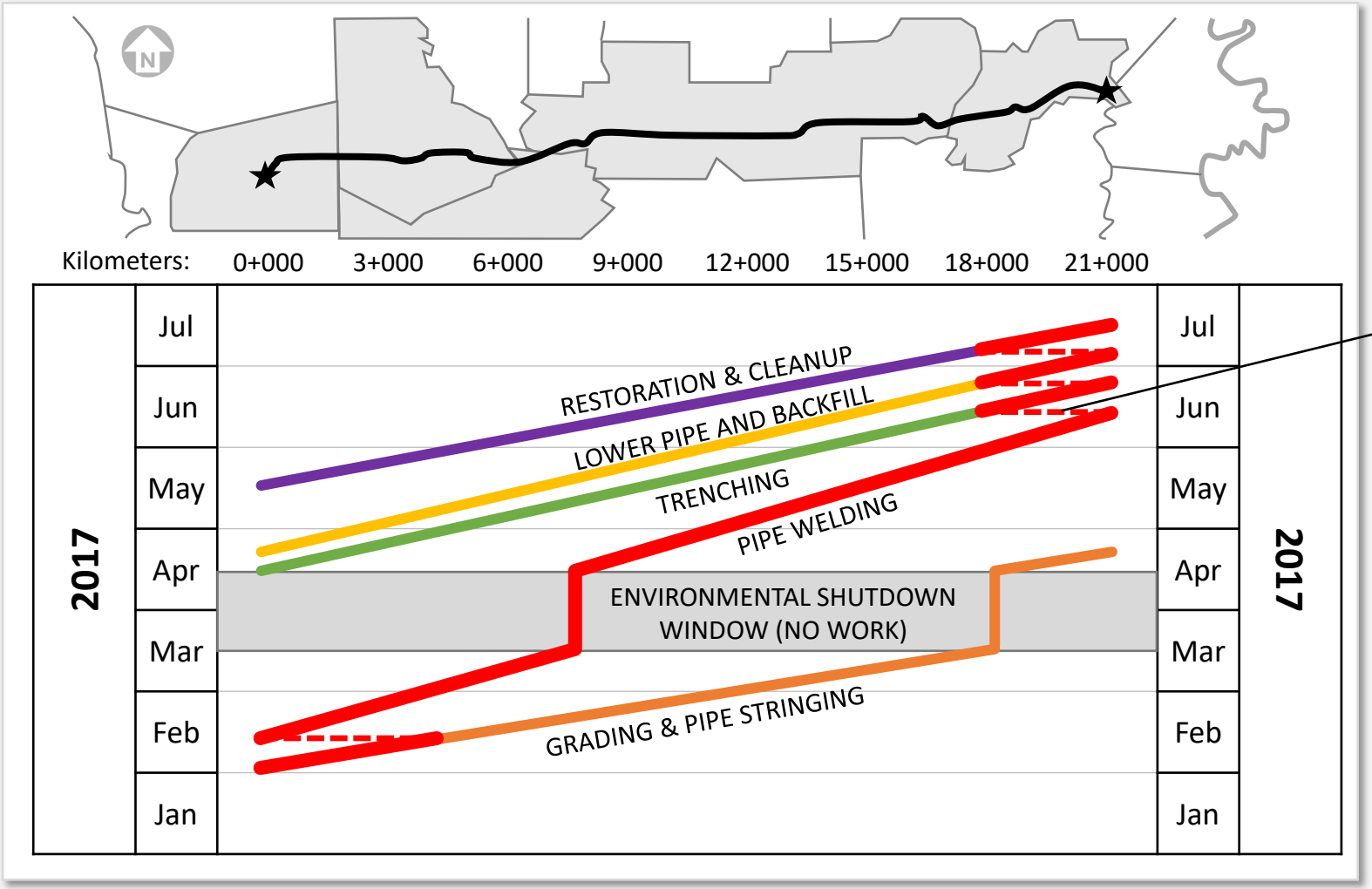
Overlay Planned Activities for Remaining Work



Great for Markups & Alternatives:



Highlighting the Critical Path:



These links represent the spacing between work crews as they advance. (Also called a “buffer”)

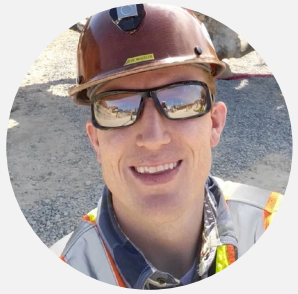
A Simple-Yet-Powerful Tool:

"From a risk management perspective, I find great value in using linear schedules to compare complex base (deterministic) schedules and risk-based (probabilistic) schedules. This helps identify the "trouble" activities where uncertainty is the highest. Overlaying the two schedules is a simple, quick, and effective way to help project managers focus their attention and manage their resources."

-Norman Perez, Senior Engineer at Schnabel Engineering

"One page, one clear pathway to completion, and infinite combinations of tasks for multi-faceted projects. Brilliant."

-Allen Jensson, Mechanical Engineer at The Boring Company



"This is what our Director wants to see."

-Steve Wheeler, Construction Program Scheduler at Shrewsberry & Associates

Thanks for making it this far!

Here's where we've been together:

- You've seen how a 1-page linear schedule can effectively communicate your plan to a wide variety of audiences.
- You've seen how this method can be applied to all sorts of projects where location of the work is key.
- And you've learned how to maintain your linear schedule during construction, when the rubber meets the road.

We hope you've enjoyed this guide.

But more importantly, we hope you'll do something with it.

Is there software that creates linear schedules?

We thought you'd never ask...

There are a few products out there. Some are extremely powerful and sophisticated, and can practically cook you breakfast if you can get past the steep learning curve.

We're taking a different approach; providing a simple tool that's easy to use and runs right in Microsoft Excel, which most of you already use every day. If that sounds interesting to you, visit www.gritcity.co to learn more.

Create something your entire team will love!

About Grit City Labs:

I'm James Wonneberg, President of Grit City Labs. I'm passionate about providing simple tools and methods to help you deliver better projects.

If you're the type of person that wants to roll up your sleeves and create a 1-page schedule that your boss and team members will love, I want to help you.

Visit our website: www.gritcity.co

Get in touch: james@gritcity.co