PHX Sky Train – Taxiway 'S' & 'T' Undercrossings

Taking Trains Under Planes

David A. Burrows, P.E., Gannett Fleming, Inc.

PHX Sky Train – Taxiway 'S' & 'T' Undercrossings

PHX Sky Train – Taxiway 'R' Bridge

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PHX Sky Train – Taxiway 'S' & 'T' Undercrossings

Acknowledgements

City of Phoenix Aviation Department

GF Structural Design Team:

- Mark Pilwallis (PM)
- Steve Sherrill (Design Lead)
- John Lobo (Structural Engineer)
- **Assistance from various other Gannett offices and other design firms:**

  Kimley Horn, Nabar Stanley Brown, Hatch Mott MacDonald, and Premier Engineering

McCarthy Kiewit Joint Venture (CMAR Contractor)

PHX Sky Train – Taxiway 'R' Bridge

1. Project Location and Introduction
2. Design Constraints
3. Load Pattern
4. Design Optimization
5. Construction

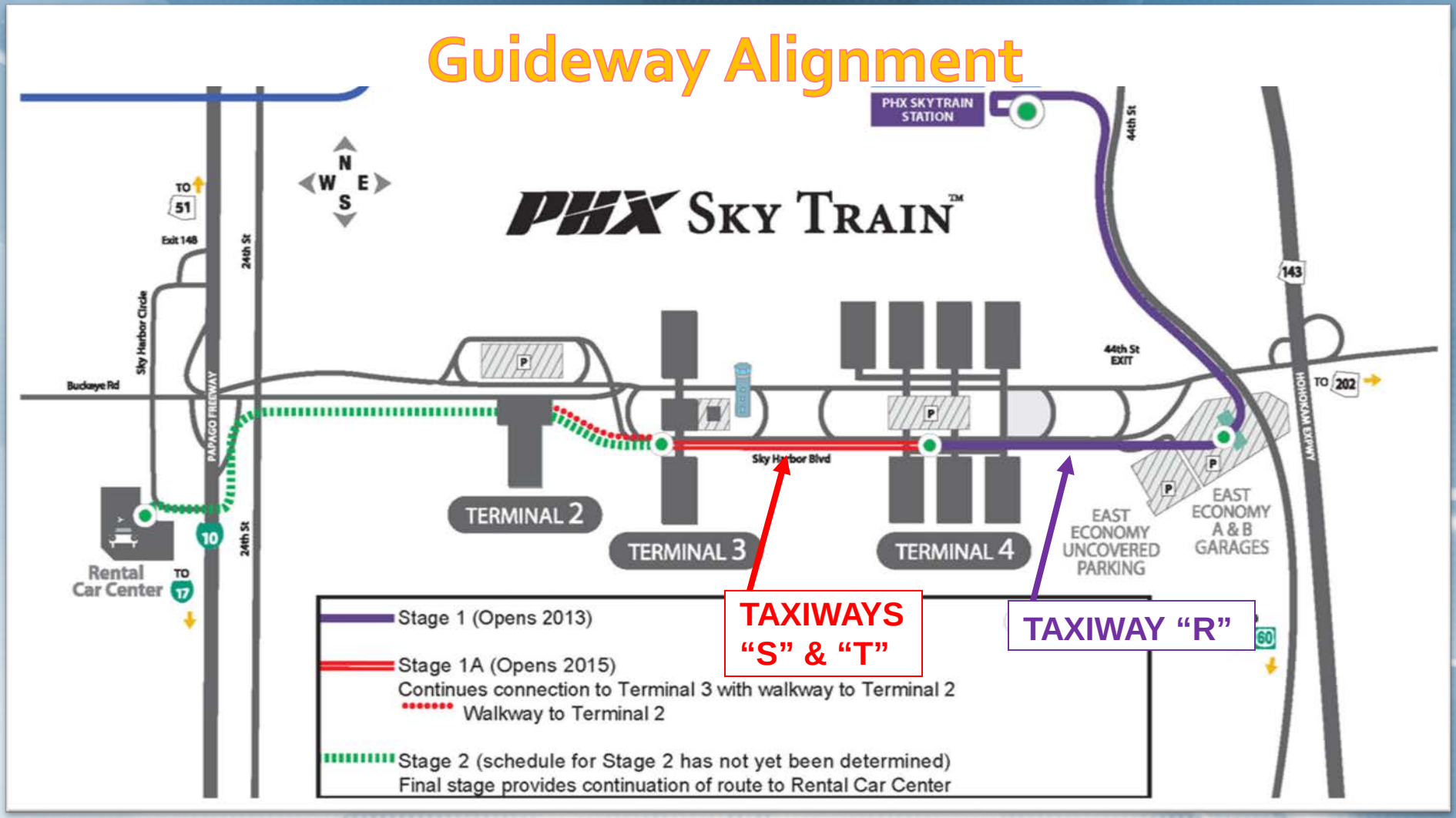
Project Location

PHOENIX SKY HARBOR INTERNATIONAL AIRPORT

Project Location

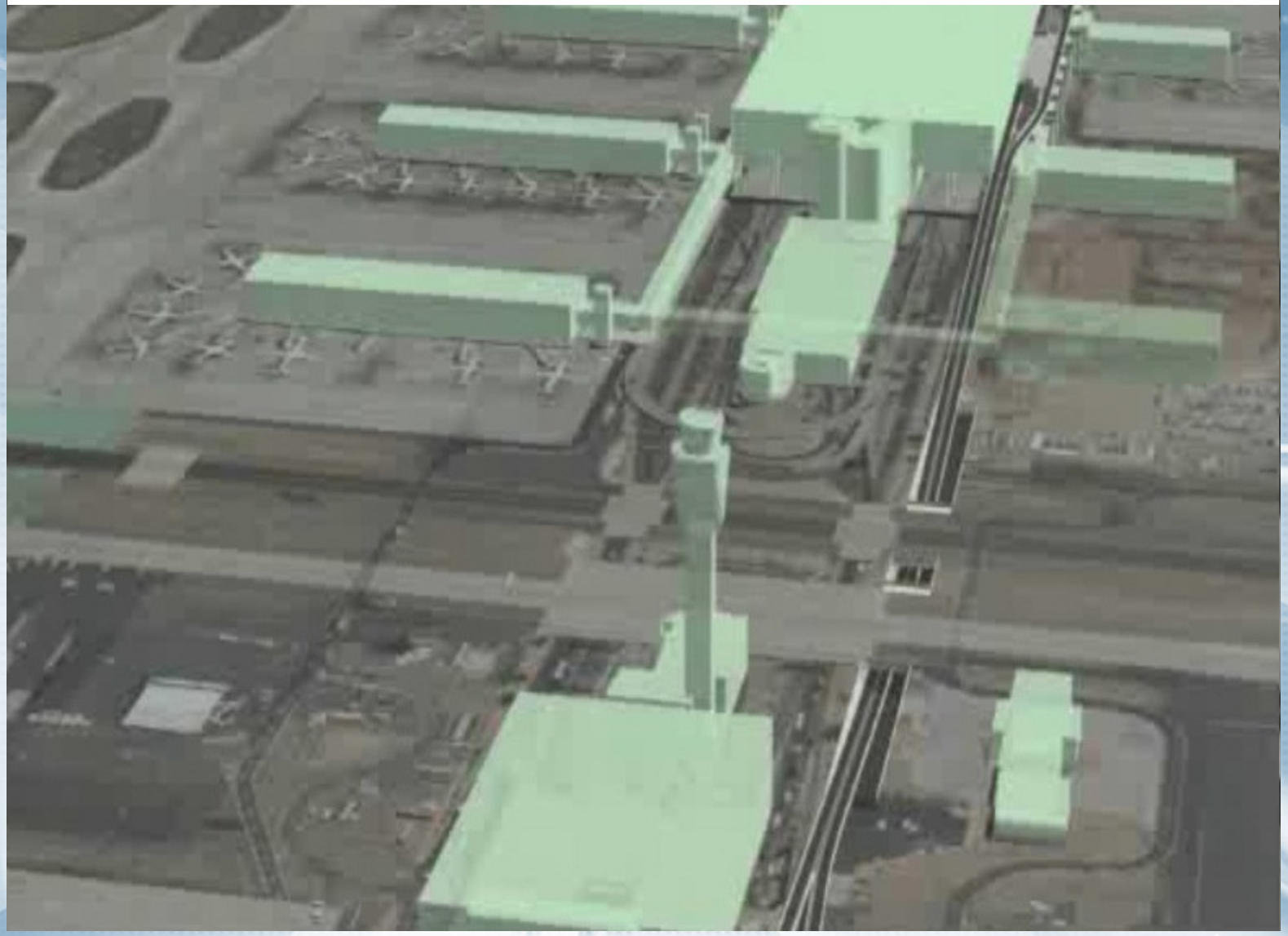
PHOENIX SKY HARBOR INTERNATIONAL AIRPORT

Guideway Alignment



- **Stage 1 CM-at-Risk Construction Cost = $644M**
- **Stage 1A CM-at-Risk Construction Cost = $240M**

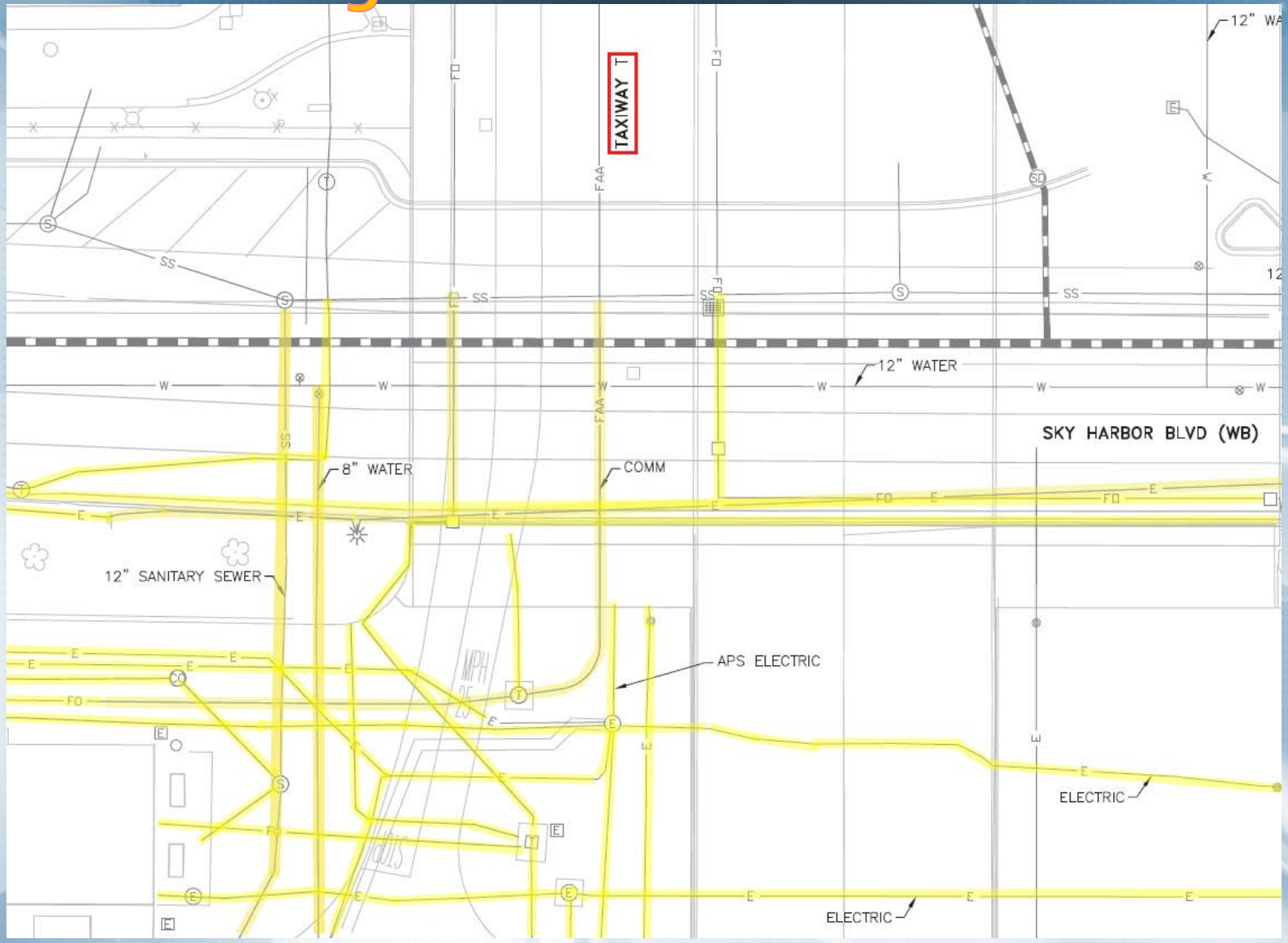
STAGE 1A GUIDEWAY ALIGNMENT



Design Constraints

1. Utilities
2. Construction Schedule
3. Existing Taxiway Bridges
4. Guideway Alignment / Clearance Envelope

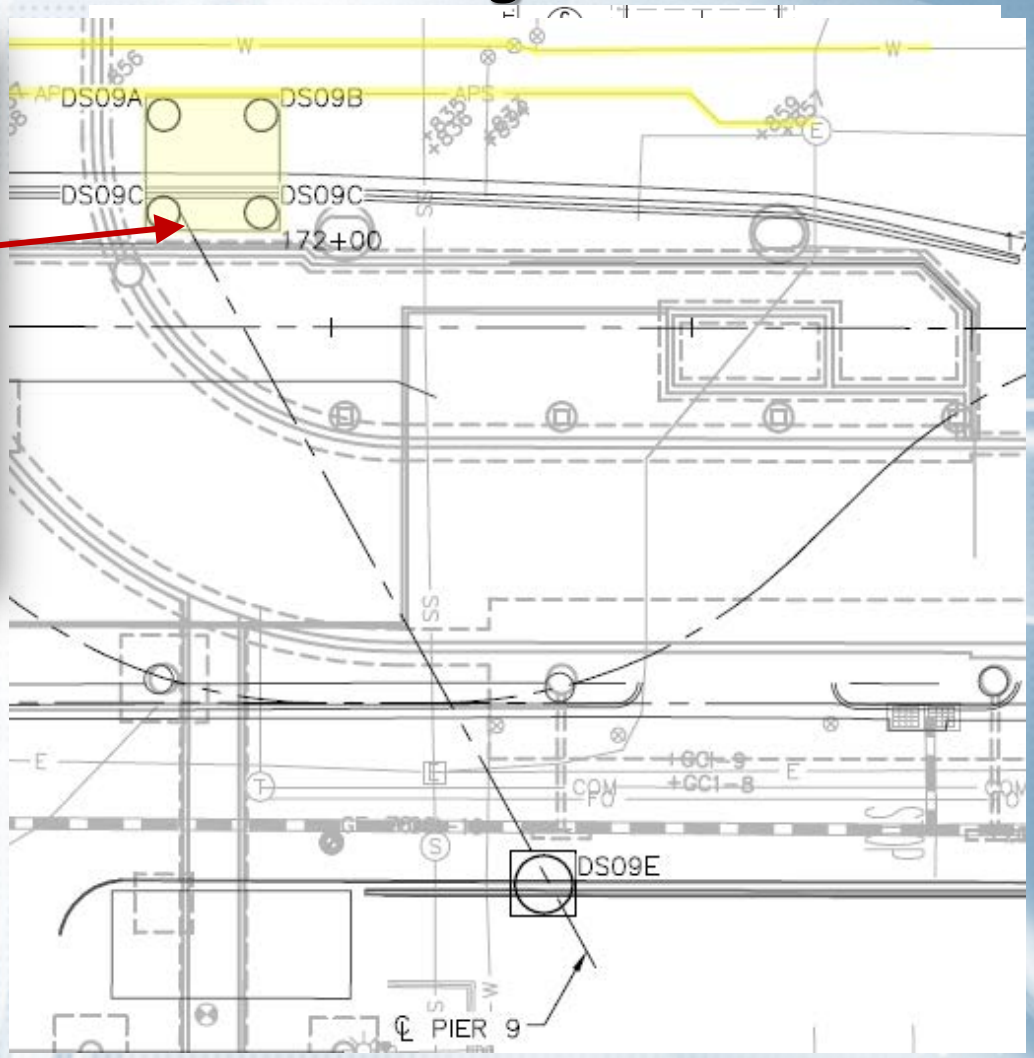
Design Constraints - Utilities



Design Constraints – Utilities

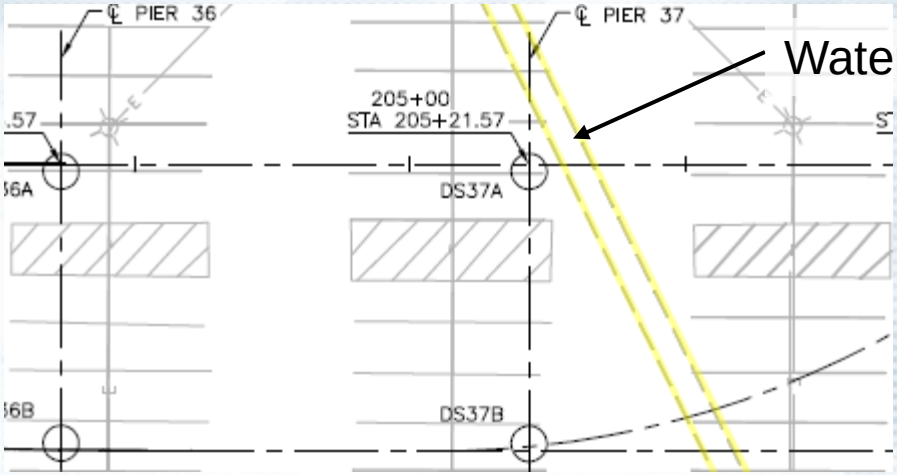
Unexpected Conflicts in Stage 1

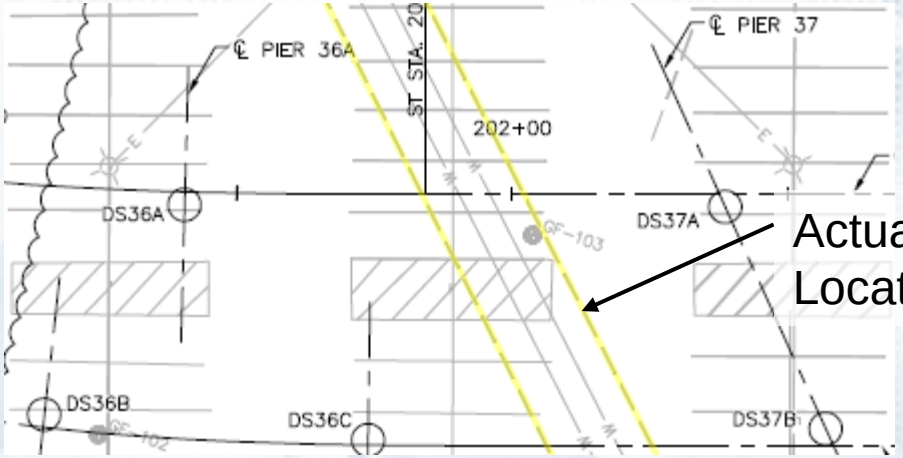
Unknown conduit bank not identified in record drawings directly interfering with pile cap placement



Design Constraints – Utilities

Unexpected Conflicts in Stage 1

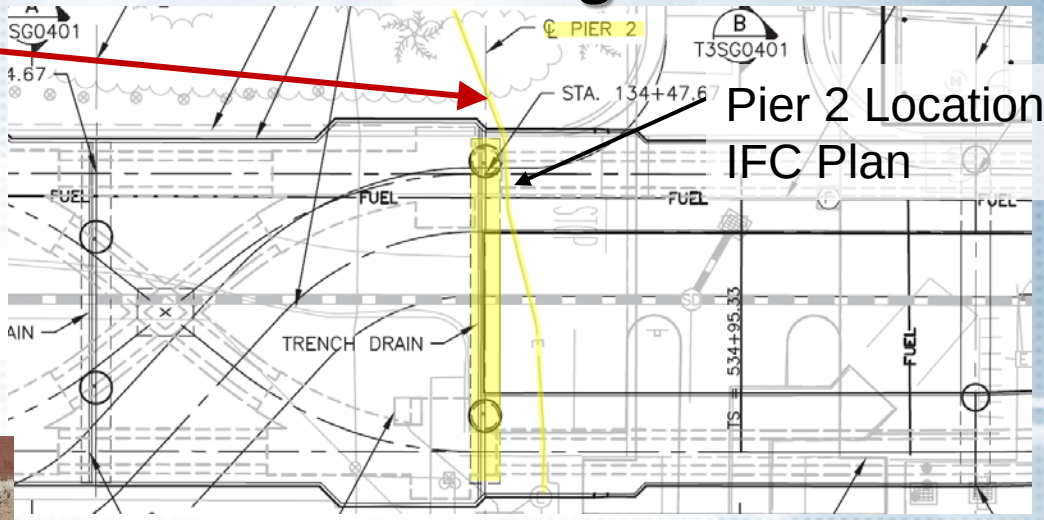




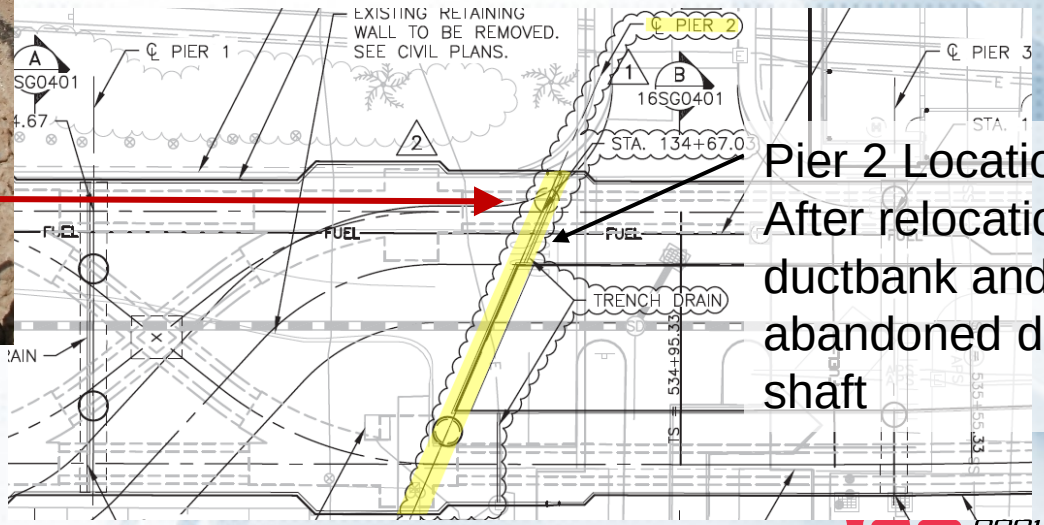
Design Constraints – Utilities

Unexpected Conflict in Stage 1A

Small electrical line turns out to be major power ductbank for T3



Pier 2 Location per IFC Plan



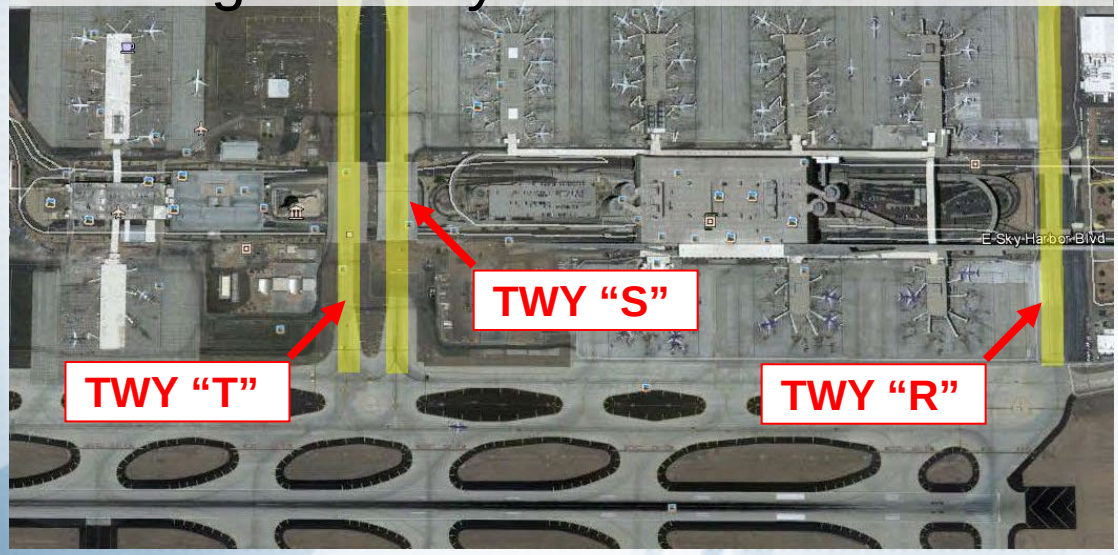
Pier 2 Location After relocation for ductbank and abandoned drilled shaft

Design Constraints

1. Utilities
2. Construction Schedule
3. Existing Taxiway Bridges
4. Guideway Alignment / Clearance Envelope

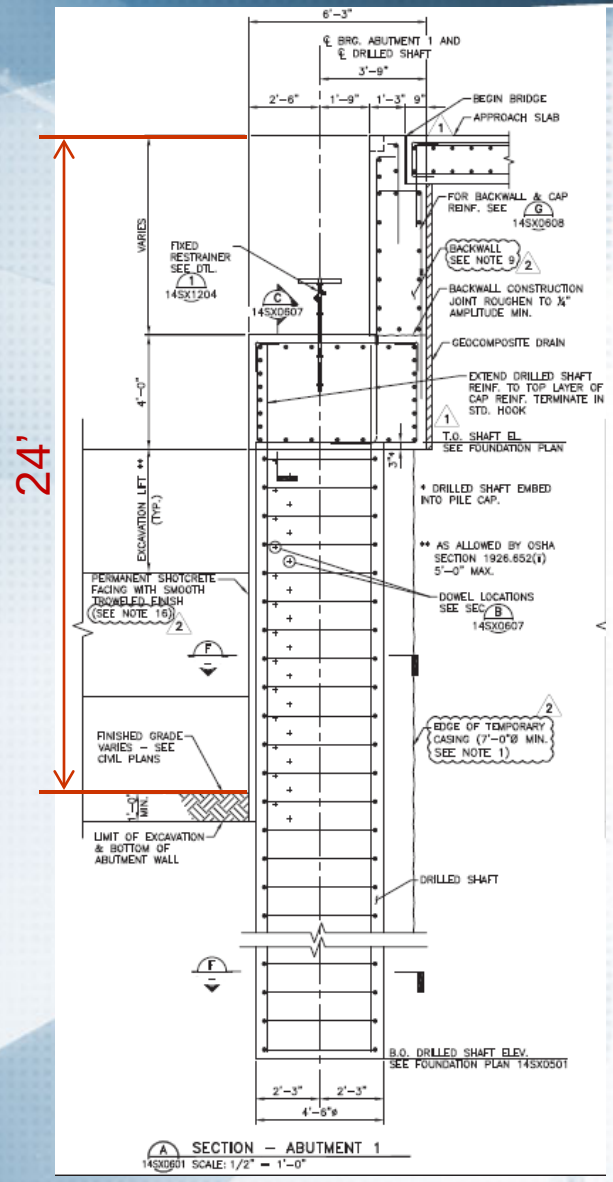
Design Constraints – Construction Schedule

- Unforeseeable utility conflicts in Stage 1 cost several weeks of construction time to resolve.
- Short window for construction – 6 months outside peak travel times of Thanksgiving and Christmas.
- Different approach taken for new abutment to mitigate utility conflict and schedule risk.



- Approx. 1,300 aircraft daily.
- 42 gates south of Sky Harbor Blvd.
- 64 gates north of Sky Harbor Blvd.

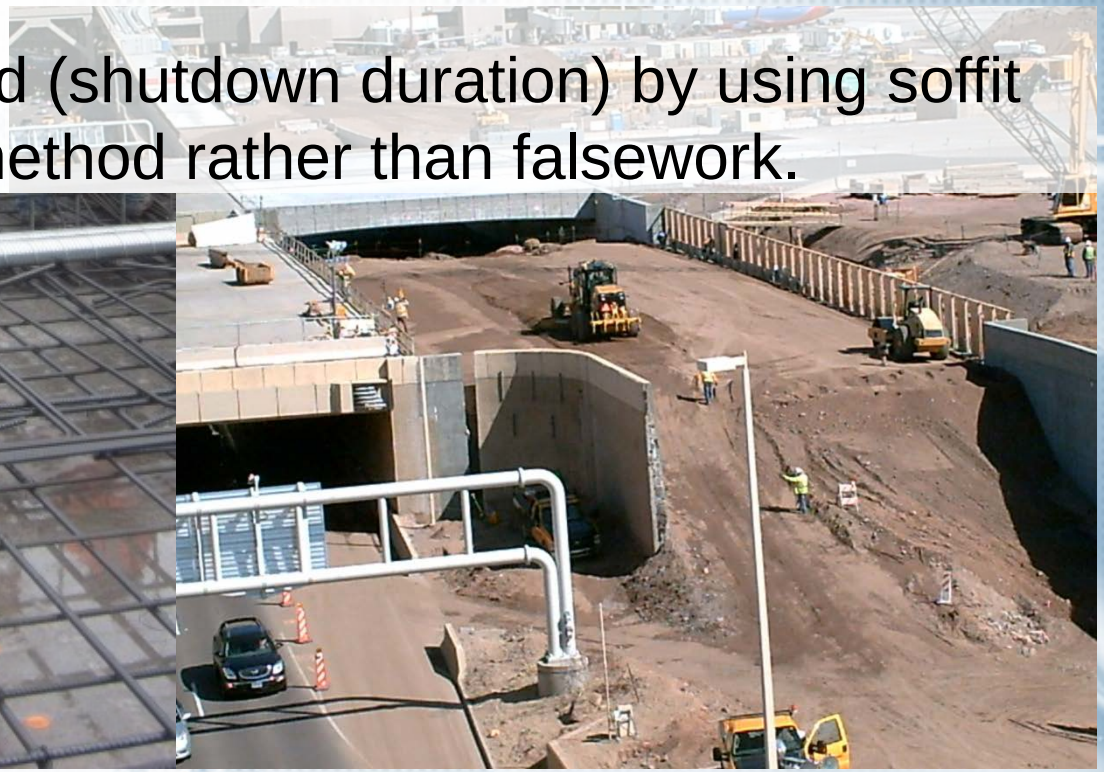
Design Constraints – Construction Schedule



Innovative south abutment uses drilled shafts and shotcrete wall restrained at the top of backwall to minimize excavation and shorten schedule.

Design Constraints – Construction Schedule

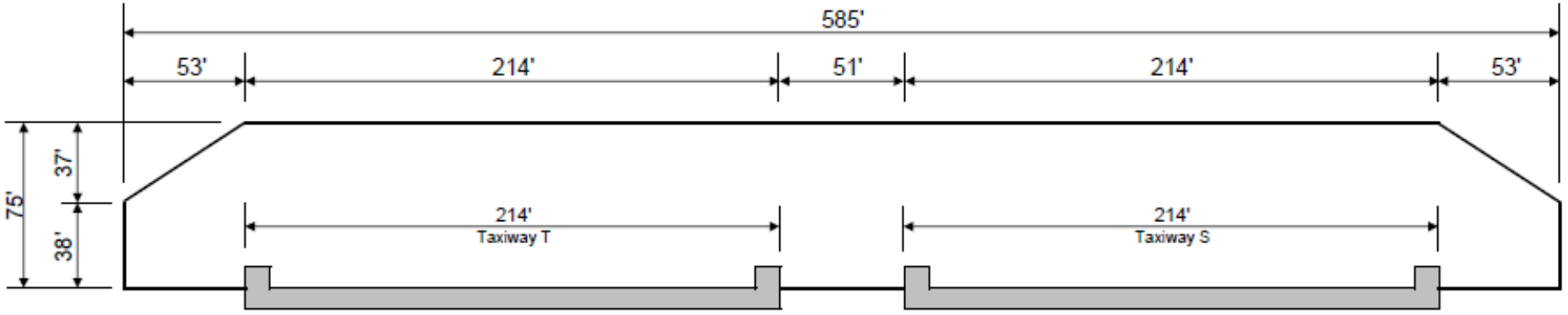
- Airport operations could only allow one taxiway to be taken out of service at a time.
- Close proximity to Sky Harbor Blvd. required some night-time work for high traffic construction.
- Schedule reduced (shutdown duration) by using soffit fill construction method rather than falsework.



Design Constraints

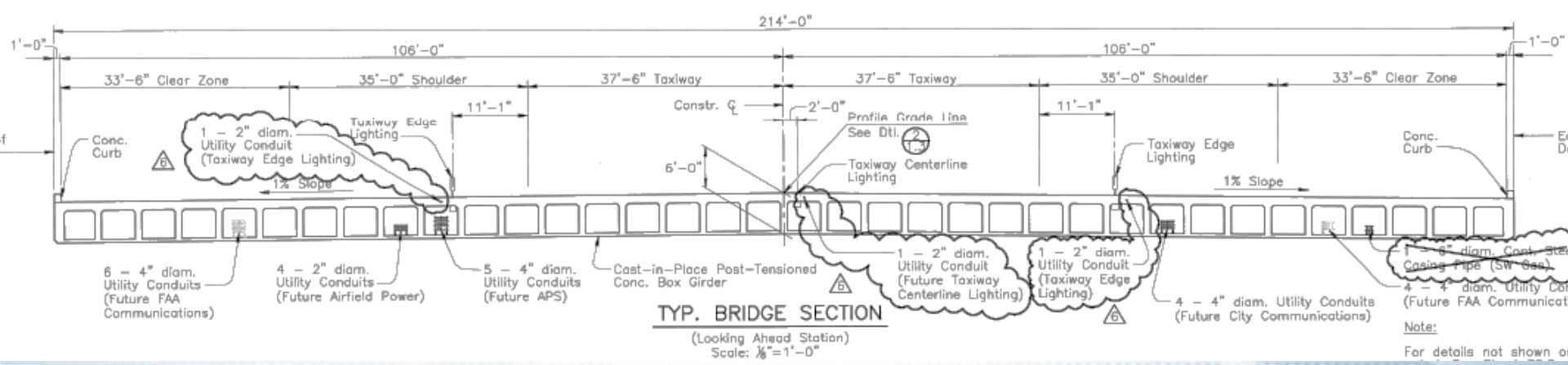
1. Utilities
2. Construction Schedule
3. Existing Taxiway Bridges
4. Guideway Alignment / Clearance Envelope

Design Constraints – Existing Taxiway Bridges



Group V

Design Constraints – Existing Taxiway Bridges

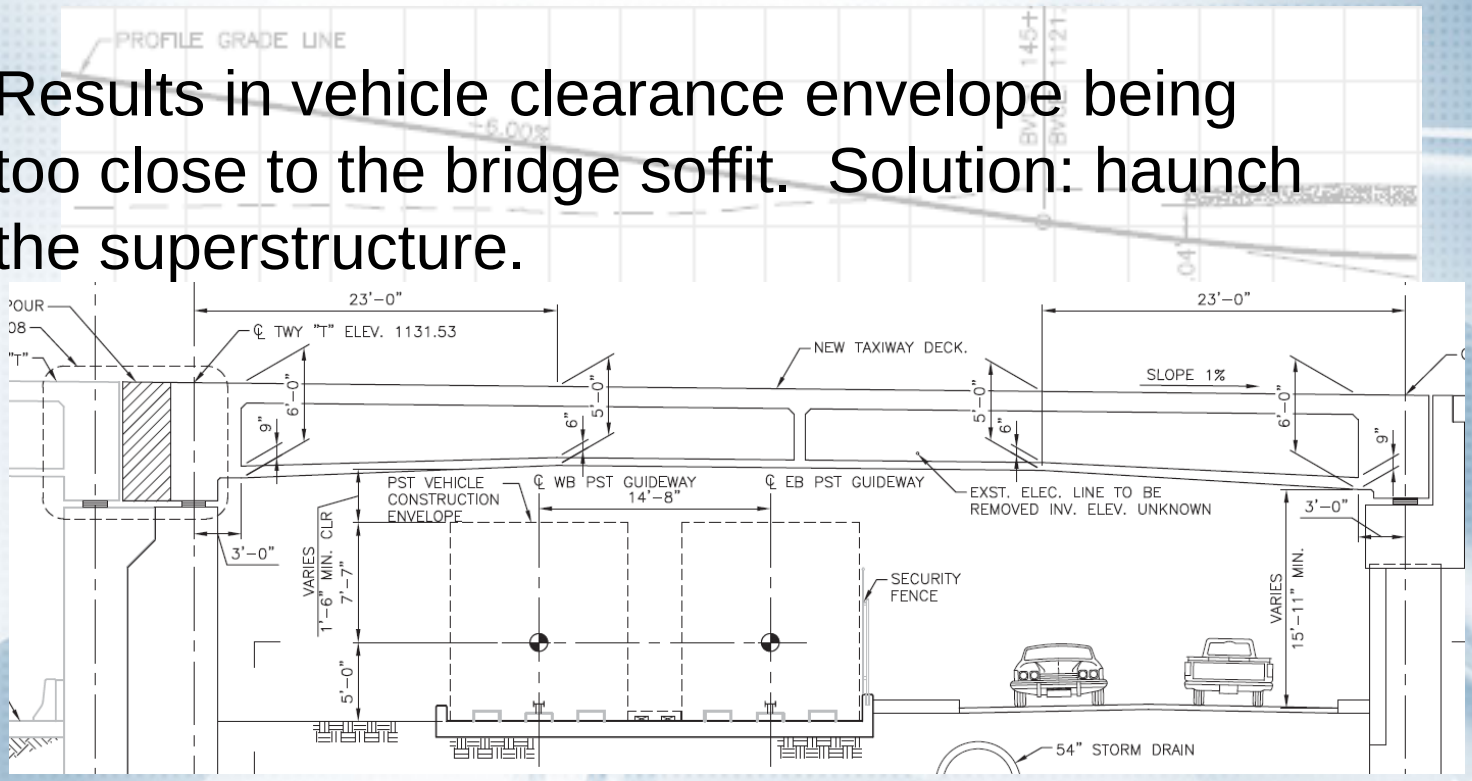


Design Constraints

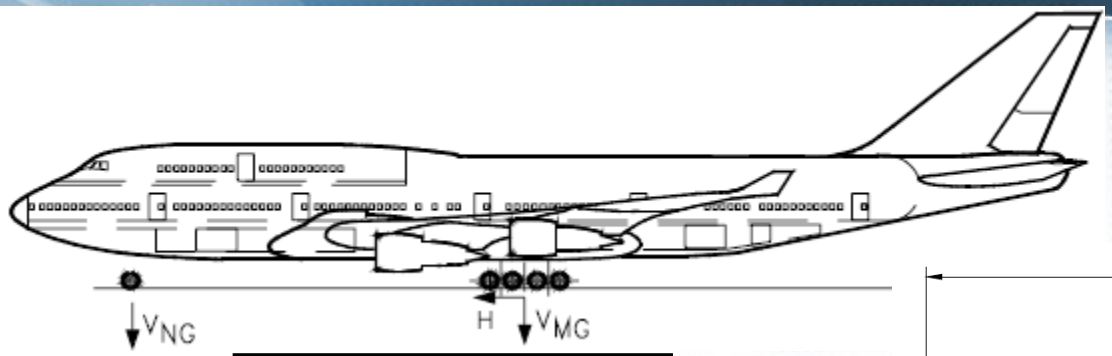
1. Utilities
2. Construction Schedule
3. Existing Taxiway Bridges
4. Guideway Alignment / Clearance Envelope

Design Constraints – Guideway Alignment / Clearance Envelope

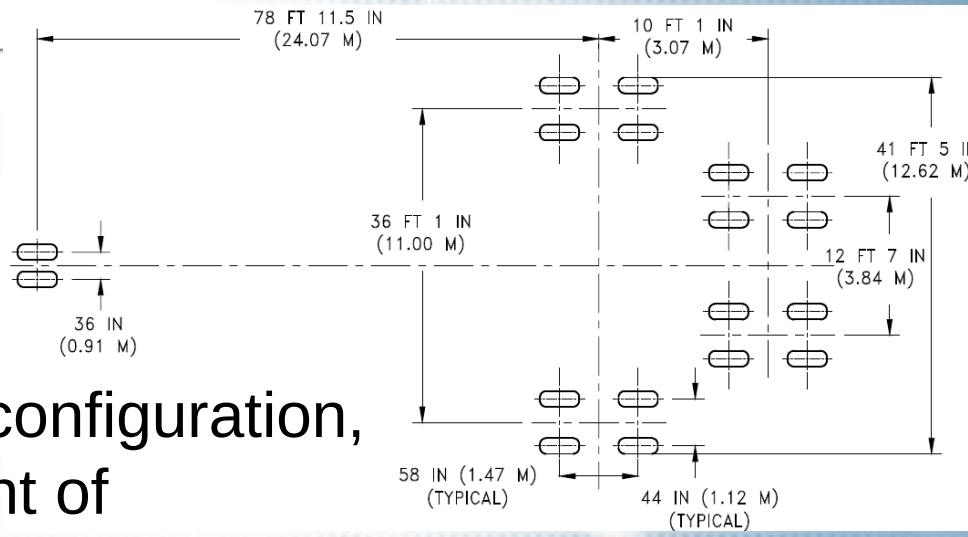
- Max. guideway slope is 6.0%.
- Little distance between the edge of Taxiway T and Terminal 3 Station.
- Results in vehicle clearance envelope being too close to the bridge soffit. Solution: haunch the superstructure.



Load Pattern



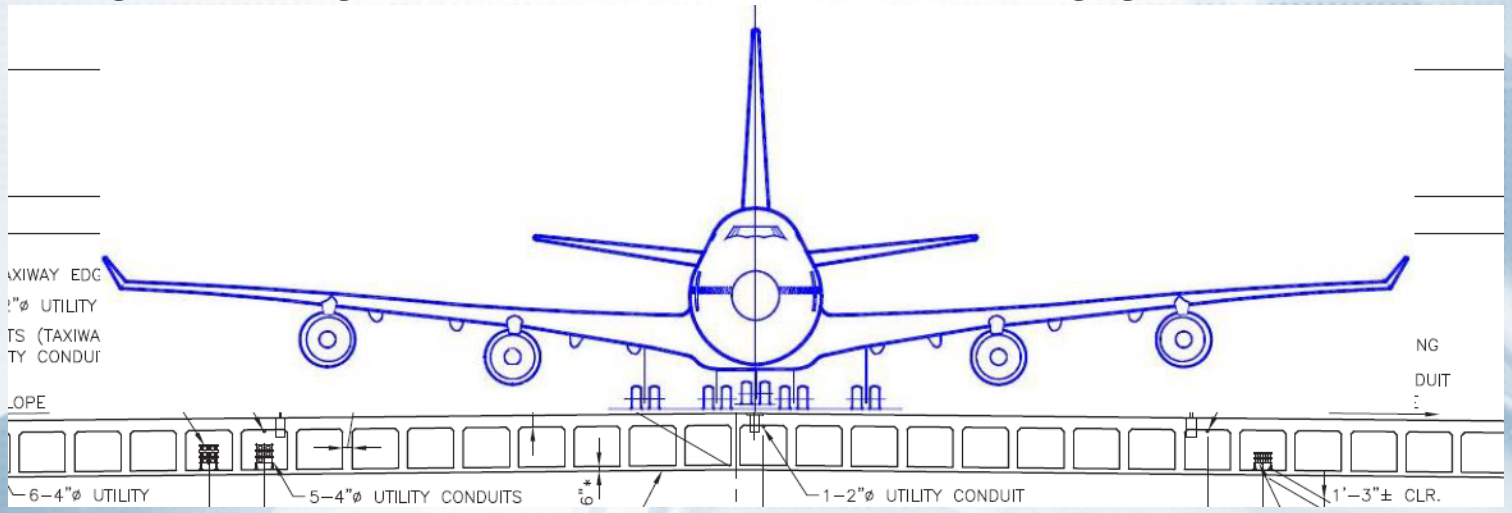
	UNITS	747-400ER
MAXIMUM DESIGN TAXI WEIGHT	LB	913,000
	KG	414,130



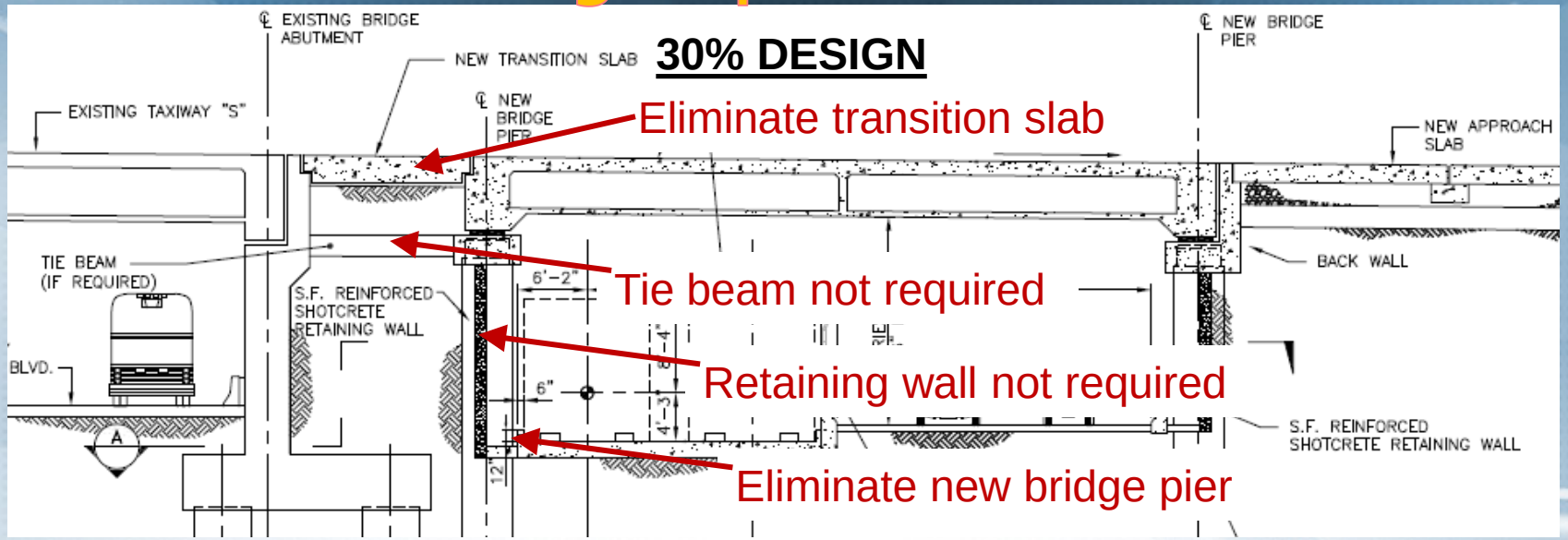
- Load based on Boeing 747 configuration, with a maximum gross weight of 1,500kips.
- 92% of load carried by rear landing gear.

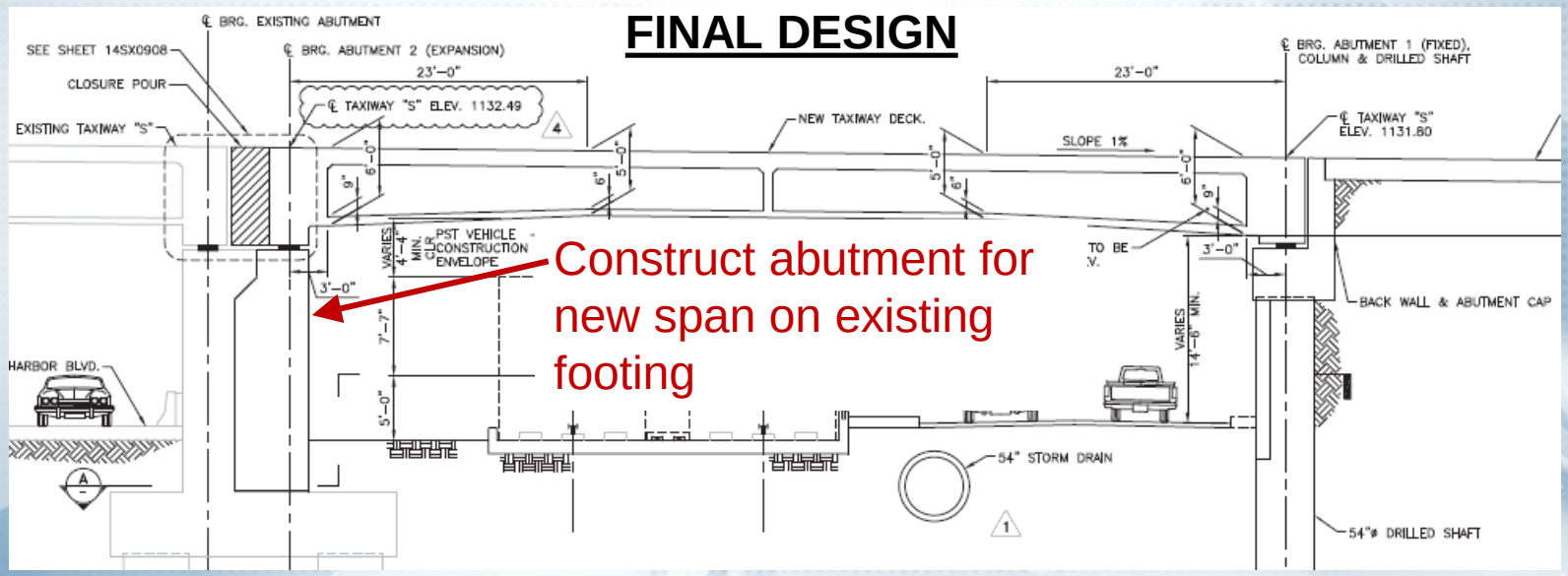
Load Pattern

- Per ACI 343, all girders between outside landing gear, if monolithic with slab, may be considered equally effective in resisting aircraft load.
- With Boeing 747 configuration, 7 girders resist rear landing gear load.
- Since aircraft can move laterally across entire bridge width, design each girder to take 1/7 rear landing gear load.



Design Optimization





Design Optimization

Construction

MAY 2012: DEMO EXISTING TAXIWAY ‘S’

Construction

MAY 2012: DEMO EXISTING TAXIWAY ‘S’

Construction

MAY 2012: EXCAVATE ADJACENT TO EXISTING ABUTMENT

Construction

MAY 2012: PREP. EXISTING ABUTMENT SURFACE

Construction

JUNE 2012: INSTALL ABUT. 1 DRILLED SHAFTS, ABUT. 2 REBAR

Construction

JUNE 2012: INSTALL ABUT. 1 DRILLED SHAFTS

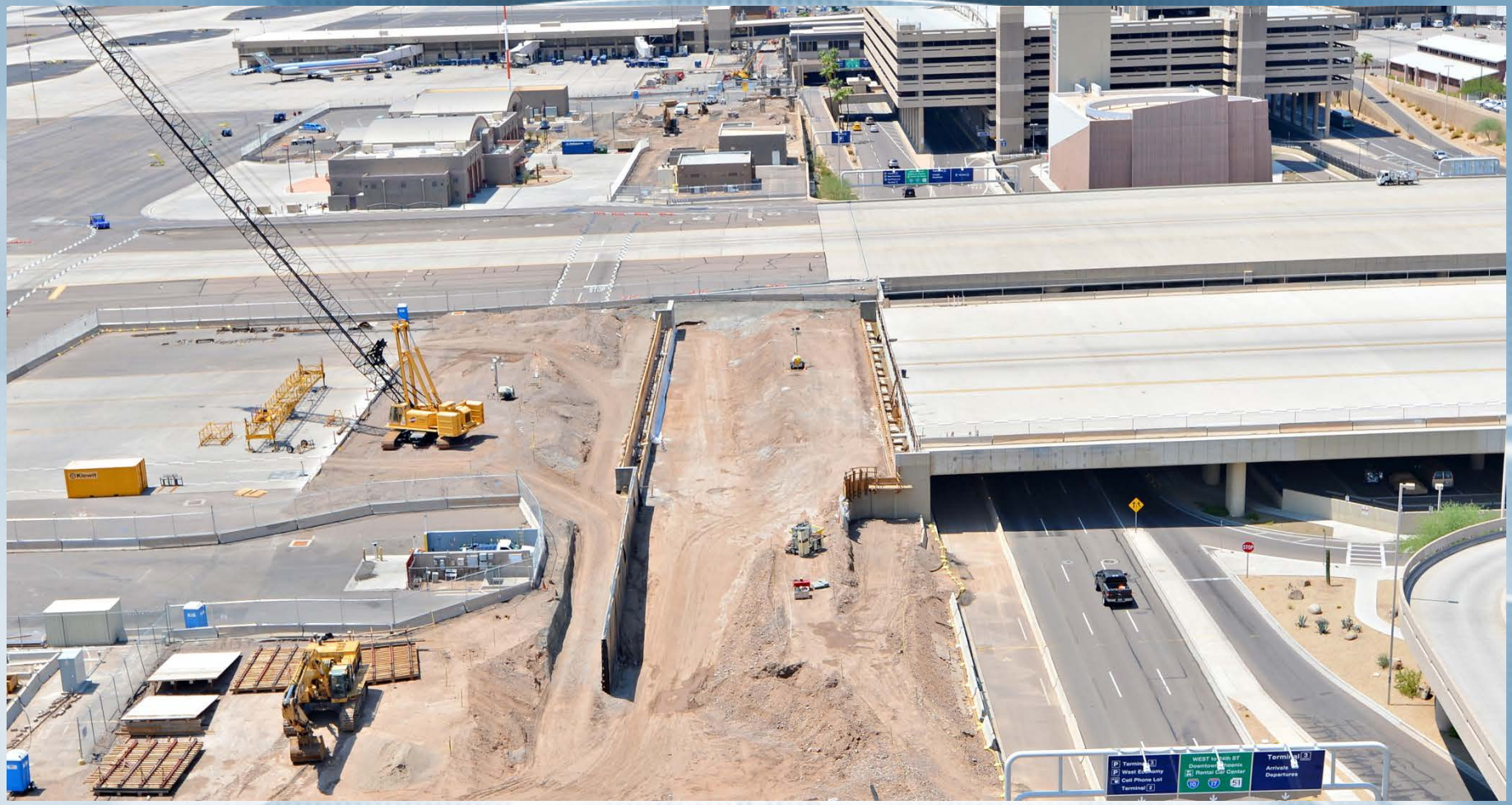
Construction

JUNE 2012: INSTALL ABUT. 1 DRILLED SHAFTS

Construction

JULY 2012: CONTINUED WORK ON ABUT. 1, BACKFILL ABUT. 2

Construction



AUG. 2012: WORK ON ABUT. 1 BACKWALL, BACKFILL FOR SOFFIT

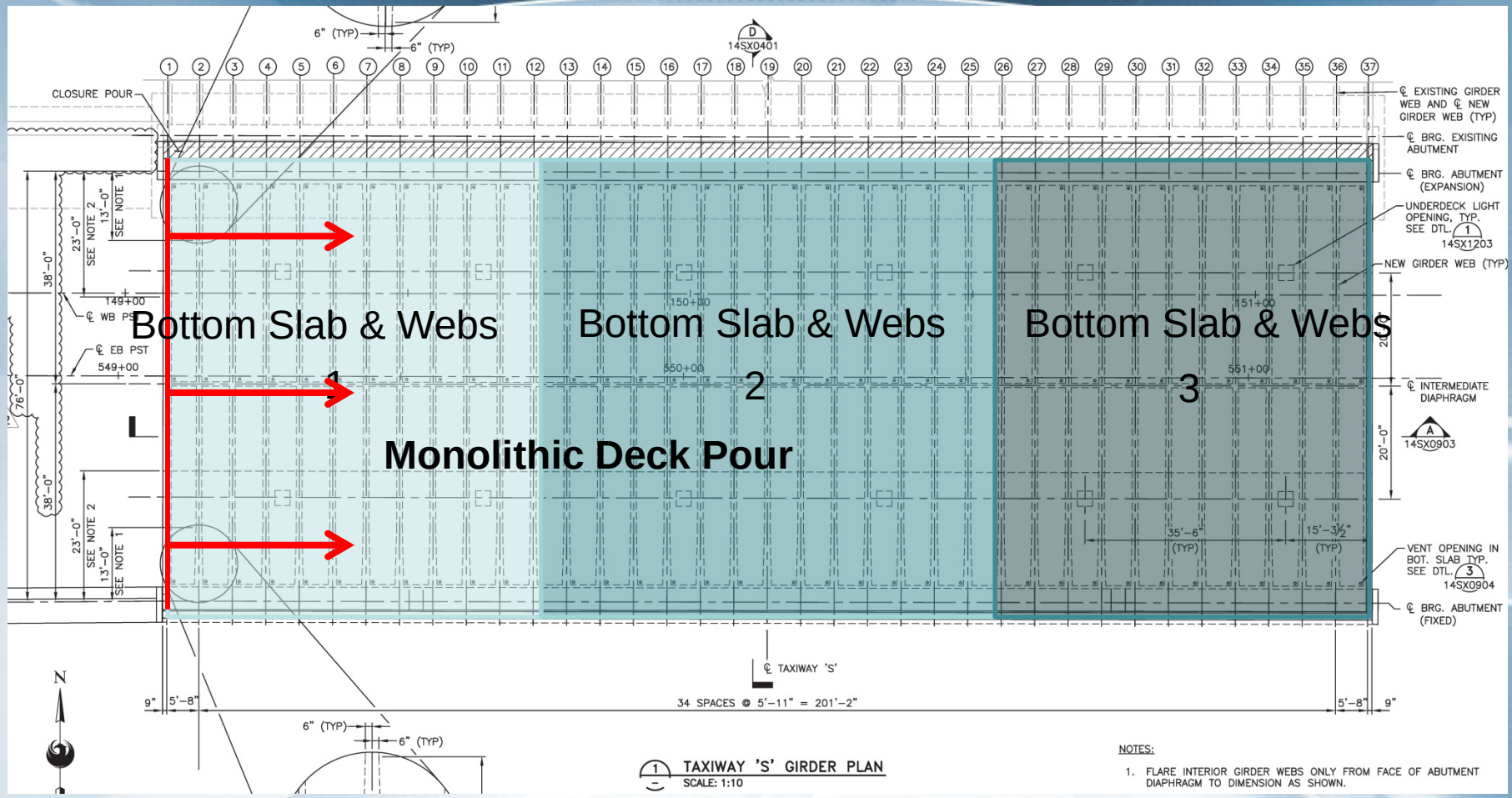
Construction

AUG. 2012: WASTE SLAB CAST AGAINST SOFFIT FILL

Construction

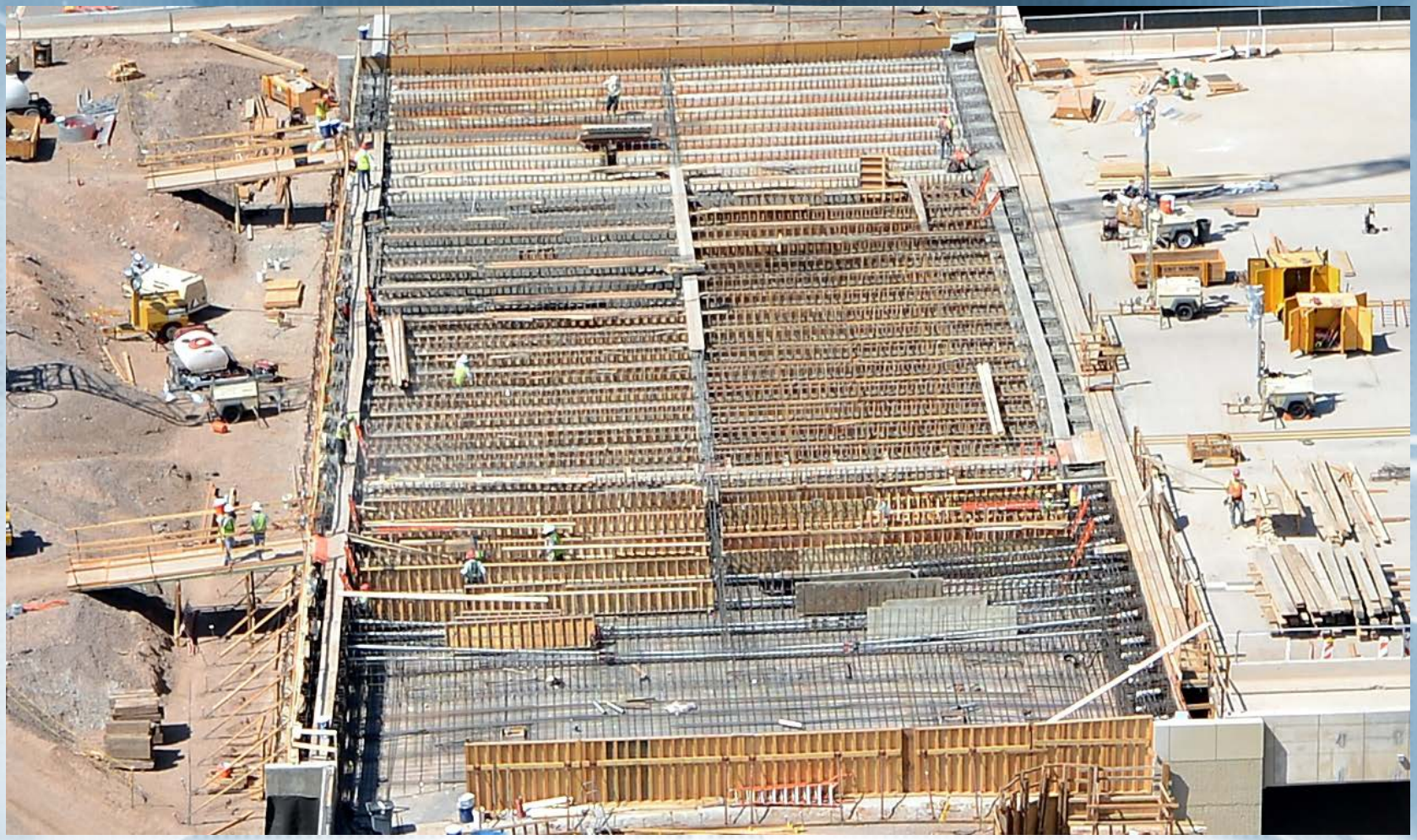
SEPT. 2012: FORMING BOTTOM SLAB AND WEBS

Construction



SEPT. 2012: POUR SEQUENCING

Construction



SEPT. 2012: FORMING BOTTOM SLAB AND WEBS

Construction

SEPT. 2012: FORMING BOTTOM SLAB AND WEBS

Construction

SEPT. 2012: POURING BOTTOM SLAB AND WEBS

Construction

SEPT. 2012: MONOLITHIC DECK POUR

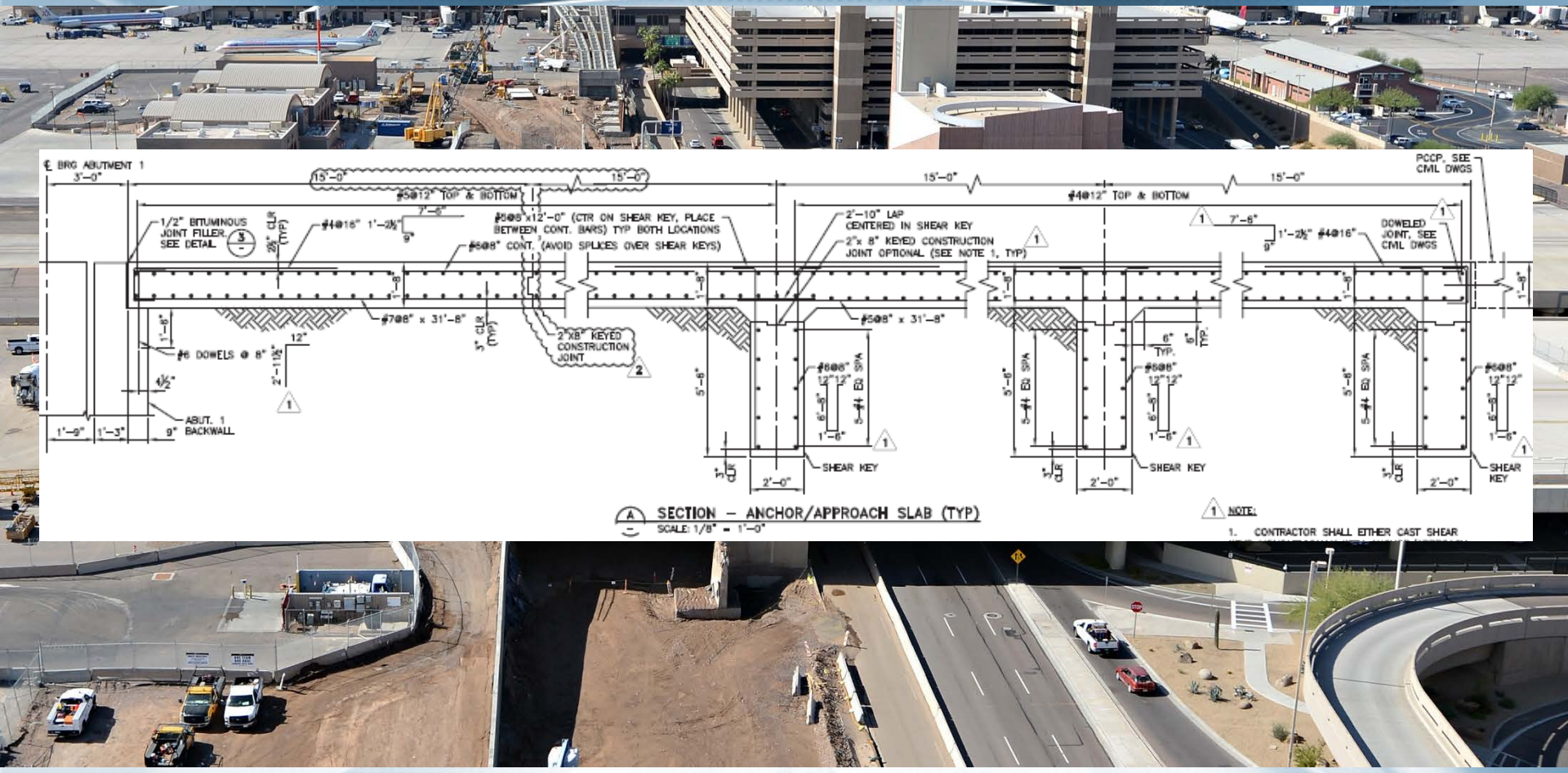
Construction

SEPT. 2012: MONOLITHIC DECK POUR

Construction

OCT. 2012: POST-TENSIONING

Construction



OCT. 2012: SUPERSTRUCTURE DONE, WORK ON ANCHOR SLAB

Construction

NOV. 14, 2012, TAXIWAY RE-OPENED – 5 DAYS AHEAD OF SCHEDULE

Construction

PROCESS REPEATED FOR TWY ‘T’. JAN. 7, 2013 TAXIWAY SHUTDOWN RE-OPENED THREE WEEKS AHEAD OF SCHEDULE ON JUNE 11, 2013.

Construction

ORIGINAL CONSTRUCTION ESTIMATE = $9.85M
FINAL CONSTRUCTION COST = $8.73M

Questions?