Elevated Guideway Structures for Sound Transit West Seattle Link Extension Project

Yang Jiang - HNTB Corporation

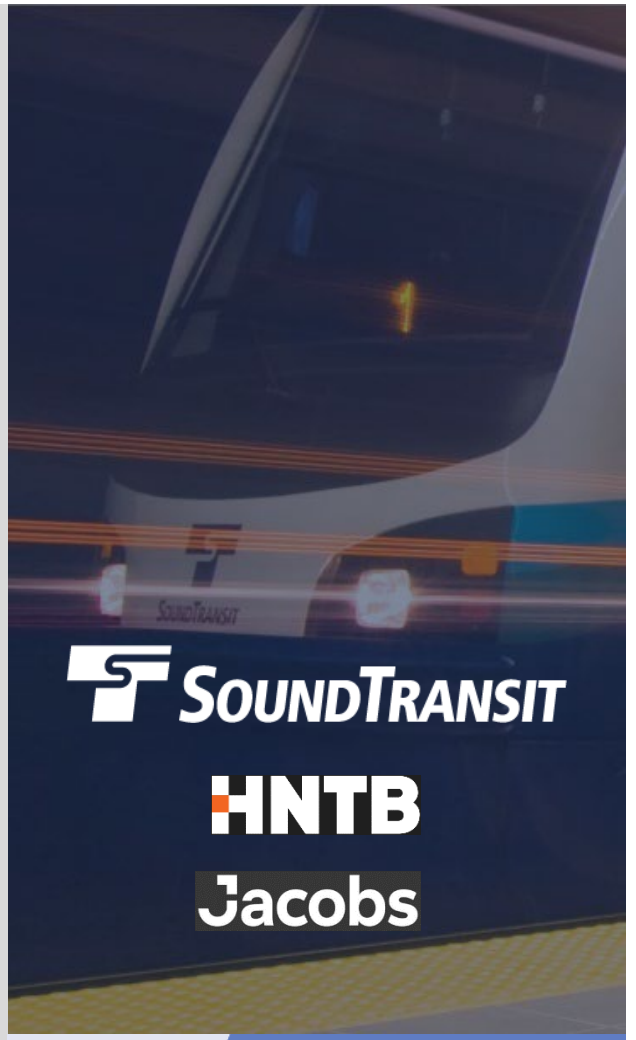
Dirk Bakker - Sound Transit

Amanda Wong - Jacobs Engineering

2023 Western Bridge Engineers' Seminar

Phoenix, Arizona

September 5–8, 2023

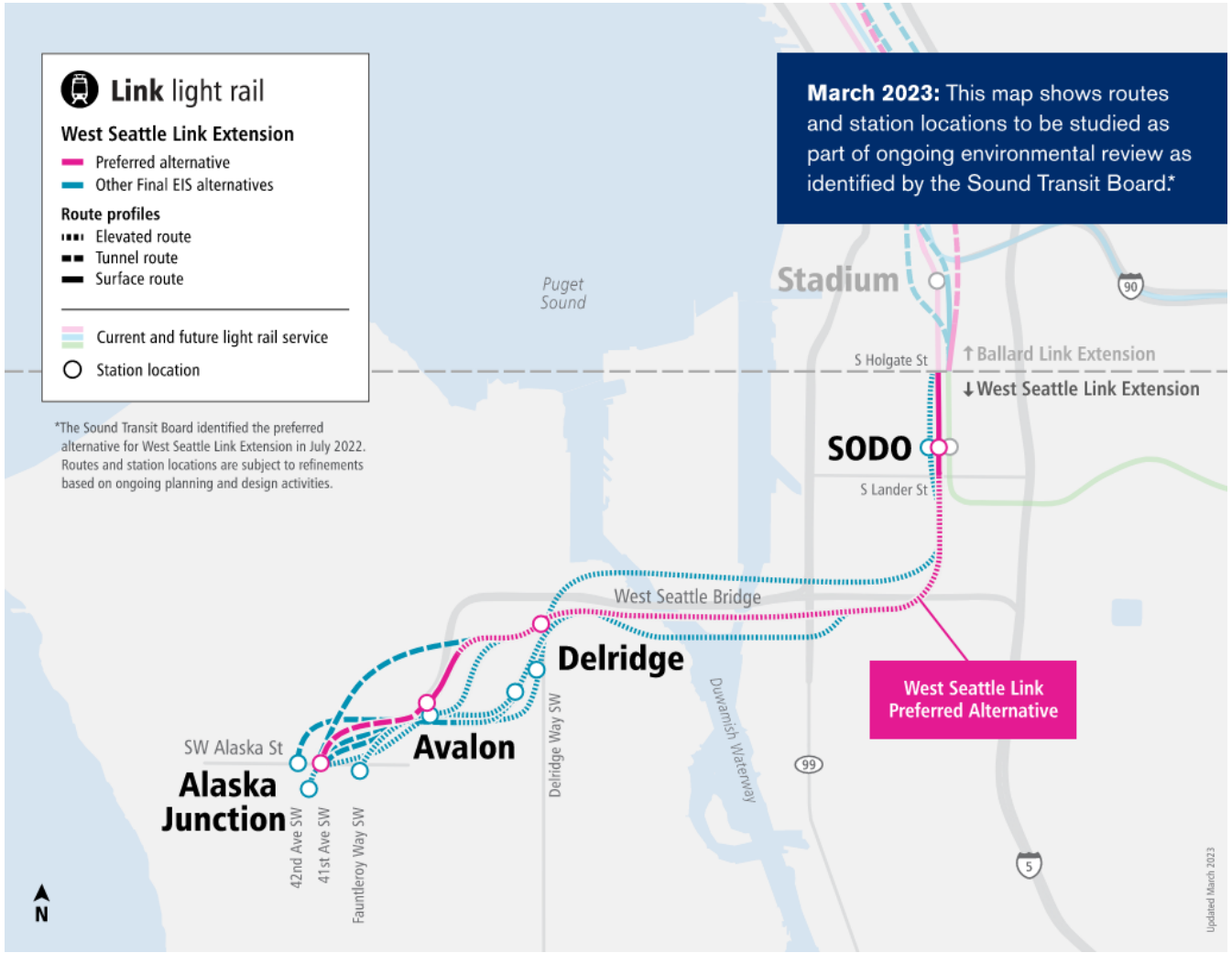


Western Bridge Engineers' Seminar

Agenda

- Project Overview & Timeline
- Elevated Guideway Alignment
- Typical Guideway Structure
- Long Span Guideway Structure
- Cable-Stayed Bridge
- Project Status

Project Overview



West Seattle Link Extension - Downtown to West Seattle

- 4.7 miles
- 4 stations
- Opening 2032

Dates reflect an affordable schedule based on current financial projections and cost estimates, and a target schedule.

HNTB

Project Timeline

Alternatives development

2017-2019

- ✓ Early scoping
- ✓ Scoping
- ✓ ST Board identifies preferred alternative and other EIS alternatives

Environmental review

2019-2024

- ✓ Draft Environmental Impact Statement
- ✓ ST Board confirms preferred alternative
- Final Environmental Impact Statement
- ST Board selects project to be built
- Federal Record of Decision

PUBLIC INVOLVEMENT

- Final route design
- Final station designs
- Construction contract procurement
- Permitting

PUBLIC INVOLVEMENT

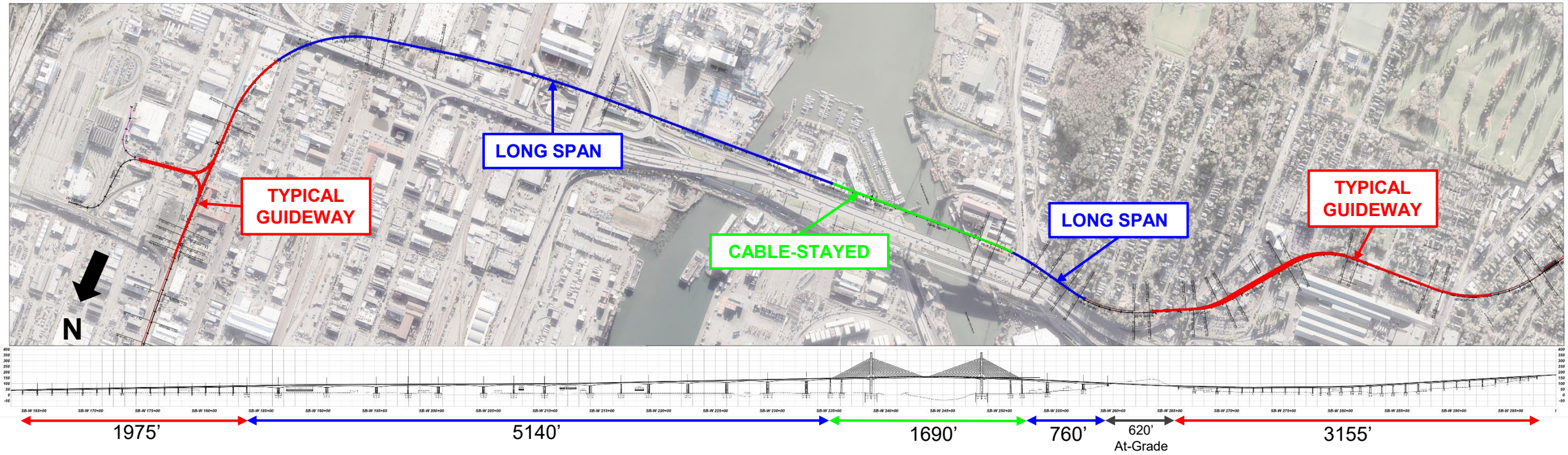
- Groundbreaking
- Frequent construction updates
- Safety education
- Testing and preoperations

PUBLIC INVOLVEMENT

West Seattle Link Extension Elevated Guideway Structures

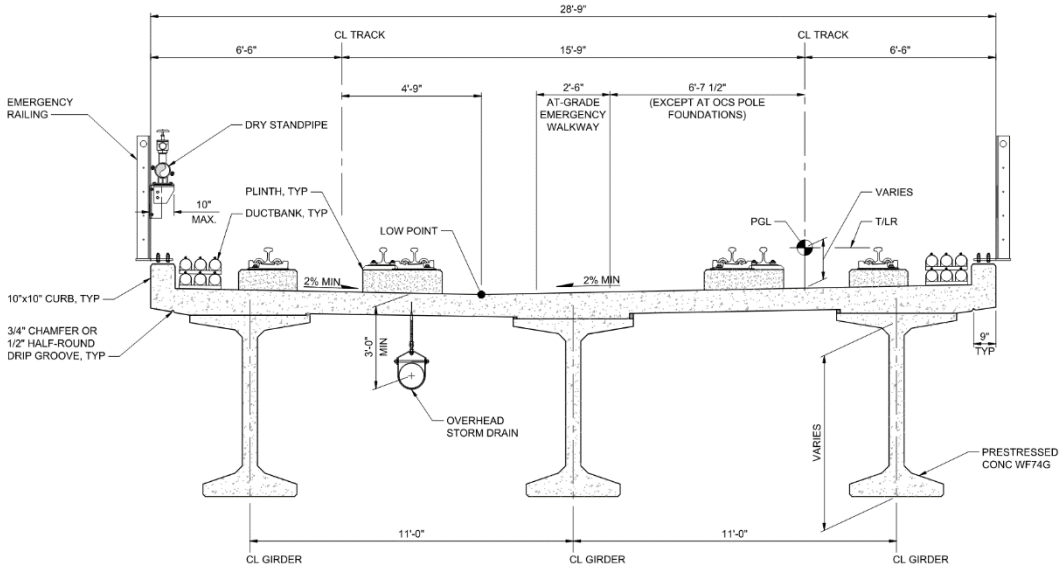
Elevated guideway comprised of 3 primary structure types

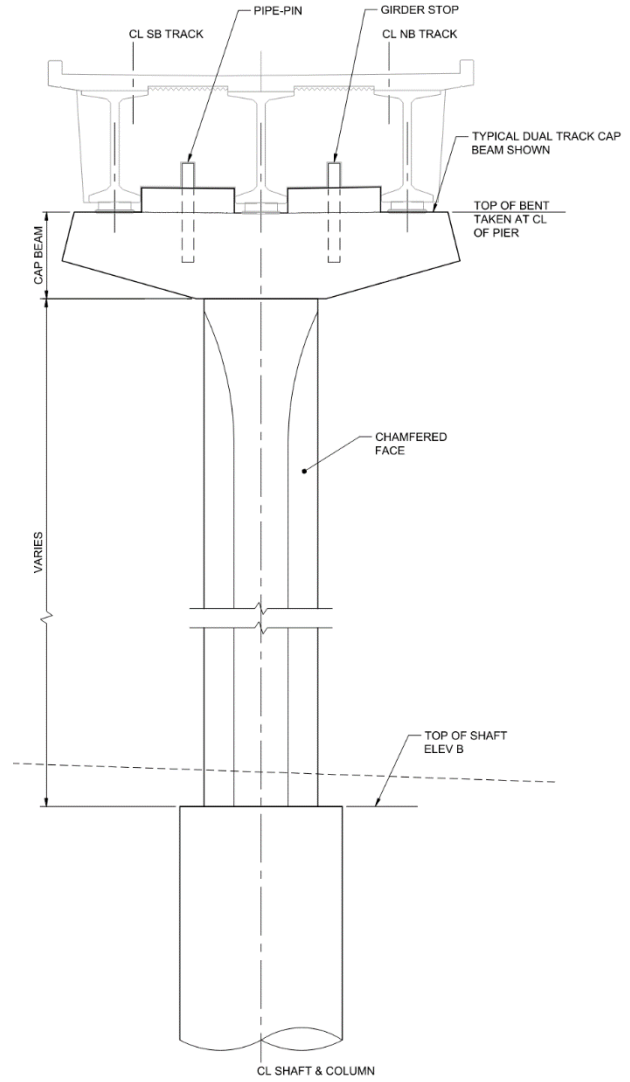
- Typical Guideway
- Long Span Guideway
- Cable-Stayed Bridge



Typical Guideway

- Consistent with previous Sound Transit projects
- Used at locations where the guideway is ~75’ or less above existing grade
- 3 lines of prestressed wide flange girders
- Typical span length approximately 130’
- Single column, single shaft foundations

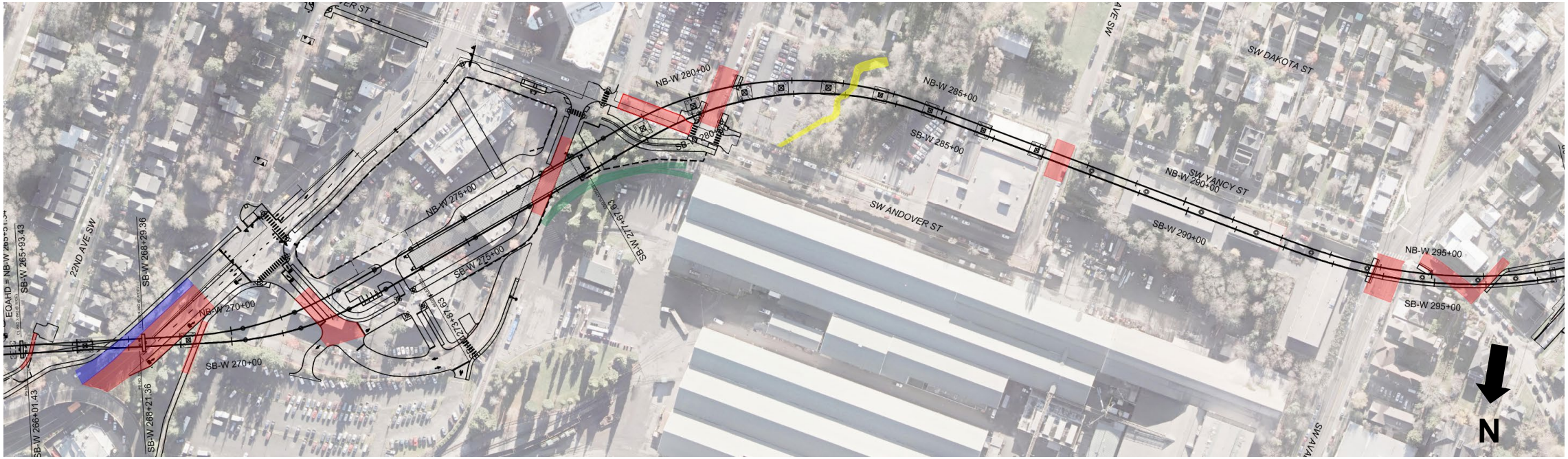




Typical Guideway – West Seattle

Structure Layout Parameters

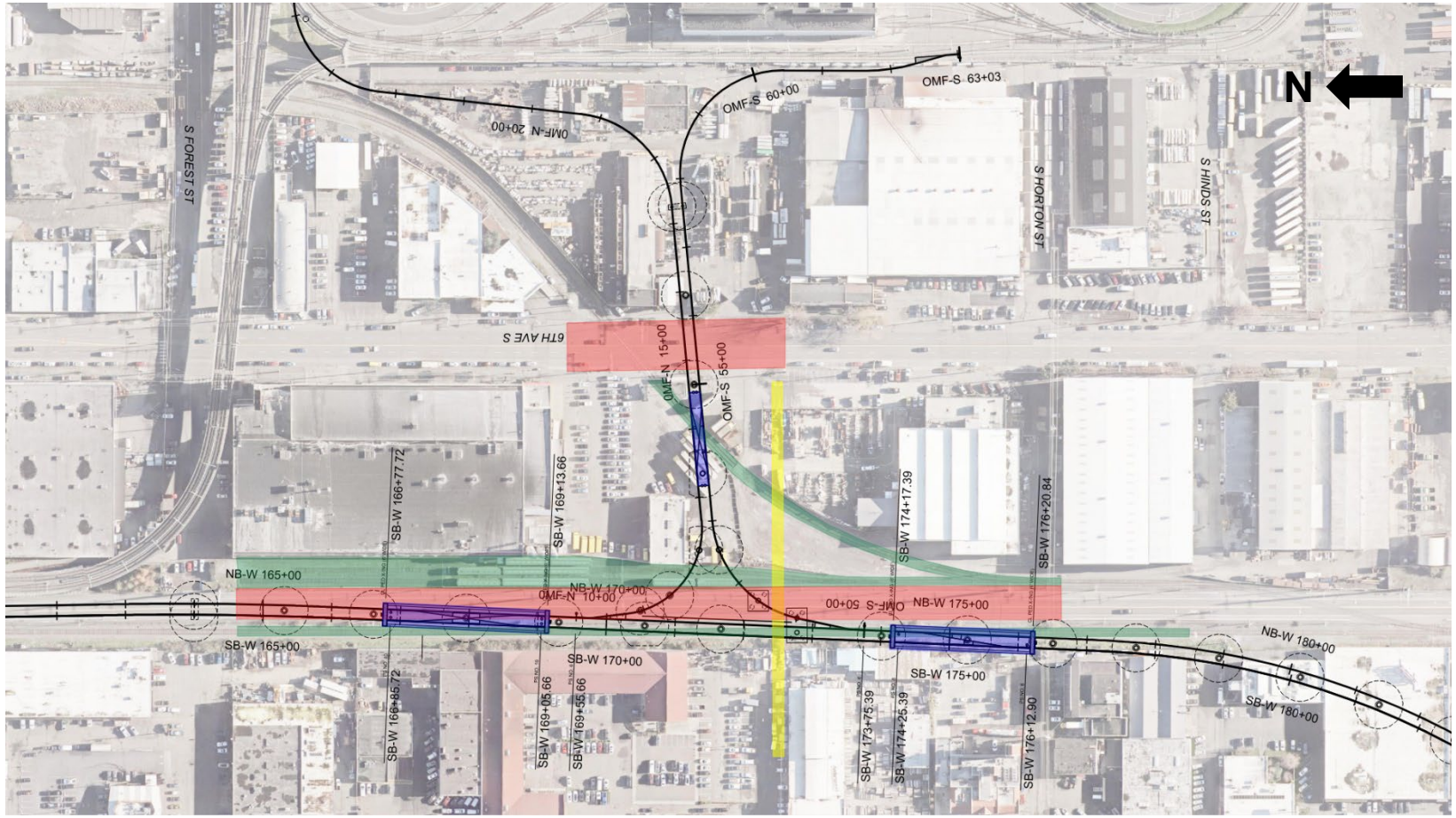
- Right-of-way impacts
- Existing infrastructure including – roadways, bridges and utilities
- Longfellow Creek – environmentally sensitive
- Tight curvature coming out the station



Typical Guideway - SODO

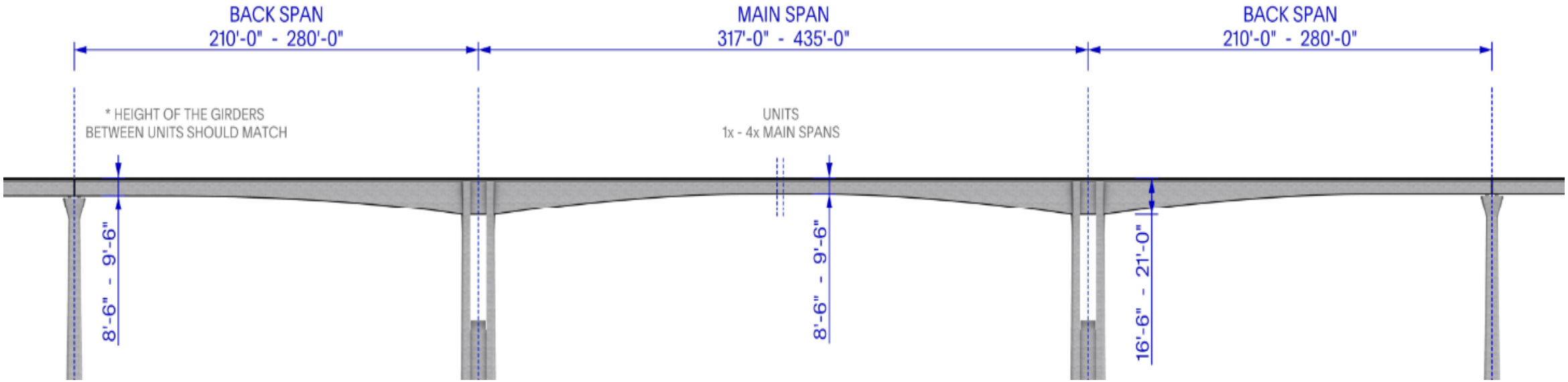
Structure Layout Parameters

- Poor soil conditions
- BNSF railroad tracks
- Right-of-way impacts
- 150” X 100” pile supported sewer line
- Special trackwork including a turnout to the Sound Transit Operations Maintenance Facility (OMF)



Long Span Guideway

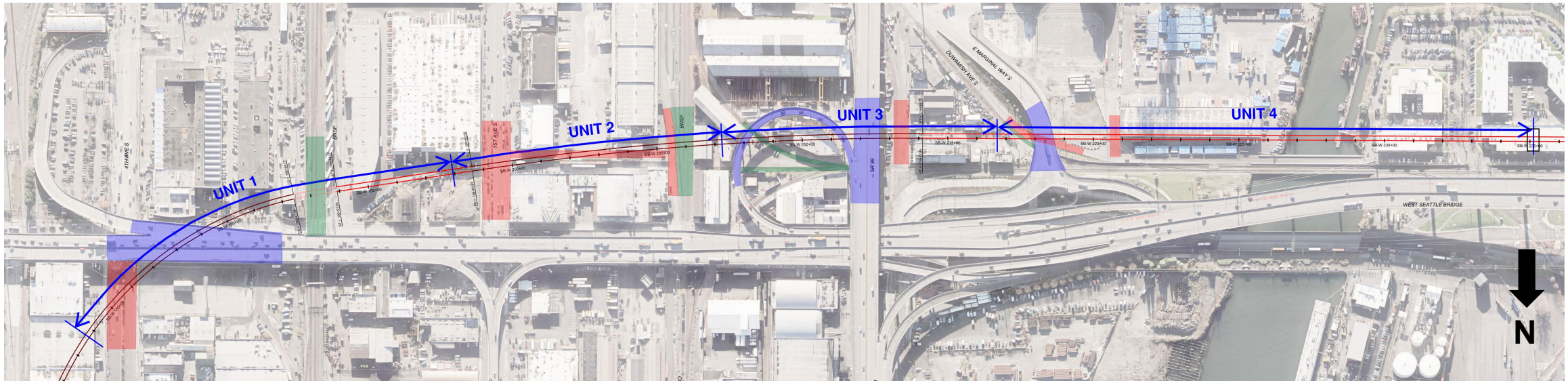
- 5 units – comprised of 3-6 spans
- Structure height ranging from 60’-130’ above existing grade
- Superstructure are segmental box girders with balanced cantilever construction
- Selected for functionality, structural efficiency, redundancy, similar to previous ST project and to minimize on-ground impact
- Main span piers are double-leaf columns with a fill section between the two leaves near the bottom for tall piers



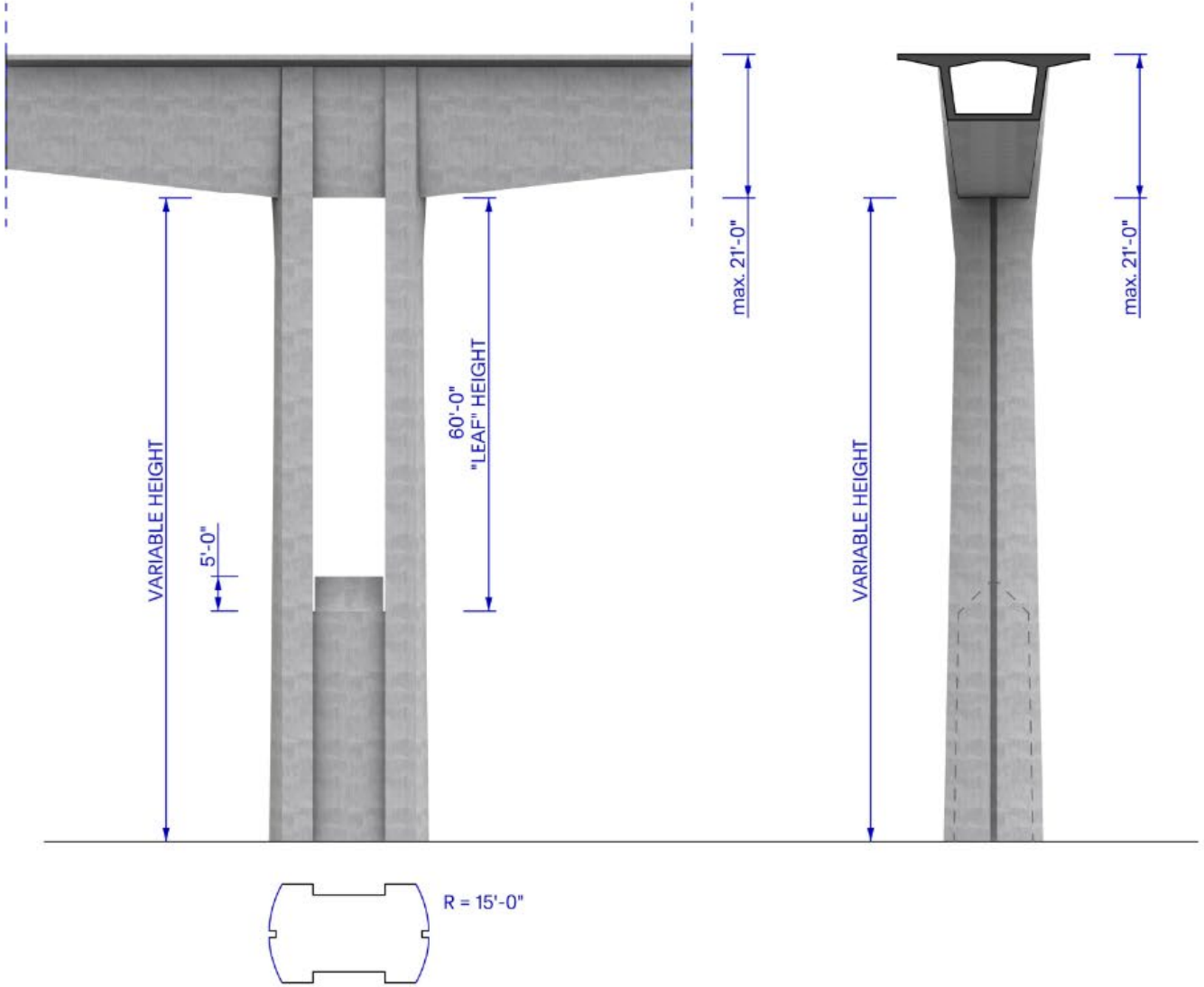
Long Span Guideway

Structure Layout Parameters

- BNSF railroad tracks
- Right-of-way impacts
- Existing infrastructure including – roadways, bridges and utilities
- East Duwamish Waterway – objective is to avoid in-water piers
- Cable-Stayed Bridge configuration

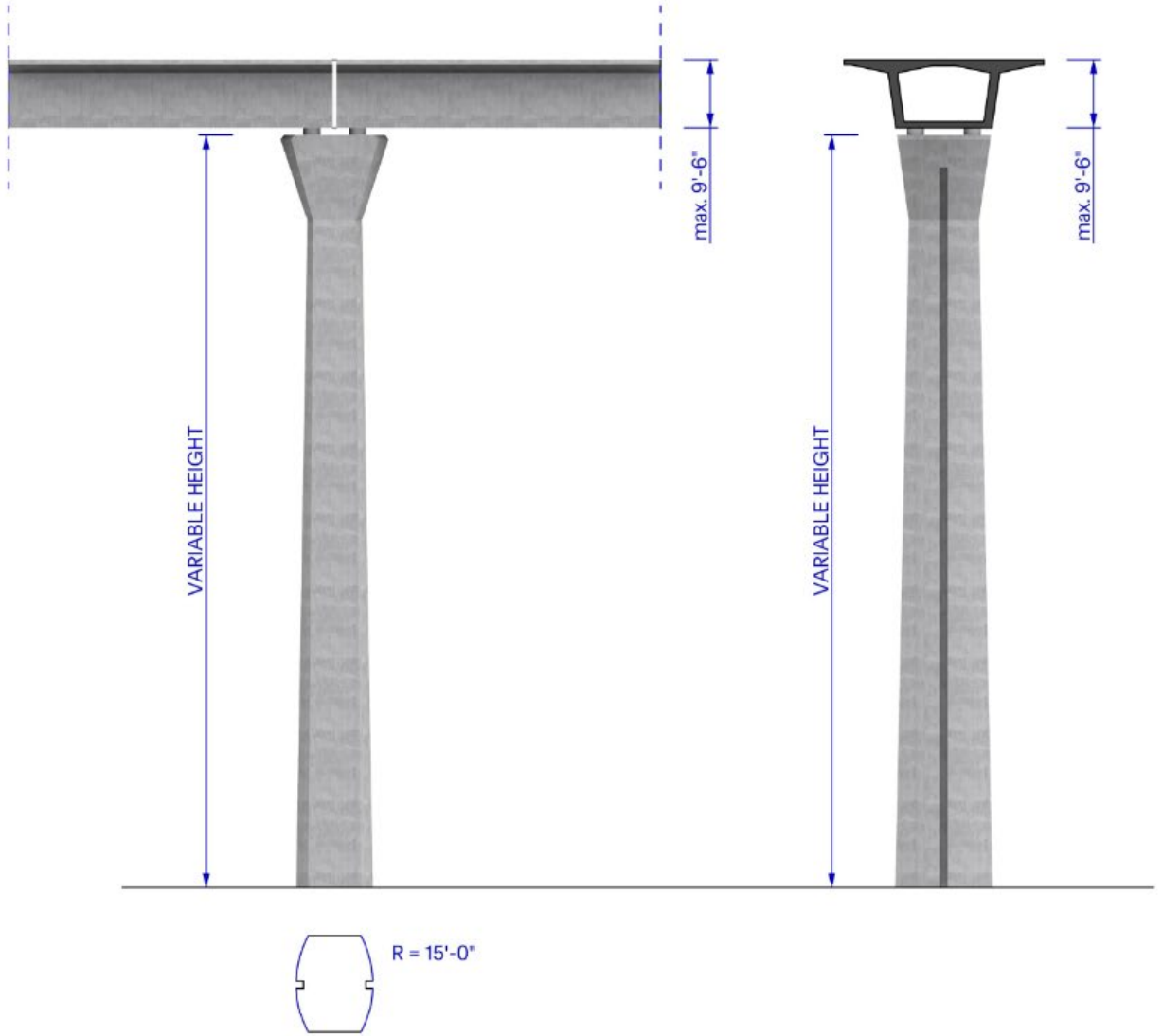


Long Span Guideway – Integral Piers



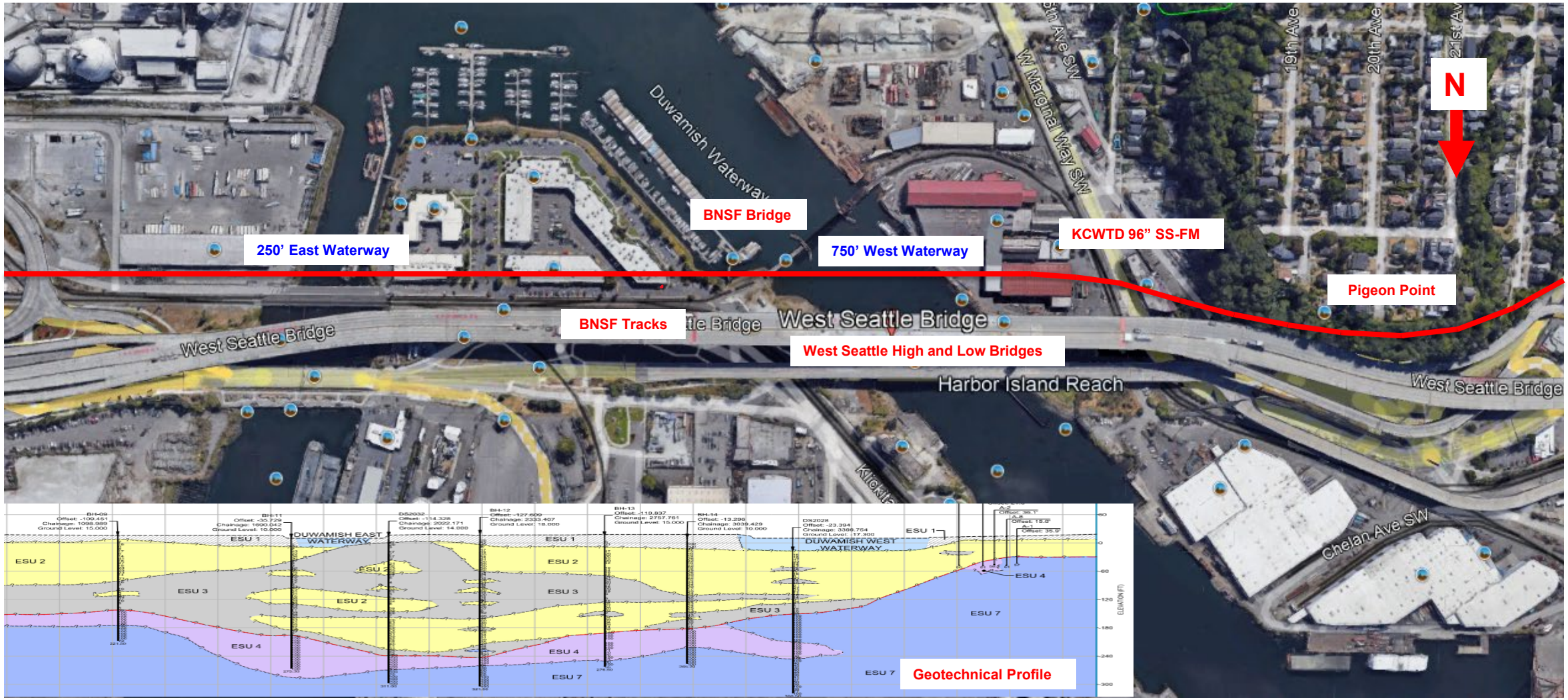
HNTB

Long Span Guideway – Expansion Piers



Typical and Long Span Guideways

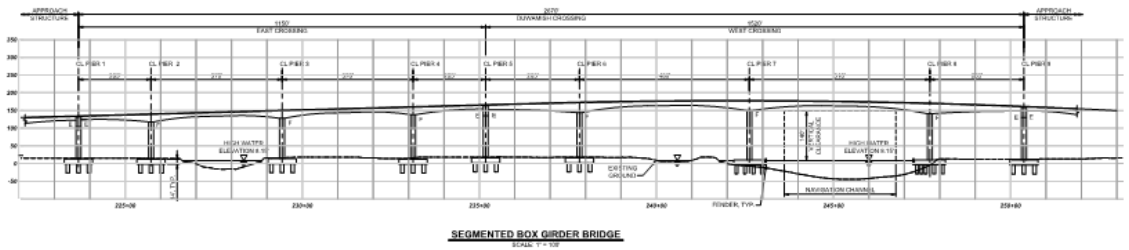
Duwamish Crossing Site Conditions



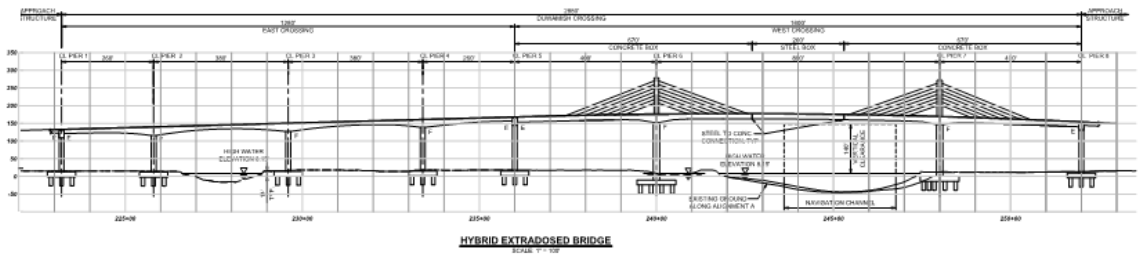
Duwamish Crossing Bridge Concept Development

- Phase 1
  - Studied multiple alignments and multiple bridge concepts
- Phase 2
  - Focused on the preferred alignment (south) and developed four bridge types
  - Conducted bridge type evaluation without a bridge type recommendation
- Phase 3
  - July 28, 2022: Board confirmed the South Crossing as Preferred Alternative
  - Oct 27, 2022: Following workshops with interagency partners, Sound Transit decided to only consider bridge types that avoid in-water piers
  - Nov 18, 2022: Sound Transit conducted Internal Evaluation – Cable-Stayed is to be advanced in Preliminary Engineering and Environmental Permitting
  - April 2023: Preliminary engineering began
- Sound Transit is engaging Seattle Department of Transportation and Seattle Department of Construction and Inspections through Engineering Group meetings
- Sound Transit is engaging Seattle Design Commission

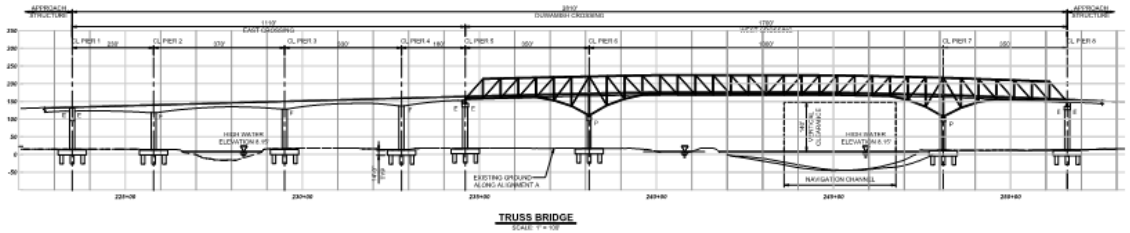
Phase 2 Bridge Alternatives



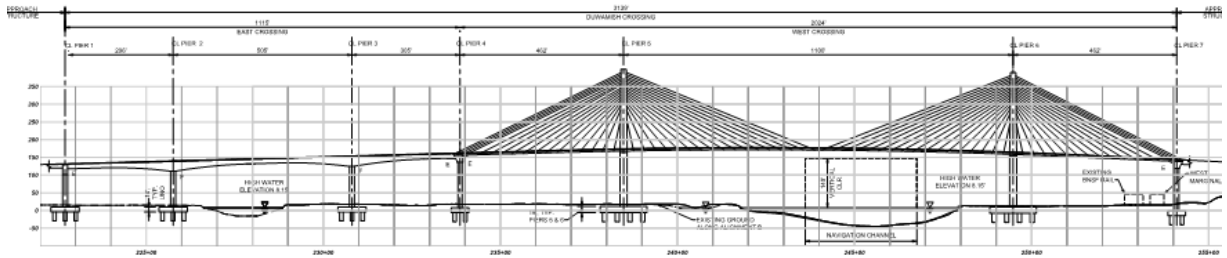
Segmental Box Girder



Extradosed



Steel Truss



Cable-Stayed

HNTB

Duwamish Crossing – Phase 2 Bridge Type Evaluation

WSBLE Long-Span Bridge Studies								
Duwamish Crossing - Summary of Comparison	**Segmental Box Girder**		**Hybrid Extradosed**		**Continuous Truss**		**Cable Stayed**	
Considerations	**Rank**	**Appropriateness of Fit**	**Rank**	**Appropriateness of Fit**	**Rank**	**Appropriateness of Fit**	**Rank**	**Appropriateness of Fit**
Construction / Temporary Environmental								
Construction Duration In/Over Water	4	Low	3	Medium	1	High	2	High
Benthic Footprint during Construction	4	Low	3	Medium	1	High	1	High
Pier Protection / Pile Cap Location	4	Low	3	Medium	1	High	1	High
On Shore Impacts	4	Low	3	Medium	1	High	2	High
Permanent Environmental								
Benthic Footprint	4	Low	3	Medium	1	High	1	High
Pier Protection / Pile Cap Location	4	Low	3	Medium	1	High	1	High
Over-Water Inspection & Maintenance	1	High	3	Medium	4	Low	1	High
Anticipated Mitigation	4	Low	3	Low	1	High	1	High
Permitting Complexity	4	Low	3	Low	1	High	1	High
On Shore Impacts	1	Medium	1	Medium	1	Medium	1	Medium
Fishing Treaty Rights								
Compatability with Tribal Fishing Activities	4	Low	3	Low	1	High	1	High
Operations & Maintenance								
Access for Bridge Inspection & Maintenance	1	High	2	Medium	4	Low	3	Low
Duration of Bridge Structure Inspections & Maint.	1	High	2	Medium	4	Low	3	Medium
Durability of Material Type	1	High	3	Low	4	Low	2	Medium
Frequency of Bridge Structure Inspection & Maint.	1	High	4	Low	3	Low	2	Medium
In-water Inspection & Maintenance	4	Medium	1	High	1	High	1	High
Asset Management Consistency	1	High	2	Low	3	Low	3	Low
Permits Needed for O&M Activities	1	High	2	Medium	2	Medium	1	High

HNTB

Duwamish Crossing – Phase 3 Bridge Type Evaluation

Category	Cable-Stayed	Steel Truss
Design	High	Low
Context	High	Medium
Sustainability	Medium	Medium
Constructability	High	Low
Asset Management (M&I)	Medium	Low
Environmental	High	Medium

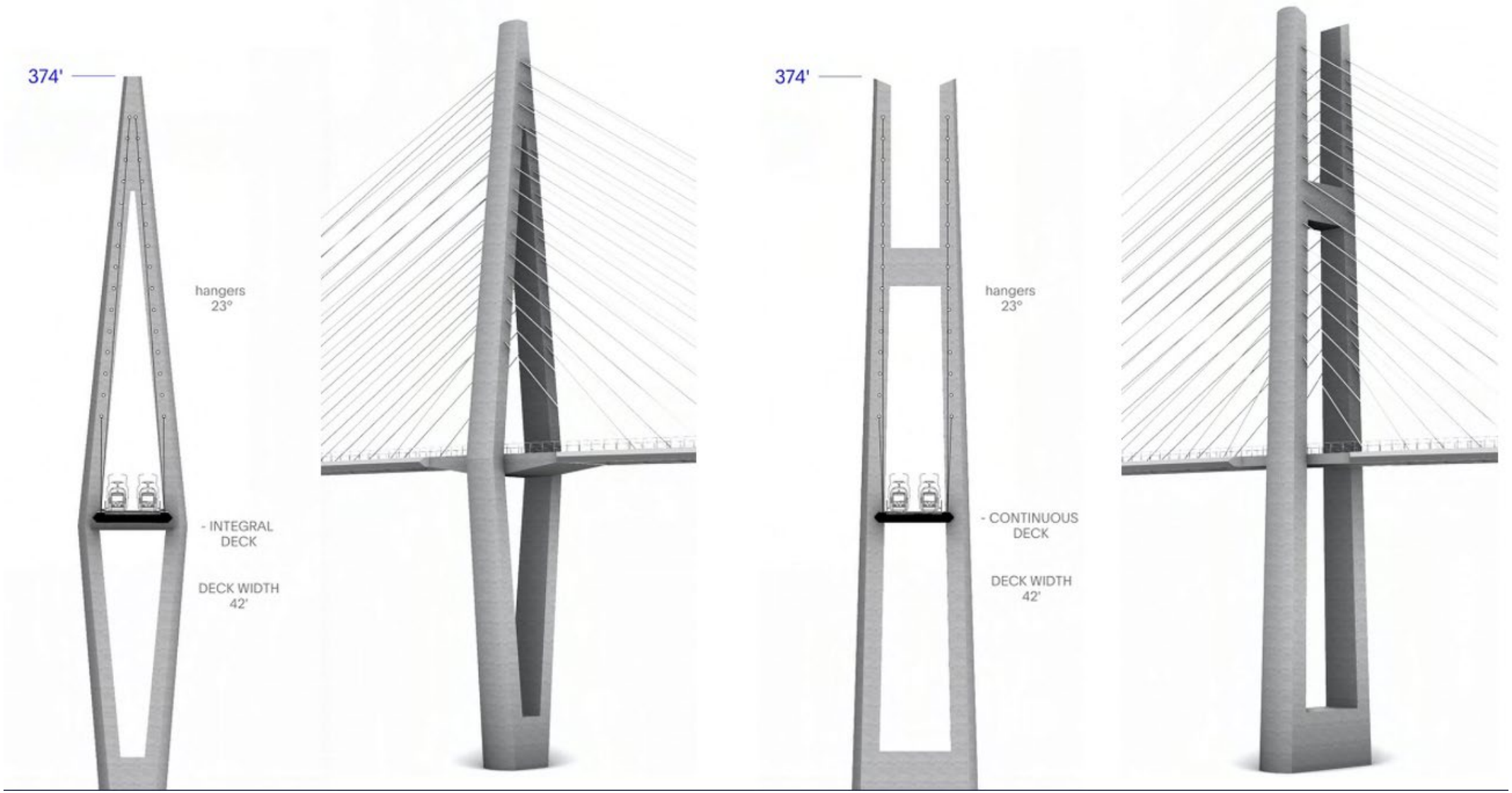
Note: The ratings were entered by consensus of the participants at the end of the workshop on November 18, 2022.

Duwamish Crossing – Steel Truss Alternative

HNTB

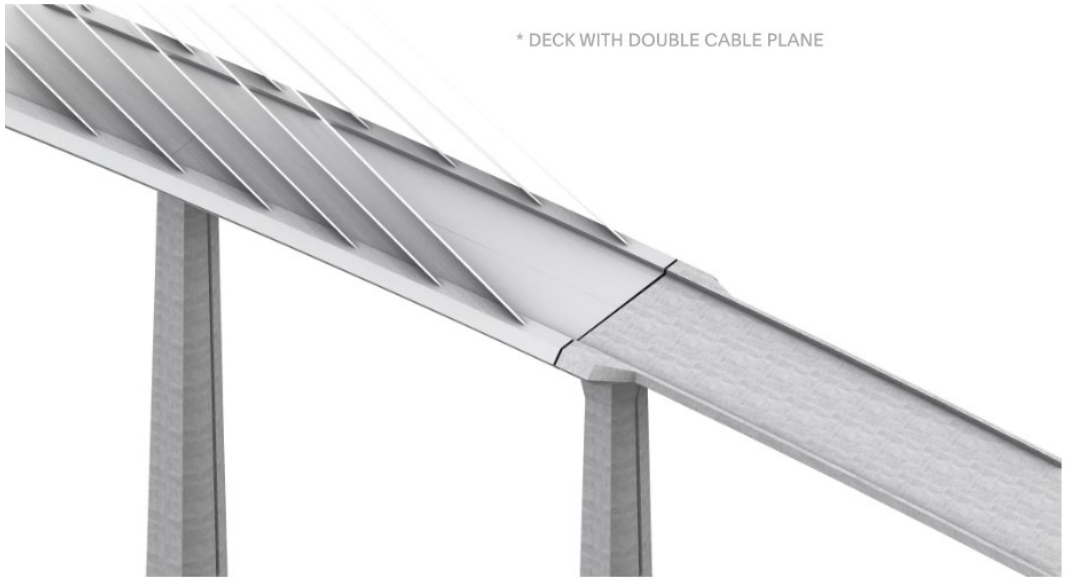
Duwamish Crossing – Cable-Stayed Alternative

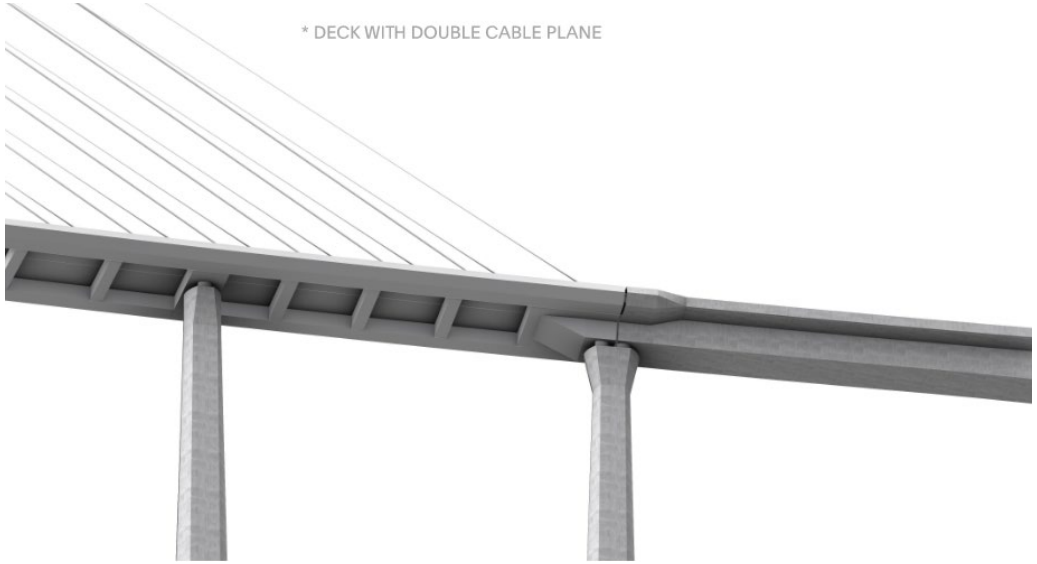
Cable-Stayed Tower Options



HNTB

Cable-Stayed to Guideway Transition





HNTB

Project Status

- Progressing on preliminary engineering, which is planned to be completed in April 2024
- Evaluating various procurement methods including DB, Progressive DB, GCCM, and DBB

Acknowledgments and Disclaimers

Acknowledgments

- Sound Transit Staff and Consultant Team Members
- HNTB is the primary consultant, subconsultants for the elevated guideways include:
  - Jacobs – Structures and Geotech
  - RHC – Walls and structures
  - Dissing+Weitling, Denmark – Bridge Architecture
  - RWDI, Canada – Wind Consulting and Testing Services
  - Shannon& Wilson, Inc. Geotech

Disclaimers

The opinions expressed in this presentation are those of the authors. They do not purport to reflect the opinions or views of Sound Transit. The designations employed in this presentation of material therein do not imply the expression of any opinion whatsoever on the part of Sound Transit. Official documents or materials shall come from Sound Transit.