

PHYSICAL CONDITION OF PUREX STORAGE TUNNELS POST-STABILIZATION

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

Contractor for the U.S. Department of Energy
under Contract DE-AC06-08RL14788

CH2MHILL
Plateau Remediation Company

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Total pages: 86

1.0 Introduction

1.1 Background

The Plutonium-Uranium Extraction (PUREX) Facility is a canyon facility located in the 200 East Area of the Hanford Site. The 202A PUREX facility includes PUREX Storage Tunnel Number 1 and PUREX Storage Tunnel Number 2 (referred to as Tunnel 1 and Tunnel 2) located at the southeast end of the PUREX Plant as an extension of the rail road tunnel. The tunnels were used for storage of failed radioactive processing equipment.

Subsequent to the partial collapse and initial remediation of Tunnel 1, a plan was instituted for long-term stabilization of the Tunnels to ensure the safe storage of the equipment stored within them until the time of their permanent disposition. Tunnel 1 was stabilized using engineered grout in November 2017. Tunnel 2 was stabilized using engineered grout in April 2019.

1.2 Purpose

Options that may be considered for long-term disposition of the tunnels are (1) removal (e.g., cut each tunnel monolith between railcars and haul these blocks for treatment or disposal in an appropriate waste disposal facility); or (2) capping in place (e.g., cover the entire tunnel with an engineered surface barrier). This document was created to provide technical information that will support future disposition.

This document provides the following information:

- Tunnel 1:
 - Overview of Tunnel 1
 - Documented view of each railcar
 - Documented contents of each railcar
 - Estimated void spaces remaining in the tunnel
 - Estimated railcar positioning with respect to south face of the Water Door Building (WDB)
- Tunnel 2:
 - Overview of Tunnel 2
 - Estimated railcar positioning with respect to south face of the Water Door Building (WDB)
 - Riser positioning with respect to south face of WDB
 - Radiological readings at each riser, measured before grouting took place
 - Estimated void spaces remaining in the tunnel
 - Documented view of each railcar

- Documented contents of each railcar

1.3 Tunnel 1

Storage Tunnel 1 construction was completed in 1956 as part of the PUREX Plant. The main parts of the tunnel are:

- A Water-fillable door located at the North end; sealed on the north exterior side in 1973.
- A 358-foot-long tunnel proper
- A reinforced concrete vent structure located at the South end. The ventilation system was deactivated, air gapped, and blanked off in 1996
- 2.4-m (8 ft) of soil overburden, intended to provide shielding of the tunnel contents.

The storage tunnels are isolated from the PUREX railroad tunnel by a water-fillable steel plated shield door. The water-fillable shield door was deactivated by removal of the water and sealing of the door.

The main portion of Tunnel 1 is 358 feet long, 22.5 feet in height, and 19 feet wide. The tunnel was constructed using 12-inch by 14-inch creosote treated Douglas Fir No. 1 wood timbers. The first 103-foot length of the northern part of the tunnel (closest to the main PUREX Plant) has a 3-foot thick reinforced concrete wall on the east side and wood timbered west wall and roof. The remaining 255-foot length of the south portion of the tunnel has timbered walls and roof. The same size and grade of wood timber supports were used throughout the tunnel structure. The top and bottom of Tunnel 1, including the soil fill cover, slopes at a 1% grade downward and away from the PUREX Plant (north to south). The tunnel was designed to (and currently does) accommodate eight (8) rail cars holding failed processing equipment from the PUREX Plant.

Approximately 4400 cubic yards of engineered grout was placed in Tunnel 1 between October and November of 2017. The engineered grout was a 2000-psi compressive strength, cementitious non-aggregate flow-able fill. The mix was designed to fill open voids of ½ inch and greater. The grout was placed in the tunnel by boom truck, attached to 8 inch grout pipes (fabricated at 90 degrees) to place grout to the north and south of the collapse location. See Figure 1 for a visual representation of the setup. A 4-inch riser in the top of the tunnel was used initially to provide camera and lighting in the tunnel, then as an injection location during the final phases of grouting.

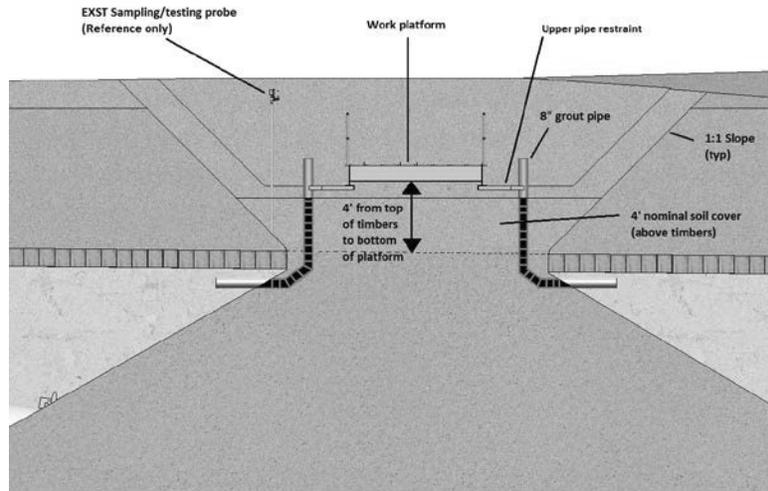


Figure 1: Conceptual Profile of Grouting Connections at Tunnel 1 Collapse Location

1.4 Tunnel 2

Tunnel 2 construction was completed in 1964. The main parts of the tunnel are:

- A water-fillable shield door located at the North end
- A 1688 foot-long storage tunnel constructed in a steel Quonset hut arched dome configuration
- A reinforced concrete ventilation structure located at the South end. The ventilation system was deactivated, air gapped, and blanked off in 1996
- 8 feet of tunnel cover soil (soil overburden) to provide protection of the tunnel structure as described in CP-14977, *Plutonium Uranium Extraction Facility Documented Safety Analysis*

The internal nominal dimensions of Tunnel 2 are 1688 feet in length, 26 feet in height, and 34 feet in width. The tunnel construction is a combination of steel and concrete. The structural assembly consists of a 34 foot diameter steel semi-circular shaped roof system using a series of 3/16-inch thick stamped steel plate panels with bolted connections supported by 6 inch I-beam arched ribs (transverse direction). These are supported by 12 inch deep retrofit wide-flange wale beams (longitudinal direction) which are underhung and supported by retrofit external ribbed concrete arch supports (transverse direction).

Interior and exterior roof surfaces are coated with a bituminous compound. The tunnel floor is soil sloped from the continuous concrete footing extending along the base of the arched wall (on each side of the tunnel) to the bottom rail section with a slope of 1:1.5 (horiz/vert) on each side. The tunnel is sloped downward with a 0.1% grade from north to south.

Tunnel 2 has 17 ports equipped with risers spaced at approximately 96 foot intervals along the length of the tunnel. These risers are located on the top and centerline of the tunnel with the top of the risers exposed and visible. Each riser/port provides for a 15-3/4" diameter penetration into the tunnel and is provided with a removable concrete plug to seal the port/penetration. The riser plug is a 29 1/2" diameter by 34 1/2" high concrete plug which also includes a 3" diameter by 34

½” penetration through the center. The 3” diameter penetration is equipped with a steel bar plug and may be removed without disturbing the concrete plug.

Tunnel 2 was designed to accommodate 40 rail cars, each measuring 40 to 42 feet in length. Current documented inventory within the tunnel is 28 cars of various lengths.

Approximately 41,500 cubic yards of engineered grout was placed in Tunnel 2 between October 2018 and April 2019. The engineered grout was a 2000-psi compressive strength, cementitious non-aggregate flow-able fill. The mix was designed to fill open voids of ½ inch and greater. Due to the exclusion zone imposed by engineering after calculating loading restrictions on the tunnel, six 30-foot conveyance booms were used to pump grout from pump trucks to the risers located at the top of the tunnel. See Figure 2 for a visual representation of the conveyance booms. The risers contained adapters (called “insertion devices”) to distribute grout into the tunnel, while providing ports for lighting and a camera for monitoring. See Figure 3 for a visual representation of the insertion devices.

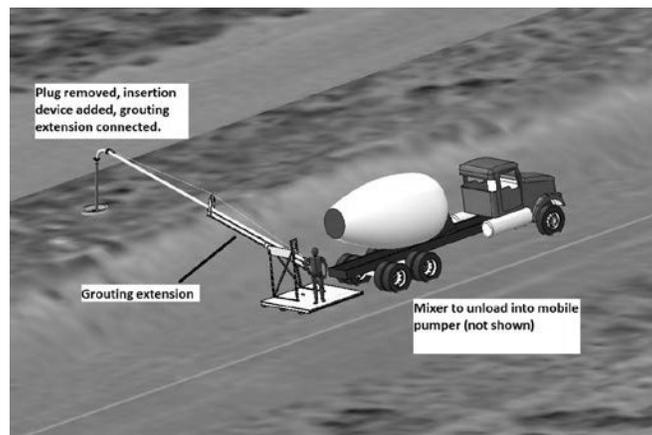


Figure 2: Rendering of Grout Extension Boom Shown Next to Tunnel 2

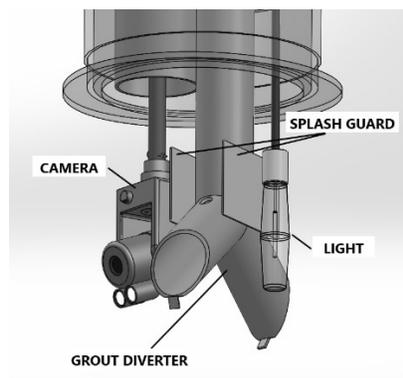


Figure 3: Insertion Devices used in Tunnel 2 Stabilization

2.0 Summary

This section provides concisely summarized details on the resting state of Tunnels 1 and 2 to aid in future remediation. A 3D model of Tunnel 1 and Tunnel 2 was created to aid in design and provide a visual representation of the equipment layout. For more Tunnel 1 details and figures see Appendix A. For more Tunnel 2 details and figures see Appendix B.

2.1 Rail Car Positioning and Void Spaces

2.1.1 Tunnel 1

Table 1 Notes:

- Estimations based on structural and equipment drawings, documented information and assumptions. A verification method (e.g. scans, core drill, etc.) should take place prior to separation of the monoliths.
- The railcar positions are estimated with respect to the south face of the water door building (WDB).
- Position # is counting cars from South to North, based on the order that they were placed into the tunnel.

Table 1: Railcar Details – Tunnel 1

Position #	North End Estimated Distance from WDB (ft)	Car Length (ft)	Estimated Void Space Above Car (yd³)	Estimated Void Space Inside Car (yd³)	Estimated Vertical Void Space Remaining
1	300	42	29.5	11.6	12”
2	258	42	29.5	7.5	12”
3	216	42	29.5	16.6	12”
4	174	42	29.5	9	12”
5	132	42	29.5	16.6	12”
6	90	42	29.5	16.6	12”

Position #	North End Estimated Distance from WDB (ft)	Car Length (ft)	Estimated Void Space Above Car (yd ³)	Estimated Void Space Inside Car (yd ³)	Estimated Vertical Void Space Remaining
7	48	42	0 ¹	16.6	0
8	6	42	29.5	16.6	12"

Total volume of Tunnel 1 (empty)²: 5670 yd³

Total estimated void space in Tunnel 1 *rail cars*: 206.5 yd³ (approximately 3.6% of total Tunnel 1 volume)

Total estimated void space *at the top* of Tunnel 1: 111.1 yd³ (approximately 2.0% of total Tunnel 1 volume, see Appendix A for assumptions)

Total estimated void space remaining in Tunnel 1 (in rail cars + top of tunnel): 317.6 yd³ (approximately 5.6% of total Tunnel 1 volume)

Average estimated vertical headspace in Tunnel 1: 12" (approximately 4.4% of total Tunnel 1 height)

2.1.2 Tunnel 2

Table 2 Notes:

- Estimations based on structural and equipment drawings, visual inspection and assumptions. A verification method (e.g. scans, core drill, etc.) should take place prior to separation of the monoliths.
- The railcar positions are estimated with respect to the south face of the water door building (WDB).
- Position # is counting cars from South to North, based on the order that they were placed into the tunnel.

¹ Rail car #7 was below the collapsed section of the tunnel. Backfill was initially used to remediate the opening, and car #7 was entirely buried, therefore, no void space remains above it.

² Empty volume based on total volume of Tunnel 1 from structural drawings, calculated using SolidWorks modeling software.

- Some railcar couplers were removed, while others were left attached. Car lengths may vary.

Table 2: Railcar Details – Tunnel 2

Position #	North End Estimated Distance from WDB (ft)	Car Length (ft)	Length Known or Estimated (See Appendix A)	Estimated Void Space Above Car (yd³)	Estimated Void Space Inside Car (yd³)	Estimated Range of Vertical Void Space Remaining
1	1636	42	Estimated	4	16.6	0'2" to 0'11"
2	1592	42	Estimated	7	16.6	0'2" to 1'1"
3	1548	42	Estimated	22	16.6	1'1" to 1'6"
4	1504	42	Estimated	22	195.5	1'6" to 1'6"
5	1462	42	Estimated	22	7.5	1'6" to 1'6"
6	1419	42	Estimated	12	14.9	0'2" to 1'8"
7	1384	33	Estimated	46	0	1'8" to 3'0"
8	1340	42	Estimated	52	1.9	1'9" to 3'0"
9	1307	33	Estimated	43	0	1'9" to 3'0"
10	1265	42	Estimated	59	45.4	1'9" to 3'0"
11	1222	42	Estimated	12	0	0'10" to 1'9"
12	1178	42	Estimated	11	36	0'10" to 0'11"
13	1132	42	Estimated	10	42.1	0'8" to 0'11"
14	1088	42	Estimated	11	24	0'11" to 0'11"
15	1046	42	Estimated	11	11.4	0'10" to 1'2"
16	1004	42	Estimated	13	16.6	1'0" to 1'2"
17	959	42	Estimated	12	3.8	0'11" to 1'0"

Position #	North End Estimated Distance from WDB (ft)	Car Length (ft)	Length Known or Estimated (See Appendix A)	Estimated Void Space Above Car (yd ³)	Estimated Void Space Inside Car (yd ³)	Estimated Range of Vertical Void Space Remaining
18	914	42	Known	12	12.6	0'11" to 1'0"
19	862	52	Known	13	29.9	0'6" to 1'0"
20	810	52	Known	18	16.6	1'0" to 1'2"
21	756	54	Known	20	30.6	1'0" to 1'6"
22	700	56	Known	51	7.1	1'6" to 2'2"
23	647	53	Known	27	3.8	0'10" to 1'8"
24	595	52	Known	26	6.2	1'0" to 1'6"
25	543	52	Known	16	6.2	0'10" to 1'6"
26	491	52	Known	40	99	1'6" to 2'6"
27	439	52	Known	48	99	1'9" to 2'6"
28	387	52	Known	25	99	0'11" to 1'9"

Total volume of Tunnel 2 (empty)³: 42,600 yd³

Total estimated void space in Tunnel 2 *rail cars*: 858.9 yd³ (approximately 2.0% of total Tunnel 2 volume, see Appendix B for assumptions)

Total estimated void space *at the top* of Tunnel 2: 1192.0 yd³ (approximately 2.8% of total Tunnel 2 volume, see Appendix B for assumptions)

Total estimated void space remaining in Tunnel 2 (in rail cars + top of tunnel): 2050.9 yd³ (approximately 4.8% of total Tunnel 2 volume, see Appendix B for assumptions)

³ Empty volume based on total volume of Tunnel 2 from structural drawings, calculated using SolidWorks modeling software.

Range of remaining vertical headspace in Tunnel 2: 0'2" to 7'5" (approximately 0.7-29.0% of total Tunnel 2 height, see Appendix B for assumptions, note that largest headspace was at water door, where no equipment was located)

Average estimated vertical headspace in Tunnel 2: 1'6" (approximately 5.9% of total Tunnel 1 volume, see Appendix B for assumptions)

2.2 Radiological Readings - Risers

2.2.1 Tunnel 1

Due to the urgent conditions surrounding the stabilization of Tunnel 1 following roof section collapse, limited radiological surveys of the tunnel interior were performed. Dose readings were recorded only at riser 1, and at the plenum. Work instructions and survey results were documented in work package SM-17-05067. The highest dose rate recorded in Tunnel 1 during this effort was 75.73 R/hr, which was surveyed 25 feet down from the top of riser 1. Maximum dose rate at the plenum was 0.033 R/hr, 20 feet down from the opening. Radcon surveyed the work areas exterior of the tunnel (which were of greater concern than the interior of the tunnel) and found no dose.

2.2.2 Tunnel 2

In 2018, a campaign took place to measure radiological readings within Tunnel 2. Surveillance was performed through each riser, when they could be accessed and opened. Table 3 summarizes the highest readings taken at each riser.

Notes for Table 3:

- See Appendix B page B-2 for more detail.
- Readings were taken without visual verification of height. Since obstructions were noted by feel, some of the depth recorded may not be correct. See Appendix B page B-2 for notes on likely uncertainties at risers.
- Depth was measured with the top of the riser being the Datum (0') and the floor being maximum depth (~35').
- Risers were numbered from North to South.
- Riser distance was measured using GPS from South face of water door building (WDB). Reference: H-2-837314.

Table 3: Riser Maximum Dose Measurements

Riser #	Riser Distance from WDB (ft)	Maximum Dose Measurement (mrem / hr)	Approx. Depth of Max Measurement (ft)	Notes
1	47.14	N/A	N/A	No readings taken, no access to riser.
2	141.18	0	0	0 @ all elevations.
3	264.66	3	18	No rail cars under riser 3.
4	383.97	30	10	Just north of car 28.
5	478.08	1500	17	Above car 27.
6	578.64	N/A	N/A	Riser not opened due to ALARA concerns. Increase in background was detected by RadCon before opening riser.
7	672.79	2680	9	Above car 23.
8	767.37	650	35*	*Probe likely landed on deck of car 21, obstruction not noticed.
9	864.71	710	28	Above car 19.
10	959.18	120	25*	Probe assumed to have swung into open box on car 17.
11	1056.74	1120	27	Above car 15.
12	1151.12	960	27	Above car 13.
13	1248.60	N/A	N/A	No readings taken, riser would not open.
14	1342.64	1088	26	Between cars 8 and 9.
15	1436.97	17	17	Above car 6.
16	1537.64	1400	13	Above car 4.
17	1631.87	5570	19	Between cars 1 and 2.

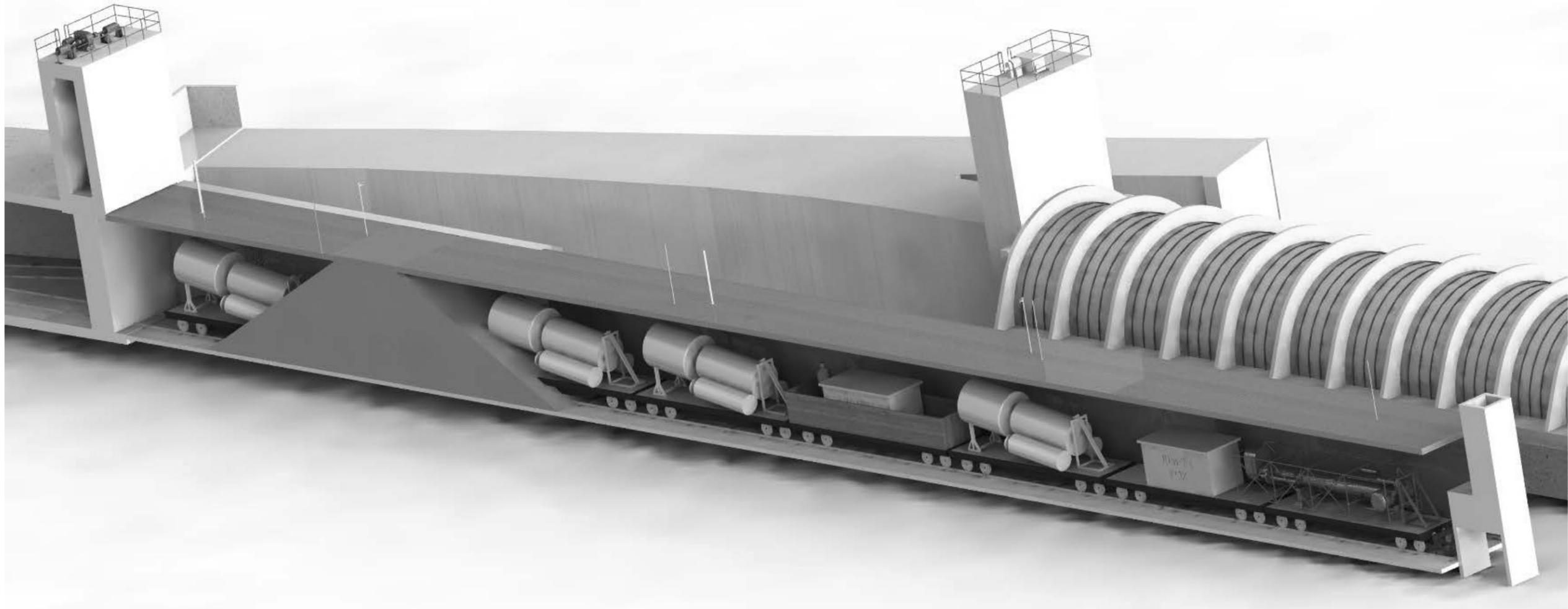
3.0 References

- Documents
 - HNF-SD-EN-WAP-007 Rev 4, *PUREX Storage Tunnels Waste Analysis Plan*
 - HNF-62216 Rev 0, *PUREX Storage Tunnels Inventory Bibliography*
- Structural Drawings:
 - Tunnel 1:
 - *H-2-55586 SHT 001, 218-E-14- DISPOSAL TUNNEL #1 FOR FAILED EQUIPMENT PLOT PLAN*
 - *H-2-55587 SHT 001, 218-E 14 STRUCTURAL FLOOR PLAN & SECTION*
 - *H-2-55588 SHT 001, STRUCTURAL SEFT. + DET*
 - *H-2-55589 SHT 001, STRUCTURAL SECTIONS & DETAILS*
 - *H-2-55590 SHT 001, FAILED EQUIPMENT BURIAL TUNNEL DOOR*
 - *H-2-55591 SHT 001, TUNNEL DOOR HOIST ASSM*
 - *H-2-55592 SHT 001, TUNNEL DOOR HOIST DET*
 - *H-2-55593 SHT 001, ELEC. PUREX TUNNEL EXTENSION POWER + LIGHTING*
 - *H-2-55594 SHT 001, SHIELDING DOOR FILL & DRAIN LINES ARRANGEMENT*
 - *H-2-55595 SHT 001, STRUCTURAL ALTERNATE TUNNEL DESIGN PLAN + SECT. PRECAST CONC*
 - Tunnel 2:
 - *H-2-58191 001, 218-E-15 DISPOSAL TUNNEL #2 FOR FAILED EQUIPMENT PLOT PLAN*
 - *H-2-58192 001, PLOT PLAN + PROFILE ARCH LINER*
 - *H-2-58193 001, ARCHITECTURAL PLANS*
 - *H-2-58194 001, STRUCTURAL SECTIONS + DETAILS*
 - *H-2-58195 001, STRUCT SECT + DETS*
 - *H-2-58196 001, ROOF PLAN STRUCT SECT + DETS*

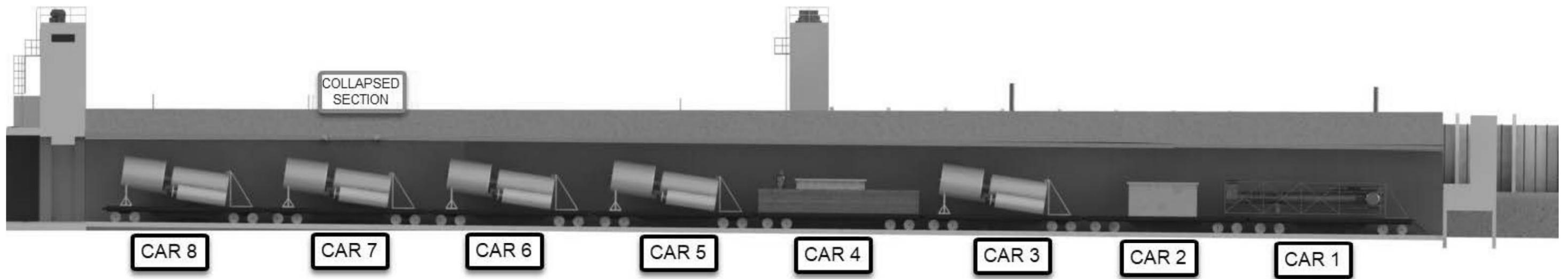
- *H-2-58197 001, SWITCH EXTENSION DETS*
- *H-2-58198 001, STRUCT + MISC DETS*
- *H-2-58199 001, WATER FILLED DOOR C*
- *H-2-58200 001, DOOR C PIPING + DETS*
- *H-2-58206 001, PIPING PLAN + DETS*
- *H-2-58207 001, PLAN + PROFILE - CONDENSATE*
- *H-2-58208 001, ELECTRICAL PLANS & DETAILS*
- *H-2-58208 002, PLAN - NO.2 BURIAL TUNNEL*
- *H-2-58208 003 SECTIONS - NO.2 BURIAL TUNNEL*
- *H-2-58532 001, PUREX TUNNEL REINFORCEMENT PLAN*
- *H-2-58533 001, PUREX TUNNEL REINFORCEMENT SECT + DETS*
- *H-2-58737 001, 218-E-15 DISPOSAL TUNNEL -2 CLEARANCE DIAG FOR TUNNEL SECT*
- *H-2-58738 001, SURVEY CONTROLS AND DATA 200E TUNNEL*
- *H-2-94665 001, RR BURIAL TUNNELS 218-E-14 218-E-15*
- *H-2-94756 001, BURIAL TUNNEL #2 FILTER ASSEMBLY*
- *H-2-94756 002, BURIAL TUNNEL #2 FILTER ASSEMBLY*

Appendix A – Tunnel 1

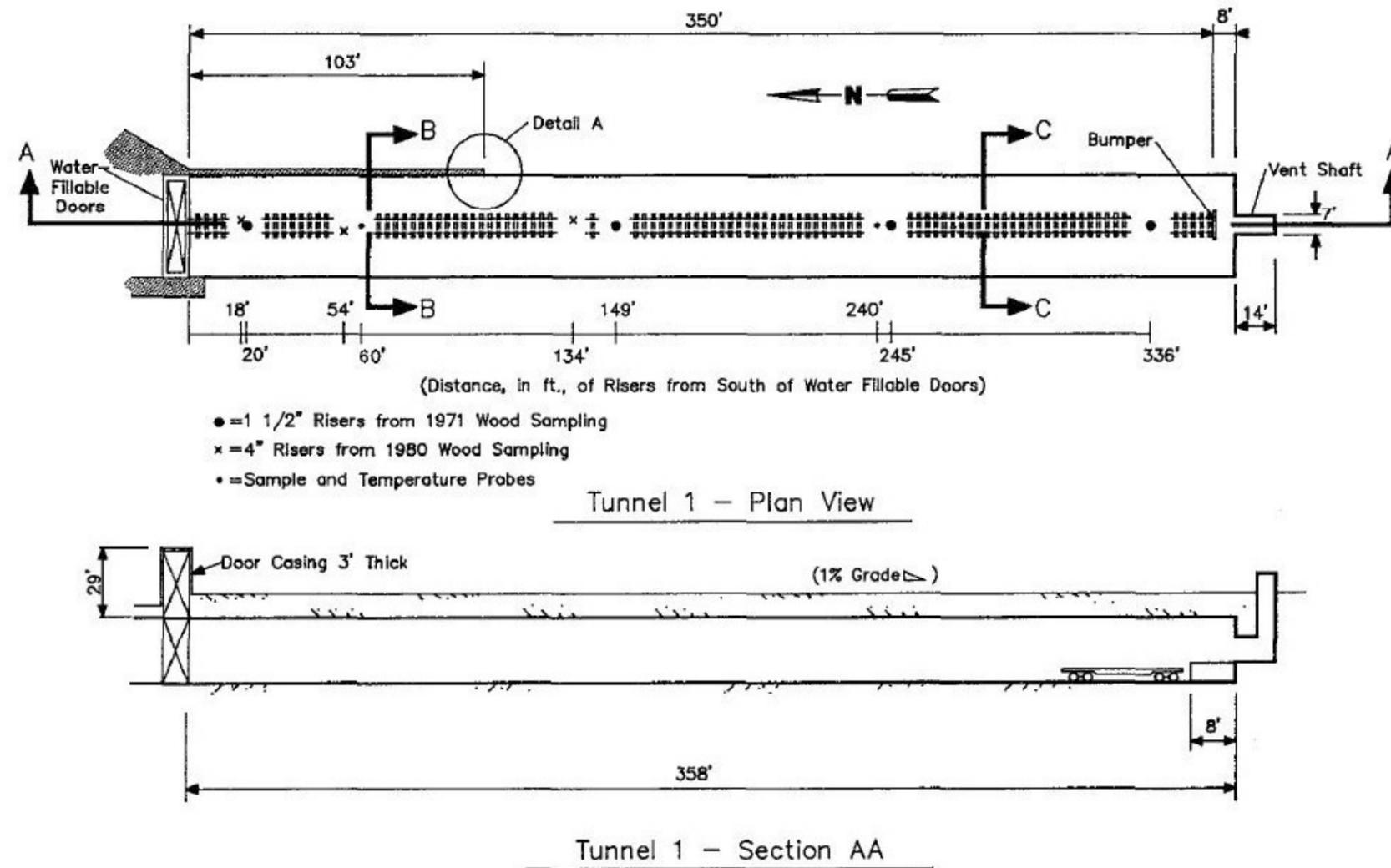
3D Model – Full Tunnel



PUREX Tunnel 1 – Elevation View



PUREX Tunnel 1 – Tunnel Sketch with Riser Configuration



MHC-SD-EN-ES-003, Rev. 0

JMF\010590-A

Figure 2. Sketch of PUREX Storage Tunnel 1 (218-E-14).

Notes on PUREX Tunnel 1 model:

1. Rail cars and equipment may shift slightly during grouting. This model is based on structural and equipment drawings, visual inspection, assumptions, and estimations. The accuracy of the model is not validated. If exact location of equipment is required, verification of location should be performed (e.g. ground scans, core drill, etc.).
2. Riser locations found from WCH-SD-EN-ES-003.
3. Rail car position based on starting 8 ft. from South end, and 42 ft. rail cars (ref. WCH-SD-EN-ES-003).
4. Rail car contents are from HNF-SD-EN-WAP-007 Rev 4, *PUREX Storage Tunnels Waste Analysis Plan*. Data are consistent with the current version of the Waste Analysis Plan (*Hanford Facility RCRA Permit, Dangerous Waste Portion, Rev. 8C Permit Number WA7890008967, Closure Unit Group 25, PUREX Storage Tunnels, Chapter 3, Waste Analysis Plan.*)
5. For images of headspace after grouting, see CHPRC-03519, Rev 1 *PUREX Tunnel 1 Stabilization Acceptance Criteria.*
6. Equipment interior void spaces were estimated using drawings of equipment exterior for overall dimensions, combined with an approximated internal void volume percentage based on equipment function or conditions (i.e. capped vs not, tank vs processing equipment, etc.). Actual drawings of internal design for most equipment were not located.
7. Entire tunnel (and overburden) is sloped downward North to South at 1%.
8. Known rail elevations:
 - a. Tunnel 1 top of rail elevation (at North end of tunnel, note the 1% slope) is **693'0"**, shown on H-2-55587.
 - b. Tunnel 1 top of rail elevation (at South end of tunnel, note the 1% slope) is **689'5"**, shown on H-2-55587.

Tallest Equipment in PUREX Tunnel 1 (for Future Consideration):

Concentrator sitting on dunnage was the tallest item in tunnel 1 (see Figure A-0). From H-2-75896, the concentrator on dunnage was 13'6" tall. The flat cars were documented as 4'0" tall. The tallest buried item is 17'6" tall.

Take the 22'0" tunnel, add the roof thickness (1'2"), and the 8'0" overburden, and the total height from top of rail to overburden is 31'2". See H-2-55589 for structural details.

Subtract the tallest car height (17'6") from the 31'2" total height, gives a buried depth of **13'8"**.

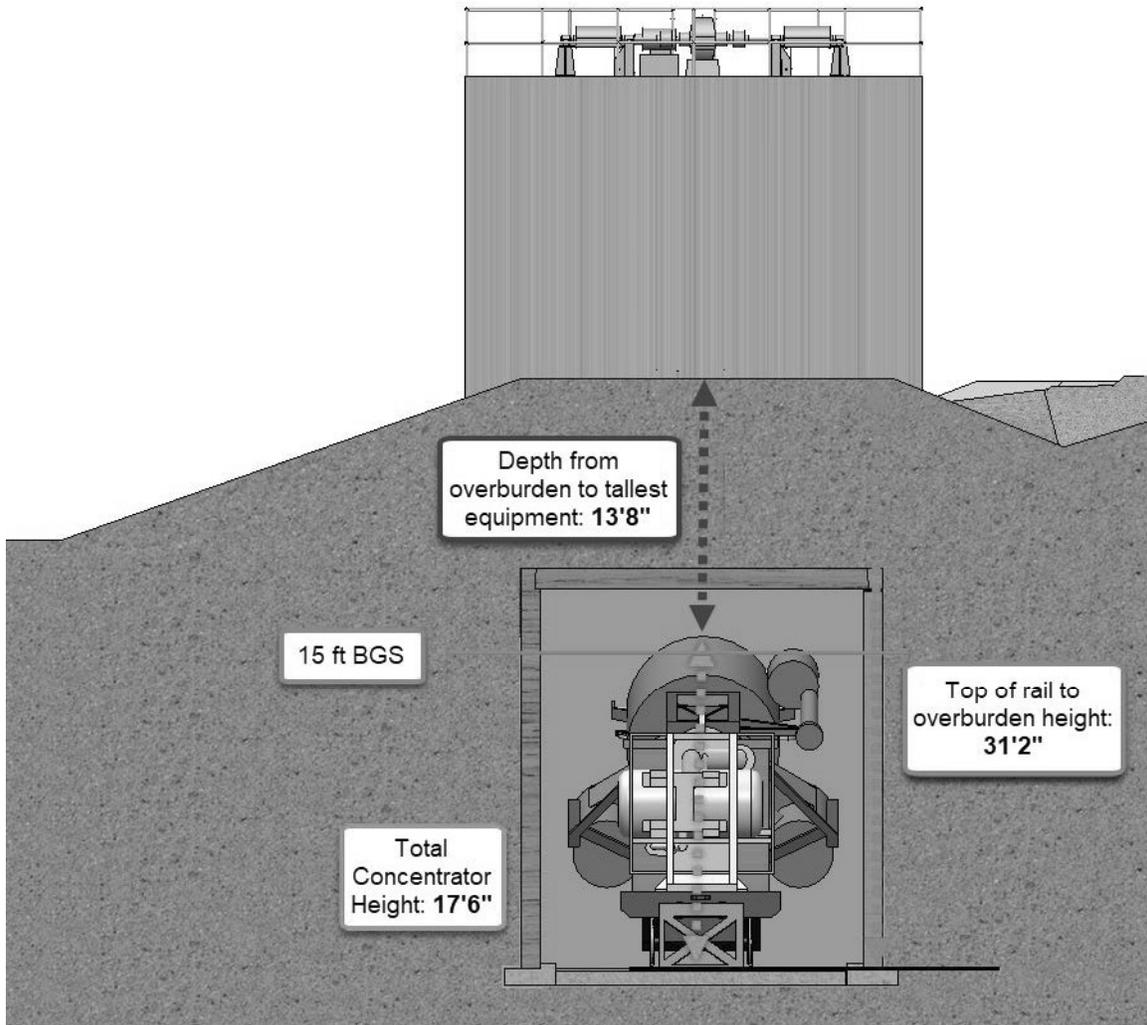


Figure A-0: Largest Equipment Measurements with Respect to Tunnel Height

Car 8 (Northernmost Car)

North end of Car 8 is estimated to be located within 6 feet of the water door building. Actual position could not be determined through video inspection. Approximately 12" of void space above Car 8 remains. If the concentrator on this car was sealed, and we assume a 30% empty volume, there is approximately 16.6 yd³ of void space within the vessel.

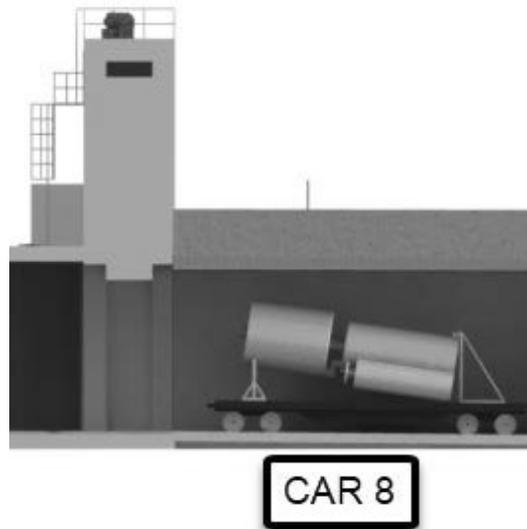


Figure A-1: Tunnel 1 Car 8.

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8. FLAT CAR 3621 PLACED IN TUNNEL ON 1/22/65;
E-F6 (#3 SPARE) (2WW WASTE) CONCENTRATOR;
2,400 CU. FT.; 700 CURIES; 5 rem/hr. @ 20'
-

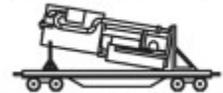


Figure A-2: Contents of Tunnel 1 Car 8.



Figure A-3: View of Tunnel 1 Car 8.

Car 7

North end of Car 7 is estimated to be located approximately 48 feet from the water door building. Actual position could not be determined through video inspection, as Car 7 was under the sand-filled collapse area. Approximately 12" of void space above Car 7 remains. If the concentrator on this car was sealed, and we assume a 30% empty volume, there is approximately 16.6 yd³ of void space within the vessel.

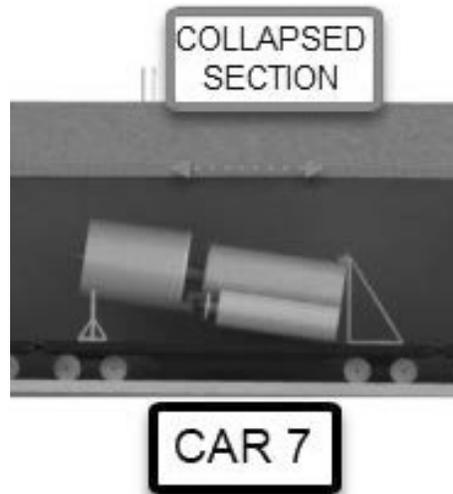


Figure A-4: Tunnel 1 Car 7.

-
7. CAR PLACED IN TUNNEL ON 2/8/62;
E-F11 (#2) (1WW WASTE) CONCENTRATOR;
2,336 CU. FT.; 40,000 CURIES; 25 rem/hr. @ 150'

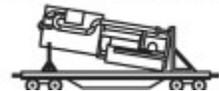


Figure A-5: Contents of Tunnel 1 Car 7.



Figure A-6: North End of Car 7.

Car 6

North end of Car 6 is estimated to be located approximately 90 feet from the water door building. Actual position could not be determined through video inspection. Approximately 12" of void space above Car 6 remains. If the concentrator on this car was sealed, and we assume a 30% empty volume, there is approximately 16.6 yd³ of void space within the vessel.

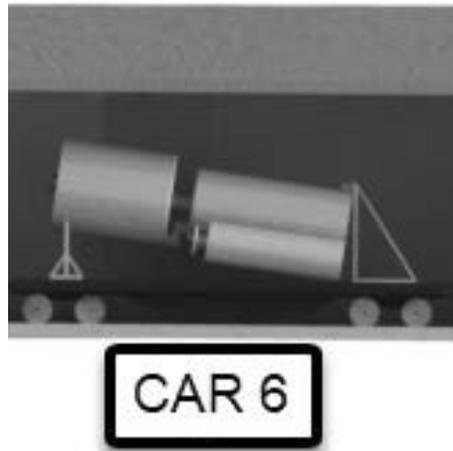


Figure A-7: Tunnel 1 Car 6.

- 6. CAR PLACED IN TUNNEL ON 4/21/61;
E-F6 (2WW WASTE) CONCENTRATOR;
2.336 CU. FT.: 700 CURIES: 5 rem/hr. @ 20'



Figure A-8: Contents of Tunnel 1 Car 6.



Figure A-9: Tunnel 1 Car 6.

Car 5

North end of Car 5 is estimated to be located approximately 132 feet from the water door building. Actual position could not be determined through video inspection. Approximately 12" of void space above Car 5 remains. If the concentrator on this car was sealed, and we assume a 30% empty volume, there is approximately 16.6 yd³ of void space within the vessel.

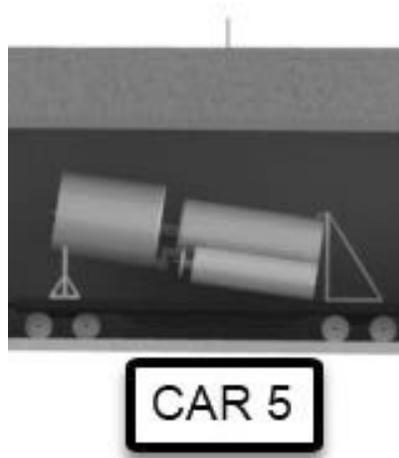


Figure A-10: Tunnel 1 Car 5.

-
5. CAR PLACED IN TUNNEL ON 1/4/61;
 E-H4 (3WB) CONCENTRATOR;
 2,336 CU. FT.; 1,000 CURIES; 0.15 rem/hr. @ 50'

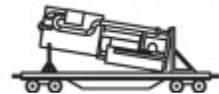


Figure A-11: Contents of Tunnel 1 Car 5.



Figure A-12: Tunnel 1 Car 5.

Car 4

North end of Car 4 is estimated to be located approximately 174 feet from the water door building. Actual position could not be determined through video inspection. Approximately 12" of void space above Car 4 remains. Assuming a 90% empty volume for the tube bundles, and 0% empty volume for remaining items, there is approximately 9.0 yd³ of void space within the car. Note that during grouting, some debris did float, and was eventually covered over with grout.

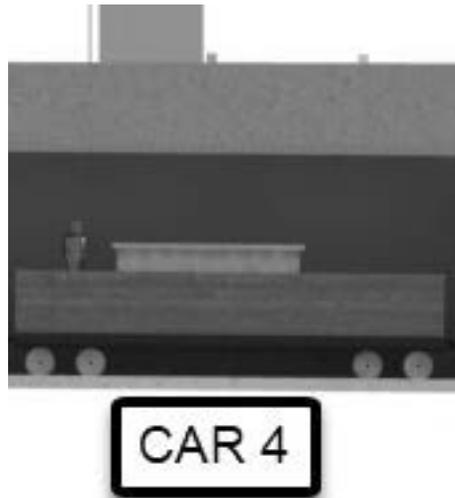


Figure A-13: Tunnel 1 Car 4.

-
4. CAR PLACED IN TUNNEL ON 12/24/60;
G-E2 CENTRUFUGE, 2 TUBE BUNDLES, MISC. JUMPERS;
2,465 CU. FT.; 3,000 CURIES; ~115 kg Pb; 1.5 rem/hr. @ 150'
-

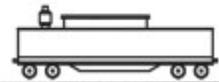


Figure A-14: Contents of Tunnel 1 Car 4.



Figure A-15: Tunnel 1 Car 4.

Car 3

North end of Car 3 is estimated to be located approximately 216 feet from the water door building. Actual position could not be determined through video inspection. Approximately 12" of void space above Car 3 remains. If the concentrator on this car was sealed, and we assume a 30% empty volume, there is approximately 16.6 yd³ of void space within the vessel. No known photos of car 3 are available due to riser being obstructed.

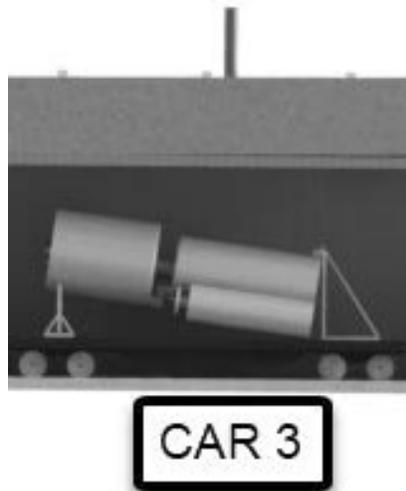


Figure A-16: Tunnel 1 Car 3.

-
3. CAR PLACED IN TUNNEL ON 7/29/60;
E-F11 (#1) (1WW WASTE) CONCENTRATOR;
1,900 CU. FT.; 40,000 CURIES; 12.5 rem/hr. @ 100'
-



Figure A-17: Contents of Tunnel 1 Car 3.

Cars 2 and 1

North end of Car 2 is estimated to be located approximately 258 feet from the water door building. Actual position could not be determined through video inspection. Approximately 12" of void space above Car 2 remains. If the box on this car was sealed (worst case), and we assume a 20% empty volume, there is approximately 7.5 yd³ of void space within the box. There is no known image of car 2 due to riser being blocked.

North end of Car 1 is thought to be located approximately 300 feet from the water door building, however, car 1 HA column was noted to be placed in the tunnel overhanging 7 feet to the North. Assume a cut position to be through part of the rail car bed on car 2, approximately 290 feet from the water door building. Actual position could not be determined through video inspection. Approximately 12" of void space above Car 1 remains. If the HA Column on this car was sealed (worst case), and we assume a 60% empty volume, there is approximately 11.6 yd³ of void space within the equipment.

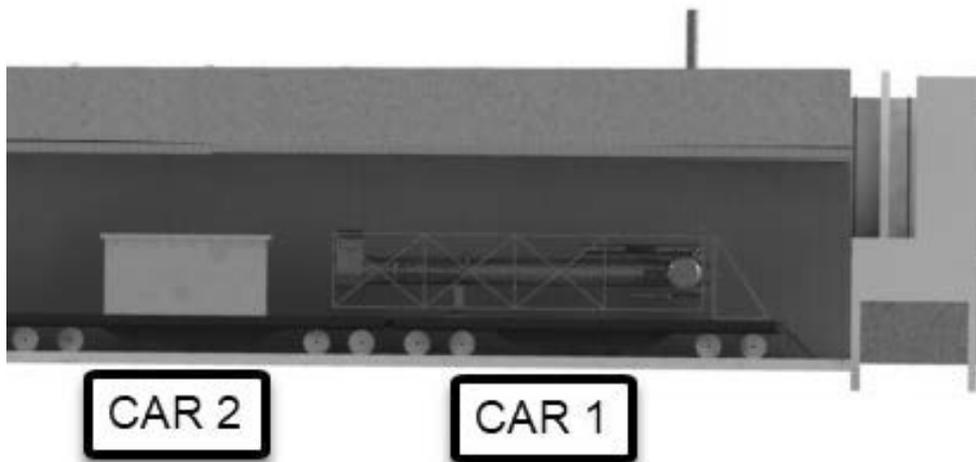


Figure A-18: Tunnel 1 Cars 2 and 1.

Position

1. & 2. CAR PLACED IN TUNNEL ON 6/60;
 HA COLUMN AND MISC. JUMPERS IN BOX (H-2-58372);
 HA COLUMN: 4,700 CU. FT.; 400 CURIES; JUMPERS: 2,190 CU. FT.;
 2,000 CURIES; ~115 kg Pb; 5 rem/hr. @ 60'



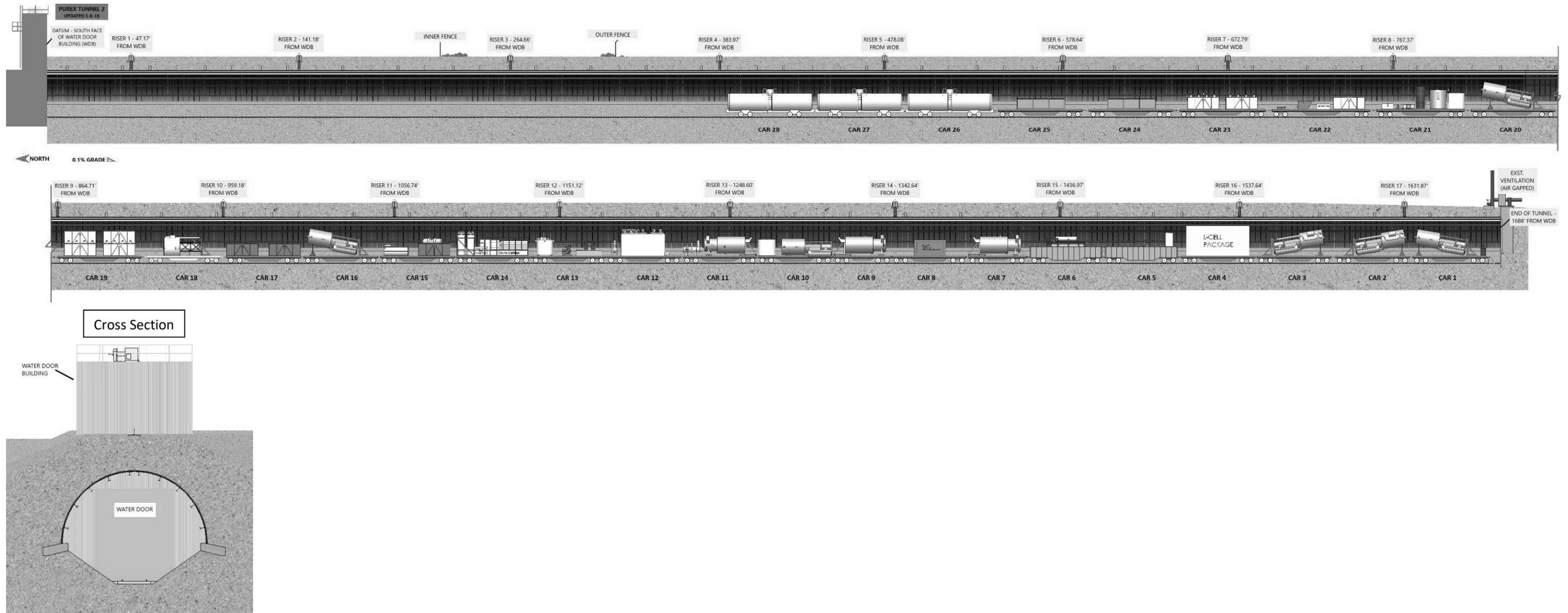
Figure A-19: Contents of Tunnel 1 Cars 2 and 1.



Figure A-20: Tunnel 1 Car 1 View from South Plenum.

Appendix B – Tunnel 2

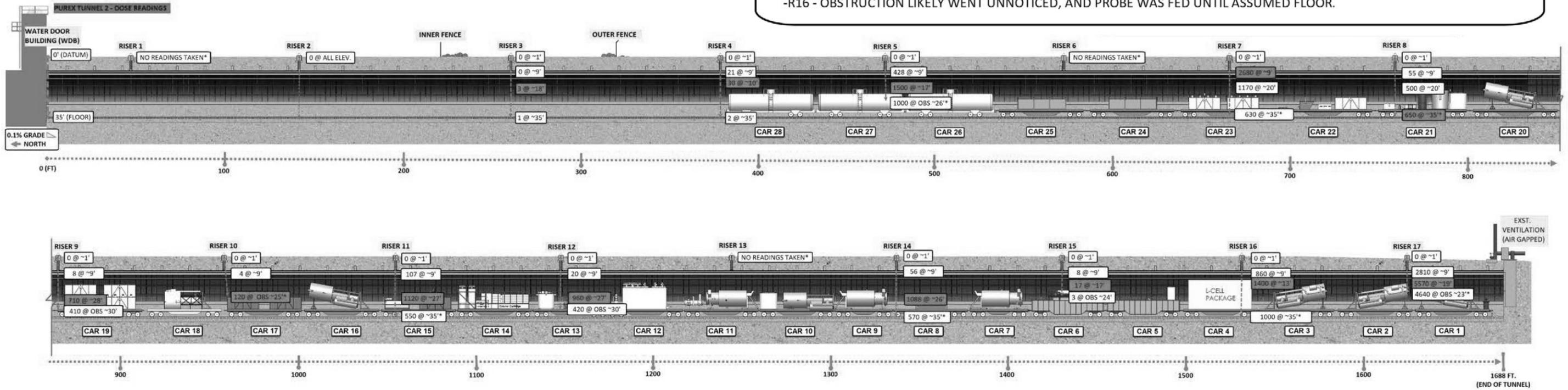
3D Model – Full Tunnel



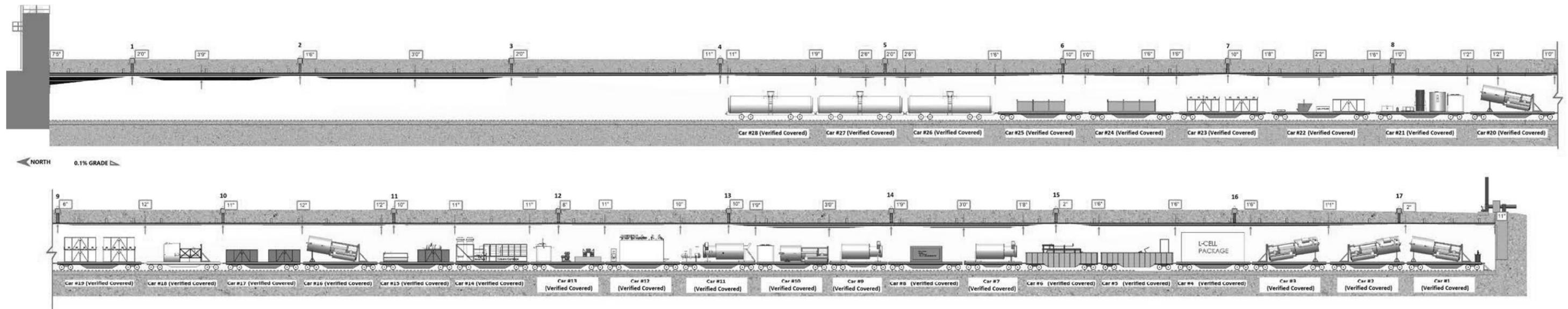
PUREX Tunnel 2 – Pre-Grout Dose Readings

***NOTES:**

- VIEW WAS NOT AVAILABLE DURING MEASUREMENT, SO OBSTRUCTIONS WERE BASED ON OPERATOR FEEL.
- ALL READINGS ARE IN MILLIREM PER HOUR (mr/hr), ALL HEIGHTS ARE APPROXIMATE LEVEL FROM TOP OF RISER.
- GREEN HIGHLIGHTED READING INDICATES HIGHEST READING AT THAT RISER.
- R1 - RISER NOT OPENED DUE TO LIMITED ACCESS
- R5 - OBSTRUCTION LIKELY WENT UNNOTICED AT FIRST, AND PROBE WAS FED UNTIL RESISTANCE WAS RECOGNIZED.
- R6 - RISER NOT OPENED DUE TO ALARA CONCERNS. INCREASE IN BACKGROUND DETECTED BY RADCON.
- R7 - OBSTRUCTION LIKELY WENT UNNOTICED, AND PROBE WAS FED UNTIL ASSUMED FLOOR.
- R8 - OBSTRUCTION LIKELY WENT UNNOTICED, AND PROBE WAS FED UNTIL ASSUMED FLOOR.
- R10 - PROBE LIKELY SWUNG INTO BOX TO PRODUCE OBSTRUCTION.
- R11 - PROBE LIKELY GLANCED OFF OF CYLINDRICAL EQUIPMENT ON CAR, AND FED TO THE FLOOR.
- R13 - RISER PORT PLUG STUCK CLOSED, MEASUREMENT NOT TAKEN.
- R14 - OBSTRUCTION LIKELY WENT UNNOTICED, AND PROBE WAS FED UNTIL ASSUMED FLOOR, OR PROBE SWUNG BETWEEN TO COUPLERS AND FED TO FLOOR.
- R16 - OBSTRUCTION LIKELY WENT UNNOTICED, AND PROBE WAS FED UNTIL ASSUMED FLOOR.



PUREX Tunnel 2 – Post-Grout Approximated Profile



Notes on PUREX Tunnel 2 model:

1. Rail cars and equipment may shift slightly during grouting. This model is based on structural and buried equipment drawings, visual inspection, assumptions, and estimations. The accuracy of the model is not validated. If exact location of equipment is required, verification of location should be performed (e.g. ground scans, core drill, etc.).
2. Riser locations are measured with respect to the south face of the water door building (WDB).
3. Riser locations found from GPS survey. Reference H-2-837317.
4. First concrete arch is located 11' 7-1/8" on center from the WDB. Each concrete arch thereafter is spaced at 15' 8-3/4" on center (ref. H-2-58532).
5. There are a total of 107 concrete arches positioned down the length of the tunnel.
6. Rail car positions approximated using riser investigation videos.
7. Entire tunnel (and overburden) is sloped downward North to South at 0.1%.
8. Rail car contents are from HNF-SD-EN-WAP-007 Rev 4, *PUREX Storage Tunnels Waste Analysis Plan*. Data is consistent with the current version of the Waste Analysis Plan (*Hanford Facility RCRA Permit, Dangerous Waste Portion, Rev. 8C Permit Number WA7890008967, Closure Unit Group 25, PUREX Storage Tunnels, Chapter 3, Waste Analysis Plan.*)
9. Rail car lengths modeled using known and assumed lengths.
 - a. Known lengths are referenced for each car, as applicable.
 - i. Length of Car #28 is noted as 52' in the "Storage Tunnel Checklist" associated with work plan WP-P-96-16.
 - ii. Length of Car #27 is noted as 52' in the "Storage Tunnel Checklist" associated with work plan WP-P-96-16.
 - iii. Length of Car #26 is noted as 52' in the "Storage Tunnel Checklist" associated with work plan WP-P-96-16.
 - iv. Length of Car #25 is noted as 52' in the "Storage Tunnel Checklist" associated with work plan WP-P-96-15.
 - v. Length of Car #24 is noted as 52' in the "Storage Tunnel Checklist" associated with work plan WP-P-96-60.
 - vi. Length of Car #23 is noted as 53' in the "Storage Tunnel Checklist" for position 23. Work plan has not been located.
 - vii. Length of Car #22 is noted as 56' in the "Storage Tunnel Checklist". Work plan has not been located.
 - viii. Length of Car #21 is noted as 54' in the "Storage Tunnel Checklist" associated with work plan WP-P-95-008.
 - ix. Length of Car #20 is noted as 52' in the "Storage Tunnel Checklist" associated with work plan WP-P-94-040.
 - x. Length of Car #19 is noted as 52' in the "Storage Tunnel Checklist" associated with work plan WP-P-94-027.
 - xi. Length of Car #18 is noted as 42' in the "Storage Tunnel Checklist". Work plan has not been located.
 - b. Assumed lengths based on HNF-SD-EN-WAP-007 (Cars #1 - #17).

10. Equipment interior void spaces were estimated using drawings of equipment exterior for overall dimensions, combined with an approximated internal void volume percentage based on equipment function or conditions (i.e. capped vs not, tank vs processing equipment, etc.). Actual drawings of internal design for most equipment were not located.
11. Grouting profile estimated by visual inspection post-grouting. In most cases, view was limited.
12. Known rail elevations:
 - a. Tunnel 2 top of rail elevation (at North end of tunnel, note the 0.1% slope) is **693'0"**, shown on **H-2-58194**.
 - b. Tunnel 2 top of rail elevation (at South end of tunnel, note the 0.1% slope) is **691'10"**, not shown on drawing, calculated from plenum vent stack elevation to top of rails measurement, **H-2-58194**.

Tallest Equipment in PUREX Tunnel 2 (for Future Consideration):

The tallest item in the tunnel was the L-cell package on car 4.

From H-2-58195, we know the bottom of riser to grade is 8'1.5" (that's 8'6" total, but grade is 4.5" below total)

From H-2-58737, the distance from the top of the rails to the bottom of the riser is 25'3".

From H-2-66092, the L cell package from top of equipment to rail measurement was 18'8".

$25'3" + 8'1.5" = 33'4.5"$ total height from top of rail to overburden.

$33'4.5" - 18'8" = 14'8.5"$ from top of 8' overburden to top of the tallest buried car.

Therefore, there is equipment less than 15' under the overburden.

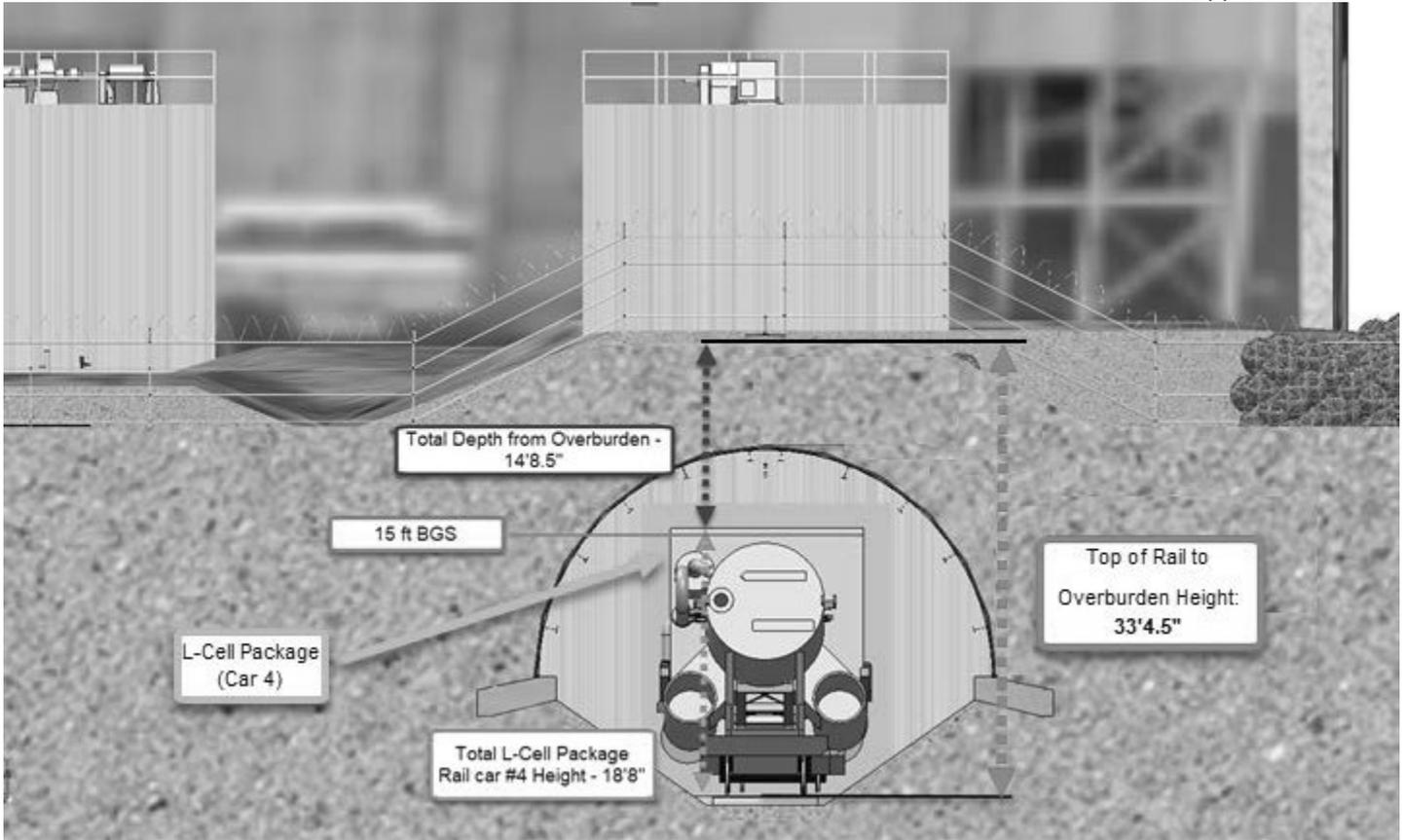


Figure B-0: Largest Equipment Measurements with Respect to Tunnel Height

Water Door to Riser 1

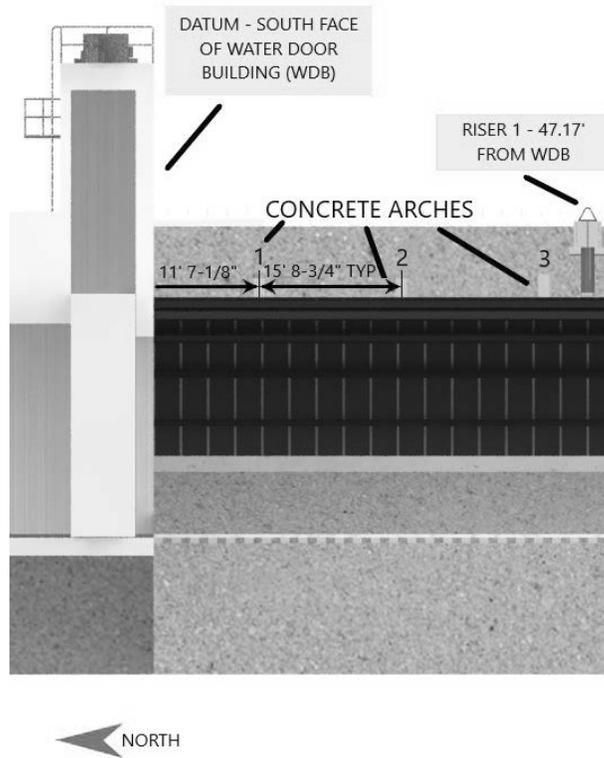


Figure B-1: Water Door Building to Riser 1 Tunnel Section.

The south face of the water door building (WDB) is the datum to which all risers and railcars are measured. Concrete arch spacing is typical at 15' 8-3/4" on center after the first arch. Arch numbers are counted from the north in this document, because the black numbers found marked inside the tunnel during video investigation were marking the center of each arch, counting from the north. Riser 1 is located 47.17' from the south face of the water door building. This was determined using GPS.

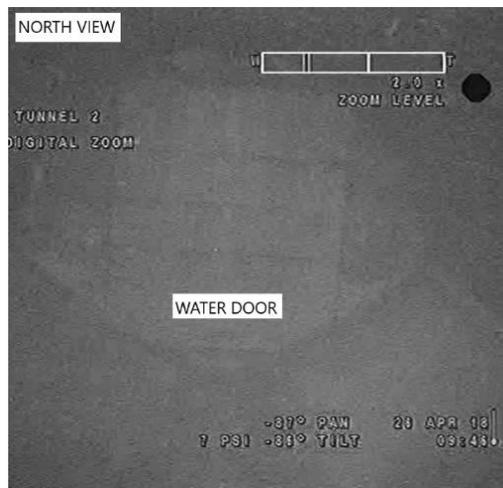


Figure B-2: View of Water Door from Riser 2.

After grouting, approximately 130 yd³ of void space was left at the top of the tunnel between the WDB and Riser 1.

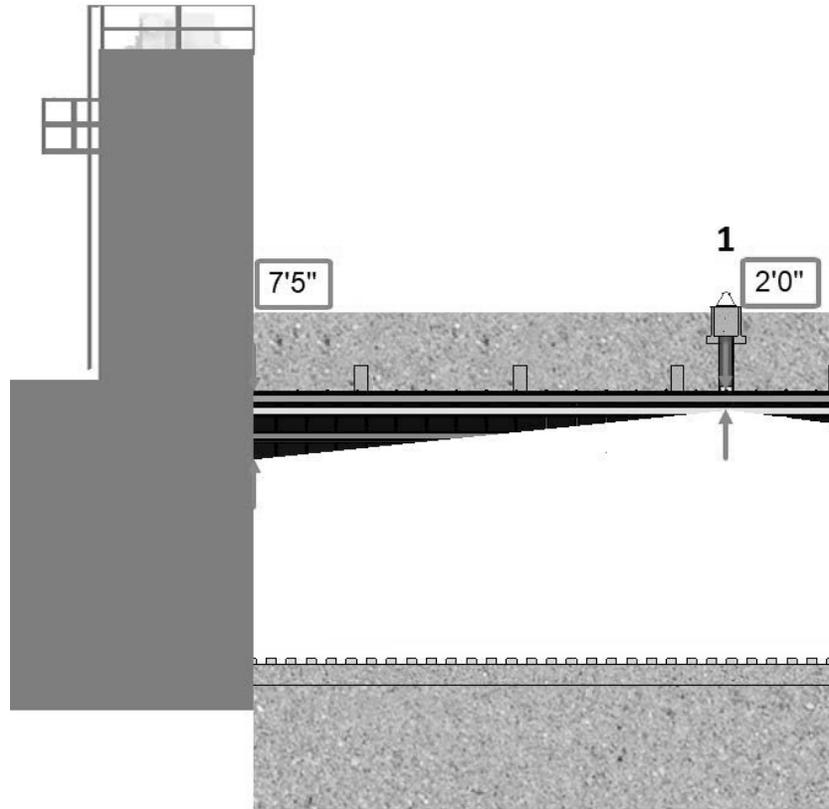


Figure B-3: Approximated Final Grout Profile from the WDB to Riser 1.

Riser 1 to Riser 2

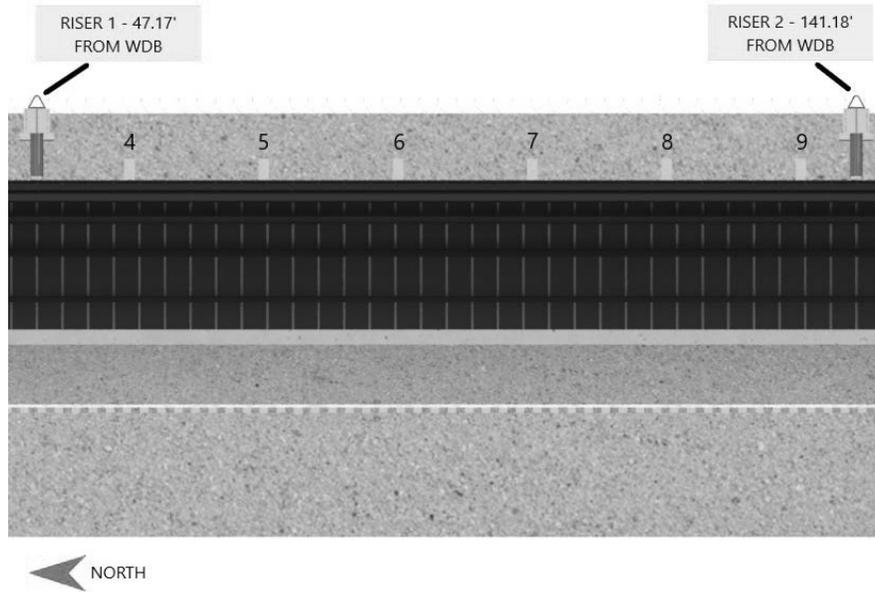


Figure B-4: Riser 1 to Riser 2 Tunnel Section.

No rail cars are located between risers 1 and 2. Riser 2 is located 141.18' from the south face of the WDB. Riser 2 is 94.01' south of riser 1.



Figure B-5: Investigation Video through Riser 2, Looking North, Showing no Cars.

After grouting, approximately 155 yd³ of void space was left at the top of the tunnel between Riser 1 and Riser 2.

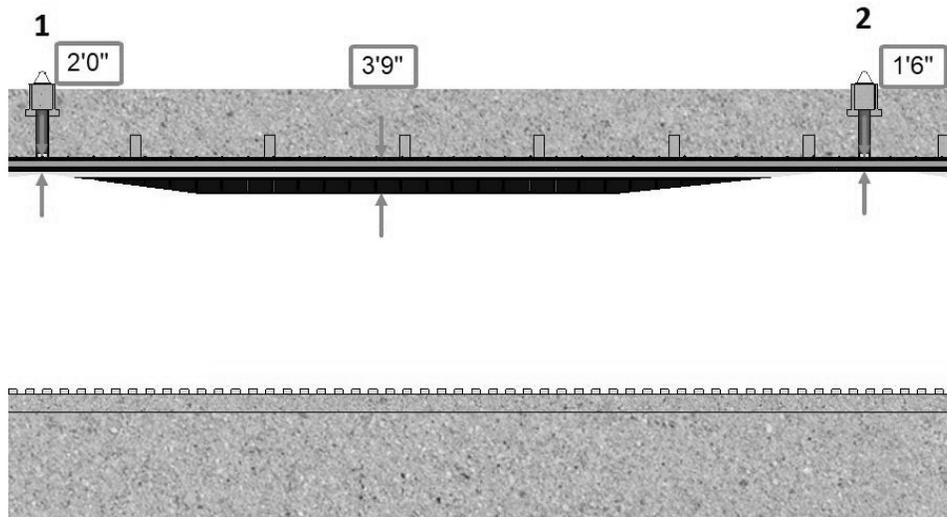


Figure B-6: Approximate Final Grout Profile from Riser 1 to Riser 2.

Riser 2 to Riser 3

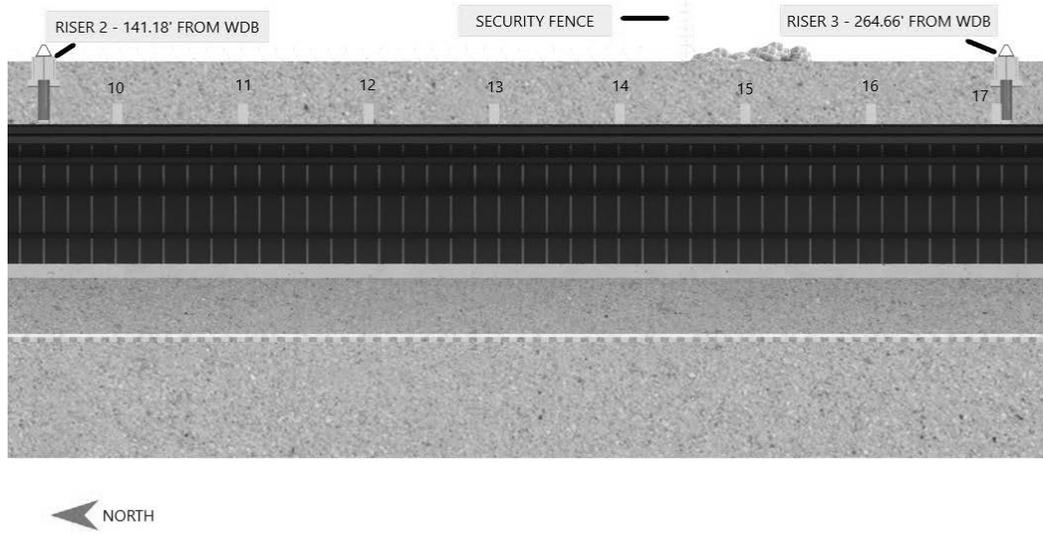


Figure B-7: Riser 2 to Riser 3 Tunnel Section.

No rail cars are located between risers 2 and 3. Riser 3 is located 264.66' from the south face of the WDB. Riser 3 is 123.48' south of riser 2.

The internal security fence is located approximately 40' north of riser 3.



Figure B-8: Investigation Video through Riser 3, Looking North, Showing no Cars.

After grouting, approximately 166 yd³ of void space was left at the top of the tunnel between Riser 2 and Riser 3.

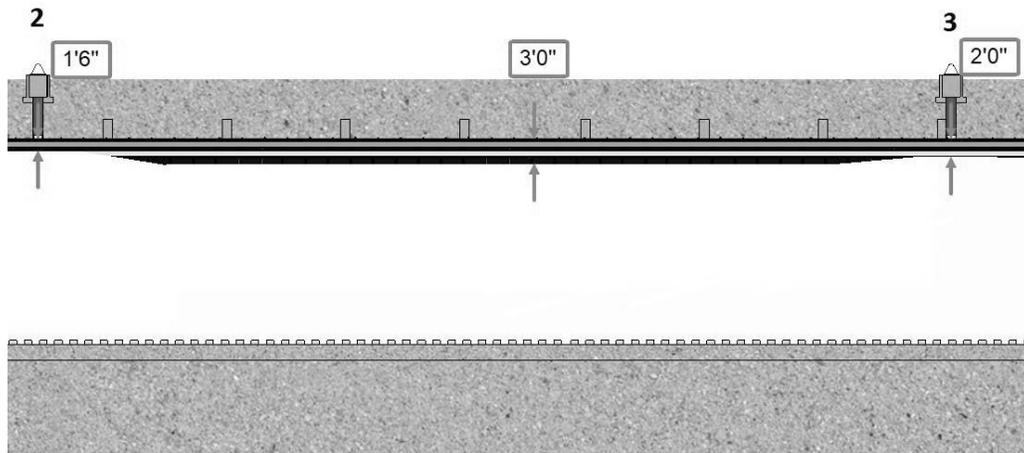


Figure B-9: Approximate Final Grout Profile from Riser 2 to Riser 3.

Riser 3 to Riser 4

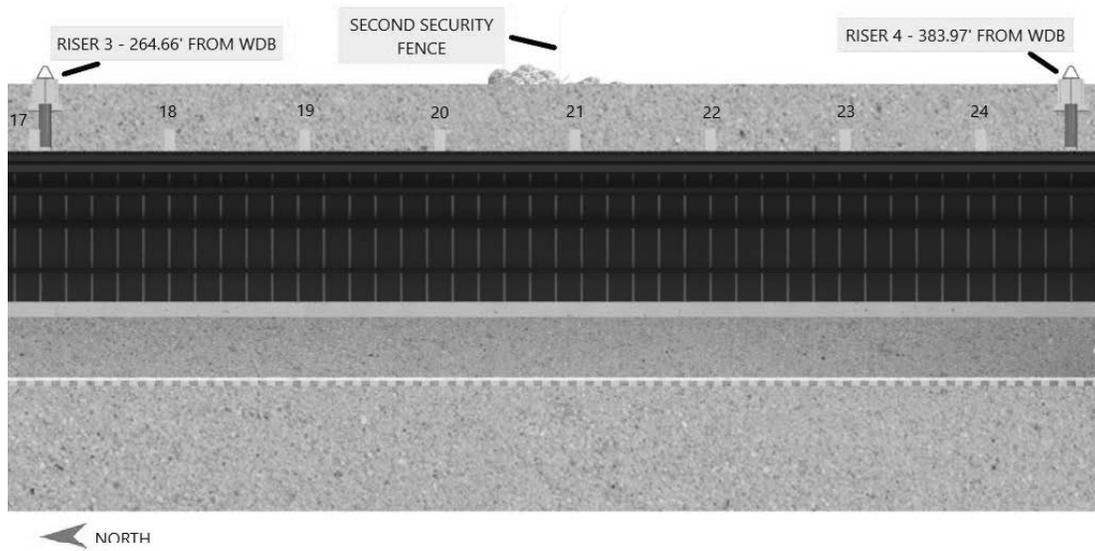


Figure B-10: Riser 3 to Riser 4 Tunnel Section.

No rail cars are located between risers 3 and 4. Riser 4 is located 383.97' from the south face of the WDB. Riser 4 is 119.31' south of riser 3.

The external security fence is located approximately 60' south of riser 3.



Figure B-11: Investigation Video through Riser 3, Looking South. Zoomed-in to View Car 28, which is approximately 3' South of Riser 4.

After grouting, approximately 62 yd³ of void space was left at the top of the tunnel between Riser 3 and Riser 4.

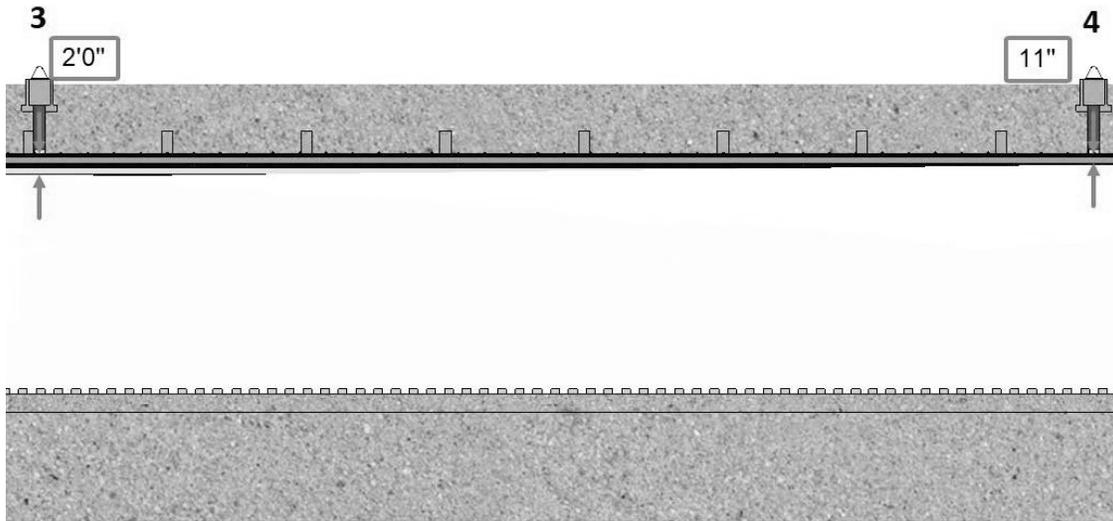


Figure B-12: Approximate Final Grout Profile from Riser 3 to Riser 4.

Riser 4 to Riser 5

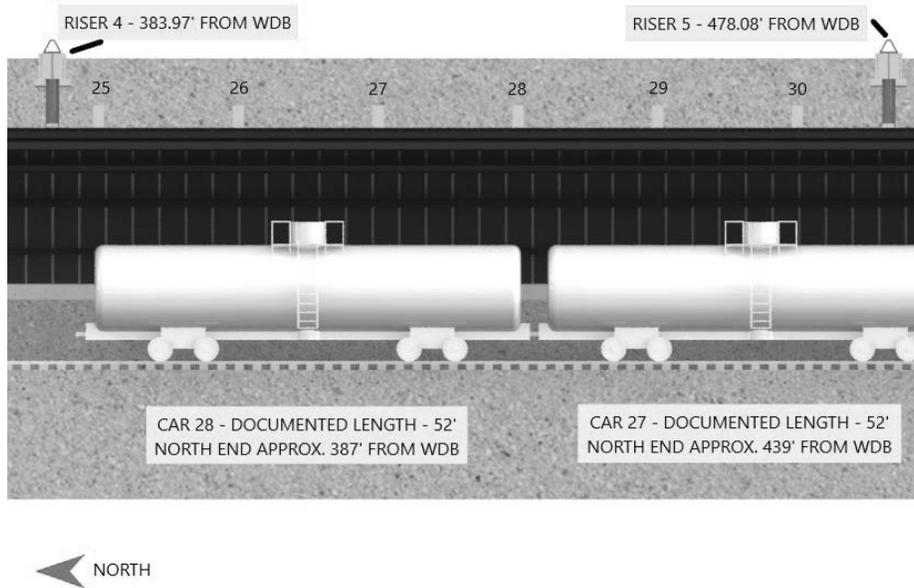


Figure B-13: Riser 4 to Riser 5 Tunnel Section.

Two rail cars are located between riser 4 and riser 5. Riser 5 is located 478.08' from the south face of the WDB. Riser 5 is 94.11' south of riser 4.

Car #28 contents are documented in HNF-SD-EN-WAP-007 Rev 4. Length of the car is noted as 52' in the "Storage Tunnel Checklist" associated with work plan WP-P-96-16.

Car #27 contents are documented in HNF-SD-EN-WAP-007 Rev 4. Length of the car is noted as 52' in the "Storage Tunnel Checklist" associated with work plan WP-P-96-16.

<p>27.</p>	<p>CAR HO-10H-18579 PLACED IN TUNNEL ON 6/19/96; 20,000-GALLON LIQUID WASTE TANK CAR (LWTC); EMPTY PER RCRA; ESTIMATED 30 TONS; 9 CURIES; ~131 g Pu; 0.3 rem/hr. @ 3'</p>	
<p>28.</p>	<p>CAR HO-10H-18580 PLACED IN TUNNEL ON 6/19/96; 20,000-GALLON LIQUID WASTE TANK CAR (LWTC); EMPTY PER RCRA; ESTIMATED 30 TONS; 5 CURIES; ~53 g Pu; 0.1 rem/hr. @ 3'</p>	

Figure B-14: Details for Cars 27 and 28 from HNF-SD-EN-WAP-007.



Figure B-15: Investigation View from Riser 4, Looking South at Car 28.



Figure B-16: Investigation View from Riser 4, Looking South at Cars 28, 27, and 26.

After grouting, approximately 25 yd³ of void space was left at the top of the tunnel above Car 28. Approximately 99 yd³ of void space is left inside the rail car (based on 20,000 gal storage capacity).

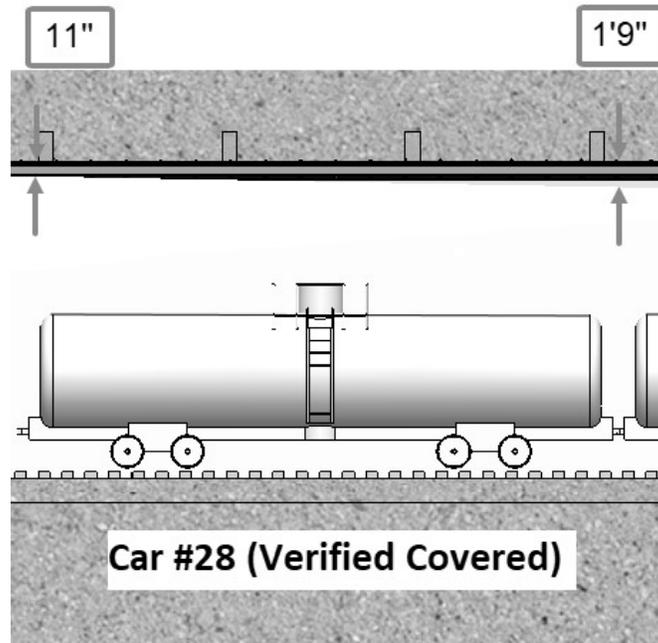


Figure B-17: Approximate Final Grout Profile above Car 28.

After grouting, approximately 48 yd³ of void space was left at the top of the tunnel above Car 27. Approximately 99 yd³ of void space is left inside the rail car (based on 20,000 gal storage capacity).

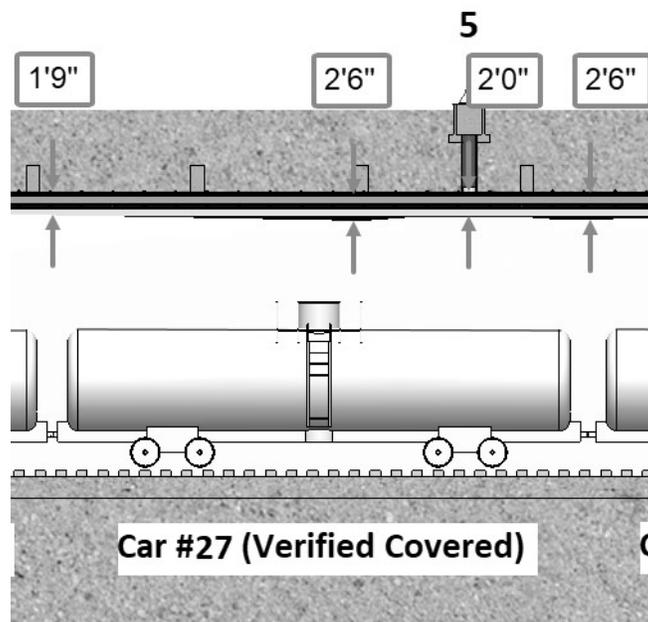


Figure B-18: Approximate Final Grout Profile above Car 27.

Riser 5 to Riser 6

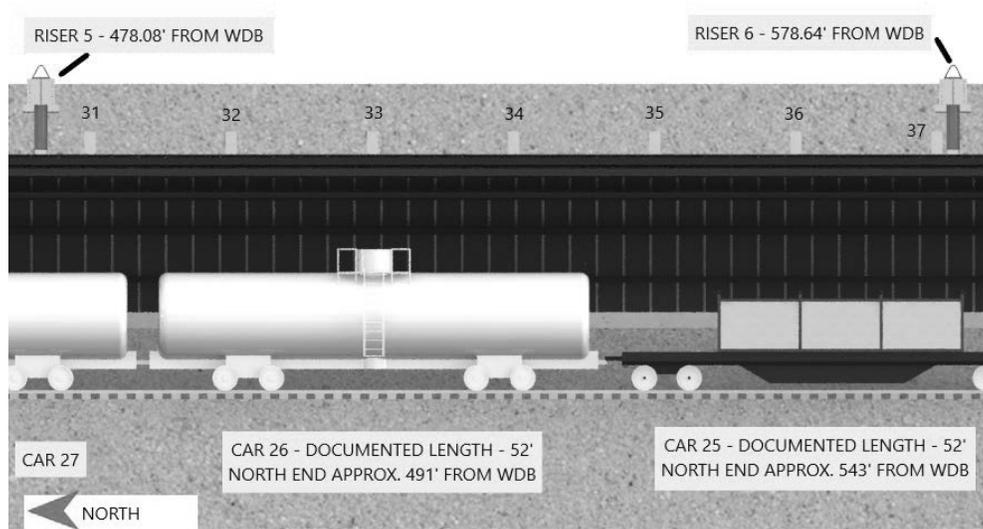


Figure B-19: Riser 5 to Riser 6 Tunnel Section.

Two rail cars are located between riser 5 and riser 6. Riser 6 is located 578.64' from the south face of the WDB. Riser 6 is 100.56' south of riser 5. Riser 6 had rad readings at the surface, and therefore was not investigated with a camera.

Car #26 contents are documented in HNF-SD-EN-WAP-007 Rev 4. Length of the car is noted as 52' in the "Storage Tunnel Checklist" associated with work plan WP-P-96-16.

Car #25 contents are documented in HNF-SD-EN-WAP-007 Rev 4. Length of the car is noted as 52' in the "Storage Tunnel Checklist" associated with work plan WP-P-96-15.

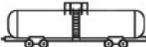
25.	CAR 10A-3619 PLACED IN TUNNEL ON 6/12/96; CONCRETE BURIAL BOX (H-1-44980) STORING 9 CONTAINERS OF 324 AND 325 BUILDING HOT CELL WASTE; ESTIMATED 46.5 TONS; 1,890 CU. FT.; <1,750,000 CURIES; <1 g Pb; < 1 g Cd; ~2 g Cr; ~4 g Ba; ~43 g Pu; ~0.2 rem/hr. @ 150' (FOR DETAILS SEE PUREX WORK PLAN WP-P-96-015)	
26.	CAR HO-10H-18582 PLACED IN TUNNEL ON 6/19/96; 20,000-GALLON LIQUID WASTE TANK CAR (LWTC); EMPTY PER RCRA; ESTIMATED 30 TONS; 23 CURIES; ~11 g Pu; 0.65 rem/hr. @ 3'	

Figure B-20: Details for Cars 25 and 26 from HNF-SD-EN-WAP-007.



Figure B-21: Investigation View from Riser 5, Looking South at Cars 26, 25, and 24.

After grouting, approximately 40 yd³ of void space was left at the top of the tunnel above Car 26. Approximately 99 yd³ of void space is left inside the rail car (based on 20,000 gal storage capacity).

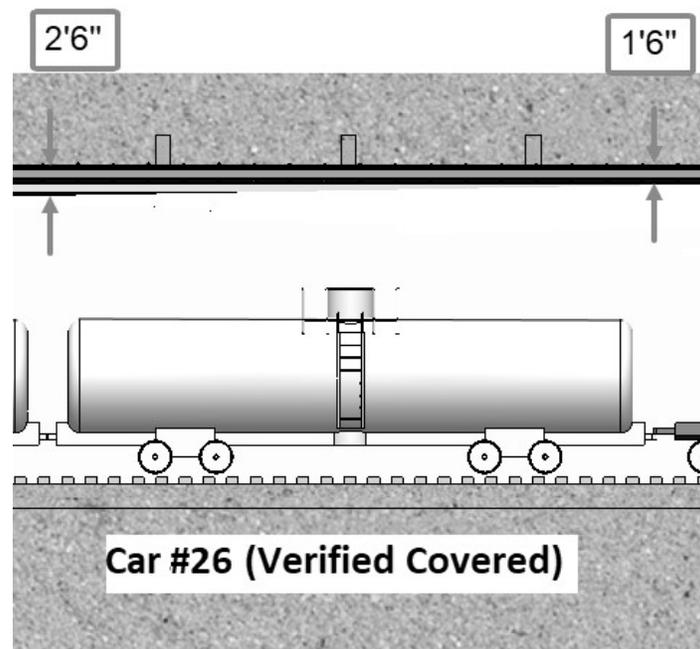


Figure B-22: Approximate Final Grout Profile above Car 26.

After grouting, approximately 16 yd³ of void space was left at the top of the tunnel above Car 25.
Approximately 6.2 yd³ of void space is left inside the rail car (based on 10% empty box volume).

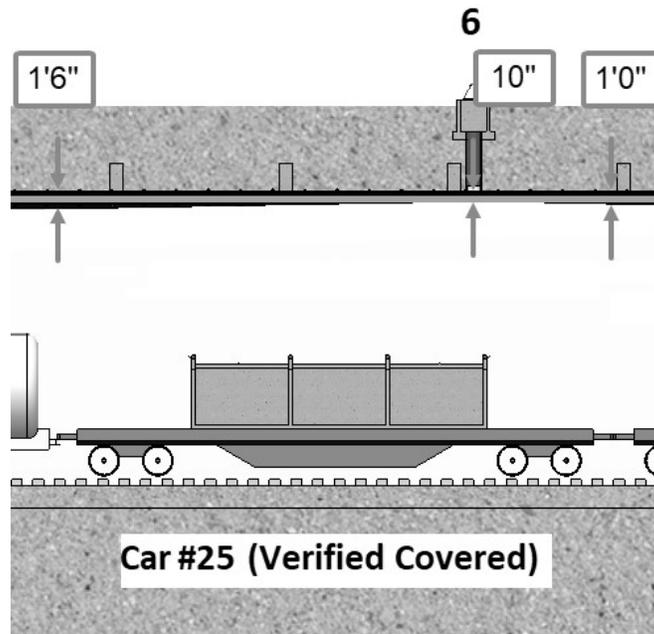


Figure B-23: Approximate Final Grout Profile above Car 25.

Riser 6 to Riser 7

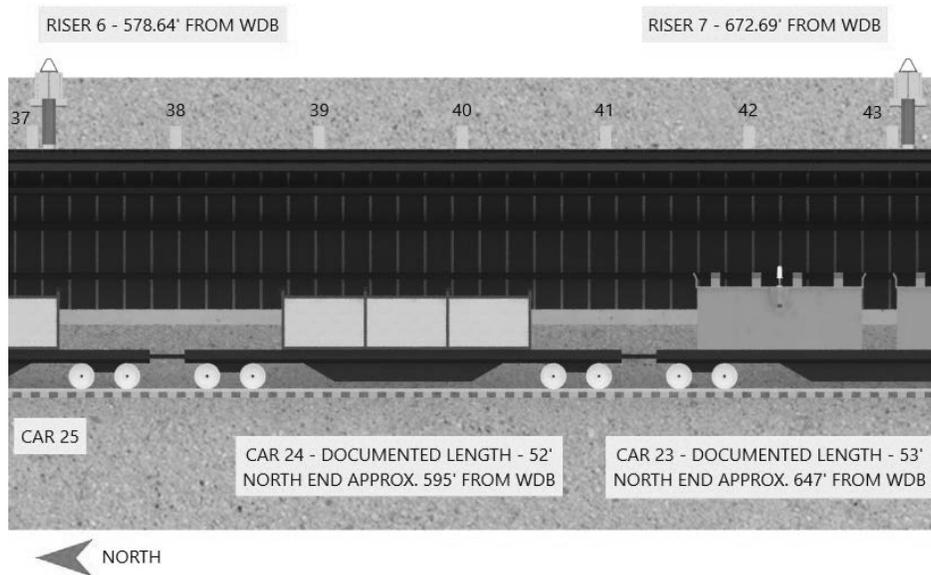


Figure B-24: Riser 6 to Riser 7 Tunnel Section.

Two rail cars are located between riser 6 and riser 7. Riser 7 is located 672.69' from the south face of the WDB. Riser 7 is 94.05' south of riser 6. Riser 6 had rad readings at the surface, and therefore was not investigated with a camera.

Car #24 contents are documented in HNF-SD-EN-WAP-007 Rev 4. Length of the car is noted as 52' in the "Storage Tunnel Checklist" associated with work plan WP-P-96-60.

Car #23 contents are documented in HNF-SD-EN-WAP-007 Rev 4. Length of the car is noted as 53' in the "Storage Tunnel Checklist" for position 23. Work plan has not been located.

23.	CAR PX-31 PLACED IN TUNNEL ON 3/11/96; 2 BURIAL BOXES (H-2-100187) CONTAINING JUMPERS AND FAILED/OBSOLETE CANYON EQUIPMENT. LIFTING YOKE (H-2-99652); ESTIMATED 21 TONS; 2,116 CU. FT.; 2 CURIES; 10 mrem/hr. @ 1'	
24.	CAR PX-29 PLACED IN TUNNEL ON 4/26/96; CONCRETE BURIAL BOX (H-1-44980) STORING 8 CONTAINERS OF 324 BUILDING B-CELL WASTE; ESTIMATED 36 TONS; 1,890 CU. FT.; <244,000 CURIES; ~1,802 kg Pb; ~10.5 kg Cd; ~8.5 kg ABSORBED OIL; ~1 kg Cr; ~3 kg Ba; ~24 g Pu; ~15 mrem/hr. @ 150' (FOR DETAILS SEE PUREX WORK PLAN WP-P-95-60)	

Figure B-25: Details for Cars 23 and 24 from HNF-SD-EN-WAP-007.



Figure B-26: Investigation View from Riser 7, Looking North at Cars 24, 25, and 26.



Figure B-27: Investigation View from Riser 7, Looking at the Northern Box on Car 23.

After grouting, approximately 26 yd³ of void space was left at the top of the tunnel above Car 24.
 Approximately 6.2 yd³ of void space is left inside the rail car (based on 10% empty box volume).

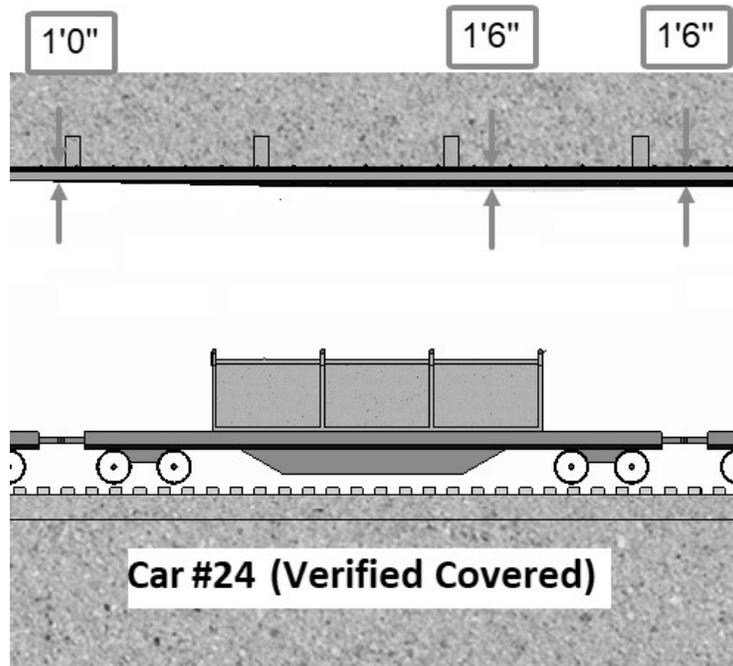


Figure B-28: Approximate Final Grout Profile above Car 24.

After grouting, approximately 27 yd³ of void space was left at the top of the tunnel above Car 23.
 Approximately 3.8 yd³ of void space is left inside the rail car (based on 10% empty box volume).

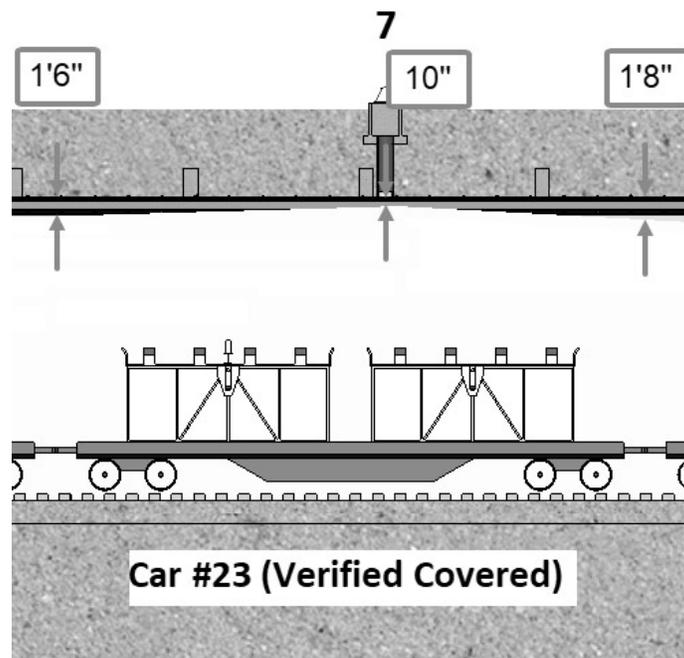


Figure B-29: Approximate Final Grout Profile above Car 23.

Riser 7 to Riser 8

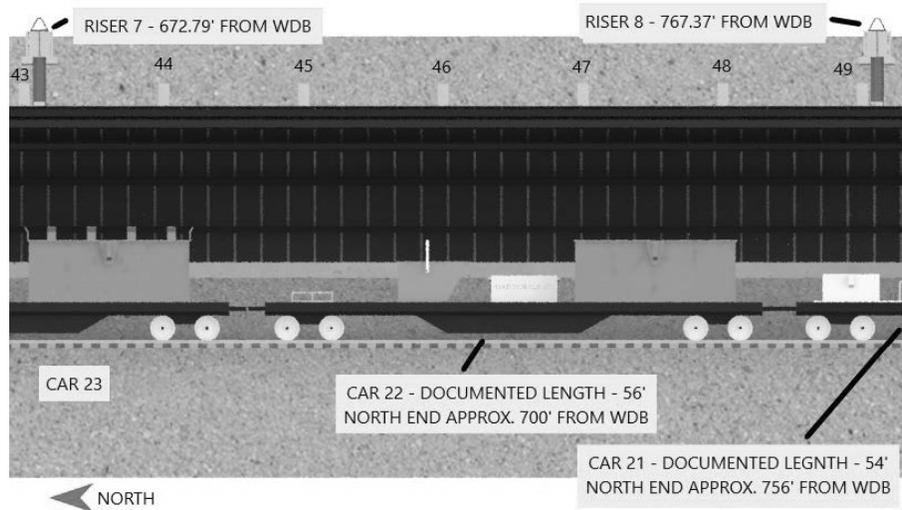


Figure B-30: Riser 7 to Riser 8 Tunnel Section.

One full rail car is located between riser 7 and riser 8. Riser 8 is located 767.37' from the south face of the WDB. Riser 8 is 94.58' south of riser 7.

Car #22 contents are documented in HNF-SD-EN-WAP-007 Rev 4. Length of the car is noted as 56' in the "Storage Tunnel Checklist". Work plan has not been located.

22.	<p>CAR 3616 PLACED IN TUNNEL ON 3/11/96; METAL LINER BOX (H-2-65095) CONTAINING JUMPERS AND FAILED/ OBSOLETE CANYON EQUIPMENT, F7 NEUTRON MONITOR (H-2-75825), LEAD STORAGE BOX (H-2-131629) CONTAINING JUMPER COUNTERWEIGHTS AND MISC. LEAD ITEMS, SCRAP HOPPER (H-2-57347) CONTAINING MISC. CANYON EQUIPMENT, CANISTER CAPPING STATION (H-2-821831), TEST CANISTER CONTAINING VARIOUS LENGTHS OF CARBON STEEL PIPE; ESTIMATED 22 TONS; 1,712 CU. FT.; 15 CURIES; ~3,232 kg Pb; ~2 kg Cd; 0.1 rem/hr. @ 1'</p>	
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Figure B-31: Details for Car 22 from HNF-SD-EN-WAP-007.



Figure B-32: Investigation View from Riser 7, Looking at the North End of Car 22.



Figure B-33: Investigation View from Riser 8, Looking North at Car 22.



Figure B-34: Investigation View from Riser 8, Looking North at the Couplings between Cars 21 and 22.

After grouting, approximately 51 yd^3 of void space was left at the top of the tunnel above Car 22. Approximately 7.1 yd^3 of void space is left inside the rail car. Estimation based on 10% lead storage box empty volume, 20% metal liner box empty volume, and complete fill for other items.

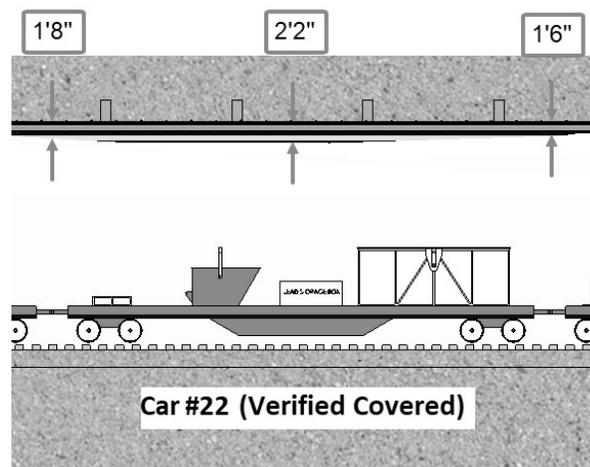


Figure B-35: Approximate Final Grout Profile above Car 22.

Riser 8 to Riser 9

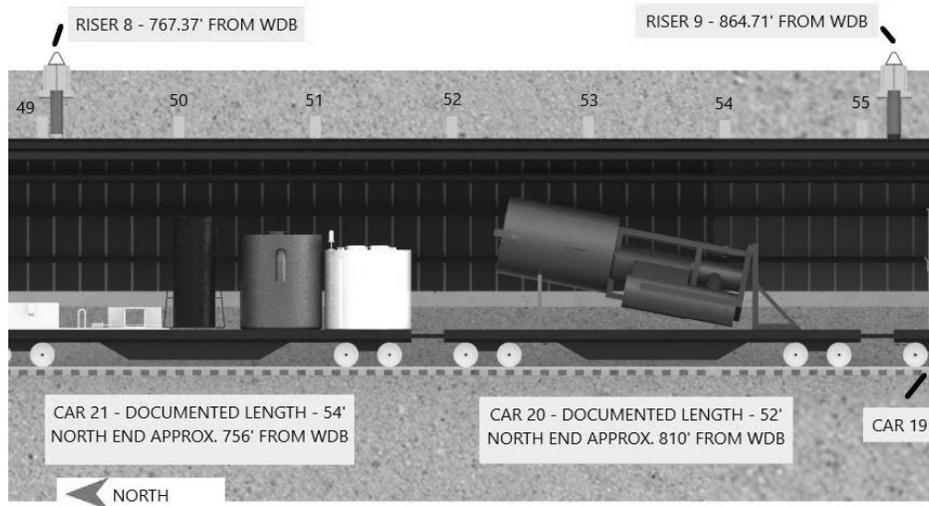


Figure B-36: Riser 8 to Riser 9 Tunnel Section.

Two rail cars are located between riser 8 and riser 9. Riser 9 is located 864.71' from the south face of the WDB. Riser 9 is 97.34' south of riser 8.

Car #21 contents are documented in HNF-SD-EN-WAP-007 Rev 4. Length of the car is noted as 54' in the "Storage Tunnel Checklist" associated with work plan WP-P-95-008.

Car #20 contents are documented in HNF-SD-EN-WAP-007 Rev 4. Length of the car is noted as 52' in the "Storage Tunnel Checklist" associated with work plan WP-P-94-040.

20.	CAR PX-28 PLACED IN TUNNEL ON 1/27/95; E-H4-1 UNITIZED CONCENTRATOR (H-2-52477) (H-2-56213); ESTIMATED 40 TONS; 5,760 CU. FT.; 3,070 CURIES; ~8 kg Cr; 1 rem/hr. @ 5'	
21.	CAR PX-3609 PLACED IN TUNNEL ON 2/8/95; H4 CONCENTRATOR TOWER (H-2-58102), TK-E5 (H-2-52453), LEAD STORAGE BOX (H-2-131629), HOT SHOP "Q" COVER PLATE (H-2-52222), TUBE BUNDLE WASH CAPSULE (H-2-58647), DISSOLVER CHARGING INSERT (H-2-75875), LIFTING YOKE #7A (H-2-96837), LIFTING YOKE #9 (H-2-52458); ESTIMATED 44 TONS; 3,457 CU. FT.; 26,000 CURIES. ~1,930 kg Pb; 1 rem/hr. @ 4'	

Figure B-37: Details for Cars 20 and 21 from HNF-SD-EN-WAP-007.



Figure B-38: Investigation View from Riser 9, Looking North at the Concentrator on Car 20.

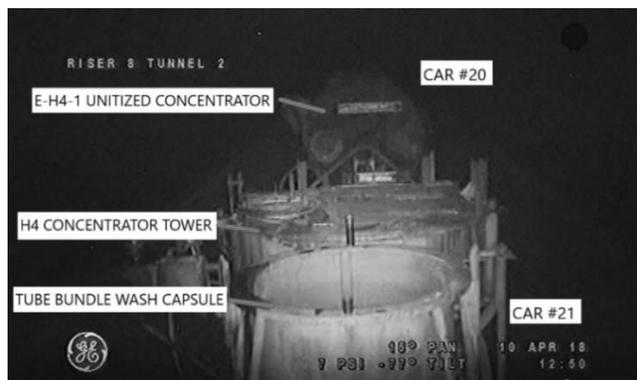


Figure B-39: Investigation View from Riser 8, Looking South at the Equipment on Cars 20 and 21.

After grouting, approximately 20 yd^3 of void space was left at the top of the tunnel above Car 21. Approximately 30.6 yd^3 of void space is left inside the rail car. Estimation based on 10% lead storage box empty volume, 20% concentrator empty volume, 90% tank empty volume (if capped), and complete fill for other items.

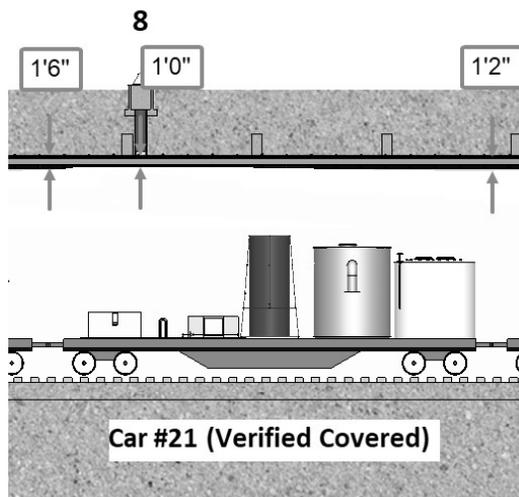


Figure B-40: Approximate Final Grout Profile above Car 21.

After grouting, approximately 18 yd³ of void space was left at the top of the tunnel above Car 20. Approximately 16.6 yd³ of void space is left inside the rail car. Estimation based on 30% concentrator empty volume.

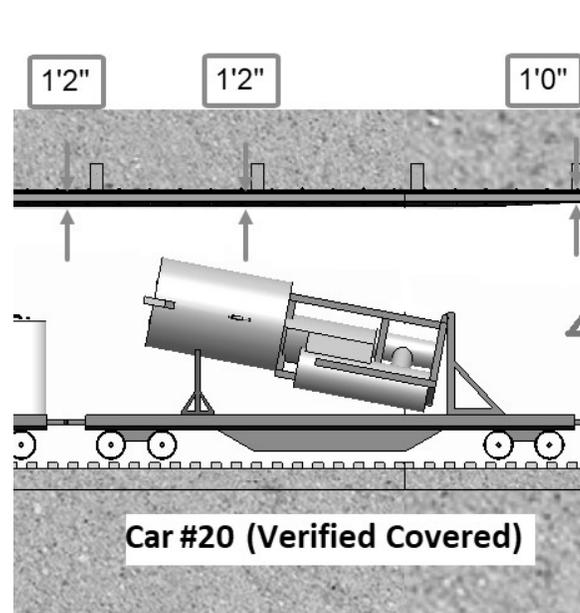


Figure B-41: Approximate Final Grout Profile above Car 20

Riser 9 to Riser 10

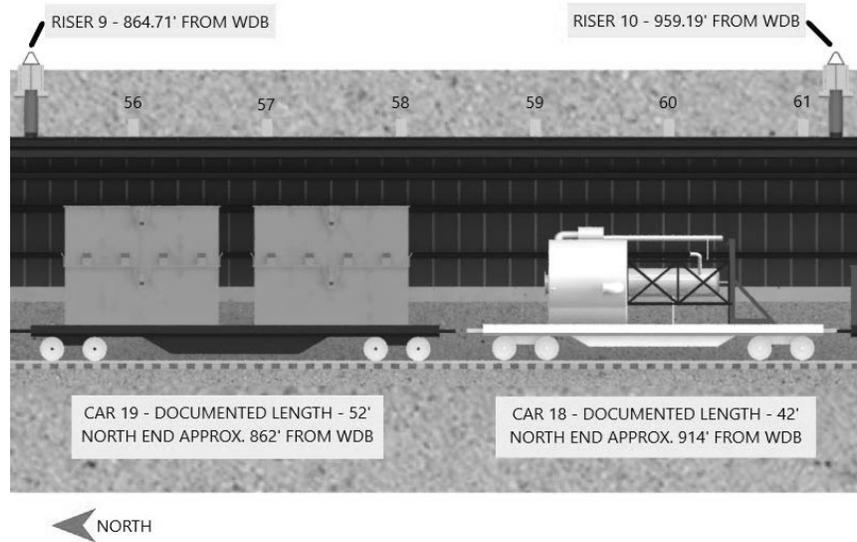


Figure B-42: Riser 9 to Riser 10 Tunnel Section.

Two rail cars are located between riser 9 and riser 10. Riser 10 is located 959.19' from the south face of the WDB. Riser 10 is 94.48' south of riser 9.

Car #19 contents are documented in HNF-SD-EN-WAP-007 Rev 4. Length of the car is noted as 52' in the "Storage Tunnel Checklist" associated with work plan WP-P-94-027.

Car #18 contents are documented in HNF-SD-EN-WAP-007 Rev 4. Length of the car is noted as 42' in the "Storage Tunnel Checklist". Work plan has not been located.

<p>18.</p>	<p>CAR PX-2 PLACED IN TUNNEL ON 4/8/94; T-F5 ACID ABSORBER (H-2-52535, H-2-52487, H-2-52488); ESTIMATED 22 TONS; 835 CU. FT.; 185 CURIES; 80 mrem/hr. @ CONTACT</p>	
<p>19.</p>	<p>CAR PX-23 PLACED IN TUNNEL ON 9/16/94; 4 METAL LINER STORAGE BOXES (H-2-65095) (H-2-100187) CONTAINING FAILED JUMPERS AND MISC. OBSOLETE CANYON EQUIPMENT; ESTIMATED 60 TONS; 4,032 CU. FT.; 927 CURIES; 30 mrem/hr. @ 2'</p>	

Figure B-43: Details for Cars 18 and 19 from HNF-SD-EN-WAP-007.

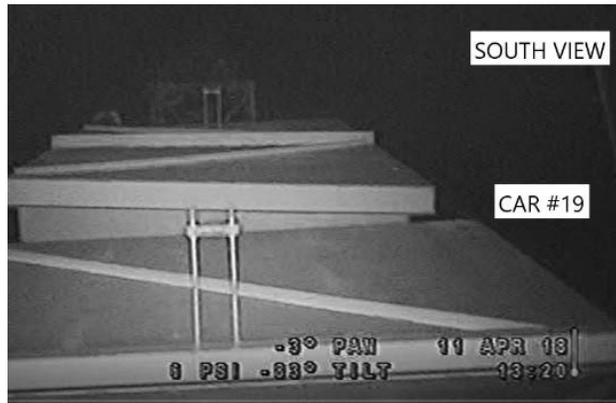


Figure B-44: Investigation View from Riser 9, Looking South at the Equipment on Car 19.



Figure B-45: Investigation View from Riser 9, Looking at the Couplings between Cars 19 and 20.



Figure B-46: Investigation View from Riser 10, Looking North at Cars 18 and 19.

After grouting, approximately 13 yd³ of void space was left at the top of the tunnel above Car 19. Approximately 29.9 yd³ of void space is left inside the rail car. Estimation based on 20% empty volume in each liner storage box.

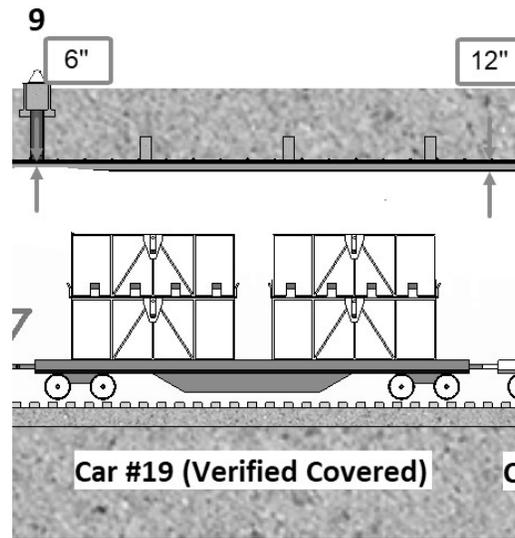


Figure B-47: Approximate Final Grout Profile above Car 19.

After grouting, approximately 12 yd³ of void space was left at the top of the tunnel above Car 19. Approximately 12.6 yd³ of void space is left inside the rail car. Estimation based on 40% empty volume in the acid absorber (assume capped).

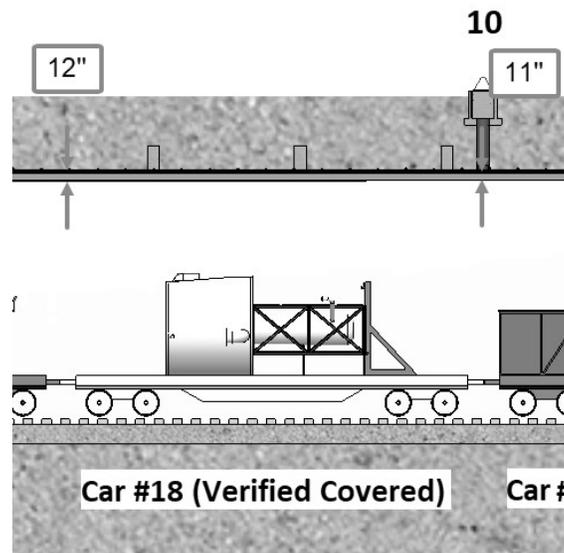


Figure B-48: Approximate Final Grout Profile above Car 18.

Riser 10 to Riser 11

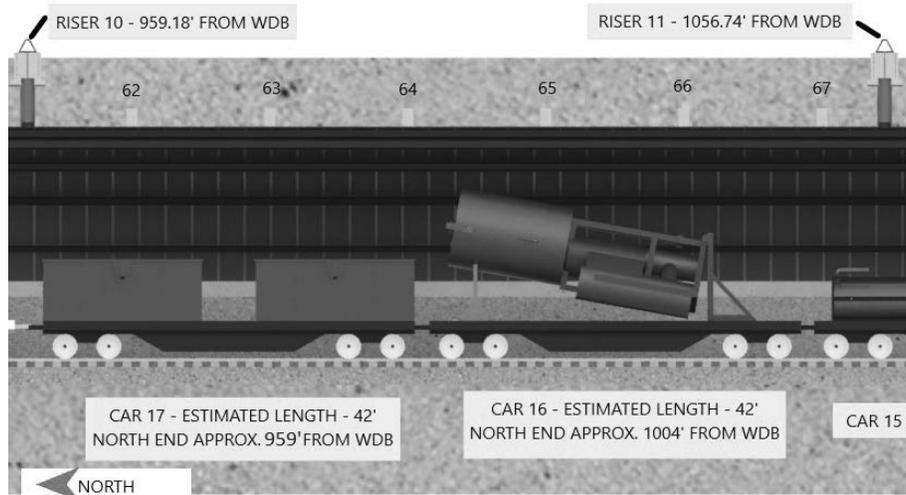


Figure B-49: Riser 10 to Riser 11 Tunnel Section.

Two rail cars are located between riser 10 and riser 11. Riser 11 is located 1056.74' from the south face of the WDB. Riser 11 is 97.56' south of riser 10.

Car #17 length is estimated 42', and contents are documented in HNF-SD-EN-WAP-007 Rev 4.

Car #16 length is estimated 42', and contents are documented in HNF-SD-EN-WAP-007 Rev 4.

16.	CAR PX-6 (H-2-99608) PLACED IN TUNNEL ON 4/6/89; E-J8-1 UNITIZED CONCENTRATOR (#1) (H-2-52477); ESTIMATED 42 TONS; 6,000 CU. FT.; 1.5 CURIES; 0.5 mrem/hr. @ 10' (REF: LETTER 12113-89-027)	
17.	CAR PX-19 PLACED IN TUNNEL ON 8/5/89; NORTH STORAGE LINER (H-2-65095) CONTAINING 6 PUMPS, AN AGITATOR AND CUT UP JUMPERS (14 TONS). SOUTH STORAGE LINER (H-2-65095) CONTAINING A PUMP, #15 YOKE, AND CUT UP JUMPERS (11.5 TONS); ESTIMATED 25.5 TONS; 2,574 CU. FT.; 3.0 CURIES; 80 mrem/hr. @ 1' (REF: LETTER 12113-89-051)	

Figure B-50: Details for Cars 16 and 17 from HNF-SD-EN-WAP-007.



Figure B-51: Investigation View from Riser 10, Looking at the North Box on Car 17.



Figure B-52: Investigation View from Riser 10, Looking at the South Box on Car 17.

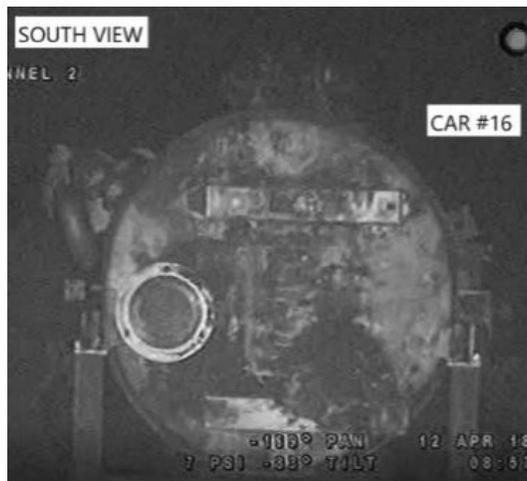


Figure B-53: Investigation View from Riser 10, Looking South at the Concentrator on Car 16.



Figure B-54: Investigation View from Riser 11, Looking North at the Concentrator on Car 16.



Figure B-55: Investigation View from Riser 11, Looking Directly Down at the Silver Reactor on Car 15.

After grouting, approximately 12 yd^3 of void space was left at the top of the tunnel above Car 17. Approximately 3.8 yd^3 of void space is left inside the rail car. Estimation based on 5% empty volume in each metal liner box.

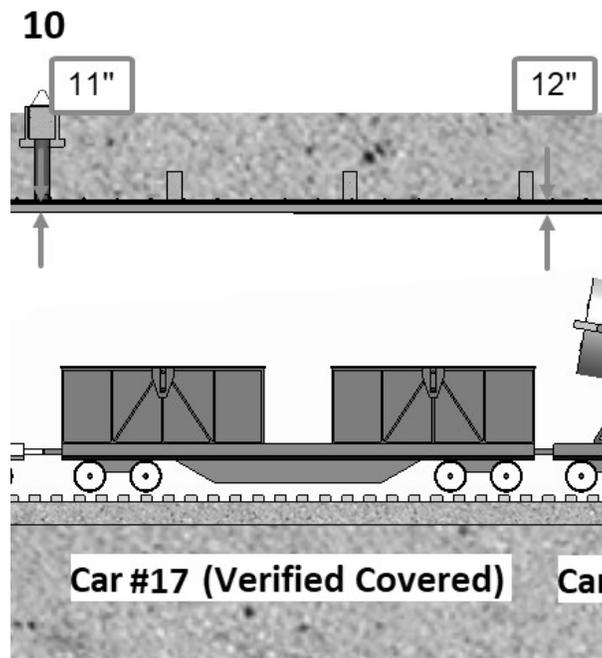


Figure B-56: Approximate Final Grout Profile above Car 17.

After grouting, approximately 13 yd³ of void space was left at the top of the tunnel above Car 16.

Approximately 16.6 yd³ of void space is left inside the rail car. Estimation based on 30% empty volume in the concentrator.

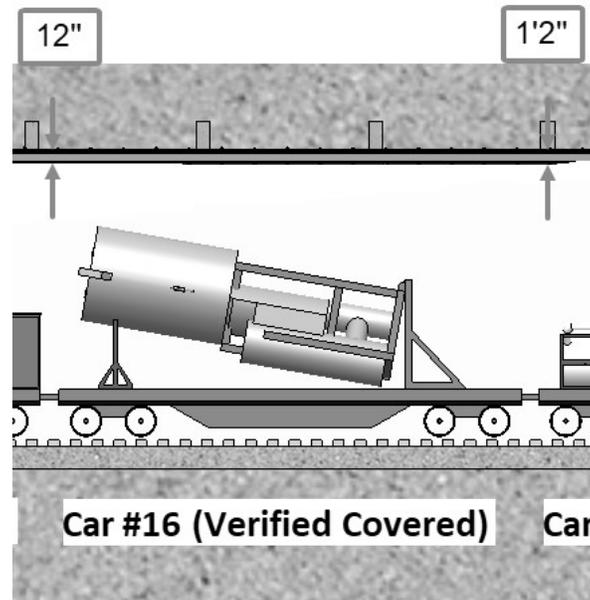


Figure B-57: Approximate Final Grout Profile above Car 16.

Riser 11 to Riser 12

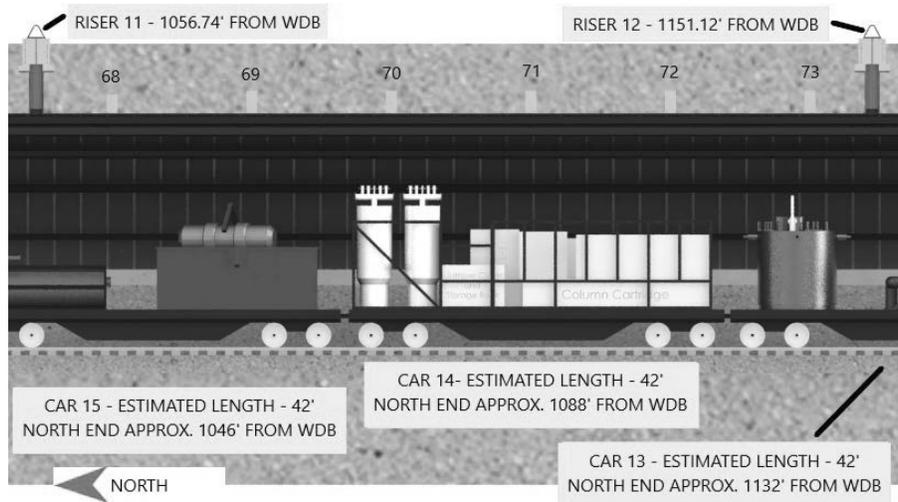


Figure B-58: Riser 11 to Riser 12 Tunnel Section.

Three rail cars are located between riser 11 and riser 12. Riser 12 is located 1151.12' from the south face of the WDB. Riser 12 is 94.38' south of riser 11.

Car #15 length is estimated 42', and contents are documented in HNF-SD-EN-WAP-007 Rev 4.

Car #14 length is estimated 42', and contents are documented in HNF-SD-EN-WAP-007 Rev 4.

Car #13 length is estimated 42', and contents are documented in HNF-SD-EN-WAP-007 Rev 4.

13.	CAR 19806 PLACED IN TUNNEL ON 1/21/86; TK-J5 2A FEED TANK (#30), E-F1 CONDENSER (#13), F12-B CELL BLOCK, DISSOLVER 4-WAY DUMPER, DISSOLVER YOKE, FLANGE PLATE; 2,500 CU. FT.; 90 CURIES; 3 rem/hr. @ 1'	
14.	CAR PX-10 PLACED IN TUNNEL ON 11/18/87; L-1 PULSER, 2 COLUMN CARTRIDGES, JUMPER CUTTER, STORAGE RACK, 3 JUMPER ALIGNMENT TOOLS, 9 EXTERIOR DUMPING TRUNNIONS, 10 PUMPS, 3 AGITATORS, 4 TUBE BUNDLES, 2 VENT JUMPERS, 7 YOKES; 50 TONS; 3,600 CU. FT.; 33,740 CURIES; 2,540 kg Pb; 5 rem/hr. @ 15' (REF: LETTER 12110-88-074)	
15.	CAR PX-9 PLACED IN TUNNEL ON 5/13/88; T-A2 SILVER REACTOR (#5 SPARE), S/R CRADLE, E-F2 STEAM HEATER, STORAGE LINER (H-2-65095) FILLED WITH CUT UP JUMPERS; 20 TONS; 2,775 CU. FT.; 240 CURIES; ~13 kg Cd; ~115 kg Ag; ~230 kg Pb; 20 mrem/hr. @ 20' (REF: LETTER 12110-88-074)	

Figure B-59: Details for Cars 13, 14, and 15 from HNF-SD-EN-WAP-007.

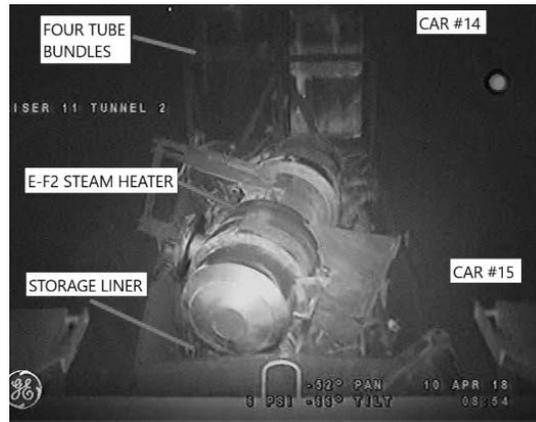


Figure B-60: Investigation View from Riser 11, Looking South at the Box on Car 15.



Figure B-61: Investigation View from Riser 11, Looking South at the Equipment on Cars 14 and 13.



Figure B-62: Investigation View from Riser 12, Looking North at the Equipment on Car 14.



Figure B-63: Investigation View from Riser 12, Looking North at the Tank on Car 13.

After grouting, approximately 11 yd³ of void space was left at the top of the tunnel above Car 15. Approximately 11.4 yd³ of void space is left inside the rail car. Estimation based on 90% empty volume in the silver reactor, and 10% empty volume in the metal liner box and heater.

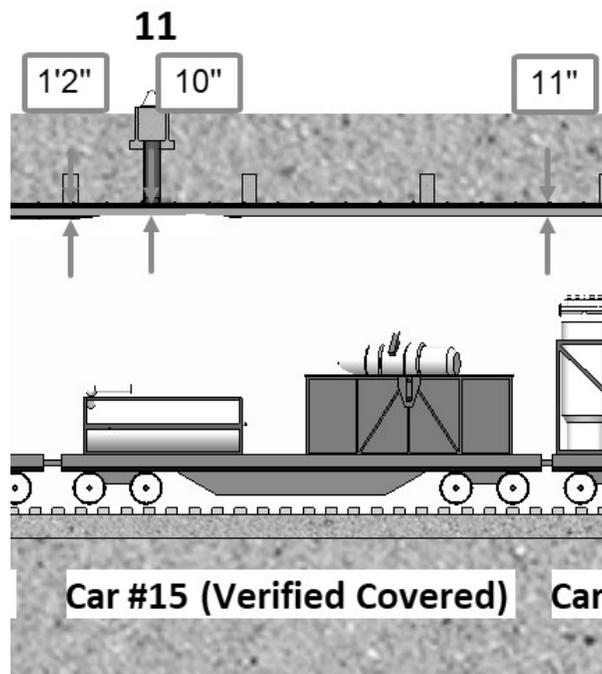


Figure B-64: Approximate Final Grout Profile above Car 15.

After grouting, approximately 11 yd³ of void space was left at the top of the tunnel above Car 14.

Approximately 24 yd³ of void space is left inside the rail car. Estimation based on 90% empty volume in the tube bundles, and 10% empty volume in the miscellaneous equipment.

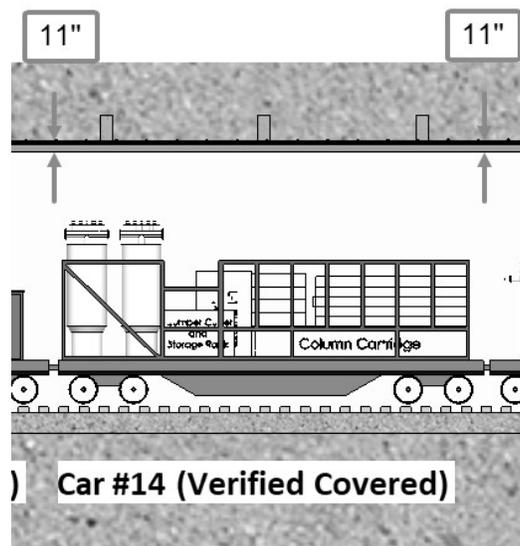


Figure B-65: Approximate Final Grout Profile above Car 14.

After grouting, approximately 10 yd³ of void space was left at the top of the tunnel above Car 13.

Approximately 42.1 yd³ of void space is left inside the rail car. Estimation based on 90% empty volume in the tank (assumed capped), 90% empty volume in the condenser (assume capped), and 60% empty volume in the cell block.

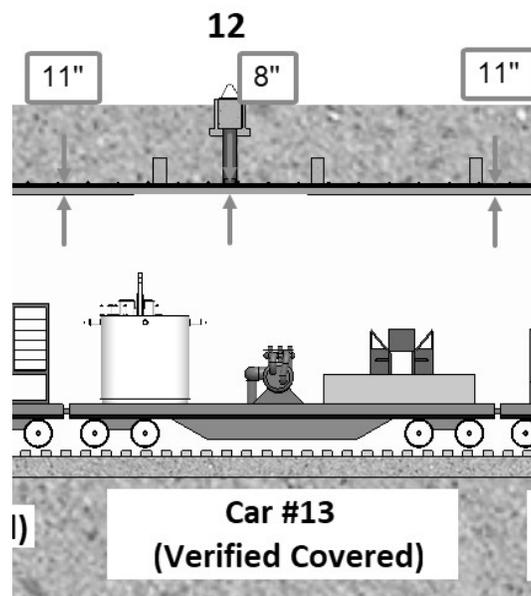


Figure B-66: Approximate Final Grout Profile above Car 13.

Riser 12 to Riser 13

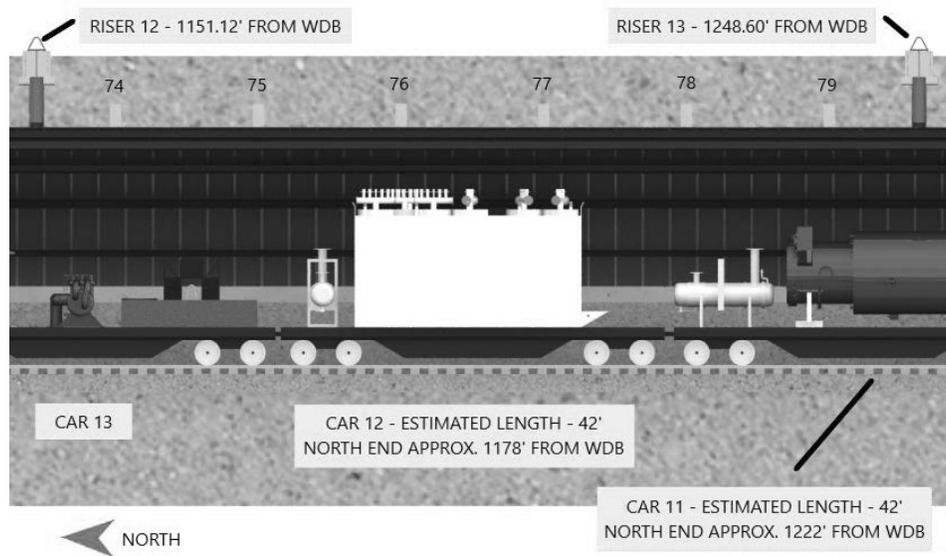


Figure B-67: Riser 12 to Riser 13 Tunnel Section.

Two rail cars are located between riser 12 and riser 13. Riser 13 is located 1248.60' from the south face of the WDB. Riser 13 is 97.48' south of riser 12. Note investigation of Riser 13 was not initially performed due to the riser port cover being rusted shut.

Car #12 length is estimated 42', and contents are documented in HNF-SD-EN-WAP-007 Rev 4.

Car #11 length is estimated 42', and contents are documented in HNF-SD-EN-WAP-007 Rev 4.

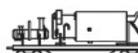
<p>11.</p>	<p>CAR 3613 PLACED IN TUNNEL ON 1/18/86; TK-A3 ANNULAR DISSOLVER (#10) AND E-A2 HEATER (#6); 3,960 CU. FT.; 0.81 CURIES; ~40 kg Hg; ~43 kg Cd; 3 mrem/hr. @ 3'</p>	
<p>12.</p>	<p>CAR 3611 PLACED IN TUNNEL ON 1/20/86; WHITE BOX (H-2-58456) CONTAINING 8 TUBE BUNDLES, PG-J6 PULSE GENERATOR (#5), DISSOLVER LID, 9 DUMPING TRUNNIONS; 5,438 CU. FT.; 540 CURIES, 2 rem/hr. @ 3'</p>	

Figure B-68: Details for Cars 11 and 12 from HNF-SD-EN-WAP-007.

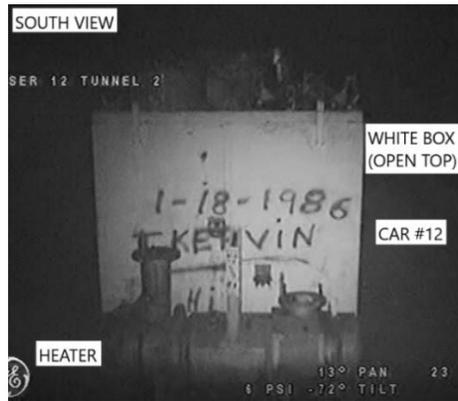


Figure B-69: Investigation View from Riser 12, Looking South at the Equipment on Car 12.



Figure B-70: Investigation View from Riser 12, Looking South at the Equipment on Car 13.

After grouting, approximately 11 yd³ of void space was left at the top of the tunnel above Car 12. Approximately 36 yd³ of void space is left inside the rail car. Estimation based on 90% empty volume in the tube bundles, and all other voids being completely filled with grout.

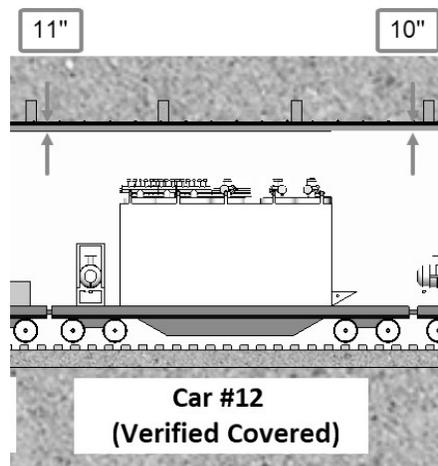


Figure B-71: Approximate Final Grout Profile above Car 12.

After grouting, approximately 12 yd³ of void space was left at the top of the tunnel above Car 11. Approximately 0 yd³ of void space is left inside the rail car. Estimation based on 100% grout fill of the dissolver and heater.

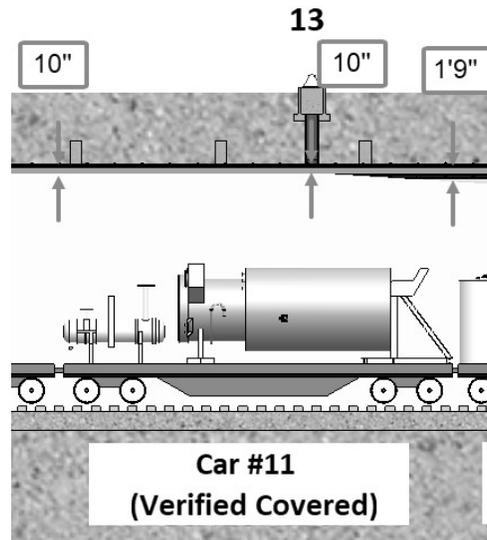


Figure B-72: Approximate Final Grout Profile above Car 11.

Riser 13 to Riser 14

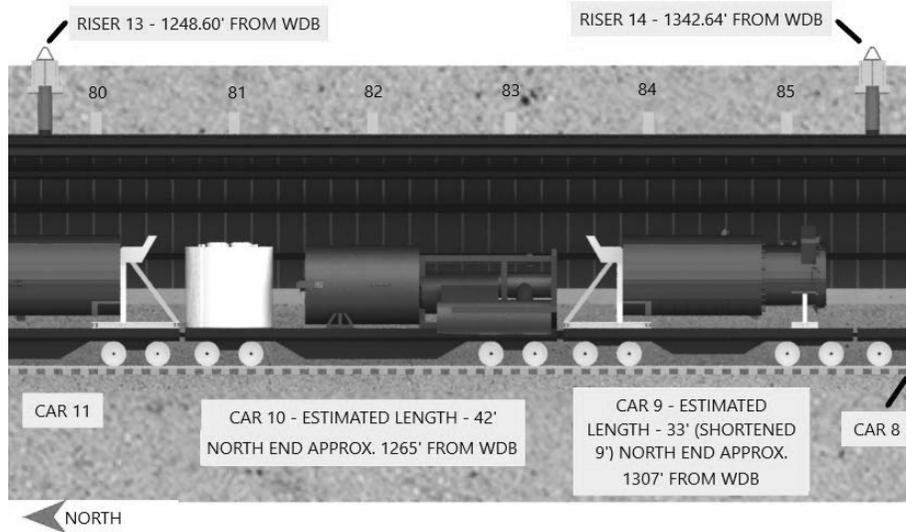


Figure B-73: Riser 13 to Riser 14 Tunnel Section.

Two rail cars are located between riser 13 and riser 14. Riser 14 is located 1342.64' from the south face of the WDB. Riser 14 is 94.04' south of riser 13.

Car #10 length is estimated 42', and contents are documented in HNF-SD-EN-WAP-007 Rev 4.

Car #9 length is estimated 33', and contents are documented in HNF-SD-EN-WAP-007 Rev 4.

9.	CAR 19811 PLACED IN TUNNEL ON 9/30/72; TK-C3 ANNULAR DISSOLVER; 1,590 CU. FT.; 50 CURIES; ~45 kg Hg; 5 rem/hr. @ 5'	
10.	CAR CDX-1 PLACED IN TUNNEL ON 8/30/83; E-H4 (3WB) CONCENTRATOR, TUBE BUNDLE, PROTOTYPE COOLING COIL, F-F1 FILTER TANK; 2,400 CU. FT.; 500 CURIES; 0.8 rem/hr. @ 2'	

Figure B-74: Details for Cars 9 and 10 from HNF-SD-EN-WAP-007.

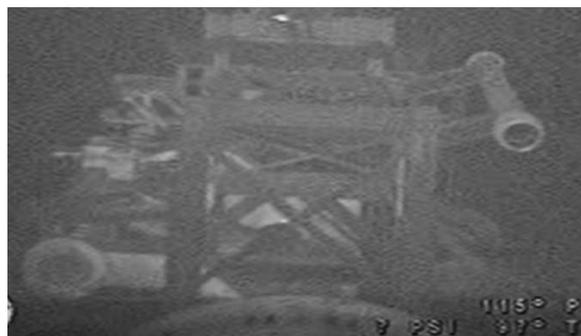


Figure B-75: Investigation View from Riser 14, Looking North at the Concentrator on Car 10.



Figure B-76: Investigation View from Riser 14, Looking North at the Dissolver on Car 9.

After grouting, approximately 59 yd^3 of void space was left at the top of the tunnel above Car 10. Approximately 45.4 yd^3 of void space is left inside the rail car. Estimation based on 90% empty volume in the tank (assumed capped), 30% void space in the concentrator, and all other voids being completely filled with grout.

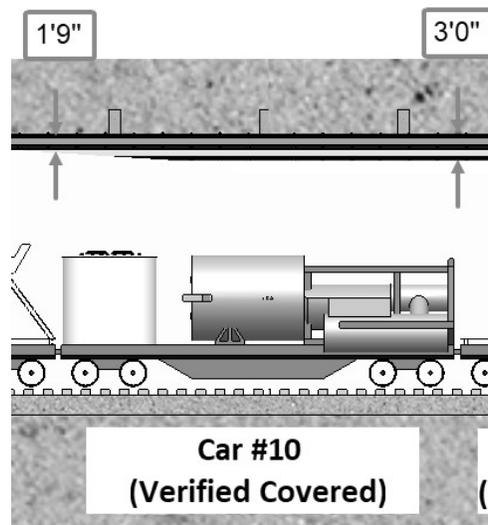


Figure B-77: Approximate Final Grout Profile above Car 10.

After grouting, approximately 43 yd³ of void space was left at the top of the tunnel above Car 9. Approximately 0 yd³ of void space is left inside the rail car. Estimation based on 100% grout fill of the dissolver.

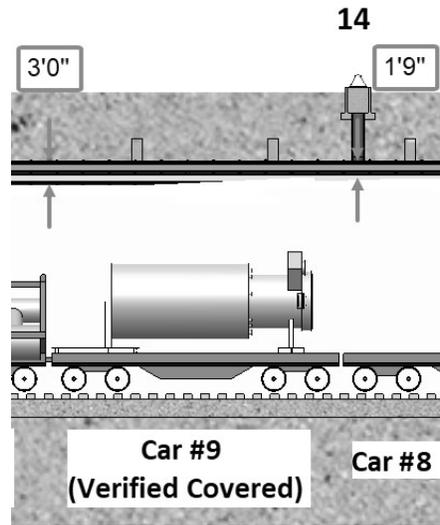


Figure B-78: Approximate Final Grout Profile above Car 9.

Riser 14 to Riser 15

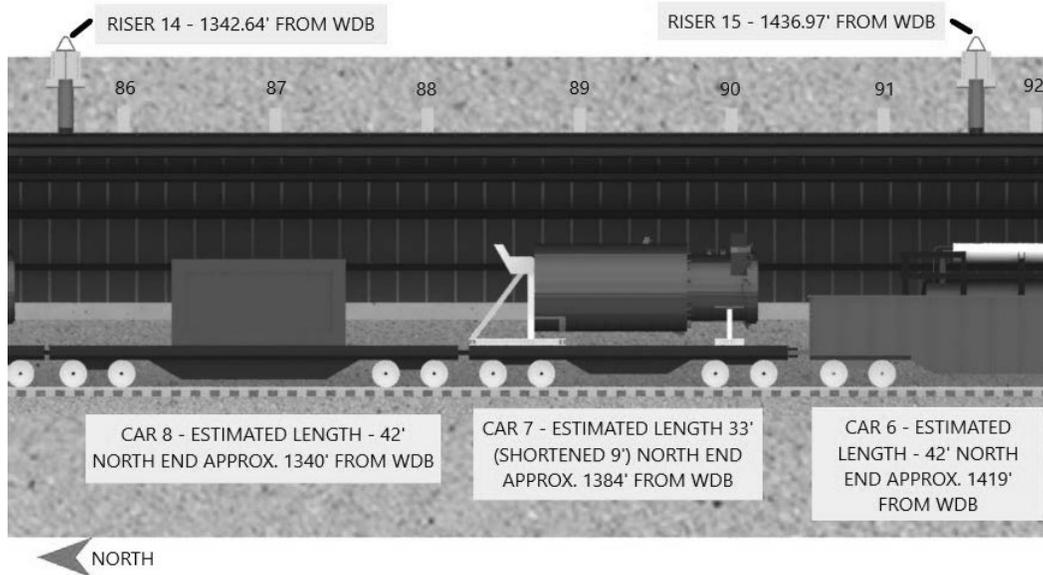


Figure B-79: Riser 14 to Riser 15 Tunnel Section.

Three rail cars are located between riser 14 and riser 15. Riser 15 is located 1436.97' from the south face of the WDB. Riser 15 is 97.48' south of riser 14.

Car #8 length is estimated 42', and contents are documented in HNF-SD-EN-WAP-007 Rev 4.

Car #7 length is estimated 33', and contents are documented in HNF-SD-EN-WAP-007 Rev 4.

Car #6 length is estimated 42', and contents are documented in HNF-SD-EN-WAP-007 Rev 4.

6.	GONDOLA CAR 4611 PLACED IN TUNNEL ON 12/12/71; MODIFIED T-A3-1 TOWER, SCRUBBER, LID, VAPOR LINE; 2,400 CU. FT.; 10 CURIES; 1 rem/hr. @ CONTACT	
7.	CAR B58 (9' SHORTENED) PLACED IN TUNNEL ON 12/22/71; TK-A3 ANNULAR DISSOLVER; 2,400 CU. FT.; 50 CURIES; ~45 kg Hg; 5 rem/hr. @ 5'	
8.	CAR 19808 PLACED IN TUNNEL ON 8/29/72; A1W1 FUEL ENDS IN STEEL LINER BOX AND NPR FUEL HANDLING EQPT. USED WITH SUSPECTED CANISTERS; 800 CU. FT.; 17,500 CURIES; 10 rem/hr. @ 150'	

Figure B-80: Details for Cars 6, 7, and 8 from HNF-SD-EN-WAP-007.



Figure B-81: Investigation View from Riser 14, Looking South at the Box on Car 8.



Figure B-82: Investigation View from Riser 15, Looking North at the Dissolver on Car 7.

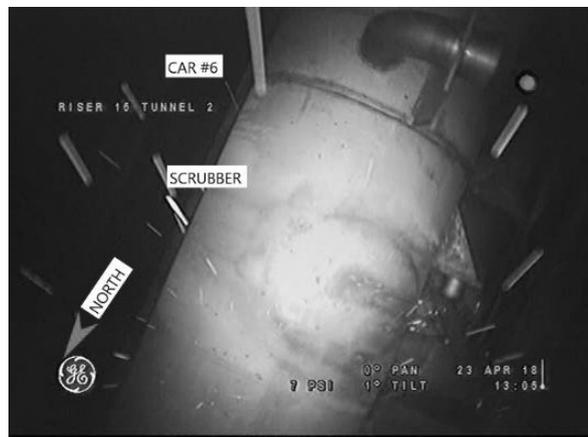


Figure B-83: Investigation View from Riser 15, Looking Down at the Equipment in Car 6.

After grouting, approximately 52 yd^3 of void space was left at the top of the tunnel above Car 9. Approximately 1.9 yd^3 of void space is left inside the rail car. Estimation based on 5% empty volume in the storage liner box, and all other voids being completely filled with grout.

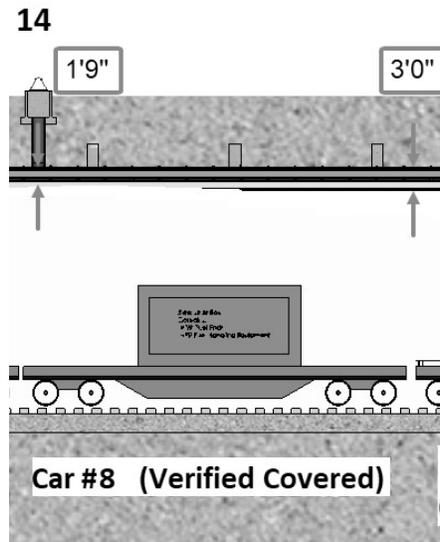


Figure B-84: Approximate Final Grout Profile above Car 8.

After grouting, approximately 46 yd³ of void space was left at the top of the tunnel above Car 7.
 Approximately 0 yd³ of void space is left inside the rail car. Estimation based on 100% grout fill of dissolver, and all other voids being completely filled with grout.

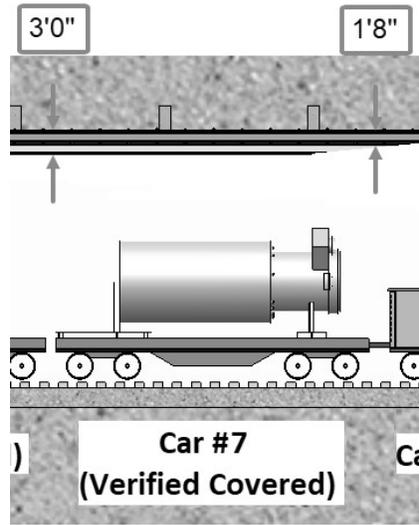


Figure B-85: Approximate Final Grout Profile above Car 7.

After grouting, approximately 12 yd³ of void space was left at the top of the tunnel above Car 6.
 Approximately 14.9 yd³ of void space is left inside the rail car. Estimation based on 90% empty volume in the tower and scrubber (assume capped), and all other voids being completely filled with grout.

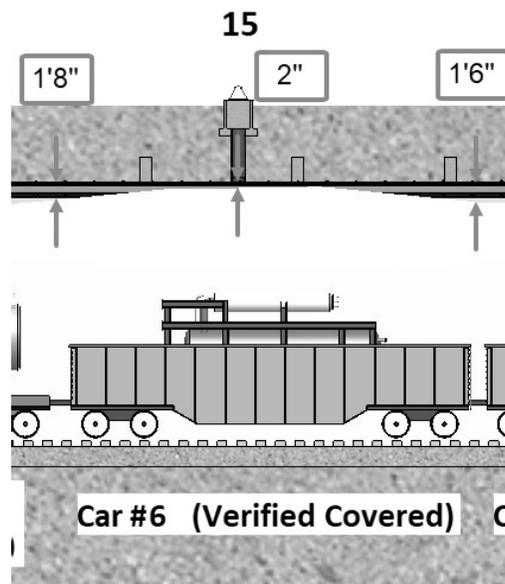


Figure B-86: Approximate Final Grout Profile above Car 6.

Riser 15 to Riser 16

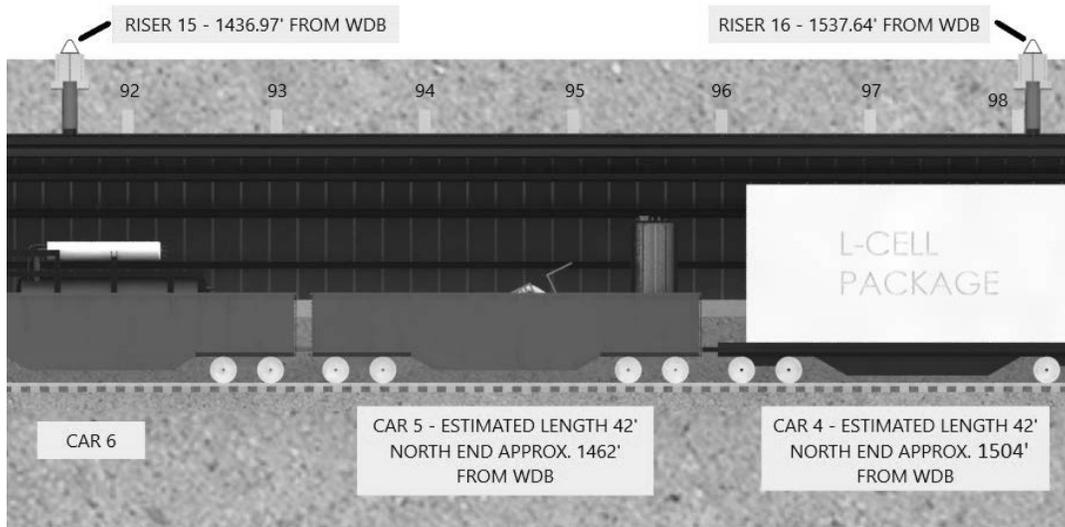


Figure B-87: Riser 16 to Riser 16 Tunnel Section.

Two rail cars are located between riser 15 and riser 16. Riser 16 is located 1537.64' from the south face of the WDB. Riser 16 is 100.67' south of riser 15.

Car #5 length is estimated 42', and contents are documented in HNF-SD-EN-WAP-007 Rev 4.

Car #4 length is estimated 42', and contents are documented in HNF-SD-EN-WAP-007 Rev 4.

<p>4. CAR MILW 60033 PLACED IN TUNNEL ON 12/30/70; L-CELL PACKAGE IN A SEALED STEEL BOX (H-2-66092); 2,400 CU. FT.; 500 g Pu; 0.2 rem/hr. @ CONTACT</p>	
<p>5. GONDOLA CAR 4610 PLACED IN TUNNEL ON 2/26/71; T-F2 SILVER REACTOR, T-F6 DEMISTER, VESSEL VENT LINE, STEEL CATWALK AND GUARD RAILS; 2,400 CU. FT.; 20 CURIES; ~625 kg Ag; 2 rem/hr. @ CONTACT</p>	

Figure B-88: Details for Cars 4 and 5 from HNF-SD-EN-WAP-007.



Figure B-89: Investigation View from Riser 15, Looking Down at the Equipment in Car 6.



Figure B-90: Investigation View from Riser 15, Looking South at the Equipment in Car 5.

After grouting, approximately 22 yd^3 of void space was left at the top of the tunnel above Car 5. Approximately 7.5 yd^3 of void space is left inside the rail car. Estimation based on 90% empty volume in the silver reactor, and all other voids being completely filled with grout.

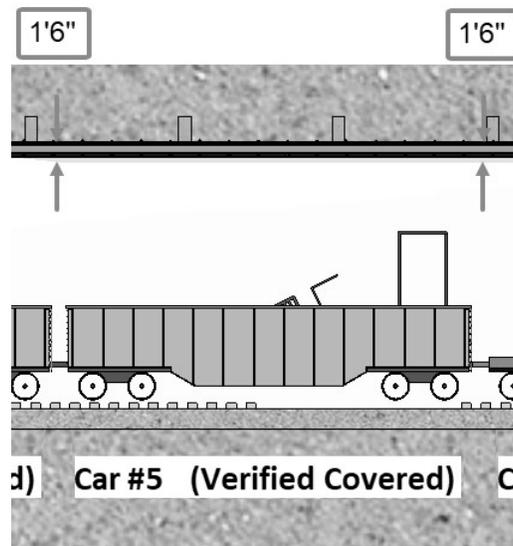


Figure B-91: Approximate Final Grout Profile above Car 5.

After grouting, approximately 22 yd³ of void space was left at the top of the tunnel above Car 4.
Approximately 195.5 yd³ of void space is left inside the rail car. Estimation based on 60% empty volume in the L-cell package.

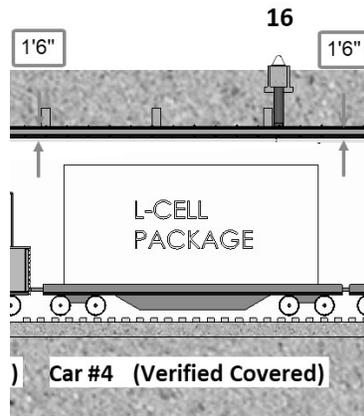


Figure B-92: Approximate Final Grout Profile above Car 4.

Riser 16 to Riser 17

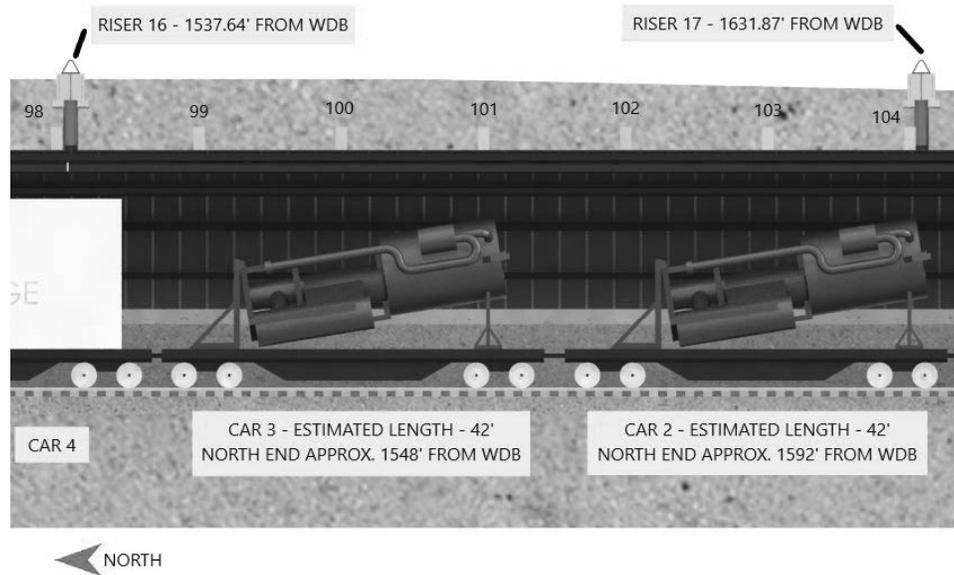


Figure B-93: Riser 16 to Riser 17 Tunnel Section.

Two rail cars are located between riser 16 and riser 17. Riser 17 is located 1631.87' from the south face of the WDB. Riser 17 is 94.23' south of riser 16.

Car #3 length is estimated 42', and contents are documented in HNF-SD-EN-WAP-007 Rev 4.

Car #2 length is estimated 42', and contents are documented in HNF-SD-EN-WAP-007 Rev 4.

<p>2.</p>	<p>CAR MILW 60883 PLACED IN TUNNEL ON 3/26/69; E-F6 (#5) CONCENTRATOR (PREVIOUSLY E-H4 3WB), 2 TUBE BUNDLES; 2,400 CU. FT.; 500 CURIES; 0.8 rem/hr. @ 2'</p>	
<p>3.</p>	<p>CAR 3612 PLACED IN TUNNEL ON 3/19/70; E-F6 (#6) (2WW WASTE) CONCENTRATOR, 2 TUBE BUNDLES; 2,400 CU. FT.; 700 CURIES; 0.5 rem/hr. @ 2'</p>	

Figure B-94: Details for Cars 2 and 3 from HNF-SD-EN-WAP-007.



Figure B-95: Investigation View from Riser 17, Looking North at the Concentrators on Cars 2 and 3.



Figure B-96: Investigation View from Riser 16, Looking South at the Concentrator on Car 3.



Figure B-97: Investigation View from Riser 16, Looking South at the Dunnage for Car 4 and Concentrator on Car 3.

After grouting, approximately 22 yd³ of void space was left at the top of the tunnel above Car 3. Approximately 16.6 yd³ of void space is left inside the rail car. Estimation based on 30% empty volume in the concentrator.

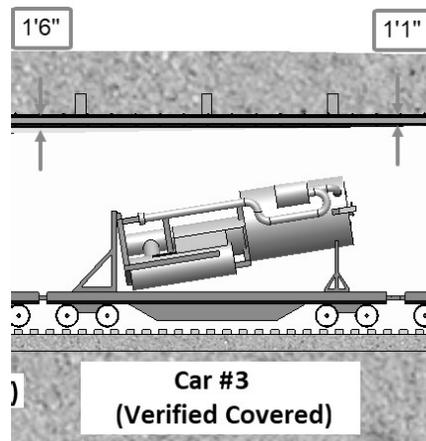


Figure B-98: Approximate Final Grout Profile above Car 3.

After grouting, approximately 7 yd^3 of void space was left at the top of the tunnel above Car 2.

Approximately 16.6 yd^3 of void space is left inside the rail car. Estimation based on 30% empty volume in the concentrator.

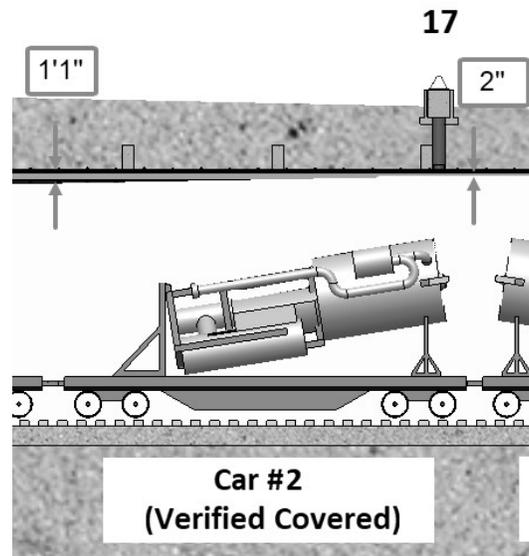


Figure B-99: Approximate Final Grout Profile above Car 2.

Riser 17 to End of Tunnel

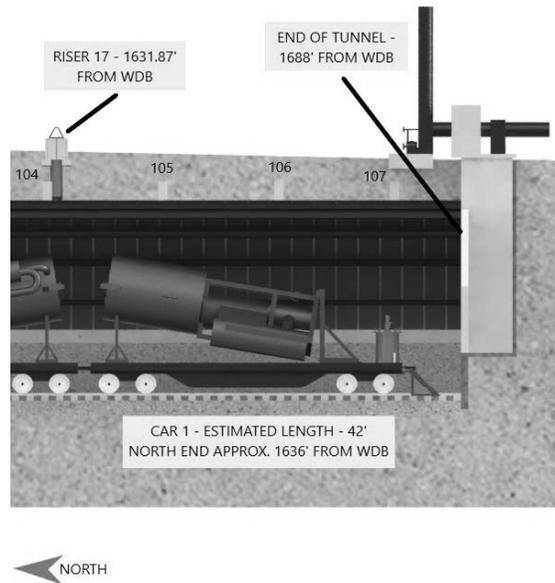


Figure B-100: Riser 17 to End of Tunnel.

One rail car is located between riser 17 and the end of Tunnel 2. The end of Tunnel 2 is located 1688' from the south face of the WDB. The end of the tunnel is 56.13' south of riser 16.

Car #1 length is estimated 42', and contents are documented in HNF-SD-EN-WAP-007 Rev 4. Note that the Tank TK-F15-2 was not visible during inspection, and is thought to be too large to fit with the concentrator on this rail car, so the tank was not included in the void space analysis.

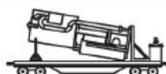
<p>1. CAR 61439 PLACED IN TUNNEL ON 12/12/67; E-F6 (2WW WASTE) CONCENTRATOR, TK-F15-2, TUBE BUNDLE, AGITATOR MOTORS; 2,400 CU. FT.; 700 CURIES; 1.3 rem/hr. @ 100'</p>	
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Figure B-101: Details for Car 1 from HNF-SD-EN-WAP-007.



