> ----- Original Message -----  
> From: "Christopher Brown" <cvbrown.pe@gmail.com>  
> To: "Elizabeth Campbell" <campbell.beth@comcast.net>  
> Sent: Saturday, August 29, 2009 5:06:29 PM GMT -08:00 US/Canada Pacific  
> Subject: Re: Deep Bored Tunnel Project

Dear Ms. Campbell:  
  
Thanks so much for the copy pf the e-mail correspondence and, too, the several design deviation request documents.  
  
Quite some reading ahead.  
  
I will confess for jumping into at least one issue that is rather glaring.  I see that Figure 3 of the Design deviation Number 1 report shows the "bored" tunnel section but, in this case, the maximum  
shoulder width is 7 feet 3 inches, not 8 feet as described in the Times publication.  Also, and of greater concern, the minimum shoulder width is 3 foot 3 inches, as opposed to the published 4 feet.  
  
I'll have to go into my files and check out the wheelchair standards per the ADA.  At the moment I'm not sure 3 feet 3 inches can meet any maneuvering needs, as in how do you get a chair out of a car and get a  
handicapped person into it in that space?  
  
Additionally, looking at Figure 4, how do you get a handicapped person up from the lower level to the upper level?  Elevators anyone?  
  
Hmmm?  
  
More on that later.  
  
My CV is very ancient but I can get a new one worked up in a short time.  
  
Can I fax you what I have at this moment?  
  
And in closing, I was with my son when he was tail-ended in a mutli-car crash on I-5 about a quarter mile south of the Spokane Street Interchange on I-5.   
  
The crash scene was attended by the WSDOT incident response tow truck and a WSP trooper.  
  
I asked both what were their views on the tunnel concept for SR 99.  
  
The short answer - scared to bloody death: no idea how to handle any major incident!  
  
Have you been in touch with the WSP troopers union?  
  
More later.  
  
Must away.  
  
Chris.  
  
  
  
Elizabeth:  
  
WOW!  Talk about a major document - although the attachment did not include a copy of the tunnel cross sectional design.  
  
I did note under Section 4.0, in paragraph 1, the usual verbiage as in "... good engineering practice ..." and thought was interesting  
  
Also, in the bullet for Design it stated "... 2 foot and 8 foot shoulders ..." so it seems that the standards first publicized and used before the legislature (4 foot and 8 foot shoulders) have yet again been changed.  
  
To me this is rather appalling since what the legislature voted on for funding is not what is under consideration, even if they were never apprised on such minor items as handicap egress from the tunnel in an emergency.  
  
By the way, in the RFQ I did not see any mention on emergency power for back-up ventilation, lighting and (water inflow) pumping.  
  
Last, did you get my ancient resume?  
  
Yours, aye  
  
Chris

For your files:  
  
The first significant document concerning traffic casualties is published by the Belgians.  It is:  
  
Cross-sectional Accident Models on Flemish Motorways Based on Infrastructural Design.  Frank Van Geirt & Irk Nuyts, Provincial College of Limburg, Belgium.  
  
It notes three general areas of transport policy involved in traffic safety: 1. change risk-taking behavior,  2.  regulations to improve the safety of vehicles and, 3.  efforts to build and design safer road  
infrastructure.  
  
Obviously, our interest is in the third.  
  
In their number 4 section, Results and discussion, under subsection 4.1, regression model for all injury accidents, we find an interesting statement.  It says, "In all zones a decreasing number of accidents is  
statistically significant associated with increasing outer shoulder width."  
  
No one can say it better then that (although one may argue about the grammar - "significant associated").  
  
By the way, for your information the "zones" they are discussing are of three types.  I.  Entry zones, 2.  Exit zones, and 3.  Link zones (i.e., the mainline between zones I and 2).  
  
The Belgian report is rather new since it uses data gathered in the period 1996 - 2001 and also cites references dated as recently as 2005.  Thus, this is the newest research I have been able to locate so  
far.  
  
The second interesting document is entitled "Estimating Safety Effects of Cross-section Design for Various Highway Types Using Negative Binomial Regression" and is found in Transportation Research Record 1500.  This research was sponsored by the Transportation Research Board's "Committee on Operational Effects of Geometrics" according to the last footnote.  Since they, the authors, cite documents as recent as 1994 we can assume it is from the mid-1990's, if that is a concern.  
  
Of particular interest is a sentence in the Conclusions section stating, "In general, increasing outside shoulder width to 3-3.7 meters (10-12 feet) also decreases crash rates." As a matter of interest, if we consider their Figure 4, Effect of shoulder width on mid-block crash rates, we can see that for the  
proposed AW tunnel section (essentially a 2-lane urban paved facility for both NB and SB roads) there is a reduction in the crash rate of about 30 percent (from 4.0/mvkm to o.3/mvkm) which is enormous when we consider the likely speeds of vehicles involved and the potential for very severe accidents, not the least fatalities.  
  
How any governmental agency can ask for a waiver in shoulder widths, setting aside the fact these accidents that are guaranteed to take place in a 2-mile tunnel where the delivery of emergency services is in clear doubt, ought to be a major concern to not only governmental agencies but to every motorist.  
  
Incidentally, this access concern is reflected in the provision of emergency egress points every 600 feet, complete with "4-hour Fire Doors".  (See Figure 4, Proposed Tunnel Section with Emergency Egress,  
page 10, Draft SR 99 Bored Tunnel Alternative, April 2009)  
  
I hope this information is of value to you and helps to support your position.  
  
Frankly, and to place a different perspective on this Alaskan Way project, what we have is the curious contrast of replacing the entire AW viaduct because at some time undefined, perhaps far in the future if  
ever in our lifetimes, there may be an earthquake, it may (or may not) fall down as a result, and if it falls down there may be accident victims.  Against this we have the absolute certainty that with this  
tunnel design there will be accidents and there will be victims.  How can this be project be justified given an obtuse likelihood versus a guaranteed outcome.  
  
Importantly, when it was presented to the legislature last winter, at the behest of the Seattle Downtown Association, did anyone provide any information, as above, for discussion/argument purposes?  
  
Last, and in closing, I am taking the opportunity of forwarding a copy of this to Representative Marylou Dickerson of the legislative transportation committee (LTC) and to Mr. Douglas Henderson, Joint  
Council of Teamsters No. 28, both of whom may share my concerns regarding traffic safety.  
  
Call me at 206/723-4567 if you have any questions  
  
Chris

Ms. Dickerson:  
  
I wanted to call and congratulate you on such a fine article in the Seattle Times the other day.  Well done.  
  
In the interim, and if you are still on the LTC, I wanted to send you some of my thoughts on the Alaskan Way replacement tunnel project which, to me as a traffic engineer, has all the earmarks of a  
negligent design.  To that end I have done some research on the matter.  It is attached for your information.  
  
If you have the time maybe we can meet at Starbucks for coffee and cake.  
  
Chris  
  
206/723-4567

Elizabeth:  
  
Thanks for the subject study.  Very interesting indeed.  
  
Setting aside the study and its findings for the moment what is most interesting, and important too, is that there are obviously enough problems with tunnels that these (China and Norway) engineering  
studies were under taken in the first place.  And, as the authors say, to date it seems that only the Norwegians have taken a hard look at the issue.  
  
From the research I have not seen much of the Goetherd (spelling) Tunnel in the Alps although it has been the scene of a spectacular collision with a fire that raised the temperature far into the 1,000's  
(C).  Getting to that fire was a major problem.  
  
What we do know so far is that WSDOT does not seem to have taken the accident issue to heart.  It is not on their horizon from what I can glean, especially if we look at the design with varying shoulder  
widths on the right side that, every 600 feet, are too narrow to get fire equipment to the scene.  In fact, the major issue here is that with the regular, non-constrained, tunnel width the left shoulder is  
only 3'-3" and the right shoulder is 7'-3" but the 7'-3" shoulder is reduced to a mere 3'-3" which obviously precludes access by a fire engine (fire apparatus as they like to call them) that is 8' wide.  
For short, with a shoulder width of 3'-3" on both sides of the NB lanes and with jammed traffic conditions - the usual result of any accident - how does the fire rig or ambulance for that matter get to  
the scene?

Actually, while WSDOT calls for a proposed "3 feet 3 inches" in table 1 of page 13, Figure 4 on page 10 shows the shoulder next to the stairwell wall as being only 3 feet.  
  
From this you can see that in the lower (NB) tunnel, the right shoulder being reduced to only 3' is even worse.  Moreover, as you have doubtless read, this reduction takes place every 600 feet inside  
the bored tunnel so it is not a once-only-happening, it is a series of "bottlenecks", maaybe as many as 20.  
  
Although the actual "bottleneck" is 80' in length its regular spacing along the length of the deep bore tunnel makes the access of emergency vehicles problematical at best and impossible at worst if there is a complete traffic jam.  
  
Looking at page 13 of their Design Deviation No.1 document, Table 1: Shoulder Widths, it seems that the narrow shoulders start at engineers station 200+00 and end at 319+90 which is a length of 11,900 feet or 2.27 miles.  For short, the "bottlenecks" occur in slightly more than 2 miles of deep bore tunnel.  From the map this is from Royal Brougham Way up to about John Street or thereabouts,  
  
With a length of 11,900 feet and "emergency egress" every 600 feet it seems there will be 20 of these constructed within the deep bore tunnel.  
  
The actual functioning of the escape route is not clear to me.  Again from Figure 4 the various stairways are to be built behind a vertical concrete wall that separates the tunnel traffic from the pedestrian  
traffic.  Thus, to gain access to each set of stairs you have to walk along the tunnel roadway shoulder until you get the the "fire door". Once you get into the separated walkway way you can turn left or right  
to climb up to the mezzanine level and then, on that mezzanine, turn to the outside of the tunnel to get to the next set of stairs to reach the upper floor that is on the same level as the SB lanes.  This second set of stairs is in two parts with a 4' landing between them.  
  
When you are on the upper level of the walkway you will note that the vertical concrete wall still separates you from the SB traffic.  The trouble is, as far as I can surmise, is that there is not enough space between the outside tunnel "circular" wall and the uppermost stair well for any linear pedestrian movements.  Thus, if your are trying to ext the tunnel, when you are the upper level, same level as the SB lanes, you have a set of down and up stairs to navigate every 600 feet - unless you leave the safety of the separated walkway and re-enter the SB shoulder via one of the fire doors.  
  
And, as we discussed before, there is no handicapped (HC) access at all.  
  
I'll send you a note on the highway capacity and slow-truck-rear-end accident issues raised by the requested Design Deviation No.3 that will be implemented for allowing long non-standard grades.  
  
The "preferred alternative" has a 4,000 foot, 5% grade at the south end and 3000 foot 5% grade at the north end.  Both are well above the standard 900 feet now permitted.  Both have two areas of concern - (1) highway capacity and (2) accidents.  
  
More on that anon.

Elizabeth:  
  
First, we are located down here about a mile south of Rainier Beach in one of those houses hanging over Lake Washington on the left side of Rainier Avenue as you head south to Renton.  (9688 Rainier Avenue S.)  
  
Been here about 35 years, or so.  
  
Second, reducing the tunnel bore by 2 feet surely poses a new problem or, perhaps better stated, makes for an even more tenuous resolution. After all, they were already asking for major modifications to the  
Design Manual and now have to make them even worse.  
  
The trouble I am having is that deep bore tunnel proponents like Taloe Washburn with the Downtown Seattle Association, actually an attorney with Foster Pepper, and his cadre got this through the legislature despite recommendations from the so called "stakeholders" with none of these significant elements being even broached let alone openly discussed.  AMAZING.  
  
So now the will of the governor, based on a mere thought of some sort of enhanced waterfront, whatever that may be, has to be engineered through what may be seen as significant public safety hurdles.  And that doesn't even touch the ADA issues not even addressed to date.  
  
Chris

Elizabeth:  
  
Got your note and yes, I did see that:  
  
1.   The RFQ on page 7, at the first bullet in the lower part of the page, references an "interior diameter" of 52 feet.  
  
2.   That the Design Deviation Number 1 document on page 10, Figure 4, shows an outside diameter of 54 feet.  
  
Thus, as of now we have those two dimensions suggesting a tunnel wall thickness of 2 feet.  
  
The RFQ also notes on page 2, in the top paragraph, the need for the project since there is allegedly, from an earlier study, a 1 in 10 chance during the next 10 years the Alaskan Way Viaduct may be rendered unusable, or words to that effect.  
  
What bothers me is that the subduction generated earthquake in Napier, New Zealand, in 1931 lead to a ***vertical*** displacement of some 12 feet.  Indeed, the Napier Airport is now built on what was the old seabed - a long flat piece of land well suited for the task.  
  
By the way, that earthquake leveled the City of Napier.  
  
If the next earthquake hitting Seattle is also due to plate subduction, the kind that created the mountains we have to the east including the Rockies, why will it not include a similar huge vertical *displacement*, al la Napier?  
  
If such a vertical displacement is produced, what is the value of the tunnel?

So, yet again, we have this assumed problem with the potential for loss of life on the current AWV versus a guaranteed loss of life with the tunnel design during its everyday normal operations and, if there is an earthquake, no assurance it, too, wont produce an even worse outcome than if the current viaduct was merely retro-fitted as proposed by Victor O. Gray, P.E. some years ago or, in the alternative, if a new overhead viaduct is constructed?  
  
Did not the proposed new overhead AW viaduct replacement not include 10-foot shoulders, since that is a major concern with the tunnel?  Thought I'd ask.  
  
Chris

So, yet again, we have this assumed problem with the potential for loss of life on the current AWV versus a guaranteed loss of life with the tunnel design during its everyday normal operations and, if there is an earthquake, no assurance it, too, wont produce an even worse outcome than if the current viaduct was merely retro-fitted as proposed by Victor O. Gray, P.E. some years ago or, in the alternative, if a new overhead viaduct is constructed?  
  
Did not the proposed new overhead AW viaduct replacement not include 10-foot shoulders, since that is a major concern with the tunnel?  Thought I'd ask.  
  
Chris

Elizabeth:  
  
Per your morning's request here is the copy of the infamous key staff letter to MacDonald .  
  
It really condemns the Nickels' tunnel proposal since it removes a shoulder in the peak hour - the 12 foot shoulder they wanted to use for peak hour traffic only - that, in turn, reduces available shoulders for emergency purposes. See their Question 2 answer.  
  
Also, they said it was capacity deficient.  See their "Answer 4".  
  
In essence, they are forging ahead with a tunnel whose geometric (cross sectional) design they vigorously opposed in the Nickels' tunnel.  
  
In closing, I will not send my next letter to the governor, et al. until you have filed the complaint.  
  
However, I would like to clue-in Dave Ross who is set to appear in the main public library on October 5th, per the Seattle Times promotion in today's edition, to question both candidates.  How about that?  
  
Maybe your complaint will be filed by then?  
  
Chris

Elizabeth:  
  
I was in a hurry to get the staff's letter to the secretary of DOT off to you and forget to draw your attention to their page 4, Question 1.  
  
Check out the "answer", line 6, starting with, "... justify a departure when safety and operational concerns can be satisfied.  
  
That should be used in your filing in bold print, with italics, since all the data we have from  the most current research is that accident frequencies will go up when the shoulders are significantly reduced.   That was clearly voiced in the February 13th memo to MacDonald by the senior corridor staff, no less.  
  
Happy reading.  
  
Chris

Oct 1

Elizabeth:  
  
Thanks for the subject report which I have briefly scanned.  I have copied several relevant pages of interest.  
  
The north and south portals, while important, do not really interest me so much as the actual deep bore component since that is the obvious sector where cross sectional geometry can never be made to fit the design needs mandated by considerations of public health, safety and welfare - not the least for handicapped citizens in need of escaping significant accident hazards such as fire or flooding.  
  
I see that the entire report deals with construction elements, from start to finish.  
  
No one looks at traffic safety, ventilation, illumination, (but signing is mentioned) or traffic operations regarding highway capacity.  
  
I suppose that is yet to come.  
  
More later, this is just my first cut.  
  
By the way, do you have a date when the matter gets placed before the court?  
  
Chris

Elizabeth:  
  
The great trip east has been put for some time now since my wife, Maggie, has just finished her exam at Group Health and got word of a new lump that needs to be checked-out with the usual testing, etc.  That is set for next week and so, since she needs a driver, and that is what I do, we are here for a while, at least up to October 13th.  
  
Ah!   The things that interrupt an otherwise dull life!  
  
By the way, I see in the Appendix of the March 9th report, Under Item I, top paragraph, they talk about "    WSDOT standard design criteria."  Well guys, that has not yet been modified and at the least needs concurrence by FHWA.  
  
And their Item II A describes "... a new set of environmental documentation, public review ..." and that is to be done by April 2011.  
  
There are significant hurdles yet to come that, in my judgment, are missing in their entirety.  
  
Last, be careful of an agency that will in a years time tell us, "We have spent so much money on the tunnel we can't just give it up, can we?"  Any bets that will emerge?  
  
Chris

Victor Gray Communications:

July 2009

Craig Keller wrote:

Would seem to be a tidbit that Elizabeth could take to a wary news media.  Victor, was this news in your paper copy of ENR?  Can Elizabeth look this up on the internet?  
  
Craig  
  
Victor Gray wrote:

You may have seen this already but a report by ENR that the DOT is  now talking with the possible tunnel builders who state that the cost of the machine is about 50 million and will take 18 to 24 months to build the machine. Not a word in the local press about this.

What this means is of course a two year delay in the start of the main big dig.. The DOT timetables mean nothing.

Vic

Sept 2009

Beth:

Thanks for sending me the 9 emails from the DOT. It appears from what I have read is that the DOT is having some real problems with the tunnel plans. At the south end they now realize that a top down cut and cover will need to be used for the first 600, with extra costs. More importantly they are now planning on deviations from accepted standards for the shoulder widths and ramps on and off on the left. All of this is proposed so that the tunnel will fit into a 54’ diameter. The current limit on the tunnel boring machines. My guess is that the DOT is now dickering with the few TBM suppliers as to what they can get. Maybe a 60 diameter would resolve the problems at extra costs.

However the bigger issue to me is the layouts at both the north and sough portals to merge the traffic into just two lanes each way.. I wonder how they plan to answer Peter Phillips letter of 6/5/09 on behalf of the BINMIC action committee. With out question all of answers will require extra costs as well as time to get agreement form all of the parties.

The existing viaduct must be kept open and no demolition of the south section.

 Over all the emails from the DOT show that they are good at dragging things out and keeping their staffs busy. What I would like to see is the schematic plans from the DOT and why they are still debating over criteria for the seismic design.

Thanks again for the emails and keep me posted.

 Vic

Seattle Viaduct Options Narrowed

12/17/2008 Engineering News Record

As a self-imposed 2009 deadline nears regarding whether to rebuild or raze the 55-year-old Alaskan Way Viaduct in Seattle, a consensus seemss far off.

In early December, a task force whittled down a list of eight design options to two: a six-lane boulevard or a reconfigured elevated highway. The former option, a six-lane waterfront boulevard resembling San Francisco’s Embarcadero, would cost $2.2 billion. With related Interstate 5 work, mass transit and other projects, that amount increases to $3.3 billion and would take 5.5 years to build. The other option, twin bridges, would cost $2.3 billion. After traffic mitigation and related projects, that figure climbs to $3.5 billion and could be completed in 6.5 years, if the viaduct is partially shut down during construction, and in 8.5 years if the viaduct is not shut down.

An idea to build a four-lane, mile-long bored tunnel was originally discarded because of its $4.5 billion price tag. But an analysis by Arup Inc., commissioned by the Cascadia Center at the Discovery Institute, a Seattle-based public-policy think tank, pegged the cost at no more than $1.7 billion. “This would be a bargain for a tunnel that would serve the region for 100 to 150 years rather than the estimated 50 years of useful life for an elevated structure,” says Bruce Agnew, director of the Cascadia Center.

In a Dec. 8 letter to planners, local engineers with HNTB Corp., Robbins Co., Sauer Corp. and others urged decision makers to reconsider the tunnel option. “There are other opportunities to reduce costs and increase benefits by considering other innovative approaches, such as using a single large-diameter tunnel rather than twin bores,” advised firm executives.

Seattle Mayor Greg Nickels has said in the past that he would oppose an elevated highway. In 2007, Nickels’ office suggested the mayor would refuse to issue construction permits in order to block such a project. He has advocated a bored tunnel.

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Billions in Bonds Voted, but Big Defeats for Some Issues  
  
enr.construction.com - 11/18/02

By Debra K. Rubin, Paul Rosta, Mary B. Powers, Stephen Daniels, Tony Illia and Kathleen McFall

WASHINGTON STATE

While Seattle voters bucked the statewide trend, authorizing a plan for a $1.75-billion, 14-mile-long monorail, state officials must now go back to the drawing board for transportation funding.

Governor Gary Locke noted his disappointment with the election results but vowed to begin work on a new transportation package that addresses voters' cost and accountability concerns. "Hundreds of thousands of people across the state said they want transportation improvements; they just didn't want the package that was on the ballot," Locke said.

Douglas B. MacDonald, secretary of the Washington State Department of Transportation, says the Nov. 5 vote will effectively terminate the handful of "megaprojects" under way in Washington, including replacement of Seattle's aging and seismically vulnerable downtown waterfront viaduct, construction of a new floating bridge across Lake Washington and a planned widening of Interstate 405---all billion-dollar projects. It will also cost the transportation department 600 jobs over the next two years.

"As a practical matter, this means there is not going to be any new construction in the state in the next biennium," says James Metcalf, former manager of public involvement for United Infrastructure Washington Inc., the Bechtel/Kiewit joint venture building the Tacoma Narrows Bridge.

"The immediate impact, for firms like ourselves, is that a lot of projects are either going to be put on hold or greatly reduced in terms of their scope and budget," says Jared A. Smith, vice president and area manager for Parsons Brinckerhoff.

Parsons was part of a business coalition that raised more than $4 million in support of the transportation referendum. It also now has a contract to manage environmental impact statement preparation and preliminary design for the Alaskan Way Viaduct, a planned $10 billion project that Smith says is now on a back burner. "We are looking at a cutback in the project of at least two-thirds," says Smith. "It will be a dramatic reduction."

"Essentially, DOT is now down to a preservation and maintenance mode," says Metcalf. "They'll be laying off 600 people over the next two years. This was a serious setback. "The only projects in the state now are Sound Transit (Seattle light-rail) and the Tacoma Narrows Bridge (an $820 million project). It's a crying shame the legislature didn't pass a transportation package when they had the opportunity to do so."

Smith says the overall impact of the I-776, the rollback of license fees, will be $1.3 billion over the next 10 years."It will have a dramatic impact on city and county highway programs. Seattle is looking at a nine percent reduction, the county, likewise."

The $7.8 billion gas tax referendum was to have been paired with a proposed $11-billion regional transportation package that was to go before Seattle-area voters in May. Whether that package will now go to voters is uncertain. There also is talk of sending a revised R-51 back to voters in the spring. But backers are disillusioned by last week's vote, say sources, and will be reluctant to spend additional time and money if the odds of passage don't improve.

The present monorail connects downtown Seattle to the Space Needle, a roughly 3-minute ride that is primarily a tourist attraction. The proposed expansion will connect Ballard, West Seattle, downtown, the stadiums and Seattle Center. If approved, engineering, design and permitting is expected to take about two years and construction another two, according to Elevated Transportation Company, the force behind the measure. While this first expansion is about 14 miles, the long-term vision is for a 58-mile network.

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| **transportation** |  |
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| **PROJECTS** | |
| **Pittsburgh TBM Jams Again With New Two-Week Delay** | |
|  | |
| 04/24/2008 | |
| [By Jonathan Barnes](mailto:enr_web_editors@mcgraw-hill.com) |  |
| |  | | --- | | Pittsburgh tunnel  Port Authority of Allegheny County  TBM is stuck in its tracks. |   For the second time in two weeks, the 500-ton boring machine digging Pittsburgh's North Shore connector light-rail project is jammed.  In early April, a large tree trunk lodged at the front of the machine and clogged a 10-inch "slurry" outtake pipe. The pipe mixes water with excavated dirt and crushed rock and pumps it to a surface pit for disposal. The 20-inch stump was removed and boring work resumed after a one-day delay, says David Whipkey, spokesman for Port Authority of Allegheny County, owner of the project.  Shortly after the first jam, the German-made machine's outtake again became clogged with wood. The machine will not be functioning again for about two weeks, Whipkey says. The blockage has stopped tunneling work on the North Shore Connector, which when completed will include twin tunnels beneath the Allegheny River that will connect the city's light rail system from downtown Pittsburgh to stops on the city's North Side.  The boring machine had dug 720 ft of tunnel from its North Shore launch pit, and is about 10 ft from the river. Drilling began on Jan. 22 and had been progressing at a rate of about 30 ft per day—exceeding the Port Authority's goal of 25 ft per day.  To repair the machine, soil and rock at the front of the machine's 21-ft-diameter cutting head will be grouted with concrete before a repair team enters a pressurized chamber to remove the blockage, which consists of pieces of wood and clay. The repair crew will inspect and replace worn teeth on the cutting head and perform any other needed maintenance.  German firm Herrenknecht manufactured the boring machine. North Shore Constructors, a partnership of Pittsburgh-based Trumbull Corp. and Japanese firm Obayashi Corp., is the North Shore Connector project contractor. | |