



**New York State Department of Transportation
Metropolitan Transportation Authority Metro-North Railroad
New York State Thruway Authority**

Presentation

***Stakeholders' Advisory Working Groups (SAWGs)
Environmental SAWG Meeting #10***

***Tappan Zee Bridge/I-287 Corridor
Environmental Review***



March 26, 2009

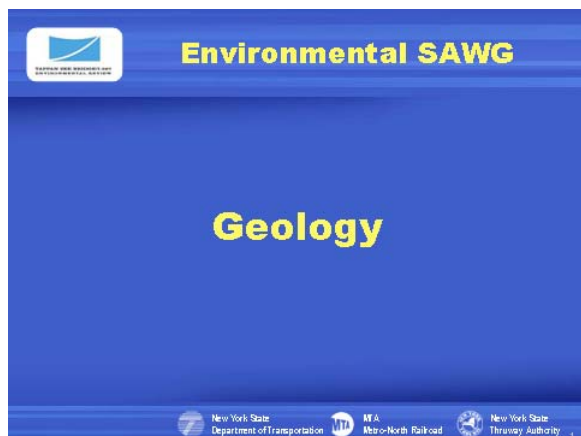


Slide 1




Slide 2

This presentation will address three separate but related topics. First is geology, which will cover the history of the formation of the study area. Second will be a discussion of contaminated materials and how they may impact project alternatives. Finally, new data from a second round of Hudson River sediment sampling will be provided (the results of a previous round of sampling was discussed in an earlier SAWG presentation).






Slide 3

The first portion of the presentation will cover the geology of the study area.




What is Geology?

- The study of the earth
 - Materials
 - Formation processes
- Physical manifestation
 - Bedrock formations
 - Soil types
 - Topography and major features
 - Ridges, valleys, rivers, lakes

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Slide 4

Geology is broadly defined as the study of the earth, and in particular the materials it is made of and their formation processes. The major geologic features we see around us that result from geologic processes include bedrock formations, the soils that overlie them, and the major topographic features that we see at the surface (including ridges, valleys, etc.).



Reasons for Analysis

- Identify how geology affects the project
 - Soil and rock types
 - Seismic parameters
- Design considerations
 - Stability of cuts and embankments
 - Areas of shallow or exposed rock
 - Seismic design

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Slide 5

Geologic impacts to the project may include design of structures to account for specific issues related to the local soil or rock conditions, as well as design to resist seismic (earthquake) activity. These design considerations might include reinforcement of cuts or embankments, alternate designs in areas of shallow rock, and designs that account for both foundation and structural stability during earthquakes.




Topics

- Bedrock
- Soils
- Seismicity
- Groundwater



www.njpalisades.org

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Slide 6



The presentation of geologic features in the study area is grouped into four major categories: bedrock, soils, seismicity and groundwater.



Photo: http://www.njpalisades.org/taranto_2825.jpg



Rock Types

- Igneous
 - Formed from magma
 - Basalt, granite
- Sedimentary
 - Formed by consolidation
 - Most common surface rock type
 - Sandstone, shale
- Metamorphic
 - "Changed" rock
 - Altered by heat and pressure
 - Gneiss, marble



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Slide 7


All rock falls into one of three types, depending on their means of formation: igneous, sedimentary or metamorphic.

Photos:

Top - en.wikipedia.org/wiki/File:Igneous_rock_Santoroni_Greece.jpg


Middle - en.wikipedia.org/wiki/File:Sandstone_Soil_Sample.jpg



Bottom - en.wikipedia.org/wiki/File:Migma_ss_2006.jpg



Rockland County Bedrock

- Reading Prong
 - Far western edge of study area
 - Predominantly gneiss and granite
- Newark Lowlands
 - Most of Rockland County
 - Predominantly sandstone and shale
 - Palisades ridge is diabase



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Slide 8

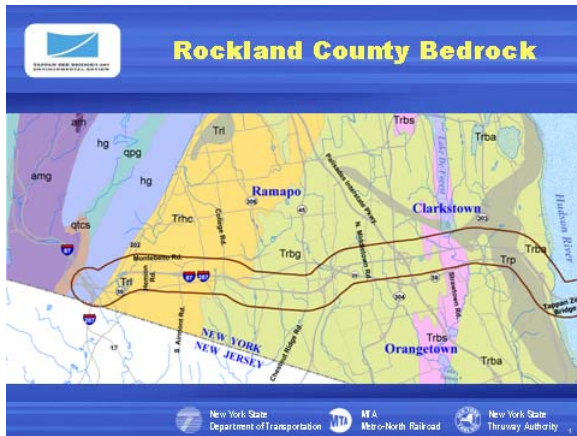
Adjacent rocks that are formed by similar or related processes are typically grouped into “physiographic provinces.” There are two such provinces in the study area in Rockland County – the Reading Prong of the New England Province passes across the very western edge of the study area, while the Newark Lowlands form the bulk of Rockland County.

Photos:

Top - http://en.wikipedia.org/wiki/File:Granite_Yosemite_P1160483.jpg

Bottom -

<http://mulch.cropsoil.uga.edu/soilsandhydrology/Important%20Rocks%20&%20Minerals.htm>



Slide 9

The triassic-aged Hammer Creek, shale and sandstone formations (labeled Trhc, Trbg and Trbs/Trba, respectively) of the Newark Lowlands underlie most of Rockland County. The shales and sandstones from this formation are perhaps most famous for their use in “brownstone” buildings, which are common throughout urbanized areas of the New York City region. The Palisades Ridge is an intrusion of igneous diabase that was formed by magma flows that escaped through cracks in the underlying sandstone, and is a very hard rock that is often quarried for use as aggregate in concrete. Several quarries are or have been located in or near the study area, including one active site within the study area in West Nyack, and another former quarry near Suffern.



Slide 10

All of the bedrock underlying Westchester County is of the Manhattan Prong of the New England Province. The county is marked by a series of distinct north-south trending ridges that are the result of a pattern of tightly-banded rock types; as the glaciers retreated, the softer marble formation (seen in the photo at right) was more easily eroded, as compared to the harder schist and gneiss formations (seen in the left and center photos), creating a series of valleys.

Photos:

Left - <http://en.wikipedia.org/wiki/File:Schist.jpg>;

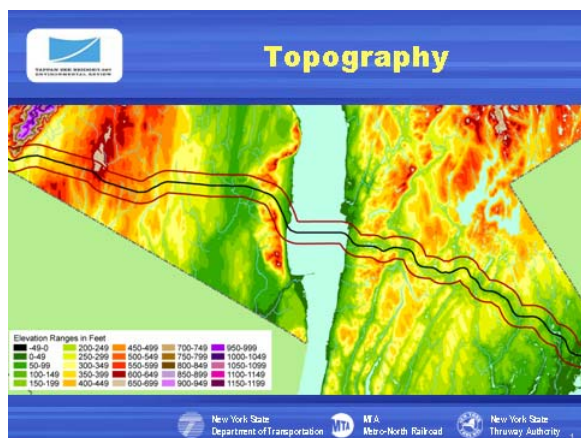
Middle - <http://www.washington-heights.us/history/archives/000446.html>;

Right - <http://www.johnbetts-fineminerals.com/jhbnyc/articles/inwood.htm>



Slide 11

The tightly-banded bedrock pattern in Westchester County is clearly visible here, particularly in the central portion of the county. The bands of Manhattan schist (labeled Om) are the same kind of rock that many of the skyscrapers in New York City are founded on. Also notice how many of the streams and rivers coincide with bands of Inwood marble (labeled OCi), which is the most-easily eroded rock type in Westchester and underlies most of the valleys.




Slide 12

This topographic map shows how the bedrock formations influenced the layout of I-287. In Rockland County, the wide expanses of similar rock types led to a uniformly-sloping base, and as a result the highway is generally straight. One geologic feature that directly influenced the location of the highway in Rockland County is a natural saddle, or low point, in the Palisades ridge near Nyack that dictated where I-287 would pass into the central portion of the county. Conversely, in Westchester County the highway alignment is much more erratic, as it seeks out natural low points along the sides of ridges as it works its way across the county.






Slide 13

Beneath the Hudson River, the relatively softer rocks of the Newark Lowlands come into contact with the harder rocks of the Manhattan Prong, and some fairly unique geology is the result. The water flow from melting glaciers cut a very deep valley into the rock here that filled in over time, primarily with clay – in some places, there is as much as 700 feet of sediment overlying bedrock. The thick formation of clay and large depths to bedrock are the primary reasons behind why the existing bridge has such unique foundation designs (such as buoyant chambers for the main span).




Soil

- Sources of soil material
 - Glacial deposits (till, outwash and kames)
 - Riverine deposits (alluvial)
 - Lacustrine
- Soil series
 - Groupings of a particular soil type
 - Based on color, texture, soil structure, etc.

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Slide 14

The type soil that overlies the bedrock at a given spot and the properties of that soil depend most directly on the source material (essentially, the rock type from which it was originally eroded), and the means by which the soil was placed (such as from direct contact of a glacier with bedrock, or sediment that settled out from historic or current lakes and rivers, etc.). Similar soil types are grouped by the Natural Resources Conservation Service (NRCS) into 'soil series.' There are over 20 soil series in or near the study area in Rockland County, and more than 15 in Westchester County.




Soil Characteristics

- Organic soils
 - Caused by decomposing organic matter
 - Usually very compressible; affects foundation design
- Reactive soils
 - Can be corrosive to steel and concrete
 - Most of Rockland and much of Westchester is at least "moderately" reactive
- Hydrologic soil groups
 - Determines how precipitation infiltrates or runs off
 - Affects drainage design

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Slide 15




The soil properties that are of particular interest from a design standpoint include organic soils (which are easily compressed; structures on organic soil often require special foundations), reactive soils (essentially, overly acidic or basic soils that can corrode steel and concrete), and hydrologic soil groups (the NRCS groups most soil types into one of four categories based on how easily precipitation drains – group A soils drain freely, while group D soils drain poorly; this directly affects drainage design).



Seismicity

- Earthquakes caused when strain is released
- Usually at faults, but can happen anywhere



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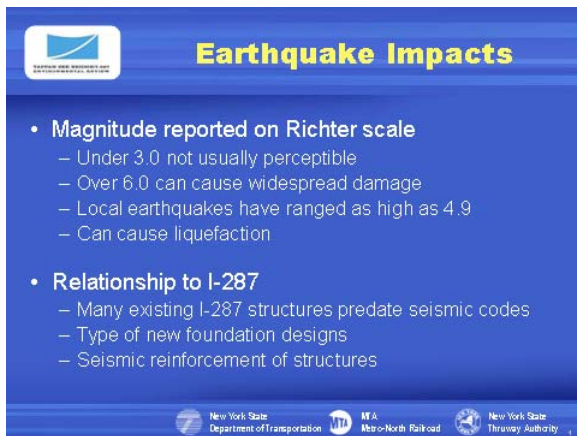
Slide 16

Earthquakes happen when enough strain has built up within the earth's crust that something 'breaks,' and pieces of the crust move. Earthquakes can happen anywhere, but usually occur at faults, such as the San Andreas fault in California (shown at left). In 1989 the San Andreas fault slipped by as much as 6 feet in some places, leading to damage such as that shown to the right, which is a photo of the Cypress Viaduct (I-80) through Oakland.

Photos:

Left - <http://pubs.usgs.gov/gip/earthq1/how.html>

Right - http://pubs.usgs.gov/dds/dds-29/web_pages/oakland.html



Earthquake Impacts

- **Magnitude reported on Richter scale**
 - Under 3.0 not usually perceptible
 - Over 6.0 can cause widespread damage
 - Local earthquakes have ranged as high as 4.9
 - Can cause liquefaction
- **Relationship to I-287**
 - Many existing I-287 structures predate seismic codes
 - Type of new foundation designs
 - Seismic reinforcement of structures

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Slide 17

Earthquake strength is often reported on the ‘Richter scale,’ which is a logarithmic scale that measures magnitude. Because it is logarithmic, each whole number increment represents a ten-fold increase in magnitude. For example, a 4.0 earthquake is 10 times as intense as a 3.0 earthquake, and a 6.0 earthquake is not twice as intense as a 3.0 earthquake – it is actually 1,000 times as intense.



Groundwater

- Exists nearly everywhere
- Result of infiltrating precipitation
- Movement controlled by soil type
 - Fast movement through sand and gravel
 - Slow movement through silt and clay
- Groundwater divides usually match watersheds

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Slide 18

Groundwater is the naturally-occurring result of precipitation filtering into the soil, and exists nearly everywhere.



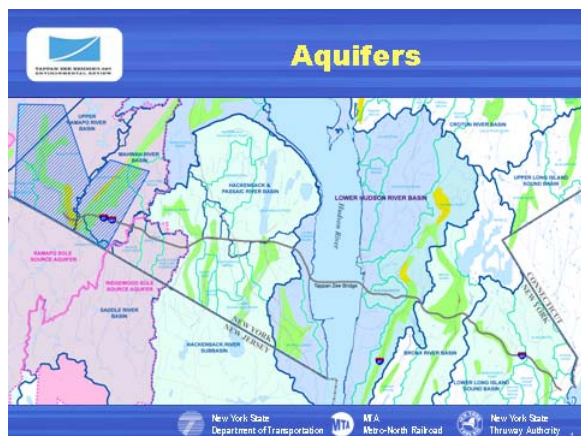
Aquifers

- **An aquifer is groundwater that can be “usefully extracted”**
 - Generally, a capacity of at least 10 gpm
 - Ramapo and Mahwah River aquifers actively used for drinking water
- **Sole source aquifers**
 - Provides 50% of a community’s water supply
 - Regulated by EPA to prevent pollution
 - Ramapo and Ridgewood (Saddle River) aquifers

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Slide 19

‘Aquifer’ is the term used to describe where groundwater has accumulated in sufficient quantities such that it can be usefully extracted, such as for drinking water or industrial uses. In New York State, this is generally understood to be any aquifer where a well could produce at least 10 gallons per minute (gpm). When an aquifer supplies more than half of any community’s water supply, that aquifer is known as a ‘sole source aquifer.’ Sole source aquifers are protected by federal regulation; any major project requiring an EIS that overlies a sole source aquifer and receives federal funding must be approved by the Environmental Protection Agency.



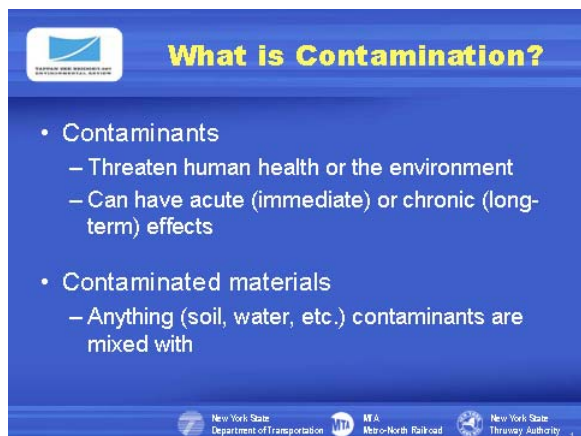
Slide 20

The groundwater drainage areas are outlined in blue and green lines, and aquifers are shown in green and yellow – green represents basic productive aquifers (those that produce at least 10 gpm), while yellow represents highly productive (greater than 100 gpm) aquifers. There are several productive aquifers throughout the study area, generally corresponding to river valleys. The Ramapo and Mahwah River aquifers are heavily used for drinking water in Rockland County, and are designated and protected by the NYSDEC as ‘primary’ aquifers (denoted by blue hatching). They are both also part of the Ramapo sole source aquifer. I-287 also crosses the Ridgewood sole source aquifer, which is not actively used for drinking water supply in New York but is heavily used in New Jersey. Both sole source aquifers are shaded in pink. Groundwater in the Westchester County portion of the study area is not actively used for drinking water supply, and no primary or sole source aquifers exist in the study area.



Slide 21

The second portion of the presentation will cover contaminated materials within the study area.



What is Contamination?

- Contaminants
 - Threaten human health or the environment
 - Can have acute (immediate) or chronic (long-term) effects
- Contaminated materials
 - Anything (soil, water, etc.) contaminants are mixed with

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Slide 22

A contaminant is any substance that threatens human health or the environment, and can have immediate or 'acute' impacts (such as poisoning), long-term or 'chronic' impacts (such as cancer), or both. In the context of a construction project, these contaminants often become mixed with soil and groundwater, which can complicate management and disposal of these materials from a site.



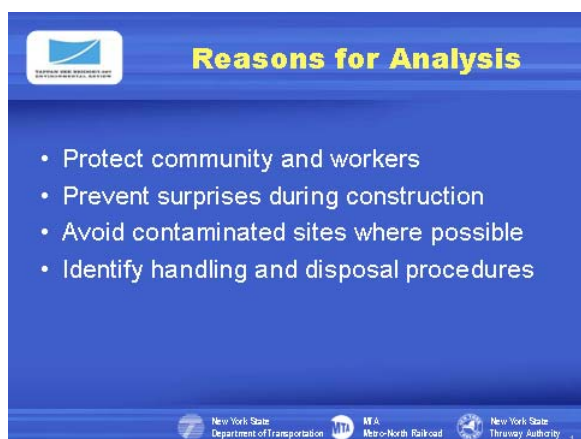
Review Process

- Find sites that may be contaminated
- Compare to project alternatives
- Identify "Sites of Concern"
- Investigate Sites of Concern
- Avoid or mitigate

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Slide 23

Generally speaking, the review process for this project will include a broad review of the study area for sites that are or may be contaminated, a comparison of such sites to project alternatives to see if there is a potential impact to the project, identifying and possibly investigating any such sites (known as 'Sites of Concern'), and developing plans to avoid or mitigate contamination from these sites.




Reasons for Analysis

- Protect community and workers
- Prevent surprises during construction
- Avoid contaminated sites where possible
- Identify handling and disposal procedures

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Slide 24

A primary goal of this analysis is to find out if (and how) both the surrounding community and site workers might need to be protected during construction. The analysis also aims to avoid 'surprises' that can negatively affect project cost if contamination is encountered. If contaminated sites are identified, then methods of either avoiding the contamination or means of proper handling and disposal must be identified.



Types of Contaminants

- **Metals**
 - Common residue of industrial processes
- **Volatile organic compounds (VOCs)**
 - Associated with petroleum products and solvents
- **Semi-volatile organic compounds (SVOCs)**
 - Associated with petroleum and coal products
- **Polychlorinated Biphenyls (PCBs)**
 - Found in transformers and electrical machinery

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Slide 25

While there is a wide variety of contaminants that might be encountered, this list encompasses that types of contaminants often found in areas with long-standing industrial development that may be encountered as part of this project.



Finding Potential Contamination

- **Phase I Environmental Site Assessment (ESA)**
 - Basic screening tool
 - Now done for most commercial property sales
 - Review existing and former site uses
 - Uses existing information

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Slide 26

The typical means of screening for contaminated sites is known as a Phase I ESA. They are performed according to established standards, so all Phase Is review a specific set of data sources. Phase Is have become a common screening tool over the past two decades, and are often performed regardless of whether contamination is suspected – in fact, they are now often required by lenders for commercial mortgage approvals. Phase Is don't look just at the site being investigated – data sources are searched for up to a mile away from the subject site to see if nearby sites may have caused wide-spread contamination. For this project, the screening employs most of the tools used for full Phase Is, although some data sources are omitted during the screening phase.



Site History – White Plains



19502006

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Slide 27

Aside from governmental records, common data sources reviewed during Phase Is include historic fire insurance maps (which document site uses and building types at varying intervals, dating as far back as the mid-1800s in some areas), and aerial photographs. In this example comparing downtown White Plains from 1950 to today, we can see that sites formerly used for leather goods manufacturing and electroplating have been replaced with residential and office towers, and parking garages. Without the historic mapping, such potentially contaminating site uses may not have been identified.



Slide 28

In this example comparing Nyack from 1946 to today, we can see a site formerly used as a mason's shop and yard is now occupied by the Nyack Department of Public Works. I-287 itself, as well as Cooper Drive, now occupy portions of what had been residential properties.



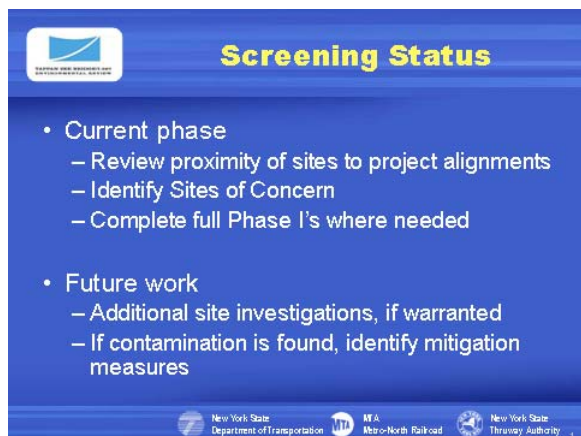
Slide 29

Phase I ESAs often find a variety of sites which may be cause for concern. Many of these sites have current or former site uses identified here.



Slide 30

If a site might be of concern, the next step is to determine what level of concern is justified, based on the available information. A site that has an environmental permit but with no records suggesting a release of contamination (for example, a site with a process water discharge permit but no spill reports) might be considered of low concern; conversely, a superfund site would be of high concern, because contamination has been confirmed. If contamination does exist, it becomes a question of whether enough exists to be of concern. State and federal criteria are used for comparison; if contamination exceeds these criteria, then the site is 'contaminated.'



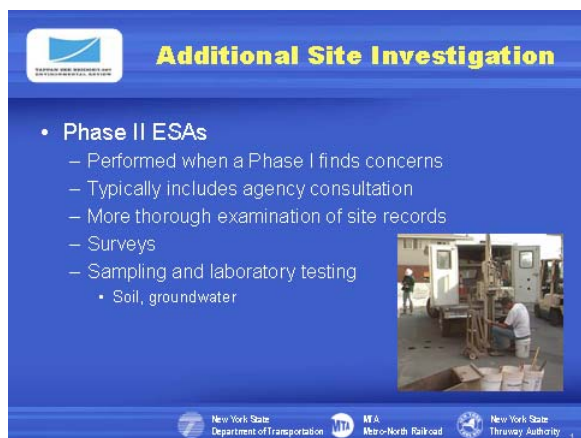
Screening Status

- Current phase
 - Review proximity of sites to project alignments
 - Identify Sites of Concern
 - Complete full Phase I's where needed
- Future work
 - Additional site investigations, if warranted
 - If contamination is found, identify mitigation measures

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Slide 31

The screening process is ongoing, and will result in identification of Sites of Concern. For some of these sites, a full Phase I will be completed (as opposed to the screening-level effort being conducted for the entire study area). If Phase I ESAs cannot definitively establish site conditions, further investigation may be warranted to confirm or rule out site contamination.



Additional Site Investigation

- Phase II ESAs
 - Performed when a Phase I finds concerns
 - Typically includes agency consultation
 - More thorough examination of site records
 - Surveys
 - Sampling and laboratory testing
 - Soil, groundwater



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Slide 32

If necessary, Phase II ESAs are typically the next phase of site investigation. They typically involve a more detailed review of site history and sampling of site soil and groundwater.

Photo:
<http://www.epa.gov/region09/mtbe/charnock/images/site23/23geoprobe3-16-00.jpg>



Mitigation Options

- Worker and community protection
- Removal (excavation)
 - If contaminated but not hazardous, landfill
 - If hazardous, treat then dispose
- Avoidance
 - Use foundations that avoid excavation and dewatering
- Remediation
 - Treat soil and groundwater to remove contaminants

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Slide 33

If contamination is confirmed to exist on a project-related site, mitigation will be employed. First, means of protecting site workers and the surrounding community are identified. Secondly, management issues are considered. Often, cleanup is accomplished by removal of the contaminated material. Depending on the level of contamination, landfilling or treatment of the removed material is employed. Sometimes, foundation methods that avoid excavation (such as pile foundations) are used. Another option is to treat the soil or groundwater to remove contamination.



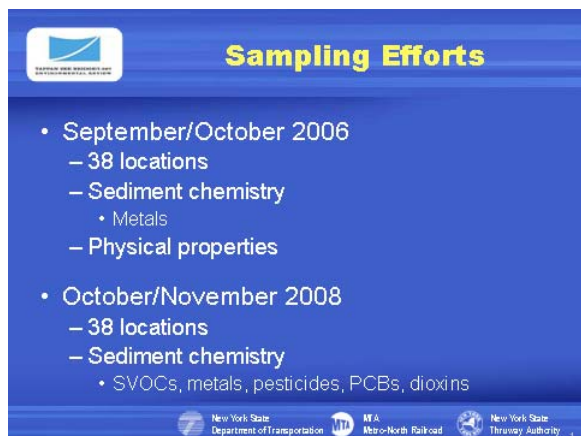
Slide 34

The last portion of the presentation will cover the results of sediment sampling within the Hudson River, and potential means of managing sediment if removal is necessary.



Slide 35

Sediment sampling was undertaken to identify the existing conditions of river sediments so that management and disposal options may be considered, and the potential impacts of resuspension during construction may be evaluated.



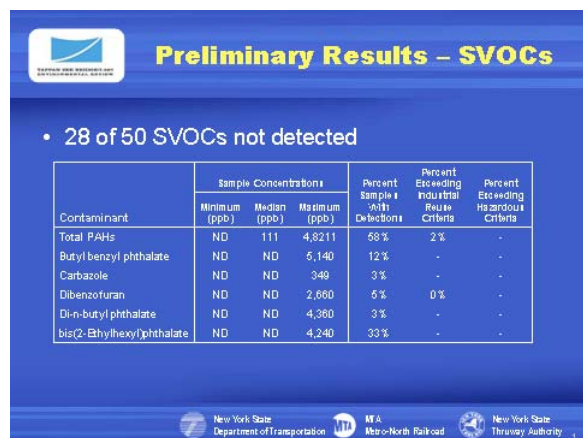
Slide 36

Two separate sampling events occurred. The first was in September and October of 2006; only data on the metals contents of river sediments is available for that sampling event. Data on metals, as well as a variety of organic pollutants are available from a second investigation conducted in October and November of 2008.



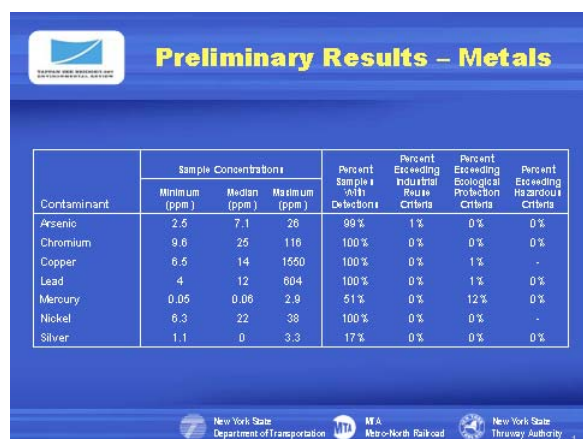
Slide 37

This map identifies the 38 locations from which Hudson River sediment was collected in the October/November 2008 program.



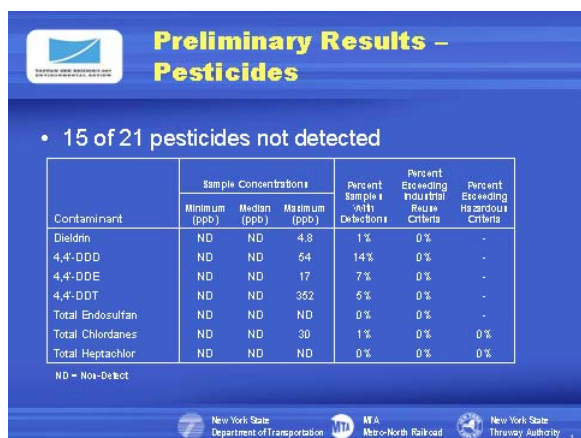
Slide 38

Most SVOC pollutants for which analyses were conducted were not found in Hudson River samples at the Tappan Zee Bridge. Of the samples where SVOCs were detected, the levels were generally low.



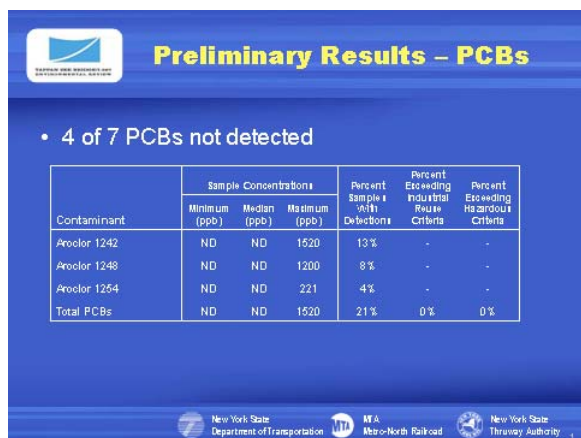
Slide 39

Metals are naturally occurring, and many of them will be found in any sediment or soil sample. In the case of sediments near the Tappan Zee Bridge, metals were commonly found, although generally at low levels.



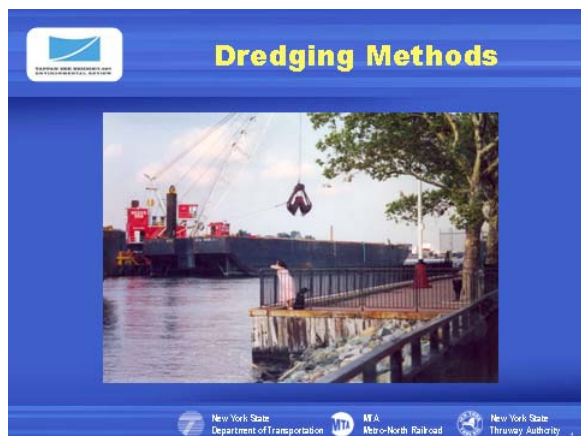
Slide 40

A majority of pesticide pollutants were not found in any Hudson River samples taken at the Tappan Zee Bridge. Of the samples where pesticides were found, the levels were generally low.



Slide 41

Most types of PCBs were not found in Hudson River samples obtained at the Tappan Zee Bridge. Of the samples where PCBs were found, the levels were generally low. PCBs are a pollutant of concern throughout the Hudson River due to historic releases near Fort Edward, NY.



Slide 42

If it is determined that sediment removal is required to construct a project alternative, several methods may be applicable. In this photo, a traditional 'clamshell' bucket is shown. This type of bucket removes sediment in large 'bites'. They are usually employed on navigational dredging projects.



Slide 43

This video shows an example of an ‘environmental’ bucket. This particular bucket is affixed to a hydraulic excavator with a GPS system allowing for accurate placement. This bucket also takes a ‘level’ or flat cut, making it ideal for projects in shallow water where resuspension may be a concern.



Slide 44

This is another example of an environmental bucket. This particular bucket has seals that work to prevent the escape and resuspension of dredged material as the bucket is closed and brought back to the surface.



Slide 45

Hydraulic dredges work by breaking up sediment with a ‘cutter-head’ and, essentially, vacuuming the disturbed sediment by pumping water through the head.

Photo:
<http://www.tug44.org/canal.corp.boats/ellcott-dragon-dredge/>



Slide 46

If dredged sediment must be transferred and handled on land, it typically first goes to a shoreside sediment processing facility to be dried out. The sediment can then be loaded out for reuse or disposal.



Slide 47

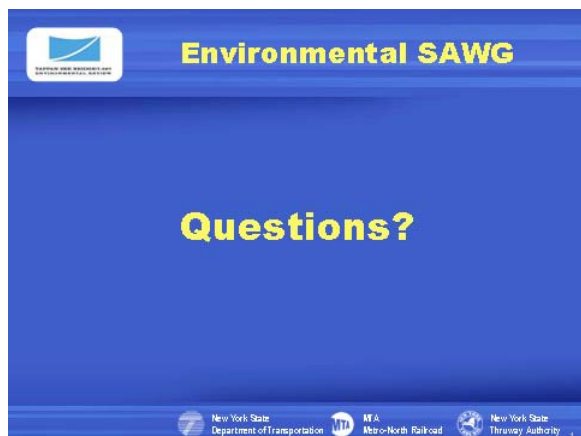
A long-standing means of disposing of dredged sediment is at sea. However, this method is now typically available only for uncontaminated sediments. For contaminated sediments, upland use may be an option if contamination is low, or if it the sediment can be stabilized. Reuse options include use as daily fill at landfills, or where large quantities of fill are needed for landscaping (as was the case at the Bayonne County Club, shown in this photo, where dredged sediment was used to create rolling topography for a golf course on a formerly flat site). If contamination levels rule out reuse, dredged sediments are then most typically disposed in a properly lined landfill.

Photo:
<http://www.nytimes.com/2006/02/26/nyregion/nyregionspecial2/26njC OVER.html>



Slide 48

This photo is another example of how dredged sediment can be reused. In this case, dredged material from the Port of Rotterdam is being used to create additional land for expansion of the port.



Slide 49