**NASJRB WILLOW GROVE**  
**RAB MEETING MINUTES**

Meeting Date: December 8, 1999  
Meeting Time: 6:00 p.m. – 8:00 p.m.  
Meeting Place: Navy Conference Room, Building 1, NASJRB Willow Grove

<table>
<thead>
<tr>
<th>Name</th>
<th>Organization</th>
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<tr>
<td>Thomas Hibbs</td>
<td>RAB Member</td>
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<td>Eric Lindhult</td>
<td>RAB Member</td>
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<td>John C. Martin</td>
<td>RAB Member</td>
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<td>Ray Leopold</td>
<td>RAB Member</td>
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<td>Kaye Maxwell-Martin</td>
<td>RAB Member</td>
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<td>Jim Edmond</td>
<td>NASJRB Willow Grove</td>
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<td>LCDR Mark Leemaster</td>
<td>NASJRB Willow Grove</td>
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<td>CDR Gilbert Viera</td>
<td>NASJRB Willow Grove (Co-Chairperson)</td>
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<td>Major Marge McGlinn</td>
<td>ARS Willow Grove</td>
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<td>Major Byron Schieber</td>
<td>ARS Willow Grove</td>
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<td>Charanjit Gill</td>
<td>ARS Willow Grove</td>
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<td>Col. Dana Marsh</td>
<td>ARS Willow Grove</td>
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<td>Scott Shaw</td>
<td>HSI Geotrans</td>
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<td>James Cotter</td>
<td>NORTHDIV</td>
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<td>John Way</td>
<td>Professor, Lock Haven University</td>
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<td>Dan Goode</td>
<td>USGS</td>
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<td>Kevin Kilmartin</td>
<td>Tetra Tech Nus, Inc</td>
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<td>Lori Baker</td>
<td>EPA</td>
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<td>April Flipse</td>
<td>PADEP</td>
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Jim Edmond opened the meeting and introduced Charanjit Gill to speak for the Air Force Reserve. Mr. Gill announced that the Air Force wanted to give the RAB an update on the pilot remedial action at the POL area.

Charanjit Gill introduced Scott Shaw, of HSI Geotrans, to summarize the status of remediation activities at the Air Force petroleum, oils, and lubricants (POL) site. Mr. Shaw presented a summary of the current status and history of remediation studies of JP-4 jet fuel in the Air Force POL area. The current remediation pilot program began in March 1999. The pilot project uses oxygen release compound (ORC) to promote biodegradation of contaminants remaining in the subsurface (soil and groundwater) at the site.

Oxygen released from the ORC (magnesium peroxide) promotes bacterial growth and attendant POL consumption by the bacteria. In the presence of oxygen, the bacteria consume the POL compounds, breaking the potentially toxic compounds down into harmless carbon dioxide and water. The ORC was injected into a series of 1-1/2 inch diameter wells. Results of groundwater sample analysis have been inconclusive. Upgradient monitoring well samples continue to show an absence of benzene, toluene, ethylbenzene, and xylene compounds, and there is dissolved oxygen present. Downgradient monitoring wells continue to have concentrations of benzene, ethylbenzene, and naphthalene, and limited concentrations of dissolved oxygen. The most recent downgradient groundwater sampling showed some results of benzene and ethyl benzene are lower. Continued monitoring will help determine if this trend is significant.

A RAB Member asked if other remediation methods were compared. Mr. Shaw stated that two other methods, Soil Vapor Extraction and Passive Recovery Trench were evaluated.

A RAB Member asked if low water table conditions of the summer drought or the effects of hurricane Floyd and the rainy weather in autumn could have affected the analytical results. Mr. Shaw agreed that fluctuations in water table affect the concentration of contaminants found in
groundwater samples; that is why continued data acquisition and analysis is needed before conclusions can be drawn.

A RAB Member asked if the ORC was injected all at one time, and why at the tail end of the plume rather than at the center of the plume? Mr. Shaw mentioned that the required amount of ORC was calculated based on the perceived size of the groundwater plume and injected all at once. No ORC was injected into the concentrated center of the plume because the high concentration of surface and subsurface utilities essentially made that area inaccessible to heavy equipment.

Mr. Goode asked if the Air Force is continuously monitoring water levels in the area? Mr. Shaw replied that the original plan included monitoring water levels monthly. The Air Force now has water level data back to 1998, and knows what to expect as far as fluctuations are concerned.

A RAB Member asked at what depth was the ORC injected? Mr. Shaw replied that it was injected as deep as possible, to an average depth below the ground surface of about between 9 and 11 feet, into the groundwater in the overburden soils.

Jim Colter, the Navy remedial project manager, provided a summary of how the Navy plans to proceed with each of the four NASJRB Willow Grove Installation Restoration program (IR) sites over the next several years. This was in reply to requests from RAB members in their response to the RAB Questionnaire. Mr. Colter's notes on this topic are attached. Mr. Colter also provided a copy of an article summarizing the PCB-contaminated soil removal activities completed at the Privet Road Compound Area Site near the Bowling Alley.

A RAB Member asked what is the relationship between EPA and the Navy, who is the final decision-making authority, and is EPA adequately staffed to guide this program? Mr. Colter replied that as a federal facility on the national priorities list (NPL), the Navy is subject to federal laws and the federal cleanup program administered by EPA, just like any private party cleanup. The Navy conducts the program, but throughout the process seeks EPA agreement and comment on conclusions and recommendations. EPA comments and points out if anything is missing before conclusions and recommendations can be finalized.

Glorie Baker, the EPA Project Manager, explained that the hydrogeologist assigned to this work is also responsible for the former NAWC Warminster project groundwater issues. Progress of the groundwater evaluation program at NASJRB Willow Grove (which is not a Base Realignment and Closure [BRAC] site) suffers because of the urgency of work at NAWC Warminster (which is a BRAC site) needed to speed the pending property transfer(s). Ms. Baker stated that EPA is currently dealing internally with the allocation of limited resources. Mr. Colter mentioned that some comments are being received, and there is progress underway. For instance, the planned temporary shutdown/pumping test of municipal well No. 26 near Site 5, and additional hydrogeological studies at Site 5 and Site 1.

Mr. Edmond reiterated that Mr. Colter's program summary (a copy of the chart is attached) was presented to reply to RAB member request for an update of program status in the Questionnaire, and introduced Dan Goode of the United States Geological Survey (USGS). Mr. Goode said that, (also) in response to a RAB request to make the RAB meetings less formal, he would use handouts rather than use the overhead slides he had prepared.

Mr. Goode has recently completed site-wide water level mapping to tie together water level data from the different parts of the air station. This preliminary discussion is to summarize background issues and to present preliminary results and findings. Mr. Goode introduced Professor John Way to summarize local geology. Mr. Way gave a summary of local geology and provided copies of handouts (copy attached).
Mr. Edmond asked about the impermeability of the diabase dike known to pass through the southern part of the base property and its effects on groundwater flow. Mr. Way explained that the dike is probably fractured in the vicinity of the air station, resulting in it being a leaky barrier.

Mr. Goode explained that the major goal of the (continuing) groundwater level investigations is to integrate the local (site-related) groundwater flow maps into a bigger picture. The handouts provided include figures and text explaining interpreted groundwater flow directions across the facility.

Mr. Goode explained Navy plans to use USGS and Tetra Tech NUS to perform water level studies in the vicinity of Site 5 – Fire Training Area. Horsham Township Water Authority (Ralph McQuaid) has agreed to stop pumping groundwater from municipal well No. 26 (H26) for an extended period (about 3 weeks) in January. The Navy team will measure effects of this shutdown on nearby wells. The USGS will analyze the data using mathematical methods to draw conclusions on the nature of groundwater flow in this area.

A RAB Member asked what portion of the Township pumping capacity is represented by H26? Mr. Edmond mentioned that the Navy water wells produce approximately 150 gallons per minute. Kevin Kilmartin, the Tetra Tech NUS hydrogeologist, felt that that rate was probably in the correct order of magnitude for well H26. (Editors Note: Horsham production well, H26 was producing approximately 275 gallons per minute in April 1999.)

Mr. Cotter asked if the flowing artesian wells at Site 3-Ninth Street Landfill would be a concern considering the increased water levels which may result in the deeper aquifer as a result of the H26 shutdown/pump test? Mr. Kilmartin said that he would expect no major trouble, he would be interested to see any potential impacts. Mr. Kilmartin agreed with Mr. Goode that the plugs used to stanch the flow of groundwater from the artesian flowing wells probably could withstand the additional head pressure from the anticipated rising water levels.

A RAB Member asked what is the source of the topographical elevation lines on the USGS topographical maps? Mr. Goode suggested that many maps were probably prepared from stereophotographs from aerial photography using known elevations (monuments) from land surveys. Mr. Edmond mentioned that there is a USGS benchmark located where the water tower used to be, but now much of this type of work is performed using lasers and global positioning equipment using orbiting satellites. That is how they found out that Mount Everest is 6 feet taller than originally thought.

A RAB Member asked what models are used to impart different permeability to each stratum? Is it 3-dimensional modeling? Mr. Goode replied that yes it would be 3-dimensional modeling. The model will be selected to best take advantage of the data available.

A RAB Member asked if you could find out where water is from the USGS topographical maps? Mr. Goode replied that although water is everywhere, you couldn’t generally predict how much groundwater a well will produce using a USGS map in this area of the country. April Flipse of Pennsylvania DEP, said that her experience in similar geology at the nearby former NAVC Warminster, is that groundwater production from wells installed in the same geologic formation, as close to one another as 40 feet apart, can vary from as much as from one gallon per minute total production, to as much as 40 or more gallons per minute total production. Mr. Goode concurred that similar variability could also happen at NASJRB Willow Grove (in the same Stockton Formation).

Jim Edmond asked RAB members to review the RAB responses to the Questionnaire and make suggestions on how the RAB should proceed at the next meeting.

The next RAB meeting was scheduled for March 8, 2000, at 6:00 p.m. (Editors Note: The RAB meeting scheduled for March 8, 2000 has been changed to March 15, 2000, at 6:00 p.m.)

On behalf of the Navy and Air Force, Jim Edmond wished everyone a merry Christmas and a Happy New Year.
REGIONAL GEOLOGY

in the vicinity of the

Willow Grove Naval Air Station
Joint Reserve Base

MONTGOMERY and BUCKS COUNTIES

AMBLER AND HATBORO
7.5' topographic maps

Restoration Advisory Board Meeting (12/8/99)
Willow Grove Naval Air Station Joint Reserve Base
Presentation of USGS Regional Hydrogeologic Investigation — In Progress
2. The Newark-Narrow Neck-Gettysburg Basin Complex in Southeastern PA (Root and MacLachlan, 1999):

1. The linked Newark-Narrow Neck-Gettysburg basin complex in SE PA is the largest of a several exposed rift basins of Late Triassic to Early Jurassic age exposed along the eastern edge of the Appalachian Piedmont.

2. The study area is located in the Newark Basin in eastern Montgomery County and western Bucks County, PA.

3. Within the basin, the white area represents the distribution of sedimentary rocks and the black indicates the position of the igneous rock—diabase.

More Geological “Factoids” about the Newark-Gettysburg (N-G) Basin

- The N-G Basin formed as a result of the breakup of the Supercontinent Pangaea beginning in the Late Triassic time (~ 220 million years ago) when North America separated from Africa and the Atlantic Ocean began forming. This separation continues today at a rate of approximately 10 in/year or about as fast as your fingernails grow.

- The N-G Basin only one of a series of narrow, linear, disconnected basins that formed along the eastern margin of North America and beneath the continental shelf off the eastern coast of North America as a result of stretching of the crust.

- Triassic basins occur from Nova Scotia to North Carolina. In addition to the N-G Basin, these include the Connecticut (CT & MA), the Culpepper (VA), and Chatham and Dan River (NC) basins.

- The structural form of the N-G basin is that of a tilted fault block or half graben with the sedimentary units dipping toward the major normal fault on the northwest margin of the basin.

- Low-angle extensional faulting defines the northwest border of the Newark Basin. Southeast dips on the fault surface range from 25° to 30° in the vicinity of the Delaware River to 35° to 45° at Boyertown.

- At its maximum extent along the Delaware River, the Newark Basin is about 30 miles wide.

- The N-G Basin is filled with thousands of feet of clastic sediment derived from the erosion of highlands on both sides of the basin. Animal and plant fossils found in these rocks, in addition to the sedimentary structures and the mineral and geochemical evidence all indicate that these sedimentary rocks were deposited on the North American continent nearly 200 million years ago.

2. Map of the Newark-Gettysburg Basin in Southeastern PA. The cross-hatched squares in the Newark Basin indicate the position of the Ambler and Hatboro 7.5' topographic quadrangles. The Willow Grove Naval Air Station Joint Reserve Base is indicated by the dot in the east-central part of the Ambler quad. (Root and MacLachlan, 1999, p. 298)
# 3. Geologic map of a portion of the Newark Basin including the study area in eastern Montgomery County (Rima and others, 1962, Plate 2):

1. The colored area represents the extent of the Late-Triassic age Stockton Formation, the bedrock unit beneath the area of study.

3. The Stockton Formation comprises three geologically similar groups of rocks called members:
   a. **pink**—Lower arkosic member (Trsl) at bottom of map (older)
   b. **buff**—Middle arkosic member (Trsm) in middle
   c. **blue**—Upper shale member (Trsu) at top (younger)

3. Farther to the north, the Lockatong and Brunswick formations (Trbl), younger sedimentary units, overlie the Stockton Formation.

4. To the south, older geologic units lie beneath the Stockton Fm. This contact also marks the southern boundary of the Newark basin.

5. The Stockton Formation trends generally 30°W of north.

6. The thick black line labeled Trd indicates the position of the diabase dike that transects the region.

7. Note the line D-D' which marks the position of the cross section on the next slide.

More Geological “Factoids” about the Newark-Gettysburg (N-G) Basin

- As the crust stretched and the basins formed, they became lowland areas. The surrounding marginal highlands weathered and were eroded by rivers. These rivers flowed down off the highlands and brought sediment into these basin lowlands. As stretching continued, the basins were lowered and collected more sediment.

- Sediment comprising gravel, sand, silt, and clay was moved by the rivers and deposited on broad floodplains and lakes on the basin floor.

- Today, conglomerate, sandstone of arkose (feldspar-rich) composition, mudstone, and argillite comprise the sedimentary rocks in this basin.

- Much of this rock sequence is referred to as red beds. The red or brown color is due to the presence of ferric oxide (hematite) coatings on the grains. Red beds have been deposited in continental settings rather than in marine basins which tend to produce gray rock sequences.

- In addition, igneous rocks, as vertical dikes and extensive sheets of diabase, occur throughout the basin. (Diabase is a dark-colored, medium- to coarse-grained igneous rock.)

# 4. Geologic cross section of a portion of the Newark Basin including the study area in eastern Montgomery Count

1. This cross section is oriented roughly perpendicular to the trend of the rocks.
2. The grain size within the Stockton Formation progressively decreases from south to north.
   a. **Lower arkosic member** (Trsl)
      - coarse-grained sandstone and conglomerate
      - contains beds of medium-grained sandstone and red shale and siltstone
   b. **Middle arkosic member** (Trsm)
      - medium-grained sandstone
      - contains beds of coarser-grained sandstone and red shale and siltstone
   c. **Upper shale member** (Trsu)
      - fine-grained siltstone and mudstone
      - contains beds of coarser-grained sandstone and medium-grained sandstone

More Geological “Factoids” about the Newark-Gettysburg (N-G) Basin

A preponderance of the rocks throughout the basin complex are red beds (red/brown in color), although sequences of black and gray beds that are younger occur above the Stockton Fm.

The Stockton Formation comprises sedimentary materials deposited by a complex of river systems that drained from the southeast uplands into and through the basin to the northwest. Below is a summary of the sedimentary properties and an interpretation the depositional setting of this three-member unit (after Smoot, 1999, p. 183):

- Lower arkose member represents proximal braided-river deposits: comprises broad, thin sheets of pebbly sandstone containing trough and tabular foresets which form irregularly spaced, fining-upward sequences (7'-13' thick) that alternate with similar thicknesses of bioturbated mudstone and siltstone.

- Middle arkose member represents meandering streams: regularly spaced lenses of coarse-to fine-grained, arkosic sandstone forming fining-upward sequences (13'-23' thick) that grade into reddish-brown, bioturbated siltstone.

- Upper shale member represents distal floodplains with broadly spaced channels and the occasional input from flood events: thick sequences of bioturbated mudstone containing interbeds of thin, inclined lenses of arkosic sandstone, commonly with carbonate-granule intraclasts, forming uniformly spaced, fining-upward sequences (4'-7' thick).

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4. Cross section D-D' through geologic map (modified for this study from Rima and others, 1962, Plate 3). Contacts between members are likely interfingering and transitional, rather than sharp and laterally continuous.
# 5. Distribution of early Mesozoic igneous rocks throughout the Newark-Gettysburg Basin Comp. x (Froelich & Gottfried, 1999):

1. Igneous rocks, occurring as diabase sheets and dikes, have extensively intruded Triassic sedimentary rocks of the N-G basin.

2. Northeast-trending diabase dikes extend beyond the borders of the basins into the Piedmont crystalline terrain to the southeast and into the Paleozoic sedimentary rocks of the folded Appalachian mountains.

3. Both the thick sheets and thin dikes stand out in relief above the adjacent sedimentary rocks. Elevations can reach 1,000 feet or more on some of the larger bodies. Dikes tend to produce lower, narrow ridges that stand a few tens of feet above the adjacent landscape. Soils above intrusives are almost always stony, and remain forested, and therefore are easily recognizable on aerial photographs and satellite images.

4. The country rock adjacent to the margins of these igneous bodies typically is metamorphosed or baked by the intense heat generated when the liquid magma intrudes the surrounding sedimentary rock.
   a. Thermally metamorphosed shale and siltstone are represented by hornfels, a brittle, gray to black, commonly spotted, massive rock with original bedding preserved, but with subconchoidal (curved) fracture.
   b. When sandstone is metamorphosed, it becomes a quartzite, a very hard, brittle, medium- to coarse-grained, compact form of a quartz-rich rock.
   c. Beds with high percentages of limestone are transformed to marble, a medium- to coarse-grained, soft, calcium-carbonate-rich rock.

More Geological “Factoids” about the Newark-Gettysburg (N-G) Basin

- Igneous rocks comprise about 20% of the materials filling the N-G basin.
- Metamorphosed zones surrounding the igneous intrusives display changes in both the physical character as well as the chemical character of the original country rock.
- Often new minerals form in the surrounding rocks from fluids that emanate from the magma. Fluids are also generated by the interaction of the magma with the ground water.
- Both porosity and permeability in igneous rocks is low. The same can be said for most of the contact-metamorphosed country rock. Fluid yields from these rock types typically are extremely low. The presence of these rock types in an area can influence ground-water flow patterns.

5. Distribution of the early Mesozoic igneous rocks in southeastern PA. (in Froelich & Gottfried, 1999, p. 202; modified from Lanning, 1972, Plate 1). The Jurassic dike transecting the Ambler 7.5' topographic quadrangle, called the Conshohohocken dike of Stose and Stose (1944).
1. The Newark and Narrow Neck basins are structurally more complex than the Gettysburg basin.

2. In addition to the major faults at the northwest border of the Newark basin, there are several lesser faults that formed either contemporaneous with or slightly later than the border faults.

3. Faults both traverse to and parallel with the structural grain occur within the basin. With good exposure, both types can be mapped. However, in regions of poor exposure, traverse faults are somewhat easier to recognize. Faults which parallel the grain may go unrecognized.

4. Major left-lateral wrenching of the basin generated several faults (6, 7, 8), including the Chelfont fault (8), a left-lateral synthetic fault (a minor normal fault of roughly the same orientation as the major fault).

5. Displacement on these faults is considerable. (The dotted block of Paleozoic basement limestone has been uplifted some 20,000 feet.)

6. Folds are best developed at the north margin of the basin and associated with the faults. Folding is consistent with the regional motion indicated by the faulting.

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More Geological “Factoids” about the Newark-Gettysburg (N-G) Basin

- The generally uniform northwest dip of strata across the basin suggests that progressive downfaulting and significant rotation of the basin did not occur during deposition. However, if only minor rotation (less than 5 degrees) occurred, then syndepositional faulting at the northwest margin could have been active at times and not be apparent in the present dips.

- The congruence of the configuration of the Mesozoic basins and arcuation of the older Appalachians suggests a genetic relation between the two. Workers have concluded that Mesozoic rifting was developed along the late Precambrian rift zone that formed the original margin of the Appalachians.

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6. Faults and folds mapped within the Newark Basin. A major wrench fault, the Chalfont fault (8) separates the Bucks-Hunterdon fault block (north) from the Montgomery-Chester fault block (south). The study area falls within this southern fault block (Root and MacLachlan, 1999, p. 303)
REFERENCES


Willow Grove NAS/JRB Regional Water-Level Study

Dan Good & John Way
371 Eastville Hwy
Baltimore, MD 21215

Regional Water-Level Study

- Hydrogeologic Setting
- Prof. John Way, Lehigh University
- Local Scale Studies
- Water Levels on October 7th, 1999
- Water Level Changes, Aug - Nov. 1999

Plan for Shutdown Test of Horsham Well 25

- Horsham Water Authority has agreed to take Well 25 offline for about a week
- Continuous inductive measurements at the pumping well, about 7 on-base wells, 34 off-base private wells
- Manual measurements at continuous wells and at about 10 additional wells, 3 times daily during shutdown, daily during pre- and post-shutdown
Plan for Shutdown Test of Horsham Well 26

- Pre-shutdown monitoring for about 1 week
- Shutdown about 1 week
- Post-shutdown monitoring for about 1 week
- Groundwater flow model analysis

Results

- Hydrographs and Map of Recovery
- Calibrated Local Model of Flow
- Simulated Flowpaths
  - Fracture Conditions
  - Re-pumping Conditions