RESTORATION ADVISORY BOARD
FOR
NAS JRB/ARS WILLOW GROVE

Willow Grove, PA, December 8, 1999

Meeting held at the Naval Air Station Joint Reserve Base at 6:10 p.m. on the above date before Kimberly A. Overwise, a Registered Professional Reporter and Notary Public of the Commonwealth of Pennsylvania.

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SPEAKERS:

JIM EDMOND
JIM COLTER
CHARANJIT GILL
SCOTT SHAW
DAN GOODE
PROFESSOR JOHN WAY

PRESENT:

ERIC LINDHULT
THOMAS HIBBS
RAY LEOPOLD
JOHN C. MARTIN
KAYE MAXWELL-MARTIN
CDR. GILBERT VIERA
KEVIN KILMARTIN
LORIE BAKER
APRIL FLIPSE
MJR. MARGE MCGLINN
MJR. BYRON SCHIEBER
LCRD. MARK LEEMASTER
COL. DANA MARSH
MR. EDMOND: Mr. Gill will give the Air Force presentation.

MR. GILL: My name is Charanjit Gill. The only site we're going to discuss today is the POL. We're going to show you the latest groundwater samples. This is in reference to the pilot study we're doing. I'm going to have Scott Shaw from HSI Geotrans go ahead and give you the status and update on that.

MR. SHAW: As Mr. Gill said, my name is Scott Shaw. I work for HSI Geotrans. We're in Sterling, Virginia, just outside of Washington, D.C. The project we're involved with at the base is a biodegradation pilot study in the POL area. That is where the Air Force and the base stores and dispenses fuels for airplanes. The map you see here shows the perimeter fence here, the POL area, basic outline of the POL area and three things of particular interest, two of which involved past remedial activities. The first is the passive recovery trench located approximately in this area and the other
are a series of soil vapor extraction wells located just beyond the perimeter fence. The other thing that’s important is the 1996 outline of where they believe residual jet fuel is located in the ground, in the subsurface.

The objective of our study, plain and simple, is to get oxygen into the ground, specifically into the groundwater. The reason why is because in the presence of oxygen biodegradation or bioremediation takes place at a much quicker rate. We’re doing that through the injection of ORC or oxygen release compounds. Plain and simple, it’s magnesium peroxide, Milk of Magnesia. It comes in 5-gallon buckets. It looks just like powdered Milk of Magnesia. We mix it with water and inject into the ground. We do that through what looks like a very small cement mixer through a rig that’s mounted on the back of a pickup truck and we do it with a series of 1-1/2 inch diameter wells. This all took place last March, the very beginning of last March.
This is a mockup of the POL area, above-ground storage tanks, dispensing buildings and so forth. In a general sense, the groundwater flows from the base towards the perimeter fence and then off-site. You can see the general description of the groundwater flow direction, once again the residual jet fuel. As groundwater flows past or comes in contact with that residual jet fuel, it forms a plume, a plume of dissolved contaminants, in this case what we call RTEX, benzene, toluene, ethyl benzene and xylene and a couple of other compounds.

Shown here along these lines are a representation of what we call ORC fence line, a series of borings in which we've injected the ORC. Along each of those fence lines are approximately 30 1 to 1-1/2 inch diameter borings. This is a map of basically the same thing. You can see the tanks, buildings and so forth in the POL area, the monitoring wells we use to conduct our investigation and the location of the fence line.
Now, what are we monitoring? We're monitoring those BTEX compounds to see what the change in concentrations were over time and we're also monitoring the level of dissolved oxygen in the system. Prior to the injection of ORC, we collected a series of background samples. That is the last one collected in February just before we installed ORC. You can see in the upgradient wells 1, 2 and 6 there's an absence of the benzene, toluene, ethyl benzene and xylene compounds and there is dissolved oxygen. In the downgradient wells below the POL area, below being downgradient from there, you have concentrations of benzene, ethyl benzene, another compound called napthalene. There is a limited amount or no oxygen present in the groundwater, dissolved oxygen present in the groundwater.

At the beginning of the summer and approximately two to three months after the injection of the ORC, we collected another series of samples. You
can see the same situations still exist. In fact, the concentrations of the BTEX compounds were approximately the same as they were before. Oxygen has not reached these downgradient wells at this point. The last of the samples we collected were back in October, at the very end of the month. You still see a lot of same conditions that existed before. There is some reduction, low, specifically in benzene and ethyl benzene at these wells. We don't know yet if that's significant. That's basically what I'm here to say tonight. We need some more time to be able to determine that.

In summary, to date the performance of the system is inconclusive but the results of the most recent sampling are encouraging. What are we going to do between now and when the project is supposed to end? Continue to monitor performance. We'll be collecting another series of groundwater samples in those same wells and then prepare a final assessment in either March, April or May of the year.
Remembering this map from 1996 and the location of these wells and the apparent -- remembering that groundwater flows in this direction, we prepared the next slide. This is the data from 1996. The travel time here is calculated based on a groundwater flow of perceived seepage or groundwater flow rate. The values you see up here are concentration of a parameter called total petroleum hydrocarbons and the distance, relative distance from the perceived source area, the POL area.

Now, travel time is calculated based upon that groundwater flow velocity. As you see, as we move away from the perceived source area towards what is now our off-site wells, you can see a steady decline or perceived decline in concentration. This line, this trend line, is used to calculate a rate constant, degradation rate constant. Using that rate constant along with other parameters associated with biodegradation, you can
come up with a half life for the compounds that this represents.

Now, keep in mind total petroleum hydrocarbons in any kind of hydrocarbon spill is a pretty gross idea. It gives you a pretty gross idea of the level of contamination. It's not chemical specific. It's not just benzene. It's not just toluene. It's those plus a lot of others. You get a half life value of about a little over half a year. That means that in this system once something is dissolved in groundwater and exposed to or goes through the process of degradation, whether it's biodegradation or any other type of degradation that's going on, it is out of the system or it has degraded in about half a year.

Now, why is there still contamination? If you go back one more slide, still in 1996 you had this residual jet fuel on the ground still acting as a force of dissolved contaminants in the groundwater. What we're hoping to see and some of the things we have seen in our
sampling is that the limits of this residual have decreased quite a bit. What we're trying to boost through additional biodegradation is a further reduction in not only that but also in the mass of the contaminants in groundwater.

That's all I have.

MR. EDMOND: Any questions?

RAR MEMBER: I'm just curious if you can give me a little thought of ORC's versus other --

MR. SHAW: Any kind of remedial action is conditioned on physical conditions at the site. As Gill can attest and I'm sure anybody else who worked in geology here, the level of groundwater in the last three or four years has been extremely unpredictable. When the system ran, one of the problems we had with that was an extremely high groundwater level. In the last two years, one of the problems I've had to deal with is an extremely low groundwater level because of the drought. And data that was collected throughout this investigation that began in the middle '80s
indicate that that condition continues to exist, very large fluctuations in groundwater. So, yes, while you can see some short-term gains from SVE, those gains may not exist through the year making it an impractical remediation technology.

Now, the reason why we installed ORC is because we attempt and we are usually successful at getting it into the groundwater right off the bat. It’s going with the groundwater flow. It’s not associated with a smearing effect. You’re not losing that mass because of the rise and fall of the groundwater. So we believe in this type of system where you have fluctuations, and this is a shallow groundwater system, this may be a better alternative than actual physical removal.

Now, the other alternative that was used was a passive recovery trench, wait until the product or whatever’s coming down the pipe gets to you. It works but in past presentations -- we had a map from 1992 and if you look at this, the residual jet fuel has receded
back to a point where this is no longer effective. If you had looked at the 1992 map, I don't have it with me now, there was residual to here. That's the reason why that location was selected for the trench. It moves. It's a functioning moving system.

RAB MEMBER: Another question that comes up is you were saying that it's not really the case of a smear zone so the fact you took the water sample in October and after Floyd and probably the water table rose a couple of feet --

MR. SHAW: Let me clarify that. I was talking about the ORC itself. I'm talking about dissolving the ORC into the groundwater.

RAB MEMBER: I guess my question would be then, the October groundwater sampling, was there one that was taken like in September before Floyd hit?

MR. SHAW: No.

RAB MEMBER: So you're not sure -- it's hard to say how much of that
is due to the water table coming up and
impacting or saturating soils that hadn't
been hit before?

MR. SHAW: That's correct,
but we've had this situation in the past at
the site. Our first round of groundwater
samples were collected in November of '98.
And because of the fluctuation in the water
table, we weren't able to collect samples
in DM 3, I believe DM 4. They were low at
that time. We have watched the effect of
that and what happens. I think if you look
at the background samples, evidence from
the background samples in February and the
concentrations that we saw in May and how
similar they are, I think you're seeing,
first of all, water that's been in contact
with residual for quite a long period of
time and actually seeing those actual
background concentrations. But I think
that's valid. That's one of the reasons we
say at this point until we have additional
information, we can't really draw too many
conclusions.

RAB MEMBER: Was this a
one-shot deal on these wells or did you continually pump this stuff in over time?

MR. SHAW: Each boring was just once.

RAB MEMBER: Just one shot?

MR. SHAW: That's correct.

We perform a series of calculations based on the perceived size of the groundwater plume, calculate how much we have to get into there to affect the change in the concentrations, and that's how much we inject. I can't recall the exact amount we put into each. I think it was around 10 pounds but I can't remember the exact number.

RAB MEMBER: All your injections were at the tail end of the plume and upgradient. Is there any reason you didn't go for the center of the plume to help enhance degradation at that point?

MR. SHAW: Well, the reason why we did not work in the POL area is because there's a lot of fuel in the POL area and we're dealing with heavy equipment, drilling holes into the ground.
You have to balance one risk as opposed to another. And access to that area is not that safe a place to operate heavy equipment.

MR. EDMOND: Any other questions?

MR. GOODE: Looks like the fluctuations of the water level are very important. Are you monitoring this with a continuous transducer?

MR. SHAW: No, we're not. Our original plan was to be here monthly. And we know based on past performance of the system -- we have water level data back to 1998 -- in general what we can expect to see as far as fluctuations are concerned. We designed monitoring wells for this particular project with that in mind, i.e., length of screen, placement of the screen and those types of things.

RAB MEMBER: What was the depth that was injected into the ground of the peroxide?

MR. SHAW: We got it as deep as we could get it. The average depth of
placement was somewhere between 9 to 11 feet. When I say that, we didn’t go to one specific depth and inject all of it. We know that the groundwater fluctuates and we know sort of within which range that is, so we go as deep as we possibly can. We usually retract it 3 to 4 feet injecting.

RAB MEMBER: Does that reflect the depth of the plume?

MR. SHAW: It does in that we inject it in the area where the water is in the overburden. When I say overburden, we have in this area and as in most areas you have a certain specific soil layer above bedrock. Once groundwater gets into the bedrock, where it’s located is controlled largely by fractures and things like that. So being able to predict where those are is extremely difficult to do and too time-consuming to even attempt to do in this case. So what we try to do is in the unconsolidated overburden where the location of groundwater is controlled by the porosity or size of the open spaces in the soil, we try to inject over that entire
range that's affected and that's what we did here.

MR. EDMOND: Any other questions? Thank you.

MR. SHAW: Thank you.

MR. EDMOND: I guess now Jim Colter will give us a short little update on what's been happening on the Navy's side. Everyone knows Jim. He's the remedial program manager.

MR. COLTER: We'll just follow along. I don't have it on an overhead. Based on one of the responses to the questionnaire that Jim is going to go over, it seemed like a lot of people wanted to see a strategy of how the Navy plans on attacking each of its sites over the next several years. So what I did is I put together a bullet list here and we can go over it point by point. Did you all get a copy of this?

Just a little bit of background, back in 1997 we conducted fieldwork supporting a Phase 2 remedial investigation. You all saw the nice, big
document that we sent out. That was issued in April of '98. We got State comments in July of '98. We got EPA comments several months later, actually in April of '99. We held a TRC, a technical review committee, with the regulators to discuss their comments and that was at Northern Division offices in April. And the main conclusions out of that were that there were major concerns with regard to the data quality because of a sampling technique that we used called low flow sampling. There's a very stringent protocol that you're supposed to follow and there was some question as to whether that was followed and, if it wasn't, what were the impacts to the data. The other conclusion was that there was a data gap that existed as far as a well placement that the EPA wanted to see to confirm our suspicions of groundwater flow before they gave their final concurrence.

Those items were pretty substantial, especially the data quality review. We spent several months going over
the field notes to see if the protocol was followed. We found that in some instances certain parameters were not sampled for which the EPA considers to be important so we had to then take several months to assess the impact of that data and what did it mean or did it change the conclusions of the baseline risk assessment. And I'll skip ahead a little bit. We collected all that data and handed it to the regulators this past October. Right now they're still reviewing that.

Basically after that we asked the RAB how we should attack these sites. It was obvious that we couldn't carry four sites in a report. It was too voluminous and too hard to comprehend. So we decided let's go site by site. And we asked the RAB for prioritization and they said, you know, start with the fire training area. The April technical review committee meeting generated about seven action items total for the fire training area. Like I said, most of that was the data quality review. They wanted to see a
water level study on a nearby Horsham Township production well or supply well and one of the other main ones was they're called EPIC photos. They're aerial photos that the EPA gathers. They review them historically to see if there is any disposal areas and cutouts and things like that that you can see from the air. And then they want to see if that was a disposable operation or storage operation, something that might be a source of contamination.

Those anomalies they've sent to us and we're still actually under way looking at trying to see what some of those historic bare spots are in the aerial photos. We don't have that done yet. The new well cluster that the EPA would like us to put in is located southwest of the new Marine Corps Reserve Center. We have that work budgeted for this spring. The pump test on well No. 26 is going to be conducted this January. We finally got permission to shut the well down for a period of time. We asked that back in the
summer and, of course, with the drought, they wouldn't let us affect any water supply in the area. So they asked us to come back in the fall. We did and they said that things looked good for a January shutdown so we're going to conduct a pump test on that well in January. And when Dan Goode goes over his water level pump results, he'll mention what's going to happen there. We'll put a work plan out telling everyone what our plan is and we'll send it around for review before we get out of here.

Concurrently, we're doing a feasibility study. Although we're not completely done with remedial investigation, we are starting the initial stages of a feasibility study to assess different alternatives for cleaning up soil and groundwater based on what we do know. Filling these data gaps really won't change where the contamination is and our basic understanding of it. It's more to fill in some questions and concerns from the EPA and also to have a better -- to better be
able to put a good alternative and a cost analysis together. Once the feasibility study is finished, of course, we'll send it out to everybody for review.

Regarding Site 1, which is the Privet Road compound, the only chemical of concern in soils based on the Phase 1 and Phase 2 remedial investigation were PCB's, polychlorinated biphenyls. As most of you know, over the last several public meetings, I've been giving you status reports of that removal action. And Jim has handed you out an article I wrote for our newsletter and basically summarizes the completion of that. It was completed in July. Because of the drought, they didn't top soil and vegetate. They just did that in October. If you were to go out there today, the grass is grown in. You could hardly tell anything was done out there. So it was a complete success. The only thing for that is we're waiting submission for a final closeout report from our contractor and at that time we'll probably submit a no further action decision
document in accordance with CERCLA regulations to close that part of the site out.

There's still a groundwater component of that site that we're dealing with. And one of the action items again was data quality for the Phase 2 investigation. That holds true for Site 1 as well and we're reviewing that data. We've sent it to the regulators and, as I said, they're still reviewing it.

In the meantime, the Air Force did additional data interpretation and investigations at the Washrack area. The Navy also sent them our data. We got data that they collected. We jointly sat down at a meeting in October to discuss the overall results with the state and the EPA. The main conclusions of that technical meeting was basically the source of the deep volatile organic contamination which is low level is not or no longer emanating from the Privet Road landfill site. You can't say for sure that it never was there but all indications are today
that there's no continuing source there. It's either all washed out or was never there to begin with. That's mostly because the VOC's that are being detected are being detected in the deeper aquifer and not the shallow aquifer.

Also, there's a concern because of the continuing contamination that exists in the Navy supply wells. Based on that additional investigation done by the Navy and the Air Force, we determined that the code of influence of the supply wells does not reach down to the Washracks area so we concluded that it's probably not likely that contamination from the Air Force property is the cause of the contamination in the supply wells. Also, monitoring wells that the Navy has just outside of the supply wells just downgradient are nondetect for VOC's. So you would expect if the Privet Road site was the source of the contamination and the production wells were drawing it back that you would see it in the wells closer to the supply wells and we're not seeing any
contamination there at all. We do have supposition as to where the contamination is coming from but I think that would be better served in a separate RAB meeting when the Air Force gives their presentation. We can follow up with our presentation but, as Gill said, the data right now is in the hands of the State and EPA for review and we haven't got comments back yet so we really don't want to give that presentation yet until we get their concerns and comments.

What we did do, though, is to look at where possibly this contamination might have come if it's not coming from Privet Road and the supply wells. So we did a preliminary assessment effort on the administrative portion of Willow Grove, the buildings and structures upgradient of the supply wells trying to see if historically maybe there was some maintenance activities conducted up there or an activity that's no longer conducted if historically maybe there's a spill of something that would have VOC contaminants
in it. The basic conclusion of that study was that's always been an administrative corps even way back. We had some people that have worked here 25 years and it's always been administrative with the exception of the public works building, which is kind of sidegradient of groundwater flow where the supply wells are so it's not likely that those activities have impacted it, but it's one of the action items that came out of the meeting was to investigate an historic detection of PCE, which is a solvent used at the public works building historically. So the EPA and the State wants us to go back out there and try to find that historic site and do a little investigation of that area.

The other main point that the State and EPA would like us to do is to do geophysical logging on the Navy supply wells themselves to find out where the wells are drawing water from and where exactly -- it's a 350 foot well, where exactly is this contamination coming into. We're not able to do that currently because
of the equipment that’s in the well that
doesn’t get pulled and changed out. I’m
not sure. It’s an old type of pump that I
was talking to Tetra Tech earlier and most
of the equipment’s up in the pump house and
you just do your routine maintenance right
there. What we have to do is shut the well
down, pull all the equipment so the bore
hole is open and put our equipment in
there. There’s a problem with shutting the
well down because base operations needs
it. In case there’s an accident on the air
field, they need fire protection and other
types of emergency water. So we’re looking
into it now to see if there’s a time frame
where we can shut at least one well down at
a time and do the actions that the EPA and
State would like us to do. I’ll have more
updates as we get into that. We just
started that.

As far as the antenna field
landfill goes, again we have the same data
quality issue with regard to the Phase 2
investigation. But before that, we really
had no contradictory comments regarding our
recommendations that there really is no soil contamination there. The landfill basically is construction debris, things like that, and the groundwater is low level contamination and we recommend basically no further action basically for the site.

Again, we can't follow up on that until we get concurrence but we're probably -- after the data quality review is done, if we don't have any contradictory comments at that time, we'll probably proceed with a no further action document for that site.

The last site of interest is the Ninth Street landfill. Again, based on the recommendations and conclusions of the Phase 2 report, we really have no soil issues there. We will have to meet in a technical review committee setting to discuss the adequacy of our off-site groundwater program where we went to the golf course and sampled some existing bore holes there. It wasn't as much as the regulators wanted us to do but we had trouble getting access to sample the existing holes, let alone drill new ones of
our own. So whether we collected enough
data yet or not is yet to be known and we
have to follow up with a special meeting to
discuss that and maybe ways of getting more
data off-site if it's possible.

The only other major issue
that came out of that report was that there
were contaminated sediments in the adjacent
pond. This pond, however, is part of the
base's surface water drainage system for
the air field. And we've talked it over a
little bit and my recommendation is that
since this pond is really part of a utility
system, that it should be regulated under
the base's compliance program and not
really my cleanup program. We haven't got
a read on that yet. And so that's one
thing we'll have to recommend again after
we get our data quality back from the
regulators.

So that's kind of where
we're at and a quick snapshot of how I see
the program progressing. I'll keep you
informed. Any questions?

RAB MEMBER: I don't get the
relationship between your efforts and the EPA. What gives there?

MR. COLTER: The EPA is the regulatory agency.

RAB MEMBER: I know what that is.

MR. COLTER: We are subject to the federal laws that they govern as far as cleanup. They govern the federal government's cleanup program like they would any other private party cleanup.

RAB MEMBER: In other words, they're the final authority on this stuff?

MR. COLTER: Because we're a national priorities list site, yes. So everything we do, we ask for their opinion on adequacy of our program. After we conduct the program, we ask them how did we do, is there anything we're missing, do you agree with our recommendations and conclusions.

RAB MEMBER: Well, off the record, what would you say the EPA -- are they staffed adequately to understand what you're doing?
MR. COLTER: She's right behind you.

RAB MEMBER: You're EPA? You're just out of high school. These fellows seem to have a lot of experience. I don't know about the EPA.

MS. BAKER: The problem that we're having is a lot of these issues are groundwater issues and the hydrogeologist we have working on the site is also working on the Warminster site and right now that's a priority for her. And the EPA is to try to get that site closed out by next September and so, unfortunately, the work here suffers because her time is devoted to Warminster. And so we are trying to internally to address that to see if we have enough resources to assign someone else.

RAB MEMBER: I like that word, resource.

MS. BAKER: So that's really the issue right now is we just don't have the resources.

RAB MEMBER: I just wanted
to know how the relationship worked between you and these fellows here.

MR. EDMOND: Another thing, Warminster, that's a BRAC base and the Navy wants to give the land back to the community. And they can't give the land back to the community until the EPA says it's all right. We're here. We're going to be here. They would rather get that out and get it back to the community, make the community happy and worry about us secondary, not secondary but less priority.

MR. COLTER: We are getting comments on what we've done and based on that there's some fieldwork that has to be done that we really can't do until the next construction season anyhow because of funding issues and we have to get work plans out, let people know how we're going to attack the problem, make sure we cover all the bases. The program is running, a little bit slow but it is progressing. We are getting enough coordination that we have some work to do.
Any other questions?

MR. EDMOND: Thanks, Jim.

Like Jim said, this is in response to a RAB questionnaire about the RAB suggested having a strategy on what we’re doing, how we’re doing it, what we’ve done in the past and what we plan to do in the future. On the same lines as this, you all might remember from our first newsletter handout there was a chart showing all the sites and where we were at at that time, the chemical concern and steps. What we plan to do in the near future is update this to the point where we’ll hand it out and you can have a better idea. This you have to do some reading and understand everything it said but this will be a quick, easy handout chart to give you an idea of where we’re at, where we’ve been and what we’re doing.

We’re going to press on.

We’ll finish up with Dan’s presentation on the groundwater investigations he’s done with USGS. This is Dan Goode. He works for USGS. Dan?
MR. GOODE: Thank you.

MR. EDMOND: I'd like to apologize to Dan. He has nice overheads but we didn't know he was bringing them and there's no overhead projector for him to present them on.

MR. GOODE: One of the responses to the questionnaire was to make the meetings less formal. I was going to show you overheads and make it very formal but I've decided to tone it down a little bit and we'll just have handouts. To that end, there's a lot of chairs at the table here. It's really going to be tough to see these little pieces of paper if they're not on the wall. So anybody who's interested in the groundwater story, please move up to the table so you can see a little better. We'll have some handouts. That's not Jim's fault. That's my fault. Geological Surveys moves a little slowly sometimes compared to this computer technology and everything. That's really my fault that we're behind on that. This is just a copy of some overheads. There's plenty of
copies of this. The other thing is I only
made ten copies so we might have to share a
little bit.

United States Geological
Surveys is part of the Department of
Interior. We are an independent agency
that is responsible for natural resources
information in the country and we do a lot
of cooperative studies with local agencies,
other federal investigations, state
gencies and other groups to try to provide
information about water resources, geology,
biological resources and topographic
mapping information. I brought a
topographic map. You can't give a U.S.
presentation without a map. I'll show you
the map for this area.

We've been working at Willow
Grove for maybe about four years now at a
not very intensive -- not a lot of activity
but continuous activity over quite some
time doing the geophysical logging that Jim
mentioned in particular has been done in
the past. This last about six months we've
been looking at water level information and
One of the people working with us on that is Professor John Way, who is a professor at Lock Haven University. He's on sabbatical and is a volunteer working with U.S. Geological Survey on this study. I'm going to turn it over to John to give you a little bit of hydrogeologic setting before we get into actual groundwater levels.

PROF. WAY: I'd like to give you some handouts again. I had anticipated an overhead as well. This is more than you ever wanted to know and it's called overkill and I promised Dan I would only take a couple of minutes. I really only want to take a couple minutes. So the cover is basically my first slide, regional geology of the area. And that's what I'm interested in just briefly giving an overview relative to the geology of the region.

So if you turn to the second page and look at the numbers 1, 2 and 3 under No. 2, which would be the second
slide and then turn to the next page, the
next page is that slide. And basically
that's the basin analysis in southeastern
Pennsylvania, the location, little inset
map shows the location of the
Triassic-Jurassic basins throughout
southeastern Pennsylvania. It comprises --
it's actually what's called a basin
complex. There are three subbasins. The
easternmost is the Newark basin and that
continues to the east and north into New
Jersey. The narrow neck runs roughly from
the Schuylkill River to the Susquehanna
River roughly and then the third subbasin
is the Gettysburg basin that runs from
basically Harrisburg and south toward
Maryland.

So the study area, obviously
we here in Willow Grove and the study area
is in the Newark basin. And the Newark
basin, within the Newark basin the two
little squares that are illustrated there
with a crosshatching is the Ambler and the
Hatboro seven and a half minute topographic
quads. Dan has the Ambler quad stretched
out before you. So the little dot that's in the Ambler quad is a rough approximation of where the base is located. So that gives you some perspective of the base relative to the Newark-Gettysburg basin. The white area throughout the basin is fundamentally sedimentary rock. I'd like you not to think about a layer cake and a series of alternating chocolate/vanilla, but roughly that's it. It's not exactly like that. We'll talk a little bit about that. The black areas within the basin are igneous rock, igneous material that was intruded into these sedimentary layers. The little bullets below the geologic factoids I call them, again that's more than you ever want to know. I don't want to deal with that right now. It's enough so you can take it home and fall asleep reading that stuff tonight. Slide No. 3 is meant to be a color overhead. It's the next illustration with the USGS card at the lower left-hand corner.
Dan, do you have the enlarged map?

MR. GOODE: Yes.

PROF. WAY: This is what this would look like in color. And we're basically dealing with the Stockton formation, the name of the unit. The geologic unit in this area is the Stockton formation. It's of late Triassic age. It says that on No. 1 here. There are fundamentally three subunits within the Stockton going from the south to the north. The pink area roughly is the lower one-third. The middle maybe a little bit more than a third is the middle Archeozoic layer and the top is the upper unit referred to as the upper shale member. Now, what that Archeozoic means is that it is a sedimentary sandstone conglomerate rich in feldspar and that's all it means. It's just a sandstone or a conglomerate, a coarse grain clastic rock with an abundance of the mineral feldspar. Typically feldspar comes from a granitic source so these sedimentary rocks more than likely
came from igneous rich in feldspar. Much of that lay to the south out of the basin. Where we're looking, the basin contact goes through this lower southeast corner of the map. This area uncolored is older rock out of the basin. It is not part of the Mesozoic basin.

To the north beyond the blue, beyond the upper kind of shaded area that's referred to as upper shale layer, those are sedimentary units of Mesozoic age, Triassic, Jurassic age that are younger and overlie the Stockton formation. The black line that transects the area from the upper right-hand corner to the lower left-hand corner is a -- actually it's a Jurassic age diabase dike. It's an igneous intrusion that cuts not only across the map area but, if you notice, it cuts the southern border of the base.

The line that more or less goes from the upper left to the lower right, the capital "D" is missing at the upper left but the D prime is lower right,
that's the cross-section that will be the next illustration. And the next illustration, No. 4, is my cartoon sketch of what the rocks look like at depth. Again, the layer cake idea is something perhaps to start with but these units interfinger with each other. As the coarser grain, what is referred to as the TRSL, was being deposited, at the same time the finer grain units were being deposited farther away from the source area.

So what we have is a series of units that progressively get finer from the bottom of the map area down here. These are the coarsest. These are kind of medium and these are the finer grain sizes of rock material. The rocks are dipping to the -- okay. Another point that I should have made earlier, the general fabric across this basin is from the northeast to the southwest. And you kind of see that with the fingers that are illustrated here. These units basically interfinger with each other and so in the coarse grained segment there are finer grained
units as well. So each of the three subunits has elements of each other within them. And the cross-section attempts to try to suggest the relative relationships of the rock units one to another. If you notice, the diabase dike more or less cuts vertically through the edge of the basin.

And unless there are any quick questions, I'll turn it back to Dan. I tried to save five minutes.

MR. EDMOND: One quick question. The dike, does that stop water, groundwater flow?

PROF. WAY: It is virtually no pores. It's impervious to water movement virtually. If the rock is fractured, then water will move through.

MR. EDMOND: But with that said then, basically we'll call that the dike between water running on one side of it and water running on the other side of it unless there is fractures?

PROF. WAY: Chances are this rock is fractured. It may not act as a 100% barrier to water movement. I think
Dan will probably start to talk a little bit about that as well.

MR. GOODE: Yes.

MR. EDMOND: Thank you, sir.

PROF. WAY: I will be more than happy to answer any questions you folks may have after the meeting. I was out in the field on just such a lovely day. I have a whole bunch of samples if you want to see what some of this rock looks like too. Thank you very much.

MR. EDMOND: Thank you, sir.

MR. GOODE: Thanks, John.

As John mentioned, we’ll have some things afterwards if people want to see more. We brought a couple newsletters. We can pass this around, please. Instead of overheads, we’re taking the RAB suggestions for informality here. So the issue that’s come up here has been looked at before. What direction is the water going? That’s the basic question that’s been going back and forth a little bit. It’s complicated
because of the geology. The rocks that
John mentioned are dipping and have
potentially high permeability zones that
dip with the beds and so how do -- what’s
the interaction between water levels that
we see and actual rates of groundwater
movement and directions.

So what I’ve just passed
around is actually a water table map
prepared by Tetra Tech at the fire training
area, Site 5. On this map you can see
contours. These are contours of water
levels measured in wells. And water flows
downhill. So the driving force for water
motion is this pressure gradient that you
see from high to low. And so a dashed line
is drawn just north of the fire training
area to indicate that water on either side
of that dashed line is going in more or
less opposite directions. That’s like a
peak in the water levels. You think of it
as a topographic map sort of. That’s a
peak and then the pressure drops on either
side and that’s what’s controlling water.
Overall water motion is from high to low.
Now, the arrow that's drawn on there is showing the dip direction. So there's some complicating factor here because these rocks are dipping and the permeability of the formations may be very different in the dip direction versus the strike direction. That's something we wanted to look at a little bit here.

You'll also see this is a pretty small area and to date the water table maps that we've prepared have all been at each individual operable unit. I'm not sure if that's the term you all are using but each of the sites would have a number of wells and water table map prepared right at the site. You can see on this map just to the southeast is the antenna landfill but the water levels there haven't been integrated into a bigger picture.

So that was our main responsibility here was to try to integrate this existing information, collect some new regional information to try to put these kind of small scale local maps into the big picture. The contours that you're looking
at here range from about 340 to 344 feet, so about a 5 foot range in this small area. We’re going to step back and look at a much bigger range in water levels to try to get a regional perspective on where the water is going.

To follow up on Jim’s question, the diabase that cuts across the very southern tip of the base is just off of this picture. So at least locally here the diabase is not the only factor for determining does groundwater divide. There are other areas groundwater flows in other directions because you’re on a ridge. The air strip was built on the regional ridge.

The next thing I’d like to pass around is again something I’ve modified from existing information that Tetra Tech had already put together. Again, I apologize. I only made ten copies here. Perhaps some of us can share. This is my version. The colors show up a little bit better. There’s three pieces of information on this picture. This is a cross-section and exaggerated quite a bit
vertically. This runs from north to south of the fire training area. And I think you’ve actually seen this picture previously at a RAB meeting but I extended the plume over in this area and it wasn’t extended over there previously. The blue lines are the water levels in cross-section now, so high water level up at the north and shallow and low water levels as you go down. So this is a recharge area. Water’s going into the ground from rainfall and it’s flowing towards the south. So we’re on the southern part of this groundwater divide. Two things, the pressure’s dropping towards the south and vertically to go downward. So those are the light blue lines. I’ve added on here all the contours at well cluster 11 over in the very end. The deep well there has a water level that’s on the order of 20 feet lower than the wells at the same location that are shallower. So over a distance of about 100 feet vertically between the screened openings we have a water level difference of about 20 feet, which is really quite
large. This is not unheard of but very large vertical head gradient down in this area. This suggests two things. Number one, water’s flowing down there. That’s the direction down is, very strongly. But you only have this kind of very steep pressure gradient because there are low permeability materials in between these two depths. So the formation is very resistant to flow from here to there. It is flowing downward but slowly because there’s low permeability, mudstone, fine grain material, a rock that’s less fractured, something like that. So the main part of the body, the other brown lines are the dipping beds which again dip in the other direction. And in the Stockton formation there’s a large control locally on dipping beds. Water wants to stay in a bed in a high permeability bed as a way to think about it. So the water is much easier to move along the beds than across them. So you might think there would be some enhanced flow, a long dip or long strike in and out but you can see that the overall
direction has got to be the other way
because water goes downhill. It's just
very hard to go that way. It's resistant
to flow. The contours on the plume are
based on concentrations of total VOC's
measured in the wells. The main body was
drawn by Tetra Tech already. I just
extended this over to try to say at least
on or that data point, maybe that's a real
data point that would be in the yellow, the
main part of the plume seems to be going
downgradient more or less in this picture.
And this complicating factor with the
geology is maybe something that's
responsible for some of it shooting off to
the north if the flow directions change
over time or something like that. So this
is the issue that we're trying to get at by
stepping back and taking a little bit
bigger look at this system to try to see
overall where is the water likely to go
from the base to other places.
If you have any questions,
please just jump right in.

RAB MEMBER: I don't recall
the concentrations in the groundwater were big enough that would flow counter to groundwater; correct?

MR. GOODE: That’s right.

This question is about if you had a dense separate phase of a liquid that was heavier than water, it would not necessarily be pushed by the water gradient. So these gradients control the water direction and anything that’s dissolved in the water moves down hill with the water. But if you had a heavy fluid that was a separate phase of a dense liquid, potentially it could slide down a high permeability bed. It has its own controls on motions that are gravity in addition to the water pressure. We don’t see any evidence of that at depth in these formations. We don’t see any evidence that there is such a thing. So these concentrations, you know, one part per million were like a thousand times lower than something or maybe ten thousand times lower.

RAB MEMBER: The vertical lines are the monitoring wells?
MR. GOODE: The wells. And the gray boxes are their screened opening.

So that's the depths that are open to the different monitoring wells. So a lot of the clusters we have one or two wells at different depths. That would be 11S, 11SI, shallow intermediate and 11 intermediate would be the deepest one there.

RAB MEMBER: If I'm understanding you correctly the way we're looking at this, the way we're looking at this right now is the spread horizontally but then with the various sizes you have here is the depth?

MR. GOODE: That's right.

This is a cross-section basically in this area right here, about like this from the north to the south. And it's angled a little bit towards the southwest. So that's a cross-section. The north part starts up here and the southern part ends at well 11, which is just down there. So from this map, which is done just on the shallowest water levels, this is the contour map of just the shallow levels,
that would say that the flow direction is
generally to the south in that area where
the cross-section is.

John, did you have that big
piece of paper? I'll use that as a
background. This is basically the result
of what we've done so far. Together with
Tetra Tech, we measured water levels, I
think the total is about 75 wells, on
October 7 and a day or two before or after
October 7. And we're in the process of
contouring that information. So this map
is at the scale of the topo sheet. The
outline here is the base. Right here is
the base. And this is the fire training
area that we were just looking at is about
this big on this picture, very small.
These results agree with what we were just
looking at that Tetra Tech did I think it
was in July or something I think. The
levels on here were about 340 feet so those
are the high levels in here. The green
line is the 320 foot contour.

So, again, there's a -
groundwater divide regionally at the
southern part of the base and generally
flows to the north north of that line,
which would be the Ninth Street landfill
and everything up where we are now, Privet
Road and everything and toward the south at
the fire training area and antenna
landfill, the southern sites. Those are
40-foot contours so a much bigger scaled
picture. The blue are the rivers, the
creeks. This is the Neshaminy-Park Creek
here. The elevations along Park Creek and
Neshaminy are much lower than along the
Pennypack. Again this is another factor
promoting flow to the north because the
elevations are lower to the north.

There are a number of
pumping wells on here which we measured the
levels in. These are public supply wells
for the township. You can see in many
cases there's a contour right around that
well. So the level right at the well is
much lower and areas pretty close to it
because it's drawing water into the well at
a relatively large rate. This circle right
here is for Horsham well 26, which we're
going to talk about when we’re doing the shutdown test at well 26 right here.

So this is the main picture. This overlays on the topo sheet if you want to get a feel for where things are a little bit better. So we’re at the base here. We’re here. This is the high. We’re on groundwater divide between the Neshaminy basin and Pennypack to the south. The Pennypack is a smaller stream, higher elevations. The groundwater levels are a modified version of the topography basically. Here’s the ridge topographically and that’s where the high water levels are. Here are the streams and that’s where the low water levels are. And despite the fact this is a complicated geology, fractured rocks and everything, that basic feature is still true. There’s a lot of similarity between the surface water drainage basins and groundwater drainage basins. Water is not coming from outside the township and crossing this area. Recharge for these wells is derived locally from rainfall inside the basin.
That's the water we're drinking, same thing at the base. In other words, you can't go to the north and find much higher levels. You have to go down to the stream and that's a discharge point that's going to keep water from coming across Park Creek. So that's basically the result.

The thing that the geology is likely to do is not so much promote flow in the down dip direction but a long strike because we have high permeability beds that dip this way and so you can be at the same depth and be in a relatively high permeability part of the system along this way. This geology is shown by the streams, for example, because they found a soft part of the rock to erode so the major streams tend to line up with the strike of the geology like Park Creek does here. You see this in a lot of areas sort of winding up to the Northeast. The interesting thing is up here north of the base, very low groundwater levels possibly due to water supply pumping up here in Warrington. We really didn’t get much measurements. We
didn't measure the pumping wells there.

One other feature I wanted
to show on this map was the role of the
diabase dike. I have some contours here
that just end at the dike. It does appear
that it's again relatively resistant to
flow and so there's a pretty large water
level gradient across the dike. It's high
on the side of the basin, lower to the
southeast. We actually had measurements
that seem to be pretty much right at the
dike just across the street from the base
boundary and saw a very large water level
gradient just across a parking lot of about
20 feet again suggesting permeability is
really low where the dike is. It's not
impermeable. Water is moving through the
dike but at a slower rate than through
other parts of the formation.

MR. EDMOND: Does that
affect the aquifers, upper or lower
aquifers that, say, we're drawing our water
from?

MR. GOODE: Well, I guess I
think of this system as one large aquifer.
MR. EDMOND: Then there's like little several aquifers connected through the dike?

MR. GOODE: That's right. The sedimentary rocks were sitting there and the dike basically came through as a vertical sheath. It's very narrow. I guess John was measuring today about 600 feet wide. Out on the Gettysburg formation it's about 90 feet wide. So it's a really small geologic feature across it but it extends for miles. You can map the thing out. That came up more or less vertically.

MR. EDMOND: More or less like an eruption where it came up this way and stayed and everything else came on top?

MR. GOODE: No. This came through everything that was sitting there. The sedimentary rocks were sitting there and this diabase dike was pushed vertically upward. You can think of it like a big crack but it doesn't appear to be associated with any shallow faulting. So
the cracks occurred way down, a long linear magma source that just came up as this very thin sheet. It's really amazing.

RAB MEMBER: Excuse me. You mentioned Gettysburg. That's 115 miles from here.

MR. GOODE: That's right.

MR. SHAW: I live 175 miles from here and it's almost the same situation.

MR. GOODE: Right. This diabase cross-cuts these rocks. The Gettysburg has a long sill of diabase, large area which forms a lot of the ridges out there, same thing here. This diabase is associated with a ridge. The diabase cuts across the southern part of the base. As soon as you pass that on 611, you go straight downhill basically to go into the center of Horsham. It's really steep gradient right there and the ridge is all the way along. On John's map this diabase is up in this neighborhood because some of the houses have boulders in their front yard. You don't want to move this stuff.
It erodes boulders, which is what's out in Gettysburg and here locally.

RAB MEMBER: I was just out there about two months ago.

PROF. WAY: One other factor I might mention relative to the diabase is there's a baked effect on the sedimentary rocks adjacent to the diabase. So for some distance on either side the rocks are a little harder and a little tougher relative to erosion, in fact, may be a little bit more resistant to erosion than diabase itself. So we see hornfels, which is a baked shale. Instead of it being red, it's black, a conglomerate being a metaconglomerate. It's a little tighter for flow to move through so there are factors associated with the diabase beyond the diabase dike itself.

MR. GOODE: Yes. Well, it gets complicated because when this dike pushed up, it also cracked the rocks. So in some cases there's enhanced permeability along the dike because it was basically cracking these rocks apart right where it
came through. So it can go both ways it
turns out. It’s a little complicated. At
a regional scale, we see some evidence that
it’s playing a role but it’s not an
impermeable wall that one side is separated
from the other.

MR. EDMOND: More or less a
speed bump?

MR. GOODE: Yes. One other
thing I wanted to just mention briefly, we
do see some evidence of the geology in that
the water level contours appear to be
steeper up north of the base. We see
steeper gradients because of the
permeability of the formations is lower.
They don’t transmit water as easy as the
lower part of the Stockton. That kind of
appears on this information too.

We are also monitoring water
levels continuously before or after the
test and we’re actually continuing to do
that now. This picture shows hydrographs
of the water levels in well cluster 11 at
the fire training area and precipitation
running from the beginning of August
through -- the data runs through I think November 18 was when I last downloaded the data loggers. So the line with the circle, the open circle line is the deep well and it's plotted on a different scale. It's plotted on the right-hand scale. So you can see that the depth to water in that well ranges between 30 and 45 feet. The depth to water in the shallow two wells basically plots on top of each other. They're measuring almost the same pressure. The orange and black line, that depth ranges from 11 feet to 18 feet. These wells are about 12 feet apart horizontally and you saw in the cross-section that they're separated by depth. So there's a very large gradient. The dominant feature on here is these wells responding to recharge and you can see right in September I guess, middle of September we had Floyd come through. That's the big spike there, a little over 8 inches of rain at the base in that two-day period. It killed the drought basically. Water levels jumped up. I mean
the water level in the deep well has increased about 15 feet or at least 10 feet right after that rainfall. The water level came up 10 feet. Our measurement is October 7. So you can see that's on the high part of this picture, which I think is good. I think that means we're characterizing more typical conditions and we're not characterizing drought conditions with this map of the water levels. So I think this is pretty indicative of typical groundwater flow directions in this area.

The other thing you can see a little bit is that the deep well before Hurricane Floyd occurred, the water level in the deep well was coming up while the shallow wells, hard to tell if they're coming up or not. So there's something different that's influencing those wells.

MR. EDMOND: Water conservation might have been influencing the wells.

MR. GOODE: That's right.

What that means is less water was being pumped or used. And the deep well here,
what we want to test is to what extent is this deep well influenced by pumping at the township well 26. That's exactly what we want to get out of this shutdown test. To me this may be some evidence there is an influence as the pumping rate decreases in Horsham because of water conservation. Water levels come up in the deep well and maybe that's why those levels are so low because they're being pulled down from the pumping that goes on there routinely. The shallow wells don't respond because they're isolated more from that effect by these low permeability parts of the formation and more connected to what's happening in the soil with recharge.

So that leads us to the next part of my presentation, which is just a summary of our plans for the shutdown test. Any questions about the water table map? We'll leave this out here so people can come up and look at where the groundwater underneath your house is going, things like that.

We're continuing to monitor
water levels and probably try to do this again maybe at a different time of year now that we've got a good database with homeowner wells, public wells and wells on the base. So on that first sheet I passed out there was a summary of the plans. We met with Horsham Water Authority. Ideally we'd like to run a pump test where we pump the well for a long period at a constant rate but that logistically is a big problem for the authority because they don't have disposable water. However, they felt like they could shut down the well for a week. So instead of pumping it two or three times every day, they would just take it out of the system for a week.

See, what we're really going to look at is how water levels come up during that week when the well is turned off. Then it will be turned back on. So this is going to focus much more on the southern part of the base, the fire training area and Horsham well 26, which is this dot here southwest of the fire training area. We're going to get -- Tetra
Tech and USGS are going to work together on this project, set up continuous monitoring at about seven locations on the base, primarily the fire training area and antenna landfill wells and focusing on the deeper wells because they’re more likely to be influenced and also try to get three or four off-base wells where we can do continuous monitoring, including the pumping well itself so when it does turn back on and during the preshutdown, we’ll have a good record on when that well is pumping.

RAB MEMBER: Well No. 26, do you know what the GPM of that is offhand?

MR. GOODE: I don’t have that offhand.

RAB MEMBER: Or how that relates in terms of its capacity to the other wells to the township?

MR. GOODE: I don’t know. I think I have -- I probably have the number here. Didn’t we say at the meeting?

MR. COLTER: I don’t recall.
MR. GOODE: What you tend to see is the newer wells after well 10 tend to have about ten times yield so I would expect it's a couple hundred gallons a minute at least.

Do you know, Kevin?

MR. KILMARTIN: No, but I think it's definitely that magnitude.

MR. EDMOND: Our wells here are 150 gallons per minute, our drinking water wells.

MR. GOODE: 1 and 10 I think are on the order of 60 gallons. In addition to this continuous monitoring, we'll have a number of additional wells where we do manual measurements. So we will have a transducer to make a series of measurements in particular during the shutdown period. This picture has some of those locations, some of the possible locations off the base in particular. You're probably all familiar with on the base. So we're looking closer in on the area of the base near the fire training area here. This is the antenna landfill
and this is the Ninth Street landfill up here.

So well cluster 11 is the one that we had our continuous monitoring in and we'll continue to do that during the test, probably get a well on the other side of the fire training area, kind of as far upgradient as we can be, maybe well 6 or something, 61, then maybe one of the wells at the antenna landfill, then on the other side of the groundwater divide at the Ninth Street landfill to just see if we get any response on the other side of this dashed line, kind of a background. So those are the colored dots on the site. I guess you can't see the colors so I won't explain the colors. The open circles off-site are wells where we potentially have the opportunity to monitor private wells, homeowner wells and the pumping well is also shown. That's the H26. So you can get a feel for how far away from the base that well is. We're not sure we'll be able to monitor all these wells. We just have data on them. We know there's a well
there. We measured the water level before. The wells J4 and J5, John actually measured the water level during our water table map so we'll probably be able to make measurements at those locations.

RAB MEMBER: The site of this map is going back quite a few years if I'm not mistaken. This is the runway. There used to be a runway that ran from 611 across 32 or 33. So this here layout is quite old.

MR. GOODE: The background is from the topographic map.

MR. EDMOND: It's from the '70s.

MR. GOODE: It's photo revised in '83 but the actual base map was done in '66.

MR. GOODE: That's new. From the geologist point of view, this stuff is all just --

MR. EDMOND: That is a taxiway.

RAB MEMBER: This?

MR. EDMOND: Yes, sir.
RAB MEMBER: Used to be a runway when I was here.

MR. EDMOND: But that's the Army taxiway right there.

RAB MEMBER: West of the runway but not east.

MR. GOODE: This is west.

This is southwest.

RAB MEMBER: This is Horsham Road?

MR. GOODE: This is north at the top. North is at the top.

RAB MEMBER: I had it upside down.

MR. COLTER: Dan, the artesian conditions that exist over Ninth Street, are they a concern with this test at all?

MR. GOODE: I'm not sure.

As far as what?

MR. COLTER: The well's flowing and we basically at Ninth Street had to put a stopper on it to stop it from flowing.

MR. GOODE: Do you want to
address that, Kevin? I don't think it's going to be a concern.

MR. KILMARTIN: No. In fact, I think it will be a point of interest to see if there's any influence at all or any relationship between the pump and the well.

MR. GOODE: The system you installed there shouldn't be sensitive to the water levels going up a few feet. I mean it won't break the seal or whatever?

MR. KILMARTIN: No, no.

MR. EDMOND: We hope.

MR. GOODE: It will break eventually but this probably won't be the final straw. That's this area here. The deeper wells in this area are flowing. If you don't put a cap on them, they flow all the time. There's also a well at the golf course that does the same thing that we monitor. So again you get water going from high elevations to low. And a water level change of 20 feet is a lot of pressure. I mean that's going to really push. So you can easily get these wells in the drainage
areas that have water coming up trying to
get out of that drain and they're above
land surface. You provide it a nice easy
path to come out. The basic idea would be
to do continuous monitoring for about a
week before the shutdown just to see how
things are going along with the regular
schedule, turn that well off for one week
and monitor closely how the water levels
recover during that period and then turn
the system back on and continue monitoring
for about a week after the system is
started up again.

What we're going to do with
this information is look at the levels but
go beyond to try to put this information
into a model with how the system works,
with the geology, activity of the rocks and
look at levels. I just brought some
examples from a study we're doing right now
in Lansdale with the EPA in the Lansdale
area and we ran a shutdown test there of an
industrial supply well and continuous
monitoring at nearby wells. So it's the
same idea. There is a plot of I guess
about eight days of time. During the yellow stripes is when the industrial well is turned off. So you can see that some of the wells respond almost immediately to that well being turned off. The green well here, the water level comes up about 4 feet pretty quickly right after the production is turned off. That's a well that's used for -- runs continuously for a cooling operation. Wells that are farther away respond less. So like the orange line here it's only coming up a foot or 2. Actually that green line is over here. This is the access for the green line. It actually came up about 12 feet. One of the complexities is there are other wells nearby. This well right here, 2S, is responding to some other well that's turned off. The pretzel factory is a quarter of a mile away and it looks like their well shut down, their tank filled up. So that well responded to that.

So it's not sufficient just to look at the overall change in water levels. We have to try to look in a little
bit more detail at what changes are due
solely to the well that we’re interested in
and try to filter out these other regional
effects that are going on because people
are using water in the area, private wells,
industrial wells and the public supply
wells. So this is where the model can
really help us a lot to try to figure out
here this black line is responding to the
well going back on and then another well
tURNS on immediately after that that
affects it even more. We try to figure
those things out with the model but still
keep it kind of simple at a local scale.
This is just an example for that area.
We’re watching the change in water level
which is drawn down on this axis over
time. The points are data we measure and
the lines are the model. We try to
simulate this process. And to get the
model to match the data, we have to change
permeabilities, hydraulic activities,
important parameters that control
groundwater flow in the area. That’s the
plan, to do a relatively simple analysis
with the recovery data and match that with
the model.

So the results of this
project would be the hydrographs of
recovery like I showed you, map of recovery
similar to this plan where instead of
looking at the water level, we’re going to
look at the change in water level that was
caused by turning the well off. That’s
sort of like a way to think of that is
almost like a draw down cone or cone of
influence for this pumping well. Water
levels will recover but the recovery level
will be large in wells that have a good
connection to this pumping well. Farther
away or isolated from the well we should
see little recovery during that one week
period. Then with the model we can also
combine this information about the change
in levels and the existing water levels,
the regional flow picture to look at where
water is moving and the water that’s pumped
from this well, where does it come from.
The model allows us to put this together
and to draw pictures like this which again
is for the project we're working on in Lansdale. The red dots are wells and the black dots are the area of recharge on the ground that's captured by that well. So in this case this well captures recharge locally and then captures water that falls on the ground upgradient from where the well is located. We can do these kinds of analyses with a local modal of how the flow system works.

So that's the plan. As Jim mentioned, we're putting together a work plan now with a little bit more specific information and we'd be very interested to hear people's ideas or suggestions about how to do this so we get the most information.

MR. EDMOND: Questions for Dan or the professor?

MR. VIERA: In the future, can we get college credit for this?

MR. GOODE: Class participation.

MR. EDMOND: A test at the end.
RAB MEMBER: On these topographical maps, you have all these squeegee lines like 350 and all that; right?

MR. GOODE: Yes.

RAB MEMBER: How did they arrive at all that?

MR. GOODE: Well, I won’t say they’re old I guess but these maps produced earlier were done with stereophotographs, stereo aerial photographs.

RAB MEMBER: How about before that?

MR. GOODE: I’m not sure what you mean before that. Surveying, I guess.

MR. EDMOND: What’s that?

MR. GOODE: To produce a topographic map. On this map you see the numbers, 353, 367. Those are survey locations that are used with the stereo map to actually figure out -- you can tell on the stereo picture, real easy to tell what’s uphill and downhill but the absolute
elevation is hard to tell. You use these actual survey measurements to tell you exactly what this is. It's pretty easy to see what's downhill from there. At road intersections you often have a benchmark or something. There is a benchmark right on the edge of this picture just east of 611 where that B is. That's actually a benchmark, a monument there. You would survey from that point.

MR. EDMOND: Basically where the water tower used to be, the benchmark was right underneath that. Now they’re doing a lot of this surveying with satellites using lasers like they found out that Mount Everest I think is 6 more feet higher than they thought it was using satellites.

MR. GOODE: I think they found out the Washington Monument is about 5 inches taller than they thought. The GPS unit was used using satellites.

RAB MEMBER: They use geological survey maps to cover the whole country; right?
MR. GOODE: Topographic maps, yes.

RAB MEMBER: I have some property in Maine really in the boondocks and it's really a meticulous map of the area. That thing was done 50 years ago.

MR. GOODE: That's right. It's an art and there is some art in it. So when you blow these up and get real close to the site, then you start to see some things that maybe aren't really there but at the big scale they're very good. I don't know if the base has their own separate topography which would be much more accurate on the base.

MR. EDMOND: I think the base has a set of 32 that cover the base. I think it's 32.

RAB MEMBER: You can order them in different sizes.

MR. GOODE: Well, the survey maps are pretty much this size. We don't do the smaller scale. You can hire a company to do it.

MR. EDMOND: We have one of
those and also have taken the base and
broken it down in 37 quadrants.

RAB MEMBER: What type of
software do you use to do the modeling? Is
it like three-dimensional software?

MR. GOODE: Right, right.

RAB MEMBER: You model each
strata and impart different permeability
for each strata?

MR. GOODE: Our basic
approach to the modeling is incorporate the
level of detail you have. So we’re going
to start out with relatively crude sort of
big dipping beds. I don’t know exactly
where the beds are. We certainly don’t
know where the fractures are. We don’t get
that fine in detail. But we will try to
have a model that realistically
incorporates this idea of these dipping
beds and how those relate to where wells
are in particular. So if you have two
wells that are open to the same bed in the
model, they’re going to have a much higher
permeability connecting them than two wells
that are in different beds. So that will
be incorporated in the model. Then we actually let the computer try to adjust the parameters, the properties so it best matches the measurements that we make once we kind of set it up. So it's not a simple analytical plug in the numbers and just match one parameters. There will be many more parameters. It's a little bit more complicated but conceptually it's the same idea. You make a measurement, which is what we're doing, and then you use the measurements that you make to figure out what the properties are.

MR. EDMOND: Any more questions for Dan?

RAB MEMBER: You can't really find out from these maps where the water is, though; right?

MR. GOODE: Where the water is? Water is everywhere.

RAB MEMBER: It's not the same. You drill a well here and there and you're not going to get the same amount of water.

MR. GOODE: That's right.
So what we were just talking about using the model is aimed at answering that question. It is aimed at where are the high permeability parts of the system at least locally. We will try to identify that with this.

RAB MEMBER: We had a funny deal going with this property up in Maine. We drilled two wells 100 foot apart. One was 200 feet and one was 300. The 300 foot well gave us two gallons a minute. The other well gave us 16 gallons a minute.

MR. GOODE: Yes. You can have the same result here.

RAB MEMBER: They’re 80 foot apart, you know.

MS. FLIPSE: At Warminster the new well they just put in had -- they’ve got wells that are badly contaminated on the inside of the fence line that are drawing one to two gallons a minute. 50 feet away on the other side of that fence they drilled today and they got 40 gallons a minute. We’re drilling new wells up there right now and in the space
of 40 feet we got from one gallon a minute to 40 gallons a minute and it's not as contaminated but there's lots more water and they deliberately drilled into the same part of the formation. Of course, it's also a formation of the horsepower of the pump and --

MS. FLIPSE: No.

MR. EDMOND: It's free flowing.

MR. GOODE: That's the Stockton formation. Those are the same as at the base here.

MR. EDMOND: John, you need one of these mining rods.

MR. EDMOND: Anything else? Then I'd like to say I'd like for the community members to look over the RAB responses for the RAB questionnaires and get some ideas on where you think we should go, give you a step ahead of the other members who weren't here tonight, give us some ideas on how you think we should proceed with the recommendations that the RAB members made
to me in conjunction with the questionnaire I had sent out.

Are there any questions for either Gill, Jim or myself?

RAB MEMBER: Do we have to schedule another meeting?

MR. EDMOND: I'm going to schedule another meeting for 8 March 00. If nothing else, everybody here at the Air Station, both Navy and Air Force, would like to wish everybody a happy Christmas, merry Christmas, happy New Year. We'll see you in '00 as long as the sky doesn't fall January 1.

(Whereupon the meeting adjourned at 8:00 p.m.)

REPORTED BY: Kimberly A. Overwise, RPR.
TO: JIM COLTER (Naval Facilities Engineering Command)

FROM: RUSS TURNER (Tetra Tech, NUS)

SUBJECT: NASJRB Willow Grove, Stenographers Report From December 1999 RAB Meeting

Jim,

A copy of the subject report is enclosed for your use. The original stenographer report, along with the electronic copy has been sent to Jim Edmond at NASJRB Willow Grove.

Regards.

Russ.

Copy. Garth Glenn (Tetra Tech NUS) w/o enclosures

File