STATE OF NEW MEXICO

WATER QUALITY CONTROL COMMISSION

Nos. WQCC 03-12(A) and 03-13(A)

IN THE MATTER OF THE APPEAL PETITION OF PHELPS DODGE TYRONE, INC.'S, PROPOSED GROUNDWATER SUPPLEMENTAL DISCHARGE PERMIT FOR CLOSURE (DP-1341).

TRANSCRIPT OF PROCEEDINGS

VOLUME 5

BE IT REMEMBERED that on the 31st day of October, 2003, the above-entitled matter came on for hearing before the Water Quality Control Commission, taken at the Paisano Building, 2968 Rodeo Park West, Cactus Room, Santa Fe, New Mexico, at the hour of 8:10 AM.

MR. MOELLENBERG: Yes, Madam Hearing Officer. I think that's fine.

MS. WATCHMAN-MOORE: All right.

Mr. de Saillan.

CLINT MARSHALL

having been first duly sworn or affirmed, was examined and testified as follows:

DIRECT EXAMINATION

BY MR. DE SAILLAN:

Q. Can you state your name, please?

A. My name is Clint Marshall.

Q. And your position?

A. My position is a hydrologist with the Groundwater Quality Bureau of the New Mexico Environment Department.

Q. And how long have you held the position of hydrologist with the Groundwater Quality Bureau?

A. A little over 10 years.

Q. Mr. Marshall, I'd like you to briefly discuss your qualifications.

Could you describe your work experience since college, please?

A. Since college, right after -- right out of college, I worked for a major oil company for four years as an exploration geologist.

talk a little bit more about what role this aquifer plays a little bit later in my talk.

Q. Okay.

Now, could you proceed to describe the major features at the Tyrone Mine facility that are sources of groundwater contamination?

A. Well, first of all -- and I'll just mention this in passing. We've got six tailing impoundments up here in Mangas Wash, on the northwest side of the mine site. And we've got about 74 catchment basins associated with those six tailing impoundments to kind of catch storm water as it flows off.

I'm mentioning those in passing as it's been testified earlier that we've actually reached an agreement with Phelps Dodge on reclamation of these impoundments. So my talk today will actually focus on the mining area, the leached ore stockpiles and the waste rock stockpiles down here in this area.

And for that, I would like to change maps now and divert your attention to another exhibit.

Q. Mr. Marshall, you've put up a couple of maps that are marked as Exhibits 35 and 36.

And those, again, are in the exhibit notebooks that you have in smaller versions.

Beginning with Exhibit Number 35, could you explain how this document was prepared?

A. Exhibit 35 is a -- again, a digital map showing a -- kind of a close-up of the mining area. And what this is is just kind of a digital blowup of the previous map that you just saw, showing the mining area and the tailings area. This is just kind of a blowup of that area.

Again, it shows some of the same features. We've, I think, taken maybe the mining boundary off to -- so the map's not so cluttered.

We've got some kind of dark blue lines on here that show the discharge plan permit areas, some red and orange dots which indicate the approximate locations of some of the contaminated wells and some dashed lines that show faults.

Again, it's just a digital composition created by our staffer in-house. Again, the base map was provided by Phelps Dodge.

Q. Okay.

And what about Exhibit 36, how was this map prepared?

A. Exhibit 36 is, again, a digital base map provided primarily by Phelps Dodge, a lot of the same features. It focuses on the east side of the mine and Oak Grove Wash, which extends off the east side of the mine.

Again, a lot of the same features as the map I just previously described. The dashed lines represent faults, the dark blue lines represent approximate locations for discharge plan boundaries.

And we've got a couple of green lines on there, as well, which show the approximate location of a couple of cross-sections that I'm going to show you later on in my talk.

Q. Okay. Why don't you go ahead and describe the features and the sources of contamination of the mining area.

A. The mining area is covered by eight discharge plans. And those are most -- those are labeled here on this map, all except for DP -- I'm referring to Exhibit 35 here -- DP-896, a pending discharge plan is shown on -- is the only one that's not shown on Exhibit 35, it's shown on Exhibit 36.

These discharge plans cover various leach ore stockpiles, waste rock stockpiles and open pits within the mining district.

A lot of this stuff has been covered by Tom Shelley, I think, previously. He did an excellent job at talking about it. So I'll try to move through this fairly quick.

We've got approximately seven open pits. Actually, if we could show Figure 1, I've got a slide presentation here, too, and if you want to introduce that or -- okay.

This is to kind of help out. You've seen some of these aerial photos from Phelps Dodge, as well, just to kind of give you a better idea, rather than looking at the map.

This Figure 1 on my slide presentation here is a photo of the Tyrone mining area looking west to east. So that pit right in front of, you know, in the foreground of the slide, is the Copper Mountain Pit. And on Figure 35, it's labeled over here, it's located on the west side of the mine, kind of down towards the south.

Q. You meant to say Exhibit 35?

A. Exhibit 35. I'm sorry.

MR. DE SAILLAN: And I should point out again for the record that Mr. Marshall's slides are Exhibit 34, and each slide is indicated as Figures 1 through -- I forget what the last one is, but sequentially.

MR. MARSHALL: In the -- kind of in the background of this photo, you'll -- there's the Main Pit, kind of up in the upper left-hand corner of the slide. That's the Main Pit.

Off to the far right -- upper right-hand corner of the slide, in the background, is the Gettysburg Pit.

Now, in between those is another pit called the Savanna Pit. Okay.

So just to give you an idea, this isn't a mine with a great big open pit in the center of the mine that they pulled all this stuff out of and stockpiled. It's multiple pits. And we're talking -- I've counted lately seven open pits that now exist at the Tyrone Mine, and that doesn't include the backfilled pits.

There are a few backfilled pits, pits that have been filled in with leach ore and turned into leach systems, which are also here. But we've got multiple pits on the site. So it kind of adds to the complexity of the mine site, and something I -- just needs to be kept in mind when I talk later about the containment of the contamination there.

As I explained a little bit earlier, we've got the Main Pit. And I'm referring back to Exhibit 35. It's the biggest one, about 796 acres, about 1,400 feet deep. And it's located kind of in the center of the mine, a little bit off to the northeast.

The Gettysburg Pit is located down here to the south, southeast part of the mine.

This and the Main Pit are two of the pits that you've heard discussion about pumping, the open pits. Those are the -- probably two of the largest -- or the two largest pits in the area.

Although the Savanna Pit -- which on Exhibit 35 doesn't show up real well, because it's actually grown quite a bit in the last couple years. They just recently kind of excavated the thing. So it's gotten quite a bit larger than this map shows. But it sits between the Gettysburg and the Main Pit.

And the Copper Mountain Pit is another large one. Again, it's got some groundwater that flows into the base of it.

We've got some leach ore stockpiles associated with the mine site, obviously. The oldest one -- I believe it's the oldest one. Yeah. It's the oldest one. The very first one that they actually proposed us to leach is the No. 2 Leach Ore Stockpile.

Now, this refers to -- it says "Stockpile," but these are kind of multiple stockpiles. And if you go to Phelps Dodge and kind of look at their mining plan, they actually name a lot of these stockpiles. They have different names for them. But for discharge plan purposes, it's kind of a stockpile complex. It's labeled on Exhibit 35, and it's located on the southwest end of the mine site here.

A couple of other leach systems is the East Main Leach System. It's DP-670. It's also located within the central mine site.

Also, I'd like to point out that No. 2 Leach Ore Stockpile, the big one, on the southwest -- DP-166 is its name -- it also covers -- or is proposed to cover kind of the Main Pit. That's why the boundary extends all the way around the Main Pit and back up.

It also covers the SX/EW plant, which is also labeled on Exhibit 35. The SX/EW plant is located up here on the northwest side of the mine site.

Q. (BY MR. DE SAILLAN) Mr. Marshall, I want to interrupt you here just for a second to clarify something.

A. Um-hum.

Q. You're referring to various discharge permits, discharge plans with numbers when you're describing this map.

Are you referring to operational discharge permits?

A. Yes, I am.

Q. And are those distinct from the discharge permit that is the matter of this hearing?

A. Yes, they are.

Q. And the matter -- the discharge permit that's the matter of this hearing is a permit for closure of the entire mine facility; is that correct?

A. That's correct.

So we've got the -- we've got DP-166, which is No. 2 in the Main Pit.

We've got DP-670, which used to be a pit. It's been backfilled with leach ore and now been turned into a leach system. And it's got some adjacent stockpiles that also feed into that backfilled pit. But that's another leach system that's covered by a separate discharge plan.

Moving up to the north side of the mine site, we've got DP-286. Again, now, this is a fairly large stockpile. The north half is referred to on this map as the 3A Leach Stockpile. That's the stockpile that's being actively leached.

Kind of attached to its south end is the No. 3B Waste Rock Stockpile. Okay. That stockpile kind of sits out towards the pit a little ways. It's not being leached.

Moving down to the west side of this -- of the mine site, the 2A Leach Ore Stockpile, one of their newer leach stockpiles, actually, DP-435, sits perched out here.

Parts of the 2A -- it's actually not shown on this map, but western portions of the 2A, especially kind of up here -- and I'm presently pointing to an area of the stockpile just above the labeled No. 2A on the diagram -- is the 2B Leach -- or Waste Rock Stockpile. It's actually a portion of the stockpile that's not being leached because there's problems there with Deadman Canyon, which I'll talk about in a minute.

Other discharge plans include the DP-455, which is the Gettysburg Pit and Leach System. Again, we have some leaching in the pit, but this pit is primarily open. However, there is some leach facilities off to the southwest of the pit that are included in that discharge plan.

The 1D Waste Rock Pile is located on the northeast side of the mine. You've heard some discussion about this. This one is -- it's not -- yeah. It's a waste rock -- it's a waste rock pile, and the material -- most of the material in this pile is fairly inert. And this is actually what Phelps Dodge is proposing they use as a cover for a lot of their covers at the mine.

So DP-286 is actually part of the DP -- the No. 3 Leach Ore System. It's all DP-286, or will be once we actually renew that permit. They're going to pull that all into one permit.

We've got some fairly -- or some active leach stockpiles here, on the east side of the mine, the No. 1A and the No. 1B. I believe in a previous presentation by Phelps Dodge he just referred to it as the No. 1 Leach System. We kind of break it out here, 1A, 1B. 363 and 383 cover those.

Down here, on the southeast corner, in the -- kind of extending along the southern perimeter of the mine site, is DP-396. That discharge plan covers the 1C Stockpile. This is a waste rock stockpile.

Actually, they proposed to leach it at one time. We denied their request to leach it but required them to get a discharge plan anyway, just to cover the seepage coming off of this waste rock pile, because -- and they're presently permitted to collect about 30,000 gallons a day of acid rock drainage or acidic seepage that actually comes off this pile.

This is -- I'm going to be talking more about this waste rock pile, because this is kind of an experiment in the field. I mean, we've heard talk about what happens to these stockpiles when they just sit out there and get rained on, and this one has been sitting out there and getting rained on for some time.

We've got some seepage coming off of this thing, and I'll talk a little bit more about the groundwater quality associated with this particular stockpile.

But it does have a discharge plan associated with it. That discharge plan is not for leaching. That's just to cover the seepage that comes off of it due to rainfall.

Okay. Out here -- and I'm referring now to Exhibit 36. Out here -- and this is east of the mine, so it's kind of moving east out here.

The No. 1 Leach Ore Stockpile is one of their older leach ore stockpiles. It sits out here all by itself, and it sits across the highway.

Highway 90, by the way, kind of comes down the east side of the mine here and across the highway. Again, Highway 90.

I'm pointing just to the east -- or the highway runs kind of north/south along the east side of the -- along the east side of the mine, but across the highway is the No. 1 Leach Ore Stockpile. It's a pending permit, hasn't been approved yet, DP-896.

They're not leaching the stockpile at this present time. However, they do have seepage collection facilities in place, and seepage is still coming off this pile.

Again, this is kind of -- this is another one of those situations where you have a stockpile out there that's getting rained on, we've got seepage. We've got information on this, and I'll be talking about it.

Just to the southwest -- or southeast of the No. 1 Leach Ore Stockpile is the Burro Mountain Tailings Impoundment. This is a historical tailing impoundment, constructed from an old -- I believe a mine in this area -- I'm not entirely sure, but it was constructed back in the 1920s. It's still out there.

They've done some -- they've put some cover on this at this point and done some regrading, and that's kind of about the gist of it right now. They've got a catchment basin just to the south of this tailing impoundment that catches some water that comes off of that.

Q. Mr. Marshall, let me interrupt here.
A. Um-hum.
Q. A few minutes ago, you mentioned the settlement agreement that has been entered into between the Environment Department and Phelps Dodge --
A. Yes.
Q. -- which covers the Mangas Valley Tailing Impoundments to the northwest of the mine facility.

Is the Burro Mountain Tailing Impoundments covered by that settlement?

A. No, it's not.

Q. Okay.

A. So I've talked mostly about the leach ore stockpiles.

I do want to kind of come back and reemphasize that we do have some waste rock piles here at the mine site that are not currently being leached.

Again, those are the 1D, that's fairly inert material in this area, in this particular stockpile. There is a little acid-generating kind of sulfide material on the far west side of the stockpile, but other than that, it's fairly passive material.

The 2B, which is actually just a western portion of the 2A Leach Ore Stockpile, on DP-435 -- and again I'm pointing to Exhibit 35. That portion of that stockpile is not being leached. There is seepage coming off of that waste rock pile. I call it a waste rock pile. It's just a rock pile that's not being leached. There is seepage coming off of that.

We've got contamination in Deadman Canyon. Actually, when I point to it, I believe it's actually a little bit lower, down here. It's not exactly designated on this map, but let me say it's just a western portion of the 2A Stockpile that's now being leached. We've got some seepage coming off of that in Deadman Canyon, which I'll talk about.

The 1C Stockpile, down here on the southeast portion of the mine -- or -- yeah, southeast portion. And I think there -- and Phelps Dodge will have to elaborate to other piles within the mine site that are not being leached. But there may be a few. I've got maps that show -- that designate waste in some areas. I'm not exactly sure as to what those mean.

Again, I think -- I believe most of the -- I mentioned most of the other facilities that we talked about.

The SX/EW plant is the plant where all the collected pregnant leach solution -- when I say pregnant leach solution, or PLS, that's the solution that's full of copper that they've passed through the stockpiles. They bring it up to the SX/EW plant, they extract the copper out of it, and they take the solution, and they run it back out to the top of the stockpiles and run it back through the circuit again.

That plant is located up here on the northwest side of the mine. And I'm again pointing to Exhibit 35.

Our discharge plans also cover numerous leachate collection ponds.

And I'll tell you what, if we can move to

Figure 2, back up on the Exhibit 34 here. I'd like to direct the Commission's attention to the slides, Figure 2.

This is another aerial photo. I'd just like to point to the direction of this one. This one's of the southeast part of the mine. So you're actually kind of -- from this mine, you're kind of up in the air, kind of down here, on the southeast part of the mine, you're kind of looking out this direction, kind of up to the northeast. Okay. Over the top of the Gettysburg Pit, which is the pit in the center of the slide there.

And the stockpile in the foreground is actually the 1C Waste Rock Pile. Okay. So that's this one here. And down -- and back around the corner here is the 1A and the 1B Stockpiles.

So you can see the way -- this kind of gives you an idea of the way the mine's been developed. There's pits, and around the perimeter of the pits are some of the stockpiles. So that's one reason I want to kind of show this picture, to kind of give you an idea of the way that works.

Again, in the foreground of this particular slide, down in the lower right-hand corner, you'll see a portion of Oak Grove Draw, which has received some attention during this hearing and I'll be talking more about. But it's running off from the -- if flows from the south off to -- kind of off to the right-hand side of the picture there.

MR. SHANDLER: I'm going to interrupt for a second to be consistent with how we've been throughout.

You've been giving a lot of if X, then to tie it in, then Y. I mean, dial it in a little closer to what the ramifications might be. But I think you're giving a lot of good scientific information. I don't mean to be rude, but just to be consistent, let's dial in.

MR. DE SAILLAN: Thank you, Mr. Shandler.

MS. WATCHMAN-MOORE: Commissioner Brandvold --

MR. DE SAILLAN: We'll try to do that.

MS. WATCHMAN-MOORE: Commissioner Brandvold has a question or comment.

MS. BRANDVOLD: Yes, actually a comment about a break.

Can -- is this a good time, as long as you already interrupted, to take a break? Or is there one coming up shortly?

MR. MARSHALL: Actually --

MS. WATCHMAN-MOORE: What time do you have?

MR. DE SAILLAN: Right now would be fine to take a break.

MS. WATCHMAN-MOORE: Is that all right with you?

MR. DE SAILLAN: We can do that.

MS. BRANDVOLD: Thank you.

MS. WATCHMAN-MOORE: Why don't we do that.

Ten minutes, then.

(Proceedings in recess.)

MS. WATCHMAN-MOORE: Mr. de Saillan, I think we're ready to go, get started.

MR. DE SAILLAN: Okay.

Q. Mr. Marshall, if you could proceed with your description of the sources at the Tyrone Mine.

A. Yes. Just one fine -- one final item regarding the facilities that we cover under discharge plans here, and that's all these leach ore and waste rock piles have leachate and storm water collection systems associated with them.

If we can go to Figure 4, I'm going to skip Figure 3 for now to kind of shorten this thing some. I'll come back to it later towards the end of my talk.

Figure 4 just shows an example of this leachate collection system. This one's at the No. 3. I'm pointing to Exhibit 35 here up on the north side.

If you look at this photo, the photo's actually taken, I think, from kind of standing up on the stockpile, which probably isn't safe, but anyway, it's looking down the slope of the stockpile.

And the collection system here, you see in front of you, is leachate running out of the toe of the stockpile and being collected at a collection system.

Just behind this photo, you'll also notice several white posts sticking out of the ground. Those are actually extraction wells to collect leachate that's moving underneath the ground. Okay. And they're pulled up in those wells.

And then all that leachate collected at the surface and at the subsurface reports to that -- and it's not very clear on this photo, and I apologize, but towards the back, you'll see a big lined impoundment, kind of the size of an olympic-size pool or something, back towards the back, and that's where it all reports to.

And from there, they take it to the SX/EW plant and pull the copper out of it.

So just an example of that.

Q. Mr. Marshall, I want to make one point of clarification here.

You just testified a few minutes ago regarding the Burro Mountain Tailings.

Do you recall that?

A. Yes.
Q. And you mentioned that there was a cover on that tailing impoundment?
A. Yes, I did.
Q. Was that put on the impoundment at the request of the Environment Department?
A. Yes, it was.
Q. And do you know why?
A. For air quality issues, I believe.
Q. So it wasn't a water -- it wasn't put there for water quality purposes?
A. No, it wasn't.
Q. Okay.
Now, I'd like to ask you a little about the discharges from the facilities at the Tyrone Mine.
And again, Madam Hearing Officer, these -- this issue goes to the discharges that would be occurring from uncovered and unregraded stockpiles.
And I'd like to ask you about a little bit of background information. I'd like to ask you about a process that's known as acid rock drainage. And I understand that doesn't have anything to do with Jimi Hendrix.
Go ahead, Mr. Marshall.
A. Is that on the transcript?

Okay.

MS. BRANDVOLD: Just a little humor.

MR. MARSHALL: I want to read that later. Yeah.

The stockpiles that we've been referring to, the waste rock piles, or at least most of the waste rock piles, and the leach ore stockpiles on this side, contain sulfide minerals.

These sulfide minerals, when they go through an oxidation, are oxidized to sulfate, and it creates a low pH water, referred to as acid rock drainage. That's a term you hear a lot associated with contamination at mine sites.

This low pH water is formed. This water is primarily what leaches or pulls metals associated with the ore into solution and, therefore, moves downward and, in some cases, contaminates surface and groundwater.

There's also bacteria present. So when you take the sulfide minerals, basically, you add water, generally from precipitation, you add oxygen, and with the help of some local bacteria, you get this acidic leach solution, or this acidic water that forms.

And it's this acidic water that carries metals such as cadmium, manganese, lead, copper. There's a --

there's quite a few of them I'll be talking about. But it carries these contaminants, and this is the -- these are the contaminants -- or this is the solution that actually moves into groundwater.

They also mobilize as nonmetals, as well, fluoride, sulfate, TDS. There's some other contaminants we see show up in groundwater as a result of this process.

This ARD process -- I want to distinguish this for a second, because we're talking about leaching at the Tyrone Mine, the operations at the Tyrone Mine.

You know, Phelps Dodge takes millions of gallons of leach solution which they pour on top of the mine to actually extract this. So this leaching process is what they want to get their copper. Okay.

But when you talk about other stockpiles in the Tyrone area that are not being leached, okay, this leaching solution -- this leaching process is still occurring, probably not at the magnitude when you're dumping millions of gallons of leach solution on top, but when rainfall comes in contact with these sulfide minerals and these waste rock piles, again, you have oxygen, you have bacteria, you have a leach solution that forms.

And this seepage, or acid rock drainage as it's called, moves out of these piles and can move into groundwater and surface water.

Q. So then does that mean that it's true that the acid rock drainage, or ARD, process occurs at both the leached piles and the unleached waste rock piles?

A. That's correct, most of them where sulfide minerals exist. As I pointed out earlier, the 1D Stockpile is the stockpile where a lot of these sulfide minerals don't exist.

Q. Now, Mr. Marshall, I'm going to ask you to slow down just a little bit. I know we want to try to move through this material quickly, and there's a lot of material here, but our court reporter is having a hard time keeping up with you.

A. Sorry about that.

Q. Now, does this acid rock drainage generally contain contaminants for which there are health-based groundwater quality standards?

A. Yes.

Q. And what are some examples of those constituents?

A. Again, we have fluoride, lead, cadmium. Those are some of the health-based standards.

Q. Okay.

Now, how long into the future is this acid rock drainage process expected to continue in the leach ore stockpiles and the waste rock piles at the Tyrone Mine?

A. Well, Phelps Dodge conducted a materials characterization study -- there's actually several reports -- to evaluate the contents of a lot of the piles. And they found that most of the stockpiles contain acid-generating materials, the sulfide materials. Other reports have indicated that this acid generation could continue for 300 years or more.

Q. Okay.

Now, could you give an overall description of the discharges that move into groundwater at the Tyrone Mine?

A. Again -- and I'll go through this as briefly as possible. I've mentioned the stockpiles on the site. The fact that they -- I believe the total -- the total permitted discharge at this point for the leach ore stockpiles at the site is about 98.3 million gallons per day. So it's quite a heavy operation that's going on there now.

This PLS is covered at these various collection -- surface collection impoundments around the mine site at various locations.

Now, there's also seepage that comes out of some of these stockpiles, as well, but the PLS, the stuff that they're going after to get the copper, is actually tried -- or they try to direct it towards various collection points for these various stockpiles, and they each have their own collection sites.

Most of them are -- most of this PLS is collected at the surface. Some of it is collected in the subsurface. I'll give you an example.

The 1B Leach Ore Stockpile, there are no collection ponds at the surface for this. You can stand out on the toe of the pond, and all the leachate being, you know, dispersed to the top of this pile runs underneath the ground.

It is collected in trenches, cutoff trenches. They pump it out of the ground, put it in a stainless steel tank and take it off to the SX/EW plant.

So there's kind of -- there's surface as well as subsurface collection associated with these.

Like I said, the PLS is taken up to the SX/EW plant. They pull the copper out of it. In some cases, they cure it with additional sulfuric acid to get that pH back down. They like it, I think, in the 1.5 to 2 range. Then they send it back out to the leach ore piles.

Q. And, Mr. Marshall, does this -- do these collection systems collect all of the leachate solution that's added to the piles?

A. No, it does -- no, they do not.

And I'll show a little bit of evidence later of some contamination that we've got going on in the regional aquifer where there's -- it's good evidence that a lot of this -- or portions of the leachate here are escaping. And like I said, we'll talk about that a little bit more here in a minute.

Q. Okay.

Did you have anything more to say about the discharges?

A. I believe that's it at this point.

Again -- and I'll talk a little bit more about the history here in a minute, but we've got some unpredictability that results when they're leaching these stockpiles. I mean, preferably we want the leachate to go down into the stockpiles and come out the bottom at designated areas. That doesn't always happen, though.

One example is the 1A Leach Ore Stockpile, here. They've actually got a waterfall that comes out of the back of this leach ore stockpile and cascades down into the Gettysburg Pit. And that wasn't intended, but they're collecting the leachate anyway as part of the Gettysburg system now and working towards approval on that.

But there are some rather misguided events that occur with this leaching process sometimes.

Q. And now, what about discharges from the waste rock piles that haven't been leached?

A. We do have discharges, and as I explained a minute ago, the 1C Stockpile has a discharge plan. They have three different seepage collection systems along the toe of this stockpile. They collect nothing but incident rainwater or waters that are in the stockpile from coming out. It's not being leached at this point.

They also have seepage collection systems along -- about nine of them along Deadman Canyon, where we have acid rock drainage coming out of the side canyons into Deadman Canyon, on the east side of the canyon.

And those systems again are collected in impoundments. That's -- most of that is pumped back up to the 1A -- or the 3A Leach Collection System and returned back to the circuit.

Q. Now, Mr. Marshall, could you talk just a little about background water quality at the Tyrone Mine?

A. The groundwater -- as far as locating groundwater data for premining conditions, I don't -- I haven't been able to find any at this point. The mining in this area goes back quite a ways. But we do have some historical data.

Some of that has come from the Trauger report, which was referred to the other day during Ms. Leavitt's testimony. It's probably one of the most comprehensive documents we have on water quality in the area, as well as all the wells in the area that existed at least back in 1972, when the report was first written.

So out of that report, I'd just like to give you a couple ideas of some groundwater quality that come out of that report.

The old Tyrone Mine site, which was actually -- it's actually up here, right at the head of Mangas Draw. It was one of -- it's a historical -- there's actually still some historical buildings up there.

They had a well back in 1919 with a reported sulfate concentration of 4.2 milligrams per liter and a TDS concentration of 184 milligrams per liter (sic). So that kind of gives you an idea of what existed back then.

Another well is the Oak Grove Ranch Well, located down here, on an old ranch that Phelps Dodge now presently owns. But back then, they had a supply well there. In 1975, they reported a sulfate concentration of 165 milligrams per liter and a TDS concentration of about 394 milligrams per liter.

MR. HUTCHINSON: That date again?

MR. MARSHALL: 1975.

MR. HUTCHINSON: Thank you.

MR. MARSHALL: Now, in 1970 -- and actually, Phelps Dodge actually reported some water quality from 1970 in Deadman Canyon as part of their application for the No. 2 Stockpile, sulfate concentration of 13 milligrams per liter, TDS concentration of 242 milligrams per liter.

So that kind of gives you an idea of the range of the sulfate TDS from a historical standpoint and a few dates back.

We also have some recent upgradient monitoring. As I explained, groundwater moves onto the site from the southwest, kind of moves onto the site in this direction.

So when you see these red dots and orange dots around the mine site, you don't really see a whole lot down in this area, in the southwest corner of the mine, because you're coming down Deadman Canyon, and again, the Big Burro Mountains are off to the southwest, so you're kind of going uphill as you move southwest to the mine here.

Groundwater moves in this direction. So drainages kind of -- kind of angle towards the pit in this direction. So we've got our freshest water here -- and this was mentioned by Mr. Blandford, as well -- the best water quality is along the southwest corner, down here.

We have a regional monitor well, 2-11, located down just outside the toe of the stockpiles here that actually --

Q. (BY MR. DE SAILLAN) Which stockpiles are you referring to, for the record?

A. No. 2 Stockpile, the south -- near the southwest corner of the No. 2 Stockpile, on Exhibit 35.

We have a sulfate concentration here of 67 milligrams per liter and TDS concentration of 380 milligrams per liter.

I don't have an exact date on that, Commissioner Hutchinson. I can get that for you, though.

The -- we have an alluvial aquifer in Deadman Canyon here, too, at this southwest corner of the mine site. TWS-8. It shows a sulfate concentration of 37 milligrams per liter and a TDS concentration of 220 milligrams per liter. So that's somewhat comparable to the historical data.

MS. BRANDVOLD: How deep are those wells? Are those alluvial or regional?

MR. MARSHALL: 2-11 -- I can get that information for you. I think it's less than 100 feet, and it's in bedrock. So that's a regional well, the 2-11 down here. The alluvial aquifer up here is tens of feet at most because it's in the alluvium.

TWS-8 and --

MS. BRANDVOLD: Okay. That's fine.

MR. MARSHALL: Okay.

Q. (BY MR. DE SAILLAN) Now, Mr. Marshall, is there any information that groundwater at the Tyrone Mine has background concentrations of total dissolved solids above 10,000 milligrams per liter?

A. No. We have no information.

Q. Okay.

Now, Mr. Marshall, let's move on to present groundwater conditions.

And again, these questions and Mr. Marshall's testimony here goes to groundwater contamination that has resulted from unregraded and uncovered waste rock piles and leach ore stockpiles.

MR. LEMATTA: Objection. I think that assumes facts not in evidence. I don't know that there's any evidence to establish what a -- I think the evidence establishes that the cause is acid rock drainage. I don't think there's any evidence in the record that the fact that the stockpiles are unregraded or uncovered means that they're -- that there would otherwise not be acid rock drainage.

So I object to the question -- or I object to the statement by counsel.

MS. WATCHMAN-MOORE: Mr. de Saillan.

MR. DE SAILLAN: This is my statement of the Environment Department's position, and this is the evidence that we're about to be putting on. So you're right, my statement is not evidence, but I'm just explaining to the Commission what this line of questioning is going to address.

MR. SHANDLER: I'm going to advise the Hearing Officer to overrule the objection, noting that, you know, a lawyer can't testify, and I think he's just trying to provide a context courtesy that I asked for.

So with those boundaries in mind, I advise you to overrule the objection.

MS. WATCHMAN-MOORE: I agree with that. I'm going to overrule the objection.

Proceed, Mr. de Saillan.

MR. DE SAILLAN: Thank you.

Q. Now, Mr. Marshall, is there currently groundwater contamination at the Tyrone Mine?

A. Yes, there is.

Q. And is that groundwater contamination the result of discharges from the leach ore stockpiles and the waste rock piles?

A. That is correct.

Q. And does that contamination include the exceedance of groundwater quality standards that are health-based?

A. Yes.

Q. Could you give us a description of that contamination, please?

A. I have put Exhibit 33 back up for a moment. This is the big regional map with all the little yellow boxes on it.

For reasons of time, I'm not going to run through all these boxes at this point. I think it's fairly self-explanatory. But each box kind of tops a different discharge plan area and shows the exceedance for various constituents in that area. I'll just run through what some of those constituents are very quickly.

Health-based groundwater standards are

exceeded for cadmium, chromium, lead and fluoride.

Domestic supply standards are exceeded for copper, iron, manganese, sulfate, TDS and zinc.

Irrigation standards are exceeded for aluminum, cobalt and nickel.

And again, there's kind of these yellow boxes summarizing this information at this point.

Yes.

MS. BRANDVOLD: Are the exact numbers available at some point?

MR. MARSHALL: We've got lots of numbers from lots of wells over a long period of time, but we can -- I'm going to go through some examples later in my talk. I'm actually about to start on that right now, Commissioner Brandvold.

Q. (BY MR. DE SAILLAN) Why don't you go ahead and proceed to describe the contamination in a little bit more detail, Mr. Marshall.

A. Okay. What I'm going to do is take you for a quick tour of the mine site and just talk a little bit about the contamination around the mine site, what's been going on, some historical information. And I'm going to throw in a few examples of some wells with some actually -- actual numbers of groundwater in some of the wells there, to give you the extent of the contamination.

What I'd like to do is start in the central mining area. Again, this area is comprised of several leach ore stockpiles, open pits and backfilled pits that are now leach systems.

MR. MOELLENBERG: Madam Hearing Officer, I just want to clear up some confusion that I think may have been created by Counsel's statement.

Counsel said that this testimony was going to go to the point of what the Department views as contamination from unregraded and unleached stockpiles.

There are a lot of areas in this map, particularly in this central mining area, that are associated with pits, leach stockpiles and various things like that.

So based on Counsel's statement, I don't want any of the Commission to be confused that everything that Mr. Marshall is going to be talking about here is as has been represented by counsel.

MR. DE SAILLAN: I -- yeah. I would agree that there are other features in the central part of the mine besides the waste rock piles and the leach ore stockpiles, but the important -- the important things, and what Mr. Marshall's testimony is going to focus on, are the waste rock piles and leach ore stockpiles.

MR. SHANDLER: Mr. Moellenberg, does that satisfy your concern?

MR. MOELLENBERG: I think so. I think counsel has now clarified that Mr. Marshall is going to be talking about a broader range of things.

But again, when he introduced this part of the testimony, he referred to unregraded and unleached stockpiles as being the basis of Mr. Marshall's testimony, and now I think he's clarified that we're talking about much more than contamination that is from sources limited to unregraded and unleached stockpiles.

Just for another point of clarification, I assume that was when counsel was talking about unleached stockpiles, and I think that's what you said.

Am I mistaken?

MR. DE SAILLAN: I was -- I believe what I said, and the record will tell me if I'm wrong, was waste rock piles and leach ore stockpiles, and when I say waste rock piles, I'm referring to the unleached stockpiles. Yes.

MR. MOELLENBERG: Okay.

And by unleached, you're talking about the leaching process that Tyrone undergoes as opposed to the --

MR. DE SAILLAN: Correct.

MR. MOELLENBERG: -- other leaching that you talked about that --

MR. DE SAILLAN: Correct.

MR. MOELLENBERG: Okay.

MR. DE SAILLAN: When I say unleached, I'm referring to Tyrone's leaching process as opposed to leaching that occurs as a result of natural precipitation falling on the piles.

MR. MOELLENBERG: Thank you.

MR. SHANDLER: Madam Hearing Officer, it appears the clarification has been reached, so I advise that the Environment Department can continue.

MS. WATCHMAN-MOORE: Sounds good.

Mr. de Saillan.

MR. DE SAILLAN: Thank you.

MR. MARSHALL: Okay. Like I said, we're starting our tour here in the central part of the mine site. Again, you saw an aerial photo earlier of the stockpiles and the pits in this area.

I'd like to pull up well data for a well referred to as EM-2. That's what they call it. On Figure 35, it's actually represented by a red dot that's just up and to the right of the number DP-670. You can refer to that on your map. That's the well I'm going to talk about now.

It's actually -- if we can go to Figure 5.

Figure 5 actually is just a summary of the background data that I reported to you a while ago. I won't go through that again. You can use that for reference.

We'll go on to Figure 6.

Figure 6 is a table showing contaminant concentrations in this well. This data is from April 28th of this year.

And the first column is a list of the constituents that have been exceeded.

And the second column is the water -- is the WQCC standard for that constituent.

And the third column is the actual concentration at this particular sampling event.

This will be true for all -- you'll see several of these tables. That will be the same format for all the tables when I go through them. So I won't repeat that.

Again, I'm not going to run through all these. I'll just give a couple of examples.

For EM-2, the sulfate concentration, our standard is 600 milligrams per liter, in this well it's 65,500 milligrams per liter.

Fluoride, our standard is 1.6 milligrams per liter, in this well it's 315 milligrams per liter.

Aluminum, our standard is 5, in this well it's 3,660 milligrams per liter.

Cadmium, our standard is .01 milligrams per liter, in this well it's 14.6 milligrams per liter.

So that gives you an idea of a few of them. There are some other numbers on there, and you can review them at your leisure.

MR. LEMATTA: Madam Hearing Officer.

MS. WATCHMAN-MOORE: Mr. Lematta.

MR. LEMATTA: Just a point of clarification.

Is this well, EM-2, shown on any of the maps here?

MR. MARSHALL: Yes. I just explained that. It's on --

MR. LEMATTA: Yes, on this map. Okay. I couldn't find it, so --

MR. MARSHALL: Figure 35.

MR. LEMATTA: Thank you very much. I apologize for the interruption.

MR. MARSHALL: Just up and to the right of 670.

See DM-670 in the middle of the mine there?

MR. LEMATTA: Yes.

MR. MARSHALL: Kind of off to the right a little bit.

MR. LEMATTA: Thank you. I apologize.

MS. WATCHMAN-MOORE: You mean the red dot?

MR. MARSHALL: The red dot. That's the approximate location of it.

MS. WATCHMAN-MOORE: All right.

MR. HUTCHINSON: And as a clarification further, is that -- is that feature right there a pit?

MR. MARSHALL: Just -- it's just south of the pit, actually, my recollection.

That pit's kind of hard to identify because it's been filled in, but this is a groundwater monitor well. It's a designated groundwater monitor well. It is very close to the leaching operations here. So this is probably the worst well you're going to see in my presentation.

But just -- I'm just giving you an idea of the contamination within the open pit capture zone, or what they call the open pit capture zone, in the main area of the mine.

Again -- now, I want to move up to the north side of the diagram. Again I'm pointing to Exhibit 35. We're going to go up to the 3A Leach Ore Stockpile.

You'll see a lot of red dots on the north side of this. And as I -- you know, the red dots -- we didn't identify all the wells that were contaminated. In this area, it would almost be impossible because there's a lot of contamination up here.

Back in the early '90s, after Phelps Dodge started leaching the stockpile, they had a couple monitor wells at the toe of this, and suddenly contamination showed up in the wells in rather fairly high strength, and after that, Phelps Dodge was called in for a corrective action to deal with the contamination in the subsurface.

Now, in this area, we have an alluvial aquifer and a regional aquifer. They're both contaminated along this north side. Both of those aquifers actually merge into the regional aquifer as you move down Mangas Wash. Contamination at this site extends -- I'm not entirely sure -- half a mile or so down the wash.

There's about 500 wells associated with this containment system. And I want to stress that this is a containment system, not an abatement system. This is something that they installed as part of a corrective action to basically stop the contamination from moving any farther.

Okay. Groundwater is still heavily contaminated in this area, both regionally and in the alluvial aquifers.

And like I said, they've got an extensive and very complicated system out here to extract the contamination and pump it back into their collection system to get the copper out, as well as monitor how well the system is performing.

So we've -- we'll go to Figure 7.

Here's Well P-12A. It's actually a replacement for the discovery well, the contamination, as I understand it. I don't directly oversee this discharge plan.

If you'll look at Figure 7, concentrations again are pretty high in this particular well.

Sulfate, our standard, again, is 600 milligrams per liter, in this well it's 20,600 milligrams per liter.

Cadmium, our standard is .01, in this well it's 10.

Manganese, our standard is .2 milligrams per liter, in this well it's 790.

So contamination -- and this is a regional aquifer, by the way -- is fairly heavy in this particular area.

Okay. We're going to move over to the west side.

MR. LEMATTA: Madam Hearing Officer, again for clarification.

MS. WATCHMAN-MOORE: Mr. Lematta.

MR. LEMATTA: Could you identify which dot you're talking about?

MR. MARSHALL: That dot is not specifically -- I couldn't actually point it out on here.

MR. LEMATTA: Okay.

MR. MARSHALL: Okay. It's one of these red dots.

MR. LEMATTA: It's one of the red dots.

MR. MARSHALL: But this whole area actually is --

MR. LEMATTA: Okay.

MR. MARSHALL: -- is contaminated. So it's one of the wells located in this particular area up here. That's close enough. That is our approximate location.

MR. LEMATTA: Thank you, Madam Hearing Officer.

MS. WATCHMAN-MOORE: Commissioner Hutchinson, you had a question?

MR. HUTCHINSON: I was going to ask the same thing.

MR. MARSHALL: Okay. Going down to the west side of the mine now, remember -- I talked about Deadman

Canyon. We've got a 2A Leach Stockpile in portions of the No. 2 Stockpile, and we've got the Copper Mountain Pit along the west side of the mine here, and we've also got the remnants -- and I believe it's remnants of the USNR stockpile.

This is an old stockpile that kind of -- portions of it still remain out here. Actually, Phelps Dodge has removed part of it already. But there's still an old historic stockpile that remains out here, as well.

And portions of these two stockpiles -- and again, I mentioned that the west side of the 2A Stockpile is actually not being leached. It's a -- they call it the 2B Stockpile, and it's just a portion of the stockpile that's not being leached because there's concerns about what would happen -- if you put leachate up there, what would happen down in the canyon.

But we have seepage coming off of this unleached portion of the stockpile, as well as other portions of the stockpiles, down -- about 7 to 9 seepage points.

These seepage points are collected in synthetic liners as best as possible. Obviously, we've got contamination moving in the subsurface, as well.

I think Figure 8 shows you an example of one of these collection points in Deadman Canyon. This is a synthetically lined collection point, designated as DC2-1.

Located, I think, right down here, approximately in this area, where this red dot is -- and again I'm referring to Exhibit 35 -- you'll see the words Copper Mountain Pit. And if you go north of that label, and off to your left a little bit, there's an orange and a red dot in that area, and that's the approximate location of this seepage collection point.

Q. (BY MR. DE SAILLAN) Mr. Marshall, let me interrupt you here.

A. Um-hum.

Q. The USNR stockpile, the historic stockpile that you were referring to, has that ever been leached?

A. It's been leached in the past. I think it's been -- I think about 30 years since it's been leached, maybe more at this point. But it's a historical feature.

Q. Okay. Thank you.

A. So if we go to Figure 9, I'll take you through a well here.

This well is actually in Deadman Canyon, on Figure 35 again. I think it's the northernmost -- probably the northernmost orange dot. It's an alluvial well. It's located somewhat downgradient from their 5E Seep collection system, which is one of the several seep collections systems along here.

This well was actually shown in Mr. Shelley's presentation, as well. You see the graph there. Here it's just -- this data was collected in May of this year.

Sulfate concentration, our standard is 600, in this well it's 828. Not as bad as some of the other wells.

Cadmium, there's a slight exceedance of cadmium in this well. The standard is .01, and this is .0117. Not much, but --

Copper, our standard is 1 milligram per liter, and here it's 42 milligrams per liter.

So again, this is an alluvial aquifer. This contamination is not being contained. There's nothing downgradient of this well at this point.

And we see this with several other alluvial wells along this canyon. There's contamination in the alluvial aquifer. There's no system really to contain this contamination at this point. It's really uncontained.

Okay. Now, I want to move around to the south side, very quickly. Now we're in Oak Grove Draw. Like

I said, Oak Grove Draw kind of runs along the south at least -- the southeast portion of the mine here.

And we've got the 1C Stockpile which is not being leached. It was proposed to be leached at one time, like I said. They've got a discharge plan, and they've got three seepage collection systems associated with that.

One of them is near the southeast corner, one a little bit farther, kind of below the 6 in 396, somewhere in that area, and then the 7C collection system, which is farther to the west along the toe of the 1C as well.

If we can move to Slide Number 10.

This is -- Slide Number 10 shows a photo of the 7C collection system. And this photo, I want to clarify, was taken prior to a catchment system that they've actually installed now to catch the seepage at this particular site.

The stockpile behind the pool of PLS in the foreground of this photo is part of what they designated as the 1C. It's waste rock. It's not being leached. And this is the -- some of the seepage coming off of that.

They collect the seepage now, and they pump it. It eventually gets pumped around to the 1A collection system, over here, and is put back into the system.

As I said, they requested to leach this at one time, so there's obviously sulfide materials in this. It's not being -- it's not being leached, but again, just the incident rainfall has caused contamination of both the alluvial and the regional aquifers in this particular area.

And this is something we will -- we'd like to emphasize, because contamination is not just due to their leaching operations. It's due to water passing through the stockpiles that contain sulfide materials, and groundwater has been impacted.

One reason we denied their permit to leach this facility is groundwater was already contaminated. So we wrote them a letter back and said, "Can't be done, but we're still going to require a discharge plan because there's a discharge occurring."

Again, this is a -- what we're going to do is we're going to go to Figure 11.

This is the alluvial aquifer well designated as 1C-5. Actually, it's not designated on this map, so I want to point that out. I want to apologize. There should be an orange dot here on the southeast corner of Figure 35 where some of these red dots are.

And again, this map is to give an approximate location where some of these contaminated wells are. It's not -- it wasn't really intended to be extremely accurate. Just due to its scale, it's kind of hard to do that. But the well I'm referring to is down here where this cluster of red dots it.

The red dots designate contamination in the regional aquifer. This is actually an alluvial well here.

Again, sulfate, our sulfate standard is 600, in this well it's 7,760 milligrams per liter.

Cadmium, our standard is .01, in this well it's 1.3 milligrams per liter.

I'll slow down.

Copper, our standard is 1 milligram per liter in groundwater, here it's 1,270 milligrams per liter.

So what I would like to point out here is the extent of contamination in the alluvial aquifer, and this is from a stockpile that is not being leached. This is just natural precipitation of water moving through the stockpile and contaminating this well.

Now, I'd like to move to Figure 12.

Figure 12 is in the same area. Actually, it's -- one of these red dots refers to this particular well. This is Monitor Well MB-18D. D stands for deep.

This monitor well monitors the regional aquifer, which is not too far underneath the alluvial aquifer in this area. That's because we're on the -- again, we're on the west side of the Sprouse-Copeland Fault. Okay. So the regional aquifer up here is shallower.

Once we cross the fault, which I'll talk about more in a minute, the regional aquifer gets much deeper, down around 500 feet.

MS. BRANDVOLD: So which one is this one?

MR. MARSHALL: This one is one of these four red dots.

MS. BRANDVOLD: Okay.

MR. MARSHALL: Okay? Is that close enough?

Actually, the northernmost red dot is more than likely that particular -- that particular well. There's a lot of wells in this area. They're monitored both -- they monitor the regional -- regional aquifer.

Again, sulfate, our standard is 600 milligrams per liter, in this well is 2,500 milligrams per liter.

Cadmium, the concentration in this well is .25 milligrams per liter, when the standard is .01.

Manganese, our standard is .2 milligrams per liter, in this well it's 50.8 milligrams per liter.

So we've got contamination of the regional aquifer. Again, this is, again, I want to stress, due to passive precipitation passing through this unleached stockpile.

So that kind of covers the main mining area here. Okay. And as I said before, groundwater flow, okay, is moving from the southwest to the northeast through this area. We've got the groundwater divide, the Continental Divide, that kind of comes through this area.

And contamination in this area -- again, we've got freshwater moving on-site. We've demonstrated the background concentrations there. That's fairly good water -- good quality water.

As it moves underneath these stockpiles, though, that water is getting contaminated. And we've got definite proof from the extensive monitoring that we've got all around the mine site.

I just wanted to point that out, that we've got a lot of freshwater moving on the site and it's getting contaminated.

And what we're asking Phelps Dodge to do, as far as covering all their stockpiles across the entire mine site, is to prevent groundwater contamination.

And that's why we are asking for complete coverage of all the stockpiles in this area, is to keep this freshwater from being contaminated at the site as it moves on, because once it gets underneath here, you know, it's -- you're hard-pressed to find any clean wells within this area of the mine area -- within the central mining area.

You have to go out to the perimeter in some areas, and there are some clean wells, but like I said, most of the clean wells are up here in this area, where freshwater is moving onto the site.

I want to move over to the east side now. This is Figure 36. So we're moving east, we're coming over into the area where Oak Grove Draw extends east away from the site.

We've got two major drainages, one that comes off -- one that comes along the south end of the No. 1 Leach Stockpile, Brick Kiln Gulch, and it merges with Oak Grove Draw. Like I said, Oak Grove Draw is a major drainage that runs south of the mine.

Now, it actually runs underneath the 1C Stockpile. So we've got stockpile material -- I mean, it just disappears. It completely goes underneath the stockpile, it comes out for a little ways, then it goes back in, and then it pops out at the stockpile again over here on the west side -- I mean on the east side of the mine and continues.

So this drainage does fill up with water during storm events, and a lot of that water does move through the stockpile and comes out the other end. So this particular drainage has been the focus of a lot of our activity here since 1996.

In 1996, I, as a representative of the Environment Department, requested them to drill a monitor well to monitor the deep groundwater that exists on this side of the mine. Up until that time, there wasn't really that much -- there was no indication that this deep regional aquifer out here had been impacted by the mine.

So in between, we requested that they install that one to monitor the deep groundwater. That well is about 550 feet deep. Groundwater in that well is about 500 feet deep. Okay.

When they were drilling it, they discovered copper staining at about 20 feet. Okay. And so therefore, they discovered that they had shallow contamination running off-site. And that is designated by this yellow -- this yellow stippled area on that particular figure, Figure 36.

They conducted the groundwater investigation, drilling numerous wells, well over a hundred.

Q. (BY MR. DE SAILLAN) Now, Mr. Marshall, could

I interrupt you there?

A. Sure.

Q. When you say "they," you're referring to Tyrone?

A. Tyrone. I'm sorry.

Q. Thank you.

A. So Tyrone began drilling wells to discover the extent of this contamination. And this is eventually what they discovered, was this plume extending -- actually, it's about 3.5 miles offsite. You've heard previous testimony of 4 to 5. It's not that far.

It does come within a half -- about a half mile of their own production wells down here in Oak Grove Draw, and I'll get into that a little bit more later.

Again, the orange dots on this map show some of the wells and the alluvial aquifer. So this is the alluvial aquifer that's been contaminated here. Okay.

There was extensive contamination found both in Brick Kiln Gulch and Oak Grove Draw and tributaries to Oak Grove Draw which actually go up into the stockpiles, under the 1A and under the 1B. And this is important.

So they've installed not only a remediation system to pump out a lot of this contamination. So this stippled area down here, this kind of area that's marked somewhat different, this -- the extent of the plume, down in the lower right-hand side, right-hand corner of Exhibit 36, that shows the extent of the contamination when they first found it.

Now, they put in several transects, they pumped out a lot of contamination. So the wells in the stippled area are now dry for the most part.

It's -- it would be a misnomer, it would not be accurate to say that they pulled back the contamination, because there's still contamination out there. It's in the vadose zone.

And since this is alluvial aquifer, and it gets recharged by storm events or water -- you know, rain events or water running down this creek when it fills up, that water moves right back down into this aquifer, recharges it, so it remobilizes a lot of these salts and contamination.

But as far as wells that they do have water in, it's in this approximate location here. It extends about a mile, two miles from the site now at this point.

Q. When you say "it," what are you referring to? "It" extends --

A. Oh, the plume. I'm sorry.

In the first -- in the first quarter of '03, like I said, they've installed capture systems to capture this, because this is actually good -- this is good stuff. This is stuff that you can get copper out of.

So they installed actually a trench system across Oak Grove Draw that's about the size -- about the length of a football field, if I recall when I looked at it, a really large system, and they kind of put a wall across there. And they collect the seepage, and they pump it back into the system.

They have trench systems up here for the 1B, as well. And as I mentioned earlier, 1B doesn't -- you really can't find any surface collection of the PLS. It all moves underneath the ground, underneath this trench system. Then it's pumped out, stored in tanks, then pumped back to the PLS system, or the SX/EW plant.

They've got some other trench systems along -- just along the east side of the 1A Leach Stockpile, as well.

In the first quarter of 2003, they pumped an average of 842,630 gallons per day of PLS out of this surface -- this subsurface collection system primarily. So that kind of gives you an idea that it's part of their collection system now.

This is not -- this is -- this system up here is not an abatement system. It just becomes part of the collection system. They just kind of moved it out a little ways.

So we've got -- we've got alluvial contamination, obviously, in this aquifer. It's very -- it's been heavily contaminated. They've -- like I said, they've made some efforts to dry up a lot of this contamination. They still have proof that contamination exists out in this area.

Their most recent seepage report indicates that there's still residual waters out here that are still showing up. They suspect that it may be from the No. 1. But the No. 1 is one source of contamination here. The 1B Leach Ore Stockpile, the 1A, as well as the 1C are all contributing to the contamination in this area.

Are we on Figure 13?

I'm going to show up Figure 13. This shows a quick table of the alluvial aquifer contamination in OG-25. This is, I believe, approximately out here near the confluence of the Brick Kiln Gulch and Oak Grove Draw. It's located about one mile east of the 1A Leach Stockpile.

Again, sulfate, our standard is 600 milligrams per liter, in this well it's 9,360 milligrams per liter.

Cadmium is 1.36 milligrams per liter in this well.

Copper is 220 milligrams per liter, our standard is 1.

Manganese is 235 milligrams per liter in this well, our standard is .2.

So still some pretty heavy contamination out here.

So now, I want to talk about the regional aquifer. And I think this is important out here, because the regional aquifer out here, like I say, is quite deep.

And it gets deep because you cross the Sprouse-Copeland Fault, and you head from west to east, and when you cross the Mangas Fault from north to south, the water level drops off to about 500 feet. So it's down there a ways. It's in the Gila Conglomerate.

And what I'd like to do now is go to Figure 14, and I'll try to be as explicit about this as possible. But this actually shows a cross-section.

This cross-section was provided by Harlan & Associates, which is a consultant of Phelps Dodge. They did an investigation of the 1C Stockpile out here in the contamination. So this cross-section is provided courtesy of them.

On your map, on your Exhibit 36, you'll see a green line that says A at the left end of the line and A-prime at the right end of the line. That's an approximate location of this cross-section. And what this is is kind of a slice through the earth.

Several wells are connected to this. And on Figure 13, the dashed line shows the water table. Okay. And the vertical lines show the different wells, and there's total depths written -- yes.

MS. BRANDVOLD: Just a correction for the record.

This is Figure 13, not --

MR. MARSHALL: Do you have Figure 13?

MS. BRANDVOLD: No. It's Figure 14 that you're --

MR. MARSHALL: Yeah, Figure 14.

Did I say Figure 13?

MS. BRANDVOLD: Yeah.

MR. MARSHALL: Oh, I'm sorry.

MS. BRANDVOLD: Just a correction.

MR. DE SAILLAN: Thank you for clarifying that, Commissioner.

MR. MARSHALL: Thank you.

So Figure 14 here shows a cross-section. It's designated on this map as A-A-prime. And you'll see to the left -- on the left side of this cross-section it shows groundwater tables fairly close to the surface.

And as this cross-section approaches the Sprouse-Copeland Fault -- and on Figure 14, it's indicated by a dashed line, and it's labeled -- you'll see the groundwater drops off. Okay.

So groundwater on the west side of the Sprouse-Copeland Fault ranges from 100 to about 300 feet, maybe even shallower in some cases, depends. But on the west -- on the east side of the fault, it drops off to around 500.

Regional contamination in the past has been mostly identified on the west side of this fault, where the regional aquifer is somewhat shallower.

I want to show you another cross-section real quick just to give you an idea of the Mangas Fault. We'll go to Figure 14.

This cross-section --

Q. (BY MR. DE SAILLAN) You mean 15?

A. I mean 15. Sorry about this. A lot of data to go through, and I'm trying to hurry -- and then not hurry for you.

This cross-section, B-B-prime, is also located in Exhibit 36, and it crosses the Mangas Fault up here. It also again shows a drop in water level as you go from north to south along the -- across the fault, as I said.

And groundwater down here, like I said, in this little wedge -- groundwater in the regional aquifer south of the Mangas Fault and east of the Sprouse-Copeland Fault is about 500 feet.

So when we see this behavior in faults, we generally associate that drop in water level with the fault kind of inhibiting the horizontal flow of water across that fault. Okay. So I want to stress that. It kind of acts as a dam of sorts. Okay.

And so the Sprouse-Copeland Fault adds to that to some degree, and the Mangas Fault also acts that way to some degree.

So again, we've got contaminated -- we've got some contaminated regional wells, that I'm going to get into here in a minute, but I just want to express that it was actually believed, when I first started work on this discharge permit, that was actually containing the contamination from getting into this regional aquifer that's deeper.

And this regional aquifer is important, because this aquifer is the very aquifer that Tyrone had some of their own production wells in and pumped really good groundwater out of. It's good quality. And like I said, those production wells are down here. So we view this area as a valuable source of groundwater.

While I'm on the subject of damming, as well, like I said -- and I want to move back over to Exhibit 35 for a second.

The West Main Fault also exhibits this characteristic, okay, with water levels being higher on one side and lower on the other. The Mangas Fault and actually the Burro Chief Fault, as well, exhibits some of this behavior.

We know this because when they were putting in this extensive pump-back system up here on the north side of the No. 3, drilling all the wells to get the contamination, they found that when they drilled on the opposite side of some of the faults running through the area and pumped one well, they couldn't get any reaction in the other. So there was no communication between the wells.

So again, we see this damming effect. Okay. And this is a -- this is an effect that really anyone that's trying to induce a capture zone needs to take into account when you're trying -- because inducing a capture zone across these faults, you have the same problem. You have this damming effect.

So getting this capture zone across these faults that act as dams or act as blockages to horizontal flow can be a difficult problem.

And I'm just presenting data here today to show that we see this in the field. It's not a result of modelling. We see this in the field. And it's a result of a lot of the wells that we have in place.

Also, I'd like to point out another thing about these faults while we're talking about them.

A geophysical study was actually conducted by Phelps Dodge consultants about the Mangas Fault, out here, because when they were, you know, discovering all this contamination and measuring it and figuring out where it was pooling in the alluvial aquifer, they found a phenomenon out here where it was kind of lining up in this deep kind of -- this area where it seemed to -- the pooling effect seemed to line up with the fault.

So they conducted a geophysical study out here to see if they could detect any evidence of the contamination moving down the fault. And the conclusion of that study was, in fact, they did see some highly conductive liquids actually moving down the fault.

So this is one piece of evidence that these faults, although they act as horizontal barriers -- or barriers to horizontal flow, they can act as vertical conduits to fluids. Okay.

The same thing was discovered by a consultant that did a consult -- did a study of the Sprouse-Copeland Fault down here, as well. And he actually described the fault as a subsurface drain.

He actually drilled some core holes in the fault and again saw this behavior of fluids moving up and down the fault zone. Okay. Or at least that's how he described it in his conclusions, this subsurface drain effect.

So while his faults inhibit this way, they kind of -- they may conduct it, and we see some evidence provided by Phelps Dodge that this -- these may be vertical conduits. And that's a concern when you see a fault such as the Mangas running directly beneath the 1C Leach Ore Stockpile. Okay.

But I want to explain a little bit more about some contamination that we've got in the regional aquifer. Okay.

If we can go to Figure 16.

I'm going to show you three graphs -- this is getting towards the end of the contamination talk anyway -- but three graphs here that are very similar.

The first graph, Figure 16, shows the TDS and sulfate concentrations for MB-27. Now, actually, this well was designated on a previous exhibit. You saw Mr. Blandford's exhibit, and I believe he had this particular well on there, too, designated as contaminated.

I want to give you a little bit more information about the contamination here.

The graph that you're looking at here is groundwater monitoring since we required the well to be drilled back in 1996 up through the present. These are TDS and sulfate concentrations. Okay.

And what we have seen is a steady increase. The TDS was actually exceeded shortly after the -- our standard for TDS was exceeded shortly after they drilled the well in '96, and sulfate contamination -- or the sulfate standard was exceeded shortly thereafter.

And as you can tell from the graphs, these -- the concentrations for these two contaminants has been steadily increasing over the last six years.

Now, we find this very alarming because this is occurring at 500 feet below ground surface. This stuff is -- when you see -- we see contamination this deep, it's harder to get to. When you're trying to contain contamination in the alluvial aquifer, that's one thing. When you're trying to contain contamination in the regional aquifer, it's something else. Okay.

And so actually this is very alarming. This is what I view when I look at this data as the tip of the iceberg. Okay. We see an acidic front that is showing up in this well.

Another alarming thing about this is we've got some other regional wells nearby where we don't see it. So remember all that faulting I showed you in the geologic map? Okay? Well, that faulting doesn't stop when we cross here. It's just covered over. So we don't know what's going on here hydrologically in the paths of contamination. Okay.

So I want to kind of enlighten you a little bit about the fact that we've got a high degree of uncertainty as to where this contamination is directly coming from.

However, evidence presented by Phelps Dodge about the Sprouse-Copeland Fault, that could be a conduit. It sits right along the edge, okay, of this stockpile. And the contamination from the alluvial aquifer could be moving down the fault and into the regional aquifer.

We don't know. Maybe it's moving directly into the regional aquifer from the alluvial aquifer, just down through the Gila Conglomerate. But this well is in the regional aquifer, and it's uncontained contamination.

Now, I want to explain that a little bit, because I think you heard in previous testimony that the -- all the contamination out here, okay, was basically contained by these faults. Okay. In other words, it was on the right side of the fault.

This well is not on the right side of the fault. And I just want to specifically point that out, because I think there was an impression that maybe this fault -- this well was on the west side of the Sprouse-Copeland Fault, and it is not.

Q. Excuse me, Mr. Marshall.

You said the right side of the fault?

A. Yes.

Q. What did you mean by that?

A. Oh, I'm sorry. On the east side of the fault is where this well is located. We know that because the well penetrated 500 feet of Gila Conglomerate. The water level is at 500 feet. Okay. We see those same characteristics for regional wells down here, located on the southeast corner of the mine, where we have wells on both sides of the fault.

Now, if you've got a well on the east side of the fault, you tend to see higher groundwater levels. Okay. And you also -- and some of this was -- actually hit the bedrock. Okay. That was never tagged in this particular well. So this well, and the contamination that I've shown up here, is uncontained. Okay. And not only that, it is getting worse, and steadily worse.

I'd like to point out, while we're on this graph, that -- you see that very last point, it goes down. Okay. This is a suspicious data point. We think that may be a lab error because the TDS continues to go up. Nevertheless, I needed to put it up there because that's the data they presented to us, and that's the data that's actually applied.

Now, I want to show you a couple of other wells, too.

If we can go on and move to MB -- Figure 17, which shows MB-36.

That well -- and I'm pointing again to Exhibit 36 -- is up here, east of the 1B Leach Ore Stockpile. It's pretty close to their leach collection system, actually. When you stand at this well, I mean, the stockpile is right in front of you. It's pretty close.

We required this well actually to kind of get in closer to the stockpiles to see what's happening in the regional aquifer.

Again, this one penetrated nothing but Gila Conglomerate, okay, didn't hit the bedrock at depth. The depth to water here is about 450 feet, I believe. So it's fairly deep.

And again, this is in the area where the Gila Conglomerate is thickening. Okay. It thickens from south to north as it approaches the Mangas Fault. So we kind of lose definition as to where the Sprouse-Copeland Fault is. We know it's down here on the southeast corner because we have wells on both sides, so it's well defined. Okay. That's why they drew it in there.

Okay. We come up here to MB-27, and we know that well goes through 500 feet of Gila Conglomerate, and the water is deep, so we know we're in the regional aquifer there.

Up here, though, we kind of lose definition as to the fault because wells all across -- wells in this particular area, just west of the No. 1B stockpile, you know, the difference in water level is about 30 feet. So we kind of lose definition.

And I want to point that out because, again, this is another well that is becoming contaminated. If you'll look at Figure 17, we've got increasing TDS and sulfate.

And this is -- this is alarming for a hydrologist to look at. Again, TDS and sulfate standards have been exceeded for this well and continue to rise. There's some slight perturbation, but the trend is generally upwards.

Again, we're not so -- we don't know about the confinement of the contamination in this regional aquifer. Actually, previous water table maps provided by Phelps Dodge actually show groundwater in this area as moving in an easterly direction. Okay.

So we believe that the groundwater in this well is actually moving in an easterly direction. Therefore, it's not captured, it's unrestricted. Okay.

The problem with this area is we don't have a lot of wells. Okay. We really don't know what's going on in this area. You've seen previous exhibits that show a pit capture zone, a barrier, a green line that runs through this area. It actually runs right through MB-36.

We don't have enough information to know exactly where the capture zone is out there because we don't have any wells. And actually, that's something we're actually evaluating now as part of our discharge permit renewals. We need more well data in that area.

I just want to point out we've got contamination in this area, it's deep, it's increasing, and, from all appearances, it seems to be totally uncontained at this point, and it's moving off-site.

The last well I want to refer you to -- let's see.

Let's go to Figure 18.

This is MB-29. MB-29 -- I'm pointing again to Exhibit 36. It's the red dot with the B-prime right below it. It's part of the cross-section. It's actually part of your B-B-prime cross-section.

I believe Mr. Blandford mentioned this well as kind of just exceeding TDS standards. Our standard's a thousand, it's about 1,050. Okay. And that's -- I guess that's about true enough. It just did exceed standards.

But again, I want to show you this graph because this gives you the other dimension, the time dimension. When this well was first drilled, it did not exceed standards. And the contamination is steadily increasing. TDS and sulfate are moving steadily upwards.

Now, this well is way out here, away from the fault zone. So we don't know how it's getting contaminated. There could be a buried fault. There could be contamination moving directly downwards. All we know is it's being contaminated and it's quite a ways out here. So again, we've got three wells here that show increasing contamination.

MS. BRANDVOLD: And this is how deep?

MR. MARSHALL: This well is about 400 to 500 feet. Same depth.

MS. BRANDVOLD: And water depth is --

MR. MARSHALL: The water depth is about there. I think the wells may be 500 to 550, and the water depth is 500, 450, somewhere in that area. And that's the depth to the well.

And there is documentation in the record that shows the -- kind of gives -- there are water table maps, and you've seen some of them in earlier testimony, that show the flow. But the regional groundwater flow in this area is generally to the southeast.

Now, I want to talk a little bit more briefly about the TDS and sulfate, these two constituents, because we haven't shown you any metals here. Okay.

So what I'd like to do is skip back up to Figure 3 now, which we skipped earlier, and show you a little phenomenon, because what we believe -- what we know is that TDS and sulfate, especially with contaminants that are associated with the leaching at mine sites such as this -- TDS and sulfate are just two of the contaminants in ARD and in the leach solutions that contaminate this area. Okay.

And when we see TDS and sulfate that are increasing, but we don't see the other metals yet, okay, we -- we see those as precursors to other things that come, basically, other metals coming down the line.

And one reason for that is this stuff is passing through 500 feet of vadose zone before it gets to these wells. So a buffering capacity within the vadose zone may cause some of the metals to fall out, but a lot of times there's a lag time between TDS and sulfate increases and the metals that come later. Okay.

And we've seen this up on the north side of the mine.

So I'm showing you a graph here of a monitor well, C8-7. This is a region -- this is a -- I don't know if this is a regional or a -- well, in this area, there's regional and there's alluvial aquifers, but this is a monitor well on the north side of the No. 3 up there.

This well is actually still being monitored for field parameters, but they quit monitoring all the metals and the chemical analysis back in '96, or close to '97. So that's why the bottom of the graph just spans '91 to 96, but it shows the phenomenon that I'm talking about.

And if you'll look at the January time, January, '91, the pink and the black lines represent TDS and sulfate. Actually, that's a navy blue line, I think.

And you'll see that they start increasing. Following all the dots that run right along the X axis, those are the metals. Okay. We don't see really any increases in metal until about 1993. So we see increases in TDS and sulfate in '91, and then two years later here come the metals.

And then, obviously, in '94, we see a big break-through in the contaminants. They increased after that. They've gone down and since increased again.

But the reason for showing this graph is to kind of show you this phenomenon, okay, that we see with TDS and sulfate increasing first because that's -- we're seeing increasing TDS and sulfate out here. Okay.

And like I said, we expect worse things to come. We expect other contaminants to show up in these wells along there. And actually, in MB-27, we -- in the last three sampling events alone, they've exceeded iron and fluoride on a couple of occasions. So we're keeping an eye on these wells.

I just want to point out that we do have uncontained contamination here, okay, on the west side of the mine site. It's in the regional aquifer.

Going back again to the main mine site, we've got uncontained contamination on the alluvial aquifer out here. We only have one regional well in this canyon. So we actually -- I think we have some more monitoring to do out here as far as the regional aquifer in this area because it's only 40 to 50 feet below the alluvial aquifer. So it's relatively shallow. We have some concern down here. But at this point, the alluvial aquifer has contamination, it's not contained.

Up here, as far as we can tell at this point, we need some more wells, but we -- you know, we think that, at least within the first half mile, it looks like, they stopped it at this point.

So I just want to point out, again, that we've got contamination around the site, it's moved off-site, we've got lots of sources of contamination here, and it's from leached as well as unleached stockpiles in and around the mine site.

Q. (BY MR. DE SAILLAN) Now, Mr. Marshall, were you here for Mr. Blandford's testimony when he described the open pit capture zone, as it's been referred to?

A. Yes.

Q. Now, in your opinion, will pumping of this capture zone successfully contain all of the groundwater contamination that flows into it?

A. No. I do not believe that.

Q. Why not?

A. Because we have areas of the mine site where, again, we have faults that tend to act as barriers, and propagating a -- propagating a pit capture zone across these faults, again, presents a high degree of uncertainty as to the capturability of this -- of this zone that they're proposing on doing.

In addition to that, as I pointed out earlier, we have this alluvial aquifer that has fingers that reach up into the mine site, okay, underneath the stockpiles.

And this alluvial aquifer acts as a conduit of sorts to transfer contamination off-site, above the regional aquifer, and then subsequently has the potential to put it down into the regional aquifer outside the pit capture zone.

So there's a very complex area here, with a lot of things dynamically going on at one time that can get contamination outside the pit capture zone.

Q. And just to make things clear, there was some testimony, and, I guess, a little bit of controversy, over whether the alluvium qualifies as groundwater.

Does this phenomenon that you're talking about of contamination getting transported from -- on the mine site to off the mine site outside the pit capture zone and into the regional groundwater -- does that depend on whether the alluvial is an aquifer or not, or whether it's ground -- whether it's considered groundwater or not?

A. Whether it's considered groundwater?

Again, the alluvium -- the alluvial aquifer -- we refer to it as an aquifer because it contains water most of the time, but in addition to that, it also acts as a conduit, as a contaminant pathway of sorts, to transfer contamination off-site, and in the regional aquifer.

And whether you want to call it an aquifer or not call it an aquifer, it still has the ability to transfer that contamination off-site.

So that's a good point to make.

Q. Now, Mr. Marshall, some Tyrone witnesses have testified that -- actually, I don't know if any Tyrone witnesses have testified, but Tyrone in some of its papers has argued that the contamination at the Tyrone Mine is confined to its property and, therefore, there's an exemption that exempts this contamination because the groundwater doesn't mix with other waters.

Does the groundwater at the Tyrone Mine mix with other waters?

A. Absolutely. And as I explained earlier, groundwater flow comes off the Big Burro Mountains and onto the site. We've given you some water quality data on that. That groundwater moves onto the mine site, and it gets contaminated. So there's one mixing there.

And as I just got through demonstrating, we've got perfectly good regional aquifer out here that is now showing contamination. We've got contamination on this side of the mine site. Again, this is -- there's nothing wrong with this water, but it's being contaminated.

So there's water -- there's contaminants mixing with perfectly good water and becoming contaminated.

Q. Okay, Mr. Marshall. I'd now like to move on to another topic in your testimony and ask you about the use of groundwater in the vicinity of the Tyrone Mine.

MR. LEMATTA: Madam Hearing Officer.

MS. WATCHMAN-MOORE: Mr. Lematta.

MR. LEMATTA: I move to strike the previous testimony of this witness on the grounds that the counsel represented to the Commission that this testimony would demonstrate that the cause of the contamination was the fact that the stockpiles and waste rock piles were unregraded and uncovered, and this witness has offered no testimony on that subject.

What he offered was a great deal of background testimony about current water conditions but no evidence